AD-03 Block Seismic Survey

MYANMAR

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

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CONTENTS

0. EXECUTIVE SUMMARY 11
0.1. INTRODUCTION 11
0.1.1. Outline Project Description 11
0.1.2. Project Schedule 11
0.2. PROJECT DESCRIPTION 12
0.2.1. Seismic Survey 12
0.2.2. Logistics 13
0.2.3. Inventory of waste, discharge and emissions 14
0.2.4. Impact Producing Factors 14
0.3. DESCRIPTION OF THE ENVIRONMENT 15
0.3.1. Physical Environment 15
0.3.2. Biological Environment 15
0.3.3. Socio-economic Environment 16
0.3.4. Summary of Sensitivities 16
0.4. ENVIRONMENTAL AND SOCIAL IMPACTS 17
0.4.1. Recommended Mitigation Measures 20
0.5. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 26
1. INTRODUCTION 27
1.1. CONTEXT 27
1.2. PROJECT LOCATION 27
1.3. OBJECTIVES OF THE IEE 28
1.4. IEE METHODOLOGY 28
2. PROJECT DESCRIPTION 29
2.1. LOCATION OF SEISMIC SURVEY 29
2.2. SURVEY SCHEDULE 30
2.3. SEISMIC DATA ACQUISITION TECHNIQUE 30
2.3.1. General Description of Marine Seismic Surveys 30
2.3.2. Description of 3D Seismic Surveys 31
2.4. SEISMIC ACQUISITION EQUIPMENT 32
2.4.1. Survey and Support Vessels 32
2.4.2. Seismic Source for 3D survey 34
2.4.2.1. PRINCIPLES OF UNDERWATER ACOUSTICS 36
2.4.2.2. ACOUSTICS OF THE SEISMIC SOURCE 38
2.4.2.3. ACOUSTICS ATTENUATION IN WATER AND SOUND SPREADING 39
2.4.3. Streamers 40
2.4.3.1. VESSEL STEERING AND POSITIONING 41
2.4.3.2. ANCILLARY EQUIPMENT AND ONSHORE SUPPORT 42
2.4.3.3. POSITIONING SYSTEMS 43
2.4.3.4. ADDITIONAL EQUIPMENT 43
2.5. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK 43
2.5.1. Environmental Institutions and Strategies 43
2.5.2. Myanmar Environmental Legislation Relevant to the Project 44
2.5.3. Environmental and Social Impact Assessment Legislation 49
2.5.4. International Agreements and Conventions 49
2.5.5. International Guidelines and Standards Relevant to the Project 50
2.6. EMISSIONS, DISCHARGE AND WASTE INVENTORY 53
2.6.1. Acoustic Emissions 53
2.6.2. Atmospheric Emissions 53
2.6.3. Water Discharges 54

2.6.3.1. DOMESTIC AND SANITARY WASTEWATER 55
2.6.3.2. DECK AND BILGE WATER 55
2.6.4. Hazardous and non-hazardous waste 55
2.7. IMPACT PRODUCING FACTORS 56
2.8. GEOGRAPHICAL SCOPE OF THE IEE 56
3. PROJECT PROPONENT DETAILS 58
4. INFORMATION ON EXPERTS 59
5. DESCRIPTION OF THE ENVIRONMENT 60
5.1. INTRODUCTION 60
5.2. PHYSICAL ENVIRONMENT 60
5.2.1. Geology and Geomorphology 62
5.2.2. Meteorological Conditions 66
5.2.2.1. TEMPERATURE 68
5.2.2.2. RAINFALL 69
5.2.2.3. HUMIDITY 69
5.2.2.4. WIND 70
5.2.2.5. VULNERABILITY TO NATURAL HAZARDS 70
5.2.3. Regional Oceanography 71
5.2.3.1. BATHYMETRY 71
5.2.3.2. TIDES 72
5.2.3.3. WAVES 72
5.2.3.4. STORM SURGE 73
5.2.3.5. CURRENTS AND CIRCULATION PATTERNS 74
5.2.3.6. WINDS 74
5.2.4. Sediment 78
5.2.5. Seawater Quality 79
5.2.5.1. TEMPERATURE AND SALINITY 79
5.2.5.2. CHLOROPHYLL-A 80
5.2.5.3. NUTRIENTS 82
5.3. BIOLOGICAL ENVIRONMENT 83
5.3.1. Offshore Environment 83
5.3.1.1. OFFSHORE FAUNA 84
5.3.2. Coastal Environment 98
5.3.2.1. COASTAL FLORA 98
5.3.2.2. COSTAL FAUNA 101
5.3.3. Protected Areas 102
5.3.3.1. MEINMAHLA KYUN ISLAND 103
5.3.3.2. THAMIHLA KYUN WILDLIFE SANCTUARY 104
5.4. SOCIO-ECONOMIC ENVIRONMENT 106
5.4.1. Administrative Organization 106
5.4.2. Governance 107
5.4.3. Population and Demography 109
5.4.3.1. DEMOGRAPHY 109
5.4.3.2. ETHNICITY AND RELIGION 110
5.4.3.3. DISPLACED PERSONS 111
5.4.4. Human Development and Access to Basic Services 112
5.4.4.1. EDUCATION 112
5.4.4.2. WATER AND SANITATION 112
5.4.4.3. ENERGY 113
5.4.5. Marine Socio-economic Environment 113
5.4.5.1. OFFSHORE OIL AND GAS OPERATIONS 113
5.4.5.2. FISHERY SECTOR 115
5.4.5.3. INTERACTIONS BETWEEN THE FISHERY SECTOR AND THE PROJECT 122
5.4.5.4. PORT INFRASTRUCTURE AND MARINE TRAFFIC 123
5.4.6. Stakeholder Identification 127
5.4.6.1. PUBLIC AUTHORITIES 127
5.4.6.2. BUSINESS ASSOCIATIONS 128
5.4.6.3. OIL AND GAS COMPANIES 129
5.4.6.4. INTERNATIONAL ORGANIZATIONS 129
5.4.6.5. INTER-GOVERNMENTAL ORGANIZATIONS 129
5.4.6.6. INTERNATIONAL NON-GOVERNMENTAL ORGANIZATIONS (INGOS) 130
5.4.6.7. NATIONAL NON-GOVERNMENTAL ORGANIZATIONS (NGOS) 131
5.4.6.8. MEDIA 131

5.5. SYNTHESIS OF ENVIRONMENTAL SENSITIVITY 132

6. IMPACTS AND MITIGATION MEASURES 135

6.1. ENVIRONMENTAL/SOCIAL RISK ASSESSMENT METHODOLOGY 135

6.2. IDENTIFICATION OF RISKS AND IMPACTS 138

6.2.1. Environmental/Social Aspects 138

6.2.2. Environmental/Social Impacts 139

7. ASSESSMENT OF IMPACTS AND RISKS 140

7.1. DISTURBANCE TO MARINE FAUNA 140

7.1.1. Discharge of Underwater Seismic Pulses 140

7.1.1.1. BACKGROUND 140
7.1.1.2. PATHOLOGICAL EFFECTS 141
7.1.1.3. DISTURBANCE TO BENTHIC INVERTEBRATES 141
7.1.1.4. DISTURBANCE TO PLANKTONIC ORGANISMS 143
7.1.1.5. DISTURBANCE TO FISH 144
7.1.1.6. DISTURBANCE TO WHALE SHARKS 146
7.1.1.7. DISTURBANCE TO MARINE TURTLES 146
7.1.1.8. DISTURBANCE TO CETACEANS 147
7.1.1.9. TOOTHED WHALES 149
7.1.1.10. OVERLAP WITH CRITICAL MARINE FAUNA HABITAT AND PEAK PERIODS OF ACTIVITY 150
7.1.1.11. MITIGATION AND MANAGEMENT MEASURES 150
7.1.1.12. RESIDUAL RISK LEVEL 152

7.1.2. Light Generation 152

7.1.2.1. POTENTIAL IMPACTS 152
7.1.2.2. MITIGATION AND MANAGEMENT MEASURES 153
7.1.2.3. RESIDUAL RISK LEVEL 153

7.1.3. Vessel and Towed Equipment Interactions with Marine Fauna 153

7.1.3.1. POTENTIAL IMPACTS 153
7.1.3.2. MITIGATION AND MANAGEMENT MEASURES 154
7.1.3.3. RESIDUAL RISK LEVEL 155

7.2. DISTURBANCE TO BENTHIC HABITATS 155

7.2.1. Vessel Anchoring 155

7.2.2. Loss of Towed Equipment 156

7.2.2.1. POTENTIAL IMPACTS 156
7.2.2.2. MANAGEMENT AND MITIGATION MEASURES 156
7.2.2.3. RESIDUAL RISK LEVEL 156

7.3. REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS 156

7.3.1.1. POTENTIAL IMPACTS 156
7.3.1.2. MITIGATION AND MANAGEMENT MEASURES 157
7.3.1.3. RESIDUAL RISK LEVEL 157

7.4. INTRODUCTION OF INVASIVE MARINE SPECIES 157

7.4.1. Ballast Water 158

7.4.1.1. POTENTIAL IMPACTS 158
7.4.1.2. MITIGATION AND MANAGEMENT MEASURES 158
7.4.1.3. RESIDUAL RISK LEVEL 158

7.4.2. Biofouling 158

7.4.2.1. POTENTIAL IMPACTS 158
7.4.2.2. MITIGATION AND MANAGEMENT MEASURES 158
7.4.2.3. RESIDUAL RISK LEVEL 159

7.5. MARINE POLLUTION FROM ROUTINE DISCHARGES 159

7.5.1. Sewage, Grey Water and Putrescible Wastes 159

7.5.1.1. POTENTIAL IMPACTS 159
7.5.1.2. MITIGATION AND MANAGEMENT MEASURES 159
7.5.1.3. RESIDUAL RISK LEVEL 160

7.5.2. Bilge Water 160

7.5.2.1. POTENTIAL IMPACTS 160
7.5.2.2. MITIGATION AND MANAGEMENT MEASURES 160
7.5.2.3. RESIDUAL RISK LEVEL 160

7.5.3. Other Wastes 160

7.5.3.1. POTENTIAL IMPACTS 160
7.5.3.2. MITIGATION AND MANAGEMENT MEASURES 160
7.5.3.3. RESIDUAL RISK LEVEL 161

7.6. MARINE POLLUTION FROM ACCIDENTAL DISCHARGES 161

7.6.1. Hazardous Materials 161

7.6.1.1. POTENTIAL IMPACTS 161
7.6.1.2. MITIGATION AND MANAGEMENT MEASURES 162
7.6.1.3. RESIDUAL RISK LEVEL 162
7.6.2. Fuel and Oil Spills 162
7.6.2.1. POTENTIAL IMPACTS 162
7.6.2.2. ASSESSMENT OF LIKELIHOOD 162
7.6.2.3. ASSESSMENT OF CONSEQUENCE 164
7.6.2.4. MARINE FAUNA 164
7.6.2.5. SOCIO-ECONOMIC ENVIRONMENT 165
7.6.2.6. MITIGATION AND MANAGEMENT MEASURES 165
7.6.2.7. RESIDUAL RISK LEVEL 165
7.6.3. Vessel Collisions 166
7.6.3.1. MITIGATION AND MANAGEMENT MEASURES 166
7.6.3.2. RESIDUAL RISK LEVEL 166
7.7. DISTURBANCE TO ECONOMIC ACTIVITIES 166
7.7.1. Fisheries 166
7.7.1.1. POTENTIAL IMPACTS 166
7.7.1.2. MITIGATION AND MANAGEMENT MEASURES 167
7.7.1.3. RESIDUAL RISK LEVEL 167
7.7.2. Shipping 167
7.7.2.1. POTENTIAL IMPACTS 167
7.7.2.2. MITIGATION AND MANAGEMENT MEASURES 168
7.7.2.3. RESIDUAL RISK LEVEL 168
7.8. SUMMARY OF ENVIRONMENTAL/SOCIAL RISK ASSESSMENT RESULTS 168
8. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 171
8.1. INTRODUCTION 171
8.2. PURPOSE AND OBJECTIVES 171
8.3. CONTENT OF THE ESMP 171
8.4. PERFORMANCE COMMITMENTS, MANAGEMENT ACTIONS AND KEY CONTROLS 172
8.5. STANDARDS 172
8.6. ROLES AND RESPONSIBILITIES 176
8.6.1. Ophir's Role 176
8.6.2. Dolphin Geophysical's Role 176
8.6.3. Project HSE Plan 176
8.6.4. Key Roles / Responsibilities 186
8.6.4.1. SHORE-BASED PERSONNEL 186
8.6.4.2. VESSEL-BASED PERSONNEL 187
8.7. TRAINING AND COMPETENCIES 189
8.7.1. Environmental/Social Inductions 189
8.7.2. Marine Mammal Observers 189
8.8. MONITORING, RECORD KEEPING AND REPORTING 190
8.8.1. Monitoring and Record Keeping 190
8.8.2. Reporting 190
8.8.2.1. INCIDENT REPORTING 190
8.8.2.2. MONTHLY REPORTS 191
8.8.2.3. MMO FINAL REPORT 191
8.8.2.4. END OF SURVEY REPORT 192
9. PUBLIC CONSULTATION & INFORMATION DISCLOSURE 198
10. CONCLUSION 202
11. SOURCES & REFERENCES 205
11.1. ENVIRONMENTAL SOURCES & REFERENCES 205
11.2. SOCIO-ECONOMIC SOURCES & REFERENCES 212
11.2.1. Socio-economic articles 212
11.2.2. Reports 212
11.2.3. Conventions 214

ANNEXES

ANNEX 1 **Specifications of the Vessels** 215

ANNEX 2 **Curriculum Vitae of the Experts** 227

ANNEX 3 **Public Consultation Documents** 262

ANNEX 4 **Marine traffic maps, AIS Data, other maps** 285

ANNEX 5 **Cyclone Contingency Plan** 302

ANNEX 6 **Information Sheet for Fishermen** 315

TABLES

Table 0-1: Summary of environmental and social sensitivities 16
Table 0-2: Summary of environmental/social risk assessment for the 3D seismic survey in the AD-03 Block, offshore Myanmar 18
Table 2-1: Boundary coordinates of the AD-03 Block 29
Table 2-2: Characteristics of the AD-03 Block 3D seismic survey 31
Table 2-3: Generic characteristics of survey and support vessels for the 3D seismic survey 33
Table 2-4: Characteristics of the seismic sources 35
Table 2-5: Characteristics of source signature intensity 38
Table 2-6: Characteristics of the streamers 41
Table 2-7: Myanmar environmental and socio-economic legislation applicable to the Project 45
Table 2-8: International agreements and conventions relevant to the Project 49
Table 2-9: International guidelines and standards relevant to the Project 50
Table 2-10: Hypotheses considered for the AD-03 Project for calculation of the atmospheric emissions 54
Table 2-11: Calculation of atmospheric emissions 54
Table 2-12: Summary of domestic and sanitary wastewater 55
Table 2-13: Summary of deck and bilge water estimations 55
Table 2-14: Estimated wastes and emissions from the 3D seismic survey 56
Table 2-15: Geographical scope 57
Table 4-1: Project's Team presentation 59
Table 5-1: Details of Thandwe meteorological station 68
Table 5-2: Average temperatures recorded in Thandwe district 68
Table 5-3: Average rainfall recorded in Thandwe district 69
Table 5-4: Tidal range along the coast of Rakhine State, based on Mean High Water Spring (MHWS) and Mean Low Water Spring (MLWS) conditions 72
Table 5-5: Major cyclones in the Rakhine state 77
Table 5-6: Pelagic fish present in Myanmar waters 89
Table 5-7: Marine mammals present in the Bay of Bengal 92
Table 5-8: Distribution of marine turtles in Myanmar 95
Table 5-9: Seabird species recorded in Myanmar 97
Table 5-10: Characteristics of Myanmar's mangroves 99
Table 5-11: Location / characteristics of coral reefs in Myanmar 101
Table 5-12: Sensitive areas close to the AD-03 Block 103
Table 5-13: Demographic data in the districts and townships close to the project area 109
Table 5-14: General principles for sensitivity scoring (Se) 132
Table 5-15: Synthesis of the description of the environment 132
Table 6-1: Impact assessment scoping matrix for the AD-03 Block 3D seismic survey, offshore Myanmar 136
Table 6-2: Definitions for qualitative assessment of likelihood and environmental or social effects 137
Table 6-3: Generic environmental/social risk assessment matrix 138
Table 7-1: Summary of impacts of seismic airguns on marine invertebrates on literature reviews 142
Table 7-2: Observed seismic noise pathological effects on fish eggs and larvae 144
Table 7-3: Results of airgun exposure to marine turtles 147
Table 7-4: Sounds produced by baleen whales that may be encountered during the proposed 3D seismic survey in the AD-03 Block 148
Table 7-5: Summary of environmental/social risk assessment for the 3D seismic survey in the AD-03 Block, offshore Myanmar 169
Table 8-1: Ophir 3D seismic survey, AD-03 Block, offshore Myanmar – management actions to mitigate potential environmental and social impacts 178
Table 8-2: Monitoring and recording requirements for the 3D seismic survey in the AD-03 Block 190
Table 8-3: Incident reporting requirements for the 3D seismic survey in the AD-03 Block 190
Table 8-4: ESMP implementation – control measures, responsible parties and estimated costs 195
Table 9-2 Concerns and expectations expressed about the project during the public consultation process 200

FIGURES

Figure 0-1: Location of AD-03 Block offshore Myanmar 12
Figure 1-1: Location of AD-03 Block, offshore Myanmar 27
Figure 2-1: Location of the Project 29
Figure 2-2: Technique and example of data acquisition in marine 3D seismic surveys 30
Figure 2-3: Racetrack pattern usually followed in 3D seismic surveys 31
Figure 2-4: Seismic survey vessel M/V *Sanco Sword* 33
Figure 2-5: Support vessel M/V *Rig Andromeda* 34
Figure 2-6: Typical air gun mechanics and example of airgun sub-array 34
Figure 2-7: Schematic of seismic array proposed for the AD-033 Block 3D seismic survey 35
Figure 2-8: Source layout 36
Figure 2-9: Source farfield signature 37
Figure 2-10: Source absolute spectrum in water 38
Figure 2-11: Concept of spherical and cylindrical spreading 39
Figure 2-12: Graphical representation of a typical airgun array acoustical spectrum in water 40
Figure 2-13: Typical seismic streamers 41
Figure 2-14: Fan mode geometry 42
Figure 2-15: Example of birds 42
Figure 3-1: Location of AD-03 Block, offshore Myanmar 58
Figure 5-1: Location of the AD-03 Block, offshore Myanmar 60
Figure 5-2: Elevations and rivers in Myanmar 61
Figure 5-3: Myanmar's agro-ecological zones (a); and physio-geographic regions (b) 62
Figure 5-4: Structural geology around the project area (a) Plate boundaries; (b) Depth of basaltic basement (extension of Ninetyeast ridge under the sediment); (c) Transect from Bay of Bengal to Central Myanmar Basins at 22°N (north of the project area)– shoreline is located in the outer wedge 65
Figure 5-5: Annual average rainfall (a); and annual average temperatures over Myanmar (b) 66
Figure 5-6: Location of the nearest meteorological station to the AD-03 Block 67
Figure 5-7: Average temperatures at Thandwe 68
Figure 5-8: Rainfall at Thandwe 69
Figure 5-9: Changing patterns of wind circulation (cm/s) in the Bay of Bengal 70
Figure 5-10: Natural hazard risks in Myanmar according to OCHA (L/H side) and a closer view to the Rakhine region (R/H side) 71
Figure 5-11: Bathymetry of the project area 72
Figure 5-12: Storm surge hazard map for the Rakhine State of Myanmar (central and southern part) corresponding to a tropical cyclone event of maximum wind speed 270 km/h 73
Figure 5-13: Average wind and current direction around the project area 75
Figure 5-14: Tropical cyclone tracks during 1985-2005 in Myanmar 76
Figure 5-15: Storm tracks of 13 events over Myanmar during the period of 2000-2010 76
Figure 5-16: Illustration of the Bengal Fan - South Asian hinterlands-to-deep-sea sediment-routing systems 79
Figure 5-17: SST of the Bay of Bengal: (a) winter; (b) spring; (c) summer; and (d) autumn 80
Figure 5-18: Chlorophyll sampling stations in the Bay of Bengal 81
Figure 5-19: Concentration of chlorophyll-a (mg/m^3) in Area A of the Bay of Bengal: (a) 2m (b) 10m (c) 125m (d) 200/250m 82
Figure 5-20: IUCN Red List categories 83
Figure 5-21: Oceanic stratification of the study area 84
Figure 5-22: Sampling locations during the M/V SEAFDEC field survey 85
Figure 5-23: Phytoplankton density (cells/litres) in the surface layer 85
Figure 5-24: Dominant phytoplankton species in the Bay of Bengal 86
Figure 5-25: Zooplankton distribution and abundance (individuals/m^3) in the Bay of Bengal 87
Figure 5-26: Spatial pattern variation in abundance of total fish larvae in the three areas 88
Figure 5-27: All known positions of blue whales catches, sightings, strandings and acoustic detections in the northern Indian Ocean 94
Figure 5-28: Marine turtles presents in Myanmar waters 95
Figure 5-29: Marine turtle nesting sites close to the AD-03 Block 96
Figure 5-30: Location of mangroves and coral reefs 99
Figure 5-31: Organisms likely to be encountered in the Myanmar's seagrasses (Ocean Health Index) 100
Figure 5-32: Example of shallow water marine mammals in Myanmar 102
Figure 5-33: Meinmahla Kyun protected area 104

Figure 5-34: Thamihla Kyun protected area 105
Figure 5-35: Rakhine State administrative organization 107
Figure 5-36: Coastal villages close to the project area 108
Figure 5-37: Rakhine State population density by township 110
Figure 5-41: Offshore oil and gas blocks 114
Figure 5-42: Marine fishery spatial organization 118
Figure 5-43: Main coastal ports on northwest coast of Myanmar and in Ayerwaddy delta 124
Figure 5-44: Marine traffic in the Bay of Bengal, ship density map produced from the marinetraffic.com website 125
Figure 5-45: Marine traffic in the Bay of Bengal, AIS fleet monitoring data for January 2014 126
Figure 6-1: Key steps used for risk assessment 135
Figure 7-1: Proportion of marine mammal sighting occurring within specified distances of the airgun during seismic surveys 150
Figure 7-2: Precaution zones surrounding the acoustic source 152
Figure 7-3: Vessel-marine fauna interaction procedures 155
Figure 8-1: Ophir HSE Policy 174
Figure 8-2: Dolphin Geophysical HSE Policy 175
Figure 9-1: Pictures of stakeholder consultations 199

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
DG	Director General
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
ER	Emergency Response
ERC	Emergency Response Coordinator
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
INCOIS	Indian National Centre for Ocean Information Services
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
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
MD	Managing Director
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
MSI	Maritime Safety Information
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
PERR	Post-survey Environmental Review Report
PSC	Production Sharing Contract
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SAR	Search and Rescue
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

Ophir Energy plc (Ophir) proposes to conduct a 3D seismic acquisition survey of the AD-03 Block offshore of Myanmar in the Rakhine Basin (Rakhine region), in the Bay of Bengal.

This Initial Environmental Examination (IEE) was prepared to allow the environmental authorities of Myanmar to determine how the project affects the environment and existing socio-economic activities and to decide whether the project should proceed, given suitable mitigation measures. The form, content and structure of the report provides relevant information on environmental and social issues and mitigation measures to be taken into account in order to protect the environment during the scheduled offshore seismic survey.

The IEE has been developed in accordance with the current national legal framework and best international practices and it includes an Environmental and Social Management Plan (ESMP).

The document was performed by the Risk, Society & Environment department of Artelia, which has operated a branch office in Yangon since October 2012, in cooperation with Galaxia Marine Environmental Consulting Pty Ltd.

The project team included environmental engineers with international experience in environmental impact assessment studies (including in Myanmar), an engineer trained in Marine Mammal Observation (MMO) standards in UK (JNCC), specialist marine scientists, a geologist, a social specialist experienced in the management of offshore seismic campaign in Asia and an environmental engineer based in Yangon, which supported the team during data collection and local coordination.

0.1.1. Outline Project Description

In March 2014, Myanmar's Ministry of Energy (MOE), through its 100% State-owned entity Myanmar Oil and Gas Enterprise (MOGE) announced the provisional award to Ophir of a 95% operated interest in deep-water Block AD-03 offshore of Myanmar as part of the current licensing round. The award is subject to finalisation of a Production Sharing Contract (PSC) with the Ministry of Energy (MOE).

The AD-03 Block is approximately (~) 10,000 square kilometres (km^2) in area and is located at ~124km west of Myanmar's north-western coast (~64km from Cheduba [Munaung] Island) in the Rakhine Basin (Rakhine region), in the Bay of Bengal (Figure 0-1).

The survey will comprise a 3D seismic acquisition area of ~9,898km² (i.e. complete block coverage). The 3D seismic data will be performed via Narrow Azimuth Towed Streamer (NATS) technique, using airgun arrays as seismic sources.

0.1.2. Project Schedule

The 3D seismic survey is planned to commence in mid-March 2015 with the arrival of the survey and support/chase vessels in the AD-03 Block. It is estimated that the likely maximum duration of the proposed survey will be ~105 days (three months), including mobilisation and demobilisation phases. On this basis, the survey is expected to be completed by the end of June 2015.

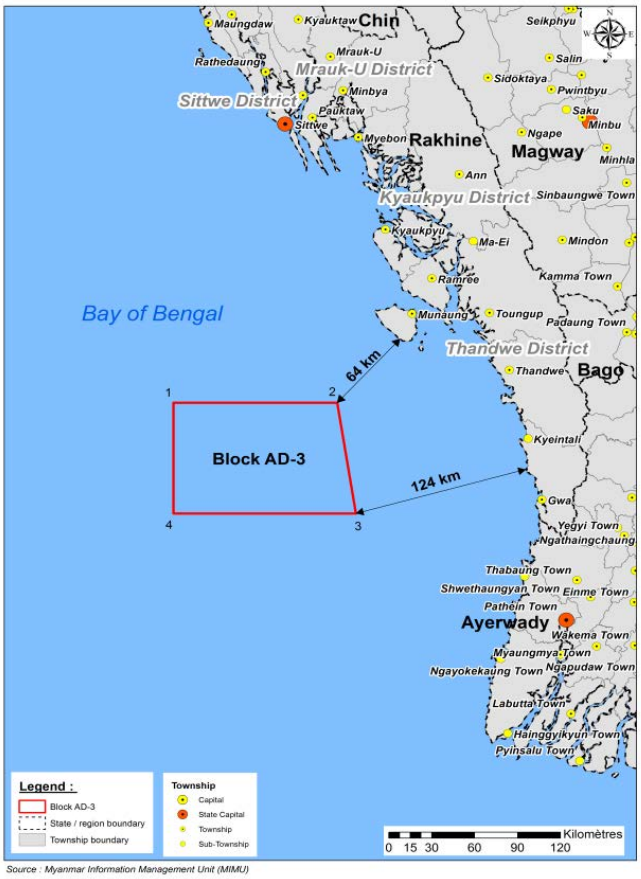
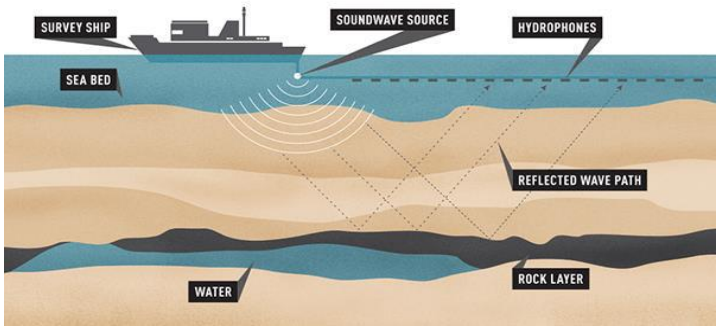


Figure 0-1: Location of AD-03 Block offshore Myanmar

0.2. PROJECT DESCRIPTION

0.2.1. Seismic Survey



Marine seismic surveys are undertaken in order to allow the mapping of the subsurface geological formations and the identification of potential hydrocarbon deposits. It employs 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 and that are reflected back to the water surface by the different geological formations in the earth's crust. These are then detected and recorded over a predetermined time period by underwater microphones (hydrophones). The data recorded is stored for later analysis and generation of seismic data profiles, which can be interrogated to determine the presence of potential hydrocarbon reserves.

Data acquisition during a 3D survey normally takes place 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. Line changes are performed approximately every 30 minutes with a survey vessel speed of 4.5knots (turn radius of max. 5km).

A marine seismic survey system is composed mainly of a main 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.

The AD-03 Block 3D seismic survey will use one survey vessel; two support vessels for supply, at-sea bunkering (refuelling), crew change and protecting the seismic spread (towed equipment), and two additional chase vessels for managing interactions with fishing vessels and shipping. Estimated numbers of personnel aboard the vessels are ~60 for the survey vessel ~12 each for the support and chase vessels.

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. For the proposed 3D seismic survey, two seismic sources will operate in “flip-flop” mode. 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 10 seconds). 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 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 6 km-length solid streamers will be towed in order to record reflected acoustic signals. 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. The anticipated source pressure level (SPL, 0-P) will be 257 dB 1µPa.m-1.

0.2.2. Logistics

The survey will be acquired using a state-of-the-art purpose-built 3D vessel, the M/V *Sanco Sword*, which is owned and managed by Sanco Shipping AS. The vessel is part of the marine seismic fleet operated by Dolphin Geophysical AS.

The support vessel for this survey will be the M/V *Rig Andromeda*, and two additional chase vessels will be used to manage interactions with shipping traffic and fishing vessels – the M/V *7-Waves* and the M/V *Swissco Synergy*.

The only anticipated onshore activities proposed for this seismic survey will be associated with crew changes, which will take place in the port of Gyeiktaw.

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

0.2.3. Inventory of waste, discharge and 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.

Atmospheric emissions are generally associated with engines' combustion and energy generation processes. An estimate of Greenhouse Gas (GHG) emissions was conducted by multiplying fuel consumption and emission factors for the relevant atmospheric components. GHG generated by the project has been estimated at a total of 15,290 tons eqCO2.

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. Based on the vessels' characteristics, the crew, the project schedule and expected meteorological conditions, the volume of domestic and sanitary wastewater has been estimated at 2,097m^3; and deck and bilge waters estimates at 952m^3 for the total duration of the project.

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. Hazardous and non-hazardous waste estimations for the total duration of the project are 650mt and domestic waste 42m^3.

0.2.4. Impact Producing Factors

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.

Based on the project description, the impact-producing factors resulting from the AD-03 Block seismic survey were 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 (which in this project, it does not).
- **Accidental releases:** spills of MGO during at-sea bunkering, or resulting from vessel collisions.

0.3. DESCRIPTION OF THE ENVIRONMENT

An Environmental Baseline Survey has not been performed in the AD-03 Block, and this part of the study has been compiled from desk-based information.

0.3.1. Physical Environment

The project is located in the Rakhine Basin in the eastern part of the Bay of Bengal, part of the Indian Ocean and on the Indian Tectonic Plate. The Bay of Bengal subsurface is the Bengal Deep Sea Fan consisting of sediments resulting from the erosion of the Himalayas and supplied by the Ganges and Brahmaputra rivers, and thereafter dispersed southward by turbidity currents and multiple north-south trending fan valleys.

During the proposed period of the project (March to June), average air temperatures should be between 21-25°C and low rainfall is anticipated, as it will be the period of the Northeast Monsoon. Predominant wind direction in AD-03 Block will be north/northeast during the period when the survey is planned to occur.

The water depth in the area of prospect ranges from approximately 1980m to more than 2400m in the southeast part of the block (offshore deep waters).

An average value of the maximum tidal range (2.4m), corresponding to spring tide, was obtained based on data from several tidal stations along the coast of Rakhine State.

The movement of swell in the region is related to the dominant monsoon wind. The area from the Ganga (Ganges) estuary to the Gulf of Martaban, including the Andaman Islands, has a generally moderate swell from the southwest, though this becomes heavy during the Southwest Monsoon. Turbulent seas are encountered from time to time, associated with storms.

The northern Indian Ocean, and especially the Bay of Bengal, has complicated current patterns due to the geography of the region and its unique wind forces. The monsoon winds have an important role in the seasonal patterns of the region. From January to October, the current is southward flowing and the Bay of Bengal monsoon moves in a northwest direction contacting the Nicobar Islands, and the Andaman Islands at the end of May and then the north-eastern coast of India by the end of June.

Surface waters are characterised by low salinity due to large freshwater influx from the rivers flowing into the northern Bay of Bengal, which also has an impact on the local turbidity and chlorophyll-a concentrations.

0.3.2. 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.

According to the bibliographic searches performed, 31 pelagic fish species listed on the IUCN Red List of Threatened Species have been recorded in this part of the Bay of Bengal (of which 24 are oceanic species and likely to be found in the project area).

Among the 29 marine mammal species recorded as occurring in Myanmar's waters, 21 species may be encountered in AD-03 Block; of these, eight species are listed as Least Concern on the IUCN Red List; 10 species as Data Deficient; one species as Vulnerable (sperm whale), and two whale species as Endangered (blue whale and fin whale).

Six threatened seabird species have been identified as possibly occurring in the AD-03 Block, of which four are listed as Least Concern, and two as Near Threatened on the IUCN Red List.

Most observations of marine turtles in Myanmar waters occur in shallow, inshore waters. However, all of the five species of marine turtles recorded in Myanmar are migratory, and as such they may be encountered in the offshore waters of the AD-03 Block.

Key characteristics of the Myanmar coastal environment have also been described in this IEE, even though the project area is located at ~124km from the mainland coastline of Rakhine State. The closest coral reef is situated ~64km from the project area (Cheduba [Munaung] Island). There are no marine protected areas in the vicinity of the AD-03 Block or surrounding waters.

0.3.3. Socio-economic Environment

At this distance from the coast, the project will have limited impacts on the human environment. The only socio-economic activities that may interact with the proposed seismic operations are commercial marine traffic and offshore industrial fisheries. These interactions will generally be limited due to the moderate shipping traffic density in the shipping lane that crosses the AD-03 Block, and as a result of the control and mitigation measures that will be implemented to manage this potential impact. Similarly, interactions with fishing operations are expected to be low due to the small number of fishermen authorized to fish in the offshore fishery area (2,000 compared to 27,000 in the inshore fishery area), the location of the block relatively far away from the coast, and a recent ban on foreign vessels fishing in Myanmar waters that further reduces the likelihood of encountering fishing vessels in the offshore fishery area (apart from illegal fishermen whose possible presence in the project area cannot be determined).

0.3.4. Summary of Sensitivities

Based on the existing conditions of the environment described above, a synthesis of sensitivities by environmental component was defined and summarized in the table below.

Table 0-1: Summary of environmental and social sensitivities

Aspect/Environmental Sensitivity (Se)	Sensitivity
Sediment Quality	
The Bay of Bengal is covered by the Bengal Deep Sea Fan consisting of sediments resulting from the erosion of the Himalaya and supplied by the Ganges and Brahmaputra rivers, and hence dispersed southward by turbidity currents and multiple north-south trending fan valleys	Very Low
Water Quality	
The Rakhine Basin exhibits strong seasonal variations due to a large freshwater influx from the Himalayan rivers. In AD-03 Block the salinity of the surface water is low and the high turbidity may contribute to decrease the chlorophyll-a concentration.	Very Low
Air Quality	
No scientific study has been performed on the air quality within the project area. Nevertheless, the air quality within the AD-03 Block is predicted to be good, being remote from air pollution sources.	Very Low
Benthic community	
Taking into account the water depths (~1,800-2,500m) of the project area, the abundance and richness of benthic communities within the AD-03 Block are predicted to be low.	Very Low
Phytoplankton/ Zooplankton	
Bibliographic research shows that 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.	Low
Cetaceans	
Among the 29 marine mammal species recorded by the IUCN with different levels of vulnerability, 21 may be encountered within the project area:	High

Aspect/Environmental Sensitivity (Se)	Sensitivity
Fish	
The pelagic system of the Bay of Bengal in general is related to the considerable seasonal variations imposed by the monsoon systems. A total of 31 pelagic fish species were identified by the IUCN as threatened with different levels of vulnerability from which 24 can be found at the project site.	Medium
Turtles	
Amongst the turtle species occurring in Myanmar, five species breed regularly on Myanmar's beaches and are migratory, therefore they may be encountered in the offshore waters of the AD-03 Block.	High
Birds	
A total of 20 seabird species have been recorded in Myanmar marine waters. Amongst these species, four species are listed as Near Threatened and 16 species are listed as Least Concern on the IUCN Red List. Six species have been identified as potentially occurring within the AD-03 Block.	Low
Coastal ecosystem	
Habitats in coastal areas of Myanmar consist of mangroves, coral reefs, seagrass beds, evergreen forest, wetlands and various types of agricultural land. The closest coral reef is situated ~65km from the project area (Cheduba Island). The nearest mangroves and seagrass beds are located >60km.	Low
Marine protected areas	
There are no marine protected areas in the vicinity of the AD-03 Block.	Very Low
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 are only of Burmese origin since foreign fishing vessels have been recently banned from Myanmar waters. The project area could also be used by artisanal fishermen who generally fish in the inshore fishery zone (10nm from the coast) but sometimes venture out to the offshore zone, although the likelihood ot this occurring is low. Illegal fishermen from Thailand and Bangladesh could also be encountered.	Medium
Marine traffic	
The project area is crossed by a regional shipping route connecting Bangladesh to the Malacca Strait. Apart from legitimate marine traffic, the AD-03 Block is known to be located on a smuggling boat route connecting northern Rakhine State and Bangladesh to Thailand and other Southeast Asian countries.	Medium

0.4. ENVIRONMENTAL AND SOCIAL IMPACTS

An Environmental and Social Risk Assessment (ESRA) of the proposed 3D seismic survey 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. A summary of outcomes are presented in the table below.

The risk assessment indicates that the potential risks/impacts arising from the 3D seismic survey in the AD-03 Block can be categorised as having **Low** to **Medium** risk levels. No risks were assessed as **High**. Table 0-2 below 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:

- Accidental fuel and oil spills from the survey vessel, support and chase vessels.
- Vessel collisions resulting in fuel and oil spills.
- Disturbance to fisheries and shipping.

Table 0-2: Summary of environmental/social risk assessment for the 3D seismic survey in the AD-03 Block, offshore Myanmar

Environmental / social aspect	Potential environmental / social impacts	Risk		
		Consequence	Likelihood	Residual level
Disturbance to marine fauna				
Discharge of underwater seismic pulses	Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish	Slight	Possible	**Low**
	Physiological effects on benthic invertebrates and plankton	Slight	Possible	**Low**
Light generation from vessels	Behavioural effects on turtles, fish and seabirds	Slight	Possible	**Low**
Vessel and towed equipment interactions	Behavioural and physical effects on cetaceans, whale sharks and turtles	Minor	Possible	**Low**
Disturbance to benthic habitats				
Equipment loss	Localised physical damage to benthic habitats	Slight	Possible	**Low**
Atmospheric emissions				
Operation of machinery and vessels powered by internal combustion engines	Localised reduction air quality/Greenhouse gas emissions	Slight	Likely	**Low**
Invasive marine species				
Discharge of ballast water from vessels	Introduction and establishment of IMS and displacement of native marine species	Minor	Possible	**Low**
Biofouling of vessel hulls, other niches and immersible equipment		Minor	Possible	**Low**
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**
Discharge of bilge water	Acute toxicity effects on marine fauna and flora/Localised reduction in water quality	Slight	Possible	**Low**
Discharge of other wastes i.e. garbage	Localised reduction in water quality/ Physical impacts on marine fauna i.e. from plastics	Minor	Possible	**Low**

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**
Fuel and oil spills		Moderate	Possible	**Medium**
Vessel collisions		Moderate	Unlikely	**Medium**

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	**Medium**
Interaction with shipping	Disruption to shipping activities	Moderate	Possible	**Medium**

0.4.1. Recommended Mitigation Measures

Discharge of Underwater Seismic Pulses

The following systems, practices and procedures are recommended to be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks to marine fauna associated with the discharge of underwater seismic pulses are continuously reduced to As Low as Reasonably Practicable (ALARP):

- Adherence to the Australian EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales – Part A Standard Management Procedures; and appropriate Part B Additional Management Procedures (DEWHA 2008):
  - precaution zones (Observation zone: 3km+; Low power zone: 2km; and Shut-down zone: 500m);
  - two dedicated Marine Mammal Observers (MMO) will be aboard the survey vessel for the duration of the 3D seismic survey in the AD-03 Block; and
  - survey personnel (marine and seismic) to be provided with pre-survey induction on EPBC Act Policy Statement 2.1.
- As a precautionary measure the Part A Standard Management Procedures will be applied to whale sharks as well as to whales for the duration of the survey.
- 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 on whale species. 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 are predicted to exhibit avoidance behaviour. These procedures are adapted from the EPBC Act Policy Statement 2.1 – *Interaction between offshore seismic exploration and whales* (DEWHA 2008). For interactions involving acoustic energy source operations, the procedures are based on a tiered response depending on the 'safety zone' occupied by observed whales. For the duration of the 3D seismic survey in the AD-03 Block, Part A – Standard Management Procedures will be implemented. Under the EPBC Act Poly Statement 2.1, 'whales' are defined as: baleen whales and larger toothed whales, such as, sperm whales, killer whales, false killer whales, pilot whales and beaked whales. Application of these procedures will not apply to the smaller odontocete (toothed) cetaceans – i.e. dolphins and porpoises.

The key elements of the Part A - Standard Management Procedures are:

- **Visual observations**: 30 minutes prior to commencement of the soft start procedure, observations are to be made, where visibility allows, extending to 3+km (observation zone) from any source vessel but with particular focus on the low power and shut-down zones around the acoustic source. If no whales have been sighted within the low power (2km radius; see Figure 7-2) and shutdown zone (500m radius) during the pre-start-up procedure, the soft start procedure outlined below may commence.
- **Soft start procedures**: A sequential build-up of warning pulses (over a period of 30 minutes) must be made at the start of each acquisition line ('soft start') to warn and deter whales from approaching the survey vessel. 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.
  - 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.
- **Continuous watch**: A continuous watch for whales must be maintained during 'soft start' sequences and during operations to determine the presence or absence of whales within 3km of the vessel.

- **Power down procedures**:
  - 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.
- **Recommencement**: Power-up of the acoustic source with 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.
- **Night-time / Low visibility procedures:** soft start up may be commenced provided that there have not been three or more whale instigated power-down or shut-down situations during the preceding 24 hour period; or if operations were not previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10km) of the proposed start up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.

Two dedicated, expert MMOs will be aboard the survey vessel for the entire duration of the survey. Only appropriately qualified and experienced MMOs will be contracted for the 3D seismic survey in the AD-03 Block.

The key role of the MMO will be to visually monitor the waters around the survey vessel for the presence of cetaceans, turtles and whale sharks during daylight hours. The MMO will be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities. The MMO 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.

Light Generation

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.

Vessel and Towed Equipment Interaction with Marine Fauna

The following systems, practices and procedures will be implemented:

- 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 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 AD-03 Block.

Disturbance to Benthic Habitats

The following systems, practices and procedures will be implemented:

- 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).

Reduced Air Quality from Atmospheric Emissions

The following systems, practices and procedures will be implemented:

- Adherence to MARPOL 73/78 Annex VI requirements:
  - optimisation of fuel use to increase efficiency and minimise emissions;
  - 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 AD-03 Block and surrounding waters.

Invasive Marine Species

The following systems, practices and procedures will be implemented regarding ballast water and bio-fouling:

- the survey and support vessel will not routinely discharge ballast water.
- recording (in vessel engine room log) of any non-routine ballast water discharges.
- the survey and support vessels will have had a recent dry dock, IMS inspection, hull and other niche cleaning and anti-foulant application.

Marine Pollution form Routine Discharges

The following systems, practices and procedures will be implemented associated with routine discharge of sewage, grey water and putrescible wastes:

- 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.
- Sewage and putrescible wastes to be 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 should be small enough to pass through a screen of less than 25 mm diameter prior to sea disposal.
- 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.

The following systems, practices and procedures will be implemented for routine discharge of bilge water:

- Bilge water will be treated and disposed of in accordance with MARPOL 73/78 Annex I.
- 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.

The following systems, practices and procedures will be implemented for routine handling and disposal of garbage:

- Garbage will be disposed of in accordance with MARPOL 73/78 Annex V.
- 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.

Marine Pollution from Accidental Discharges

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with accidental discharge of hazardous materials are continuously reduced to ALARP:

- 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.

The following systems, practices and procedures will be implemented to prevent accidental discharge of fuel and oil:

- 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 (i.e. Cheduba Island, or the Rakhine mainland coastline).
- Refuelling at sea will be subject to the Dolphin Geophysical bunkering operations 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.

The following systems, practices and procedures will be implemented regarding vessel collision:

- 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—e.g. issuance of NTM.
- 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).

Disturbance to Economic Activities

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 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 Rakhine 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 leaflets on the seismic campaign in Burmese and Bengali language for distribution to fishermen encountered at sea.
- Recruitment of a Fisheries Liaison Officer able to speak Burmese (and when possible Bengali). Their role will be to participate in the survey and handle encounters with both Burmese fishermen and Bengali boats, directly solving any issues that could arise between these fishermen and the project. An alternative solution proposed to this specific recruitment is to add this responsibility to an already existing position and appropriate crew member.
- 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.
- Fishermen alerted 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.

The following systems, practices and procedures will be implemented regarding 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.

- 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).

0.5. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) for the project 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.

The ESMP includes the following items:

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

1. INTRODUCTION

1.1. CONTEXT

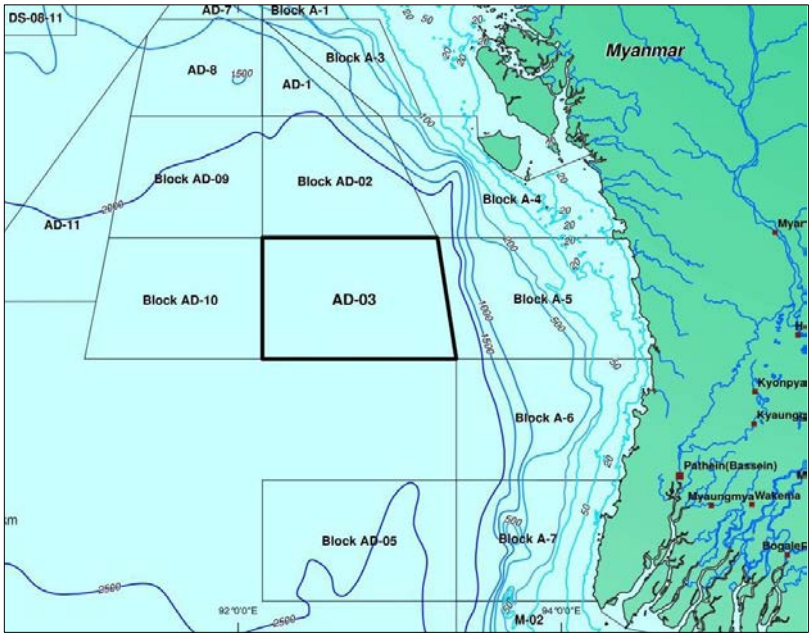
In March 2014, Myanmar's Ministry of Energy (MOE), through its 100% State-owned entity Myanmar Oil and Gas Enterprise (MOGE) announced the provisional award to Ophir Energy (Ophir) of a 95% operated interest in deep-water Block AD-03 offshore Myanmar as part of the current licensing round. The award is subject to finalisation of a Production Sharing Contract (PSC) with the Ministry of Energy (MOE).

The AD-03 Block is approximately (~) 10,000 square kilometres (km^2) in size and is located in the Rakhine Basin (Rakhine region), in the Bay of Bengal, on trend with the multi-trillion cubic feet (TCF) Shwe gas field. Ophir intends to acquire a three dimensional (3D) seismic survey over all of the AD-03 Block.

Ophir has prepared the present Initial Environmental Examination (IEE) with the agreement of Myanmar's Ministry of Environmental Conservation and Forestry (MOECAF) and based the study on international best practice standards and guidelines, such as the World Bank guidelines for Environmental Impact Assessment (EIA).

1.2. PROJECT LOCATION

The proposed 3D seismic survey will be located in the AD-03 Block ~124km west of the Myanmar's north-western coast (~65km from Cheduba [Munaung] Island - Rakhine region coastal area), in the Bay of Bengal (Figure 1-1).



Source: OPHIR, 2014

Figure 1-1: Location of AD-03 Block, offshore Myanmar

1.3. OBJECTIVES OF THE IEE

The Initial Environmental Examination (IEE) is a report comprising a systematic assessment of a proposed activity or project that is prepared to aid in determining whether such an activity or project has the potential to affect significantly the environment, humans and other living things, including socio-economic impacts, and to support a decision whether such an activity or project should be allowed or not.

This IEE study was based on international best practice standards and guidelines, such as the World Bank guidelines for EIA, amongst others. The contents of the IEE report are presented in Box 1 below.

Box 1. Content of IEE Report

The proposed IEE will comprise the following parts:

a) Project description in reasonable detail together with overview and layout maps;

b) Identification of the Project Proponent including the identification of the owners, directors (if any) and day to day management and officers of the Project Proponent;

c) Identification of the IEE experts, including which expert is responsible for which part of the IEE report;

d) Description of the surrounding environmental conditions of the Project;

e) Identification and assessment of potential adverse impacts;

f) Results of the public consultation/public participation process and the Ophir's written response to comments received during that process;

g) The environmental protection measures of the Project;

h) The conclusion of the IEE;

i) The Environmental and Social Management Plan (ESMP); and

j) The Persons, Organizations and Budgets needed for implementation of the ESMP.

1.4. IEE METHODOLOGY

The IEE methodology involved the description of the existing environment, impact identification and evaluation, development of mitigation measures and elaboration of guidelines for an Environmental and Social Management Plan (ESMP).

The description of the existing environment of the AD-03 Block was based on data from literature research and past studies performed in the area. The scope of work did not include an Environmental Baseline Survey within the AD-03 Block or surrounding waters.

The IEE report was prepared in 2014 by the environmental consultants Artelia Water & Environment – Risk Society and Environment Unit (France). It was compiled over a one month period by an international team of specialists, specialized in the following areas: marine seismic survey techniques, ESIAs for the upstream oil industry, geology, marine and coastal biodiversity, socio-economics, environmental law and mapping.

2. PROJECT DESCRIPTION

2.1. LOCATION OF SEISMIC SURVEY

The proposed 3D seismic survey will be located within the AD-03 Block ~124km west of Myanmar's north-western coast (~64km from Cheduba Island - Rakhine region coastal area), in the Bay of Bengal. The AD-03 Block is operated by Ophir Energy.

The survey will comprise of a 3D seismic acquisition area of ~9,898km² (i.e. complete block coverage). The 3D seismic data will be performed via Narrow Azimuth Towed Streamer (NATS) technique, using airgun arrays as seismic sources.

The project location is presented on Figure 2-1 and **Annex 4**. Boundary coordinates of the AD-03 Block are presented on Table 2-1 (Datum: WGS84).

Table 2-1: Boundary coordinates of the AD-03 Block

Point n°	Easting (X)	Northing (Y)
1	92°09'00"	18°15'00"
2	93°14'00"	18°15'00"
3	93°21'00"	17°30'00"
4	92°09'00"	17°30'00"

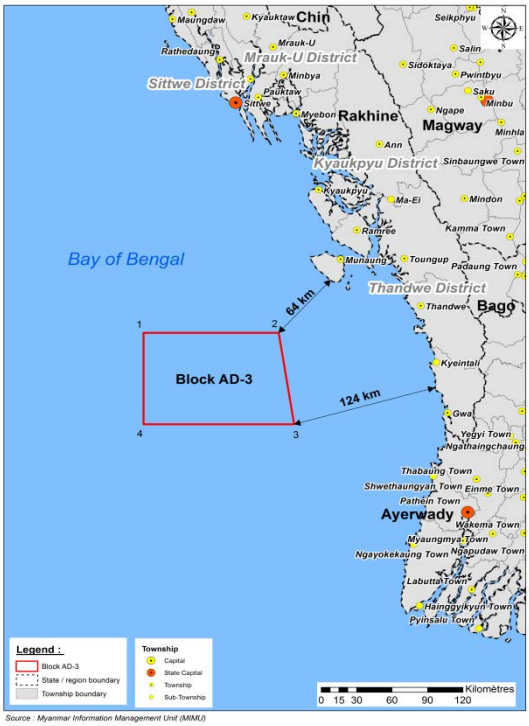


Figure 2-1: Location of the Project

Water depths across the AD-03 Block range from ~1,980m to more than 2,400m in the southeast part of the block.

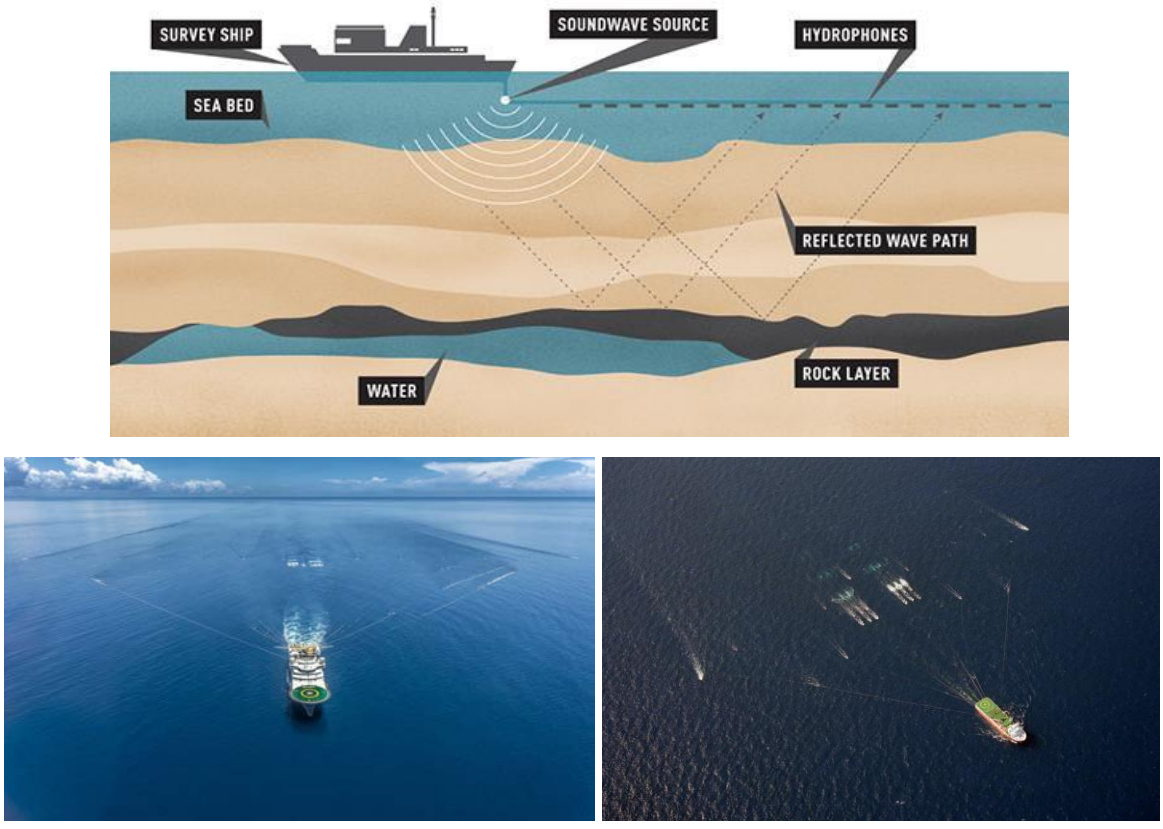
2.2. SURVEY SCHEDULE

The 3D seismic survey is planned to commence in mid-March 2015 with the arrival of the survey and support/chase vessels in the AD-03 Block. It is estimated that the likely maximum duration of the proposed survey will be ~105 days (three months), including mobilisation and demobilisation phases. On this basis, the survey is expected to be completed by the end of June 2015.

2.3. SEISMIC DATA ACQUISITION TECHNIQUE

2.3.1. General Description of Marine Seismic Surveys

Marine seismic surveys are undertaken to allow the mapping of the 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 interrogated to determine the presence of potential hydrocarbon reserves. An example of the marine seismic data acquisition technique is given in Figure 2-2.



Source: Ophir, 2014

Figure 2-2: Technique and example of data acquisition in marine 3D seismic surveys

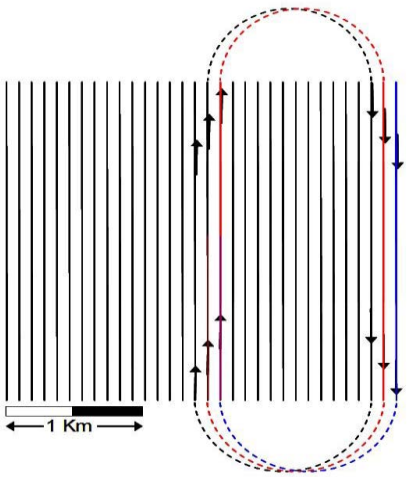
2.3.2. Description of 3D Seismic Surveys

In 3D surveys several hydrophone streamers are towed behind the survey vessel, together with dual seismic sources. It is this technique that is proposed for the proposed survey in the AD-03 Block.

Because seismic waves travel along expanding spherical wave fronts they have surface area. A truly representative image of the subsurface is only obtained when the entire wave field is sampled. AD-03 3D seismic survey is more capable of accurately imaging reflected waves because it utilises multiple points of observation. 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 subsurface 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 in Figure 2-3, 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.



Source: Ophir, 2014

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

Line changes are performed in ~30 minutes (survey vessel speed of 4.5knots; turn radius of max. 5km) using the racetrack pattern.

The 3D seismic survey for the proposed 3D seismic survey in the AD-03 Block will have the following characteristics (Table 2-2).

Table 2-2: Characteristics of the AD-03 Block 3D seismic survey

Parameter	Acquisition area
Survey area	~9,900 km²
Shooting direction (sail line)	E 090° / W 270°
Prime line length	~120 km (min. 114km, max. 127km)
Number of prime lines	~101
Turn radius	3-5km line turns off edge of block (E&W)

2.4. SEISMIC ACQUISITION EQUIPMENT

A marine seismic survey system is composed mainly of the following equipment:

- 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 AD-03 Block 3D seismic survey there will be one (1) survey vessel, one (1) support vessels for supply, at-sea bunkering (refuelling), crew change and protecting the seismic spread (towed equipment), and 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 each for the support and chase vessels (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 (crew changes for the AD-03 Block 3D survey will take place in port rather than by helicopter) 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 survey will be acquired using a state-of-the-art purpose-built 3D vessel, the M/V *Sanco Sword*, which is owned and managed by Sanco Shipping AS. The vessel is part of the marine seismic fleet operated by Dolphin Geophysical AS. Specifications for the *Sanco Sword* are provided in Table 2-3 and **Annex 1**. Figure 2-4 provides a photograph of the *Sanco Sword*.

The support vessel for this survey will be the M/V *Rig Andromeda*, and two additional chase vessels will be used to manage interactions with shipping traffic and fishing vessels – the M/V *7-Waves* and the M/V *Swissco Synergy*. Specifications are provided in Table 2-3 and **Annex 1** for the M/V *Rig Andromeda* (Figure 2-5), and specifications for the *7-Waves* and *Swissco Synergy* are also provided in **Annex 1**.

Source: Ophir, 2014

Figure 2-4: Seismic survey vessel M/V *Sanco Sword*

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

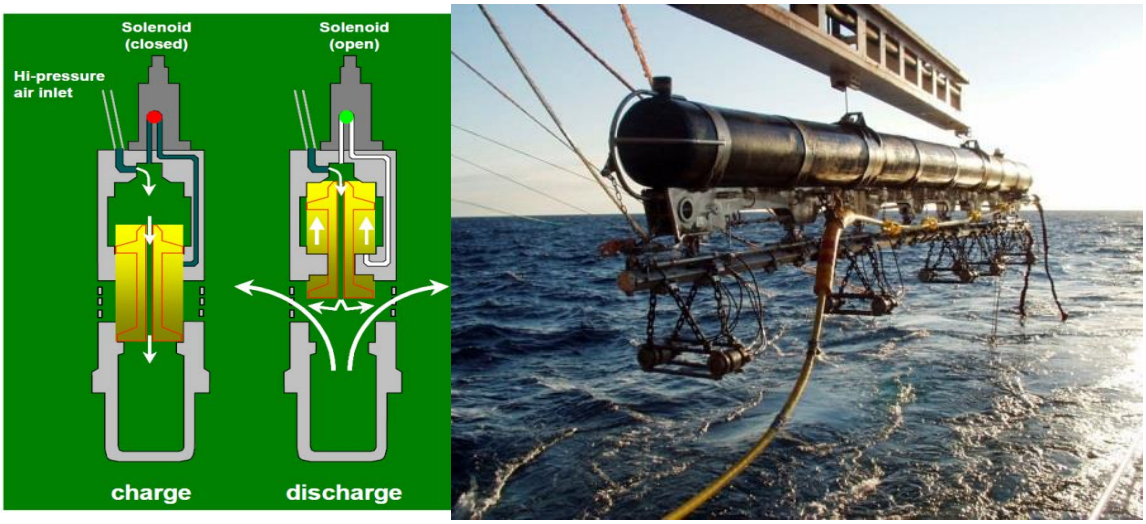
General information of the seismic vessel M/V *Sanco Sword*	
Length	96.15m
Fuel consumption	40m^3/day (production); 60m^3/day (Transit, 4 ME's at 85%)
Crew	60
Survey speed	4.5 knot
Normal turn radius on operation	Max 5km
Water ballast	1630m^3
Fresh water production	15m^3/day (2 x Alfa Laval AQUA 80-HW)
Sewage	11.10m^3/day (Gertesen & Olufsen BR011100)
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)

Source: Ophir, 2014

Figure 2-5: 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 2-6). 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.



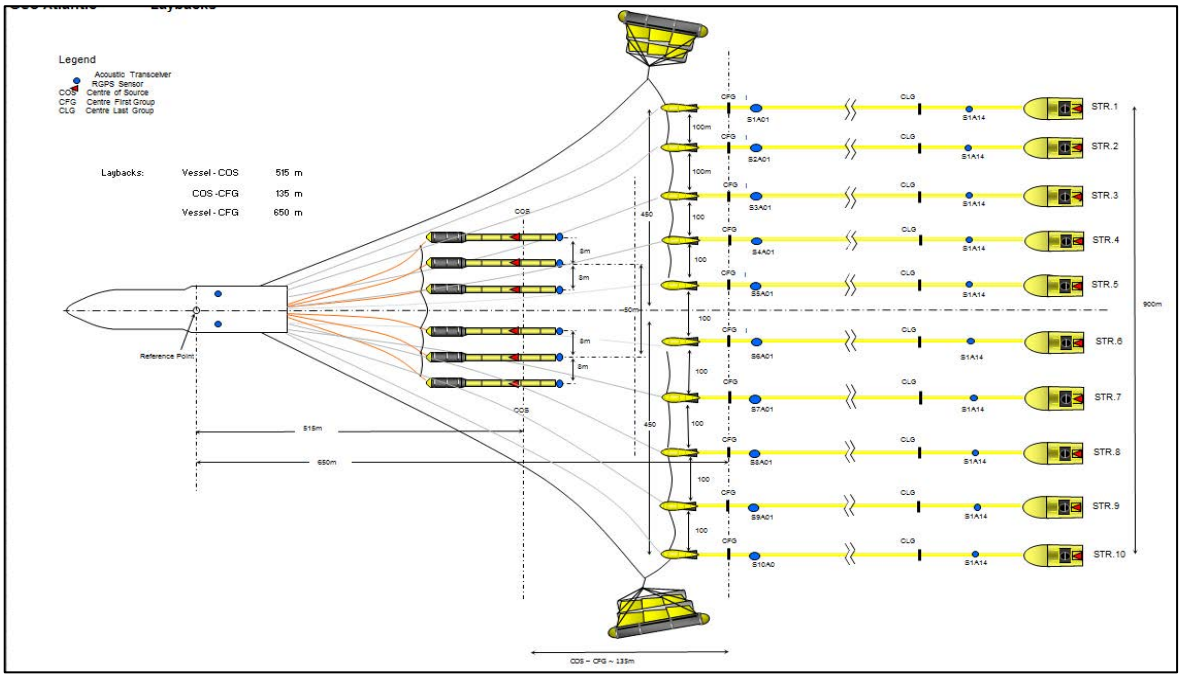
Source: Ophir, 2014

Figure 2-6: 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. 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).



Source: Ophir, 2014

Figure 2-7: Schematic of seismic array proposed for the AD-033 Block 3D seismic survey

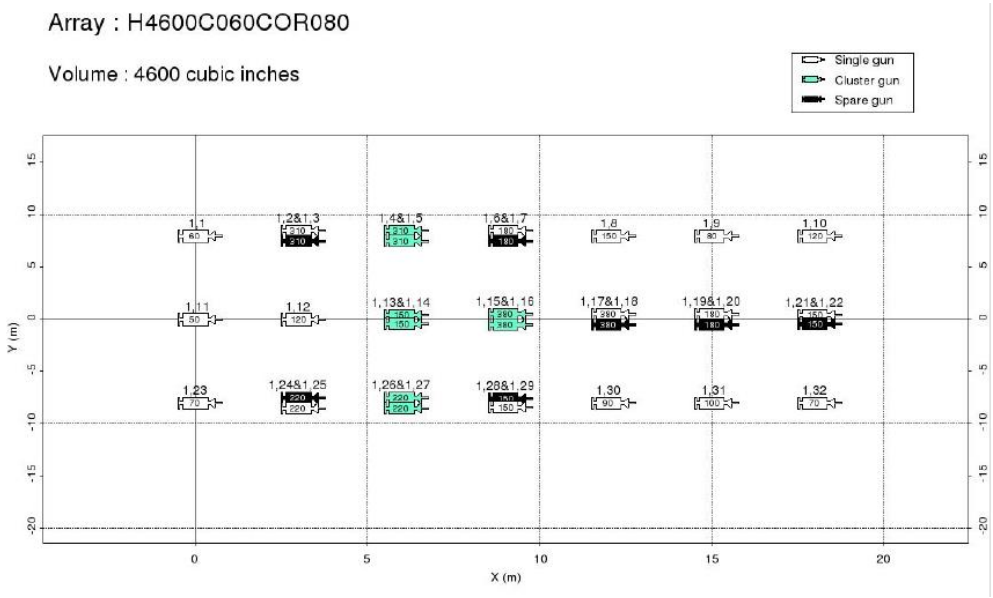
The sources will have up to 27 guns in each airgun array (24 active and 3 spare). The individual gun volumes range from 330 to 70 cubic inches (cui).

The characteristics of the seismic sources are summarized in Table 2-4.

Table 2-4: 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

The figure below shows the configuration of the airgun array.



Source: Ophir 2014

Figure 2-8: Source layout

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.

Figure 2-9 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.

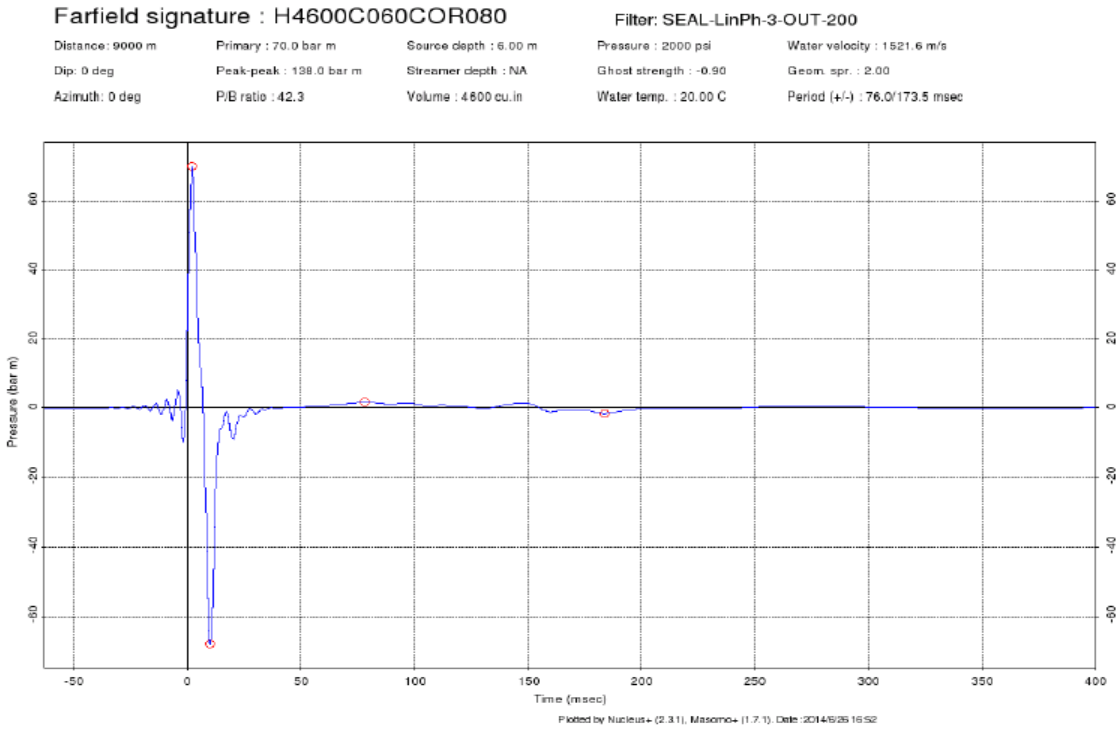


Figure 2-9: Source farfield signature

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 AD-03 Block are as follows:

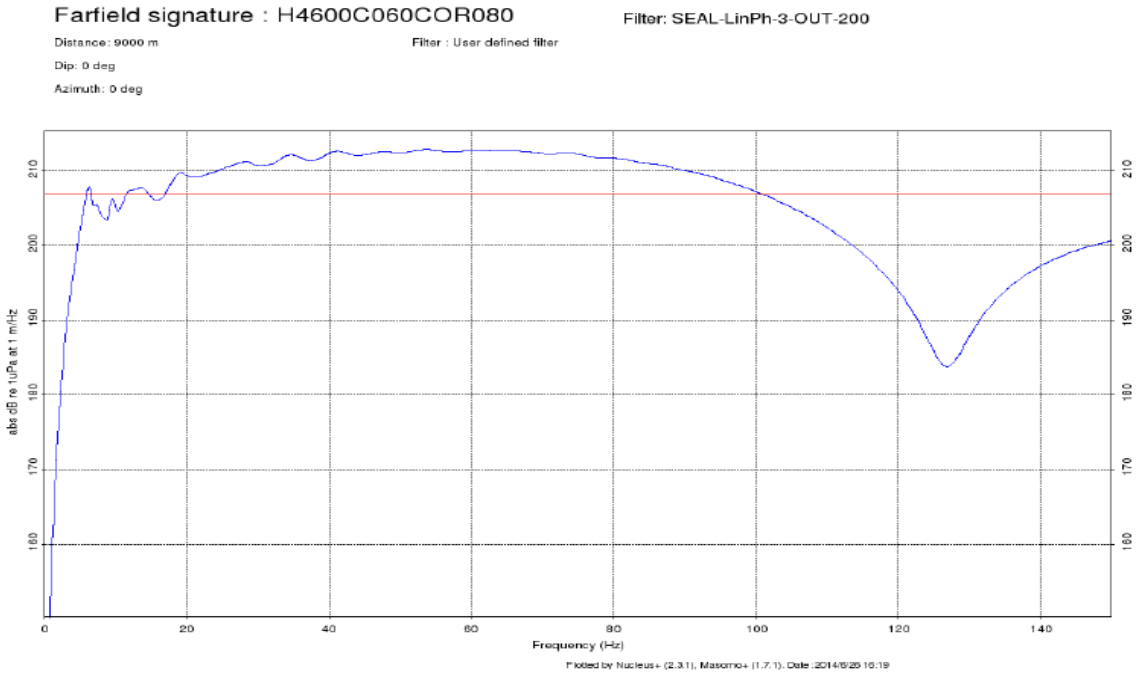
- **Intensity**: characteristics are summarized in Table 2-5.

Table 2-5: 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.



Source: Ophir, 2014

Figure 2-10: 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 Figure 2-11.

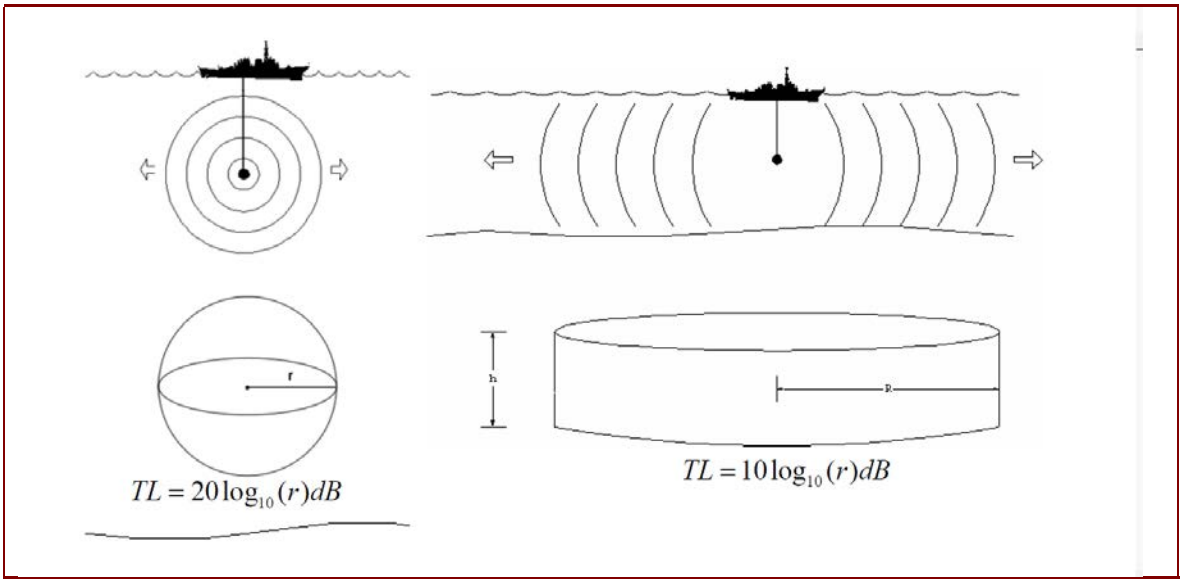


Figure 2-11: Concept of spherical and cylindrical spreading

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 three 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 2-12). 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 AD-03with the result that source signals are much lower near the water surface than on the vertical axis.

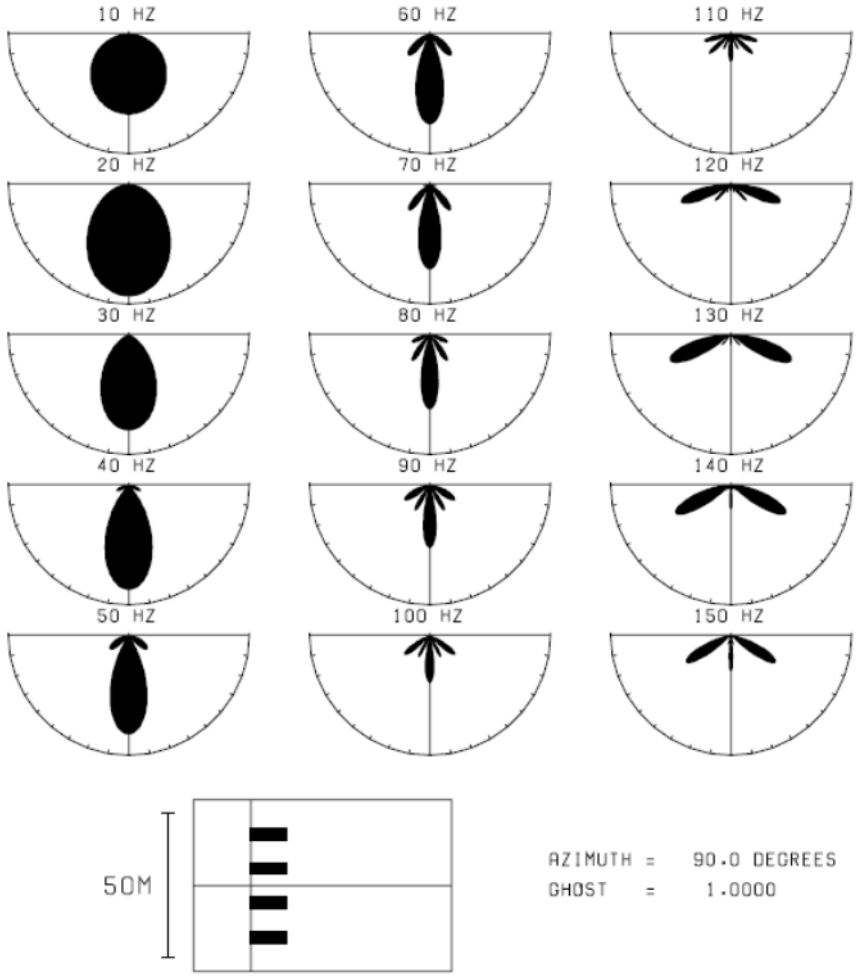


Figure 2-12: Graphical representation of a typical airgun array acoustical spectrum in water

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 2-6: Characteristics of the streamers

Parameter	Value
Streamer length	7,000m
Number of streamers	10+2=12
Streamer separation	150m
Streamer depth	8m (head) to 25m (tail)
Tow width	~1.75 to 2km (15% fan at tail)

Figure 2-13: 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 AD-03 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.

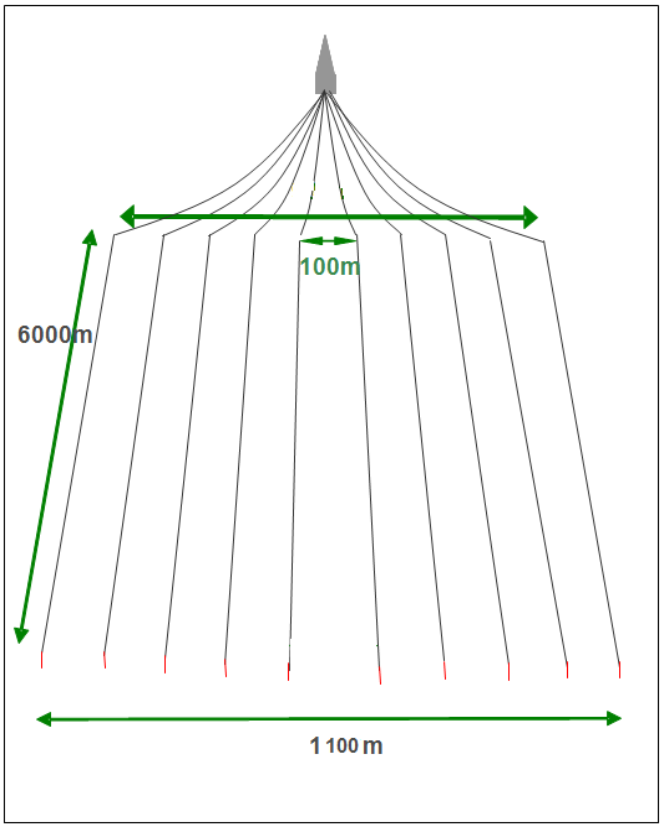


Figure 2-14: Fan mode geometry

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.

Figure 2-15: Example of birds

2.4.3.2. **Ancillary Equipment and Onshore Support**

Support vessels for this project will include one support vessel (*Rig Andromeda*) and two additional chase vessels (*7-Waves* and *Swissco Synergy*), which will accompany the survey vessel to monitor the survey zone and to provide any emergency assistance required.

Crew changes will be carried out by the support vessel from the port of Gyeiktaw.

It is likely that the survey vessel will be bunkered (refuelled) at sea within or immediately adjacent to the survey area, using the 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, LEGAL AND ADMINISTRATIVE FRAMEWORK

Currently, Myanmar does not have a detailed framework of laws or comprehensive action plans concerning environmental management. However, the Myanmar Government has been involved in a significant number of investments regarding strategic planning reforms of environmental management policy. The country has joined a number of international and regional agreements and treaties such as ASEAN (Association of South-East Asian Nations) and it is in the process of enhancing its national environmental laws.

This section presents a summary of the relevant regulatory framework that currently applies in the case of the AD-03 Block 3D seismic survey.

2.5.1. Environmental Institutions and Strategies

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 persons are simultaneously senior officials in the MFA, with the NCEA Chairman being the Minister of Foreign Affairs. Thus, there appears to be great potential for coordination between the MFA and NCEA, especially regarding international environmental rules and cooperation with international agencies.

The sectorial agencies in the area of environmental protection concerning the AD-03 Block are:

- National Commission for Environmental Affairs (NCEA);
- 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 is Myanmar's principal policy document on environmental protection. The NCEA also assists the sectorial ministries in drafting legislation and instruments with potential impact upon the environment (e.g. the Forest Law 1992, the Wildlife and Wild Plants Law 1994 and the Forest Policy and Forestry Action Plan 1995). The NCEA published the Myanmar Agenda 21 in 1997 which outlines programmes and activities for sustainable activities 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.

Furthermore, in 2003 the government released an Integrated Water Resources Management (IWRM) document entitled *Myanmar Water Vision* to generate public awareness and participation. A Strategic Planning and Management Plan was launched in 2004 as a result, leading to the development of core groups and the formation of the national Myanmar Water Resources Committee in 2005, comprised of numerous government ministries. The Myanmar Water Resources Committee has the aim of streamlining the relationships amongst water-related agencies, establishing rules for water resource management and establishing a pilot river basin management study.

A Strategic Plan on Integrated Water Resources Management in Myanmar was developed by The Inter-Ministry Task Force on Water Resources and Ministry of Agriculture and Irrigation with the aim of regulating the "sustainability of water resources to ensure sufficient water quantity of acceptable quality to meet the needs of the population in terms of health, food security, economy and environment." This plan involved the cooperation with the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the Food and Agriculture Organization (FAO) in June 2003 and recommended a new water Vision Statement, and the review and amendment of most of the laws, regulations and legislation set out in the early 1900s.

The Government of Myanmar was also involved in the ASEAN Strategic Plan of Action on Water Resources Management published in 2005. This document highlighted the need for reform in the water management assessment process through the ASEAN region and recommended the preparation of guidelines by an expert panel in regard to regional and national goals.

The Government is in the process of preparing the Union of Myanmar Environmental Protection Law (to be enacted in the very near future).

2.5.2. Myanmar Environmental Legislation Relevant to the Project

The laws which currently exist in Myanmar are generally broad and not specific. Detailed implementing legislation does not exist to deal with specific issues such as waste management, land use and biodiversity protection. Myanmar has no specific laws to govern air and water pollution. However, there are a number of discrete laws relating to environmental management in the Union of Myanmar.

The table below summarises Myanmar's environmental legislation that is relevant to the 3D seismic survey in the AD-03 Block.

Table 2-7: Myanmar environmental and socio-economic legislation applicable to the Project

Legislation	Description
Law on Standardization - The Pyidaungsu Hluttaw Law No.28/ 2014	The objectives of Law on Standardization are as follows: • to enable to determine Myanmar Standards; • to enable to support export promotion by enhancing quality of production organizations and their products, production processes and services; • to enable to protect the consumers and users by guaranteeing imports and products are not lower than prescribed standard, and safe from health hazards; • to enable to support protection of environment related to products, production processes and services from impact, and conservation of natural resources; • to enable to protect manufacturing, distributing and importing the disqualified goods which do not meet the prescribed standard and those which are not safe and endangered to the environment; • to support on establishing the ASEAN Free Trade Area and to enable to reduce technical barriers to trade. • to facilitate technological transfer and innovation by using the standards for the development of national economic and social activities in accordance with the national development program. By this law, the National Standard Council is to be formed as well as the Standard Working Committee.
Foreign Investment Rules – Notification No. 11/2013	In exercise of the power conferred under sub-section (a) of Section 56 of the Republic of the Union of Myanmar Foreign Investment Law (Law No. 21 of Pyidaungsu Hluttaw, 2012), the Ministry of National Planning and Economic Development has prescribed these Rules with the approval of Union Government. The Commission Office - Directorate of Investment and Company Administration is the responsible to implement the duties and responsibilities of Myanmar Investment Commission. Chapter II - "The Commission shall issue the Notification and designate the economic activities applicable to the Foreign Investment Law with the approval of the Union Government. It shall submit and obtain approval from the Union Government for the designation of investment businesses which are categorized by prohibited business for investment within the Union, investment business only to form joint - venture with citizens and investment business only permitted with the specific condition." Several businesses which are able to be carried out by citizens are prescribed in several Schedules. These rules also define the Economic Zones in Myanmar and on Chapter III the Forms of Investment are described. The investors should apply for a Permit by filling a Proposal Form, which will be analysed by the Commission and Government departments. If approved, a permit will be issued. Rules for construction periods, insurances, employment of staff and labour, land rights, foreign capitals are also defined under this

Legislation	Description
	notification.
Chemical and hazardous materials law - Pyidaungsu Hluttaw Law No.28/2013	The objectives of this law are as follows: • to prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials; • to control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business; • to carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically; • to carry out continuous development for worksite safety, health and environmental conservation. Chapter 7 – "Any person, who wants to do the business of chemical and associated materials, shall apply to the central body for the acquisition of the license, attached with the management plan for the environmental conservation in accord with the stipulations". Chapter 8 – "20. License holder shall apply to the central supervising body in accord with the stipulation for the relevant chemicals and associated materials using for his chemicals and associated materials business" for a certificate. "22. The registered certificate holder shall abide by the regulations contained in the registered certificate and shall follow the order and directives issued from time to time by the central supervising body".
The Environmental Conservation Law (30th March, 2012)	The objective of this Law is to implement the Myanmar National Environmental Policy, laying down the basic principles and giving guidance for systematic integration of environmental conservation matters in the sustainable development process. The 7th article confers the following powers and functions on the Ministry: • To set environmental quality standards. • To prescribe emission standards. • To formulate EIA and SIA systems. • To ensure the polluter pays principle. • To issue rules, regulations and by-laws as may be necessary with the approval of the Union Government. On the basis of this law, EIA rules have been issued in draft by the Myanmar administration on the 5th June 2014.
Foreign Investment Law - Law No. 21 of Pyidaungsu Hluttaw, 2012	Forms the Myanmar Investment Commission, its duties and powers and stipulates the rules for the investments in the country. A list of investments are restricted or prohibited a priori and others need to pass an approval procedure. The basic principles for investment in Myanmar are established. The duties and rights of the investors are also defined under this Law.
National Sustainable Development Strategy (2009)	This strategy presents a guiding document formulated by NCEA, MOF and UNEP and regards the sustainable management of natural resources, integrated economic development, and

Legislation	Description
	sustainable social development in the country.
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 Zone Law (2008)	After clause 3 of the annex to the Territorial Sea and Maritime Zone Law, clause 4 and clause 5 have been inserted with new coordinates which have no impact on the offshore AD-03 Block.
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)	This law has been created to establish a procedural framework for the 1994 Protection of Flora and Fauna, and Protected Area Conservation Law.
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

Legislation	Description
	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.
National Environment Policy (1994)	The aim of this law is "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 Protection of Wildlife and Conservation of Natural Areas Law (1994)	Government policy for wildlife protection, conservation of natural areas, protection and conservation of wildlife ecosystems and migratory birds, protect endangered species and their natural habitats. Chapter 11 outlines the penalties "causing water and air pollution, causing damage to a water-course or putting poison in the water in a natural area', and 'possessing or disposing of pollutants or mineral pollutants in a natural area".
Myanmar Insurance Law (1993)	The Myanmar Insurance is established under this Law as a legal entity having perpetual succession, capable of suing and being sued in its own name. The rules for establishing insurances in the country are established. The Myanmar Insurance is established with the following aims: • to overcome financial difficulties by effecting mutual agreement of insurance against social and economic losses which the people may encounter, due to common perils; • to promote the habit of savings individually by effecting life assurance, thus contributing to the accumulation of resource, of the State; • to win the trust and confidence of the people in the insurance system by providing effective insurance safeguards which may become necessary in view of the social and economic developments.
Union of Myanmar Marine Fisheries law (25 April 1990, amended 1993)	The relevance of this law to the offshore component of the AD-03 Block campaign 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."
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
The Petroleum Act (1939)	This act refers that the import, transport or store of any petroleum cannot be made save in accordance to the rules that may be defined by the President of the Union. "All receptacles containing dangerous petroleum shall have a stamped, embossed, painted or printed warning, either on the receptacle itself or, where that is impracticable, displayed near the receptacle, exhibiting in conspicuous characters the words " Petrol " or " Motor Spirit ", or an equivalent warning of the dangerous nature of the petroleum". It also establishes the needs and exemptions from licenses and authorizes the testing of petroleum by the President of the Union and rules that might issue rules on that regard.

Legislation	Description
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 may 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

On the 5th of June 2014 MOECAF has promulgated the Environmental Conservation Rules – 2014 and published a draft of the upcoming EIA procedures. It is thus appropriate for developers to complement the studies with their own internal environmental guidelines and internationally accepted best practice standards.

2.5.4. International Agreements and Conventions

The main international agreements and conventions that Myanmar is signatory to and that are relevant to the proposed Project, AD-03 are provided in the Table 2-8 below.

Table 2-8: International agreements and conventions relevant to the Project

International conventions and protocols	Adherence of Myanmar in
United Nations Framework Convention on Climate Change	2003
Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS)	1998
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1997
Convention for the Protection of the World Cultural and Natural Heritage	1994
London Amendment to the Montreal Protocol, London	1993
Convention on Biological Diversity, Rio de Janeiro	1992
Montreal Protocol on Substances that Deplete the Ozone Layer	1989
Vienna Convention for the Protection of the Ozone Layer	1988
United Nations Convention on Law of the Sea	1986
International Convention on the Prevention of Pollution from Ships, 1973 as modified by the protocol of 1978 (MARPOL 73/78)	1988 Myanmar has only ratified Annex I/II. Nevertheless, requirements of Annex IV and V have been applied for this IEE.
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

International conventions and protocols	Adherence of Myanmar in
SOLAS convention (Safety Of Life At Sea)	1987 International maritime safety treaty. It ensures that ships flagged by signatory States comply with minimum safety standards in construction, equipment and operation.
1948 Convention on the International Maritime Organization	1951
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.

2.5.5. International Guidelines and Standards Relevant to the Project

The following table summarizes the international guidelines and standards relevant to the Project, and applied for this IEE.

Table 2-9: 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: ● 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 aanticipated 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

Standards/guidelines	Aim/Goal
	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 acoustic energy sources should be used, where possible. ● 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.
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 onboard 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
EPBC Act Policy Statement 2.1 - Interaction between offshore seismic exploration and whales: Industry guidelines (September 2008)	The aim of the policy is to: 1. provide practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations. 2. provide a framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours, and 3. provide guidance to both proponents of seismic surveys

Standards/guidelines	Aim/Goal
	and operators conducting seismic surveys about their legal responsibilities under the Australian *Environment Protection and Biodiversity Conservation Act 1999*
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.
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 200m or less.

2.6. EMISSIONS, DISCHARGE AND WASTE INVENTORY

This section of the IEE 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).

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

Table 2-10: Hypotheses considered for the AD-03 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 105 operating days (three months of seismic survey + 15 days for mobilisation/demobilisation).

Table 2-11: 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 2-12: 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 96.15m by 21.5m at waterline metres (according to the *Sanco Sword* specifications– see **Annex 1**) and all water falling within this area will be contained in isolated drainage systems. Annual rainfall in the AD-03 Block area is in the order of 5,323mm/year. However, considering that the seismic survey is planned to take place in the first quarter 2015, the rainwater and deck washdown water volumes are likely to be almost zero because during these months there is very low rainfall (~ 1mm/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 2-13: Summary of deck and bilge water estimations

Waste stream	Quantity (m^3)	Assumption for estimation
Deck water	21	Survey vessel = 96.15 x 21.5m and rainfall about 1mm/month in the considered period. Support vessel = 90.5 x 14.6m and rainfall about 1mm/month 2 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 4 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 2-14: 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.

2.8. GEOGRAPHICAL SCOPE OF THE IEE

The geographical scope of the impact evaluation depends on the receiver environment, the involved activities and the direct or indirect nature of the impact as well as the potential for cumulative impacts. In fact, the geographical scope of the analysis should be part of the potential impact analysis, as one of the components of the impact analysis scope. It is legitimate to say that the impact intensity decreases with distance and/or that the contribution of this impact has a direct or cumulated impact that decreases with distance.

This IEE is focused on AD-03 Block 3D seismic survey to determine its potential and residual impacts.

The typical geographical scopes are given in the table below to set the order of magnitudes.

Table 2-15: Geographical scope

Impact factors	Physical environment	Natural environment	Human environment
Physical presence of vessels and towed equipment	Direct effects: streamers towed by survey vessel: less than 10 km	Direct effects: presence of equipment and buffer zones: several hundreds of metres	Indirect effects: up to several kilometres around survey vessel
Underwater acoustic emissions	Direct and indirect effects: around a few metres	Direct effects: around a few tens of metres Indirect effects : up to a few kilometres around the survey vessel	Direct effects: presence of towed equipment: less than 10 kilometres Indirect effects: up to several kilometres around survey vessel
Atmospheric emissions (GHG)	Direct effects: several kilometres for air quality aspects to worldwide for climate change aspects potentially associated with GHG emissions	Direct effects: between a few hundreds of metres to several kilometres Indirect effects : worldwide for climate change aspects potentially associated with GHG emissions	Direct effects: several kilometres for health aspects Indirect effects: worldwide for climate change aspects potentially associated with GHG emissions
Discharges to sea	Direct effects: tens of metres. There is a strong relation between impact intensity and distance	Direct effects: tens to hundreds of metres. There is a strong relation between impact intensity and distance. Indirect effects: tens of metres and potentially cumulative	Direct effects: tens of metres. Indirect effects: hundreds of metres to several kilometres. Effects potentially cumulative with other discharges from other activities
Vessel noise and light emissions	Direct effects: hundreds of metres to several kilometres. There is a strong relation between impact intensity and distance	Direct effects: hundreds of metres to several kilometres. There is a strong relation between impact intensity and distance. Indirect effects: several tens of kilometres	Direct effects: hundreds of metres to several kilometres. There is a strong relation between impact intensity and distance.
Hazardous and non-hazardous solid wastes	Direct effects: tens to hundreds of metres	Direct effects: tens to hundreds of metres. Indirect effects: several kilometres	Direct effects: hundreds of metres to several kilometres. Indirect effects: several tens of kilometres
Accidental fuel spills	Direct effects: several kilometres to tens of kilometres. No trans-boundary impacts expected	Direct effects: several kilometres to tens of kilometres. No trans-boundary impacts expected	Direct effects: several tens of kilometres
Workforce, subcontracting and supplies	-	-	Indirect effects: international effects (no hiring of local persons)

3. PROJECT PROPONENT DETAILS

The operator of the project is Ophir Energy PLC (Ophir).

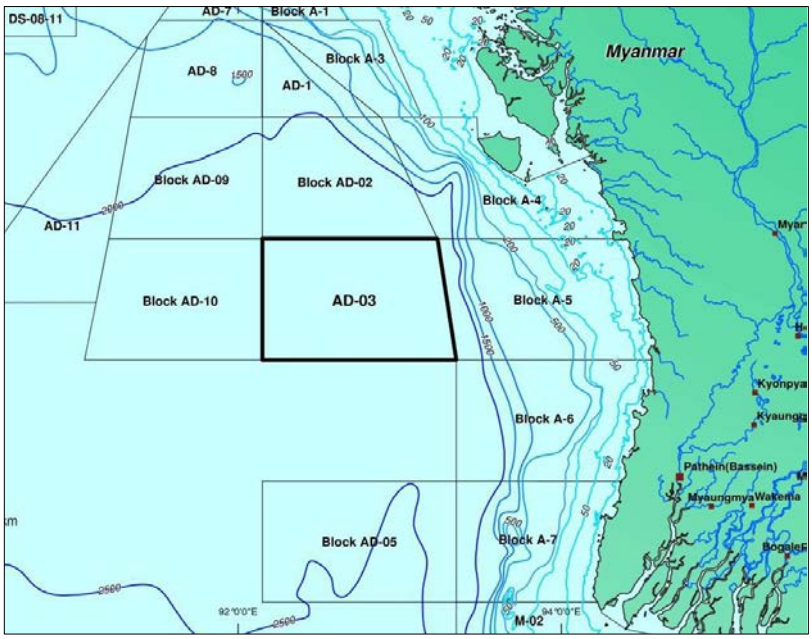
Ophir is the United Kingdom (UK) incorporated holding company of a group of companies with oil and gas exploration assets in a number of African locations. Ophir's headquarters are located in London (England), with operational offices in Perth (Australia), Dar es Salaam and Mtwara (Tanzania), Malabo (Equatorial Guinea), Libreville (Gabon), Nairobi (Kenya), Dakar (Senegal) and Yangon (Myanmar).

Since its foundation in 2004, the Company has acquired an extensive portfolio of exploration interests consisting of 17 projects in eight jurisdictions in Africa. Ophir is the fifth largest deep water acreage holder in Africa, present in four key emerging sub-Saharan exploration areas, and the largest net acreage holder in offshore East Africa. The company has an extensive and diversified portfolio of assets across East and West Africa comprised of 20 licences, 18 offshore and two onshore, located in 10 countries including Tanzania, Kenya, Equatorial Guinea and Gabon (Ophir, 2014).

In Myanmar, Ophir has been provisionally awarded a 95% operated interest in deep water Block AD-03 offshore waters as part of the current licensing round. The award is subject to finalisation of a Production Sharing Contract (PSC) with the Ministry of Energy (MOE).

The AD-03 Block is ~10,000 km^2 in area and is located in the offshore Rakhine Basin (Figure 3-1), on trend with the multi-TCF Shwe gas field. The initial exploration period will see Ophir re-process existing 2D seismic data and acquire new 3D seismic data.

The AD-03 Block 3D seismic survey is Ophir's first campaign in Myanmar.



Source: OPHIR, 2014

Figure 3-1: Location of AD-03 Block, offshore Myanmar

4. INFORMATION ON EXPERTS

Artelia operates a branch office in Yangon since October 2012 and has already performed offshore environmental monitoring and several EIA studies for Oil & Gas companies in Myanmar.

An environmental engineer from Artelia's Risk, Society & Environment department is based in Yangon, which facilitates data collection and local coordination and allows Artelia to have a good understanding of the local context and requirements, as well as access to existing data about the offshore environment in Myanmar.

Artelia's experts also have a good knowledge of seismic survey environmental and social issues: the project team includes an Environmental Project Manager with several years of experience in ESIA studies, an environmental engineer trained in Marine Mammal Observation (MMO) standards (such as the UK JNCC guidelines) and a social specialist experienced in the management of offshore seismic surveys in Asia. The curriculum vitae of the team are presented in **Annex 2** of this report.

Table 4-1: Project's Team presentation

Name	Specific Knowledge/Skills	Responsibility
Rita ARNAUD	Project Manager/environmental engineer	Sections 0 and 1 Sections 2.1, 2.2, 2.5 to 2.8 Sections 3 and 4 Sections 5.1, 5.2.2, 5.2.3, 5.2.5, 5.5 Section 10, 11
Anne-Charlotte DUFAURE	Environmental engineer, Marine Mammal Observer (JNCC accredited)	Section 2.3 and 2.4 Section 5.3
Armeline DIMIER	Social impact management specialist	Section 5.4 Section 6: inputs on 6.2 Section 7: inputs on 7.7 Section 8: inputs on 8.7 Section 9
Charles BOUHELIER	Environmental engineer, based in Yangon	Responsible for data collection, local coordination with stakeholders
Dr. Frederic MATHIEU	Environmental expert, noise modelling	Technical control acoustic analysis
John Philip BUTLER	Senior project engineer	Section 5.2.1 and 5.2.4 Technical peer review
Christophe DERRIEN	Senior HSE engineer	Technical peer review, QA/QC
Dr. Mark MCLELLAN	Senior project engineer	Technical peer review, Executive Summary
Dr. Jeremy COLMAN (Galaxia Marine Environmental Consulting Pty Ltd)	Marine scientist	Sections 6, 7 and 8 Technical peer review, QA/QC
Dr. Nick FITZGERALD (Ophir Energy plc)	Project geophysicist	Technical peer review Section 2

5. DESCRIPTION OF THE ENVIRONMENT

5.1. INTRODUCTION

This section provides a description of the existing environmental conditions of the AD-03 Block within the maritime jurisdiction of Myanmar (offshore) and its north-western coastal areas.

The main environmental and social data for the project area has been obtained from a bibliographical research and previous environmental studies performed by Artelia in Myanmar.

The study area covers all potential zones that may be exposed to potential impacts from project activities, i.e. the offshore area of the project in the Bay of Bengal, the coastal area of the Rakhine region, its natural environment (wetlands, rivers, national park, forest, deltas, etc.) and socio-economic context.

Figure 5-1 presents the location of the AD-03 Block and the nearest coastal zone to the project.

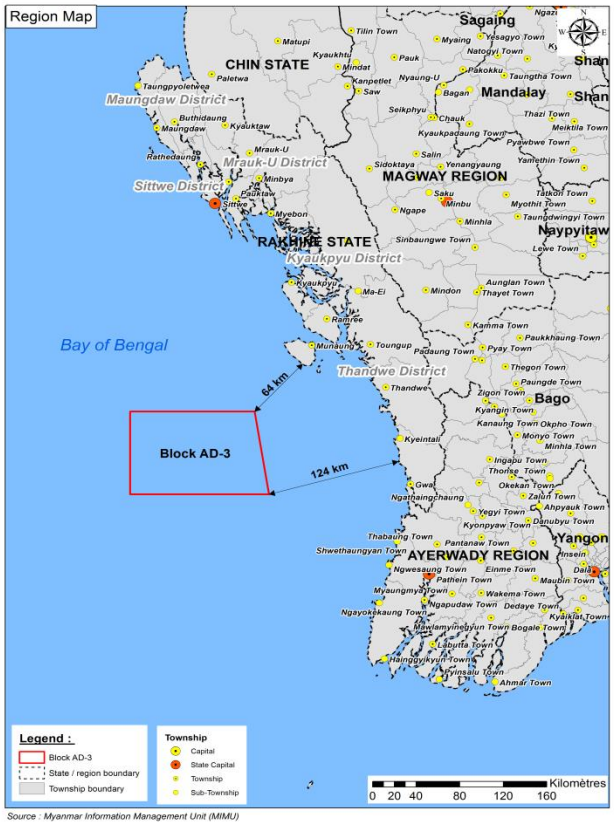


Figure 5-1: Location of the AD-03 Block, offshore Myanmar

5.2. PHYSICAL ENVIRONMENT

Myanmar is the largest country in mainland Southeast Asia comprising a land area of over 676,577km^2 and l located geographically between 9°32' and 28°31' N latitude and 92°10' and 101°11' E longitude stretching

over 2,280km. 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 5-2a).

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 5-2b). The Ayeyarwady (2,170km long), with its major tributary the Chindwin (960km) has a vast drainage area (~255,081km²) (Figure 5-2c) 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.

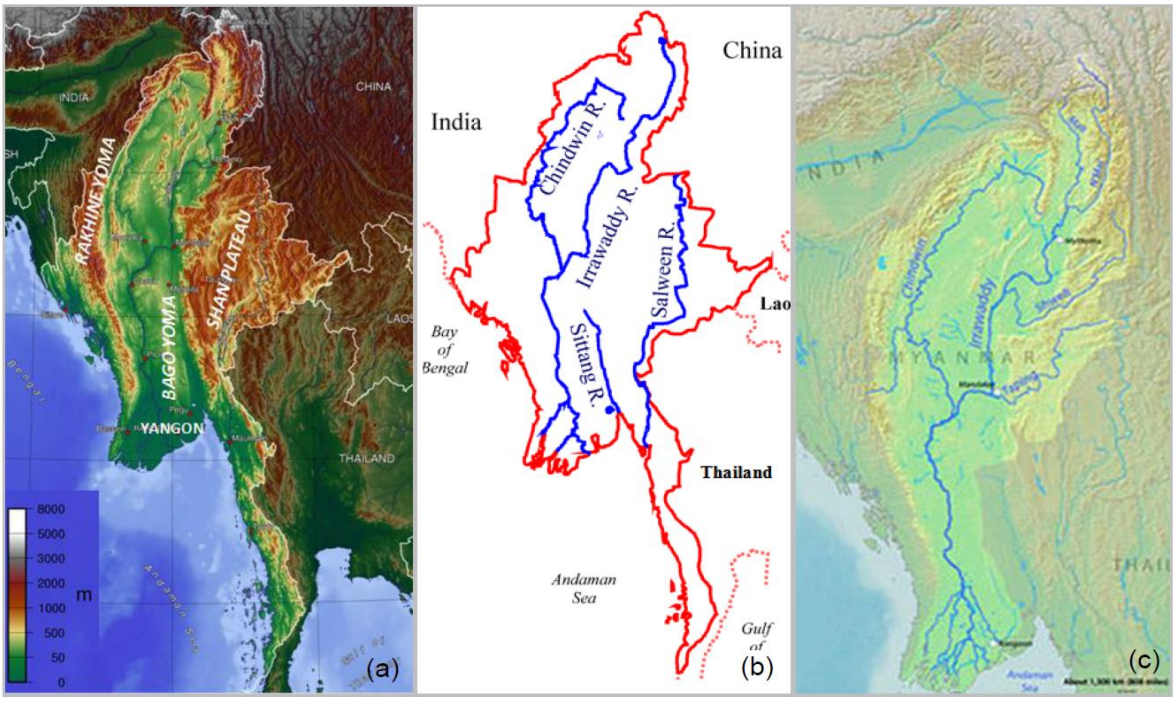


Figure 5-2[1]: Elevations and rivers in Myanmar

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

The country as a whole can be divided into three main agro-ecological zones: i) Central Dry; ii) Coastal; and iii) Hilly (Figure 5-3a). 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 5-3b)[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.

[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
[4] http://www.roadtomandalay.com/business/myanmar_burma.htm

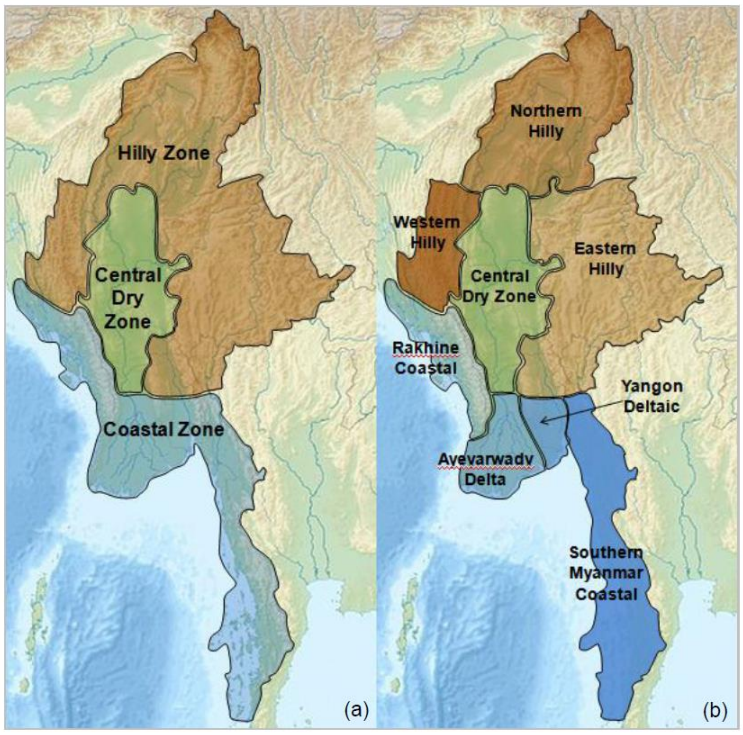


Figure 5-3[5]: Myanmar's agro-ecological zones (a); and physio-geographic regions (b)[6]

The project is located in the offshore area of the Rakhine Coastal Zone which is adjacent to the Bay of Bengal in the west and has a total land area of 367,780km^2. The mountain ranges within the Rakhine State extend from Bangladesh to the Chin State and slope downwards from north to south, having average elevations of ~900m. The Rakhine coast extends 740km from the Naff River in the north to Mawdin Point in the south. The upper part of the coastline is shallow and deltaic and the southern part is more or less rocky. The continental shelf down to 200m water depth is narrow compared to other areas. Two big islands namely "Yan-bye Kyune" (Ramee Island) and "Man-aung Kyune" (Cheduba Island), are located near the Sittwe valley of the Rakhine coast (BOBLME, 2011).

5.2.1. Geology and Geomorphology

Geomorphologically as well as tectonically, Myanmar can be subdivided into four major tectonic provinces which are north-south trending linear belts, these are from east to west: (1) Shan-Tanintharyi Block; (2) Central Cenozoic Belt; (3) Western Fold Belt; and (4) Rakhine Coastal Belt.

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).

- The first province was originally a part of Sinoburmalaya Block (also known as the Sibumasu Block) which had been situated in northern Gondwanaland and which started separating from it in Carboniferous times. It collided and combined with the Indochina Block to form the Proto-Southeast Asian Peninsula. This Eastern Highland is a part of the Shan-Thai Block, a large tectonic domain that connects to the Pacific tectonic plate; it is composed mainly of older rock groups containing plateau limestone and a metamorphic complex. It is bounded on its western edge by a large active fault, the Sagaing Fault (Win Swe, 1981).

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

- The other three provinces form part of the Burma-Andaman plate and are more closely related to each other (e.g. P.Basu et al., 2010); they have a strong flycsh component and are variously influenced by the collision between Indian Plate and Eurasia Plate at the close of Eocene. That collision also caused clockwise rotational movement of the Southeast Asian Peninsula. Then, during the Middle Miocene the oceanic crust moved northwards from a spreading centre in the Andaman Sea (Ir. Subagyo Pramumijoyo; Kyaw Linn Zaw; Kyaw Zin Lat, 2010).
    - The fertile alluvial plain is the Central Lowland, intermittently cropped out by the mountain range and hills running in north south direction and also enhanced by Mount Popa, a dormant volcano in its central part. (Ir. Subagyo Pramumijoyo; Kyaw Linn Zaw; Kyaw Zin Lat, 2010). The Central Myanmar Basin shows typical features of an en-echelon right pull-apart basin (Rangin, 2012).
    - Geologically, the Western Fold Belt or Indo-Burman Ranges consists mostly of a very thick sequence of flysch type sedimentary rocks and tectonic mélange of basic and ultrabasic rocks and exotic limestone in the form of ophiolite suite as resulted by the subduction of the Indian Plate underneath the Burma Plate along the Bengal tectonic boundary and also continued collision between these two plates leading to high mountain arc in the west and north-western parts of Myanmar. (Ir. Subagyo Pramumijoyo; Kyaw Linn Zaw; Kyaw Zin Lat, 2010). The Indo-Burman Ranges and southern extensions along the Andaman-Nicobar islands show obliquely accreted volcanic ridges (90°) associated with exotic continental terrains which drifted from Antarctica during the northern motion of India. The original material (ophiolites and flycsh sequences) are metamorphosed to blue schist facies.
    - The Rakhine Basin, where the project is located, forms the transition with the Bay of Bengal and is described below.

Due to location of the Bengal Basin at the juncture of three interacting plates, viz., the Indian, Myanmar and Tibetan (Eurasian) Plates, the basin-fill history of these geo-tectonic provinces varied considerably. Sedimentation in the Bengal Basin started in isolated graben-controlled basins on the basement. With the breakup of Gondwanaland in the Jurassic and Cretaceous, and northward movement of the Indian Plate, the basin started downwarping in the Early Cretaceous and sedimentation started on the stable shelf and deep basin; and since then sedimentation has been continuous for most of the basin (Alam, M, Alam MM, Curray JR, Chowdhury ALR, Gani MR., 2003). The Indian Plate subducts beneath the Burma Plate at the Sunda Trench or Java Trench, with a length of 2,600km and maximum of depth of 7,725m; the pressure of the two plates on each other in this location increases pressure and temperature resulting in the formation of a volcanic arc called the Sunda Arc. As a consequence, this area has a very intense seismicity; the most impressive event was the Sumatra-Andaman earthquake and Asian Tsunami, as a result of the pressure in this zone, causing an underwater earthquake which then resulted in a huge tsunami in 2004. With a magnitude of M_W 9.1–9.3, it was the third largest earthquake ever recorded on a seismograph.

The project lies in the offshore part of the Rakhine Basin, which is ~850km long by 200km wide. This basin is located at the contact between a rigid oceanic part of the Indian Plate (Bay of Bengal), and the Burma-Andaman platelet; it is bounded to the east by the Indo-Burma Ophiolite belt, and extends south into the Andaman-Sunda-Java foredeep. The Burma-Andaman platelet is a narrow sliver plate that developed during the Cenozoic along the India – Sunda plate boundary (Rangin, 2012). In Myanmar, the contact between the Burma and Sunda plates occurs as a major dextral fault, known as the Sagaing fault, which in the south of the country connects to the Andaman rift. The Sagaing fault aborbs at least half of the deformation related to the India – Sunda contact.

A key feature of the Eastern Indian Ocean is the Ninetyeast ridge, a very straight north-south ridge that extends for 2,500 nautical miles (nm) from 12°N to 30-32°C and consists of Ocean Island Tholeiitic basalt. This feature is considered to be an extension of the Kerguelen hot spot. Although it does not appear clearly in the topography of the project area, free air gravity maps suggest that it might extend that far north, and this is confirmed by 2D seismic surveys. It has also been suggested that the presence of the Ninetyeast ridge contributes to preventing the subduction of the India under Burma and forcing a pure dextral strike-slip instead (Rangin, 2012).

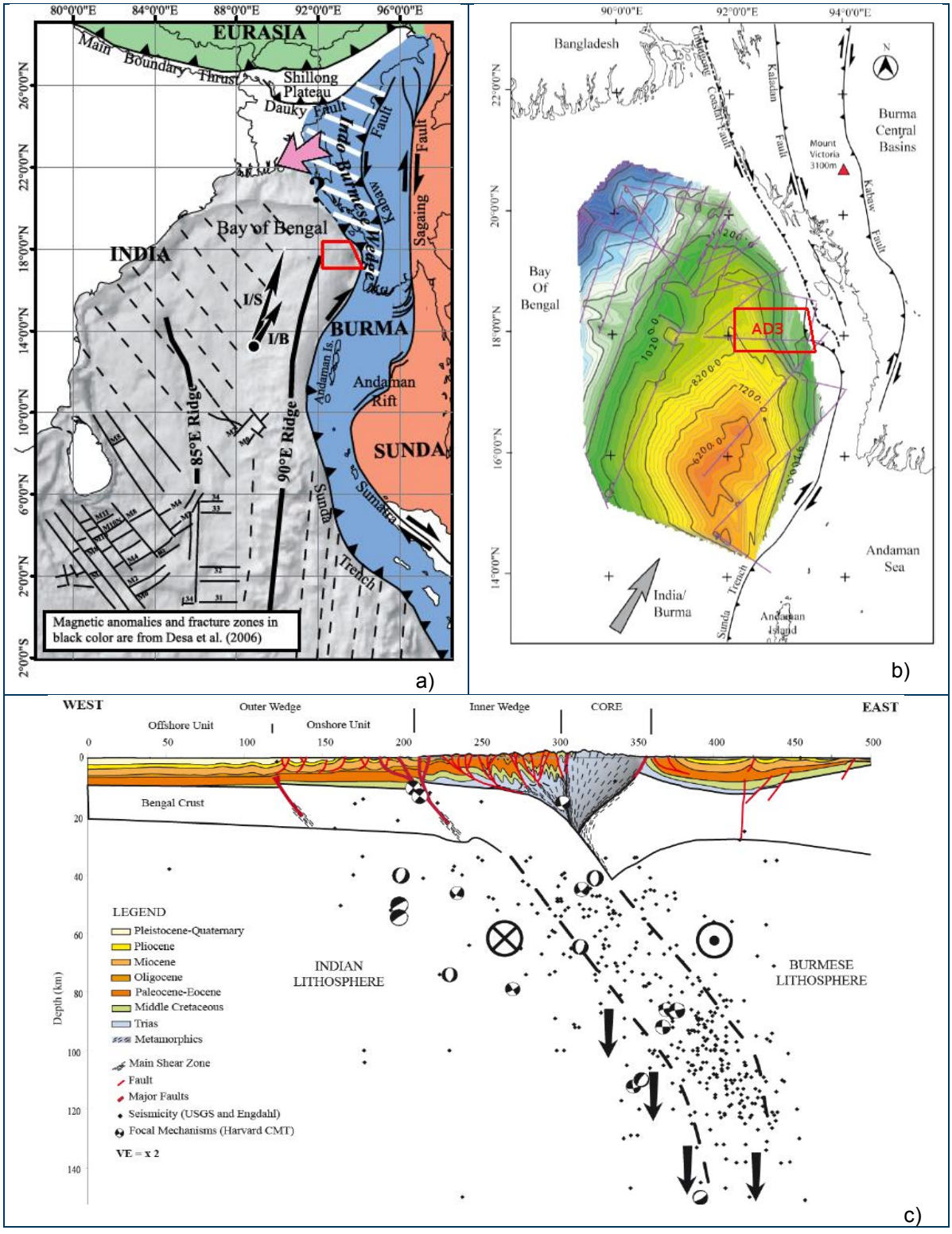
The tectonic evolution of Rakhine Basin is closely related with the oblique convergence of the Indian plates beneath the Burma plates. Three structural provinces are evident in the basin. From east to west they are: thrust and nappe fold belt, gentle fold transitional zone and abyssal plain. The Middle Miocene to Pleistocene

sequences shows different characteristics of deepwater deposition, which the Late Pliocene sequence dominantly exhibits meandering channel features, with its termination into fan lobes (Hongping, Fuliang, Fan, Mao, & Hui, 2012) (see section 5.2.4).

No clear subduction zone appears in 2D seismic surveys across the Rakhine Basin; it seems that the subduction plane is in the process of getting disconnected from the Indian Plate. Moreover, in northern Myanmar, the tracking of geodetic movements and other evidence suggest a major gravity collapse of the Tibetan plateau has been affecting the northern movement of the platelet for the last 10 million years (Ma) (Rangin, 2012). The sediments in the Rakhine Basin may thus correspond to an accretionary wedge along the plate boundary (Basu et al., 2010), with a major gravity sliding (Rangin, 2012).

In summary, the major processes affecting Myanmar are: (1) the subduction (with collision only in the north) of the northward moving India Plate underneath the Burma Plate at an average rate of 4 to 6 cm/yr along the Andaman Megathrust Zone; (2) the northward movement of the Burma Plate from the spreading centre in the Andaman Sea at an average rate of 2.5 to 3 cm/yr.

Very large over-thrusts along the Western Fold Belt have resulted from the former movement, and the Sagaing and related faults from the latter movement. Intermittent jerks along these major active faults have caused the majority of earthquakes in Myanmar. These seismo-tectonic processes are still going on. The earthquakes generated by seafloor spreading in the Andaman Sea, however, are mostly small to moderate and shallow-focus (Ir. Subagyo Pramumijoyo; Kyaw Linn Zaw; Kyaw Zin Lat, 2010). Additionally, a gravity collapse of the Himalaya leads to movements towards the west in northern Burma (Rangin, 2012). Key periods shaping the tectonics of Myanmar are the lower Eocene (collision of Indian and Eurasian plates) and the upper Miocene (separation between India and Australia) (Maurin, 2009).



Sources: Maurin, 2009, Maurin & Rangin, 2009

Figure 5-4: Structural geology around the project area (a) Plate boundaries; (b) Depth of basaltic basement (extension of Ninetyeast ridge under the sediment); (c) Transect from

Bay of Bengal to Central Myanmar Basins at 22°N (north of the project area)– shoreline is located in the outer wedge. Dark arrows indicate motion of Indian plate, pink arrow growth direction of Indo-Burmese wedge.

5.2.2. 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%.

Myanmar has three distinctive seasons namely: hot, dry inter-monsoonal (March to May with average temperatures 30-35°C), rainy Southwest Monsoon (June to October with average temperatures 25-30°C) and cool relatively dry Northeast Monsoon (November to February with average temperatures 20-24°C). Temperatures are generally lower in mountainous regions.

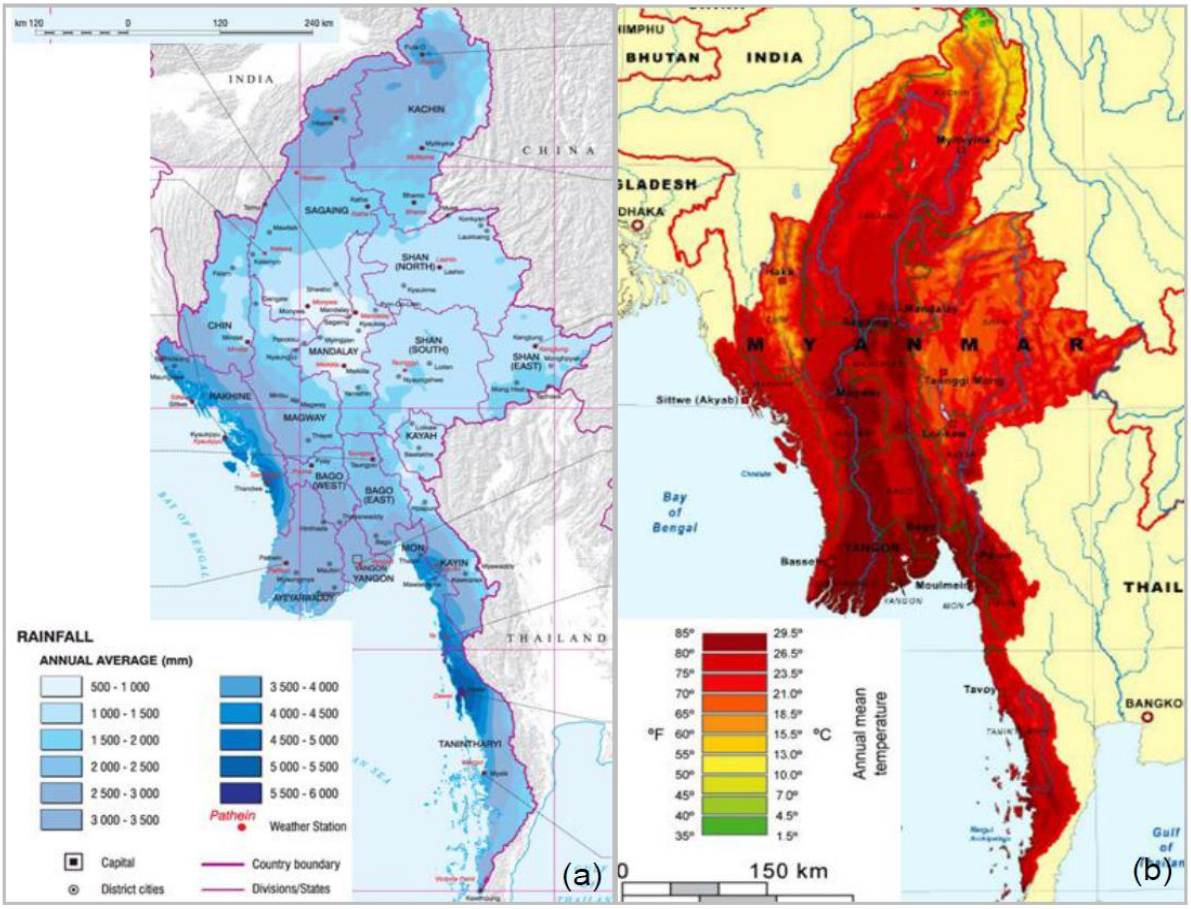


Figure 5-5[7]: Annual average rainfall (a); and annual average temperatures over Myanmar (b)

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

The country receives practically all its rainfall between mid-May and October, when the sun's rays strike directly above the equator and the land mass of Asia is heated more than the Indian Ocean. This draws moist hot air from over the ocean onto the land, bringing the rains of the Southwest Monsoon season. Annual precipitation in most of Upper Myanmar averages ~890mm and in Lower Myanmar ~5,080 mm[8].

When the tilt of the earth brings the direct sun rays south of the equator, the heating of the Indian Ocean draws the cooler dry air of the Northeast Monsoon from the highlands of Asia across the countries of South and Southeast Asia. The dry, cooler weather occurs from October/November to February.

According to the Department of Meteorology and Hydrology of the Myanmar's Ministry of Transport the closest coastal meteorological station to the AD-03 Block is Sandoway in Thandwe (~118km from the block) (Figure 5-6). Details of the Thandwe meteorological station are provided in Table 5-1.

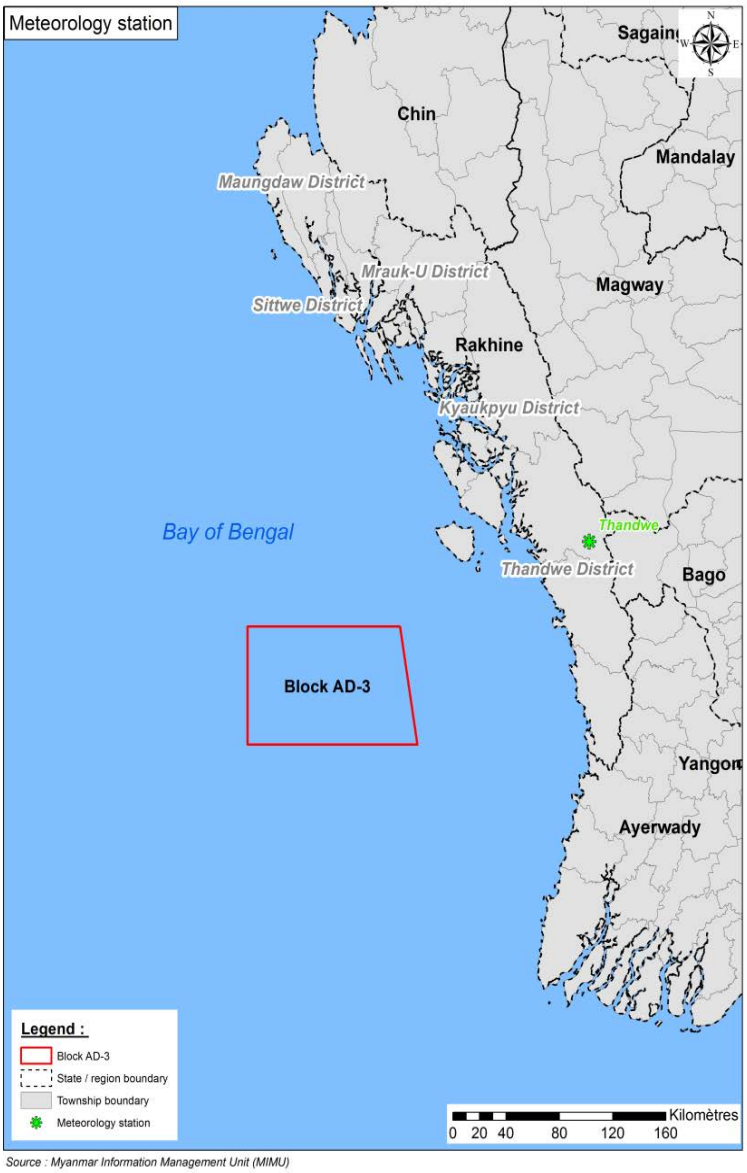


Figure 5-6: Location of the nearest meteorological station to the AD-03 Block

[8] http://tourismmyanmar.com/climate.htm

Table 5-1: Details of Thandwe meteorological station

Source: World Meteorological Organization/ Myanmar's Ministry of Transport

Division	District - #	Station	Station Code	Coordinates	Elevation	Years
Rakhine	Thandwe - 1204	Sandoway	48080	Latitude 18°47' Longitude 94°35'	11m	30

Therefore, it is possible to estimate the conditions in the project area from the meteorological conditions observed at this station. The following data was recorded at this station according to the World Meteorological Organization.

5.2.2.1. **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.

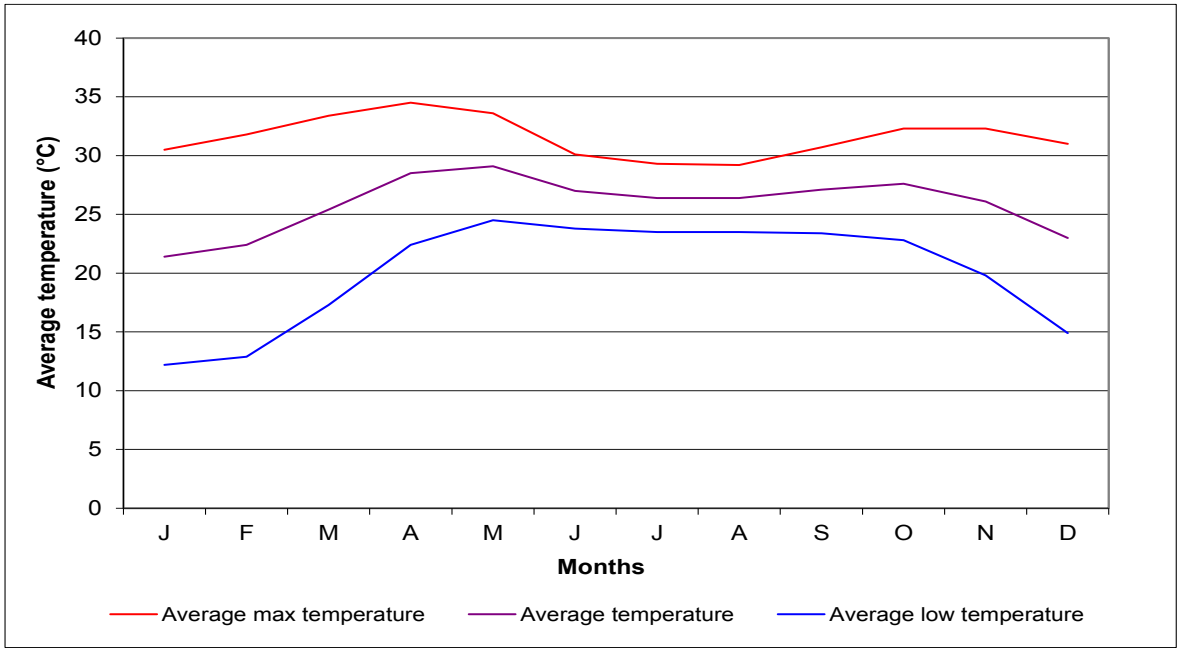
According to the following data, the average annual temperature at Thandwe is 25.8°C (Figure 5-7). The maximum temperatures are recorded in April (34.5°C) and the minimum in January (12.2°C).

Table 5-2: Average temperatures recorded in Thandwe district

Source: World Meteorological Organization/ Myanmar's Ministry of Transport

T (°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av.[3]
Maximum[1]	30.5	31.8	33.4	34.5	33.6	30.1	29.3	29.2	30.7	32.3	32.3	31	**31.6**
Minimum[2]	12.2	12.9	17.3	22.4	24.5	23.8	23.5	23.5	23.4	22.8	19.8	14.9	**20.1**
Mean	21.4	22.4	25.4	28.5	29.1	27	26.4	26.4	27.1	27.6	26.1	23	**25.8**

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



Source: World Meteorological Organization/ Myanmar's Ministry of Transport

Figure 5-7: Average temperatures at Thandwe

5.2.2.2. **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)[9].

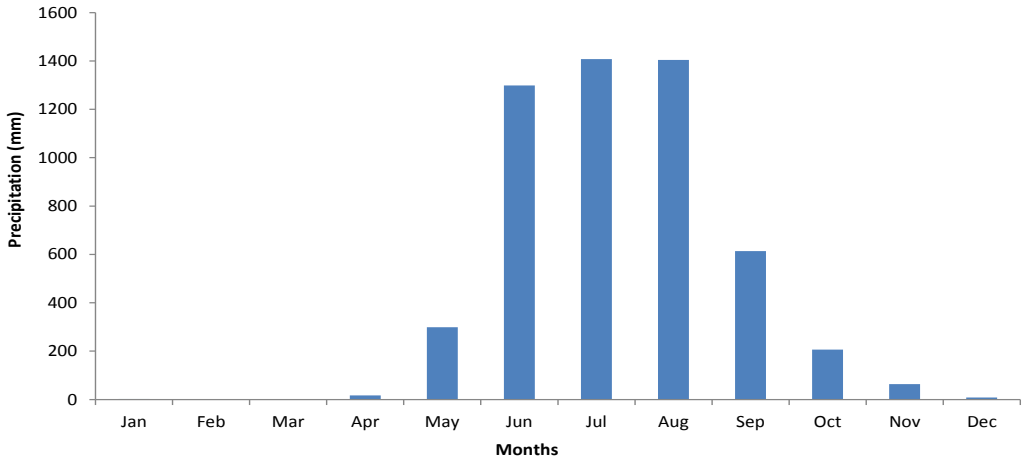
Levels are highest along the coast exposed to the moist Southwest Monsoon from Chittagong to Victoria Point, which covers the entire Myanmar coast. Intense rainfall events are quite common with up to 250mm in a day and 100mm in one hour, depending on the period.

Rainfall in Lower Myanmar continues almost daily from late May until October (this is also the case in Thandwe) (Figure 5-8). In most months of the year, there is significant rainfall in Thandwe, with an annual average rainfall of 4,798mm. Torrential rain falls from June to September, with over 1,200mm falling in each of the months of June, July and August.

Table 5-3: Average rainfall recorded in Thandwe district

Source: World Meteorological Organization/ Myanmar's Ministry of Transport

(mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average rainfall	2	1	1	17	299	1299	1408	1404	614	206	64	8	**5,323**



Source: World Meteorological Organization/ 30 years of record

Figure 5-8: Rainfall at Thandwe

As shown in Table 5-3 and Figure 5-8, the driest month is January. Most rainfall occurs in June-August with an average of 1,370mm. The average annual rainfall is 5,325mm.

5.2.2.3. **Humidity**

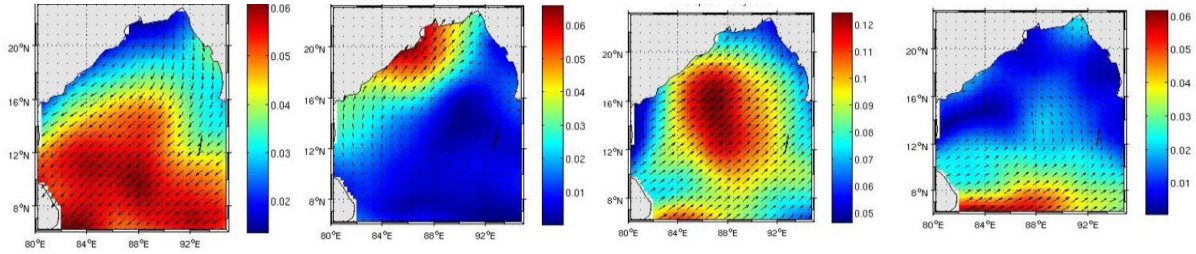
The main differences in the humidity values occur during the seasonal changes from the moist equatorial air of the Southwest Monsoon to the dry continental winter monsoon.

[9] 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.

5.2.2.4. **Wind**

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).

Several modelling studies show that the annual wind circulation in the Bay of Bengal alters twice a year. This pattern is characterized by northeast winds that blow from November to February with minimum intensity along the coast and southwest winds that blow from May to September with maximum intensity in the centre of the Bay. The intervening months are the transition months from winter to the summer monsoon period and from the summer to the winter monsoon period (Figure 5-9).



a) b) c) d)

Source: (RAMMOU, 2012)

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

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

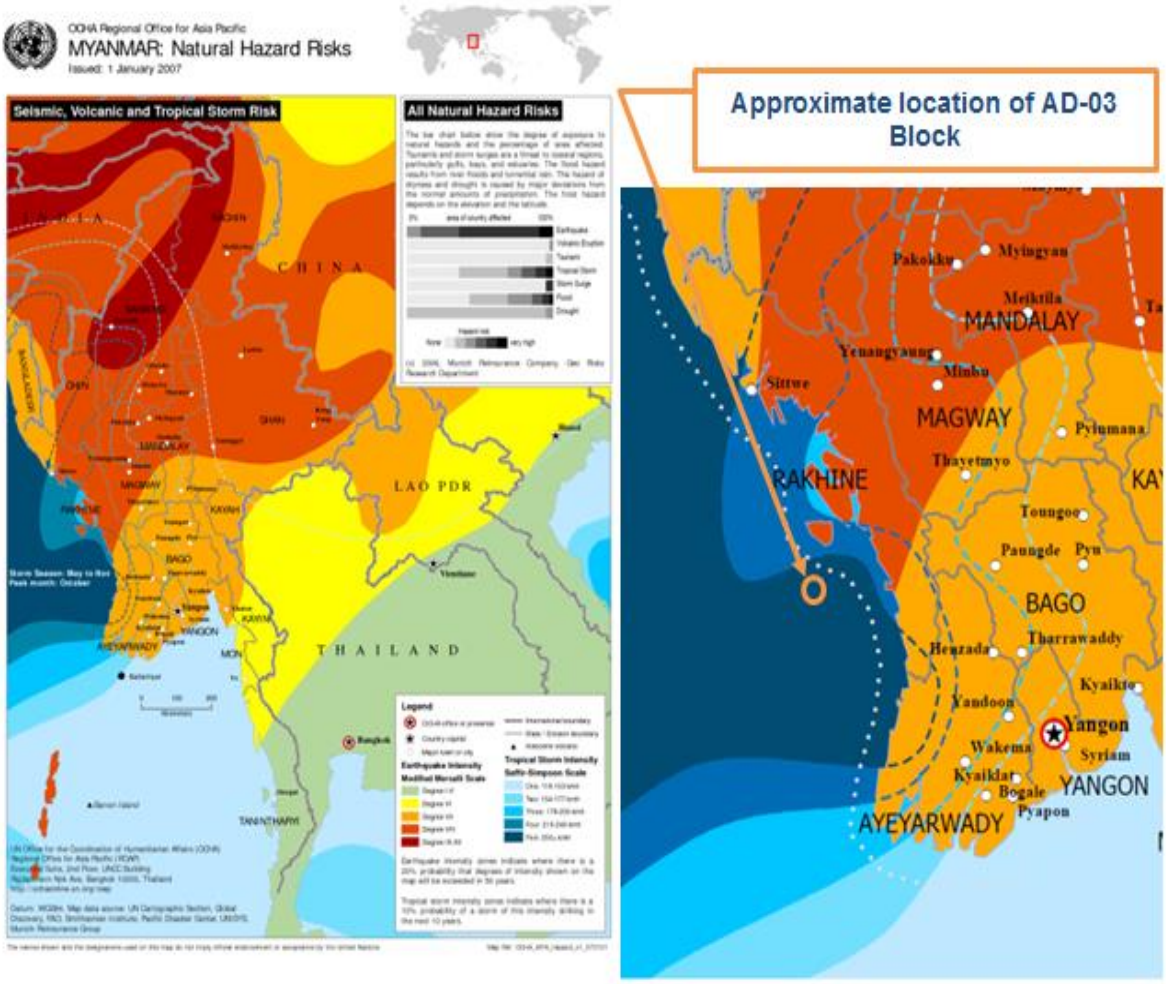
5.2.2.5. **Vulnerability to natural hazards**

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.

The United Nations Development Programme (UNDP) project “Multi-Hazard Risk Assessment in the Rakhine State, Myanmar” performed modelling studies and assessments of several priority hazard types in Rakhine State, namely:

- cyclones and storm surge;
- riverine flood;
- landslides;
- rural and forest fire;
- earthquakes; and
- tsunami.

According to the Regional Office for Asia Pacific of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the tropical storm season in Myanmar occurs from May to November, with a peak of risk in October. Taking into account the figure above, the major natural hazard risks in Myanmar are, according to OCHA, earthquakes; tropical storms; and floods (onshore). Earthquake intensity zones indicate where there is a 20% probability that degrees of intensity shown on the map will be exceeded in 50 years - red, orange, yellow and green colours in Figure 5-10. Tropical storm intensity indicates where there is a 10% probability of a storm of this intensity striking in the next 10 years – shades of blue in Figure 5-10. It is possible to conclude that in the Rakhine region the Earthquake Intensity Degree is VIII (Modified Mercalli Scale – maximum Degree is IX to XII) and the Tropical Storm Intensity is Four in the coastal area and Five (maximum) in the offshore areas according to the Saffir-Simpson Scale.



Source: OCHA, 2011[10]

Figure 5-10: Natural hazard risks in Myanmar according to OCHA (L/H side) and a closer view to the Rakhine region (R/H side)

The AD-03 Block is therefore highly exposed to tropical storms with a high risk period from May to November, and a highest risk in October (outside the predicted timeframe for the project), and is in a high risk area for significant earthquakes.

The proposed outline of the Emergency Response Plan to be implemented in the event of a tropical storm or earthquake event is provided in Annex 5. The specific detailed Emergency Response Plan will be provided after the seismic contractor is selected. more detailed description of cyclones and tsunamis in the Rakhine State is provided in section 5.2.3.

5.2.3. Regional Oceanography

5.2.3.1. **Bathymetry**

Water depths range from ~1,980m to more than 2,400m in the southeast part of the AD-03 Block (Figure 5-11; also refer to **Annex 4**).

[10] http://reliefweb.int/sites/reliefweb.int/files/resources/map_1303.pdf

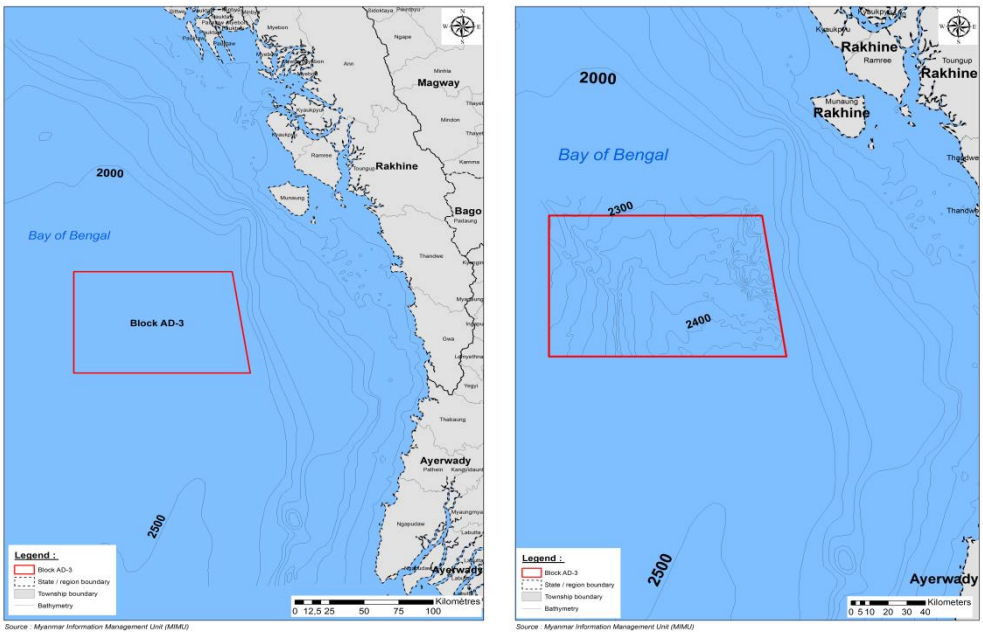


Figure 5-11: Bathymetry of the project area

5.2.3.2. **Tides**

According to the UNDP Hazard Assessment study, an average value of the maximum tidal range (2.4m), corresponding to spring tide, was obtained based on data from several tidal stations along the coast of Rakhine State (Table 5-4).

Table 5-4: Tidal range along the coast of Rakhine State, based on Mean High Water Spring (MHWS) and Mean Low Water Spring (MLWS) conditions

Source: Admiralty Chart Nos. 817 and 818 – (National Environmental Conservation Committee, Ministry of Environmental Conservation and Forestry; Myanmar Ministry of Tranport - Department of Meteorology and Hydrology; UNEP, 2012)

Location	Tidal station		Max. tidal range based on MHWS and MLWS (m)
	Latitude (N)	Longitude (E)	
Chaungtha Kyun	16° 57’	94° 26’	2.0
Gwa Bay	17° 35’	94° 34’	2.1
Andrew Bay	18° 21’	94° 21’	2.2
Sagu Kyun	18° 48’	93° 59’	2.3
Searle Point	18° 54’	93° 37’	2.5
Kyaukpyu	19° 26’	93° 33’	2.8
Sittwe	20° 08’	92° 54’	2.3
S. Martin’s Island	20° 37’	92° 19’	2.7
Average max. tidal range along seaboard off Rakhine State			**2.4**

5.2.3.3. **Waves**

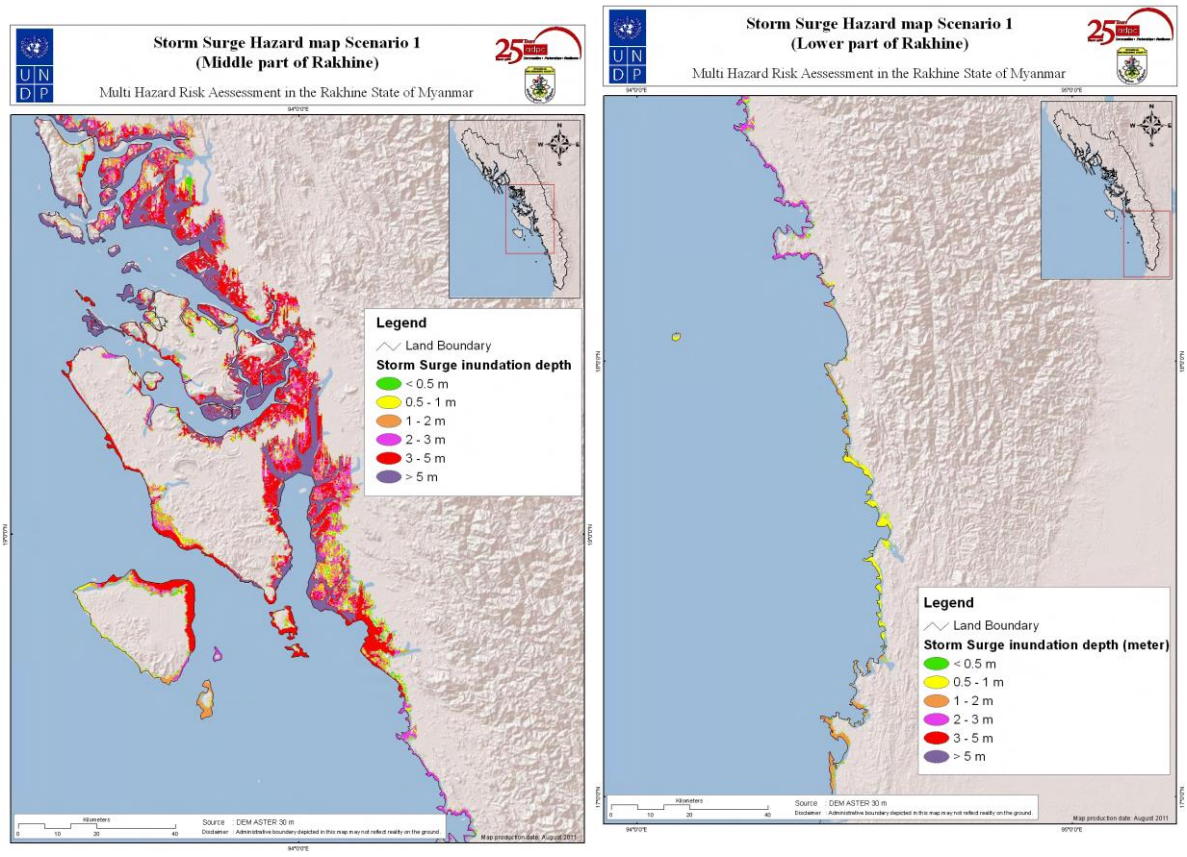
The movement of swell in the region is related to the dominant monsoon wind. The area from the Ganga (Ganges) estuary to the Gulf of Martaban, including the Andaman Islands, has a generally moderate swell from the southwest, though this becomes heavy during the Southwest Monsoon. Turbulent seas are encountered from time to time, associated with storms.

5.2.3.4. **Storm Surge**

Storm surge is an extraordinary flooding due to a storm. It generally occurs due to waves generated by the strong wind in tropical revolving storms. The slope of the coastline is considered as one of the important factors controlling the intensity of storm surge. Myanmar, which borders the Bay of Bengal and the Andaman Sea, has a 2,400km long coastline that is potentially threatened by waves, cyclones and associated weather.

In the 1982 Gwa cyclone, with a radius of maximum wind at 30km, the storm surge was as high as 4m near the landfall point near Gwa. The 1992 Thandwe cyclone, with a radius of maximum wind at 20km, resulted in the maximum surge of 1.5m near Thandwe, and in Sittwe at 0.7m in height. During the 1994 Sittwe cyclone, with a radius of maximum wind at 30km, the maximum surge that occurred near Sittwe was 4m. In addition, there are also two more storm surge events—viz. Kyaukphyu (2003), Gwa (Mala cyclone) (2006) (UNDP Myanmar; ADPC; GRIP; UNDP, September 2011).

GIS-based modelling tools and supplementary software were used by UNDP Hazard Assessment study to obtain the likely inundation distribution onshore, based on the computed surge heights at the Rakhine coastline. Several scenarios were studied according to a statistical analysis of past cyclone events. Storm surge hazard maps, depicting the spatial distribution of onshore inundation at high tide obtained for a scenario of a tropical storm event of maximum wind speed of 270km/h, are presented in Figure 5-12.



Source: (UNDP Myanmar; ADPC; GRIP; UNDP, September 2011).

Figure 5-12: Storm surge hazard map for the Rakhine State of Myanmar (central and southern part) corresponding to a tropical cyclone event of maximum wind speed 270 km/h

5.2.3.5. **Currents and Circulation Patterns**

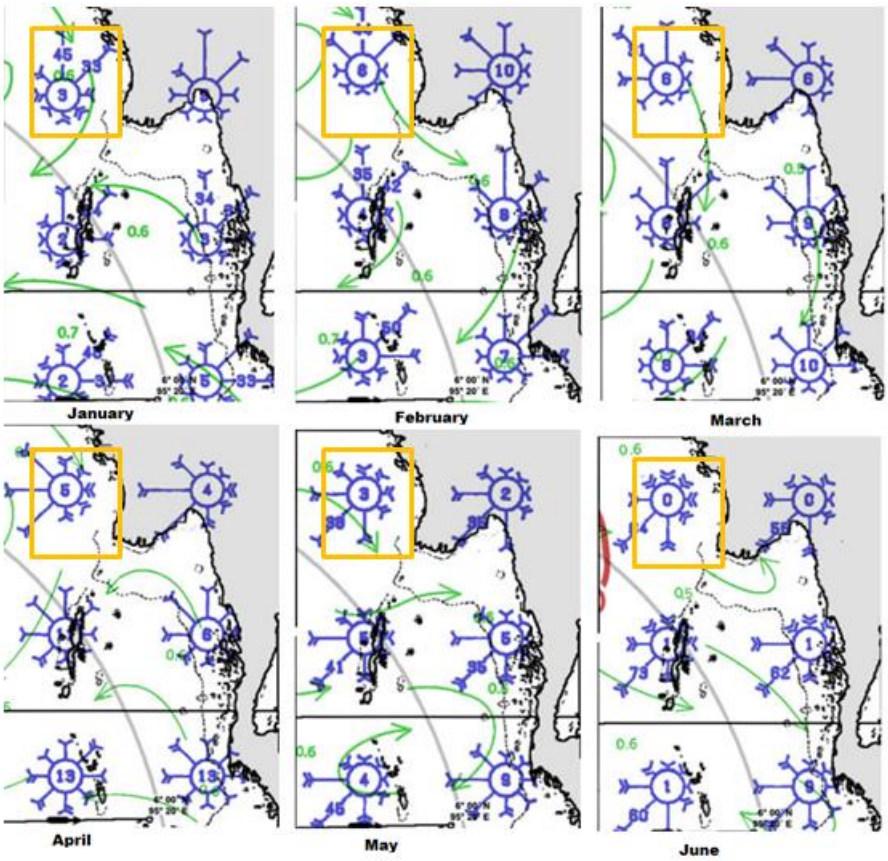
The northern Indian Ocean, and especially the Bay of Bengal, have complicated current patterns due to the geography of the region and its unique wind forces. The monsoon winds have an important role in the seasonal current patterns of the region.

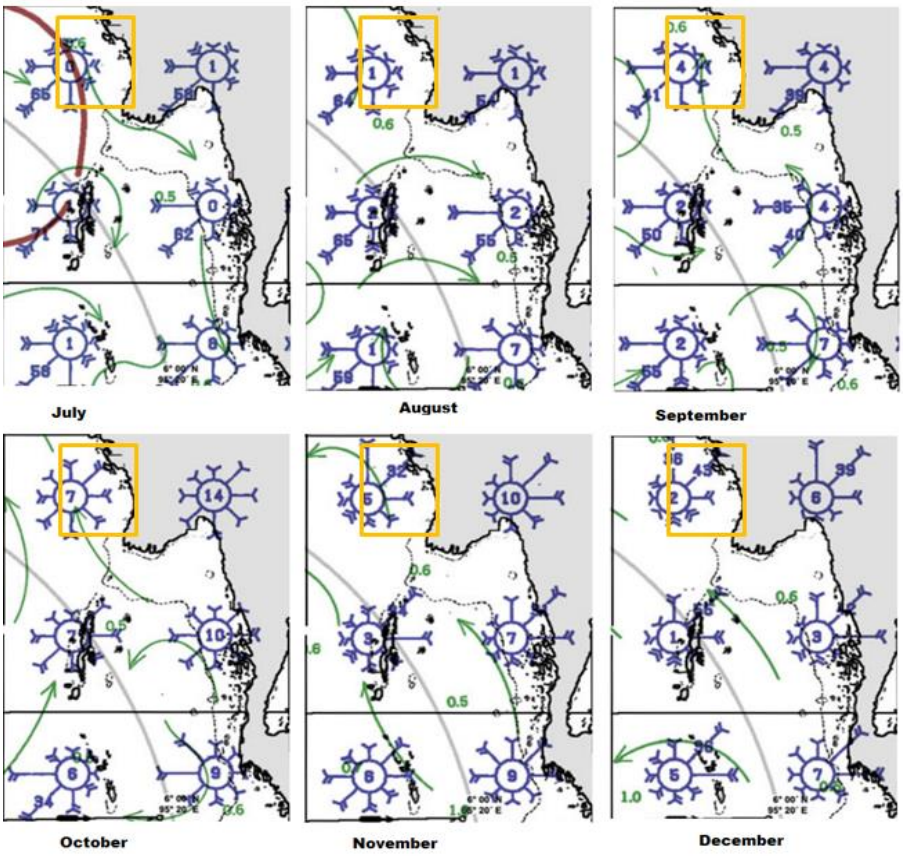
From January to October, the current is southward flowing, and the clockwise circulation pattern is called the "East Indian Current." The Bay of Bengal monsoon moves in a northwest direction contacting the Nicobar Islands, and the Andaman Islands at the end of May and then the north-eastern coast of India by the end of June.

During the remainder of the year, the counter-clockwise current is north-westward flowing, and the circulation pattern is called the “East Indian Winter Jet”. September and December see very active weather in the Bay of Bengal, producing severe cyclones which affect eastern India.

5.2.3.6. **Winds**

The wind circulation of Myanmar’s northwest coast is characterized by northeast winds that blow from November to February with minimum intensity along the coast and southwest winds that blow from May to September with maximum intensity in the centre of the Bay of Bengal. The intervening months are the transition months from winter to the summer monsoon period and from the summer to the winter monsoon period (day 285). Predominant wind direction within the project area is from the north-northeast from November to April. From May to October, the predominant wind direction is from the southwest (in Figure 5-13 – the orange rectangle indicates the project area).





Source: "Pilot Chart of the Indian Ocean" (Pub. #109) National Imagery and Mapping Agency

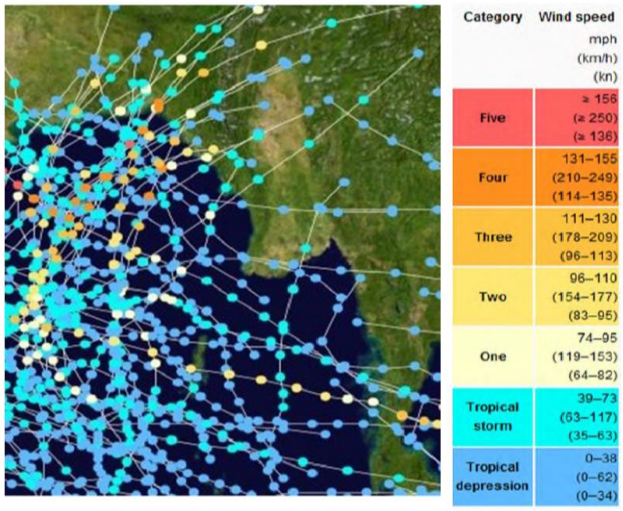
Figure 5-13[11]: Average wind and current direction around the project area

Cyclones

Cyclones are characterised by winds in excess of 32.7m/s and affect different areas of Myanmar at different times of the year. The months of April, May and October to December are considered to be cyclone months according to historical records. In the last four decades alone, several major cyclones have severely affected Myanmar: they are the 1968 Sittwe cyclone, the 1975 Pathein cyclone, the 1982 Gwa cyclone, the 1994 Maundaw cyclone, the 2006 Mala cyclone, the 2008 Nargis cyclone, and the 2010 Giri cyclone. The Nargis cyclone, the most devastating cyclone in the living memory of Myanmar, resulted in 84,537 deaths, 53,836 persons missing, affected 2.4 million people, and resulted in monetary losses of approximately 11.7 trillion Kyats (4.1 billion USD). According to the 1947-2008 data, 35 cyclones have made landfall on the Myanmar coast with the highest probability, in percentage terms, at Sittwe (20.8%), followed by Maundaw (9.6%) and decreasing towards the south (3.2% at Ayeyarwady delta) (UNDP Myanmar; ADPC; GRIP; UNDP, September 2011).

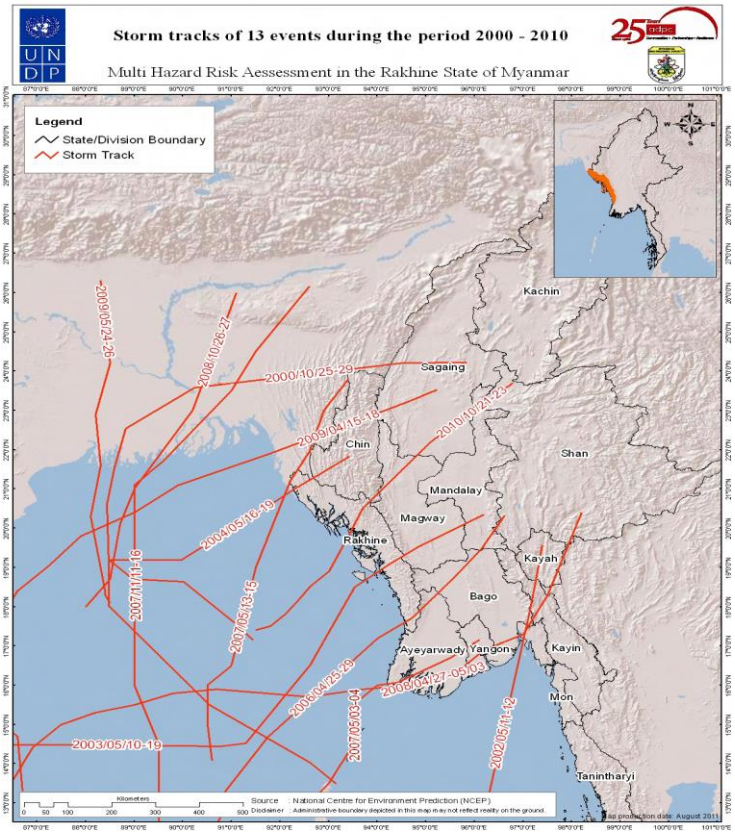
Figures 5-14 and 5-15 illustrate the tracks or paths of some of these cyclones (the colour of each dot represent the storm category, also displayed in the side bar).

[11] 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.



Source: UNDP, 2011

Figure 5-14: Tropical cyclone tracks during 1985-2005 in Myanmar



Source: UNDP, 2011

Figure 5-15: Storm tracks of 13 events over Myanmar during the period of 2000-2010

The following table presents the major cyclones recorded in the Bay of Bengal which affected the Rakhine State.

Table 5-5: Major cyclones in the Rakhine state

Source: UNDP, 2011

Date	Location
6-8 October 1948	Sittwe
22-24 October 1952	Sittwe
15-18 May 1967	Kyaukpyu
20-24 October 1967	Sittwe
7-10 May 1968	Sittwe
12-17 May 1978	Kyaukpyu
1-4 May 1982	Gwa
16-19 May 1992	Thandwe (Sandoway)
2 May 1994	Maundaw
25-29 April 2006 (Cyclone Mala)	Near Gwa
22 October 2010 (Cyclone Giri)	Kyaukpyu township

The most recent major cyclone to have made a landfall in Rakhine State was cyclone Giri in October of 2010, which struck the Rakhine coast as a category-4 storm. The cyclone triggered heavy rain and huge tidal surge (up to 7m above normal sea level) in the coastal areas and islands near the point of landfall. The wind speed reached a maximum of 177km/h at peak, shortly before its landfall. The cyclone damaged houses, buildings, and infrastructure in its path towards Magway, Mandalay and Sagaing regions. The most affected areas were the coastal townships of Rakhine State, especially Kyaukphyu, Minbya, Myebon and Pauktaw.

According to modelling studies performed by UNDP, the spatial distribution of the wind speed over Myanmar and the Bay of Bengal shows, for the project area:

- a wind speed of 50-60km/h for a 5-year return period; and
- a wind speed of >60km/h for a 100-year return period.

According to India Meteorological Department (IMD) cyclone categories classification, the first range will fall in class of Depression which has wind speed less than 51km/h. The wind speed range for 100-year return period, according to IMD classification, falls into the class of Cyclone Storm (62-87km/h) (UNDP Myanmar; ADPC; GRIP; UNDP, September 2011).

Tsunamis

Rakhine State, being located near a subduction zone off its coast, also faces a risk of future tsunamis. The northern part of the Rakhine coast consists of offshore coral islands, and areas partly covered with unspoiled mangrove forests. This setting therefore provides partial protection from tsunami waves. However, the southern coast of the state is generally rocky and sandy with popular resort areas. Thus, this part is comparatively more vulnerable to tsunami hazards. Historically, there have been written records of tsunami (or what was described as an extraordinary flood from the sea) in the 1762 Chittagong Earthquake. During the 2004 Sumatra tsunami event, it was observed that at one point along the Rakhine coast, the sea water receded by as much as about 2.5m before the tsunami waves arrived. However, no significant impact was caused as a result of the waves compared to other countries hit hardest by the tsunami.

The UNDP Hazard Assessment Report refers a recent article, Okal and Synolakis (2008), which identified five segments of subduction zones in the Indian Ocean that could generate destructive transoceanic tsunami. These seismic zones are located in the Arakan trench off Myanmar, off southern Sumatra and Java and in the Makran coast of Pakistan and Iran, besides the northern Sumatra-Andaman fault which triggered the December 2004 tsunami. However, the seismic zones off southern Sumatra and Java have an orientation and location that suggest that the bulk of the tsunami energy would be directed away from the western coast of Myanmar (source directivity, Ben-Menahem and Rosenman, 1972).

Furthermore, the western coast of Myanmar is largely shielded by India and Sri Lanka against tsunami that could be generated in the Makran seismic zone; Makran tsunami waves that get diffracted off the southern tip of India and Sri Lanka would pose negligible threat.

5.2.4. Sediment

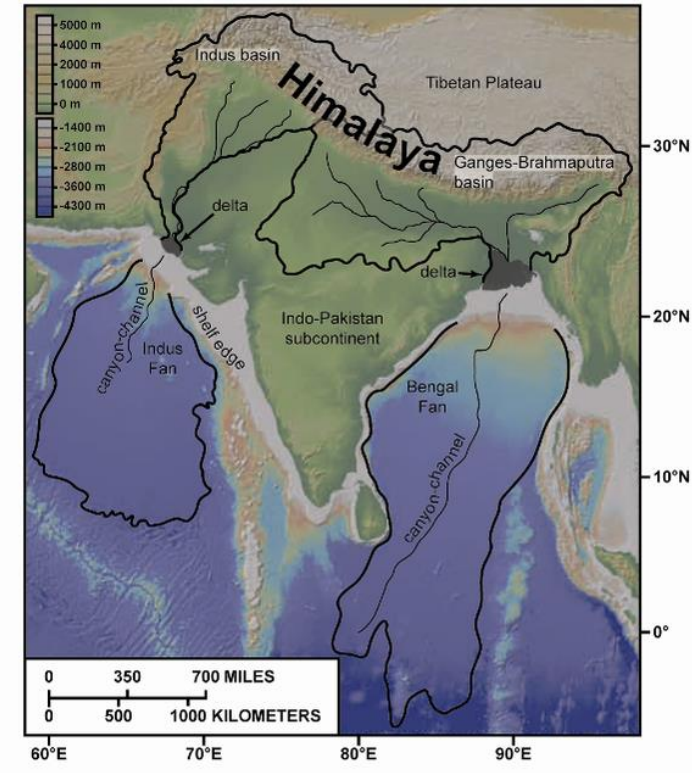
The Bengal Deep Sea Fan, the largest submarine fan[12] in the world, is ~3,000km long and 1,000km wide, with a maximum thickness of 16.5 km. The fan resulted from the uplift and erosion of the Himalaya and the Tibetan Plateau produced by the collision between the Indian Plate and the Eurasian Plate. Most of the sediment is supplied by the confluent Ganges and Brahmaputra Rivers through the Ganges Delta in Bangladesh and West Bengal, India, with several other large rivers in Bangladesh and India providing smaller contributions. Turbidity currents have transported the sediment through a series of submarine canyons, some of which are more than 2,414km in length, to be deposited in the Bay of Bengal up to 30 degrees latitude from where it began. To date, the oldest sediments recovered from the Bengal Fan are from Early Miocene age. Their mineralogical and geochemical characteristics allow identification of their Himalayan origin. The fan completely covers the floor of the Bay of Bengal and it is bordered to the west by the continental slope of eastern India, to the north by the continental slope of Bangladesh and to east by the northern part of Sunda Trench off Myanmar and the Andaman Islands, the accretionary wedge associated with subduction of the Indo-Australian Plate beneath the Sunda Plate and continues along the west side of the Ninetyeast Ridge (Curray, JR, Emmel FJ, Moore DG., 2002).

A major switch in sedimentation pattern over the Bengal Basin occurred during the Middle Eocene to Early Miocene as a result of collision of India with the Burma and Tibetan Blocks. The influx of sediment into the basin from the Himalayas to the north and the Indo-Burman Ranges to the east rapidly increased at this time; and this was followed by an increase in the rate of subsidence of the basin. At this stage, deep marine sedimentation dominated the deep part of the basin, while deep to shallow marine conditions prevailed in the eastern part of the basin. By the Middle Miocene, with continuing collision events between the plates and uplift in the Himalayas and Indo-Burman Ranges, a huge influx of sediments came into the basin from the northeast and east. Throughout the Miocene, the depositional settings continued to vary from deep marine in the basin to shallow and coastal marine in the marginal parts of the basin. From the Pliocene onwards, large amounts of sediment were filling the Bengal Basin from the west and northwest; and major delta building processes continued to develop the present-day delta morphology. Since the Cretaceous, architecture of the Bengal Basin has been changing due to the collision pattern and movements of the major plates in the region. However, three notable changes in basin configuration can be recognized that occurred during Early Eocene, Middle Miocene and Plio-Pleistocene times, when both the paleogeographic settings and source areas changed. The present basin configuration, with the Ganges - Brahmaputra delta system in the north and the Bengal Deep Sea Fan in the south, was established during the latter part of the Pliocene and Pleistocene; and delta pro-gradation since then has been strongly affected by orogeny in the eastern Himalaya. Pleistocene glacial activities in the north accompanied sea level changes in the Bay of Bengal (Alam, M, Alam MM, Curray JR, Chowdhury ALR, Gani MR., 2003). Two unconformities occur in the sediment across most of the Bay of Bengal: the more recent one in the upper Miocene, and the older one in the upper Paleocene to middle Eocene. The older unconformity marks the beginning of the collision and start of sedimentation from the Himalaya; the later unconformity corresponds to a warping of the northern edge of the Indian Plate upon collision with Eurasia, intercepting the sediment north of the current Bay of Bengal (France-Lanord et al., 2000).

Sedimentation of detritic material in a deep-sea fan is typically concentrated at the mouth of a canyon, which shifts locations as the areas are filled. In the Bengal Deep Sea Fan, the currently active canyon, known as the Swatch-of-no-Ground, is located in the central-western part of the Bay of Bengal, away from the Rakhine coast (France-Lanord et al., 2000).

[12] Abyssal fans, also known as deep-sea fans, underwater deltas, and submarine fans, are underwater geological structures associated with large-scale sediment deposition and formed by turbidity currents. They can be thought of as an underwater version of alluvial fans and can vary dramatically in size, with widths from several kilometres to several thousands of kilometres.

The emergence of the Himalaya as a major mountain chain modified the climate with the appearance of the monsoon system around 7-8 Ma ago. This change shows both in the detritic component (increase in smectite/illite ratio, which shows more intense weathering, and in the accumulation rate), and in the biogenic component (increase in the percentage of *Globigerina bulloides* among microorganisms found in the sediment to several tens percent, probably showing a strengthening of upwellings related to the monsoon) (France-Lanord et al., 2000).



Source: Bathymetry/topography from GeoMapApp, http://www.geomapapp.org (Ryan et al. 2009) (Covault, 2011)

Figure 5-16: Illustration of the Bengal Fan - South Asian hinterlands-to-deep-sea sediment-routing systems

The Indus River watershed provides sediment to the Indus Fan. The Ganges and Brahmaputra watersheds provide sediment to the Bengal Fan.

5.2.5. Seawater Quality

The Bay of Bengal annually receives large amounts of freshwater through river discharges and heavy rainfall events, especially during the summer monsoon season. This water produces a warm, low-salinity and high nutrient and oxygen-rich water layer to a depth of 100m that stretches over a distance of 1,500km.

In the Rakhine Basin, during the rainy season, the surface waters are also extensively mixed with freshwater from runoffs by the rivers. The southward flow of diluted seawater reduces the salinity to 18ppt in the nearshore areas, whereas in the dry season a northward flow of high salinity water (34ppt) can be recorded.

5.2.5.1. **Temperature and Salinity**

The salinity in the Bay of Bengal is significantly lower in comparison to the rest of the Indian Ocean but highly heterogeneous with extremely fresh waters found at the surface in the north and north-eastern parts, in response to excess freshwater supply from both continental rivers (20%) – the Ganges-Brahmaputra and Irrawaddy rivers are the main contributors - and from oceanic precipitation (80%), and saltier waters in the

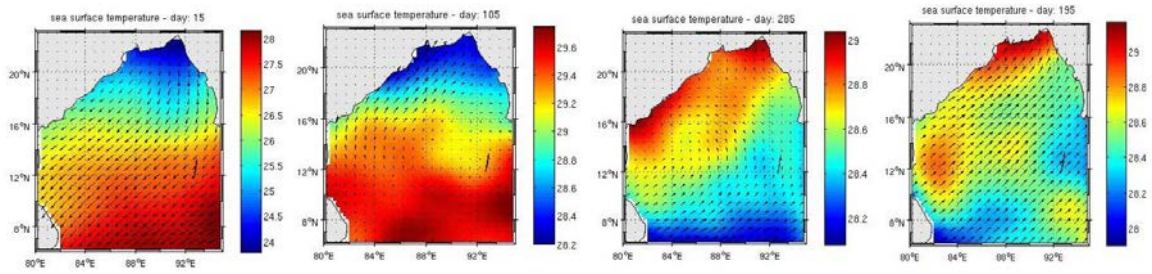
south-central Bay. However, the oceanic precipitation as well as Ganges–Brahmaputra waters get exported to the southern part of the Bay via the western boundary of the basin, with comparable contribution of the two freshwater sources; in contrast, Irrawaddy waters remain trapped in the northern half of the Andaman basin (Benshila, et al., 2013).

This freshwater cap has profound implications on the air-sea exchanges, and thus on the climate of the neighbouring continents. First, the enhanced vertical stability of the upper surface layer is conducive to a trapping of the atmospheric heat at the ocean surface, and maintains high sea surface temperatures (SST) throughout the year (Han & McCreary, 2001); (Shenoi, Shankar, & Shetye, 2002).

These high SST, in turn, are believed to favour atmospheric convective activity and freshwater supply, hereby creating a positive feedback. In particular, it has been suggested that the salinity stratification prevents the oceanic cooling effect during the development of atmospheric cyclones, hence favouring intense cyclones (Sengupta et al., 2008; Neetu et al., 2012). Second, salinity also has the potential to influence the amplitude of intra-seasonal variability of the SST in the northern part of the Bay (Vinayachandran, Neema, Mathew, & Remya, 2012)

The seasonal cycle of the SST is shown in Figure 5-17. The winter cooling is clearly depicted with a minimum of 24°C to the north and a maximum of 28°C to the south; a subsequent post-monsoon warming phase with a minimum of 28°C in the north and a maximum of 29°C in the south. During the summer monsoon the maxima and minima points are inversed hence the minimum is situated to the south (28°C) and the maximum to the north (29°C).

A warm pool (28°C) occurs from April to October, and has been observed in previous studies (Murty et al., 1998). This warming of the central basin is caused by the trapping of Kelvin waves in the central Bay for many months and it is an ideal ground for the generation of cyclones (Saheb et al., 2009).



a) b) c) d)

Source: (RAMMOU, 2012)

Figure 5-17: SST of the Bay of Bengal: (a) winter; (b) spring; (c) summer; and (d) autumn

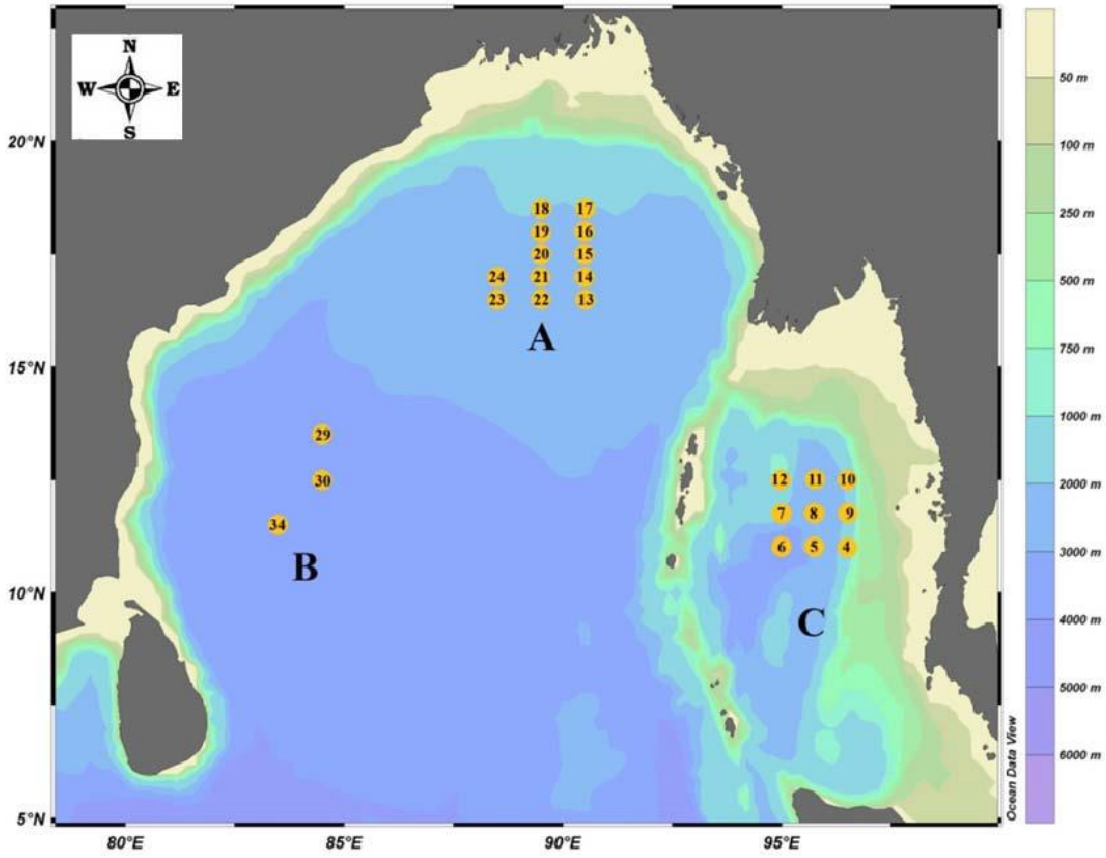
5.2.5.2. **Chlorophyll-a**

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 AD-03 Block are stations 13 to 17 (Figure 5-18).



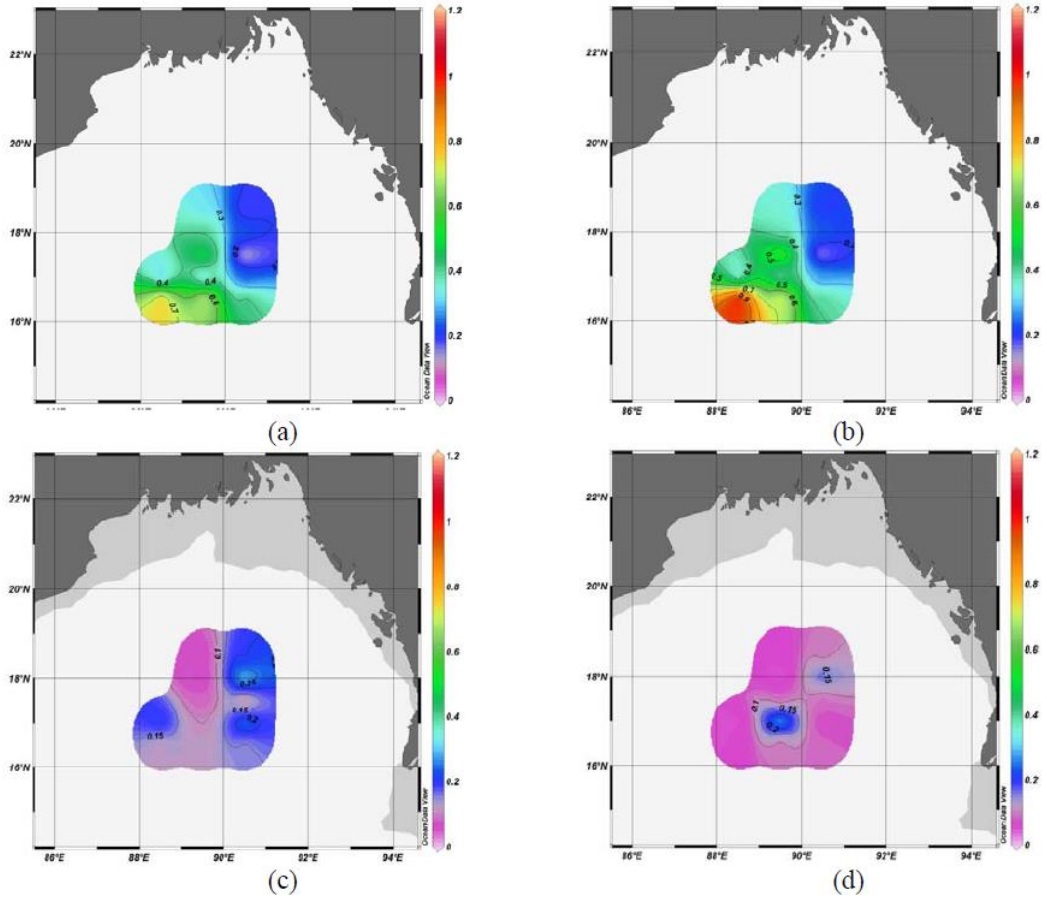
Source: (Prommas, R.; Naimee, P.; Laongmanee, P.; Sukramongkol, N.; Khumthong, N., 2007)

Figure 5-18: Chlorophyll sampling stations in the Bay of Bengal

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

The results for Area A (which is the closest to the AD-03 Block) are given in Figure 5-19, and can be summarized as followings:

- low latitude stations had higher chlorophyll-a concentration than the high latitude stations;
- most of stations had higher concentration at 10m than at 2m depth. Almost all stations deeper than 100m had lower concentration of chlorophyll-a;
- the southwest of Area A had the highest concentration of chlorophyll-a, which perhaps could be assumed, as influenced by the nutrients from deeper water lead by cold-core current. Distribution of chlorophyll-a had similar pattern to the salinity. Therefore, river discharge with high turbidity may impede photosynthesis activity of phytoplankton in the high latitudes of this area;
- the plume of chlorophyll-a distribution seemed to come from the southeast;
- the surface chlorophyll-a concentration at the southwest was higher than that in the northeast area by 0.5-0.7 mg/m^3; and
- the chlorophyll-a concentration at 2m and 10m ranged from 0.1113 to 0.7902, and 0.1388 to 1.1162mg/m^3, respectively.



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

Figure 5-19: Concentration of chlorophyll-a (mg/m³) in Area A of the Bay of Bengal: (a) 2m (b) 10m (c) 125m (d) 200/250m

As mentioned in the previous sections, it should be noted that in the study area, the chlorophyll-a concentration is dependant of the input of freshwater coming from Ganges-Brahmaputra rivers 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 surface.

5.2.5.3. **Nutrients**

The spatial distribution of nutrients (nitrite + nitrate, silicate and phosphate) in the Bay of Bengal was determined from samples collected during the same study mentioned in the previous section by the M/V SEAFDEC between October and December 2007, in the same areas.

Water samples from twenty-eight stations were analysed on-board by the Integral Futura Continuous Flow Automated Analysis. The detectable ranges of nitrite + nitrate, silicate and phosphate in the northern Bay of Bengal were 0.07-37.87, 0.01-48.56 and 0.10-3.13 µM, respectively; in the western Bay of Bengal 2.06-35.23, 2.89-46.03 and 0.15-3.16 µM, respectively; and in the eastern Bay of Bengal 0.35-36.63, 0.05-46.63 and 0.36-2.76 µM, respectively.

The results of this study showed that the distribution of the nutrients: nitrite + nitrate, silicate and phosphate uniformly increased with depth at all sampling stations. Generally, the Mixed Layer Depth (MLD) in the Bay of Bengal had very low nutrient concentrations or sometimes even undetectable levels. In addition, there were several nearshore stations that had nutrient concentrations higher than those in stations in the open sea.

Nutricline concentration was noticed to be rapidly increasing with depth below 50m. Down to depths of ~200-250m, the nutrient values were nearly constant or slightly changed (R. PROMMAS, P. NAIMEE, N. SUKRAMONGKOL, 2007).

5.3. 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 5-20: IUCN Red List categories

5.3.1. Offshore Environment

The AD-03 Block 3D is located ~64km west of Cheduba Island and ~124km from the nearest mainland coastline of Myanmar. In the AD-03 Block the water depth ranges from ~1,980m to ~2,400m. The project area is thus situated in oceanic realm, composed by the following water column stratification: epipelagic, mesopelagic and bathypelagic zones (Figure 5-21).

Descending stratifications of the pelagic realm are based on biological and physical changes with the upper euphotic epipelagic layer (shown here as a light band) reaching depths of 70 to ~200m. Because of the distance to the coast, the horizontal zoning of the project area is oceanic waters. Illustrations in Figure 5-21 indicate typical species inhabiting the different pelagic zones.

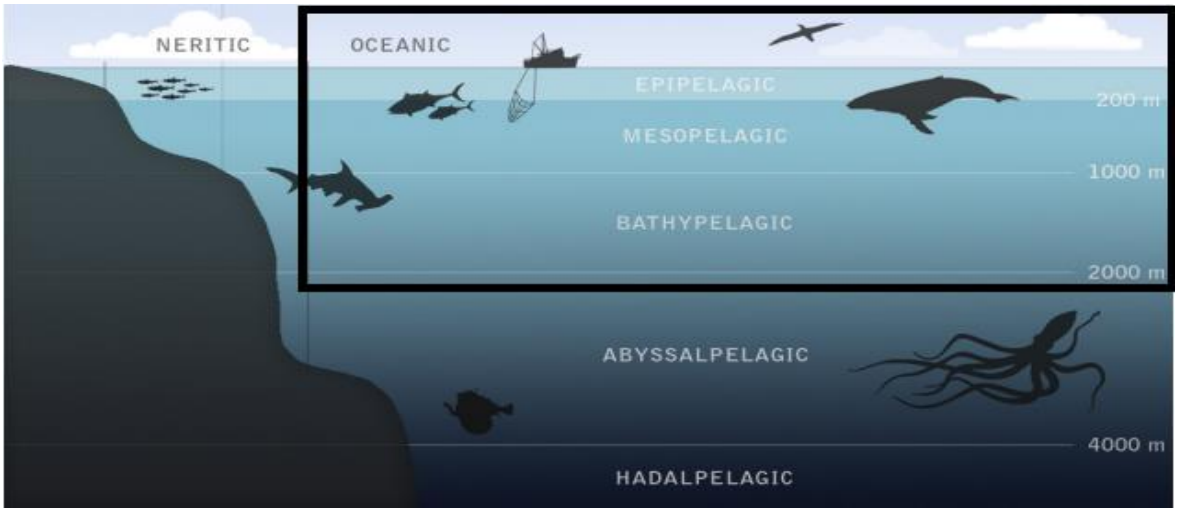


Figure 5-21[13]: Oceanic stratification of the study area

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

5.3.1.1. Offshore Fauna

Plankton

A. Phytoplankton

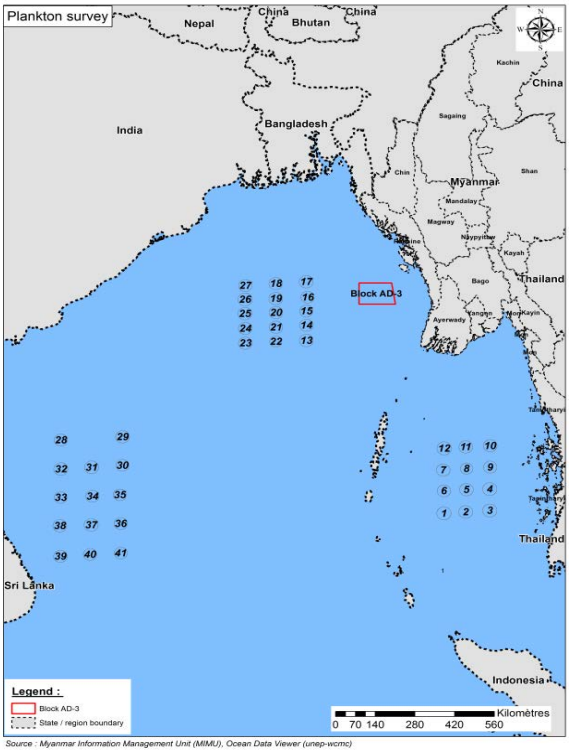
This section is based on the results presented in the Andaman Sea Fisheries Research and Development Centre on Ecosystem-Based Fishery Management in the Bay of Bengal. A 58-day collaborative survey was conducted in 2007 by the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation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

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 northern area (Area A) is the closest to the AD-03 Block (Figure 5-22). Station 16 is the closest, situated ~160km from the block.

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 52 genera with 103 species observed in Area A.

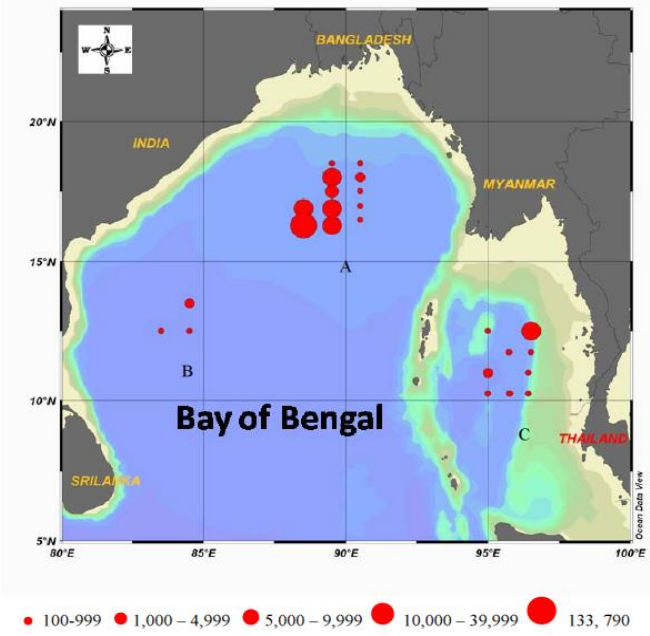
[13] A Review Of The Conservation Benefits Of Marine Protected Areas For Pelagic Species Associated With Fisheries, ISSF Technical Report 2012-02



Source: BIMSTEC, 2008

Figure 5-22: Sampling locations during the M/V SEAFDEC field survey

Concerning the abundance (refer to Figure 5-23), cell densities in the Area A were in the range of 261-133 cells/L. The maximum cell count was found at station 23 which is located in the north-western part of the Bay.

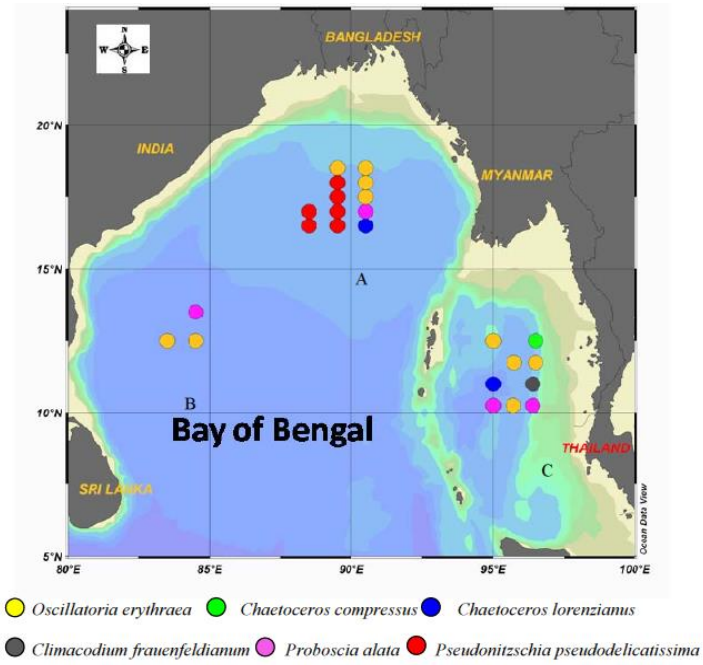


Source: BIMSTEC, 2008

Figure 5-23: Phytoplankton density (cells/litres) in the surface layer

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).

Phytoplankton population at six western stations of Area A were dominated by *Pseudo-nitzscia pseudodelicatissima* (refer to Figure 5-24) and the highest abundance (68.12%) occurred at station 20. Massive blooms of *Pseudo-nitzsci pseudodelicatissima,* as dominant species, and *Chaetoceros messanensis* as associated species, with 27.67% and 20.62% contribution to total phytoplankton density, respectively, led to distinct phytoplankton blooms at station 23 in which total phytoplankton density reached 133,790 cells/L. Phytoplankton communities in four stations in Area A were distinguished from other areas due to their lower abundance and the dominance (in term of abundance) of a cyanobacteria, *Oscillatoria erythraea*.



Source: BIMSTEC, 2008

Figure 5-24: Dominant phytoplankton species in the Bay of Bengal

It should be noted that Area A, which is the closest to the project area, was characterised by high phytoplankton densities during the Northeast Monsoon.

Naik et al. (2006) noted that surface phytoplankton population in the Bay of Bengal showed seasonal variations and the abundance peaked during the beginning of Northeast Monsoon (November). However, Paul et al. (2007) collected samples during Southwest Monsoon and revealed that micro-phytoplankton was abundant in the northern part of the Bay.

Therefore, Area A (closest to the project area) might be the most productive area in the Bay of Bengal during both Northeast and Southwest monsoons. This study showed that the phytoplankton abundance of the western part of the northern Bay of Bengal might result from the nutrient-rich water discharge from the rivers along the west coast of India. The highest phytoplankton densities occurred at station 23 where Prommas et al. (in press) also found the highest phosphate and nitrite + nitrate concentrations.

B. Zooplankton

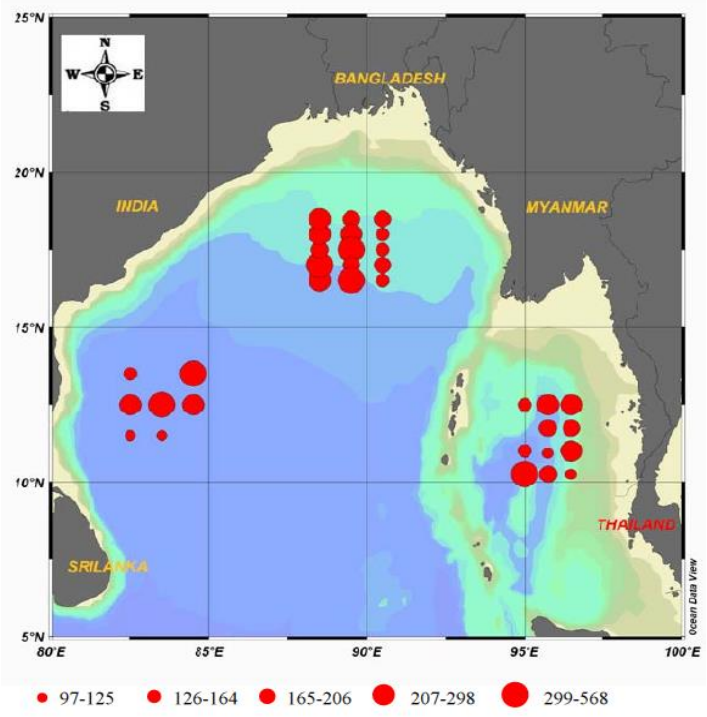
Zooplankton includes both planktonic or microscopic invertebrates and larval stages of some marine fishes that rely on water currents to move any great distance. Zooplankton is a broad categorization spanning a range of organism sizes that includes both small protozoans and large metazoans. Zooplankton 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 5-22).

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 52 genera with 103 species observed in Area A.

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.



Source: BIMSTEC, 2008

Figure 5-25: Zooplankton distribution and abundance (individuals/m³) in the Bay of Bengal

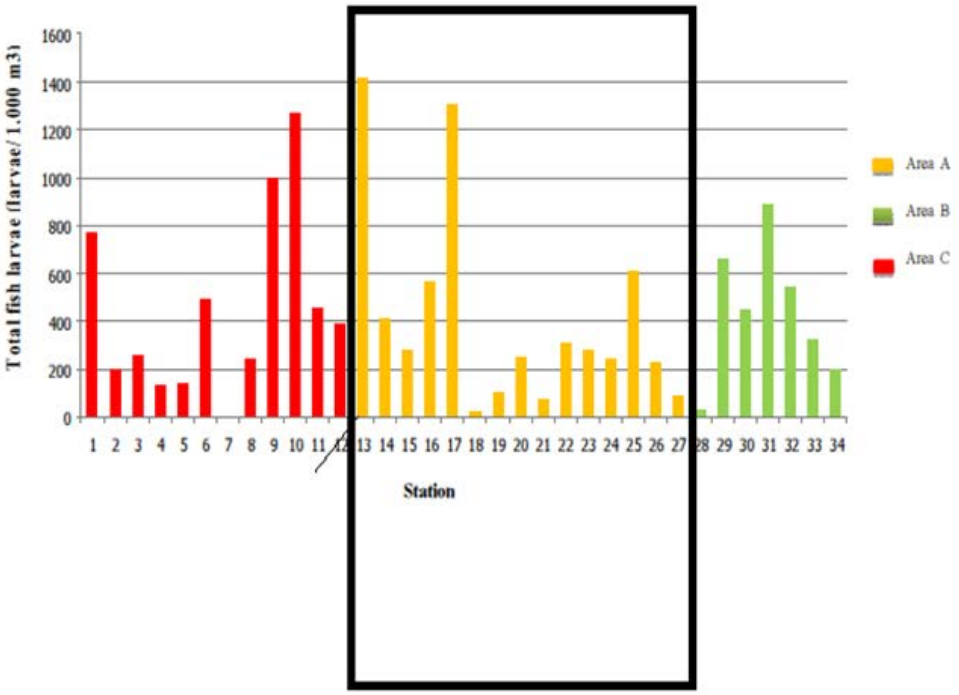
There was no significant difference in the diversity and the abundance of zooplankton from three studied areas (A, B, C). Area A had the most diverse zooplankton community with 150 species (119 genera).

Copepoda were by far the most abundant taxon, accounting for 45.82% of total zooplankton densities within the copepod communities, the relative abundance of calanoid copepods was 30.68% of total copepods followed by and poecilostomatoids (10.51%) and cyclopoids (6.17%) and harpacticoids (0.07%) in respective order. Major taxa of calanoids included Augaptiliidae, Acartiidae, Centropagidae, Pontellidae, Calanidae, Paracalanidae, Eucalanidae, Euchaetidae and Scolecithricidae. Copepodites were high in number at most stations (in Areas A, B and C). Sarcodine protozoans ranked second in abundance after copepods and comprised 17.52% of total zooplankton density.

Total zooplankton abundance was ranging from 97-568 individuals/m^3.The highest zooplankton abundance in this study was recorded at Area A (the closest to the project area) with and abundance of 154-568 individuals/m^3. The highest abundance was observed at station 24 (568 individuals/m^3).Copepods, the most abundant taxon in all areas, contributed to 43% in Area A. Sarcodine protozoans were the second most abundant taxon after copepods in this area.

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.



Source: BIMSTEC, 2008

Figure 5-26: Spatial pattern variation in abundance of total fish larvae in the three areas

In Area A (the closest to the project area), 6,170 specimens were collected. They belonged to 18 families of which seven families belong to commercially important group: Hemirhamphidae, Carangidae, Sphyraenidae, Gempylidae, Scombridae, Bothidae and Cynoglossidae. All of these contributed to ~5.64% of the total fish larvae. Among them, the most dominant family was Carangidae followed by Scombridae and Gempylidae. The average number of fish larvae per station in Area A was 411 larvae/1,000 m^3.

Referring to the type of habitats of the adult fish, six families (Labridae, Callionymidae Gobiidae, Bothidae, Cynoglossidae and Ostraciidae) were inshore-reef fish and six families (Photichthyidae, Stomiidae, Myctophidae Gempylidae, Exocoetidae and Paralepididae) represented oceanic fish. Some of them are commercially important families, namely Carangidae.

Pelagic Fish Community

The pelagic system of the Bay of Bengal is, in general, 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 predatory 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 (*Rhincodon typus* – listed as vulnerable on the IUCN Red List).

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 occurring in Myanmar waters is presented in Table 5-6 with the applicable IUCN Red List category and population trend, where available.

A total of 31 pelagic fish species listed on the IUCN Red List have been recorded in Myanmar's marine waters:

- two species are listed as critically endangered (CR), facing an extremely high risk of extinction in the wild;
- four species are listed as endangered (EN), facing very high risk of extinction in the wild; and
- 25 are listed as vulnerable (VU), facing high risk of extinction in the wild.

All species which are identified to be oceanic in Table 5-6 may potentially occur in the AD-03 Block.

Table 5-6: Pelagic fish present in Myanmar waters

Source: IUCN, 2014

Genus	Species	Common name	IUCN status*	Coastal	Oceanic
Aetomylaeus	*nichofii*	Banded Eagle Ray	VU	x	
Alopias	*pelagicus*	Pelagic Thresher, Thresher Shark, Whiptail Shark	VU	x	x
Alopias	*vulpinus*	Common Thresher Shark	VU	x	x
Anoxypristis	*cuspidata*	Knifetooth Sawfish, Narrow Sawfish, Pointed Sawfish	CR	x	x
Epinephelus	*lanceolatus*	Brindle Bass, Brindled Grouper, Giant Grouper, Queensland Groper	VU	x	
Glaucostegus	*granulatus*	Sharpnose Guitarfish	VU	x	x
Glaucostegus	*typus*	Common Shovelnose Ray, Giant Shovelnose Ray	VU	x	x
Glyphis	*siamensis*	Irrawaddy River Shark	CR	x	
Hemipristis	*elongata*	Fossil Shark, Snaggletooth Shark	VU	x	
Himantura	*polylepis*		EN	x	
Himantura	*uarnacoides*	Bleeker's Whipray	VU	x	

Himantura	*uarnak*	Reticulate Whipray, Honeycomb Stingray, Leopard Stingray, Marbled Stingray	VU	x	x
Himantura	*undulata*	Bleeker's Variegated Whipray	VU	x	
Hippocampus	*trimaculatus*	Flat-faced Seahorse, Low-crowned Seahorse, Three-spot Seahorse	VU	x	
Isurus	*paucus*	Longfin Mako	VU		x
Lamiopsis	*temmincki*	Broadfin Shark	EN	x	
Makaira	*nigricans*	Blue Marlin	VU		x
Manta	*alfredi*	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	VU	x	
Manta	*birostris*	Giant Manta Ray, Chevron Manta Ray, Oceanic Manta Ray, Pacific Manta Ray, Pelagic Manta Ray	VU	x	
Negaprion	*acutidens*	Sharptooth Lemon Shark	VU	x	
Rhina	*ancylostoma*	Bowmouth Guitarfish, Mud Skate, Shark Ray	VU	x	
Rhincodon	*typus*	Whale Shark	VU	x	x
Rhinobatos	*obtusus*	Widenose Guitarfish	VU	x	x
Rhinoptera	*javanica*	Flapnose Ray, Javanese Cownose Ray	VU	x	
Sphyrna	*lewini*	Scalloped Hammerhead	EN	x	x
Sphyrna	*mokarran*	Great Hammerhead, Hammerhead Shark, Squat-headed Hammerhead Shark	EN	x	x
Taeniurops	*meyeni*	Black-blotched Stingray, Black-spotted Stingray, Blotched Fantail Ray, Fantail Stingray, Giant Reef Ray, Round Ribbontail Ray, Speckled Stingray	VU	x	
Thunnus	*obesus*	Bigeye Tuna	VU		
Aetobatus	*narinari*	Spotted Eagle Ray	NT	x	x
Carcharhinus	*dussumieri*	Whitecheek Shark	NT	x	
Carcharhinus	*falciformis*	Silky Shark	NT	x	x
Carcharhinus	*longimanus*	Oceanic Whitetip Shark	VU		x
Carcharhinus	*macloti*	Hardnose Shark	NT	x	x
Centroscyllium	*ornatum*	Ornate Dogfish	DD		x
Cruriraja	*andamanica*	Andaman Legskate	DD		x
Dasyatis	*zugei*	Sharpnose Stingray	NT	x	
Eusphyra	*blochii*	Winghead Shark	NT	x	x

Glaucostegus	*thouin*	Clubnose Guitarfish	VU	x	
Himantura	*fai*	Pink Whipray	LC	x	
Iago	*omanensis*	Bigeye Houndshark	LC	x	x
Isurus	*oxyrinchus*	Shortfin Mako	VU	x	x
Loxodon	*macrorhinus*	Jordan's Blue Dogshark	LC	x	x
Mobula	*eregoodootenkee*	Pygmy Devilray	NT	x	x
Mobula	*japanica*	Spinetail Mobula	NT	x	x

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 off 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.

It should be noted that the typical habitat of the dugong is exclusively shallow water, and therefore this species is not expected to occur within the project area (which comprises open ocean and deep water between 1,980m and 2,400m).

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).

It should be noted that the typical habitat of these species is freshwater or marine coastal waters less than 200m in depth; therefore these species are not expected to occur within the project area (which comprises open ocean and deep water between 1,980m and 2,400m).

All the species that may occur in Myanmar marine waters are listed in Table 5-7 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 species is listed as near threatened (NT): the Indo-Pacific hump-backed dolphin (*Sousa chinensis*).

These threatened species can be found in estuaries, coastal waters, shallow waters and deep waters.

Most of the whales, including the blue whale and the sperm whale, are primarily found in offshore deep waters. However, some species may also occur in shallow coastal waters.

According to the habitats indicated in Table 5-7 the marine mammals that occur offshore from coast of Myanmar and that may be encountered during the AD-03 Block 3D seismic survey are listed below (21 species identified).

Table 5-7: Marine mammals present in the Bay of Bengal

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	✓

Order	Family	Genus	Species	Common names	IUCN status	Likely encountered in project area
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
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)

Amongst all marine mammals present in Myanmar's waters, the ones that are likely to be encountered within the project area are:

- eight species listed as Least Concern;
- ten species listed as Data Deficient;
- one species listed as Vulnerable (sperm whale), and
- two species listed as endangered (blue whale, fin whale).

Mark Baumgartner (in his study "Cetacean community ecology in waters of Sri Lanka and the Bay of Bengal, Woods Hole Oceanographic Institute, 2013), hypothesizes that, in the oceanic Bay of Bengal, cetacean community composition exhibits a significant seasonal variability associated with strong monsoonal forcing of the upper ocean and that the spatial distribution of cetaceans would be influenced by the depth of the oxygen minimum layer (which, in turn, influences the availability of prey in the upper ocean). This scientific survey is

still under development (field surveys forecast to take place between 2013-spring 2015). No results are available at this time as no fieldwork has been conducted to date.

According to Branch et al. (2007), the main catches of blue whales in the northern Indian Ocean occurred in Oman and Somalia, and around the Maldives. Sightings and strandings were recorded year-round in high productivity parts of the northern Indian Ocean, especially off Somalia (Small & Small, 1991), the Maldives (Anderson et al., 2005) and Sri Lanka (Alling et al., 1991). Strandings were also reported from a much wider area (Bangladesh, Burma, India and Pakistan) than sightings and catches. It has also been showed that blue whales avoid the oligotrophic central gyres of the Indian Ocean, but are more common where phytoplankton densities are high, and where there are dynamic oceanographic processes like upwelling and frontal meandering.

It is possible to conclude that the main catches of blue whales occurred in the southwest of the Bay of Bengal, so not in the vicinity of the AD-03 Block. Anderson et al. (2005) confirms this, as shown in Figure 5-27, which shows all detections of blue whales between 40°E and 100°E longitudes.

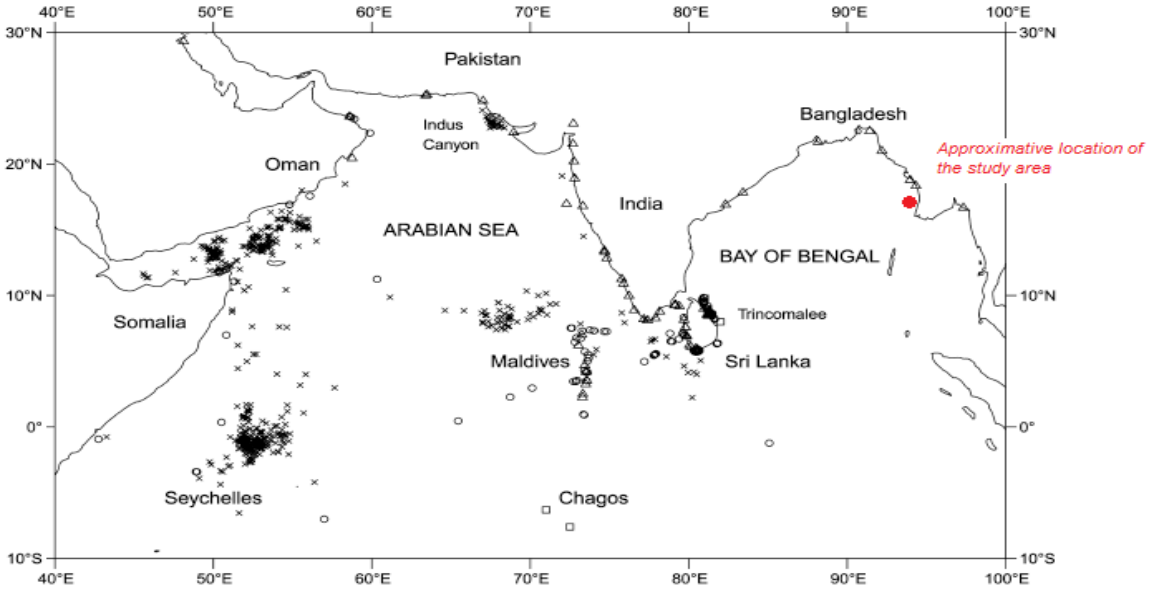


Figure 5-27[14]: All known positions of blue whales catches, sightings, strandings and acoustic detections in the northern Indian Ocean

Therefore, it is unlikely that blue whales will be present in the Project Area.

Marine Turtles

Marine turtles are one of the internationally listed aquatic endangered species for long term protection and conservation. 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.

Five species are commonly seen nesting regularly in Myanmar. They are olive ridley, loggerhead, green, hawksbill and leatherback turtles (Figure 5-28). However, loggerhead and leatherback turtles are assumed to be almost extinct.

[14] Anderson et al. 2012 - showing all known positions of blue whales catches (crosses, n = 1,288), sightings (circles, n=396), strandings (triangles, n=64) and acoustic detections (squares, n=6 locations). Data from prior to 1973 are in grey; data after 1973 are in black. This figure is updated from Branch et al (2007b).

According to the Table 5-8, all the turtles present in Myanmar occur in Rakhine coastal waters.

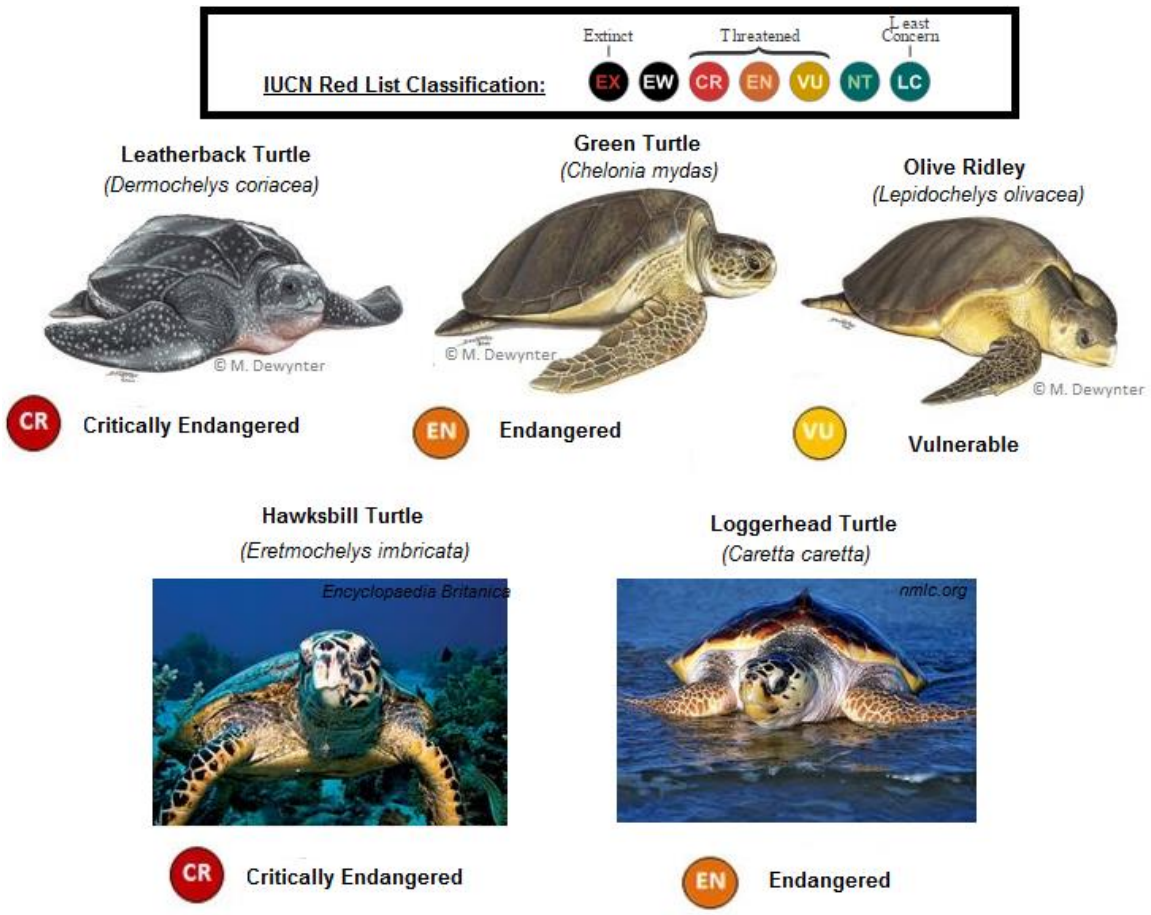


Figure 5-28: Marine turtles presents in Myanmar waters

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

Table 5-8: Distribution of marine turtles in Myanmar[15]

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

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

The project area is located in offshore from Rakhine State; therefore, all the marine turtles species recorded in Myanmar may occur in the AD-03 Block during migratory movements to and from nesting beaches along the coast.

Figure 5-29: Marine turtle nesting sites close to the AD-03 Block

The closest turtle nesting site to the AD-03 Block is located ~63km to the northwest (Cheduba Island).

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 5-9 with their IUCN Red List category.

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) on the IUCN Red List.

Table 5-9: 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, Turnstone	LC	Fully migratory/species is mainly coastal/ estuaries
CHARADRIIFORMES	SCOLOPACIDAE	*Calidris*	*temminckii*	Temminck's Stint	LC	Full migrant/coastal

Order	Family	Genus	Species	Common name	IUCN Red List category	Typical habitat
						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 AD-03 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.

5.3.2. Coastal Environment

The following section describes Myanmar's coastal environment adjacent to the project area, i.e., between the Rakhine district and coastal western part of Ayeyarwaddy and Cheduba Island (situated ~65km from the project area). It should be noted that this coastal environment is some way from the Project Area (124km to the nearest coastal point and 65km from Cheduba Island).

5.3.2.1. **Coastal Flora**

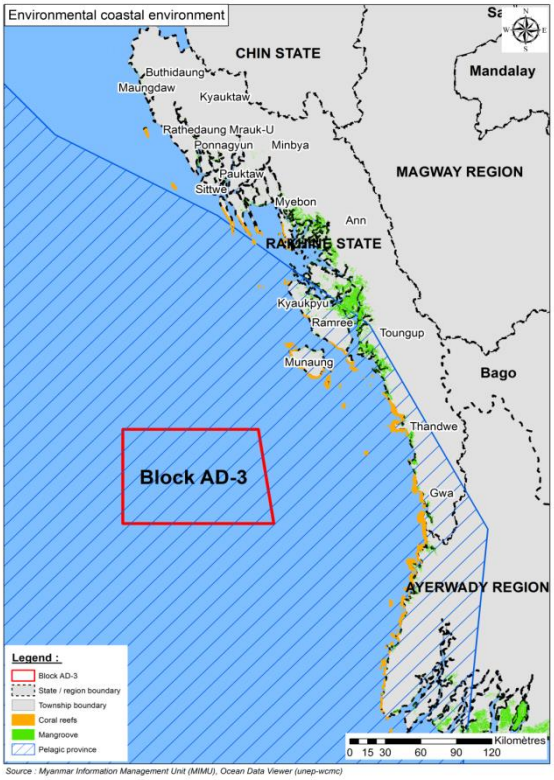
The habitats in coastal areas of Myanmar consist of mangroves, coral reefs, seagrass beds, evergreen forest, wetlands and various types of agricultural land.

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. Mangroves in delta areas are the most extensive mangrove habitats in Myanmar, which are situated in the south in the Irrawaddy delta (~188km from the project area). Other mangrove habitats are found along the sheltered coasts in the Rakhine and Tanintharyi regions. The original surface area covered by mangrove forest in Myanmar was 320,106ha 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 (also refer to **Annex 4**).



Source: HTTP://REEFGIS.REEFBASE.ORG/

Figure 5-30: Location of mangroves and coral reefs

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

Table 5-10[16]: 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.

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 in the life cycles of a number of important species in Myanmar, such as dugongs, marine turtles, etc. Seagrasses occur generally in shallow water (as they require light for photosynthesis) providing habitats and food for numerous species.

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

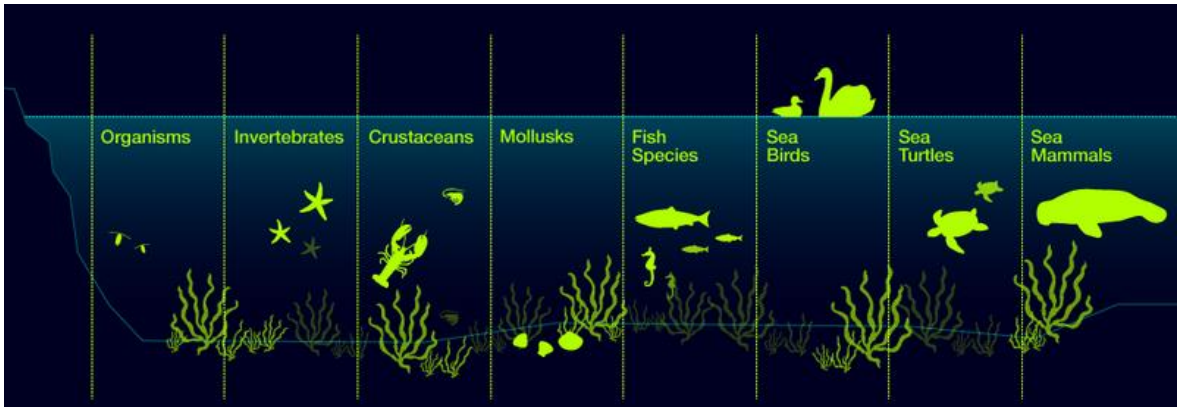


Figure 5-31: Organisms likely to be encountered in the Myanmar's seagrasses (Ocean Health Index)

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 water depths within the project area range from ~1,980 to ~2,400m hence no segrasses would occur in the area or surrounding waters.

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.

It is important to note that no seaweed species will occur in the project area due to the depth of the ocean in this location.

5.3.2.2. **Costal Fauna**

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 occurs 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 shown in orange in Figure 5-30. A description of the coral reefs in Myanmar is provided in Table 5-11.

Table 5-11: Location / characteristics of coral reefs in Myanmar[17]

	Area (km^2)	% live coral cover	Condition
Mergui 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

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

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

DUGONG

Figure 5-32: Example of shallow water marine mammals in Myanmar

It should be noted that these shallow water species are not likely to be present in the deep waters of the study area.

Other Species

Rakhine and Irrawaddy coastal waters support some others coastal species as sea snakes, marine turtles and saltwater crocodiles (*Crocodilus porosus,* IUCN Red List category: LC).

It should be noted that these shallow water species are not likely to be present in the deep waters of the study area.

5.3.3. Protected Areas

The titles used in the protected area list supplied by the Forest Department are the following:

- **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.
- **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 (note - the Rakhine Yoma elephant range reserve, which is part of Rakhine State, is not a marine reserve and is therefore not considered in the description).

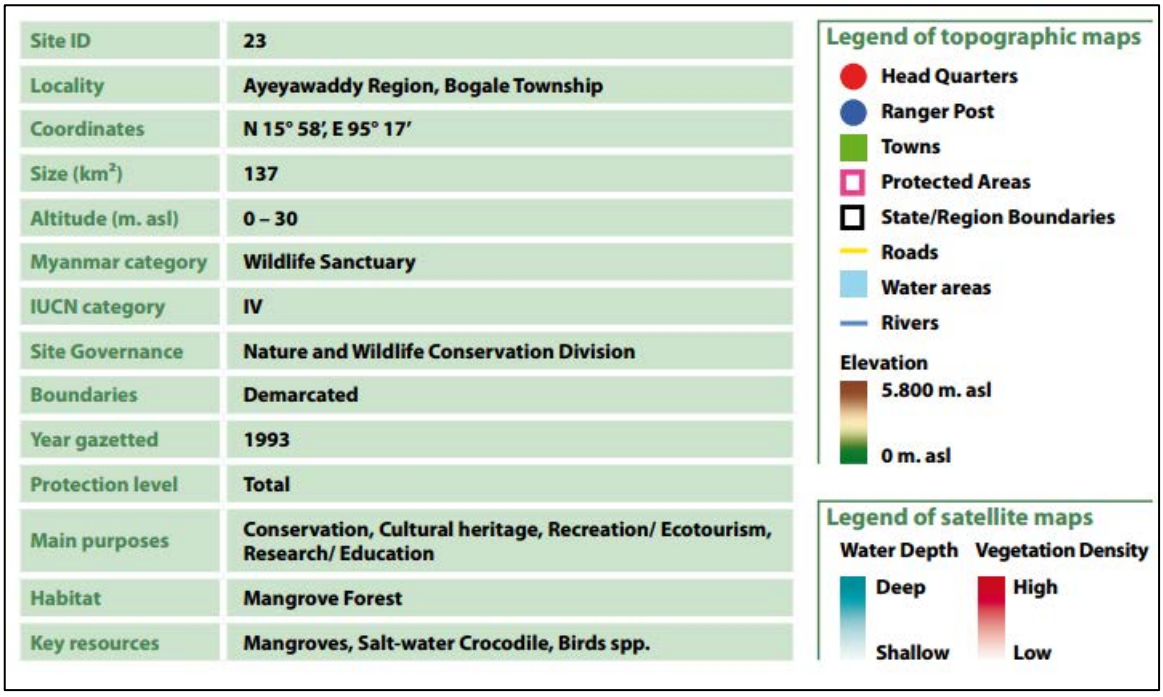
Table 5-12: Sensitive areas close to the AD-03 Block[18]

Site Name	Province	National designation	Establish year	IUCN Category
Rakhine Yoma	Rakhine State	Elephant range	1997	-
Meinmahla Kyun Island	Irrawaddy	Wildlife sanctuary	1993	IV
Thamihla Kyun (Diamond Island)	Irrawaddy	Wildlife sanctuary	1970	IV

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 the Birdlife International data, the closest IBA to the project area is located in the Ayeyarwaddy delta (~188km from the project area).

5.3.3.1. **Meinmahla Kyun Island**

Meinmahla Kyun is an estuarine island in the delta of the Irrawaddy River that is almost entirely comprised of alluvial deposits from the Bogale River. The island is flat, with low cliffs to the south and west dropping to a narrow sandy beach. Numerous creeks and channels intersect the island which also features sand dunes and mudflats. The sea throughout the entire area is highly turbid and very shallow, being no deeper than 5.5m up to 28km offshore. The tidal range is 2.0-2.5m.



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

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

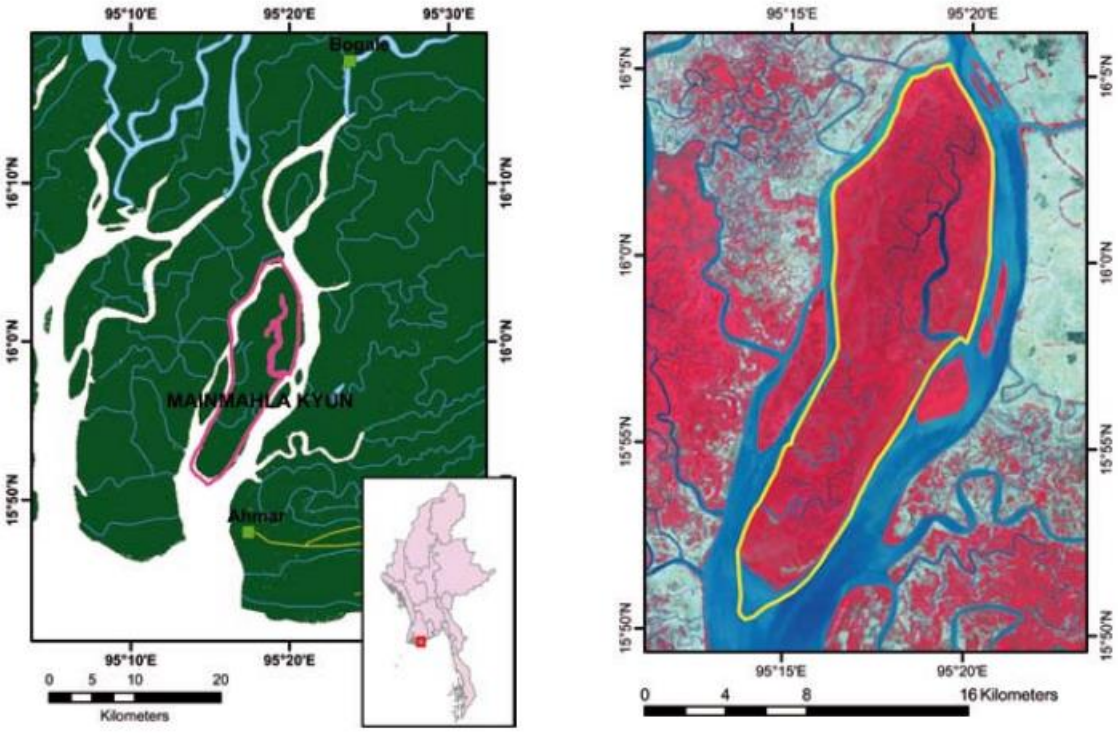


Figure 5-33: Meinmahla Kyun protected area

The island is a wetland classified as a mangrove ecosystem reserve and wildlife sanctuary. The reserve is occupies an area of 137km² and was established in 1986.

Wildlife & vegetation: An estimated 2,600 estuarine crocodiles (*Crocodylus porosus*) inhabit the island, representing about two-thirds of the entire population in the eastern delta. Other wildlife includes *Panthera tigris, P. pardus, Cuon alpinus, Lutra sp* and *Elephas maximus*.

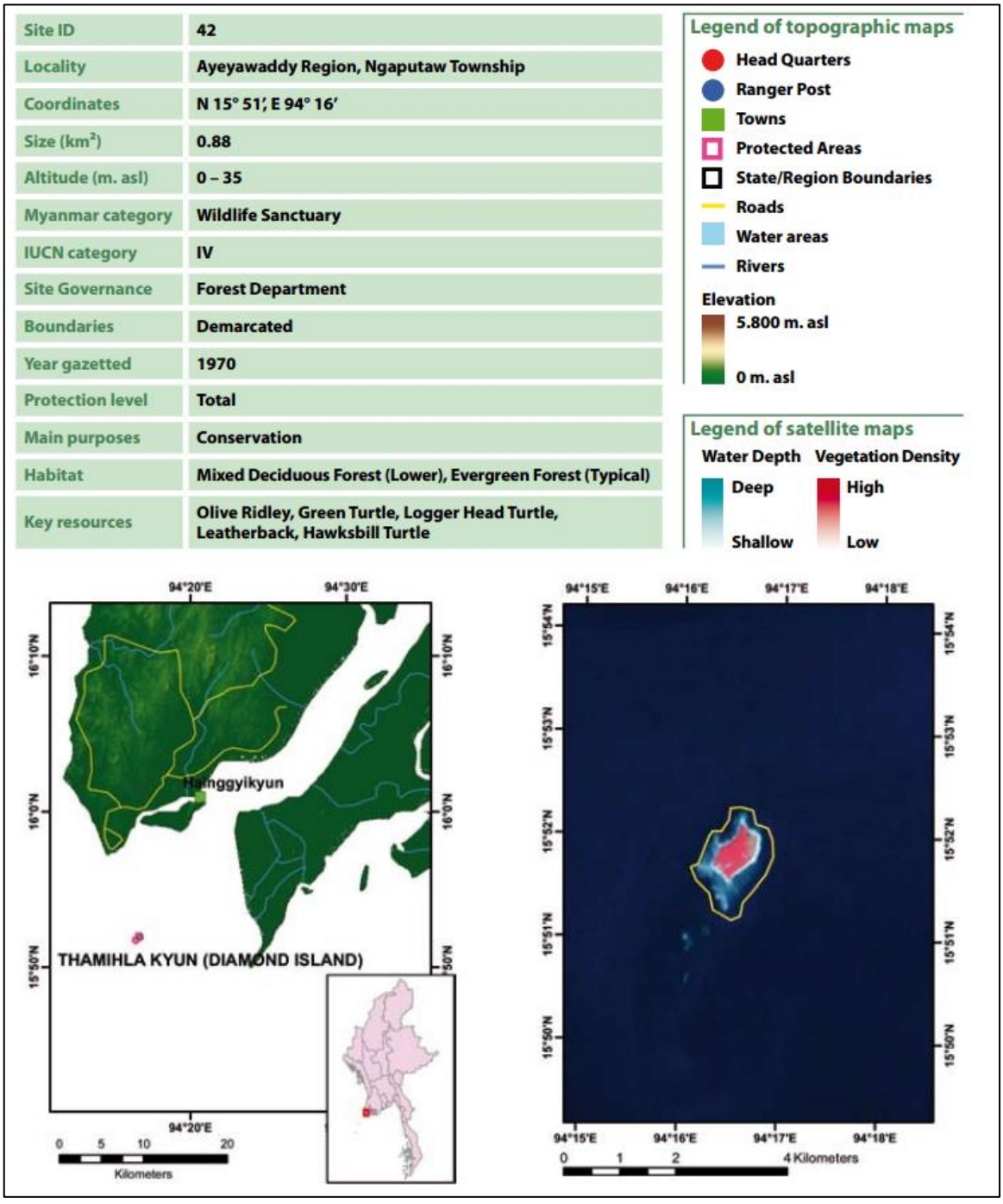
The island is likely to be of considerable importance for both resident and migratory waterfowl, but almost no information is available. Species observed on the island include 250 individuals of *Egretta* spp. and one individual of *Leptoptilos dubius* in late 1982. It has a total of 29 mangrove tree species.

Land use: Intensive fishing in the creeks. There is no resident population on the island, but temporary camps are established by fishermen.

Disturbances and threats: According to the FAO, there is some illegal logging on the island, and the waterways are heavily fished.

5.3.3.2. **Thamihla Kyun Wildlife Sanctuary**

Thamihla Kyun is a small, offshore island to the west of the Irrawaddy delta measuring ~1,100m by 730m in size. The topography is undulating, with low cliffs to the south and west dropping to narrow, sandy beaches. Much of the island is pock-marked with bomb craters. With the exception of the northern area, the island is surrounded by a rocky reef, ~270m in width, comprising sandstone and shale. There are three small freshwater reservoirs on the island, the largest covering an area of ~0.6ha.



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

Figure 5-34: Thamihla Kyun protected area

Wildlife & vegetation: Sandy beaches are backed by typical beach vegetation with *Hibiscus sp*., *Terminalia catappa, Casuarina equisetifolia* and *Cocos nucifera*. The sheltered northern part of the island has good cover of *Bombax malabaricum, Ficus* spp. *Lagerstroemia macrocarpa, Xylia dolabriformis, Terminalia belerica* and *Lannea grandis*. Evergreen shrubs and bamboo constitute a fairly dense understorey. The southern part of the island is more exposed, and supports a poorer cover with patches of open grassland and bare rock interspersed with evergreen thickets.

The island was formerly a major green and olive ridley turtle nesting site, and an extension of the reserve was recommended to create a marine reserve component.

Land use: State owned; the sanctuary notification conceded 1.1ha to the Port Commissioner of Bassein, and allowed fishermen to seek temporary shelter in bad weather.

Harvesting of marine turtle eggs and fishing are the main land use. There is no resident local population on the island. The People's Pearl and Fisheries Corporation maintains a representative and a small number of labourers, and a policeman and forest guard are resident. In 1983, there was a temporary military garrison on the island. The island has a sheltered anchorage of some 3-5m in depth.

Disturbances and threats: marine turtles are seriously threatened by the intensive egg-collecting and offshore trawling activities of the People's Pearl and Fisheries Corporation. The People's Pearl and Fisheries Corporation is permitted to collect nearly all the turtle eggs, whilst its trawling operations offshore are thought to be responsible for about 100 turtle deaths each year.

5.4. SOCIO-ECONOMIC ENVIRONMENT

The project area is located ~124km from the coastal mainland, and ~64km from Cheduba (Munaung) Island. It is in a deep water offshore area, with water depths ranging from ~1,980m to ~2,400m; it is not expected that the proposed seismic survey activities in the AD-03 Block will have any significant interactions with the human environment and associated economic activities, apart from offshore marine activities such as industrial fishing and shipping. It is extremely unlikely that coastal human activities (artisanal fishing, aquaculture or tourism) are impacted by the project are also extremely limited, due to several reasons:

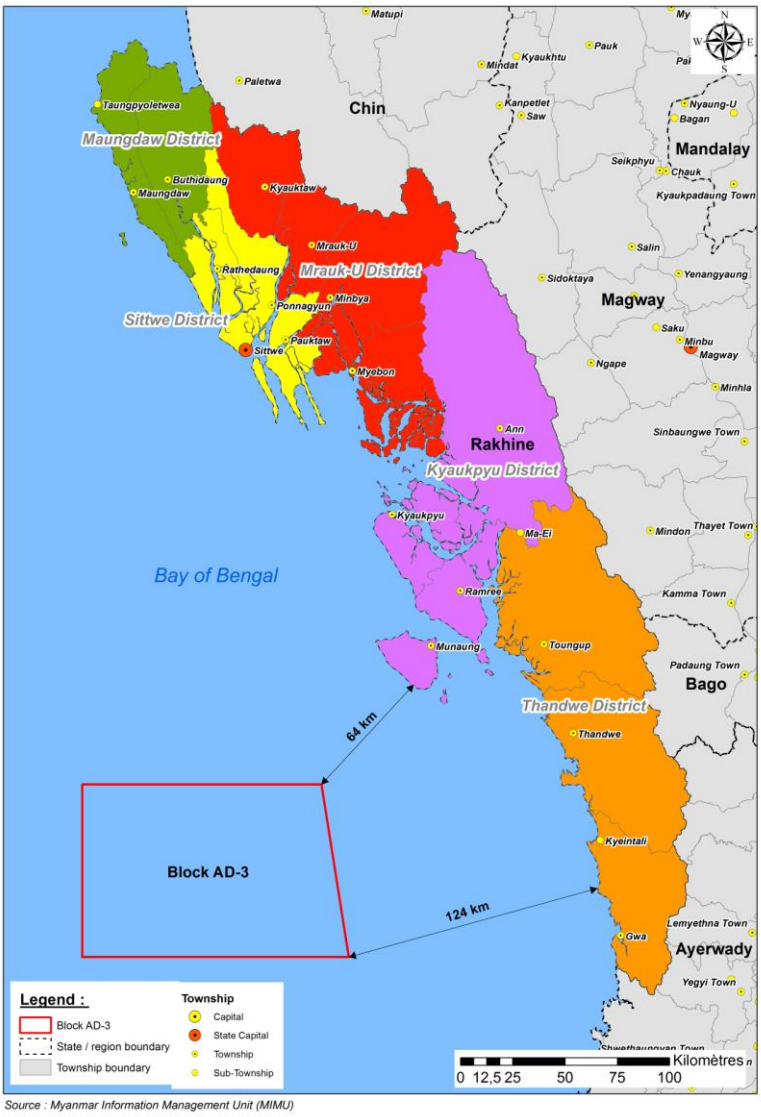
- The distance of the project area from the coast and the deep water depths within the block: both are factors deterring the presence of artisanal and small-scale fishermen in the area who lack the equipment and technical capacities to fish far from the coast and in deep water areas.
- The nature of the seismic operations, the impacts of which are restricted to the location of the survey and do not extend further than a few kilometres (unlike drilling operations where accidental situations can lead to oil spills reaching the coast and impacting coastal communities).

Consequently, this IEE focuses on analysing marine economic activities (limited to commercial shipping traffic and large-scale fishing) occurring in the project area and surrounding waters. Since fishing is an important activity in Rakhine State, and Thandwe and other towns located on the coast of this State are major ports for fish catch landing, a general overview of the socio-economic conditions of coastal communities living in this Rakhine State is included in the following sub-sections.

5.4.1. Administrative Organization

The Union of Myanmar is administratively divided into seven states, seven regions (called divisions prior to 2010), six self-administered zones and one self-administered division. These administrations are each headed by a Chief Minister, appointed by the President of the Union and chosen among the region and state Hluttaws (regional parliaments made up of elected civilians and representatives of the armed forces). The Chief Minister is assisted in his missions by a cabinet of ministers that he appoints himself, and that is responsible for various sectorial policies at the regional level (such as forestry and mines, agriculture and livestock, etc.).

States and regions are sub-divided into 67 districts and 325 townships, further divided into wards and village tracts (groups of villages). Districts and townships are headed by administrators appointed by the government and coming from the General Administration Department (GAD) of the Ministry of Home Affairs. Village tract administrators, who used to be centrally-appointed, are now directly elected by citizens since the Ward and Village Tract Administration Law has been passed in 2012.



Source : Myanmar Information Management Unit (MIMU)

Figure 5-35: Rakhine State administrative organization

As shown in Figure 5-35 (also refer to **Annex 4**), the closest shoreline (~64km) to the project area is in Rakhine State, which is composed of four districts: Maungdaw, Sittwe, Kyaupkyu, and Thandwe. It is further subdivided in 17 townships, 1,164 village tracts and 3,931 villages. Sittwe is the state capital, where all the major government institutions are based.

The project area is located directly offshore from two districts: Kyaukpyu and Thandwe, and six townships: Munaung, Ramree and Kyaukpyu townships (under Kyaukpyu district administrative limits) and Toungup, Thandwe and Gwa townships (under Thandwe district).

As seen in Figure 5-36, apart from major towns (Munaung, Ramree, Toungup, Thandwe, Kyeintali, and Gwa), numerous small villages belonging to larger village-tracts border the shoreline between Gwa (in the south of Rakhine State) and Kyaukpyu.

5.4.2. Governance

Prior to 2008, the government system in Myanmar was centralized. The central government held most of the political and economic powers and responsibilities, controlling financial resources and budgets.

Under the framework of the new Constitution of 2008, and the changes in the country 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 the local governance systems (state, region, township and village administrations)[19]. It passed several policies in order to devolve fiscal, political and administrative power to these administrations: in 2012, the government revised the Village Tract Administration Law, which increased local democracy through the direct election of the village tract administrator by the village inhabitants; on 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[20].

Source : Myanmar Information Management Unit (MIMU)

Figure 5-36: Coastal villages close to the project area

In Rakhine State, the most important stakeholder from the public authority is the Chief Minister who was appointed by the central government in June 2014. The Chief Minister is followed in importance by the district and township administrators. At the village tract level, authority is shared between administrators, directly elected by villagers, and informal leaders usually personified by elders.

[19] Nixon Hamish *et al.*, *State and Region Government in Myanmar*, September 2013, 96 p.
[20] Asia Foundation, *State and Region Government in Myanmar*, September 2013

5.4.3. Population and Demography

5.4.3.1. Demography

The Ministry of Immigration and Population conducted the last Myanmar's population census in March and April 2014 (for the first time in 30 years[21]), the results of which are expected to be released in May 2015. Published provisional results[22] show that the country's total population is ~51.4 million people[23], with an annual population growth rate of 1%, as of 2012. 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. Rakhine State has 3,188,963 inhabitants, representing 6.20% of the total population[24].

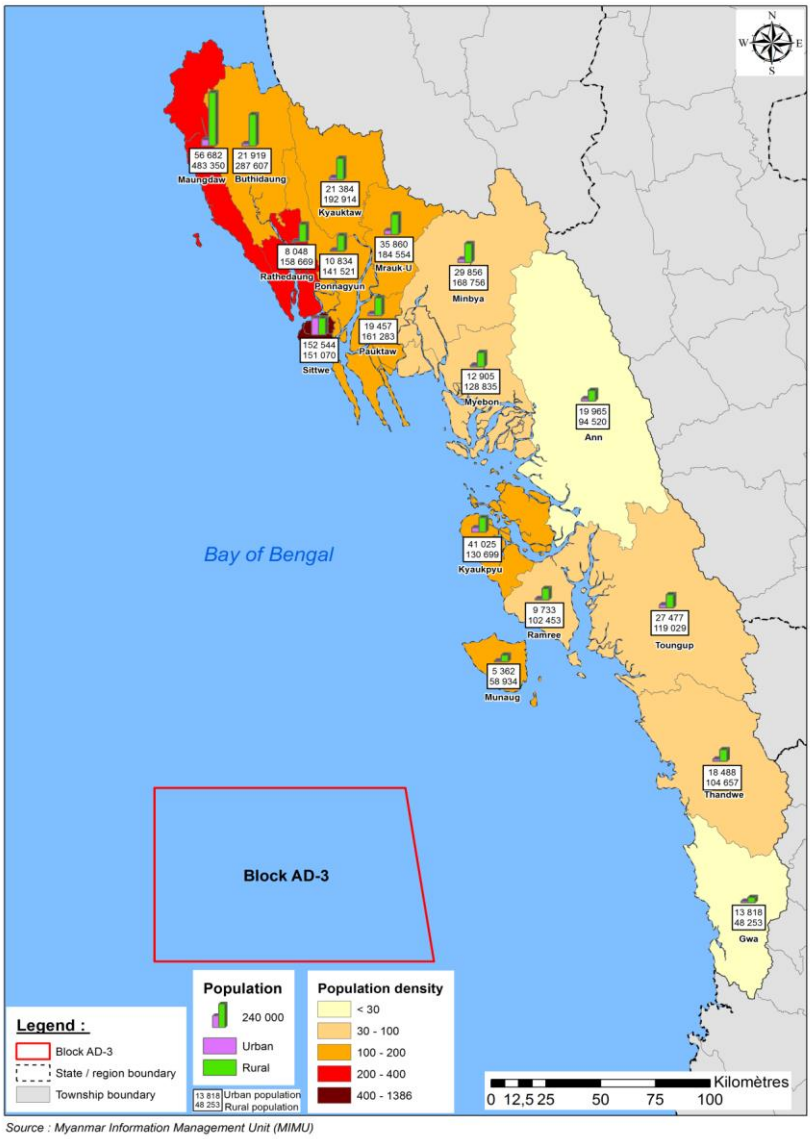
As shown in Figure 5-37, the population is mostly rural (83% living in a rural environment). The population density is medium throughout the state when compared to other states of Myanmar (87 inhabitants per km² for Rakhine, compared to 200 in Mandalay and 700 in Yangon), although population density is higher in the northern part of the state.

The main demographic figures for the districts and townships closest to the project area are presented in Table 5-13. Kyaukpyu and Thandwe are the most populated townships, with Gwa and Munaung having a lower number of inhabitants.

Table 5-13: Demographic data in the districts and townships close to the project area

District	Population	Township	Population
Kyaukpuy	439,674	Kyaukpyu	165,343
		Ramree	98,024
		Munaung	56,743
Thandwe	357,370	Toungup	114,312
		Thandwe	133,310
		Gwa	42,368
Total	**797,044**		**610,100**

[21] The last census was conducted in 1983.
[22] Department of Population, Ministry of Immigration and Population, Population and Housing Census of Myanmar, 2014, Provisional Results, Census Report Volume I, August 2014.
[23] This figure encompasses the 1,206,353 persons estimated not to have been counted in the census in parts of the states of Rakhine, Kachin and Kayin for various reasons.
[24] These figures include the 1,090,000 persons not counted during the 2014 national census.



Source : Myanmar Information Management Unit (MIMU)

Figure 5-37: Rakhine State population density by township

5.4.3.2. 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, with 29 million people (representing 69% of the population according to the 1983 census) inhabiting mostly the central and upper plains of the country. The Bamar are from Sino-Tibetan descent and migrated from Yunnan in China to settle in central Myanmar, progressively becoming the country's prevailing group.

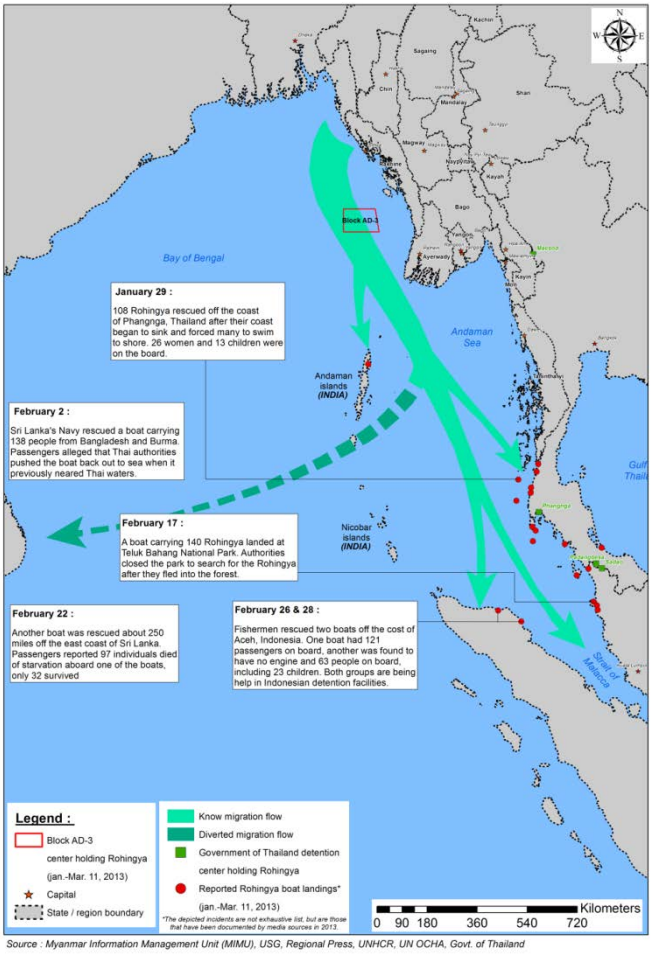
In the Rakhine State, the prevalent ethnic group is the Arakanese, also referred to as the Rakhine. They are predominantly Theravada Buddhists, and are one of the four main Buddhist ethnic groups in the country (the others being the Bamar, Shan and Mon). The state itself is also home to populations from other ethnic groups, like the Chin, Mro, Chakma, Khami, Dainet and Maramagri. There is also a minority population of Muslim Bengali.

5.4.3.3. Displaced Persons

In the region there is an important flow of Bengali people fleeing Bangladesh (especially Cox's Bazar refugee camps) or northern Rakhine State by boats to reach other countries in Southeast Asia (Indonesia, Malaysia and Thailand). They are transported by smugglers with the objective of reaching Australia, although most of them are stopped on the way for various reasons (and can enter human trafficking schemes where they are sold to illegal work camps in Thailand). This flow of migrants could cross the project area. Indeed, this migration route, as seen on Figure 5-38, traverses the AD-03 Block.

Apart from these voluntary migration flows, recent information from the UNHCR, various NGOs and international media[25] mention an important human trafficking system growing in Bangladesh and in the Bay of Bengal.

Offshore from the Bangladesh coast, in international maritime waters, large ships (sometimes fishing vessels such as trawlers) wait for smaller ships departing from the shore and carrying migrants, mostly Bengalis that were abducted and will be sold to human traffickers and illegal work camps in Thailand. This traffic has become more and more lucrative for Bengali, Thai or Burmese smugglers, and is likely to increase in the near future. **The project area could be crossed by these smuggling boats as they navigate towards Thailand**.



Source : Myanmar Information Management Unit (MIMU), USG, Regional Press, UNHCR, UN OCHA, Govt. of Thailand

Figure 5-38: Smuggling boat navigation routes and destinations

[25] SYED ZAIN AL-MAHMOOD, *Human Traffickers in Bay of Bengal Cast Sights on Bangladesh*, Wall Street Journal, 18 October 2014, available at [http://online.wsj.com/articles/human-traffickers-in-bay-of-bengal-cast-sights-on-bangladesh-1414536642]

5.4.4. Human Development and Access to Basic Services

Myanmar indicators on human development and access to basic social services have improved over the last years.. However the country Human Development Index of 0.524 ranks it 150 out of 187 countries (2013Currently, 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 inequalities among states/regions, and between urban and rural areas that have differing access to basic services and therefore have different levels of human development.

The current situation in Rakhine State reflects these increasing inequalities. The state is the second poorest in the country after Chin state, and poverty rates are almost two times higher than the national average, affecting 44% of the population according to a 2011 UN survey[26]. Rakhine State social indicators are low, especially when compared to national indicators, and the population has poor access to some basic services needed to guarantee human well-being.

This situation is partly due to its high exposure to natural disasters, in particular cyclones (the Giri cyclone hit Rakhine in 2010, killing 45 people, making 100,000 homeless and affecting thousands of houses and hectares of agricultural land)[27].

There have been recent improvements in access to healthcare in the country. For instance, 81% of the population now lives from walking distance to a hospital or a health centre. Besides, health sector expenditures by the Ministry of Health have more than doubled between 2007 and 2012.

Average life expectancy was 65.7 years in 2012, below regional neighbours, and Myanmar has the highest basic mortality rate of Asia-Pacific countries (nine per 1,000 people). Maternal and child health are an r issue, along with malaria and tuberculosis, which causes substantial mortality and morbidity. In 2012, Malaria incidence was measured at 2,743 cases per 100,000 people, while tuberculosis prevalence was estimated to 489 cases per 100,000 people[28].

On average, Myanmar has only one physician per 2,188 people and one hospital bed per 1,667 people.

Health indicators in Rakhine State are lower than the national average, with higher incidence of maternal and child health issues, malnutrition (16.3% of children under five suffer from severe malnutrition, against 9.1% at the national level), or morbidity.

5.4.4.1. Education

Government investment in primary education is demonstrated by good indicators in terms of literacy rate (90% of adults are literate) and net primary school enrolment (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)[29].

In Rakhine State, 71% attend primary school, and 32% attend secondary school.

5.4.4.2. 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 drinkable water sources in 2010. Urban populations have higher access (81.4%) than rural ones (65.2%).

In Rakhine State 49.5% of the state population had access to safe drinking water in 2010This has lead to the prevalence of diseases such as diarrhoea.

[26] UNDP, *Integrated Household Living Conditions Survey in Myanmar (2009-2010), Poverty Profile*, June 2011
[27] The source of these data is OCHA.
[28] World Health Organization, *Myanmar Health Profile 2012.*
[29] UNICEF statistics on Myanmar.

5.4.4.3. **Energy**

Overall, access to electricity in Myanmar stood at around 48% of the population in 2010. In Rakhine State 26% of its population had access to electricity.

5.4.5. Marine Socio-economic Environment

Myanmar economic development has accelerated over the last few 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. Notably, they revised the 1988 Foreign Investment Law in 2012, to facilitate international companies' investments in the country's economy. 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 succeeded, and numerous foreign companies are now willing to invest in the country's economy.

As for for other sectors, marine economic activities represent a high potential for economic growth. In part of Myanmar's maritime area, these activities are regulated by the United Nations Convention on the Law of the Sea (UNCLOS). This convention delineates the governments' rights and responsibilities related to the oceans and establish spatially defined 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[30]. Myanmar has signed UNCLOS and implemented it in its Territorial Sea and Maritime Zones Law in 1977.

The country already actively exploits its marine oil and gas resources, especially in areas offshore Rakhine State. In parallel, the government sees an important potential of 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 will need to be anticipated and whenever possible prevented.

5.4.5.1. **Offshore Oil and Gas Operations**

Myanmar offshore oil and gas resources represent an important potential of 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[31].

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[32]. 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 Rakhine State

Most of the blocks located offshore of the Rakhine state were granted during the 2013 offshore bidding round (including the AD-03 Block awarded to Ophir). A list of these blocks and the companies to which they were awarded is presented below: The location of these blocks, including the AD-03 Block where the 3D seismic survey will take place is shown in Figure 5-39.

For shallow water blocks:

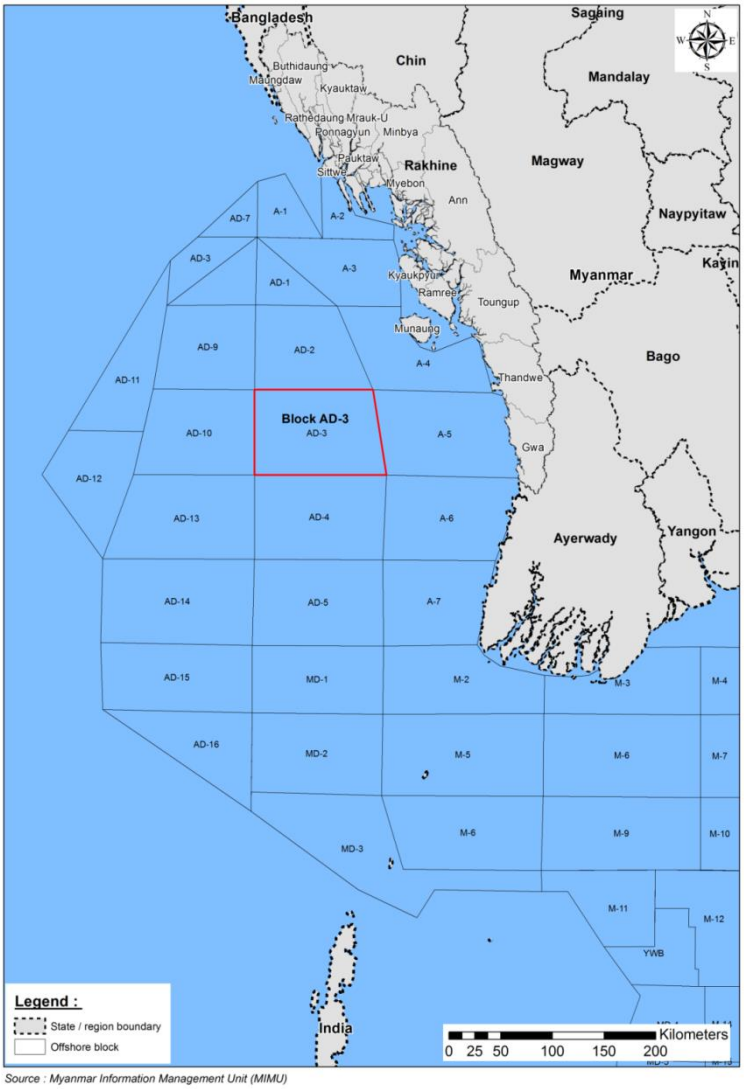
[30] UNITED NATIONS, *The United Nations Convention on the Law of the Sea (A historical perspective)*, 1998, available at [http://www.un.org/Depts/los/convention_agreements/convention_historical_perspective.htm#Exclusive Economic Zone]
[31] John Buchanan, Tom Kramer, Kevin Woods, *Developing Disparity - Regional Investment in Burma's Borderlands*, Transnational Institute (TNI), Burma Center Netherlands (BCN), Amsterdam, February 2013
[32] Offshore Energy Today, *Myanmar awards new offshore blocks*, March 26, 2014.

- A-4 and A-7 to BG Asia Pacific and Woodside Energy (Myanmar).
- A-5 to Chevron (Unocal Myanmar Offshore Co. Ltd.).

For deep water blocks:

- AD-2 and AD-5 to BG Asia Pacific and Woodside Energy (Myanmar).
- AD-9 to Shell Myanmar Energy and MOECO (Mitsui Oil Exploration Co.).
- AD-10 to Statoil and ConocoPhillips.
- AD-11 to Shell Myanmar Energy and MOECO.

Since most of these blocks were awarded recently, it is possible that several operators will start their exploration activities within the same timeframe, which could increase the potential for cumulative impacts on the marine ecosystems, commercial traffic and marine fisheries.



Source : Myanmar Information Management Unit (MIMU)

Figure 5-39: Offshore oil and gas blocks

Shwe Gas Project

So far, the only producing project offshore from the Rakhine coast is the Shwe Gas Project developed by a consortium of seven companies: Daewoo International – operator, Myanmar Oil and Gas Enterprise [MOGE], Oil and Natural Gas Corporation [ONGC], Videsh, Gas Authority of India [GAIL], Korean Gas Corporation [KOGAS], and China National Petroleum Corporation [CNPC]. The Shwe Gas Project comprises the Shwe, Shwe Phyu and Mya offshore gas fields located in Blocks A-1 and A-3. It commenced production in 2013, and is expected to generate 500 million cubic feet of gas a day. The gas produced is transported from the Shwe platform to Ramree Island through a 110km-long subsea pipeline. It is further exported through the 2,800km Myanmar-China gas pipeline network, and will supply gas to the China National United Oil Corporation (CNUOC) for 25 to 30 years.

This project is located more than 100km from the AD-03 Block.

Public Complaints and Criticism against the Shwe Gas Project in Rakhine State

The Shwe Gas Project has been criticized by national and international stakeholders, from environmental NGOs to human rights' activists (such as Earthright International, Business and Human Rights).

Opposition to the Shwe Gas Project started in 2007 with demonstrations organized by local communities and supported by various stakeholders.

Though OPHIR's AD3 Block is located relatively far away from the Shwe gas project, it could be affected by the current opposition to Shwe gas project in the future, especially if impacts from OPHIR seismic campaign on the environment and fisheries were considered as poorly managed by Kyaukpyu district stakeholders and local communities.

5.4.5.2. **Fishery Sector**

Myanmar has a coastline of 2,280km, a marine water area of 486,000km^2, and an inland water area of 124,280km^2. The potential for development of both inland and marine fisheries is therefore substantial. This sector already represents the fourth most important export earning sector and generates (with livestock) 9.9% of Myanmar's GDP[33]. It employs an estimated 7,977,000 people (among which 3,269,000 are active fishermen[34]), which represents 15% of the total population of the country. Moreover, as in many Asian countries, fish and other products are important for diet of the Burmese and contributes to the reduction of food insecurity. In 2002, per capita consumption of fish amounted to 21kg/year and constituted 60 to 70% of the total protein intake for the population[35].

Rakhine State has 741km of coastline and various coastal and inland ecosystems suitable for the practice of fishing and aquaculture. Fishery is an important economic activity at the regional and local level. It is estimated to represent a quarter of the region's economic value, and 43% of the 3.2 million inhabitants of the state rely on fishing or a combination of fishing and agriculture for their sources of livelihoods. There are an estimated 600,000 individuals involved in capture fisheries and/or aquaculture, while 150,000 individuals are involved in other stages of the value chain (processing, wholesale, export), including 489 registered fish traders[36].

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.

[33] According to the Institute of Marine Research figures, available at [http://www.imr.no/forskning/utviklingssamarbeid/surveys/myanmar_2013/en]
[34] Bay of Bengal Large Marine Ecosystem - BOBLME
[35] Pe Myint, *National Report of Myanmar on the Sustainable Management of The Bay of Bengal Large Marine Ecosystem*, BOBLME, GCP/RAS/179/WBG, 2004
[36] JOFFRE Olivier, AUNG U Moe, *Fishery Value Chain Analysis in Rakhine State Assessment for village level interventions* (Document Prepared for Tat Lan Project Partners), February 2014

- 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 has responsibility for both inland and marine fisheries. The main mission of the DoF is to develop and implement sectorial policies aimed 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. Because of a lack in equipment and funds, the DoF local offices in Rakhine State mainly focus on inshore fisheries rather than offshore fisheries, which are more difficult to control as the support of the Myanmar Navy is required[37].

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 five nautical miles (nm) from the shore for the Rakhine coast (and 10nm from the shore on the Ayeyarwady and Tanintharyi coasts). Boats entering this category should not be equipped with an engine having more than 12 horsepower and length of the boat is limited to 30 feet.
- **Offshore fishery**: covers the outer area of the inshore fishery zone up to the EEZ boundary. Boats should have an engine of more than 12 horsepower, and can use bottom trawl, purse seine, surrounding nets, drift nets and long lines[38].

In 2013, the limit for the inshore fishery zone in Rakhine State was increased from 5 to 10nm from the coast. This was done to preserve larger coastal areas from trawling fishing techniques which are destructive to the environment. The same year, the Rakhine State administration decided to replace the national Marine Fisheries Law with new regulations more adapted to the local context. The new regulations are being drafted by the DoF and would include a two-month closed season for offshore fisheries.

Figure 5-40 shows the boundaries of the fishery zones as they have been established by the Marine Fisheries Law, not taking into account the recent change in the limit of the Rakhine State inshore fishery zone.

On this map, the inshore fishery zone is represented in deep blue and is adjacent to the coast, while the offshore zone extends from the inshore boundary out to the EEZ boundary, in water depths ranging from 0 to over 200m. For licensing purposes, the DoF divided the offshore zone into 140 fishing grounds of 30 x 30nm blocks, using latitude and longitude lines. It also designated four fishing areas, namely Rakhine (40 blocks), Ayeyarwady (44 blocks), Mon (14 blocks) and Taninthary (52 blocks).

As seen on this map, the project area is located in the Rakhine offshore fishing zone, in water depths ranging from ~1,980 to ~2,400 meters.

Marine Fishery License System

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

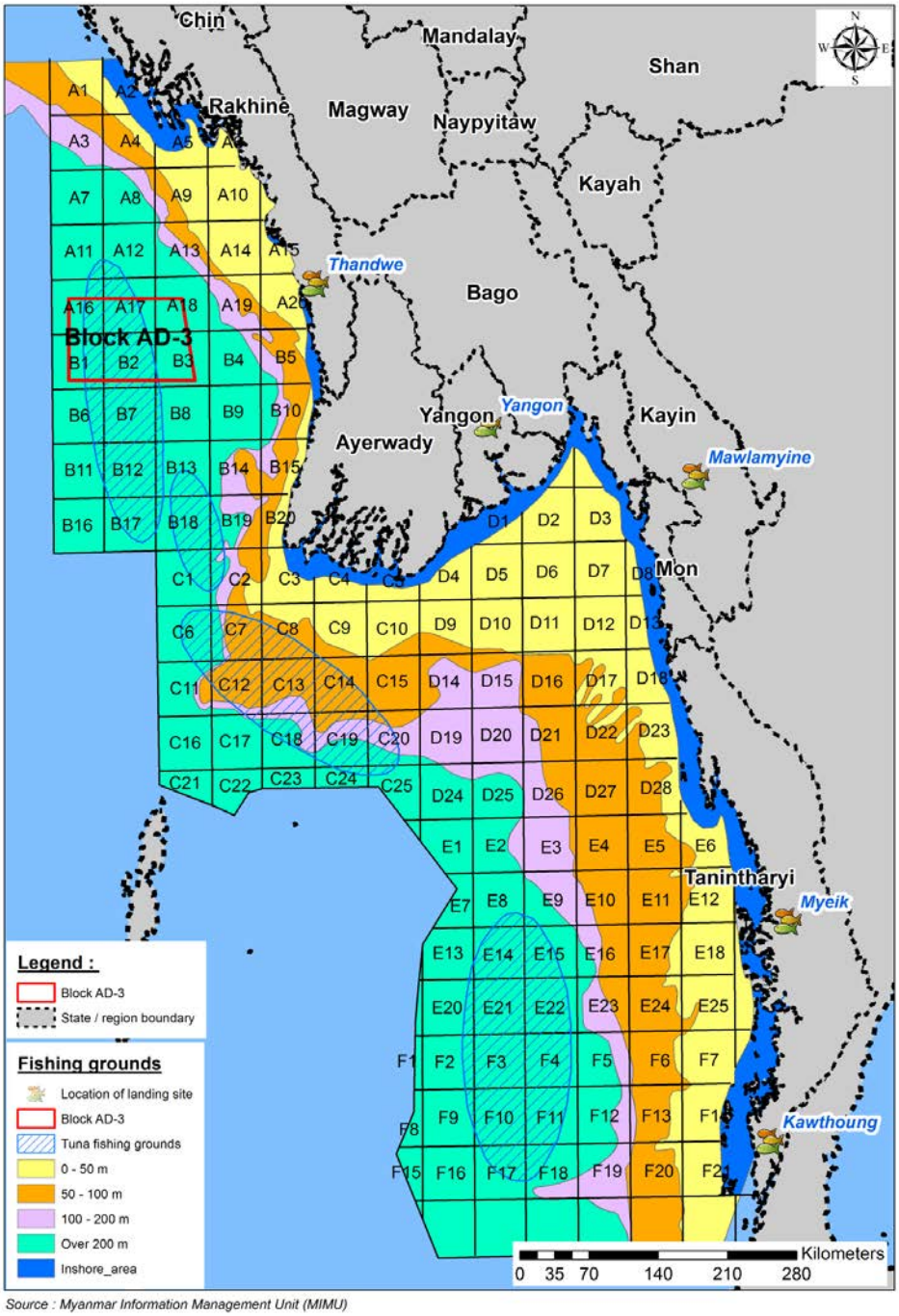
[37] **Op. Cit.,** JOFFRE Olivier, AUNG U Moe
[38] FAO, *The State of World Fisheries and Aquaculture, Opportunities and Challenges*, 2014

- **Inshore fishery zone license:** the General Administration Department (GAD) is in charge of inshore fishing boats' inspection. The DoF proceeds with the issuance of fishing licenses upon recommendation of the GAD.
- **Offshore fishery zone license:** the Department of Marine Administration (DMA) has responsibility for 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 with explicit agreement of the related government agencies that foreign fishing vessels can conduct fishing activities in the country's territorial waters. Foreign fishing companies can acquire licenses to operate in Myanmar waters from the DoF, in exchange of a fee and upon approval of the Ministry of Livestock and Fisheries.

In April 2014, the Government of Myanmar decided to suspend fishing rights and licensing of 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 had been expected for a long time[39].

[39] The Irrawady, *Burma Bans Foreign Fishing Boats From Its Waters*, April 3, 2014



Source : Myanmar Information Management Unit (MIMU)

Figure 5-40: 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 inch mesh size and trawl net cod-end mesh size

less than two inches[40]. 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 Guard, the DoF, the Myanmar Customs Department and the Myanmar Police Force.

Despite these measures, illegal fishing is commonly practiced in Myanmar waters, especially by neighbouring Thai vessels in the Andaman Sea. In the Bay of Bengal bordering Rakhine State, it is also possible to encounter Thai vessels performing illegal fishing although less likely than in the Andaman Sea due to the long distances from Rakhine to Thailand. Bengali illegal fishermen could also be encountered due to the close proximity to the Bangladesh coastline.

Marine Resources: Surveys and Estimates

Myanmar fishery institutions do not have recent and reliable data on the extent of marine resource 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 government agencies for collecting information and building expertise.

Without these data, the Ministry of Livestock, Fisheries and Rural Development and the DoF cannot draft a sustainable fisheries policy which would preserve marine resources as well as enabling the commercial fishery sector to prosper.

Myanmar is member of several inter-governmental organizations (IGOs) specialized in fisheries management at the regional scale, such as the Southeast Asian Fisheries Development Centre (SEAFDEC), the Asia-Pacific Fisheries Commission (APFIC), and the Bay of Bengal Large Marine Ecosystem Program (BOBLME). In order to develop 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 estimates to be made on the levels of 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): 1mmt for pelagic fish, and 0.8mmt for demersal fish, respectively. But according to the Government of Myanmar, the potential maximum sustainable yield (MSY) of Myanmar waters is ~1.05mmt per year (0.5mmt of pelagic fish and 0.55mmt of demersal fish)[41].

Recently, a large marine ecosystem survey was conducted under the framework of the EAF-Nansen project and the BOBLME[42]. This study gathered a team of international marine experts for a six-week field survey in November 2013, with the participation of the DoF. Waters offshore Rakhine coast were surveyed by this team (from Bangladesh border to Mawtin Point). Due to large amount of data the project has to process before being able to publish any reports, it is unlikely that the results of the survey will be available prior to the end of 2014.

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[43], on drastic depletion of stocks and overfishing both for the offshore and inshore fisheries[44]. In Rakhine State, fish catch levels are said to have declined dramatically over the past decade. A recent report suggests a massive decline of as much as 90% over the past 10 years while information on the preliminary results of the recent survey conducted by the EAF-Nansen project estimates that the decline of fisheries in Rakhine has been of about 65% over the last 30 years.

[40] KYA Kyaw, Dr., SEAFDEC, Countries profile of Myanmar Addressing the IUU Fishing in the Southeast Asian Region, 2010
[41] Tony J Pitcher, *An Estimation of Compliance of the Fisheries of Myanmar with Article 7 (Fisheries Management) of the UN Code of Conduct for Responsible Fishing*, 2007.
[42] 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].
[43] The Irrawady, *Burma Bans Foreign Fishing Boats from Its Waters*, April 3, 2014.
[44] MFF in Rakhine estimates the decline of the fish catch at 70-80% in the last 15 -20 years.

Main Characteristics of the Marine Fishery Sector

A. Fishing Grounds

Several commercially important species were identified during previous surveys as having a high potential for the development of offshore fisheries. These species are mainly pelagic fishes, such as swordfish (*Xiphias gladius*), deep-sea lobster and deep-sea shrimp, yellowfin tuna (*Thunnus albacares*), striped marlin (*Tetrapturus audax*) and sailfish (*Istiophorus platypus*)[45]. Tuna may be the most important group for industrial development, and the main fishing grounds for tuna were identified by the DoF (shown in Figure 5-40 - blue circles with blue stripes). As can be seen on the map, part of the AD-03 Block overlaps one of these tuna fishing grounds. Fishing grounds for other species have not been officially identified to date.

B. Fishing fleets and techniques

The latest estimates on the country's total fishing fleet set the number of vessels at ~30,800 in 2011, half of which were non-motorized boats, and 1,600 were trawlers[46].

The Myanmar marine 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 deeper waters. Around 2,450 national vessels were engaged in offshore fisheries in 2012. Additionally, 132 foreign vessels were reported to have licenses to conduct activities in the offshore fishery[47].

Thailand is an important stakeholder in the foreign fishery sector in Myanmar, with several Thai companies having fishing rights. Other companies from countries such as Singapore, Japan, China and 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, such as fish traps or stow nets, are also used but less are less common in the offshore fishery zone.

C. 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 metric tonnes (mt) in 2012. Among these, inland waters fisheries accounted for 1,246,460mt and aquaculture for 0.885mt.

The marine capture fisheries represented half of the total production, with 2,332,790mt of catch in 2012, an increase of 7.5% from the previous year, and from 121% between 2003 and 2012. However, this figure is likely to be an underestimate 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, Phuket in Thailand, Penang in Malaysia or even in Japan. Foreign fleets have 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 national statistics. Furthermore, the general composition of the marine catches landed in the country is also not known precisely[48]. This lack of data prevents Myanmar from identifying overfishing of particular species, and therefore from adopting a sustainable fishery policy.

[45] Julius Kyaw, Department of Fisheries, *Present Status of Off-shore Fishery Resources and Information on Tuna Fishery in Myanmar*, Special Meeting on Improvement of Tuna Information and Data Collection in the Southeast Asia7-9 September, 2011. Songkhla Province, Thailand.
[46] Bay of Bengal Large Marine Ecosystem Project (BOBLME), *Transboundary Diagnostic Analaysis vol. 2*, 2012.
[47] According to the Institute of Marine Research figures, available at:
[http://www.imr.no/forskning/utviklingssamarbeid/surveys/myanmar_2013/en].

The 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, Myeik and Kawthoung cities. 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 European Union (EU) and United States (US) markets. A recent project from the United Nations Industrial Development Organization (UNIDO) will help upgrade eight other factories, increasing their standards to allow exports to these high profitability markets[49]. However, exports to EU and US markets remain limited at present.

Global marine products exports in 2013 amounted to 376,845mt, generating revenues of USD 650 million. Excluding shrimps, fish products represented 70% of these exports (266,464mt), and USD 380 million of revenue. During 2014 fiscal year, a decrease in fishery exports was observed with only USD 550 million of revenue 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 is mainly caused by a lack of competency in the fishery sector, preventing it from competing on international markets.

In regards to low quality catches, these are processed in Myanmar to produce 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 Rakhine State[50]

A. Fishing Industry at the State Level

There is an important fishery industry in Rakhine State with a large and well organised supply chain. Traders operate at the township market level and handle fish collection, processing and conditioning of domestic exports to Yangon, Mandalay or Muse and international exports to Bangladesh and China.

As in the rest of the country, the marine fishery is mainly focused on the inshore/coastal fishing sector. This activity is commonly performed at the household level by artisanal fishermen in coastal villages. These villages are highly dependent on fishing and some of them rely entirely on this activity as a source of livelihood[51].

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 out to the offshore area. They target grouper, sea bass and mackerel, and their fishing trips can last more than one week. During the rainy season, the offshore area is less accessible because it is more dangerous, limiting the fishing grounds to the inshore fishery zone. Fishermen tend to use more passive fishing gears during the rainy season, such as stow nets, drift nets and gill nets, targeting shrimps, mud crabs or fish such as mullets or sea bass. Artisanal fishing generally produces catches of low commercial value, mostly for local consumption and/or the retail markets in Sittwe, Kyaukpyu or Thandwe townships.

Offshore fishing is also performed in Rakhine State by large fishing fleets targeting fish species with high commercial value and ideal for export, such as grouper, pomfret, hilsa, and sea bass. The DoF indicated that in the past there were 17 licensed Thai vessels conducting long-line tuna fishing in the project area[52]. However, these fishermen are now forbidden from operating in Myanmar waters.

[49] ELEVEN MYANMAR, *UNIDO to Upgrade Myanmar's Fish Factories*, 11 April 2014, available at [http://www.elevenmyanmar.com/index.php?option=com_content&view=article&id=5731:unido-to-upgrade-myanmar-s-fish-factories&catid=33:business&Itemid=356]

[50] Most of the information in this section were provided based on a report on Rakhine Fisheries Value Chain produced for the NGO OXFAM in February 2014 : JOFFRE Olivier, AUNG U Moe, *Fishery Value Chain Analysis in Rakhine State Assessment for village level interventions (Document Prepared for Tat Lan Project Partners)*, February 2014

[51] OKAMOTO Ikuko, *Issues Affecting the Movement of Rural Labour in Myanmar: Rakhine Case study*, IDE Discussion Paper n.206, July 2009

[52] This information was obtained during an initial meeting with the Department of Fisheries, and confirmed by the Myanmar Fisheries Federation which was also met in the frame of this project.

B. Fishing Industry at the Township Level

Sittwe, Kyaukpyu and Thandwe townships are important fishing centres, and are major landing sites and trade point for fishery products. In Sittwe, fish traders target high value fish such as sea bass, grouper, pomfret and mackerel. The fish are iced and transported by public bus to the wholesale market in Yangon. Sittwe is also where the processing factories for shrimp and fish, and larger traders exporting to China and Yangon, are located.

Kyaukphyu township has a strong inshore fishery sector representing about 72% of the inshore fishery catch in Rakhine State. Prawns (*Penaeus mondon* and *P. indicus*), from both wild capture and aquaculture, dominate production. The other main species are anchovies, sardines, catfish, pomfret, Indian tassell fish (*Polynemus indicus*) and mackerel as well as grouper and sea bass.

C. The Role of Bengali in the Fishery Sector

Prior to the outbreak of ethnic tensions between the Bengali Muslim community and the Rakhine ethnic group, the local Muslim community was actively involved in offshore and inshore fisheries. They were traditionally regarded as more skilled and better equipped than Rakhine ethnic group fishermen, which allowed them to fish more in the offshore area and target larger fish with a higher commercial value. In Kyaukpyu, a large Muslim fishing community was involved in offshore fisheries for mackerel, grouper and pomfret.

The outbreak of violence also changed access to the traditional fishing grounds. During the three months following the first inter-communal conflict, no fishing activity was performed at all. Two years after, fishing grounds have not been restored to what they were before. To avoid risk of attacks, each community now fishes in large groups of vessels, avoiding the offshore fishery zone and staying close to the shore, limiting their fishing grounds to the village surroundings.

D. NGO Support to Artisanal Fishing Activities

Following the Giri cyclone in 2010, that caused major damage across Rakhine State, destroying houses, agricultural land, and fishing vessels and equipment, national and international NGOs mobilized to support local communities in restoring their livelihoods. This mobilization resulted in the Tat Lan project, a food security and livelihoods program funded by the Myanmar Livelihoods and Security Trust Fund (LIFT), and implemented by the International Rescue Committee (IRC) in partnership with Save the Children UK, Oxfam, and the local NGO Better Life Organization. This program aims at improving the livelihoods of 214 cyclone-affected communities in the fields of capture fisheries, aquaculture and agriculture in the townships of Myebon, Pauktaw, Kyaukpyu and Minbya in Rakhine State.

Pyoe Pin, a national program funded by international donors, brings its support to civil society organizations by improving economic opportunities for local communities. This program has operations in Rakhine State where it actively supports to the small-scale fishery sector. It partnered with a regional initiative launched in 2012, called the Rakhine Fisheries Partnership, whose objective is to improve to tackle fish depletion and collectively support sustainable fisheries. This organization gathers together the DoF, MFF, Tat Lan project organizations and other stakeholders.

5.4.5.3. Interactions between the Fishery Sector and the Project

The project area is located in the offshore fishery zone of the Rakhine State. It is relatively close to the shoreline (64km at the closest point) but is located in deep water (>1,000m). Given the offshore, deep water location of the block, there is a possibility that fishing fleets targeting large pelagic fish species such as tuna may be encountered, since the block is in the middle of a tuna fishing ground (see Figure 5-42). It is also possible that small-scale fishermen may occasionally operate at considerable distances from the coast depending on the weather conditions. However, this cannot be confirmed with empirical data: most of the fishing boats operating in Myanmar are not equipped with Automatic Identification Systems (AIS).

Any fishing operations in the project area and surrounding waters are likely to be limited in scale, for several reasons:

1. the very low density of licensed vessels in the offshore fishery zone when compared to the inshore fishery zone (27,751 inshore licensed vessels for an area of 36,480km^2, against around 2,200 offshore licensed vessels for an area of more than 400,000km^2);
2. the ban on foreign fishing (only authorized in the offshore zone) from Myanmar waters since April 2014 for an undetermined period;
3. the lack of evidence on the practice of illegal fishing in the region (as compared to the Andaman Sea where Thai illegal fishermen often operate); and
4. the current tensions between Bengali and Rakhine ethnic groups, which strongly limits fishing in the offshore areas due to fears of attacks.

Interactions with fishermen during the 3D seismic survey in the AD-03 Block are therefore expected to be limited.

5.4.5.4. **Port Infrastructure and Marine Traffic**

Port Infrastructure

Port infrastructure in Rakhine State is very limited. As shown in Figure 5-41, there are three international ports in Thandwe, Kyaukpyu and Sittwe towns. These ports are managed by the Myanmar Port Authority, and have very limited infrastructure and capacity to accommodate a large number of vessels.

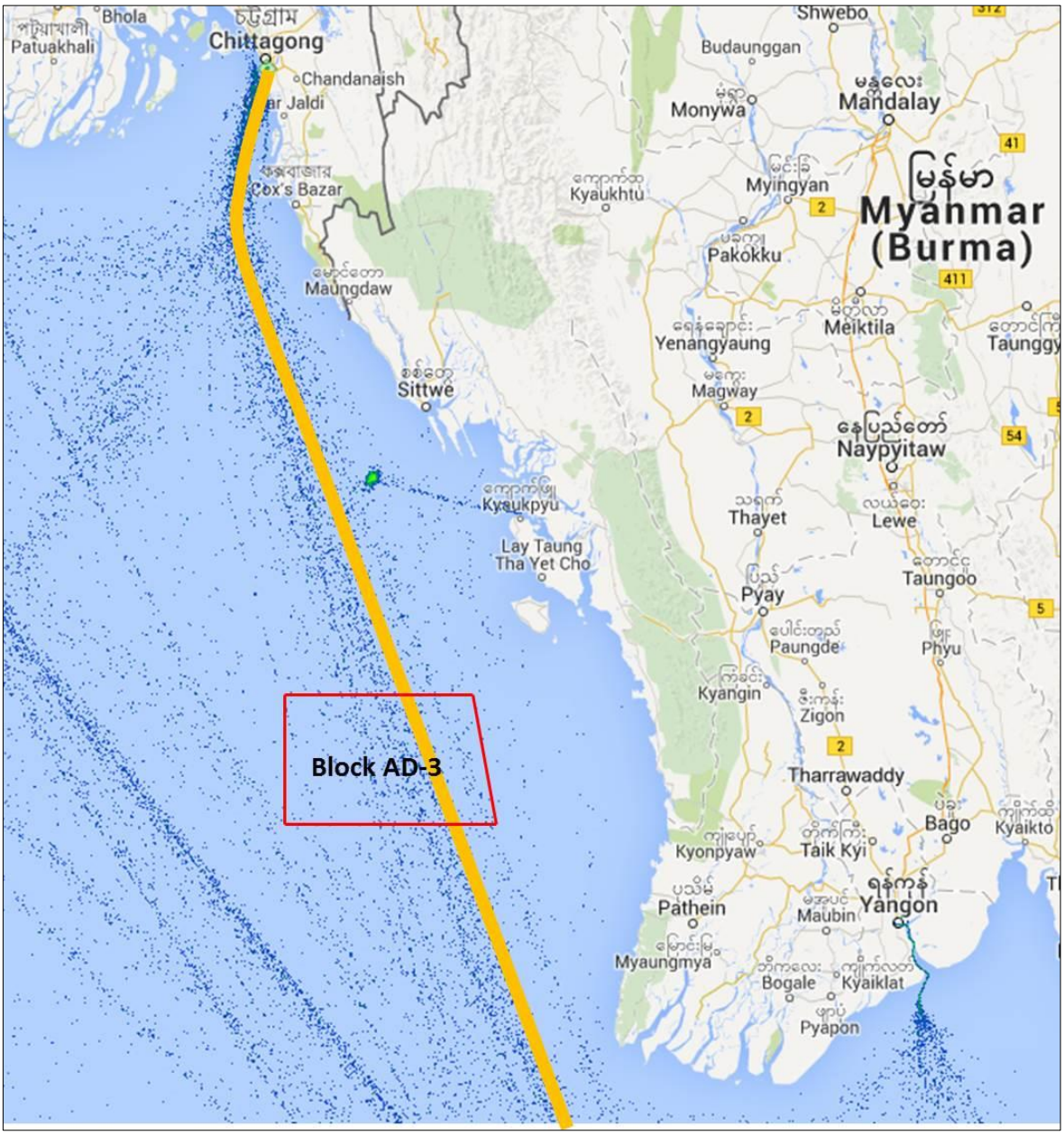
To improve maritime infrastructures in Rakhine State, the government has therefore planned the development of a Special Economic Zone (SEZ) in the town of Kyaukpyu. This project will include a deep sea port, several industrial facilities and residential areas, and aims to improve the role of Rakhine State as a hub for international trade between the Middle East, India, Myanmar and China. The SEZ administration recently appointed a Singapore-based consortium to develop a master project plan for the Kyaukpyu SEZ, and construction companies are expected to be selected in December 2014. The project will be completed in 2025, and will cover an area of around 75km².

Source : Myanmar Information Management Unit (MIMU)

Figure 5-41: Main coastal ports on northwest coast of Myanmar and in Ayerwaddy delta

Marine Traffic

As shown in Figure 5-42, marine traffic off the coast of Rakhine State is limited to regional traffic. A moderately busy shipping lane, shown by the orange lane on the map, connects Chittagong port in Bangladesh to the Malacca Strait in Malaysia. The AD-03 Block is located on the middle of this shipping lane and encounters with vessels during the 3D seismic survey can therefore be expected.



Source: marinetraffic.com, data collected on the 13th November 2014

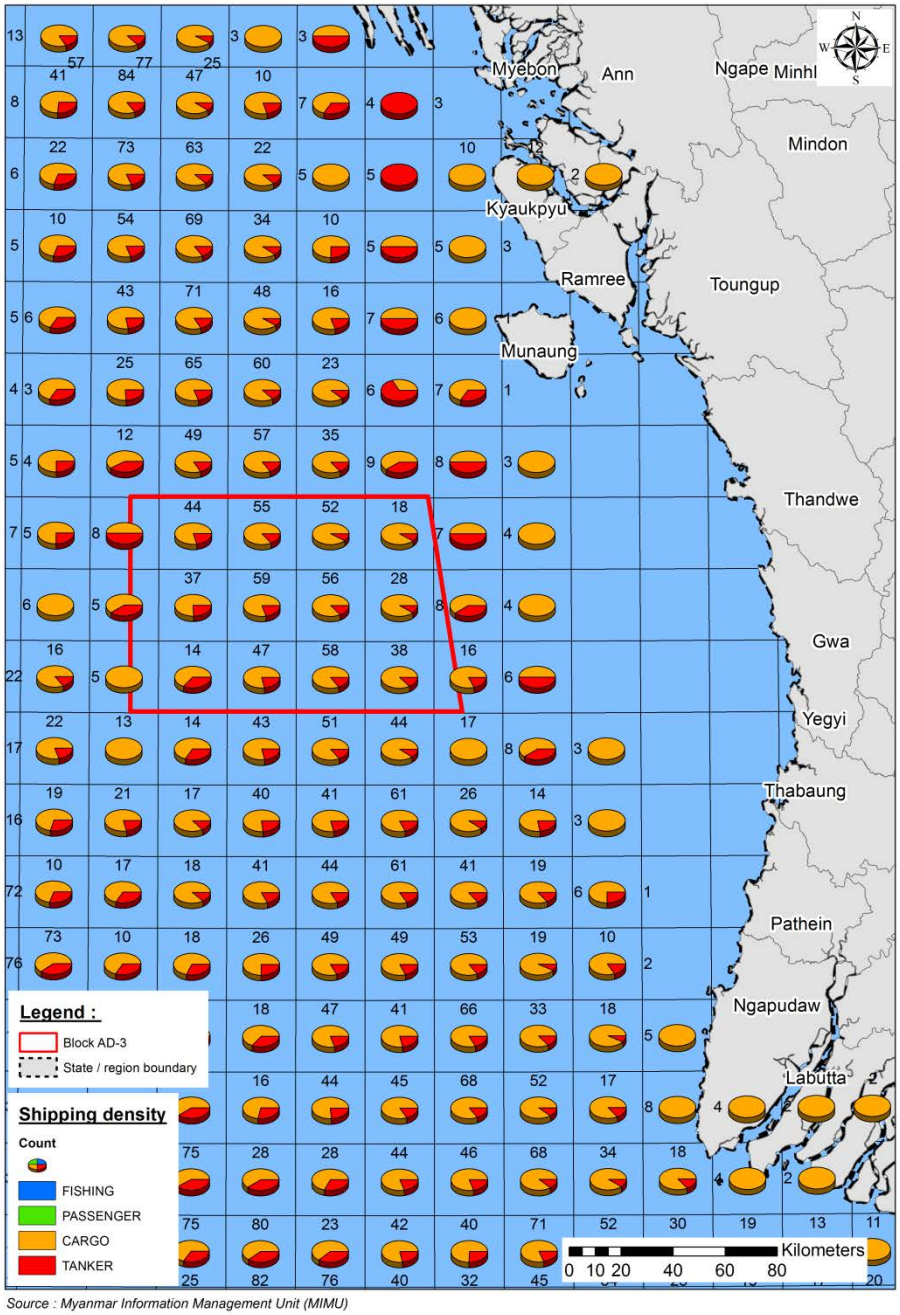
Figure 5-42: Marine traffic in the Bay of Bengal, ship density map produced from the marinetraffic.com website

Domestic ship movements from the ports of Sittwe and Thandwe do not appear on this map, and are expected to be very limited due to poor port infrastructure that limits the capacity of these ports to accommodate large numbers of vessels.

Ship movements are more important from Kyaukpyu port, with vessels navigating to the Shwe Gas Project, materialized by a green spot on the map (which indicates a high density of vessels over the whole period of data collection – usually six months). Additionally, the Kyaukpyu SEZ project development will in the future generate a greater number of vessel movements at the regional level thanks to improved port infrastructure.

Figure 5-43 below shows the Automatic Identification System (AIS) data collected by ExactEarth in the Rakhine coastal area in January 2014. Over one month, around 500 vessels (mostly cargo vessels and

tankers) crossed the AD-03 Block, which indicates an average of 16 vessels per day over an area of ~9,898km². Data for February and March 2014 are also available in **Annex 4** of this report. Interactions between the 3D seismic survey and marine traffic are therefore expected to be of moderate significance.



Source : Myanmar Information Management Unit (MIMU)

Figure 5-43: Marine traffic in the Bay of Bengal, AIS fleet monitoring data for January 2014

5.4.6. Stakeholder Identification

Due to the fast pace of economic development in Myanmar, the use of marine areas by multiple stakeholders 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 stakeholders having interests in the marine areas of Myanmar have therefore to be identified for this IEE, as they can either influence the proposed 3D seismic survey or be impacted by it. These stakeholders are listed below, covering public authorities, the private sector, and IGOs and NGOs involved in the regulation, use or protection of Myanmar marine areas and their ecosystems. Other stakeholders involved in the response to the inter-communal conflicts, mainly international organizations and NGOs are also identified in order to provide a broad understanding of the current crisis and the stakeholders involved in its resolution.

A comprehensive identification of stakeholders facilitates the development and implementation of an effective stakeholder engagement plan. This plan will determine the appropriate audience for the public consultations, the objectives of which are to gather stakeholders' perceptions of the project's potential impacts and the proposed mitigation measures described in this report.

5.4.6.1. Public Authorities

Public authorities grant the authorizations and permits needed by Ophir to perform the 3D seismic survey in the AD-03 Block. They also regulate the use of marine areas between various stakeholders, from commercial shipping vessels to fishermen.

Ministries

Ministry of Energy (MoE): MoE is in charge of developing the oil and gas resources of 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 it is in process of developing.

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 food security is achieved in the country, and to prevent infectious diseases development that could endanger national production.

- Department of Fisheries (DoF): under the MLFRD, DoF's main mission is to guarantee the preservation of fish resources in order to ensure the sustainability of the fishery sector. DoF develops conservation efforts, promotes research and surveys on the current condition of marine resources in partnership with inter-governmental agencies, maintains statistics on fisheries, and supervises the fishery sector through the delivery of licenses to fishing vessels.
    - DoF has regional offices at the township level: 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 inspection of offshore fishing vessels 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 eight coastal

ports, including Sittwe, Thandwe and Kyaukpyu ports in Rakhine State. It is also in charge of developing and improving port infrastructure, notably through the development of Special Economic Zones (SEZ) 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 vessel patrols.

Universities and Research Institutes

University of Mawlamyine (Mon State): one of the few universities in the country to offer a specialized degree in marine science, from Bachelors, Masters to PhDs. It also has a Marine Science Laboratory in the coastal town of Setse, ~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 DoF. It provides training to fishermen on fishing techniques, fishing gears and fish processing, among others. Training courses vary from basic fishing technology to fish processing supervision.

Public Enterprises

Myanmar Oil and Gas Enterprise (MOGE): MOGE is Myanmar's 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 Rakhine State.

5.4.6.2. 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 Centre for Responsible Business (MCRB): Based in Yangon, MCRB is an initiative launched in 2013 by the Institute for Human Rights and Business and the Danish Institute for Human Rights. Funded by international bilateral aid agencies such as the Irish Aid, its objectives are to promote responsible business practices by disseminating knowledge on this subject to private companies operating in Myanmar, to authorities and to the civil society. They also intervene in the field of impact assessment and CSR policy assessment. They are engaged in the oil and gas sector and regularly participate to conferences on the issues of CSR in this field.

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 nine 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.

- The MFF branch in Rakhine 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 eight other associations.

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

5.4.6.3. 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 AD-9 and AD-11 blocks with the Japanese company MOECO;

Statoil: Norwegian Oil and Gas Company, operator of the deep-water AD-10 block in partnership with ConocoPhilips;

ConocoPhilips: international oil and gas major, operator of the deep-water AD-10 block in partnership with Statoil;

BG Asia Pacific: British oil and gas company, operator of the deep-water AD-2 and AD-5 blocks, and the shallow-waters A-4 and A-7 blocks in partnership with Woodside Energy;

Chevron: international oil and gas major, operator of the shallow-water A-5 block;

Woodside Energy: Australian oil and gas company, operator of the deep-water AD-2 and AD-5 blocks, and the shallow-waters A-4 and A-7 blocks in partnership with BG Asia Pacific;

Daewoo International: regional Oil and Gas Company, operator of the Shwe gas project.

5.4.6.4. International organizations

After the 2010 Giri cyclone and following the inter-communal tensions and the displacement of thousands of Bengali people in 2012, numerous international organizations have started to operate in Rakhine State. They run development projects in the northern part of the state in the fields of health and nutrition, education, water and sanitation, and post-crisis recovery actions focusing on livelihood restoration and support to IDPs. They are summarized below (the list is non-exhaustive and bound to change over time).

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 supports the operations of several IDP camps in Rakhine state.

Other international organizations have operations in the Rakhine state 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).

5.4.6.5. Inter-governmental Organizations

Inter-governmental organizations (IGOs) involved in the protection of marine areas 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): the 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 the 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).

5.4.6.6. International Non-governmental Organizations (INGOs)

The presence of international NGOs (INGOs) in Myanmar has increased over the last five years due to the political opening up of the country, which has allowed them to open branches and lead projects in various sectors, from community development projects aimed 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. Started in 2012, this program aims at identifying marine areas that should be protected, and supports the management of exisitng protected areas. In partnership with **Biodiversity and Nature Conservation Association** (BANCA), a Myanmar national NGO, and the Forestry and Fisheries Departments, activities will consist of training in marine survey methods, community-based fisheries and marine protected areas establishment and management. One of the pilot areas for these activities is the Myeik archipelago off Thanintharyi State.

WWF: WWF has been very active in the greater Mekong region over the last few 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.

Wildlife Conservation Society (WCS): international organization based in the US involved in the conservation of species, with more than 500 projects in 60 countries. WCS 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 assistance in the establishment of protected areas.

Human Rights Watch (HRW): HRW regularly conducts human rights assessments of oil and gas projects, focusing more on the pipelines connecting the offshore fields and the receiving countries rather than on offshore oil and gas platforms.

Numerous INGOs started to operate in Rakhine State several years ago, after the Giri cyclone and the inter-communal conflict between Bengali and Rakhine ethnic groups. So far, 18 are present on the ground, including Care, the International Red Cross (IRC), Population Services International (PSI), Action Contre la Faim, Oxfam International and Médecins Sans Frontières (MSF).

5.4.6.7. National Non-Governmental Organizations (NGOs)

The economic strategy implemented by the government has succeeded in attracting international investor 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 recent 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. In particular, it has a coastal livelihood and environmental restoration program in Rakhine State.

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 programs. It works with the FFI on a marine conservation project. It also works on projects focusing on inland ecosystems with other international NGOs such as Birdlife International, the Royal Society for the Protection of Birds (RSPB), 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 CDA has worked on various humanitarian assistance programs and has 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.

Shwe Gas Movement: this organization coordinates the opponents to the Shwe Gas Project and organizes regular protests against it, benefiting from press coverage and support from INGOs.

Rakhine Fisheries Partnership: this partnership was created in 2012, and unites several stakeholders around a common goal which is to support sustainable fisheries in Myanmar in order to protect artisanal fishermen's livelihoods. The members of this partnership are the DoF, MFF Rakhine, Rakhine Tahaya Association, Tat Lan and Pyoe Pin projects organizations.

5.4.6.8. Media

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

The Myanmar Times: This newspaper has two versions, one in Burmese and one in English. It has 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 and in Burmese.

5.5. 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 1 to 4, where 1 represents low sensitivity and 4 high sensitivity. The scoring is established qualitatively. General principles for defining the sensitivity value are provided in the following table (Table 5-14).

Table 5-14: 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 by environmental component is given in the table below.

Table 5-15: Synthesis of the description of the environment

	Aspect	Environmental Sensitivity (Se)	Score
Offshore sediments	Sediment Quality	The Bay of Bengal is covered by a submarine fan that resulted from the uplift and erosion of the Himalayas and the Tibetan Plateau produced by the collision between the Indian Plate and the Eurasian Plate. Most of the sediment is supplied by the confluent Ganges and Brahmaputra Rivers through the Ganges Delta in Bangladesh and West Bengal, India, with several other large rivers in Bangladesh and India providing smaller contributions. Turbidity currents have transported the sediment through a series of submarine canyons, some of which are more than 2,414km in length, to be deposited in the Bay of Bengal up to 30 degrees latitude from where it began. To date, the oldest sediments recovered from the Bengal fan are from the Early Miocene.	1
Water column	Water Quality (offshore)	The Rakhine Basin exhibits strong seasonal variations due to a large freshwater influx from the Himalayan rivers. 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 occurs at 10m below the surface.	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 and due to low level of anthropogenic activities in the vicinity (excluding marine traffic)	1

	Aspect	Environmental Sensitivity (Se)	Score
		the air quality within the AD-03 Block is expected to be good.	
Offshore Fauna	Benthic community	Taking into account the water depths (~1,800-2,500m) of the project area, the abundance and richness of benthic communities within the AD-03 Block are expected to be low.	1
	Phytoplanckton Zooplanckton	Results for the sampling stations located in the Bay of Bengal waters indicated that area closest to the project area might be the most productive area for phytoplankton in the Bay of Bengal during both Northeast and Southwest monsoons. The abundance of zooplankton (mainly composed of oceanic and inshore reef fish larvae) is also significant in the study area.	2
	Cetaceans	Among the 29 marine mammal species recorded by the IUCN with different levels of vulnerability, 21 may be encountered within the project area: • eight species identified as Least Concern; • 10 species identified as Data Deficient; • one species identified as Vulnerable (sperm whale), and two endangered species (blue whale, fin whale).	4
	Fish	The pelagic system of 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, tunnys, barracudas, flying fish, sharks and rays are included in this community that extends across the entire Indian Ocean. A total of 31 pelagic fish species were identified by the IUCN as threatened with different levels of vulnerability from which 24 can be found at the project site.	3
	Turtles	Amongst the turtle species occurring in Myanmar, five species breed regularly on Myanmar's beaches, including the olive ridley turtle (Vulnerable), the loggerhead turtle (Endangered), the green turtle (Endangered), the hawksbill turtle (Critically Endangered), and the leatherback turtle (Critically Endangered). Most observations of turtles are typically within 15km of mainland shores in protected and relatively shallow marine waters (22-55m), i.e. well away from the project area. Nevertheless, some species may be encountered as they migrate.	4
	Birds	A total of 20 seabird species have been recorded in Myanmar marine waters. Amongst these species, four species are listed as Near Threatened and 16 species are listed as Least Concern on the IUCN Red List. Six species have been identified as potentially occurring within the AD-03 Block.	2
Coastal Environment	Coastal ecosystem	Habitats in coastal areas of Myanmar consist of mangroves, coral reefs, seagrass beds, evergreen forest, wetlands and various types of agricultural land. The closest coral reef is situated ~65km from the project area (Cheduba Island). The nearest mangroves and seagrass beds are located >60km from the project area.	2
	Marine protected areas	There are no marine protected areas in the vicinity of the AD-03 Block. The closest is situated in the Irrawady delta (Meinmahla Kyun Wildlife Sanctuary). The closest Important Bird Area is Ayeyarwaddy delta (~188km distance from the project area).	1
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 are only of Burmese origin since foreign fishing vessels have been recently banned from Myanmar waters. The project area could also be used by artisanal fishermen who generally fish in the inshore fishery zone (10nm from the coast) but sometimes venture out to the offshore zone, although the likelihood ot this occurring is low. Illegal fishermen from Thailand and Bangladesh could also be encountered.	3

	Aspect	Environmental Sensitivity (Se)	Score
	Marine traffic	The project area is crossed by a regional shipping route connecting Bangladesh to the Malacca Strait. Apart from legitimate marine traffic, the AD-03 Block is located on a smuggling boat route connecting northern Rakhine State and Bangladesh to Thailand and other Southeast Asian countries.	3

6. IMPACTS AND MITIGATION MEASURES

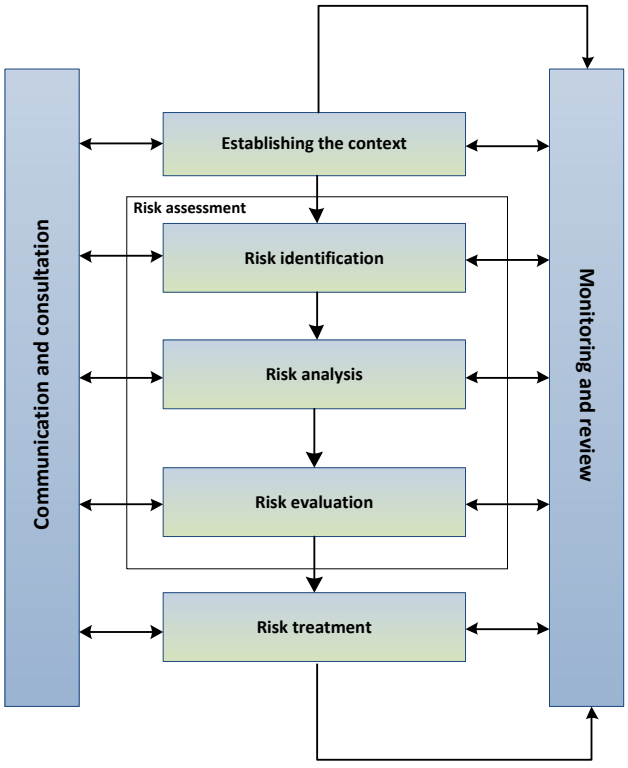
An Environmental and Social Risk Assessment (ESRA) of the proposed 3D seismic survey within the AD-03 Block offshore Myanmar has been undertaken to understand and manage the environmental and social risks associated with the activity to a level that minimises impacts on the environment and meets the objectives of the proposed survey.

6.1. ENVIRONMENTAL/SOCIAL RISK ASSESSMENT METHODOLOGY

The ESRA methodology applied is consistent with the Australian/New Zealand Standard AS/NZS ISO 31000:2009 Risk management–Principles and guidelines, Handbook HB 203:2012 Managing environment-related risk, and Handbook HB 89-2012 Risk management - Guidelines on risk assessment techniques. 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.

The key steps used for the risk assessment are shown in Figure 6-1.



Source: modified from AS/NZS ISO 31000:2009 Risk management

Figure 6-1: Key steps used for risk assessment

Potential impacts on the receiving environment (physical, biological and socio-economic) within the survey area in the AD-03 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 AD-03 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 Figure 6-1) 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 AD-03 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 AD-03 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 AD-03 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. IDENTIFICATION OF RISKS AND IMPACTS

The environmental/social risks and potential environmental/social impacts of the proposed AD-03 Block 3D seismic survey, offshore Myanmar, have been determined on the basis of Ophir's previous seismic survey experience and the outcomes of the ESRA.

6.2.1. Environmental/Social Aspects

A summary of the key sources of environmental/social risk (aspects) for the proposed activity include:

- discharge of underwater seismic pulses;
- light generation from survey, support and chase vessels;
- interactions of vessels with marine fauna;
- 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
- interactions with fisheries, shipping and other oil and gas exploration activities.

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;
- 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 social and community values due to interactions with fishing vessels and shipping.

The following section of this IEE provides a detailed assessment of these potential environmental or social impacts that could result from the proposed AD-03 Block 3D seismic survey, offshore Myanmar.

7. ASSESSMENT OF IMPACTS AND RISKS

This section of the IEE 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 ALARP and to an acceptable level.

7.1. DISTURBANCE TO MARINE FAUNA

McCauley (1994) provides a detailed review of the potential effects of seismic acquisition on marine animals. The review was undertaken by an Australian Independent Scientific Review Committee (ISRC). The ISRC report (Swan *et al*. 1994) examined all aspects of the possible effects of seismic surveys on marine life, from whales to plankton. Potential impacts on hearing, and behaviour at different stages of development were studied. The ISRC report concluded on this note:

> *"Given the relatively small scale of seismic activity, the often large scales over which biological events occur, and the low probability of encounter between seismic surveys and 'at risk' populations at an appropriate time and place, then the wider implications of disruption by seismic surveys appear to be small for most species."*

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 it is sometimes difficult to interpret studies on the effects of underwater sound on marine fauna because authors often do not provide enough information, including received sound levels, source sound levels, and specific characteristics of the sound.

Underwater sound pressure levels (SPL) are typically reported as a number of dB referenced to a reference level, usually 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 μPa^2.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 geoacoustic 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 AD-03 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 geoacoustical properties etc.) that apply in this case. This process is further complicated by the uncertainties and shortcomings of the available literature, as outlined above.

Studies relating to the environmental effect of marine seismic surveys have largely focused on the potential effects to 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.

7.1.1.2. **Pathological Effects**

The response of marine fauna to marine seismic survey sounds will range from no effect to various behavioural changes. 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.

It is prudent to point out that there is presently confusion in some quarters caused by incorrectly associating the biological effects of high explosives with those of other types of underwater sound sources. High explosives produce a shock wave in the water that is subtly different to that of a sound wave, as produced by most underwater sources (including airguns), but vastly different in its biological implications. Shock waves produce severe pathological effects at considerable ranges, which vary depending on charge size, and physical or biological factors. Airguns do not produce shock waves and the effects described for high explosives do not apply to them. For example, Larson (1985) concluded from experiments with caged fish that mortality from shock waves only occurs when two criteria are met simultaneously:

- peak pressure is ≥ 2.75 x 105 Pa, and
- rise time and decay time is ≤ 1 ms.

Airguns do not meet these criteria and do not cause shock waves.

7.1.1.3. **Disturbance to Benthic Invertebrates**

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).

7.1.1.4. **Disturbance to Planktonic Organisms**

Except for fish eggs, larvae and other minute planktonic organisms within a few metres of an airgun, no planktonic organisms are likely to be affected significantly by airgun array discharges (McCauley 1994). Data presented in Table 7-2 indicates that the range of pathological effect on fish eggs and larvae is likely to be restricted to less than approximately 2 m. Calculations show that less than 0.02% of plankton in the area would be affected[53]. 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.

[53] This assumes plankton are uniformly distributed, single gun array, 18.75 m shot point interval, maximum range of pathological effect 2 m.

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	
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		

7.1.1.5. **Disturbance to Fish**

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 AD-03 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.

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 $1\mu Pa^2$.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.

7.1.1.6. **Disturbance to Whale Sharks**

Limited research has been conducted on shark responses to marine seismic surveys. Myrberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. The study also suggested that the lateral line system does not respond to normal acoustical stimuli, and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg 2001).

Other reports indicate that sharks are highly sensitive to sound between approximately 40 and 800 Hz, which overlaps with seismic sound frequencies. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1µPa above broadband ambient SPL) when approaching within 10 m of the sound source. The available evidence indicates sharks will generally avoid seismic sources and the likely impacts on whale sharks are therefore, expected to be limited to short-term behavioural responses, possibly including avoidance of the operating airgun array. These behavioural responses are unlikely to be significant at a population level, particularly as the AD-03 Block and surrounding waters are not likely to represent critical habitat for whale sharks. Any whale sharks in the area are likely to be transient—i.e. moving through the survey area and adjacent waters during migratory movements across the Bay of Bengal.

It is unlikely that the underwater noise emissions from the airgun array would cause any pathological effects (lethal and sub-lethal injuries), resulting in immediate and delayed mortality and physiological effects, on whale sharks.

7.1.1.7. **Disturbance to 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). The auditory sensitivity of marine turtles is reported to be centred in the 400 to 1,000 Hz range, with a rapid drop-off in noise perception on either side of this range (Richardson *et al.* 1995). This auditory range matches their weak vocalisation abilities, which are also in the low frequency range (100 to 700 Hz).

From airgun exposure tests on a caged green turtle and a loggerhead turtle (see Table 7-3), that were extrapolated to response levels for a typical airgun array operating at full power in 100 m water depth, McCauley *et al.* (2003) concluded that turtles would, in general, probably show behavioural responses at 2 km

and avoidance behaviour at 1 km from such operations. However, they also noted that such rules of thumb for acoustic sources with frequencies within the range of turtle hearing (<1 kHz), cannot be reliably applied to shallow coastal waters near reefs, islands and nesting beaches, where transmission losses are typically much higher than in deeper, open water areas.

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.

7.1.1.8. **Disturbance to Cetaceans**

Baleen whales produce a rich and complex range of underwater sounds ranging from about 12 Hz to 8 kHz but with the most common frequencies 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). Baleen whales make individual sounds that may last for up to 16 seconds (Richardson *et al.* 1995) and humpback whales are known to "sing" for long periods. These sounds are thought to be used in social interactions and communication between individuals and groups.

Richardson *et al.* (1995) summarised published baleen whale sound characteristics. Table 7-4 lists the estimated source levels, frequency ranges and dominant frequencies of baleen whale calls for species that may be encountered during the proposed survey. It can be seen that some species produce quite high sound levels. Likewise, McCauley *et al.* (2003) report humpback whale song components reaching 192 dB re 1µPa^2 (pk-pk) as well as levels of 180 to 190 dB re 1µPa^2 (pk-pk) for humpback pectoral fin slapping and breaching sounds.

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 good swimming abilities 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).

Table 7-4: Sounds produced by baleen whales that may be encountered during the proposed 3D seismic survey in the AD-03 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).

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 with baleen and killer whales displaying localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects. Richardson *et al.* (1995) notes that:

> *"Baleen whales seem quite tolerant of low and moderate level noise pulses from distant seismic surveys. They usually continue their normal activities when exposed to pulses with received levels as high as 150 dB re 1µPa, and sometimes even higher".*

This noise level equates to a distance of ~2 km from the source of the size proposed for the AD-03 3D seismic survey.

A comprehensive study carried out by McCauley *et al.* (2003) monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of Western Australia. The following conclusions were drawn from this research:

- only localised avoidance was seen by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the seismic survey was confined to a comparatively short period and small range displacement;
- coupled with the fact that humpback whales were seen to be actively utilising the 'sound shadow' near the surface, then it is unlikely that animals will be at any physiological risk unless at very short range from a large airgun array, perhaps of the order of a few hundred metres; and
- upper levels of noise at 1.5 km from the seismic survey array are in the order of 182 dB re 1µPa², which is still well below the source levels of the highest components of humpback whale song (192 dB re 1µPa²). Thus, at 1.5 km the received airgun signal is still well within the range which humpback whales would be expected to cope with physiologically, since it would be difficult to argue that humpback whale song can cause physiological problems to the animals (McCauley *et al.* 2003).

With regards to avoidance behaviour by baleen whales, it is known that baleen whales will avoid operating seismic vessels and 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 AD-03 Block and adjacent waters are not known critical habitats for any cetacean species.

McCauley *et al*. (2003) found that migrating humpback whales show a general avoidance of an operating seismic source at 157 to 164 dB re 1µPa (mean squared pressure). Resting cow pods show avoidance at

somewhat lower levels—for example, a mean sound level for avoidance of 140 dB re 1µPa (mean squared pressure) and a mean standoff range at 143 dB re 1µPa (mean squared pressure).

7.1.1.9. **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.

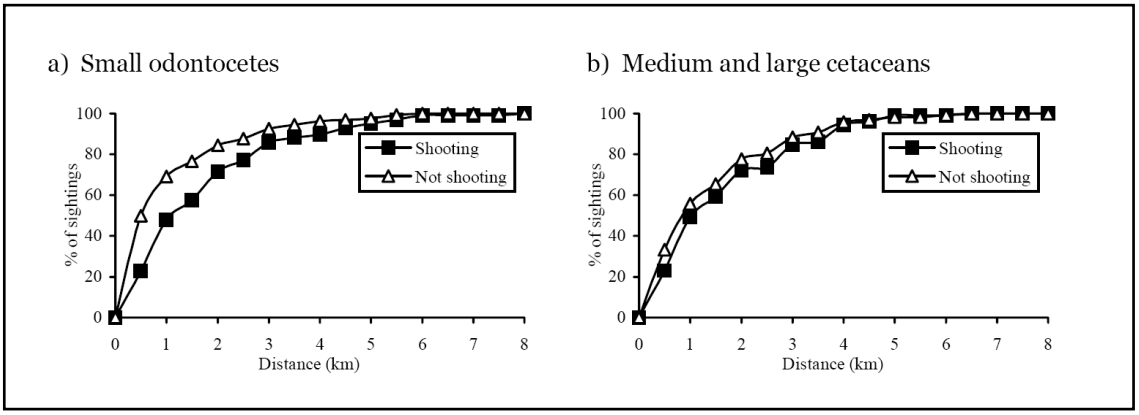
For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran *et al*. 2002). In their review, Gordon *et al.* (2004) considered the potential for TTS and concluded that the threshold for TTS was approximately 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 7-1).

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 the 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 7-1: Proportion of marine mammal sighting occurring within specified distances of the airgun during seismic surveys

7.1.1.10. Overlap with Critical Marine Fauna Habitat and Peak Periods of Activity

As described in Section 5.3.1.1, the AD-03 Block and surrounding waters do not overlap known critical habitat for any cetacean species. Given the deep water depths in the survey area it is most likely that any cetaceans encountered will be baleen whales, some of the larger toothed whales (particularly sperm whales) and offshore, oceanic delphinid species.

Similarly, the AD-03 Block and surrounding waters do not overlap known critical habitat for any of the five species of marine turtle that occur in Myanmar, nor for the whale shark.

7.1.1.11. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks to marine fauna associated with the discharge of underwater seismic pulses are continuously reduced to ALARP:

- Adherence to the Australian EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales – Part A Standard Management Procedures; and appropriate Part B Additional Management Procedures (DEWHA 2008):
  - precaution zones (Observation zone: 3km+; Low power zone: 2km; and Shut-down zone: 500m);
  - two dedicated Marine Mammal Observers (MMO) will be aboard the survey vessel for the duration of the 3D seismic survey in the AD-03 Block; and
  - survey personnel (marine and seismic) provided with pre-survey induction on EPBC Act Policy Statement 2.1.
- As a precautionary measure the Part A Standard Management Procedures will be applied to whale sharks as well as to whales for the duration of the survey.
- 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 whales. 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. These procedures are adapted from the EPBC Act Policy Statement 2.1 – *Interaction*

between offshore seismic exploration and whales (DEWHA 2008). For interactions involving acoustic energy source operations, the procedures are based on a tiered response depending on the 'safety zone' occupied by observed whales. For the duration of the 3D seismic survey in the AD-03 Block, Part A – Standard Management Procedures will be implemented. Under the EPBC Act Policy Statement 2.1, 'whales' are defined as: baleen whales and larger toothed whales, such as, sperm whales, killer whales, false killer whales, pilot whales and beaked whales. Application of these procedures will not apply to the smaller odontocete (toothed) cetaceans – i.e. dolphins and porpoises.

The key elements of the Part A - Standard Management Procedures are:

- **Visual observations**: 30 minutes prior to commencement of the soft start procedure. Observations are to be made, where visibility allows, extending to 3+km (observation zone) from any source vessel but with particular focus on the low power and shut-down zones around the acoustic source. If no whales have been sighted within the low power (2km radius; see Figure 7-2 below) and shutdown zone (500m radius) during the pre-start-up procedure, the soft start procedure outlined below may commence.
- **Soft start procedures**: A sequential build-up of warning pulses (over a period of 30 minutes) must be made at the start of each acquisition line ('soft start') to warn and deter whales from approaching the survey vessel. 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.
  - 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.
- **Continuous watch**: A continuous watch for whales must be maintained during 'soft start' sequences and during operations to determine the presence or absence of whales within 3km of the vessel.
- **Power down procedures**:
  - 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.
- **Recommencement**: Power-up of the acoustic source with 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.
- **Night-time / Low visibility procedures:** soft start up may be commenced provided that there have not been three or more whale instigated power-down or shut-down situations during the preceding 24 hour period; or if operations were not previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10km) of the proposed start up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.

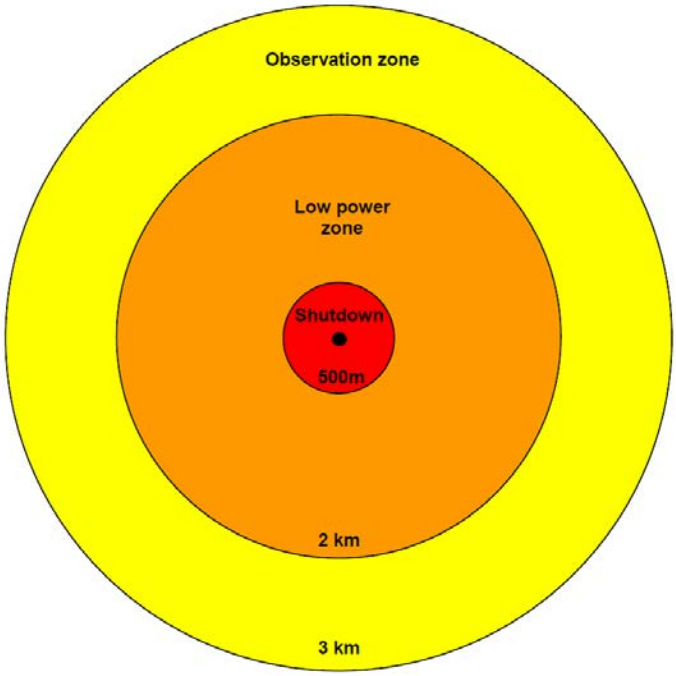


Figure 7-2: Precaution zones surrounding the acoustic source

Two dedicated, expert MMO will be aboard the survey vessel for the entire duration of the survey. Only appropriately qualified and experienced MMO will be contracted for the 3D seismic survey in the AD-03 Block.

The key role of the MMO will be to visually monitor the waters around the survey vessel for the presence of cetaceans, turtles and whale sharks during daylight hours. The MMO will be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities. The MMO 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.

7.1.1.12. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.1.2. 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.

7.1.2.1. 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 AD-03 Block 3D seismic survey is likely to be negligible. The closest turtle nesting sites to the survey area are located at least 65km 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 AD-03 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 (>64km 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.

7.1.2.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks to marine fauna associated with the light generation are continuously reduced to ALARP:

- 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.

7.1.2.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.1.3. 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 AD-03 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.

7.1.3.1. **Potential Impacts**

The impact from vessel interactions with marine fauna can be as minimal as behavioural changes by the marine fauna 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.

Although the whale shark's skin is thicker and tougher than any other shark species, the species may be behaviourally vulnerable to boat strike. They spend a significant amount of their time close to the surface of the water (DEH 2005; Norman 1999) and several sharks bear scars that have probably been caused by boat contact (DEH 2005). There have been several reports of whale sharks being impaled on the bows of larger ships in other regions (Norman 1999).

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 AD-03 Block and surrounding waters do not overlap known critical habitat for any cetacean or turtle species. Similarly, the survey area and surrounding waters do not overlap known critical habitat the whale shark. 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 *Sanco Sword* are fitted with turtle guards.

7.1.3.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks to marine fauna associated with vessel and towed equipment interactions are continuously reduced to ALARP:

- 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 7-3 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 AD-03 Block.

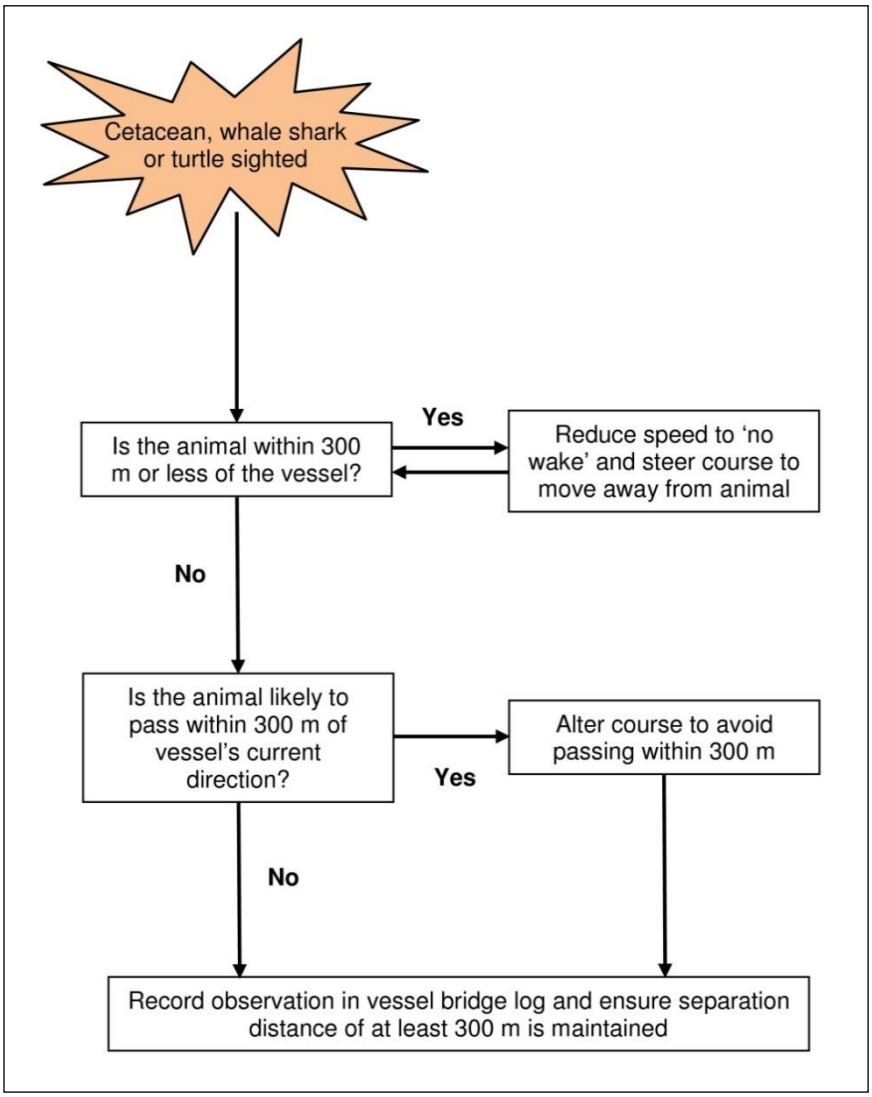


Figure 7-3: Vessel-marine fauna interaction procedures

7.1.3.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.2. DISTURBANCE TO BENTHIC HABITATS

7.2.1. 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 AD-03 Block range from ~1,980m to ~2,400m. Therefore, no anchoring of the survey, support or chase vessels will occur during the survey.

7.2.2. Loss of Towed Equipment

7.2.2.1. **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.

7.2.2.2. **Management and Mitigation Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks to benthic habitats and communities from equipment loss are continuously reduced to ALARP:

- 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).

7.2.2.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.3. REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS

Atmospheric emissions from the proposed 3D seismic survey in the AD-03 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.

7.3.1.1. **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.

7.3.1.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks from vessel atmospheric emissions are continuously reduced to ALARP:

- Adherence to MARPOL 73/78 Annex VI requirements:
  - optimisation of fuel use to increase efficiency and minimise emissions;
  - 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 AD-03 Block and surrounding waters.

7.3.1.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.4. 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 AD-03 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.

7.4.1. Ballast Water

7.4.1.1. 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.

7.4.1.2. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks of IMS associated with ballast water discharge are continuously reduced to ALARP:

- 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.

7.4.1.3. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.4.2. Biofouling

7.4.2.1. 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 AD-03 Block will relate to the length of time that these vessels have already been operating in waters of the Bay of Bengal 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 AD-03 Block 3D seismic survey.

7.4.2.2. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during prior to the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks of IMS associated with biofouling are continuously reduced to ALARP:

- the survey and support vessels will have had a recent dry dock, IMS inspection, hull and other niche cleaning and antifoulant application.

7.4.2.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.5. MARINE POLLUTION FROM ROUTINE DISCHARGES

Risks to marine environmental resources in the AD-03 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.

7.5.1. Sewage, Grey Water and Putrescible Wastes

During the 3D seismic survey in the AD-03 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.

7.5.1.1. **Potential Impacts**

Routine discharge of wastewater to the ocean will cause a negligible and localised increase in nutrient concentrations. The total nutrient loading from vessel operations during the 3D seismic survey in the AD-03 Block will be insignificant in comparison to the natural daily nutrient flux that occurs within the region.

7.5.1.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with routine discharge of sewage, grey water and putrescible wastes are continuously reduced to ALARP:

- 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.
- 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.

7.5.1.3. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.5.2. Bilge Water

The survey and support vessels may need to discharge bilge water during the 3D seismic survey in the AD-03 Block.

7.5.2.1. 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.

7.5.2.2. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with routine discharge of bilge water are continuously reduced to ALARP:

- Bilge water will be treated and disposed of in accordance with MARPOL 73/78 Annex I.
- 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.

7.5.2.3. Residual Risk Level

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.5.3. 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.

7.5.3.1. 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.

7.5.3.2. Mitigation and Management Measures

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with routine handling and disposal of garbage are continuously reduced to ALARP:

- Garbage will be disposed of in accordance with MARPOL 73/78 Annex V.
- 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.

7.5.3.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.6. MARINE POLLUTION FROM ACCIDENTAL DISCHARGES

7.6.1. 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.

7.6.1.1. **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.

7.6.1.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with accidental discharge of hazardous materials are continuously reduced to ALARP:

- 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.

7.6.1.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Low** (see Table 7-5).

7.6.2. Fuel and Oil Spills

The hazards associated with fuel and oil spills during the 3D seismic survey in the AD-03 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
- larger volume (potentially up to several hundred cubic metres) loss of diesel from a ruptured fuel storage tank, resulting from vessel collision.

7.6.2.1. **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.

7.6.2.2. **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 likelihood of a vessel collision resulting in a large diesel spill is low. Whilst the AD-03 Block overlaps a regional shipping route between Bangladesh and the Malacca Strait (see Section 5.4.5.4; Figure 5-42), 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 (Section 7.6.3). 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.

Although there is a moderate to high level of fishing activity that occurs in inshore and offshore waters of Myanmar (see Section 5.4.5.2), a collision between the survey vessel and another vessel unconnected with the activity is unlikely, again given the comprehensive control and mitigation measures in place to manage the risk of vessel collisions (Section 7.6.3). However, a possibility remains of a collision occurring between the survey vessel and the support or chase vessels during occasions when the vessels are manoeuvring close to each other (e.g. during at-sea refuelling operations).

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.

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.

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 of the Bay of Bengal (i.e. recorded SST range of 24 to 29°- see Section 5.2.5.1; Figure 5-17).

7.6.2.3. **Assessment of Consequence**

Sensitivities at risk within and adjacent to the AD-03 Block in the scenario of an accidental release of marine diesel resulting from a vessel collision with the survey vessel are marine fauna such as seabirds, cetaceans, whale sharks and turtles.

7.6.2.4. **Marine Fauna**

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. Whale sharks often feed on dense aggregations of prey (e.g. krill, bait fish) close to the sea surface (Colman 1997) and could therefore come into contact with surface diesel slicks.

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 AD-03 Block and surrounding waters does not contain critical habitat for any cetacean or turtle species, or for whale sharks.

7.6.2.5. **Socio-economic Environment**

As described in Section 5.4.5.2, there is likely to be a moderate to high level of activity in the offshore, industrial fishery sector within or adjacent to the AD-03 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). The potential impacts from a surface slick would be indirect—i.e. exclusion of fishers from areas they normally fish due to the presence of surface diesel slicks, and/or oiling of vessel hulls and gear (buoys, lines etc.) if the equipment is deployed or retrieved through surface slicks. Direct (toxicity) effects on target species is unlikely occur, as the target species of these fisheries are pelagic fish that forage and breed in the water column (i.e. beneath any surface diesel slicks).

The potential for impacts to other socio-economic sensitivities and values within or adjacent to the AD-03 Block area is limited, due to the low frequency or absence of other marine users (e.g. inshore artisanal fisheries, tourism) in the area.

7.6.2.6. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with accidental discharge of fuel and oil are continuously reduced to ALARP:

- 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 (i.e. Cheduba Island, or the Rakhine mainland coastline).
- Refuelling at sea will be subject to the Dolphin Geophysical bunkering operations 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.

7.6.2.7. **Residual Risk Level**

The residual risk ranking for this potential impact is **Medium** (see Table 7-5).

7.6.3. Vessel Collisions

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 AD-03 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.

As described in Section 5.4.5.4 and shown in Figures 5-42 and 5-43, the AD-03 Block overlaps a regional shipping route between Bangladesh and the Malacca Strait, and consequently there may be a moderate to high level of shipping activity in the survey area and surrounding waters.

7.6.3.1. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 Block to ensure that the impacts and risks associated with vessel collision 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—e.g. issuance of NTM.
- 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).

7.6.3.2. **Residual Risk Level**

The residual risk ranking for this potential impact is **Medium** (see Table 7-5).

7.7. DISTURBANCE TO ECONOMIC ACTIVITIES

7.7.1. Fisheries

7.7.1.1. **Potential Impacts**

As described in Section 5.4.5.2, there is likely to be a moderate to high level of activity in the offshore, industrial fishery sector within or adjacent to the AD-03 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).

Disruption to fisheries in the area could result from:

- direct effects of underwater noise disturbance on target fish populations;
- indirect effects of underwater noise disturbance on fish prey species;
- restriction of access to fishing grounds due to vessel movements and operations;

- seismic equipment loss and subsequent interference with fishing gear (entanglement); and
- loss of fishing gear (e.g. long-lines, buoys, ropes, static fish traps, etc.).

7.7.1.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 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 Rakhine 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 for distribution to fishermen encountered at sea (see **Annex 6**).
- Recruitment of a Fisheries Liaison Officer able to speak Burmese (and when 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 two chase vessels to manage interactions between the survey vessel and fishing vessels.
- Strict adherence to equipment handling and acquisition procedures.
- Fishermen alerted 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.

7.7.1.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Medium** (see Table 7-5).

7.7.2. Shipping

7.7.2.1. **Potential Impacts**

As described in Section 5.4.5.4 and shown in Figures 5-42 and 5-43, the AD-03 Block overlaps a regional shipping route between Bangladesh and the Malacca Strait, and 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.

7.7.2.2. **Mitigation and Management Measures**

The following systems, practices and procedures will be implemented during the 3D seismic survey in the AD-03 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 two 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).

7.7.2.3. **Residual Risk Level**

The residual risk ranking for this potential impact is **Medium** (see Table 7-5).

7.8. SUMMARY OF ENVIRONMENTAL/SOCIAL RISK ASSESSMENT RESULTS

The risk assessment indicates that the potential risks/impacts arising from the 3D seismic survey in the AD-03 Block can be categorised as having **Low** to **Medium** risk levels. No risks were assessed as **High**. Table 7-5 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:

- Accidental fuel and oil spills from the survey vessel, support and chase vessels.
- 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 AD-03 Block.

Table 7-5: Summary of environmental/social risk assessment for the 3D seismic survey in the AD-03 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	Slight	Possible	**Low**	**7.1.1**
		Physiological effects on benthic invertebrates and plankton	Slight	Possible	**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	Likely	**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	Slight	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		Moderate	Possible	**Medium**	**7.6.2**
	Vessel collisions		Moderate	Unlikely	**Medium**	**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	**Medium**	**7.7.1**
	Interaction with shipping	Disruption to shipping activities	Moderate	Possible	**Medium**	**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 AD-03 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, Ophir and Dolphin Geophysical 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 Ophir 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 (Dolphin Geophysical).

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 Ophir and Dolphin Geophysical; 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 Ophir and Dolphin Geophysical 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 Ophir and Dolphin Geophysical. 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 AD-03 Block are described below.

- applicable Myanmar environmental legislation (see Section 2.5.2);
- Ophir's Corporate HSE Policy (see Figure 8-1) and HSE Management System (HSE-MS);
- the HSE Policy (see Figure 8-2; Dolphin Geophysical HSE Policy) and HSE-MS of the seismic contractor (Dolphin Geophysical); and
- relevant international conventions.

Environmental and social issues relevant to all aspects of the 3D seismic survey in the AD-03 Block are governed or guided by a number of 'standards', including:

- those contained in Myanmar environmental legislation;
- those required by Ophir 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);
- EPBC Act Policy Statement 2.1 - Interaction between offshore seismic exploration and whales: Industry guidelines (2008);
- UK Joint Nature Conservation Committee (JNCC) Guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys (August 2010); and
- IAGC Recommended Mitigation Measures For Cetaceans during Geophysical Operations (June 2011).

ophir energy plc

HEALTH SAFETY AND ENVIRONMENT POLICY

Ophir Energy is committed to taking an active part in the development of the countries in which it operates. The company conducts its operations in an ethical, responsible, apolitical, independent and transparent way. We manage our Corporate and Social Responsibility (CSR) with the same principles underlying the conduct of our core activities, which are determination, innovation and excellence.

Ophir Energy, as an integral part of its CSR commitment, is dedicated to the implementation, review and continuous improvement of its Health, Safety and Environmental (HSE) performance and to minimize risks related to its operations for people and the environment.

To meet its objectives, Ophir Energy will operate in accordance with the following principles:

- Comply with all applicable HSE laws, regulations and standards and to apply responsible standards where legislation is inadequate or does not exist.
- Establish a systematic framework of hazard identification and risk assessment through which safe operations can be managed.
- Implement an effective HSE management system to identify and manage risks associated with its activities by focusing on risk avoidance and prevention.
- Establish accountability and responsibility for HSE within organisational line management.
- Promote a culture within the company in which all employees share HSE commitment and are involved in the implementation of the HSE management systems.
- Implement programmes and appropriate protective measures to control risks and to respond to any emergency resulting from its operations.
- Ensure that partners and contractors' policies are compliant with our own standards, and recognise that all activities on our behalf can impact our operation and reputation and that we all share a common responsibility for HSE.
- Ensure that employees and contractors are adequately trained and aware of the importance of the HSE aspects of their jobs.
- Practice pollution prevention and seek viable ways to minimize the environmental impact of operations, reduce waste, conserve resources and respect biodiversity.
- Protect and minimise any harm to the environment in our activities, and continuously strive to improve our environmental performance.
- Monitor and review our CSR and HSE policies and procedures on a regular basis to ensure suitability and effectiveness.

Nick Cooper
Chief Executive Officer
Ophir Energy
February 2012

Figure 8-1: Ophir HSE Policy

Dolphin geophysical

HSE Policy

Dolphin Geophysical is committed to prioritising the health and safety of every person involved in our operations as well as the protection of the environment in which those operations take place. The Company believes that all accidents are preventable.

Dolphin Geophysical recognises that it can only eliminate incidents, occupational health hazards and unsafe practices if all employees and contractors are aware that they are each responsible for their own safety and the safety of others at the same work place.

In a rapidly-changing marketplace, the immediate business success of Dolphin Geophysical relies upon each and every employee's commitment to HSE.

To co-create this culture with our employees, Dolphin Geophysical shall:

- Set clear HSE Objectives against which performance is measureable;
- Consistently demonstrate leadership by example: HSE accountability, authority and performance is a visible Line Management responsibility;
- Encourage the use of leading indicators when setting HSE Objectives. Emphasis shall be placed upon prevention rather than correction;
- Promote training and provide resources in order that all employees improve their knowledge and capabilities to take ownership of their, and the company's, HSE performance;
- Provide a secure and safe work environment to protect all employees, contractors and any other persons visiting our work sites, from harm;
- Maintain an OGP-Compliant Management System with active tools to transparently demonstrate that the company conducts safe operations and captures continuous improvement;
- Demand focus and awareness of the hazards associated with all company operations and promote techniques to manage their associated risks;
- Empower and expect any employee to intervene in any task they consider to be unsafe or inadequately planned or controlled;
- Encourage employees to take responsibility in finding safer work-practices by recognising and documenting any improvements, including the use of behavioural safety techniques;
- Carry out regular audits and inspections of our own operations, facilities and departments and those of our major contractors and suppliers.

Continuous monitoring and evolution requires an integrated Quality, Health, Safety and Environment Management System, which shall be developed through the use of regular reviews.

The commitments within this Policy are intended to uphold the best interests of all our stakeholders: customers, employees, contractors and shareholders. It is the CEO of Dolphin Geophysical who carries the ultimate responsibility of ensuring that they are adhered to.

Atle Jacobsen
CEO

Mike Hodge
VP QHSE

Date March 21st 2012

Figure 8-2: Dolphin Geophysical HSE Policy

8.6. ROLES AND RESPONSIBILITIES

8.6.1. Ophir's Role

Ophir, as the overall responsible entity for all HSE matters during the 3D seismic survey in the AD-03 Block, will ensure that seismic acquisition operations are carried out safely and in accordance with the Ophir HSE Policy (Figure 8-1; Ophir HSE Policy), and the requirements of the Ophir HSE Management System and of this ESMP. Ophir 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, Ophir will be responsible for the management of medical and health issues and the provision of appropriate care. Ophir 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, Ophir 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 AD-03 Block will be conducted by Ophir with Dolphin Geophysical prior to commencement of operations.

8.6.2. Dolphin Geophysical's Role

Ophir will ensure that Dolphin Geophysical will comply with the requirements of this ESMP during the 3D seismic survey in the AD-03 Block. Dolphin Geophysical will need to demonstrate to Ophir's satisfaction how compliance with the requirements of this ESMP will be ensured. Dolphin Geophysical 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 AD-03 Block, Dolphin Geophysical 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 (Ophir), the Contractor (Dolphin Geophysical) and any 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: Ophir 3D seismic survey, AD-03 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); • Two dedicated MMO aboard survey vessel for duration of survey • 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 • 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* • Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan • Australian EPBC Policy Statement 2.1 – *Interaction between offshore seismic activities and whales*
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* • Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan
Vessel and towed equipment	Behavioural and physical effects on cetaceans, whale	Minimise likelihood of interactions with	• Application of vessel-marine fauna interaction procedures.	• Support vessel Master	Throughout survey	• *Environmental Conservation Law 2012*

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
interactions	sharks and turtles	marine fauna	• Use of streamer tail buoys fitted with appropriate turtle guards • Any vessel or towed equipment interactions with marine fauna recorded and reported	• Chase vessel Masters • Party Chief • Client Site Representative • MMO		• *Protection of Wildlife and Conservation of Natural Areas Law 1994* • Ophir and Dolphin Geophysical 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* • Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
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 • Ophir and Dolphin Geophysical 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*

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
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	• Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan
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 • 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	• 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 • Ophir and Dolphin Geophysical 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
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 • Ophir and Dolphin Geophysical 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 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	• 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 • Ophir and Dolphin Geophysical 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
			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			
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 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	• 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 • Ophir and Dolphin Geophysical 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
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 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 • MARPOL 73/78 Annex I • Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations
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 two 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	• 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

Aspect / incident	Potential impact	Management objective	Actions to be taken to mitigate environmental / social impact	Responsibility	Frequency / timing	Key legislation, standard or guideline
			• 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			• Ophir and Dolphin Geophysical 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 two 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 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	• 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 • Ophir and Dolphin Geophysical 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
Interaction with shipping	Disruption to shipping activities	Minimise disturbance to shipping activities	• Adherence to COLREGS • Use of two 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 • Ophir and Dolphin Geophysical HSE Policies • Project HSE Plan • IAGC Environmental Manual for Worldwide Geophysical Operations

8.6.4. Key Roles / Responsibilities

Key roles and responsibilities for Ophir and contractor personnel in relation to implementation, management and review of this ESMP are described below.

It is the responsibility of all of Ophir's employees and contractors to ensure that the requirements of the corporate HSE Policy (Figure 8-1) 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, Ophir'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 instill 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:
  - Ophir and Dolphin Geophysical HSE Policies;
  - *Sanco Sword* 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, 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 Ophir Perth 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 AD-03 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 AD-03 Block.

8.8. MONITORING, RECORD KEEPING AND REPORTING

8.8.1. 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 AD-03 Block.

Table 8-2: Monitoring and recording requirements for the 3D seismic survey in the AD-03 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	Ophir 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 Ophir 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 Ophir (including financial compensation in case of damage to fishing equipment).

8.8.2. Reporting

8.8.2.1. Incident Reporting

Table 8-3 lists the types of environmental and socio-economic incidents that will be reported to the authorities in Myanmar, the persons/organisations who will be informed, and the timeframe for reporting. Incident reports will be in writing, and will be transmitted to the relevant persons/organisations by email and fax.

Table 8-3: Incident reporting requirements for the 3D seismic survey in the AD-03 Block

Incident type	Government body/organisation	Timeframe for reporting
Vessel/towed equipment interactions with marine fauna (cetaceans, turtles, whale sharks)	MOECAF – Director General MOGE – Managing Director	As soon as is practicable, but no later than 24 hrs after incident occurs
Loss of streamer and associated equipment	MOECAF – Director General MOGE – Managing Director	As soon as is practicable, but no later than 2 hrs after

Incident type	Government body/organisation	Timeframe for reporting
	DOF DMA Navy	incident occurs
Accidental discharge/release of hazardous materials	MOECAF – Director General MOGE – Managing Director	As soon as is practicable, but no later than 2 hrs after incident occurs
Fuel/oil spills >80L in size	MOECAF – Director General MOGE – Managing Director	As soon as is practicable, but no later than 2 hrs after incident occurs
Vessel collisions	MOECAF – Director General MOGE – Managing Director DOF DMA Navy	As soon as is practicable, but no later than 2 hrs after incident occurs
Interactions with offshore fisheries	MOECAF – Director General MOGE – Managing Director DOF	As soon as is practicable, but no later than 12 hrs after incident occurs
Interactions with shipping	MOECAF – Director General MOGE – Managing Director DMA Navy	As soon as is practicable, but no later than 12 hrs after incident occurs

8.8.2.2. **Monthly Reports**

During the AD-03 Block 3D seismic survey, monthly reports will be submitted to the Director General (DG) of MOECAF, and the Managing Director (MD) of MOGE. These reports will contain:

- further information concerning any reportable incidents (see Table 8-3);
- a summary of marine fauna (cetaceans, turtles, whale sharks) sightings; and
- any other relevant information on environmental performance during acquisition operations.

8.8.2.3. **MMO Final Report**

A record of marine fauna interaction procedures employed during operations will be maintained. The MFO Final Report on the conduct of the survey, and any marine fauna sightings/interactions (including any whale-instigated shut-downs of the acoustic source) will be provided to DoE within two months of the completion of the survey. The report will contain:

- the location, date and start-up time of the survey;
- name, qualifications and experience of any MMOs involved in the survey;
- the location / times / reasons when observations were hampered by poor visibility or high winds;
- the location and time any start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
- the location, time and distance of any cetacean, turtle and whale shark sightings; and
- the date and time of completion of the survey.

The MMO Final Report will be submitted to the DG of MOECAF and the MD of MOGE, and to other stakeholders if required.

8.8.2.4. **End of Survey Report**

Ophir will prepare a Post-survey Environmental Review Report (PERR) for the AD-03 Block 3D seismic survey that will comprise a review of achievement of the environmental performance objectives for the survey, to determine if they have been met, The PERR will include:

- A review of the following routine activities and incident records:
  - start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
  - cetacean, turtle and whale shark sighting records;
  - records of any vessel or towed equipment interaction with marine fauna;
  - records of any incidents involving loss of a streamer and associated equipment;
  - accidental discharge/release of hazardous materials;
  - fuel and oil spills >80L in size;
  - vessel collisions; and
  - negative interactions with fishing vessels and shipping.
- An assessment of adherence to requirements of the ESMP.
- A review of compliance with the Ophir and Dolphin Geophysical HSE Policies.
- A review of any other environmental issues that arose during the survey.
- Performance in fulfilling all commitments listed in the Project HSE Plan.

The PERR will be submitted to the DG of MOECAF and the MD of MOGE within two months of completion of the survey.

8.9 AUDITING

Environmental / social performance of the 3D seismic survey in the AD-03 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 IEE 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 AD-03 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 Ophir and Dolphin Geophysical if requested by the ERC.

The survey and support vessels have equipment aboard for responding to emergencies, including but not limited to medical equipment, fire-fighting 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 AD-03 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 (see Section 8.8.2).

8.10.3 Cyclone and Tsunami Response Measures

8.10.3.1 Cyclone Contingency Planning

Tropical cyclones have the potential to cause damage to survey equipment, present a risk to the safety and health of survey personnel and have the potential to cause spills of hazardous materials into the environment from damaged vessels. The AD-03 Block 3D seismic survey is scheduled to commence in mid-March 2015, with an expected duration of 105 days (~3.5 months). The survey will be completed by the end of June 2015. Therefore, the survey will overlap the start of the cyclone season in the Bay of Bengal (April-May).

Dolphin Geophysical has developed and implemented a cyclone contingency plan for all seismic surveys utilising its vessels (Section 11 of the Shipboard Safety Procedures Manual – see **Annex 5**). This procedure

will be applied during the AD-03 Block 3D seismic survey, and incorporated into the Project HSE Plan for the survey. During the survey, the procedure will be implemented in the event of an approaching cyclone. The survey, support and chase vessels will receive regular weather broadcasts and updates via the Inmarsat SafetyNET service (http://www.inmarsat.com/services/safety/inmarsat-c/), which is the international service for the broadcast and automatic reception of maritime safety information (MSI) and search and rescue (SAR) related information. If a cyclone looks to be forming within the region the survey, support and chase vessels will depart from the AD-03 Block location for safer waters. Depending on the situation, the survey vessel may also retrieve the towed seismic equipment (airgun arrays, vanes, streamers, tail buoys etc.) and in a worst case scenario proceed to the nearest port away from the expected track of the approaching cyclone.

8.10.3.2 Tsunami Contingency Planning

Tsunamis do not represent a threat to vessels in offshore deep waters well away from inshore, shallow water, coastal areas and shorelines. In the deep ocean, destructive tsunamis can be small—often only a few feet or less in height—and cannot be seen nor can they be felt by ships. Tsunami wave energy extends from the surface to the seabed in the deepest waters, but, as the tsunami reaches shallower coastal waters, wave height can increase rapidly. As the tsunami reaches the coastline, the wave energy is compressed into a much shorter distance creating destructive, live-threatening waves.

Regardless, Dolphin Geophysical will incorporate tsunami contingency plans into the Project HSE Plan for the AD-03 Block 3D seismic survey. During the survey, the procedure will be implemented in the event of a major earthquake in the region and release of a tsunami early warning for the Bay of Bengal. The survey, support and chase vessels will monitor the website for the Indian Ocean Tsunami Warning and Mitigation System (IOTWS), which for the Bay of Bengal region is operated and maintained by ESSO - Indian National Centre for Ocean Information Services (INCOIS - http://www.incois.gov.in/Incois/tsunami/eqevents.jsp). If the support and chase vessels have left the AD-03 Block location and are in port or inshore waters of Myanmar, the tsunami early warning will be relayed to these vessels via the survey vessel, and the support/chase vessels will immediately move offshore to deep waters away from the coast.

8.10.4 ESMP Review

Management of changes to scope (e.g. timing, location or operational details described in this IEE 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 Ophir Energy 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 IMPLEMENTATION

Table 8-4 provides a summary of the potential environmental and socio-economic impacts, key mitigation and management measures, responsible party, and estimated costs for implementation of the control measures for the AD-03 Block 3D seismic survey.

Table 8-4: ESMP implementation – control measures, responsible parties and estimated costs

Aspect / incident	Mitigation and management measures	Responsible party	Estimated costs (US$)
Routine Operations			
Discharge of underwater seismic pulses	• Part A Standard Management Procedures of EPBC Act Policy Statement 2.1 • Two dedicated MMO aboard survey vessel for duration of survey • Part A Standard Management Procedures will be applied to whale sharks • Recording of all cetacean, turtle and whale shark sightings • MMO Final Report	Seismic Contractor via ESMP	$150,000
Light generation from vessels	• External lighting of vessels will be minimised	Seismic Contractor via ESMP	No specific cost allocated[1]
Vessel and towed equipment interactions	• 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	Seismic Contractor via ESMP	$80,000
Equipment loss	• 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	Seismic Contractor via ESMP	No specific cost allocated[1]
Operation of machinery and vessels powered by internal combustion engines	• Adherence to MARPOL 73/78 Annex VI requirements: • Implementation of a Ship Energy Efficiency Management Plan	Seismic Contractor via ESMP	No specific cost allocated[1]
Discharge of ballast water from vessels	• Survey and support vessel will not routinely discharge ballast water; recording of any non-routine ballast water discharges	Seismic Contractor via ESMP	No specific cost allocated[1]
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	Seismic Contractor via ESMP	$1.2 million
Routine Discharges and Emissions			
Sewage, grey water and putrescible waste disposal	• All sewage and putrescible wastes handled and disposed of in accordance with MARPOL 73/78 Annex IV	Seismic Contractor via ESMP	No specific cost allocated[1]
Discharge of bilge water	• Bilge water treated and disposed of in accordance with MARPOL 73/78 Annex	Seismic Contractor via ESMP	No specific cost allocated[1]

Aspect / incident	Mitigation and management measures	Responsible party	Estimated costs (US$)
Discharge of other wastes i.e. garbage	• Garbage disposed of in accordance with MARPOL 73/78 Annex V	Seismic Contractor via ESMP	No specific cost allocated[1]
Non-routine Hazards and Effects			
Accidental discharge of hazardous materials	• Harmful Packaged Substances handled and disposed of in accordance with MARPOL 73/78 Annex III	Seismic Contractor via ESMP	No specific cost allocated[1]
Fuel and oil spills	• Adherence to COLREGS • At sea refuelling will only take place at a distance of >12 nm from any land • Activation of survey / support vessel SOPEP in event of fuel/oil spills; SOPEP drills conducted • Response strategy for diesel spills will be to allow small spills to disperse and evaporate naturally • Hydrocarbons located above deck stored with some form of secondary containment • Detailed records maintained of all fuel and oil spills; any spills >80 L reported	Ophir and Seismic Contractor via ESMP	$800,000
Vessel collisions	• Adherence to COLREGS • Use of chase vessels • Survey, support and chase vessels use approved navigation systems; experienced bridge crew • Adherence to standard maritime safety / navigation procedures. • Detailed records maintained of all vessel collision incidents; vessel collision incidents reported	Ophir and Seismic Contractor via ESMP	$3.5 million
Interaction with offshore fisheries	• Adherence to COLREGS • Notification of survey details to DoF and other relevant stakeholders • Use of chase vessels • Use of standard maritime safety procedures • Fishermen alerted of presence of survey 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	Ophir and Seismic Contractor via ESMP	Covered by costs for managing risk of vessel collisions
Interaction with shipping	• Adherence to COLREGS • Use of chase vessels	Ophir and Seismic Contractor via ESMP	Covered by costs for managing risk

Aspect / incident	Mitigation and management measures	Responsible party	Estimated costs (US$)
	• 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 • 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		of vessel collisions

Notes: [1] "No specific cost allocated" – i.e. cost is included in standard per diem costs of operating the survey vessel, no additional costs apply.

9. PUBLIC CONSULTATION & INFORMATION DISCLOSURE

Under the framework of the preparation of this IEE report, Artelia organized several consultations with stakeholders with the active support of Ophir, MOGE and MOECAF. The first objective of these consultations was to collect up-to-date and precise information on the current socio-economic conditions at the project area, with a focus on marine areas, their natural ecosystems (fauna and flora) as well as economic activities relying on marine areas such as fisheries and commercial shipping. The second objective was to present the project to the stakeholders, collect their opinions and views on it, and discuss the potential environmental and social impacts and the possible mitigation measures.

The consultations organized are detailed in the Table 9-1 below, and pictures from the various meeting are displayed in Figure 9-1. More details are also presented in **Annex 3**.

Organizations that were consulted expressed their appreciation of these consultations, as they proved that Ophir was transparent and open to dialogue. They provided insightful information, and gave Ophir the opportunity to introduce the project to various stakeholders that may be affected or affect the implementation of the project. They also gave indications on the stakeholder's perceptions of the project, their recommendations on which mitigation measures to implement in order to limit the impacts of the seismic survey on the natural and human environment.

Two fauna and flora protection NGOs (Fauna and Flora International [FFI] and Biodiversity and Nature Conservation Association [BANCA]) were approached for a consultation but declined on the ground that it was not relevant to consult them.

Table 9-1 Stakeholder engagement plan implemented in October and November 2014

Name of stakeholder	Reasons for consulting	Date and place of meeting	Results of the discussion (Information collected recommendations, etc.)
Ministry of Environmental Conservation and Forestry (MOECAF)	Presentation of the project proposal and the planned Initial Environmental Examination to be conducted.	10/13/14 Nay Pyi Taw	Validation of the IEE procedure application for the project by the MOECAF
Department of Marine Administration (DMA)	DMA is in charge of the general marine traffic safety, and can bring their expertise on potential interactions between the seismic vessels and commercial ships, and provide support to consolidate the mitigation measures proposed in this IEE.	10/27/2014 11/14/2014 Yangon	Role and responsibilities of DMA in vessel licensing and safety controls (request to collect seismic vessel information). Information on fishing practices in Rakhine State.
Department of Fisheries (DoF)	DoF handles the fishery sector at the national scale. This sector could potentially be impacted by the seismic campaign.	11/03/2014 and 11/21/2014 Nay Pyi Taw	Information on the current state of marine resources and the fishing practices in Rakhine State (national, foreign and illegal vessels). Sharing of documents with information on fisheries.
Myanmar Fisheries Federation (MFF)	Professional organization focusing on Myanmar fisheries protection and promotion.	11/05/2014 Yangon	Information on the fishery zones and the results of the 2013 marine resources survey (showing a decrease in fish stocks). Recommendation to consult the Department of Marine Science from Mawlaymine University.

Name of stakeholder	Reasons for consulting	Date and place of meeting	Results of the discussion (Information collected recommendations, etc.)
Department of Marine Science, Mawlaymine University	One of the only university departments specialized in marine science in the country. Undertake a lot of research in the field of marine resources and fish stocks.	11/12/2014 Yangon	Recommendation to consult the township administrators and inform local fisheries about the project through them.
Public consultation of Rakhine State authorities, business and civil society	Rakhine State is the state that will be the most directly impacted by Ophir operations in the area, therefore authorities, civil society and other companies neighbouring the project have to be consulted.	11/19/2014 Thandwe	See Table 9-2 below

Meeting with the Department of Marine Administration, Yangon

Meeting with the Department of Marine Science, Yangon

Public consultation at Thandwe, Rakhine state

Meeting with the Department of Fisheries, Nay Pyi Daw

Figure 9-1: Pictures of stakeholder consultations

In general, stakeholders were of the opinion that the project would have limited impacts on the natural and human environment. However, they raised questions during the consultation process, and a summary of the issues expressed are presented in Table 9-2 below. This list shows concerns over impacts from the project on water quality, marine resources and fisheries.

There is also a strong concern over the general purpose of the gas exploration and the final use that will be made of the gas found, if any (for national consumption or export). This specific concern is to be directly linked to the Shwe Gas Project and its effects on the general opinion of the population in Rakhine state. Indeed, the Shwe Gas Project is known, through media campaigns and advocacy by local NGOs, to have negatively

affected local communities with little to no benefits for them, with gas resources mainly exploited for export to China. Therefore, local communities have the feeling of being deprived of a resource that should benefit them directly. This is why expectations of some forms of contribution to the regional development (under the wording corporate social responsibility [CSR]) were also mentioned during the meetings.

This perception doesn't affect directly the Ophir 3D seismic survey, but could possibly affect activities at the later stage of production (should this take place), especially if a pipeline was to be laid across Rakhine State. This is why at this early stage of oil and gas exploration, no formal strategy of contribution to local community development have been proposed in this IEE, but would have to be included for a future development/production project based on hydrocarbon deposits in the AD-03 Block.

Table 9-2 Concerns and expectations expressed about the project during the public consultation process

Examples of concerns raised
Do earthquakes have an impact on the project?
Response: This is an active earthquake-prone area. The effect of an earthquake in deep water is minimal, however the company has an emergency response plan in place if such an event should occur.
What is the radius of the sound waves around the seismic source?
Response: The sound source is designed to be focused downwards so the radius is minimal in the horizontal direction. The sound magnitude drops off very quickly away from the source.
Why the area is so large
Response: WE have not yet identified where exactly the gas field may exist, so need to survey a broad region in order to narrow down the target areas where we expect gas may be found.
What is the impact of light on turtle behaviour?
Response: Light can attract turtles and affect their behaviour, so we are using very careful and specific light management techniques to minimize lights at night.
What are the impacts in case of boat fuel spill?
Response: Fuel spills are dangerous for the environment and must be avoided because this pollution will have a bad effect on the fish resources. The crew is trained to respond to a fuel spill and will follow the shipboard oil pollution emergency plan.
Is it required to perform water quality test before/after the campaign?
Response: No, water quality will not be tested before and after the campaign. The seismic program has no or negligible effect on water quality.
What are the impacts on the fish and on fisheries?
Response: There may be temporary displacement of fish from the project area, but there will be no effect on local fisheries.
What would be the impact on tourism industry and hotels?
Response: The project is located more than 100 kilometers from tourism and hotel areas so there will be no impact.
What will happen if Ophir finds gas?
Response: Over a period of years the gas field will be developed by drilling and subsequently a subsea pipeline will likely be constructed to Kyaukpyu to meet existing gas facilities
If some gas is sent abroad, to which country?
Response: Yes, some gas will be sold abroad possibly to China. Alternatively there is a possibility that the gas may be liquefied to sell to other countries.
Will the gas be used for domestic use or for sale abroad?

Response: Most of the gas is expected to be sold abroad however a portion will be allocated for domestic use.
Will we be notified of the commencement of the program?
Response: Yes, flyers will be distributed to the community before the commencement of operations advising of the coordinates of the area and the schedule of operations (see **Annex 6**).
Examples of expectations raised
How will Rakhine State benefit from the gas field? CSR?
Response: In order to benefit from the gas field Ophir must first go through the exploration stage – after development when the gas is produced a CSR program will be implemented.
CSR suggestion: improve access to electricity
Social development in Rakhine State
If gas is found, is it gas that can be used for the domestic market?
Some portion of the gas may be used to satisfy domestic demand.
During the production phase, will Ophir work with local people?
Yes, local people will be trained to work on facilities during the production stage.

The general feeling of the participants was that the project will benefit the community and will have minimal negative effects on the current fishing, hotel and tourism activities. The participants were very pleased to be consulted because it has not been done before and appreciated the knowledge transmission from Ophir, Parami and Artelia to the community.

10. CONCLUSION

This IEE describes the potential environmental and social impacts associated with the proposed 3D marine seismic survey in the AD-03 Block, offshore Myanmar.

This evaluation allowed concluding that the environmental and social impacts arising from the survey will not have any significant negative effects on the environment during and after the proposed activity. This outcome will be assured, as long as the management and mitigation measures recommended in this IEE (i.e. in the Environmental and Social Management Plan [ESMP]) are completely implemented.

Ophir's AD-03 Block 3D seismic survey project consists of 3D seismic acquisition in a full fold area of ~9,898km^2 in the AD-03 Block, situated ~124km west of Myanmar's north-western coast (~64km from Cheduba [Munaung] Island - Rakhine region coastal area), in the Bay of Bengal. The 3D seismic survey is planned to commence in mid-March 2015 and it has been estimated that the likely maximum duration of the proposed survey will be ~105 days (3.5 months). The survey is expected to be completed by the end of June 2015.

Water depths across the AD-03 Block range from ~1,980m to more than 2,400m in the southeast part of the block. It is, therefore, a seismic survey in offshore deep waters.

For the AD-03 Block 3D seismic survey there will be one survey vessel, one support vessels for supply, at-sea bunkering (refuelling), crew change and protecting the seismic spread (towed equipment), and two additional chase vessels for managing interactions with fishing vessels and shipping.

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). Processing of the reflected waves allows identifying potential sources of hydrocarbons under the seafloor.

For the proposed 3D seismic survey, two seismic sources will operate in "flip-flop" mode. 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). Twelve 7km-length solid streamers will be towed behind the survey vessel in order to record reflected acoustic signals. The anticipated peak at source sound level for the source arrays will be 257 dB 1µPa-m (SPL, 0-P).

Greenhouse gases (GHG) generated by the project have been estimated at ~15,290 tons CO_2eq. Volume of domestic and sanitary wastewater has been estimated at ~2,097m^3. Deck and bilge waters volumes for the duration of the project have been estimated as ~952m^3, domestic waste volumes as ~42m^3 and the quantity of hazardous and non-hazardous wastes as ~65mt.

During the proposed period of the project (March to June), average air temperatures should be between 21-25°C and low rainfall is anticipated, as it will be the period of the Northeast Monsoon. Predominant wind direction in AD-03 Block will be north/northeast during the period when the survey is planned to occur.

The project is located in the Rakhine Basin in the eastern part of the Bay of Bengal, part of the Indian Ocean and on the Indian tectonic Plate.

Surface waters are characterised by low salinity due to large freshwater influx from the rivers flowing into the northern Bay of Bengal, which also has an impact on the local turbidity and chlorophyll-a concentrations.

No environmental baseline survey has been performed in AD-03 Block; nevertheless, it is known that the Bay of Bengal is covered by the Bengal Deep Sea Fan consisting of sediments resulting from the erosion of the

Himalaya and supplied by the Ganges and Brahmaputra rivers, and hence dispersed southward by turbidity currents and multiple north-south trending fan valleys.

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.

According to the bibliographic searches performed for this IEE, 31 pelagic fish species listed on the IUCN Red List of Threatened Species have been recorded in this part of the Bay of Bengal (of which 24 are oceanic species and likely to be found in the project area).

Among the 29 marine mammal species recorded as occurring in Myanmar's waters, 21 species may be encountered in AD-03 Block; of these, eight species are listed as Least Concern on the IUCN Red List; 10 species as Data deficient; one species as Vulnerable (sperm whale), and two whale species as Endangered (blue whale and fin whale).

Six threatened seabird species have been identified as possibly occurring in the AD-03 Block, of which four are listed as Least Concern, and two as Near Threatened on the IUCN Red List.

Most observations of marine turtles in Myanmar waters occur in shallow, inshore waters. However, all of the five species of marine turtles recorded in Myanmar are migratory, and as such they may be encountered in the offshore waters of the AD-03 Block.

Key characteristics of the Myanmar coastal environment have also been described in this IEE, even though the project area is located at ~124km from the mainland coastline of Rakhine State. The closest coral reef is situated ~64km from the project area (Cheduba Island). There are no marine protected areas in the vicinity of the AD-03 Block or surrounding waters.

At this distance from the coast, the project will have limited impacts on the human environment. The only socio-economic activities that may interact with the proposed seismic operations are commercial marine traffic and offshore industrial fisheries. These interactions will generally be limited due to the moderate shipping traffic density in the shipping lane that crosses the AD-03 Block, and as a result of the control and mitigation measures that will be implemented to manage this potential impact. Similarly, interactions with fishing operations are expected to be low due to the small number of fishermen authorized to fish in the offshore fishery area (2,000 compared to 27,000 in the inshore fishery area), the location of the block relatively far away from the coast, and a recent ban on foreign vessels fishing in Myanmar waters that further reduces the likelihood of encountering fishing vessels in the offshore fishery area (apart from illegal fishermen whose possible presence in the project area cannot be determined).

The description of the environment has shown that cetaceans, turtles and whale sharks are the most sensitive components (receptors) of the environment in the project area and surrounding waters.

The main potential impact of the project identified in this IEE is the underwater noise generated by airguns on cetaceans, turtles and whale sharks. Other potential impacts identified are atmospheric emissions, generation of wastes, liquid discharges into the sea, accidental discharges, and potential interactions with fishing activities and marine traffic.

Specific mitigation measures have been developed will be implemented throughout the proposed survey, in order to minimise disturbance to other marine users, in particular to decrease the risks of vessel collisions and damage to fishing gear. These measures range from provision of information about the project to various marine stakeholders, preparation of flyers to be distributed to fishermen encountered at sea during the operation, and use of standard maritime safety procedures and chase vessels to manage third party vessels approaching the survey vessel and towed equipment array.

Summary of the Risk Assessment

The risk assessment indicates that the potential risks/impacts arising from the AD-03 Block seismic survey can be categorised as having Low to Medium risk levels. No risks were assessed as High. A summary of the assessed level of residual (post-mitigation) environmental and social risk associated with the proposed seismic survey is presented in this IEE. 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:

- Accidental fuel and oil spills from the survey vessel, support and chase vessels;
- Vessel collisions resulting in fuel and oil spills; and
- Disturbance to fisheries and shipping.

Environmental and Social Management Plan

This IEE includes an Environmental and Social Management Plan (ESMP) that is designed to:

- ensure continuing compliance with relevant Myanmar environmental legislation, Ophir and Dolphin Geophysical (the survey vessel operator) Health, Safety and Environmental (HSE) policies, international best practice, and the Project-specific HSE Plan;
- 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 Ophir to be assured that its aims with respect to environmental and social performance are being met and any commitments are implemented in full.

To either eliminate potential environmental and social risks or to reduce them to levels as low as reasonably practicable (ALARP), a number of key control and mitigation measures will be implemented during the survey, particularly with respect to potential disturbance of marine fauna.

Conclusions

With the control and mitigation measures proposed to be employed, the environmental and social effects of proposed operations during the 3D seismic survey in the AD-03 Block offshore Myanmar are expected to be localised and temporary.

For cetaceans, whale sharks and turtles that may be present in the survey area and surrounding waters during the survey period, the implementation of the procedures based on the Australian guidelines for managing interactions between seismic surveys and cetaceans, plus the implementation of specific support vessel-marine fauna interaction procedures to minimise the risk of collision with the support vessel will likely minimise the likelihood of negative impacts upon these populations from survey activities.

Overall, the proposed 3D marine seismic survey is not expected to have any long-term effects on local or regional biodiversity. The data acquisition is not likely to adversely impact ecosystem structure and function, for any of the key environmental and social sensitivities and values identified for the marine environment of Myanmar.

The characteristics of the operation, particularly its relatively short duration and separation (temporal and/or spatial) from sensitive environmental and social resources mitigate many of the potential environmental and social effects of the project.

The risk analysis indicates that, with appropriate management, the residual environmental and social risks associated with the proposed 3D marine seismic survey are all ranked Medium to Low, are within tolerable levels, and are ALARP. There are no High ranked environmental and social risks associated with the project.

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ANNEX 1 Specifications of the Vessels

Vessel Specification – M/V Sanco Sword

Vessel Details

VESSEL DETAILS	
Vessel Name	Sanco Sword
Owner	Sanco Shipping AS
Flag	Gibraltar
Port of Registry	Gibraltar
Built/Rebuilt	2014 (Norway)
Class	DNV + 1A1, ICE-1B, E0, SF, COMF-C(3)-V(3), HELDK-SH, RP, CLEAN DESIGN, NAUT-AW, TMON, SPS
Class ID N°	32660
IMO Official Number	9662100
Call Sign	ZDNE7
Safe Manning Certificate (minimum)	10 Crew
Length	96.15m
Beam	21.5m at Waterline/23m max
Max Draught	7m
Gross Tonnage	8772 tons
Net Tonnage	2632 tons
Maximum Load Speed	Circa 16.5 knots
Typical Transit Speed	Circa 16 knots
Total Fuel Capacity	2100m^3
Fuel Consumption	Transit (Typical): 60m^3/day (4 ME's at 85%) Acquisition: 40m^3/day (Dependent on Configuration)
Endurance	Unlimited, 30 days until Offshore Bunkering
Range at Transit Speed	13000nm
Lubricating Oil Capacity	80m^3
Fresh Water	218m^3
Fresh Water Production	15m^3/day (2 x Alfa Laval AQUA 80-HW)
Sewage	11.10m^3/day (Gertesen & Olufsen BR011100)
Incinerator	1 x Teamtec GS-500 CS
Roll Reduction Tanks	2 x Integrated Passive Antiroll Tank
Water Ballast	1630m^3
Provision Rooms	Fish 18m^3, Meat 18m^3, Veg 17.5m^3, Dairy 18m^3, Dry Provisions 81m^3
Engines	4 x MAN 8L 32/40, each 4000kW
Propellers	2 x Scana Volda CPP ø3900
Total Propulsion	2 x 7500Kw

Bollard Pull	Circa 216 tons
Thrusters	Bow/Azimuth 1 x Brunvoll (Combi thruster), 1000kW Stern 1 x Brunvoll FU63, 800kW
Generators	Main 4 x AvK DSG 114 M1/6 W, 2600kW Harbour 1 x CAT C32TTA, 1000kW Emergency 1 x Volvo Penta D13B-F MG, 300kW
Electrical Distribution	690V/440V/230V - 60Hz
UPS	2 x 120Kva (Circa. 10min)

Communication

COMMUNICATION	
VHF Fixed	DSC GMDSS: 2 x Sailor 6222 Simplex 2 x Sailor RT-6210
VHF/UHF Portable	VHF 3 x portable VHF ATEX SP3530
MF/HF Radio	Sailor 6300, SSB 150 W
INMARSAT Fleet 77 (Bridge)	+870 773168666 – (Voice 1)
INMARSAT C	1 x Sailor 6100
VSAT system	Double installation VSAT/Marlink to avoid blind spot,
Weather Facsimile	Furuno Weather FAX-408
Navtex Receiver	Furuno NX-700

Navigation

NAVIGATION	
Radars	1 x Furuno FCR-2117, X-Band 1 x Furuno FCR-2137S, S-Band
Gyro Compass	Dual gyro compass, Navigat X Mk1
Autopilot	Anschutz Nautopilot 2025
Speed Log	Furuno Doppler log DS-60
Echo Sounder	Furuno FE-700
ECDIS	Naut Aw Package, Dual TECDIS AW Telko

Tracking System	Kongsberg cJoy
GPS	2 x Furuno GP-150 DGPS
Magnetic Compass	Not equipped (Vessel Exempt)
Wind Indicator	Vaisala Ultrasonic
AIS	Furuno AIS FA-150
Voyage Recorder	VDR Furuno VR-3000 6G

Safety Equipment

SAFETY EQUIPMENT	
Mob Boat	Maritime Partner Weedo 700
Lifeboat	Vessel Exempt, <100m length
EPIRB	Joton tron 40 S
Life Raft	6 x 35 PAX Viking 35 DK+
Survival Suits	60 x Sea Nordic N6
Life Vests	60 x HH Sealife 2010
Work Vests	Regatta Challenger Offshore
Life Buoys	13 x W/Light – 6 W/Line – 2 W/ Smoke & Light
Radar Transponder	2 x Jotron SART 20

Firefighting Equipment

FIREFIGHTING EQUIPMENT	
Fire Alarm & Detection Monitoring System	Tyco T2000
Engine/Compressor Room	FlexiFog: in Engine Room, Aux. Engine Room, Eng. Workshop, Emerg. Diesel Room and Casing Portable Foam: in Engine Room
Instrument Room	Co_2 Fire Extinguishing
Gun Shack	Co_2 Fire Extinguishing and Water Fire Extinguishing
ECR & Switchboard Room	FlexiFog in MSBD Room
Galley	Co_2 for Galley Vent Co_2 Fire Extinguishing
Accommodation	Fire Hose and Water Fire Extinguishing
Streamer Area (Upper & Lower)	Sprinkling from Fire/Foam and Deck Wash System
Paint Store & Chemical Store	Sprinkling from Fire/Foam and Deck Wash System

Incinerator	FlexiFog
Main Foam pump, AFFF Foam Mixture	2 x FlexiFog Foam Pump, 17.2 L/min -17.1bar
Main Fire Pump Type/Flow	Allweller, 2 x 120 m^3/h
Emergency Fire Pump Type/Flow	Allweller, 1 x 48 m^3/h
Helideck Fire Pumps	2 x FlexiFog Foam Pump, 17.2 L/min - 17.1bar

Accommodation

ACCOMMODATION	
Cabin Types	46 x Single 7 x Double
Total	53 Cabins (60 Bunks)
Business Conference and Training Room	1
Sauna and Fitness Room	1 x Sauna 1 x Fitness room

Helideck

HELIDECK	
Helicopter Deck Rating	Rotor Diameter: 26m Max. Weight: 14.6T
Fire Fighting	2 x Foam Monitors Fire station nr.1: 2 x 50kg Powder, 4 x 5 kg Co_2 and Portable Foam
Non Directional Beacon	TS 1B
Ship/Air Communication	ICOM IC A 110 E (Stationary)
Motion Weather Information	HMS from Kongsberg

Small Boats

SEISMIC WORK BOATS	
Workboat	2 x Norpower 30ft
Length	9.1m
Beam	3.3m
Draught	1.2m
Weight	Max: 8.2T
Engines	425hp Cummins QSB 5.9
Water Jet	Not Equipped

Hull	Fiberglas Reinforced Polyester
Hydraulics	Hydraulic LS Pump JRR-065-C4
Bollard Pull	2800kg
Fuel	Diesel, 2 x 325L
Speed	Typical: 18 knots Max:20 knots

Uksnøy & Co AS

Vessel specification

M/V Rig Andromeda

Contact Information	
Manager	Uksnøy & Co AS
Owner	Tanux Shipping KS

Classification	
DNV	✠ 1A1, E0, RP, CLEAN
DNV number	33259
IMO number	9327528
Callsign	V7AU4
Type of ship	SEISMIC SUPPORT VESSEL

Flag	
Marshall Island	Majuro

Tonnage	
Grt	2992
Net	948

Main dimensions	
Lenght	90,50 M
Bredth	14,60 M
Draught	5,40 M

Capacities	
Fuel	166 m³
FW	43 m³
Osmosis for fresh water	7m³/day
IFO Cargo Cap	2 800 m³
Fuel meter	Vimex DIN 150
Bollard Pull	50 tonnes

Speed & Consumption	
Transit speed	12,5 knots 11 MT
Transit speed	11,0 knots 7 MT
Chase speed	4,5 knots 3 MT

Machinery / propulsion	
Main engines	2 x MAN B&W diesel
Total	2 x 960 kW
Shaft Generators	2 x 880 Kva
Generator	1 x Cummins 1 300 kW
Generator	1 x Volvo Penta 306 kW
Bow Azimuth	1 x Brunvoll 1 200 kW
Bow thruster	1 x Rolls Royce 300 kW

Accomodation	
Total Crew	12
Total Passenger Bunks	12
Total Day Passengers	40
1 x mess room	
1 x day room	
Fully air conditioned	

Deck equipment	
Cargo deck	260 m² – 3,5 T/m²
Offshore Crane 10 T	10 T - 10 M / 6,7 T - 15 M
Crane 1,5 T	13 M forward
Crane 1,5 T	8 M aft
2 x fuel hose reels	240 M - 5” (4” TODO)
1 x towing hook	100 T SWL
1 x towing line winch	
2 x 5 t capstans	
FRC	MP 770 Twin Engine
FRC davit	3,8 T SWL
Work boat davit	10 T SWL

Bridge equipment	
Radar	3 cm Sperry Marine
Radar	10 cm Sperry Marine
GMDSS radiostation	Sailor
1 x AIS	
3 x VHF	
3 x UHF	Handheld
ECDIS	Sperry Marine
Fleet 77 satcom/data	
VSAT tel/data	

Communication	
MMSI	538005069
Tel sat	+870 7731 59413
Tel v-sat bridge	+44 20 3145 4666
Tel v-sat captain	+44 20 3145 4677
E-mail	bridge.andromeda@seamail.no
E-mail	captain.andromeda@seamail.no

Specifications
Seismic Research Support Vessel
“7-Waves”

Year of construction: 2013
Vessel Name: 7-Waves
Owner: Rederij Groen II BV
Flag: Panama
IMO Number: 9714185
Call Sign: HP 4534
Class: Lloyds Register, IACS
Notation : Q 100A1, Ice Class 1^{E} UMS, LMC

Dimensions:

Lenght OA	: 35,00 Mtrs.
Lenght PP	: 29,10 Mtrs
Beam	: 8,70 Mtrs.
Draught	: 3.20 Mtrs.
Depth	: 4.25 Mtrs.
Design Speed	: 12 kts.
Gross Tonnage	: 338 Grt
Bollard Pull	: 15 Ton

Generators:

Caterpillar	: 3x C18 TA SCAC
	: 465Kva@1800Rpm
	: Insight monitoring

Propulsion system:

Propellers	: 2x Thruster 600 Bhp
Bow thruster	: 1x Veth VT-80 90 kW

Anchor(s):

Anchor	: 2x HHP 675 kg
Chain	: 357.5 mtr x 26 mm dia.

Cranes:

Deck Crane	: 1x 2t @ 10.5 Mtrs.

Safety Equipment:

Liferafts	: 4x 16 persons (SOLAS)
Fifi	: 2x General service pump 25 m³/h
	: 1x Portable emergency fire pump

Communication Equipment:

GMDSS A4	: 1x Sailor-6222
VHF Radio	: 1x Sailor-6222
	: 1x Sailor-6248
Portable VHF	: 5x Jotron TR 20
Immarsat Sat-C	: 1x Sailor-6110
AIS	: 1x Furuno FA-150
EPIRB	: 1x Jotron Tron-40S MKII
Iridium	:Pilot open port
V-Sat	:Sailor 900 Hu-Band

Navigation Equipment:

Radar	: 2x Furuno FAR 2117
Mag. Compass	: 1x Cassens & Plath
Sat Compass	: 1x Furuno SC50
Auto Pilot	: 1x Simrad AP80
GPS Navigation	: 1x Furuno GP-150
	1x Furuno GP-33
Echo Sounder	: 1x Furuno FE 700
Navtex	: 1x Furuno NX700B
Electronic Charts	: 1x Maris Dual Ecdis 900
Gyro Compass	: 1x Anschütz BST 2233

Bunker/Towing/Storage capacity:

Fuel Oil	: 150 m³
Fuel Transfer	: 4” TODO
Fresh Water	: 50 m³
F. W. Maker	: 5.3 m³/day

Storage capacity:

Cool Store	: 4,3 m³
Freeze Store	: 4,3 m³
Clear Deck	: 103.3 m²

Accommodation (fully air conditioned):

Total Capacity	: 16

Special Features:

Towing Hook	: 1x Mampeay 18/25 t
Bollard Pull Test	: 15 Ton

Rederij Groen BV, Dr. Lelykade 14B, 2583 CM The Hague, The Netherlands
Email: info@rederijgroen.nl , Telephone +31 70 355 35 88

All particulars believed to be correct but not guaranteed.

SWISSCO SYNERGY

40M MULTIPURPOSE/SAFETY STANDBY VESSEL

GENERAL DATA

Length:	40.62m
Breath:	10.00 m
Depth / Draft:	3.70 m / 3.10 m
GRT / NRT:	481 / 144 tons
Registry:	Singapore
Built:	May 2011
Official Number:	395773
Call Sign:	9V8429
IMO Number:	9616474
Classification:	BV Tug / Class1+Hull+Mach, Special Services/Standby Rescue, 100 Survivors
Bollard Pull:	30 tons (approx.)

MAIN ENGINE / GENERATOR

Main Engine:	2 x Cummins KTA 38 M2 1200 bhp @ 1800rpm fitted with oil purifier
Main Generator:	3 x Caterpillar 3406C 215 kW / 415 V / 268 kVA / 50 Hz
Gear Box:	Reintjes ratio 6:1
Bow Thruster:	HRP 3001 TT (200kW / 3 tons)
Propulsion:	2 x solid blades fixed pitched in Kort Nozzles
Max Speed:	12 knots
Consumption:	9,500 ltrs / 24hrs @ 85% MCR (approx.)

DECK EQUIPMENT

Towing Winch:	1 x single drum hydraulic winch 40 tons @ 1st layer Brake 100 tons
Anchor Windlass:	1 x double gypsies with warping end 4 tons @ 10 m/min
Anchor:	2 x Stockless Anchor; 830 kg
Wire Rope:	36 mm x 600 m
Capstan:	1 x 5 tons @ 15 m / min
Tugger:	1 x 5 tons @ 1st layer with 22 mm x 150 m wire
Crane:	Sormec 5 tons deck knuckle boom crane M17 / KN / 2S 1.65 tons @ 8.6 m (winch) 2.0 tons @ 6.8 m (hook) 2.9 tons @ 5 m (hook)

OTHER INFORMATION

Deck Space:	15.25 m x 6.8 m = 104 m² (approx.)
Deck Strength:	5 tons / m²

NAVIGATION / COMMUNICATION EQUIPMENT

Radar:	JRC JMA 2254 – 48 nm
Echo Sounder:	2 x JRC FF-60
GPS:	JRC JNav500
Auto Pilot:	ComNav 2001
Compass:	Magnetic – 2 x Saura (standard/steer)
Inmarsat C:	JRC JUE – 75C
SSB:	JRC JSB 196 GM
VHF:	2 x JRC JHS – 32A 3 x ACR SR – 103 (portable)
Navtex:	JRC NCR – 333
EPIRB:	ACR RLB – 32
SART:	2 x ACR 9 GHz
PA System:	Fitted

TANK CAPACITY

Fuel Oil:	244.748 m³
Fresh Water:	110 m³
Ballast:	110 m³
Lube Oil:	2 m³
Oil Dispersant:	2 m³
Foam:	1.7 m³

ACCOMMODATION

Single Cabin:	2 units
Twin Cabin:	1 unit
4 Men Cabin:	4 units
Total:	20 men

SAFETY EQUIPMENT

Fire Fighting:	1 x 1200 m³ FFS pump with 2 x 600 m³ / hr monitors
Engine Room:	CO^2 flooding system
Fire Detection:	Fitted
Oil Spray Dispersant:	Fitted
Rescue Boat:	2 x 20 men FRB with Davit fitted & 25hp outboard
Seating:	17 seated
Survivor Recovery:	100 pax

Last updated on: 10 September 2011

Particulars given herein are without warranty as to accuracy and interest parties must satisfy themselves by inspection or other means of details of the vessel.

SWISSCO OFFSHORE PTE LTD
60 Penjuru Lane, Singapore 609214 | Tel: (65) 6265 2855 Fax: (65) 6264 1661
E-mail: swissco@singnet.com.sg | Website: www.swissco.net

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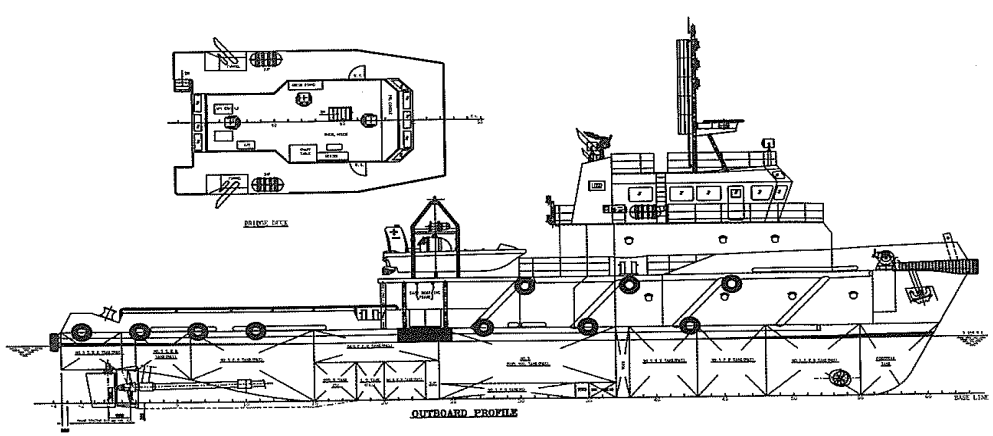
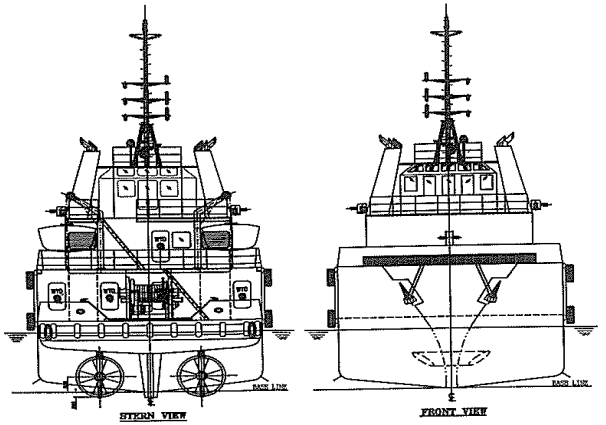
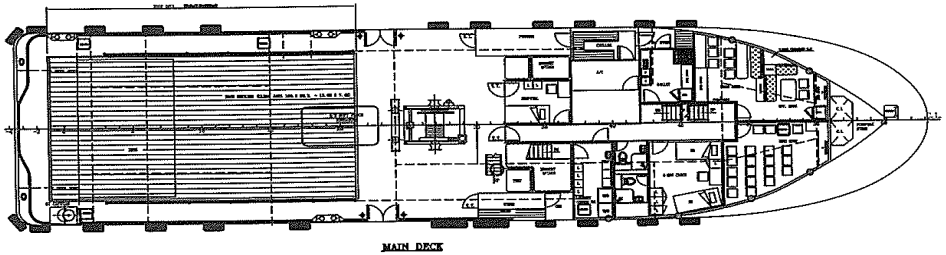
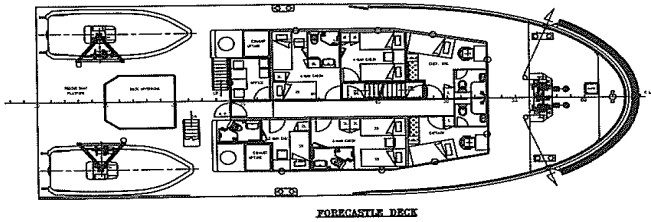
GENERAL ARRANGEMENT

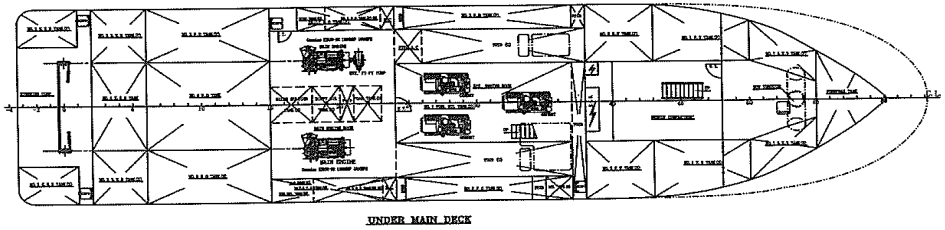
SWISSCO SYNERGY











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ANNEX 2 Curriculum Vitae of the Experts

Rita ARNAUD PEREIRA

Project Manager – Senior Environmental Engineer
Water & Environment | Risks, Society and Environment Unit (RSE)

Date of birth: 30 August 1976
Nationality: Portuguese
Education:

- Auditor/Lead Auditor EMS ISO 14001:2008 Course – DNV GL, Dubai, UAE (2014)
- MSc. Degree in Urban Planning and Territorial Studies (2 years) – Pompeu Fabra/Barcelona University, Spain, (2008)
- Post-degree in Urban Planning – Universitat Oberta de Catalunya, Spain, (2008)
- Post-degree in Environmental Management and Auditing – Oporto University, Portugal, (2002)
- BSc. Degree in Environmental Engineering (5 years) – Aveiro University, Portugal, (2000)

Languages: Portuguese (native), English (fluent), Italian (fluent), Spanish (fluent), French (moderate), Catalan (basic)
Date of employment in Artelia: September 2008

CAREER SUMMARY | SKILLS

Project Manager - Environmental Engineer with Post-Degree studies in Environmental Management and MSc. in Urban Planning.

More than twelve years of international consultancy experience with strong technical knowledge in several environmental areas gained through coordination and management of numerous projects for both the public and private sectors.

Technical and professional skills covering the following areas:

- Quality, Environmental and Health and Safety Management Systems (ISO, EMAS, OHSAS);
- Environmental audits and Due Dilligence;
- Environmental Impact Assessment studies;
- Environmental Baseline studies, Site assessments and Field monitoring surveys;
- Construction and Operation Management and Monitoring plans;
- Socio-economic studies and Sustainable Development;
- Training and Awareness.

For the past six years based in the Middle East, developing environmental studies (EIA's, EBS's, CEMP's.) and working as QA/QC Manager and Environmental Manager for several projects in the region.

In 2008, joined the coastal team of SOGREAH Gulf (Artelia Group) in Dubai, as an environmental expert and gave contribution to several maritime projects, such as the HSEIA study for the Das Island project in Abu Dhabi, the EIA study for the Lattakia Waterfront development in Syria and on the preliminary coastal studies for the Tripoli Waterfront in Lybia, among others. Responsible for the Certification ISO 9001 - Quality Management System of SOGREAH Gulf.

In 2010 joined SOGREAH Oman (Artelia Water & Environment – Oman Branch) and since then has been the responsible for all environmental projects and EIA studies of the branch, as well as for tasks related with Sustainable Development and Quality Management.

In October 2014, joined the team of Artelia Water & Environment – Risk, Society and Environment in Grenoble, France.

PROFESSIONAL EXPERIENCE

2013/14
OMAN

Sultan Qaboos Naval Base – Mirbat, Dhofar (Oman)
The project consists on the development from initial conception to construction supervision of a military naval base for the Royal Navy of Oman located 80 km from the City of Salalah and 11 km East of Mirbat, in the governorate of Dhofar. The area of the Naval Base amounts to nearly 7 km2 and is expected to accommodate nearly 750 staff at the start of its operation.
The Sultanate of Oman EEZ is estimated to be half a million km². In order to maintain its national interests and national security and to impose national sovereignty on its territorial waters, the establishment of a new Naval Base at the south of Oman is a part of the development foreseen by RNO and the Ministry of Defense.
ARTELIA is the overall project management, design and supervision consultant involving master plan for the full project comprising: the Master Plan for 30 years greenfield development, Concept Design, Risk studies, feasibility studies for infrastructure solutions taking into account construction and operational cost, redundancy and self- sufficiency required in a military facility as well as security, constructability and environmental impacts.
The Design stage includes procuring and managing subcontractors for Topographic, Bathymetric and Marine Data, Geotechnical and Environmental surveys. The environmental studies comprise Air and Noise surveys, Detailed terrestrial and Marine Ecologic Surveys, Socio-economic and Archaeological studies, Soil, Sea sediment, groundwater and seawater quality analysis, as well as topographic, bathymetric, coastal and meteorological studies and modelling.
Acquiring and Managing the design teams for preliminary and detail design stages for buildings and maritime structures and for all infrastructures, including Water Transmission, Water Distribution, Irrigation, Waste Water, Storm Water, Fire Fighting, Water Storages, Power, Fuel Network, Fuel Storage, Telecom Phone, Telecom Data, MODnet, Compressed Air, District Cooling, PA / Siren / Fire Alarm, Video / Audio / CCTV, LNG/LPG, Internal Roads, Public Lighting, Traffic Studies, Solid Waste Management, Physical Security, BMS, Power Generation, Water RO Plant, Sewage and Storm Water treatment, Dam and External access Roads
The assignment also includes preparation of all tendering documents and development of the tendering strategy prequalification and evaluation criteria towards tender award. Finally the project management and supervision of construction is expected to take 4 years.

Client: Ministry of Defense
Position: Environmental Project Engineer – Project Management Team

2013/14
OMAN

EIA for Wadi Ahin Flood Protection and Recharge Dam Scheme – Sohar (Oman)
Responsible for the execution of the Environmental Impact Assessment study (EIA) for the project, which main objective is to provide greater degree of protection to the inhabitant areas located mainly downstream of Wadi Ahin till the sea against severe cyclonic events, such as cyclone Gonu in June 2007. The said tropical cyclone lead to severe flooding, resulting in the loss of life and damage to the properties and the infrastructure of different areas in Oman. The project encompasses 2 phases:
• Stage A - Feasibility Study and Preliminary Design of:
  - three (3) flood protection dams in the Wadi Ahin catchment;
  - Study of the underground recharge of aquifers;
  - River Training downstream existing recharge dam;
  - Diversion works, if required;
• Stage B – Detailed Design and Tender Documents.
The EIA includes the following field surveys: geotechnical and soil analysis, air and noise quality, terrestrial ecology and socio-economic studies.

Client: Ministry of Regional Municipalities and Water Resources
Position: EIA Project Manager/Environmental Project Engineer

2013
OMAN

EIA and Geotechnical Investigations for Thawah Landfill Expansion, Sur (Oman)
Responsible for the Environmental Impact Assessment study (EIA) for the construction and operation of a non-hazardous engineered landfill in Sur.
The EIA includes the following field surveys: geotechnical and soil analysis, air and noise quality, terrestrial ecology and socio-economic studies.

Client: be'ah - Oman Environmental Services Holding Company
Position: EIA Project Manager/ Environmental Project Engineer

2013
GCC
COUNTRIES/OMAN

GCC Water Grid – GCC Countries (Bahrain, Kuwait, Qatar, Saudi Arabia, Oman, UAE)

Responsible for the revision of the Environmental Assessment report for the GCC Water Grid project with emphasis in Oman, execution of site visits to the desalination plant's sites and participation on project workshop. The project intends to secure the national water systems in emergency conditions by providing strategic water back up and diversifying seawater sources and fresh water resources. The project includes:

- 2 desalination plants in Oman: one on the Gulf of Oman and the other one on the Arabian Sea.
- Transmission pipelines from the desalination plants up to the State of Kuwait.
- Take-off points for the delivery of water to the six Member States.
- 12 pumping stations along the transmission pipeline with associated facilities.
- 2 single reservoirs at specific high points along the pipeline.
- Dedicated power transmission lines to supply the desalination plants and the pumping stations.

Client: Gulf Cooperation Council
Position: Environmental Project Engineer –Peer Reviewer

2012/13
QATAR

EIA for Sumaysimah Corniche – Marina and Waterfront Development – Sumaysimah city, Al Khor

Responsible for the execution of the Environmental Impact Assessment study (EIA) for the construction and operation of a marina to serve the local fishermen and the fishing industry. The development will also serve as a high-end waterfront destination - total area (landside and marine) of 1,328,000 m^2:

- Landside development (fish market, restaurants, yacht club, Majlis, landscape areas, measure facilities and parks, maintenance areas, road access, landscaping); and
- 506 berth marina for fishing boats, dhows, yachts and mega yachts.

The marine works entail marine excavation for the nearshore works and dredging for the navigational channel (11.5 km). The dredged material resulting from the project activities is used to create an offshore island. The existing waterfront is reclaimed with backfill material to accommodate the marina, the land operational facilities and leisure activities.
The environmental studies comprise a geotechnical investigation with soil and groundwater analysis, an air quality assessment using a mobile air quality monitoring station (24 hours sampling), noise monitoring, seawater and sediment quality, marine and terrestrial ecology surveys.
The EIA also includes a physical oceanography analysis with investigation of the coastal and seabed characteristics, bathymetry, water levels and sediment transport.

Client: UCC/Private Engineering Office Qatar
Position: EIA Project Manager/ Environmental Project Engineer

2012/13
QATAR

EIA for Jassassiya Chalet and EIA for Jassassiya Palace and Marina – Kaaban city, Al Shamal

Responsible for the execution of the Environmental Impact Assessment study (EIA) for the construction and operation of a private chalet and a private palace with the associated land infrastructure such as road access, parking and landscaping. In addition a small private marina for recreational shallow draft vessels, such as jet-skis and zodiac boats was also included. The marina was designed to accommodate 3 small vessels of 20m in length and 10 jet skis, protected by an impermeable vertical structure and linked to the shore by a 350m long access piled jetty. A navigation channel was also designed.
The marine works included: Dredging of the marina basin and navigation channel; Construction of a piled jetty and driven sheet pile components; Construction of a concrete block work quay wall; Installation of floating pontoons on piles and aids to navigation.
The environmental studies comprised a geotechnical investigation with soil and groundwater analysis, an air quality assessment using a mobile air quality monitoring station (24 hours sampling), noise monitoring, seawater and sediment quality, marine and terrestrial ecology surveys.
The EIA also included a physical oceanography analysis with investigation of the coastal and seabed characteristics, bathymetry, water levels (tide levels, storm surge, sea level rise, waves, currents) and sediment transport.

Client: UCC/Private Engineering Office Qatar
Position: Environmental Project Engineer

2012
OMAN

EIA and Geotechnical Studies for a Sanitary Landfill in Thumrayt – Thumrayt, Dhofar

Responsible for the management and execution of the Environmental Impact Assessment study (EIA) for the construction and operation of a non-hazardous engineered landfill in Wilayat Thumrait (Dhofar Region), 47 km north from Salalah. The chosen location is currently a dumpsite that receives all waste from Thumrayt area. The purpose is to upgrade the dumpsite to a proper engineered landfill in order to receive the waste from both Thumrayt and Salalah areas. An EIA has to be prepared to confirm the feasibility of the location, as well as of the whole project.
The EIA includes the following field surveys: geotechnical and soil analysis, air and noise quality, terrestrial ecology and socio-economic studies.

Client: be'ah - Oman Environmental Services Holding Company
Position: Project Manager and Environmental Project Engineer

2012/13
QATAR

EIA for Salwa Hotel Beach Resort – Salwa city

Responsible for the execution of the Environmental Impact Assessment study (EIA) for the development of a high-end, luxury destination resort located on the south west coast of Qatar, close to the border of Saudi Arabia.
The development consists on a coastal stretch of over 2.5 km long (total project area: 104 ha) to be developed with a marina, beaches and structures to house a hotel, conference centre, guest rooms, spa, souk, 88 beach front villas and other amenities such as mosque, parking etc. The inspiration for the project scheme was based on a Traditional Arabic Maritime Settlement and the architecture pretends to be a fusion of Qatari and Tunisian styles.
The EIA includes the following field surveys: geotechnical and soil analysis, air and noise quality, marine and terrestrial ecology, seawater and sediment analysis and socio-economic studies.

Client: UCC/Private Engineering Office Qatar
Position: Environmental Project Engineer

2011
OMAN

EIA for Wadi Umti Dam - Izki, Dakhlyiah Region

Responsible for the management and execution of the Environmental Impact Assessment study (EIA) for the project, which consists on the design review, tender and construction supervision of a dam to improve the recharge of the groundwater aquifer located in Wadi Umti (catchment area of 52 km^2).
The principal feature of the project consists of an RCC dam and appurtenant structures. The existing access track along the wadi bed will also be reconstructed over the dam structure to maintain access. The reservoir capacity is approximately 630,000 m^3, the maximum height above the river bed is 17,5m and the crest is 145m long.

Client: Ministry of Regional Municipalities and Water Resources
Position: EIA Project Manager/ Environmental Project Engineer

2011
OMAN

Site Identification Study For Non-Hazardous Waste Lanfills and Transfer Stations – Musandam, Al Buraymi And A'Dhahirah Regions

Local Project Manager of the Site Identification Study, which consisted in the identification of feasible locations for the construction of 4 non-hazardous waste engineered landfills and 12 transfer stations. The project aimed the reduction/elimination of the existent 6 dumpsites in Musandam and 86 dumpsites in Al Buraymi and A'Dhahirah regions – project area of 45,800km^2 and a population circa 236,000.
The project also involved the collection of relevant data (topographical, geological, hydrogeological, ecological, archaeological, environmental, sociological, etc.); incorporation of data on a Geographical Information System (GIS); design and application of site selection criteria, according to local/international legislation and standards, which will allow for the exclusion of sensitive areas and selection of the feasible locations and respective alternatives.
Local coordination tasks include organization of data collection and GIS teams, project management (scheduling and cost control), organization and performance of site visits, liaison with authorities, client and other stakeholders, preparation of reports and all project documentation.

Client: be'ah - Oman Environmental Services Holding Company
Position: Project Manager and Environmental Project Engineer

2011/12
OMAN

EIA for Healthcare Waste Treatment Facility – Thumrait, Dhofar Region

Responsible for the management and execution of the Environmental Impact Assessment study (EIA) for the design, financing, construction and operation of a Healthcare Waste Treatment Facility in Wilayat Thumrait (Dhofar Region), 47 km north from Salalah. The facility (total area of 14,400 m^2) will be designed to treat only the hazardous part of the healthcare waste produced and includes an incinerator for treating infectious and highly infectious wastes, and engineered landfill, a wet thermal unit and auxiliary areas and buildings (maintenance workshops, offices, guard house, storage facilities, washing area for bins and vehicles, loading and unloading platform, weighing areas, toilets, electrical rooms and control rooms, etc.).
The study included the in-house performance of several field investigations (noise and dust measurements, air and soil sampling) and coordination of local and international teams for the environmental, social and health impact assessment studies.

Client: be'ah - Oman Environmental Services Holding Company
Position: Project Manager and Environmental Project Engineer

2010/11
OMAN

EIA for Wadi Aday Flood Protection Scheme - Muscat

Main responsible for the management and execution of an Environmental Impact Assessment study (EIA) for the project, which consists in a combination of 7 dams located in the Al Amerat area upstream the city of Muscat. The project is designed for a return period of 500 years and includes several RCC and earthfill dams.

Client: Ministry of Regional Municipalities & Water Resources
Position: EIA Project Manager/ Environmental Project Engineer

2010
OMAN

EIA for Wadi Rafsah Flood Protection Scheme – Sur, Al Sharqiyah Region

Main responsible for the management and execution of an Environmental Impact Assessment study (EIA) for the project, which consists in a combination of 4 dams upstream the city of Sur and river training works between the existing Fulaij recharge dam and the sea – 9 km.

Client: Ministry of Regional Municipalities & Water Resources
Position: EIA Project Manager/ Environmental Project Engineer

2010
OMAN

EIA for Wadi Samail Flood Protection Scheme - Muscat

Main responsible for the management and execution of an Environmental Impact Assessment study (EIA) for the project, which includes the creation of 3 new dams in wadi Samail catchment area upstream the city of Muscat and the upgrade and reinforcement of the existing Al Khawd recharge dam. The project is designed for a return period of 500 years and includes RCC and earthfill dams.

Client: Ministry of Regional Municipalities & Water Resources
Position: EIA Project Manager/ Environmental Project Engineer

2009
KUWAIT

KOC Marine Facilities Upgrade

Rehabilitation and expansion of an existing harbor and design of a new harbor for the fleet support the company's activities. Project includes the provision of coastal studies including wave propagation, water circulation, navigation studies, berth planning, sediment transport, design of shore protection works and quay walls, etc.

Client: Kuwait Oil Company – KOC
Position: QA/QC Manager

2009
UAE

Hassyan Power and Desalination Complex - Dubai

Assistance to Contractor (China Harbour Engineering Company) for the selection of Artificial Reefs supplier (analysis of tender documents and proposals) under the seawater intake and outfall system project.

Client: Dubai Electricity and Water Authority – DEWA
Position: Environmental Project Engineer

2008
BAHRAIN

Marsa Al Seef
Market Study and Master Plan Support for the definition of the Marsa Al Seef development, which includes 8 km of shore protection, 6 km of canals and two marinas for a total of 350 berths.

Client: Gredco Developer
Position: QA/QC Manager

2009
MOZAMBIQUE

Maputo Port Master Plan - Maputo
Development of the Maputo's Porto Master Plan – Environmental Consultancy identifying the fatal flaws of the project according to the Mozambican Environmental legislation.

Client: Maputo Port Development Company
Position: Environmental Project Engineer

2008
SYRIA

EIA for Ibn Hani Bay Resort - Lattakia
Coordination of the Environmental Impact Assessment Studies for the design of the Ibn Hani Bay Resort (244.000m^2). The resort is located just a few kilometers down the coast from Lattakia, Syria 's main seaport, and includes a marina, beaches and canal villas, upscale apartments, and two prestigious hotels with a small selection of commercial outlets and restaurants including its marinas and waterfronts.

Client: ERGA Group
Position: Environmental Project Engineer

2008
LIBYA

Tripoli Waterfront Development - Tripoli
Environmental consultancy during the Conceptual Design of Tripoli waterfront. The design includes perched beaches, groins and rehabilitation of an existing marina.

Client: Libyan Emirates Holding
Position: Environmental Project Engineer and Assistance to coastal and marine teams (data collection and concept design)

2008
UAE

Coconut Island Development – Abu Dhabi
Environmental consultancy during the Detail Design and Marine studies for the Coconut Island Resort in Abu Dhabi, which included Shore protection, Marinas, Lagoon and an artificial flushing system.

Client: ALDAR Properties PSJC
Position: Environmental Project Engineer and QA/QC Manager

2008
UAE

Emirates Palace Marina – Abu Dhabi
Project Management of the development including definition of design and construction schedules, tendering of construction works and negotiation with contractors and suppliers.
Provision of coastal studies including wave propagation, water circulation, marina layout planning, sediment transport, design of shore protection works, quay walls, gangways, etc. Marine studies, design and supervision of iconic development in Abu Dhabi.

Client: ALDAR Properties PSJC
Position: Environmental Project Engineer and Supervision and selection of environmental consultants for the project's Environmental Impact Assessment studies

2008
UAE

HSEIA for Das Island – Abu Dhabi

Das Island is an artificial island that exists off the coast of Abu Dhabi and is used for industrial activity. The project consisted on the extension of the existing surface in order to accommodate a new airport for access to the island. This extension also includes a new smaller island connected to the main island by a Causeway, which will serve as housing quarters for the laborers who currently live and work in Das Island.

The HSEIA was prepared in order to identify and assess the main impacts caused by the dredging and reclamation works for the airport areas and for both the new island and causeway.

The baseline surveys included marine and soil investigations onshore and offshore.

Client: Bureau Veritas/ADNOC – Abu Dhabi National Oil Company
Position: Environmental Engineer and Peer Reviewer

2008
ITALY

EcoParks – Sustainable Industrial Parks - Sicily

Development of Ecopark's project (sustainable industrial parks) and Best Available Technologies in Sicilian Industrial areas (Syracuse, Modica, Palermo, Agrigento e Messina).

Implementation of Quality and Environmental Management Systems (ISO 9001, ISO 14001) and Health and Safety (OHSAS 18001).

Client: Sicilian Regional Municipality
Position: Technical Manager

2005
SPAIN

Health Institute of Catalonia (Regional Government Agency)

Implementation of an Environmental Management System (ISO 14001-EMAS) in 32 Primary Health Centres and 5 Hospitals of Catalonia.

Performance of ISO 14001-EMAS internal audits and training actions regarding Healthcare Waste Management.

Client: Institut Catala de la Salut – Generalitat de Catalunya
Position: Project Manager and Environmental Project Engineer

2006
SPAIN

Metropolitan Agency of Barcelona

Implementation of an Environmental Management System (ISO 14001-EMAS) in the headquarters of the Metropolitan Agency of Barcelona.

Performance of ISO 14001-EMAS internal audits and training actions.

Client: Entitat Metropolitana de Barcelona, EMA
Position: Project Manager and Environmental Project Engineer

2006
SPAIN

Waste Agency of Catalonia (Regional Government Agency)

Implementation of an Environmental Management System (ISO 14001-EMAS) in the headquarters of Catalonia's Waste Agency in Barcelona.

Performance of ISO 14001-EMAS internal audits and training actions.

Client: Generalitat de Catalunya
Position: Project Manager and Environmental Project Engineer

2006
SPAIN

Water Agency of Catalonia Region (Regional Government Agency)

Implementation of an Environmental Management System (ISO 14001-EMAS) in the headquarters of Catalonia's Water Agency in Barcelona.

Performance of ISO 14001-EMAS internal audits and training actions.

Client: Generalitat de Catalunya
Position: Project Manager and Environmental Project Engineer

2007
SPAIN

LEDS C4 (metalworking company)
Implementation of an Environmental Management System (ISO 14001) in the industrial site of the metal mechanical company.

Client: LEDS C4
Position: Project Manager and Environmental Project Engineer

2006
SPAIN

TEPSA – TERMINALES DE BARCELONA S.A. (chemical storage and transportation company)
Implementation of an Environmental Management System (ISO 14001-EMAS) in 4 sites of the chemical company (chemical storing and transportation in the Port of Barcelona, Port of Bilbao, Port of Tarragona and Port of Valencia)

Client: TEPSA S.A.
Position: Project Manager and Environmental Project Engineer

2005
SPAIN

ROCA (metalworking, metallurgic, graphic, ceramic company)
Implementation of an Environmental Management System according to ISO 14001 in several industries of ROCA Barcelona. Environmental supervision and legal compliance. Waste management plans and control, Health and Security guidelines. Main auditor for to all the industries of ROCA group.

Client: ROCA Group
Position: Project Manager and Environmental Project Engineer. Training. Main Auditor

2005
SPAIN

GREFACSA S.A. (animal food company)
Internal audits and environmental consultancy (ISO 9001, ISO 14001)

Client: GREFACSA
Position: Auditor and Environmental Engineer

2005
SPAIN

FUENTE LIVIANA S.A. (mineral water company)
Implementation of an Environmental Management System (ISO 14001)

Client: DAMM Group
Position: Project Manager, Training, Auditor

2005
SPAIN

AGUAS DE VERI (mineral water company)
Implementation of an Environmental management system (ISO 14001)

Client: DAMM Group
Position: Project Manager, Training, Auditor

2005
SPAIN

Environmental Agency of Catalonia (Regional Government Agency)
Implementation of an Environmental Management System according to EMAS regulation in the headquarters of Catalonia's Environmental Agency in Barcelona; Environmental training; Internal audits

Client: Generalitat de Catalunya
Position: Project Manager, Training, Auditor

2005
SPAIN

ENVIRONMENTAL MONITORING (water, wastewater, air, noise) AND MANAGEMENT

Coordination of air emissions monitoring campaigns in hundreds of industrial emission stacks/chimneys, specially on the metalworking industrial sector. Analysis and reporting of laboratorial results for legal compliance purposes. Assistance to the Clients on the compliance of legal requirements for the chimneys, such as calculation of minimum heights, installation of monitoring devices and protection structures. Coordination with laboratories and with Legal Authorities, assisting and peer reviewing including the development and implementation of national Air Quality legal standards.

Design and implementation of solvent management plans in order to reduce fugitive emissions of VOCs.

Performance of water and wastewater sampling campaigns in several industries, analysis and reporting of laboratorial results, for legal compliance purposes.

Design and implementation of waste management plans

Environmental legal compliance and improvement plans.

Organization and co-ordination of training sessions.

Environmental (ISO 14001, EMAS) and Quality (ISO 9001) internal audits.

Client: Metalworking, Graphic, Ceramic, Metallurgic, Water, Food industries
Position: Project Manager, Environmental Engineer, Training, Auditor

2002
PORTUGAL

VALSAN (metalworking industry) – Environmental monitoring

Management of the stationary emissions sources: sampling, monitoring, control/supervision.
Legal compliance. Environmental Training (factory operators).

Client: VALSAN Portugal
Position: Environmental Project Engineer – Training

2002
PORTUGAL, ITALY, POLAND

COLEP CCL (plastic, metalworking, graphic, food, aerosol industry) – Environmental management

Implementation of Environmental Management System (ISO 14001) in 4 industrial sites of the company (Madrid, Navarra, Kleszczow, Vale de Cambra).

Client: COLEP CCL Portugal
Position: Environmental Project Engineer

2002
PORTUGAL

AEP (Portuguese Business Association)

PRONACI Project - National Program of Intermediate Leaderships Qualification for the Industry as consultant, training and co-author of an Environmental Management Guide.

Client: AEP
Position: Environmental Project Engineer

2003
PORTUGAL

EIA for the upgrade of the Galvanize Process (metalworking industries)

Two Environmental Impact Assessment (EIA) studies for the expansion and upgrade of the galvanization industrial process in two industries. This process implicates the application of a protective zinc coating to steel or iron, in order to prevent rusting by hot-dip and electroplating.

Client: GALVAZA and ZINCONORTE
Position: Environmental Project Engineer – Air Quality and Monitoring Expert

2003
PORTUGAL

CORTICEIRA AMORIM (cork industry) – Environmental monitoring

Management of the water and stationary air emissions sources: sampling, monitoring, control/supervision. Environmental legal compliance.

Client: CORTICEIRA AMORIM
Position: Environmental Project Engineer

2001
PORTUGAL

SILAMPOS (metalworking industry) – Environmental monitoring
Implementation of Environmental Management System (ISO 14001), Waste Management Plans, Environmental Training sessions (factory operators, engineering team, human resources) and supervision of the Wastewater Treatment Plant.

Client: SILAMPOS
Position: Environmental Project Engineer – Training

2001
PORTUGAL

VULCANO (BOSH group) – Environmental monitoring
Supervision of the Wastewater Treatment Plant, water sampling campaigns and waste management.

Client: VULCANO
Position: Environmental Project Engineer

2001
PORTUGAL

PRODESTS (European Innovation and Cooperation Project)
Best Available Techniques and Pollution Prevention Project for Small and Medium Enterprises in Europe (attending international missions, conducting feasibility studies, analysing budgets and producing progress reports).
Partners of the project were Laboratories and Consultants from all European Countries.

Client: European Commission
Position: Assistant Environmental Engineer within the Portuguese Partner's Team

2001
PORTUGAL, SPAIN, ITALY

ENVIREDOX (European Innovation and Cooperation Project)
Technical and methodological implementation of a Best Available Technology (BAT) to treat special industrial residuals with urban waste depuration techniques – Laboratorial Tests and Pilot Project.
Partners of the project were Spanish and French Laboratories.

Client: European Commission
Position: Assistant Environmental Engineer within the Portuguese Partner's Team

2001
PORTUGAL

ENVIRONMENTAL MONITORING (Air, Water, Wastewater, Noise) AND TRAINING
Co-ordination of a large number of monitoring campaigns in stationary air emission sources in several Portuguese industries – design, installation, calculation and legal compliance of vertical chimneys and rain protections.
Consultant on water, wastewater and waste management, stationary air emissions, noise control and industrial solvent management.
Environmental compliance and improvement plans.
Organization and co-ordination of training sessions.

Client: Several Portuguese Industries – Metalworking, Cork, Plastic, Graphic, Ceramic, Cosmetic, Pharmaceutical, Metallurgic
Position: Environmental Project Engineer

PROFESSIONAL MEMBERSHIP

2008/Present - Member of 'Ordem dos Engenheiros'(Portuguese Engineering Council), Portugal

2004/05 - Member of Portuguese Technical Groups for analysis of ISO international standards, Portugal

2008 - Member of Environmental Commission of Engineers Council, Italy

2008 - Member of Italian Women Engineers and Architects Association, Italy

EMPLOYMENT RECORD

OCTOBER 2014-PRESENT GRENOBLE, FRANCE	**ARTELIA WATER & ENVIRONMENT – RISK, SOCIETY, ENVIRONMENT BRANCH** Environmental Engineer - Project Manager
2010 – JUNE 2014 MUSCAT, OMAN	**ARTELIA WATER & ENVIRONMENT – OMAN BRANCH** Environmental Engineer - Project Manager Group's Sustainable Development Correspondent Quality Manager
2008-2010 DUBAI, UAE	**SOGREAH GULF FZCO (ARTELIA Group)** Environmental Engineer - Project Manager QA/QC Manager
2008 SYRACUSE, ITALY	**CIR s.r.l.** (Private Environmental Consultancy Company) Environmental and Health and Safety Technical Manager
2005-2007 BARCELONA, SPAIN	**AMBITERR – Ambiente y Territorio S.A.** (Private Environmental Consultancy Company) Environmental Technical Manager since Sept. 2005 Project Manager since April 2005
2001-2004 PORTO, PORTUGAL	**Qualified Professional Teacher - Schools, Industries and Other Entities** (Freelance) Responsible for training sessions in: solid waste management, water management, atmospheric and acoustic pollution, sustainable development, environmental audits, environmental management
2001-2004 PORTO, PORTUGAL	**CATIM – Portuguese Technological Centre for the Metal Working Companies** Internal Junior Auditor since Jan. 2003 Junior Environmental Engineer and responsible for the Air Monitoring and Environmental Management System Projects since Sept. 2002
2000 PALERMO, ITALY	**AMAP - Azienda Municipalizzata Acquedotto Palermo** (Municipal Water and Wastewater Company) Leonardo da Vinci European Program Trainee at the Municipal Wastewater Treatment Plants and Laboratories

Frédéric Mathieu

Project Manager
Water and Environment | Risks Society Environment Unit

Date of birth: 1966
Nationality: French
Education and Training:

- Doctor in Ecology (Paris 7 University) : Chemical ecology of phytophagous insects, DEA Postgraduate Degree in Spectrochemistry and analytical organic chemistry (Paris 7 University),
- MST Degree in Management and Protection of the Environment (Paris 7 University).
- Geographic Information System (ArcGis and 3D Analyst, ESRI 2001-2002)
- Acoustics modeling (01dB Metravib: Mithra v5, 2001 and CadnaA, 2007-2010).
- Hydraulic modeling (HEC RAS and River 2D)
- GC-MS (Gas Chromatography and Mass Spectroscopy) (INRA, 1995-1997)
- Health & Safety: First aid worker, CASC (firemen), 2008;
- Health & Safety: Helicopter Underwater Escape Training (HUET), CETIS (Centre d'entraînement aux Techniques Incendie et Survie des Marins-Pompiers de Marseille), 2008.

Languages: French (native language), English (medium), Spanish (basic)
Date of employment in Artelia: 2007

CAREER SUMMARY | SKILLS

Frederic MATHIEU is a project manager with various environmental specializations: ecology, acoustic modeling, flooding area modeling, GIS (Geographical Information Systems), environmental discharges and insect control. His main responsibilities include performing environmental baseline surveys (EBS) and environmental impact assessments (EIA) in natural, urban or industrial contexts, acoustic modeling studies (often for inclusion in EIAs), GIS production and analysis, and natural area planning (tourism, education and preservation purposes).

He has experience in the following fields:

- **Management and project management**
  - Team management (up to 10 people), meeting facilitation, training, ...
  - Business Management: budget, technical responsibility, quality control, customer relationship management, tendering, technical and commercial proposals ...
  - Supervision and carrying out technical studies, assistance in project management and programming ...
  - Intervention for private and public sector in France, the TOM (French overseas territories) and abroad (Algeria, French Polynesia, New Caledonia, Nigeria, Angola, Congo, Cameroon, Romania, Myanmar, Uganda ...)
- **Intervention areas: natural and industrial environments**
  - Baseline studies and field investigation (ecosystem / biodiversity, pollution, degradation of the environment, heritage, landscape, tourism potentials).
  - Environmental Impact Assessment of industrial and development projects (subdivisions, roads, airports, tourist attractions, natural and urban areas...).
  - Modelling the acoustic contribution of infrastructure and industrial projects. Sizing baffles, estimate overruns and isolation constraints.
  - Creation of GIS (mapping and databases).
  - Flow modelling (1D and 2D) of streams for rehabilitation, flood risk and bank protection issues.
  - Calculation of supply and 2D hydraulic modelling applied to the design of artificial lagoons of big hotels on the motu in Bora Bora.
  - Development of natural environment and signalling.
  - Environmental management plan and environmental management system for industrial projects.

- **Tools: mapping, modelling, measurement and office softwares**
  - Acoustic Modelling: Mithra v5 CadnaA. Acoustic measurements: dBTrait frequency analyzer and sound level meters.
  - ArcGIS Arc Map, Arc Catalog, 3D Analyst, Spatial Analyst and geodatabase in Access.
  - HEC RAS modelling and 2D River and all rules of thumb calculation (design flow, bank protection, storm basin, thrust, and effluent dilution).
  - Sampling methods, probes and interpretation for many investigation settings of the natural and industrial environment (surface water, groundwater, air and soil). Use of many national and international standards.
  - Data analysis: STATISTIQUA: ANOVA, regression, factor analysis, parametric and nonparametric tests.
  - Gas chromatography and mass spectrometry.
  - CAO: Microstation, PAO: Photoshop, GIMP, COREL suite, Office: Office and openoffice pack; Database: Access.

PROFESSIONAL EXPERIENCE

MAIN ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL BASELINE STUDIES

INDUSTRIAL PROJECTS IN NATURAL ENVIRONMENTS

2013-ONGOING
CAMEROON

Assessment of socio-economic and environmental conditions related to electricity and interconnection production options
This study, conducted within the framework of the hydroelectricity expansion plan and the South Sudan regional integration plan in the regional electricity network, aims at: (i) carrying out an environmental assessment for the various projects and (ii) implementing a set of quantifiable environmental and social criteria/indicators helping to rank supply options.
Client : NILE BASIN INITIATIVE / NELSAP (supported by the World Bank)

Position : Project manager/environment expert

2013-ONGOING
CAMEROON

Lom Pangar hydropower project, independent environmental and social technical audit
The objective of this audit is to control independently the compliance of the implementation of the environmental and social obligations during the construction and the implementation phases. These obligations are mainly included in the project's Environmental and Social Management Plan (ESMP), but other instructions **can be established during the project, and the ESMP can be slightly modified.**
Client : EDC

Position : Support expert for the impact assessment and building site follow-up

2014-ON GOING
DRC

Environmental study of five oil fields in operation
Field missions, control of water and environment quality, modelling framework of air quality (source terms and reference values)
Client : Perenco

Position : Environment expert for water and air contamination (including field mission)

2014 – ON GOING
FRANCE

Risk assessment of ODC pipeline network
Analysis of national reference documents (BSS, LISA, ADES, CARTHAGE, protected areas…) by geoprocessing to assess the environmental seriousness of the leak scenarios on the 1,300-km pipeline (in compliance with GESIP guide appendix 11).
Client : TRAPIL

Position : Project manager of the chapter concerning the environmental seriousness of the study

2013-2014
CAMEROON

Follow-up of sea turtles in Cameroon within the framework of CLNG project environmental assessment
The preliminary ESIA of CLNG project underlines the potential cumulative impact on sea turtles of the projects related to Kribi port complex. Specific studies are required before the ESIA is conducted
Activities: Implementing the study on site: choosing the team by taking into account methodological and social aspects, reinforcing the team skills with training session and selecting the sites.
Client : GDF Suez

Position : Project manager

2012-ONGOING
DRC

Environmental and Social Impact Assessment (ESIA) for the Graben Albertine – Block III Seismic Project (Nord Kivu and Province Orientale)
The Project comprises a 2D seismic survey in Easter Congo DRC. Block III of Graben Albertine extends over 3200 km2 and close to the Virunga national parc.
Position held: Project Manager of the ESIA, Field mission, stakeholder consultation and village inquiry

- Social field survey
- ESIA/ESMP report
- Public consultation
- Management of the GPS mapping with a local NGO

Client : Total

Position : Project Manager of the ESIA, Field mission, stakeholder consultation and village inquiry

2013
CONGO

Environmental and Social Impact Assessment (ESIA) for Moho North and Phase 1 bis Oil and Gas exploitation Project
Moho Nord and Moho Phase 1 bis are two oil and gas development project in deep offshore. Project includes: (i) drilling activities, (ii) construction/operation of the facilities such as Tension leg platform and Floating Production Unit, (iii) construction/operation of an export pipeline and (iv) on shore equipment in the existing oil treatment/export complex of Djéno.

- Assessment of Best Available Technology
- TDR of the project and associated stakeholders consultation
- ESIA/ESMP of the two projects and public consultation activities
- Health study

Client : Total E&P Congo

Position : Project manager of the TDR, ESIA/ESMP also involved in public consultation

2012-ONGOING
CAMEROON

Environmental and Social Impact Assessment of CLNG project (Cameroon Liquefied Natural Gas)
Conduct studies on the impact of assessment activities onsite, on the liquefaction plant and gas pipeline. The mission also includes carrying out field investigations and public consultation throughout the process.
Client : GDF Suez

Position : Senior Engineer, Head of field mission

2012-ONGOING
CONGO DRC

Environmental and Social Impact Assessment and Resettlement Action Plan (RAP) for pilot industrial area project
ESIA and RAP conducted according to World Bank processes.
Client : World Bank

Position : Responsible for scoping mission

2012
UGANDA

Environmental Impact Assessment for a drilling exploration campaign for TOTAL
Quality control and knowledge transfer for local engineering office
Client : Air Water Earth (AWE) Engineers

Position : Field investigation supervision, review of reports and training

2009 – 2015
FRANCE

Baseline study and definition of an environmental monitoring program for CO2 geological storage of, site of Rousse
Inventory of fauna and flora, monitoring of groundwater and surface water quality (chemical and biological).
Phase 2: monitoring plan implementation (2010-2015)
Client : TOTAL

Position : Project manager

2011
OMAN

Baseline study for an incinerator and a hospital waste landfill site on a deserted site
Field operation, sampling and results analysis (soil, air, noise)
Client : Sogreah Oman

Position : Environment expert

2010
FRANCE

Environmental statement to support permit application in 4 blocks (oil and gas)
Environmental statement for onshore exploration drilling project and seismic acquisition survey of the shale gas reserves in four departments in northern France. The study was undertaken in compliance with French legislation.
Development of a specific GIS database
Client : Elixir

Position : Project manager

2011
FRANCE

Environmental statement to support permit application in 3 blocks (oil and gas)
Environmental statements undertaken in compliance with French legislation..
Client : Basgas

Position : Project manager

2010
MYANMAR

Environmental monitoring survey of Yadana offshore TEPM platform
Environmental survey of site and surrounding areas, including seawater and sediment analysis, and identification of benthic fauna species. The study is conducted in accordance with Total internal standards.
Evaluation of potential impacts of Yadana platform activities on marine environment and comparison of the results with previous studies.
Client : TOTAL

Position : Project manager

2011
MYANMAR

EIA and Environmental Management Plan (EMP) of offshore seismic acquisition campaign of Yadana block
Environmental baseline study of project area; Environmental Impact Assessment in accordance with client standards. Acoustical issues related to marine mammals
Client : TOTAL

Position : Project manager and acoustic expert

2012
MYANMAR

EIA and EMP of subsidence project of Yadana offshore TEPM platform
Relocation of activities and quarters as a result of subsidence on the Yadana Complex offshore platform due to gas extraction.

- EIA for the decommissioning of existing facilities
- Assessment for the installation of new infrastructure.

Client : TOTAL

Position : Project manager and acoustic expert

2010
ALGERIA

EBS (Environmental Baseline Survey) for an exploration project in the Ahnet block

Environmental Baseline Study (EBS) of Ahnet block, in particular future drilling sites. The study included:

- Evaluation of soil, groundwater and surface water contamination and air quality tests;
- Investigation of the biological environment (fauna-flora) and archaeology;
- Meeting with stakeholders.

Client : TOTAL

Position : Project manager

2010
ALGERIA

EIA for a drilling exploration project in the Ahnet block

Environmental Impact Assessment performed in compliance with Algerian legislation based on the previous EBS.

The study included:

- Baseline environmental assessment (landscape, fauna, flora);
- Evaluation of environmental and social impacts;
- Definition of mitigation measures;
- Preparation of a Management Plan

Client : TOTAL

Position : Project manager

2009-2010
ALGERIA

EBS (Environmental Baseline Survey) for exploration project in Rhourde Yacoub block

Involved of an Environmental Baseline Study (EBS) including:

- Field survey: air quality measurement, water and soil quality analysis, flora and fauna investigation,
- Fauna and flora identification and archaeological inventory;
- Satellite image analysis;
- Assessment of environmentally sensitive elements;
- Meeting with stakeholders.

Client : Ruhrgas

Position : Project manager

2009-2010
ANGOLA

Pre-EIA for the implementation of a FPSO (Floating, Production, Storage and Offloading) for the CLOV development project in block 17

Preliminary Environmental Impact Assessment (pre-EIA) for the development of 4 fields on block 17. The CLOV project situation is offshore Angola in a water depth of approximately 1,100 m to 1,400 m, and includes: a FPSO (Floating, Production, Storage and Offloading), a Subsea Production System (SPS), and drilling of 34 wells.

The tasks performed included:

- Environmental impact assessment;
- Definition of mitigation measures;
- Energy efficiency and greenhouse gases emissions assessment;
- Preparation of an Environmental Management Plan.

Client : TOTAL

Position : Project manager

2009
CONGO

EIA (Oil & Gas) 3D seismic acquisition survey in Block "Haute Mer"

Preparation of Environmental Impact Assessment for exploration seismic survey in "Haute Mer" C block including:

- Preparation of the EIA in accordance with Congolese legislation
- Recommendations for seismic survey methodology to minimize impact on marine mammals.

Client : TOTAL

Position : Project manager

2010
NIGERIA

Preliminary Environmental Impact Assessment (PIAR) for the extension of the Amenam platform

Preliminary Environmental Impact Assessment (PIAR) in accordance with Nigerian regulation and Total standards.

The PIAR includes:

- Environment description;
- Waste, discharge and emission inventory;
- Evaluation of the impacts and mitigations measures;
- Environmental Management Plan.

Client : TOTAL E&P

Position : Project manager

2009-2012
ANGOLA

EIA and EMP for the offshore seismic acquisition campaign in block 32 (deep sea)

- Description of the baseline environment
- Preparation of the environmental impact assessment in compliance with Angolan legislation

Client : TOTAL

Position : Project manager

2008
ALGERIA

Pre EIA and EMP for Timimoun licence development project

The socio-economic baseline survey was carried out on 3 Daïras and 2 Wilayas around the Timimoun block. The aim was to understand the socio-economic context of human development within the project area, and improve local community involvement. The mission included:

- A detailed description of the human, social, economic and cultural context;
- A number of interviews of main stakeholders including local administrative authorities, associations, NGOs, religious and educational organizations, etc.
- Stakeholder mapping;
- Client support for the regulatory public consultation process with participation;
- Impact assessment and definition of mitigation measures;
- Social Management plan.

Client : TOTAL

Position : Project manager and acoustical expert

2010
ALGERIA

ESIA for 3D seismic acquisition survey in Timimoun Block

- Description of the environmental baseline study
- Preparation of the environmental impact assessment in compliance with the Algerian laws

Client : TOTAL

Position : Project manager

2008-2011
NIGERIA

EIA (Oil & Gas industry)

Pre- Environmental and Societal Impact Assessment (ESIA) for the EGINA field development project

Client : TOTAL

Position : Project manager

2008
ANGOLA

EIA and EMP for the 4D seismic acquisition campaign in block 32 (offshore)

- Description of the environmental baseline study
- Preparation of the environmental impact assessment in compliance with Angolan legislation

Client : TOTAL

Position : Project manager

2008
ANGOLA

EIA and EMP for the 4D seismic and electromagnetic acquisition campaign for block 17 (offshore)

- Description of the environmental baseline study
- Preparation of the environmental impact assessment in compliance with Angolan legislation

Client : TOTAL

Position : Project manager

2009-2010
FRANCE

Pre EIA and EIA for the installation of a solar power plant
Field surveys, EIA in compliance with French regulation.
Issues: landscape and viticulture
Client :Photowatt

Position : Project manager

2009-2010
FRANCE

Pre EIA for the implementation of a solar power plant
Field surveys, pre EIA in compliance with French regulations.
Issues: landscape and flora
Client :POWEO

Position : Project manager

2010-2012
FRANCE

EIA for the wind farm installation project in the Forez Mountains
Landscape, acoustic and faunal issues. Field survey organization, acoustic measures and modelling, landscape integration
Client : ENR du Forez

Position : Acoustic expert

2007
FRENCH POLYNESIA
TUAMOTU

EIA for the installation of a wind farm on Makemo Island
Field baseline study, acoustic measures and modelling, landscape integration
Client : Private

Position : Project manager and acoustic expert

2003
FRENCH POLYNESIA
TAHITI

EIAs for Development of Faratea Harbour
Field investigation, preparation and sampling of the environmental and social baseline study in compliance with Polynesian legislation
Client : Établissement des Grands Travaux de Tahiti

Position : Project manager

INDUSTRIAL PROJECTS IN INDUSTRIAL AND URBAN ENVIRONMENTS

2009-2010
ALGERIA

EIA, ESBS (Environmental and Social Baseline Survey), EMP for a Gas Liquefaction Plant in Arzew

- Environmental and Social Baseline Survey (ESBS);
- Environmental Impact Assessment (EIA);
- Noise Assessment;
- Environmental Management Plan;
- Risk assessment including HAZID review, calculation using PHAST software, fault tree and event tree analysis, risk acceptability analysis.

Client : Saipem-Sonatrach

Position : Project manager

2007-2008
ALGERIA

EIAs and EMP for construction of thermal power plants
Harbour of Algiers, Harbour of Annaba, Koudiet
- Environmental Impact Assessment (EIA),
- Environmental Baseline Survey (EBS),
- Risk Assessment,
- Environmental Management and Monitoring Plan,
- Waste Management Plan
- Restoration Plan

Client : General Electric, Iberinco

Position : Project manager and acoustic expert

2006
TAHITI

Environmental Studies for industrial and port development in Taravao
Field study, sampling and preparation of the environmental and social baseline study in compliance with Polynesian legislation
Client : Établissement des Grands Travaux de Tahiti

Position : Project manager

2003
TAHITI

Identification of environment discharges and characterization studies of Papeete Harbour / Emissaries inventory
Database development, GIS of physic-chemical and biological measures over a 20 year period. Analysis and interpretation of current-meter, physic-chemical and biological data. Analysis of main elements.
Supervision of a diving mission to conduct the inventory and visit all the emissaries of the bay.
Client : The Port Authority of Tahiti

Position : Project manager and GIS expert

2008
FRANCE

Diagnosis of soil pollution, Paris airport
Field operations, analysis interpretation and report
Client : Veolia

Position : Project manager and GIS expert

OTHER EIAS OF DEVELOPMENT PROJECTS IN URBAN CONTEXTS

2000-2007
FRENCH
POLYNESIA
TAHITI

10 EIAs for the construction of housing estates
3 EIAs for the construction of commercial centers
2 EIAs for high school constructions
2 EIAs for the creation of commercial activity areas
Client: Private and public sectors

Position: Project manager, Study engineer and acoustic expert

EIAS OF DEVELOPMENT PROJECTS IN NATURAL CONTEXTS

2013-ONGOING
MALI, BURKINA FASO AND GHANA

West African Power Pool
Interconnexion project of the electrical network of Ghana, Burkina and Mali
Update of ESIAs and RAPs of the 3 countries taking into account comments of BAD (African Bank of development) and BEI (European Bank of Investment. Proposal of a shared ESIA and RAP background for the 3 countries to homogenise requirements and reports.
ESIA and RAP of an extension of the main project in Ghana (section Ham Tumu and Ham Bolgatanga)
Preliminary ESIA/RAP and TDR/Budget of the ESIA/RAP for a section of the electrical network in Mali.
Client : Economic Community of West African States

Position: Project Management and Environmental expert.

2013-ONGOING
BURUNDI

Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Jiji and Mulembwe Hydroelectric projects, including outgoing power line to Bujumbura and secondary networks connections surrounding urban centres.
The project, named Jiji and Mulembwe Hydroelectric Complex", comprises 3 components: the Mulembwe hydroelectric project (16,5 MW), the Jiji project (31,5MW), and the network of 220/110/33 kV transmission lines conveying the energy produced.
(i) Policy framework of the population resettlement, (ii) ESIA/ESMP and RAP for each dam and HT power line projects and (iii) policy framework of the environmental and social management of the secondary electrification project.
Involved in the ESIAs, ESMPs, RAPs completion and public consultations
Client : Ministry of Energy and Mines – Régie de production et distribution d'eau et d'électricité (REGIDESCO)

Position : ESIA expert

2012-ONGOING
MALI

Hydroelectric project - Felou
Monitoring of mitigation measures of impacts on the environment during the construction phase.
Client : OMVS (Organisation for the Promotion of Rivers in Senegal)

Position : Environmental expert

2011
CAMEROUN

EIA for Nachtigal dam project
Organization and participation in the field survey (10 days, 12 people) for soil occupation, health, fishing and socio-economic aspects.
Update of 2006 EIA report. Presentation of the impact study during public update meetings
Client : ALUMINIUM PECHINEY (Rio Tinto Alcan)

Position : Environmental expert

2006
FRENCH
POLYNESIA
TAHITI

EBS for a dam construction project in endemic rain forest with a rich archeological importance - Papeiha
Baseline study in an area of high biodiversity in French Polynesia
Client : Projet privé

Position : Environmental expert

2005
FRENCH
POLYNESIA
NUKU HIVA

EIA for road construction in the endemic rainforests of Toovii Ridge
Flora description in a forest of rich biodiversity in French Polynesia.
The analysis resulted in the modification of the road layout
Client : Direction of Urban planning

Position : Project manager

2003
FRENCH
POLYNESIA
TAHAA

EIA for the construction of the Dassin hotel Domain in Tahaa
- Description of natural resources
- Impact assessment
- Suggestion for natural wealth enhancement and protection

Client : Private project

Position : Environmental expert

2005
FRENCH POLYNESIA
BORA BORA

EIA for the construction of the Saint-Régis Bora Bora Resort hotel

- Description of natural resources
- Impact assessment
- Suggestion for natural resources enhancement and protection
- Development of a particular impact analysis methodology on landscape thanks to a cartographical approach
- Implementation of artificial reefs in the lagoon to develop coral colonies and increase biomass

Client : Private project

Position : Project manager

2000
FRENCH POLYNESIA
BORA BORA

EIA for the construction of the Eden Garden hotel in Bora Bora

- Description of natural resources
- Impact assessment
- Suggestion for landscape optimization to limit pesticide use in mosquito treatments

Client : Private project

Position : Project manager

2002
FRENCH POLYNESIA
BORA BORA

EIA for the construction of the Bora Bora Nui Resort hotel

- Description of natural resources
- Impact assessment
- Suggestion for natural resources enhancement and protection
- Displacement of the coral colonies doomed to destruction to create submarine landscapes
- Implementation of artificial reefs to restore marine biomass

Client : Private project

Position : Engineer

2007
FRENCH POLYNESIA
HUAHINE

EIA for hotel construction at Bali Hai Resort

- Description of natural resources
- Suggestions for the restoration of unsanitary lagoon

Client : Private

Position : Project manager

1999-2005
TAHITI

EIAs for airfield construction on isolated islands such as Kahuehi, Rimatara and Atuona Islands

- Natural resource description
- Impact assessment
- Recommendations
- Public consultation

Client : French Polynesian Ministry of Planning

Position : Engineer

2004
FRENCH POLYNESIA
HUAHINE

EBS for a golf course in a region of rich archeological and natural importance

- Natural resource description (biodiversity, landscape, historic sites)
- Risk assessment related to facilities
- Enhancement recommendations, suggestions

Client : Private project

Position : Project manager

2000
FRENCH POLYNESIA

Analysis of physic-chemical elements in Maeva Lake
Bibliographical synthesis, specific solutions to take lagoon sediment samples and interpretation of further sediment analyses
Client : Board of environment

Position : Project manager

NATURAL AND URBAN AREAS PLANNING

2006
FRENCH POLYNESIA

GIS design of the main biodiversity and cultural heritage spots of French Polynesia
- Collection of data : fauna, flora and ecosystems thanks to taxonomist experts
- Information coding
- Data base setup
- GIS data formatting

Client : Board of the environment

Position : Project manager

2006
FRENCH POLYNESIA

Tetiaroa atoll
Phase 1: synthesis and compilation of existing scientific documents
Phase 2 : GIS organization, compilation and synthesis of the expertise mission (biodiversity, archaeology, landscape, coral ecosystem, fishing areas), multi-criteria analysis of ranked results and recommendations
Client : Board of the environment

Position : Project manager

2005
FRENCH POLYNESIA

Participation in Papeete waterfront development architecture contest
- Management of environmental aspects with the architecture
- Environmental suggestions
- Participation in the report presentation

Client : Établissement des Grands Travaux

Position : Environment expert

2006
FRENCH POLYNESIA

Design of the GIS geodatabase for the dead bodies development study in French Polynesian lagoons
Development of the geodatabase and need survey interpretation
Client : Board of the environment

Position : GIS expert

2005
FRENCH POLYNESIA

Feasibility study for the EcoParck implementation on Pearson domain site
Eco Parck is the project of an association helped by the government for the implementation and promotion of sustainable development thanks to demonstrators in field such as energy, cultural practices, eco-construction, sorting and waste treatment.
- Natural resource description
- Facilities environmental risks assessment
- Suggestion for a project management structure
- Sustainable development concept presentation

Client : Board of the environment

Position : Project manager

2004-2005
FRENCH POLYNESIA

Environmental Baseline Survey and planning proposal for 7 tourism spots
Areas of interest concerning landscape, archeology, biodiversity and recreational activities
- Natural resource description
- Suggestion for enhancement regarding historical, biological, legacy and landscape constraints

Client : Board of the environment

Position : Project manager

2002-2008
FRENCH POLYNESIA

Planning of Ane Ane land and creation of pedagogic paths
- Natural resource description (biodiversity, landscape and historic sites)
- Risk assessment related to facilities
- Suggestions to enhance and use a natural area
- Programming
- Planning design and construction (paths, shelters, signage and panoramic views)

Phase 1: Baseline study
Phase 2: Planning program
Phase 3 : APS for the design and construction of an educational path
Phase 4 : signage design (visual, educational content, selection of construction methods)
Phase 5: project management, works ending in 2008
Client : City of Arue

Position : Project manager

2003-2004
TAHITI

Re-creation of an urban square "le parc de Bougainville" with garden and landscape design
Project management
Client : City of Papeete

Position : Project manager

2000-2004
FRENCH POLYNESIA

Planning of Fautaua valley
Archeological, geological, hydrogeological biodiversity and natural resources
- Natural resource description
- Environmental and social assessment approach
- Environmental hazards
- Sustainable development policy

Phase 1: EDL
Phase 2: planning program
Phase 3: pilot study, content and GIS
Client : Papeete Municipality

Position : Project manager

ACOUSTIC MODELING

MOST OF THE EIAS PERFORMED SINCE 2001 INVOLVE ACOUSTIC MODELING USING MITHRA (CSTB) OR CADNAA (DATAKUSTIK).

2012-ONGOING
RÉUNION ISLANDS

Acoustic study for ZAC Renaissance project
Initial state modeling (CadnaA), Project modeling (CadnaA), Assistance with the ground-plan optimization
Client : Public institution in the Reunion Islands

Position : Acoustic expert and project manager

2012
FRANCE

Acoustic study for an EIA: Bus of a high level of service between Place Castellane and the Luminy university
Initial state modeling (CadnaA), Project modeling (CadnaA)
Client : Public institution in Marseille

Position : Acoustic expert and project manager

2011-2012
FRANCE

High Speed Line, PACA region
Acoustic constraints study for PACA train line route selection (halos method)
Client : RFF

Position : Acoustic expert

2011
FRANCE

Noise black spot reduction
- Baseline measurements
- NF S31-085 measurements
- Modelling of the selected option (using CadnaA)
- Assistance with public presentation

Client : ASF

Position : Project manager and acoustic expert

2011-2012
FRANCE

Noise study for ZAC Saclay project
- Baseline measurements (NF S31-010)
- Baseline modelling using CadnaA
- Help with the ground plan optimization

Client : Public institution Paris-Saclay

Position : Project manager and acoustic expert

2011
ALGERIA

Gas pipeline project from Algeria to Italy
Noise study of the compression center within the framework of an EIA
Client : Galsi

Position : Acoustic expert

2011
FRANCE

Acoustic pre diagnosis for a windmill installation in Saint-Louis, Marie-Galante island
Environmental initial measures and modelling
Client : VAKUOENERGY

Position : Acoustic expert

2011
FRANCE

Acoustic pre-diagnosis for a wind farm installation in Saint-Joseph, La Réunion
Environmental initial measures and modelling
Client : VAKUOENERGY

Position : Acoustic expert

2011-2012
REUNION ISLANDS

Acoustic study for ZAC Saint-Paul project
- Initial measures NF S31-010
- Initial state modelling (CadnaA)
- Project modelling (CadnaA)
- Assistance with the ground-plan optimization

Client : Artelia

Position : Acoustic expert

2006-2008
FRENCH POLYNESIA

Noise mapping of Papeete
Methodology in accordance with the European directive EC/ 2002/49:
- Road noise and significant industrial contribution
- Calibration with field measurements

Client : Papeete

Position : Project manager and acoustic expert

2003
FRENCH POLYNESIA

Acoustic modelling for a motocross training field
- Baseline measurements NF S31-010
- Project modelling (Mithra)
- Impacts on neighbouring houses

Client : Papeete

Position : Project manager and acoustic expert

2001-2010
FRENCH POLYNESIA

Acoustic measurements and modelling of rock crushing stations, treatment stations and cold rooms
Client : Private client

Position : Acoustic expert

DECONTAMINATION – HYDRAULIC – HYDROGEOLOGY

2007
NEW-CALEDONIA

Creek Liliane study
- Field prospecting
- 2D modelling
- Remediation measure suggestions for the river damaged by mining activities.

Client : DAVAR

Position : Project manager

2007
NEW-CALEDONIA

Swamp bridge construction
Dimension hydrologic and hydraulic technic study
Client : SLN

Position : Project manager

2006
NEW-CALEDONIA

Hydrologic and hydraulic note regarding Potiaai housing building project
1D modelling (HAC RAS)
Flooding hazards
Bank protection
Client : Teva I Uta town

Position : Project manager

2006
NEW-CALEDONIA

Sizing of four storm basins for Pukalia Nui apartment complex construction
Sizing of storm basins regarding EIA recommendations
Client : Punaauia city

Position : Project manager

2006
NEW-CALEDONIA

Paul Creek study
- Field prospecting
- 2D modelling
- Remediation measure suggestions for the river damaged by mining activities.

Client : Le Nikel

Position : Project manager

2006
FRENCH POLYNESIA

Assessment of well watershed in Bora Bora
Research setting up the watershed protection perimeters
- Environmental baseline study
- Possible contamination pathways
- Groundwater body flows
- Suggested protection zones for the entire island
- Identification of affected cadastral parcels

Client : Bora Bora city

Position : Project manager

2006
ROMANIA

Supervision of a testing pump for the establishment of the capture of an industrial site
Identification of the hydraulic characteristics of the well
Client : Renault

Position : Field engineer

2006
NEW-CALEDONIA

Hydrologic and hydraulic memo for Toofa housing project
1D modelling (HAC RAS)
Flood hazards
Bank protection
Client : Renault

Position : Field engineer

2004-2006
FRENCH POLYNESIA

Hydraulic modelling (2D, river 2D and empiric method) to design artificial lagoons and beaches for the development of high luxury hotel in Bora-Bora
Within the framework of an artificial lagoon design, the water carriage system is created according to a particular approach.
- Level study regarding the lagoon and the submarine plateau
- System sizing according to renewal constraints related to artificial biotope

Client : Intercontinental hotel and Saint-Régis hotel

Position : Field engineer

PUBLICATIONS

Seven publications in international research bulletins, eleven publications in international conferences and other research on internal communications concerning ecological chemistry of insects: Semiochimic relationships inter and intra specific, orientation behavior, population dynamic, set up of emission/extraction devices (Dynamic and static head space, solid phase micro extraction,) and analysis of volatile and semi volatiles organic compounds emitted by plants and insects (GC-MS)

EMPLOYMENT RECORD

1998-2007 — Environment project manager, SNC Pae Tai Pae Uta (French Polynesia).
Responsible for the development of new technical skills (GIS, hydraulics and acoustics)

1991-1997 — Researcher in the chemical ecology of plant-eating insects, IRD and INRA

Charles BOUHELIER

Environmental Engineer & Business Developer
Water & Environment | Risk, Society and Environment Unit (RSE)

Date of birth: 11/12/1985
Nationality: French
Education:
- Master in Environmental Services Engineering and Management – VEOLIA Campus – Universities of Marne-la-vallée and Cergy-Pontoise – ENPC, 2012
- Diploma of engineer - ENSIL – Limoges (France) Engineering School - Water & Environment – 2009
- Technical University Diploma "Physics measurements" – University of Limoges, 2006

Languages: French (mother tongue), English (fluent)
Date of employment in Artelia: 2014

CAREER SUMMARY | SKILLS

Environmental Services

- Environmental Impact Assessment
- Quality/Health/Safety/Environment approach
- Territory and sustainable governance

Waste management

- Domestic and Industrial waste collection
- Waste treatment
- Recycling – Material recovery – Energy recovery

Water sciences and technologies

- Waste water treatment plant processes
- Management and protection of the resource in water

EMPLOYMENT RECORD

2010 – 2014
FRANCE

Research manager, Veolia Environmental Services
Replying to the invitations to tender in the field of the waste management (collection, waste treatment, recycling, cleaning) in a strongly competitive area:
- Analysis of the context and the requirements
- Design and costs estimation of the services, redaction and summary of the technical documentations
- Organisation and communication with: field workers, clients, subcontractors
- Follow-up of the services on the field

2009
FRANCE

Environmental engineer, **EDF – Cruas Nuclear power plant**
Internship: Updating the Environmental Management System of the plant – Environmental impacts analysis (ISO 14001).

2008
THE NETHERLANDS

Laboratory worker, **WETSUS - Water research Institute**
Biological reactor monitoring*: nutrient recovery from black water (partial nitritation+ Anammox)* - Water treatment.

2006
FRANCE

Technician internship , **BODYCOTE HIT Ambazac**
Quality control laboratory in a thermal processing factory. Autonomy – Need to apply an organised process.

Armeline DIMIER

Stakeholder Relationship and Social Impact Consultant
Water & Environment | RSE

Date of birth: December 12th 1985
Nationality: French
Education:
- Master II in Geopolitics and International Relations, International Trade, International Law, Humanitarian Rights, Development Issues, Institut d'Etudes Politiques de Toulouse, 2008
- Political Sciences Diploma (equivalent to a Master level), Politics and International Relations, Geopolitics, Institut d'Etudes Politiques de Grenoble and Sussex University in Brighton, 2007

Professional trainings:
- *Societal Management in Oil and Gas Operations*, Total, February 2011
- *Management of the relationships between NGOs and corporations*, WWF Training Center, Paris, 2010

Languages: French (mother tongue), English (bilingual), Indonesian (bilingual), German (academic)
Date of employment in Artelia: July 2014

CAREER SUMMARY | SKILLS

5-year experience in the field of corporate CSR strategy development in the oil & gas world, covering stakeholder mapping, consultation and engagement; social impact assessment, social management plan implementation and follow-up, community grievance management, and tools development.

- **Stakeholder mapping, consultation and engagement:** mapping of stakeholders from the business, authorities and civil society groups based on their interests and expectations, stakeholders' priority ranking, development of consultation tools (interview questionnaire and guidelines), realization of consultations, development of engagement action plans in line with operational priorities.

- **Social impact assessments and Social Management Plan implementation and follow-up:** contribution to the realization of ESBS (Environmental and Social Baseline Assessment) and ESIA (Environmental and Social Impact Assessment) as well as Indonesian environmental and social studies (UKL-UPL and RKL-RPL), covering consultant identification, briefing, field survey preparation, quality control, and final hand-over. Development, implementation and follow-up of Social Management Plan.

- **Community grievance management:** development of claim registration database and claim handling procedure.

- **Tools development:** integration of social data into GIS system, installation of societal management software (MOST).

PROFESSIONAL EXPERIENCE

2014
ANGOLA

Environmental and Social Impact Assessment of Water Treatment and Distribution Plant for Quilonga Grande, Kwanza River, Angola
Client: Veolia
- Gap analysis between the ESIA produced by the local partner, Angolan laws and regulations and World Bank requirements
- Provision of an upgrade for the ESIA to working with local partners and client team.

2014
MYANMAR

Environmental and Social Impact Assessment for the Offshore Seismic Acquisition Campaign on the Block YWB
Client: Total E & P Myanmar
- Coordination of the social impact assessment study realization with Artelia team in Myanmar
- Desk review of existing data and literature on the socio-economic context in which the project takes place
- Description of key socio-economic characteristics in the study area
- Stakeholder mapping (authorities, representatives of the civil society)
- Analysis of stakeholders' expectations and concerns
- Assessment of social impacts
- Development of appropriate mitigation measures and of the social management plan

2014
SOUTH SUDAN

Environmental and Social Screening of 7 dam options for the Hydropower Expansion Plan and Regional Integration Plan of South Sudan into Regional Electricity Grid
Client: Nile Equatorial Lakes Subsidiary Action Program
- Identification and selection of an appropriate set of criteria for measuring the economic and social impacts (and performance) of each dam option
- Desk review of existing data and literature on each criteria identified in order to define current context and related sensitivities (example of criteria include land acquisition, physical displacement, health, food security, ethnic groups, public services, etc.)
- Assessment of potential impacts for each criteria and proposition of associated mitigation measures
- Ranking of impact importance for each criteria and each dam option
- Final assessment of all the criteria for each dam option, in order to identify the most performing option environmentally and socially

2014
BULGARIA

Preliminary Environmental and Social Impact Assessment for the offshore drilling of two exploration wells on Block 1-21 Han Asparuh
Client: Total E & P Bulgaria
- Coordination of the social impact assessment study realization with Artelia Bulgarian team
- Desk review of existing data and literature on the socio-economic context in which the project takes place
- Description of key socio-economic characteristics in the study area
- Stakeholder mapping (business, authorities, civil society)
- Analysis of stakeholders' expectations and concerns
- Assessment of social impacts

Development of appropriate mitigation measures and of the social management plan

2014
MAURITANIA

Environmental and Social Impact Assessment for the offshore drilling of one exploration well on Block C9
Client: Total E & P Mauritanie
- Desk review of existing data and literature on the socio-economic context in which the project takes place
- Data collection of key socio-economic characteristics in the study area
- Stakeholder mapping and analysis of stakeholders' expectations and concerns
- Assessment of social impacts
- Development of appropriate mitigation measures and of the social management plan

PUBLICATIONS

"*Re-engaging with Local Stakeholders in the Mature Oil and Gas Mahakam Block*", Technical paper presented during the Society of Petroleum Engineering (SPE) Conference on HSE in Long Beach, CA, on 20th March 2014

PROFESSIONAL EXPERIENCE

2011 - 2014 **Stakeholder Relationship and Social Impact Consultant, Total E&P Indonesie, Indonesia**

- East Kalimantan District operations:

- Stakeholder mapping and implementation of a consultation plan (interviews with 45 local and regional stakeholders);
- Creation of a societal action plan, in line with company's requirements and stakeholders expectations in the fields of dialog, impact management, local content and community development projects;
- Technical assistance for environmental and social baseline and impact studies: preparation of field work/surveys with the consultants, quality control and improvement of studies for Total Head Office and the Indonesian Ministry of Environment;
- Improvement of internal societal procedures and standards in line with Head Office instructions: management of claim and grievances from local communities, mapping of social data using the company GIS
- Implementation of mitigation measures for social impacts generated by specific operations (drilling, rig movement, seismic acquisition, etc.).

- West Papua District operations: stakeholder mapping, consultation preparation, including training of the field survey team.

- *Mentawai District operations:* as a complementary study to the ESIA, stakeholder identification, mapping and ranking, Social Management Plan development and implementation, particularly related to control of contractors.

2010-2011 **Societal Officer, Total Marketing, France**

- Organizing cooperation between Total entities that have operations or projects in the region;
- Preparing consultation of relevant external stakeholders, to identify how Total can contribute in achieving the region's priorities in terms of economic and social development.

FEB 2010 – NOV 2010 **Societal Coordination Officer, Total Supply & Marketing - Africa/Middle East Division, France**

- Realizing two annual surveys in the subsidiaries: AIDS Survey, aiming at assessing the progress of the policy of fight against AIDS and Societal Survey, aiming at collecting information on the CSR actions of the subsidiaries;
- Improving the health policy (fight against AIDS and malaria) through awareness-raising campaigns;
- Creating communication tools on the division CSR strategy, and particularly a brochure presenting the Division CSR strategy as well as subsidiaries projects in favor of social and economic local development.

SEPT 2008 – MAY 2009 **Societal Coordination Officer, Total Supply & Marketing - Africa/Middle East Division, France**

- Realizing two annual surveys in the subsidiaries: AIDS Survey, aiming at assessing the progress of the policy of fight against AIDS and Societal Survey, aiming at collecting information on the CSR actions of the subsidiaries;
- Improving the health policy (fight against AIDS and malaria) through awareness-raising campaigns;
- Organization of an annual internal sponsorship committee supporting initiatives from NGOs operating in our perimeter.

MAR 2008 – AUG. 2008 **Public Fundraising Officer, Planet Finance**

- Monitoring of all the potential public donors and their related strategies/policies;
- Research of public fundings: identification of donors and of their call for proposals;
- Writing of proposals for big donors (EUROPEAID, USAID, IFC, Development Banks, etc.);
- Project management (logical framework, budget...);
- Support to private fundraising team and contribution to the research of potential NGO and private companies partnerships.

Anne-Charlotte DUFAURE

Project Engineer
Water & Environment | Risks, Society and Environment Unit (RSE)

Date of birth : 08/11/1986
Nationality : French
Education : Water Engineer

- Master in Environmental Services Management and Engineering – 2012
- Polytech'Montpellier Engineering School - Water sciences and technologies – 2010
- University Diploma (2 years) in Life Science, major in marine biology – 2006

Languages: French (mother tongue), English, Spanish
Date of employment in Artelia: 01/03/12

CAREER SUMMARY | SKILLS

Marine Mammal Observer (JNCC agreement - 2013)

Environmental Services

- Risk Management
- Territory and sustainable governance
- Performance monitoring and management
- Development strategy of range of services
- Thesis on Differentiated contract management

Water Sciences and Technologies

- Management and protection of the resource in water
- Hydraulics
- Hydrology
- Processes' Engineering and Water Treatment (sewage water/ drinking water)
- Hydrobiology
- Hydrogeology

Life Sciences – Marine biology

- marine ecology
- coastal and benthic environment
- oceanology/ oceanography
- Plant and animal biology
- Biochemistry
- Joint approach of the littoral ecosystems

PROFESSIONAL EXPERIENCE

2014 EUROPA ISLAND, FRANCE (TAAF)	**Performance of a n Impact review for an exclusive 5-year-license to hydrocarbon exploration projects** Development of an environmental and social impact assessment for offshore exploration projects **Client : SAPETRO JDN SAS** Position held : Project engineer
2014 BULGARIA	**Impact Assessment for the drilling of an exploration well in the Black Sea** Development of the environmental and social impact assessment for an offshore exploration drilling **Client : Total E&P Bulgaria** Position held : Project engineer
2014 MAURITANIA	**Impact Assessment for the drilling of an ultra deep water exploration well (block C9)** Development of the environmental and social impact assessment for an offshore exploration drilling **Client : Total E&P Mauritania** Position held : Project engineer
2014 ALGERIA	**Environmental and social Impact Assessment for the construction and the operation of two combined cycle power plants (Jijel and Biskra)** Participation in the environmental and social impact assessments for the implementation of two power plants in two different environments (urban/desert). **Client: Hyundaï Engineering Co Ltd.** Position held : Project engineer
2014 ALGERIA	**Environmental and social Impact Assessment for a power plant in a desert environment (El Borma, Ouargla)** Environmental and social impact assessment for the implementation of a new gas turbogenerator. **Client : General Electric (GE)** Position held : Project engineer
2014 MADAGASCAR	**Environmental and social Impact Assessment for an offshore seismic acquisition project (block Amilobe) in Nosy Be** Environmental and social impact assessment for a seismic acquisition project in a very tourist area and with major environmental issues. **Client : Sterling Energy PLC** Position held : Project engineer
2014 UNION OF MYANMAR	**Environmental Impact Assessment for Badamyar field development and Offshore Yadana infrastructure replacement in Burmese waters** Environmental impact assessment for Badamyar offshore gas field development and the implementation of new oil facilities (jacket, pipeline, etc.) **Client : Total E&P Myanmar** Position held : Project engineer
2014 FRANCE	**Environmental Impact Assessment for reconstruction project of 30 manual dam of the Aisne and Meuse rivers** Participation in the development of the water regulation file, the declaration of public utility and environmental impact assessment **Client: Vinci** Position held : Project engineer

2014
UNION OF MYANMAR

Environmental Impact Assessment for an Offshore Seismic and Bathymetric Campaign (M5-M6 block) in Burmese waters
Environmental impact assessment for the performance of an offshore seismic and bathymetric campaign
Client : Total E&P Myanmar

Position held : Project engineer

2013
CYPRUS

Environmental Impact Assessment for an Offshore Seismic Campaign in Cyprus waters
Participation to an environmental impact assessment for the performance of a seismic campaign
Client : Total E&P Cyprus

Position held : Project engineer

2013
EGYPT

Environmental Impact Assessment for the drilling of an exploration well in Egypt
Execution of the environmental impact assessment for the performance of an offshore exploration well
Client : Total E&P Egypt

Position held : Project engineer

2013
MADAGASCAR

Environmental and Social Impact Assessment concerning a seismic campaign in Madagascar
Execution of the impact assessment for a seismic campaign in 4 study area (North, West, and South) in Madagascar
Achieved 17 public consultations in Madagascar during 1 month; stakeholders: fishermen, mayors and regional representatives.
Client : TGS Nopec

Position held: Project engineer

2013
FRANCE

Environmental study concerning impacts of a wind farm decommissioning
Regulatory synthesis, impacts methodology development, impacts identification and proposition of mitigation measures.
Client : EDF

Position held: Project engineer

2013
ALGERIA

Environmental and Social Impact Assessment concerning the implementation of LPG pumping station with electric line, gas conduit and road
Execution of the impact assessment for the building of LPG pumping station
Client : ABB SpA

Position held: Project engineer

2012
FRANCE

Environmental Impact Assessment and Water Legislation Act in regards to dike in Manosque, France
Execution of the impact assessment and the Water Legislation Act for a dike rebuilding project close to an industrial zone.
Client : Manosque district

Position held: Project engineer

2012
FRANCE

Impact Survey for the drilling of an exploration well in Algeria
Execution of part of the environmental and societal impact assessment for the creation of an exploration well
Client : E On Ruhrgas

Position held : Project engineer

2012
MAURITANIA

Impact Assessment for drilling exploration wells in Mauritania
Realization of part of the ESIA for the construction of exploration wells
Client : Total E&P Mauritania

Position held : Project engineer

2012
FRANCE

Updating an impact statement for offshore seismic exploration
Updating an impact statement on a 3D seismic exploration at sea
Client : SAPETRO

Position held : Project engineer

2012
FRANCE

Impact survey for a gas compressor station
Assessment of the impact of the extension of a gas compressor station, Saint-Martin-de-Crau, in France
Client : GRT Gaz

Position held : Project engineer

2012
BURUNDI/RWANDA/
TANZANIA

Resumption of an impact assessment for a dam over water in Burundi / Rwanda / Tanzania - Rusumo Falls
The project initially planned involved a large-scale dam, the choice of the project has evolved into a dam over water, a full resumption of the impact study was conducted.
Client : NELSAP

Position held : Project engineer

2010
ALGERIA

Environmental and societal impact survey
Onshore gas and crude oil platform – Writing of the environmental and societal impact assessment report
Client : Bir Seba

Position held : Project engineer (internship)

EMPLOYMENT RECORD

04/10/10 – 31/12/11
FRANCE

Veolia Water
Project Manager for planning and reporting activity set up of two agencies
Project officer: set up activity reporting and planning tools.
Change management – performance management

15/06/09 – 15/09/09
SCOTLAND

Veolia Water
Implementation of a thermophilic digester
Internship: transition from a mesophilic to a thermophilic digester; Polymer optimisation ; Energy balance

2006-2007
FRANCE

JEPI : junior enterprise Polytech'Montpellier
Biotic index (IBGN) survey
Technician: Quality control and assessment of river water. Identification of the biological criteria distinctive of the quality of water in a river.

ANNEX 3 Public Consultation Documents

General Secretary
Myanmar Fisheries Association
Yangon

by email: fishfedmyanmar@gmail.com

30th October 2014

Subject: Stakeholder Consultation

Dear Sir,

Ophir is a UK based company with a strong experience in offshore gas exploration projects. The company is planning to utilize this expertise to explore for gas accumulations in Myanmar together with our Myanmar partner, Parami Energy Services on the newly awarded block AD-03. As part of our work to explore this block, Ophir plans to perform a 3D seismic survey on this AD-03 Block, located on the Rakhine Offshore Area, about 116 km from mainland coastline and 65 km from Mun Aung Island (see attached map).

This kind of project requires an Initial Environmental Examination which includes a public/stakeholder consultation. For you information I have attached a summary presentation of the project and the proposed environmental study which we intend to undertake prior to the commencement of the program. Also attached is a short questionnaire relating to the project. Can you review this and return it to me? This will help us to gather information and to understand your concerns; your kind assistance is highly appreciated.

I will be very grateful if you can advise me of the contact information for the local branch of the Fisheries Federation in the Rakhine area which includes those most likely to be affected by this operation, and if you can also forward to them the project information attached.

Following completion of the study which we anticipate will be in late November, if you wish, I will pleased to meet with you and the local Rakhine branch of the fisheries association to discuss the report and the identified environmental impacts.

Thanking you in anticipation.

Yours sincerely

Robert MAXWELL
Country Manager
OPHIR ENERGY Myanmar

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Ophir Energy plc
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123 Victoria Street
London SWE 6DE
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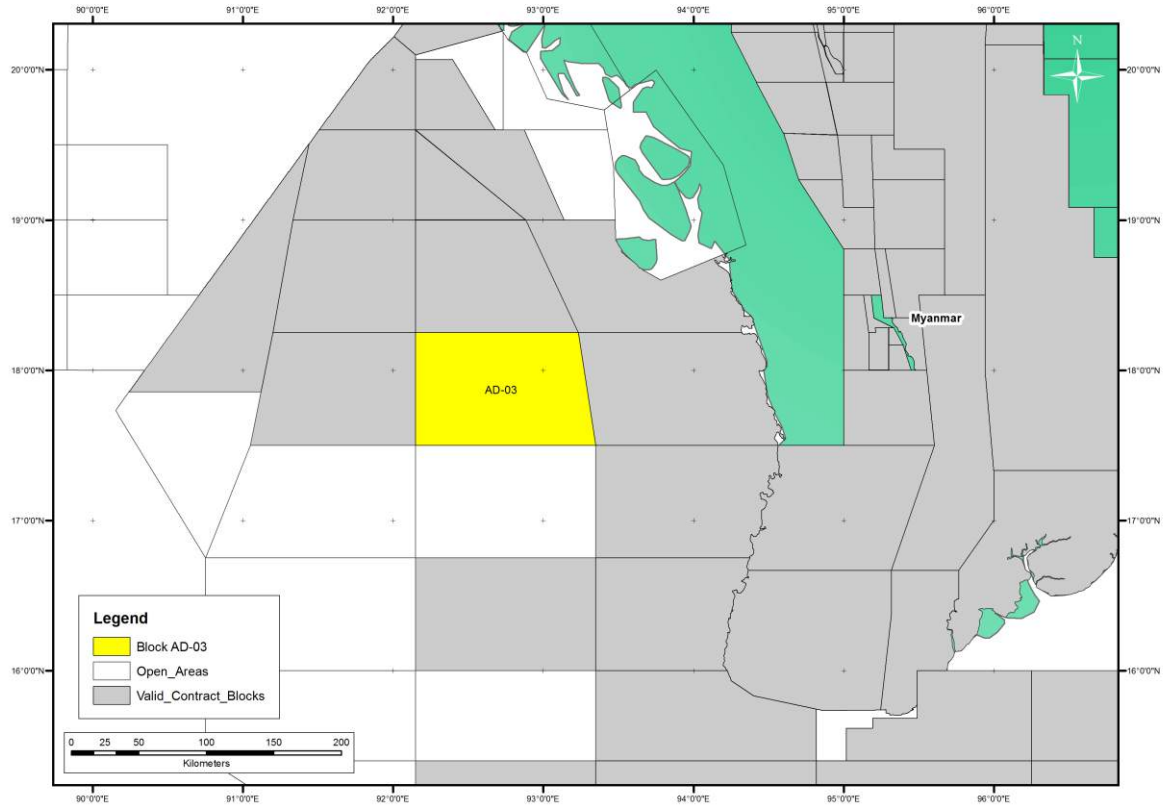
No 5047425

Attachment: Block AD-3 Location Map



Dr. San Thar Tun

Professor, Department of Marine Science Department

University of Mawlamyine, Ministry of Education

By email: santhatun@gmail.com

20th October 2014

Subject: Stakeholder Consultation

Dear Dr. San Thar Tun,

Ophir is a UK based company with a strong experience in offshore gas exploration projects. The company is planning to utilize this expertise to explore for gas accumulations in Myanmar together with our Myanmar partner, Parami Energy Services on the newly awarded block AD-03. As part of our work to explore this block, Ophir plans to perform a 3D seismic survey on this AD-03 Block, located on the Rakhine Offshore Area, about 116 km from mainland coastline and 65 km from Mun Aung Island (see attached map).

This kind of project requires an Initial Environmental Examination which includes a public/stakeholder consultation. For you information I have attached a summary presentation of the project and the proposed environmental study which we intend to undertake prior to the commencement of the program. Also attached is a short questionnaire which I will be very grateful if you can review and return to me. This will help us to gather information and to understand your concerns; your kind assistance is highly appreciated.

Following completion of the study which we anticipate will be in late November, if you wish, I will pleased to meet with you to discuss the report and the identified environmental impacts.

Thanking you in anticipation.

Yours sincerely

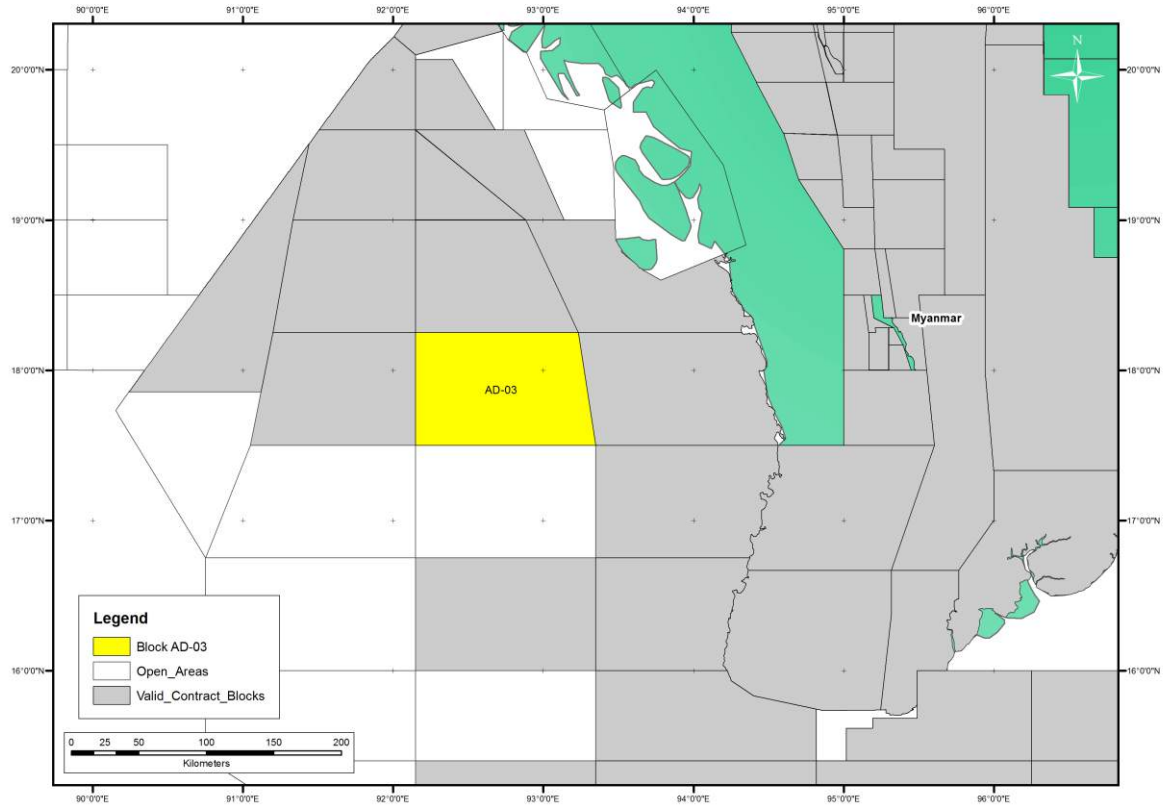
Robert MAXWELL
Country Manager
OPHIR ENERGY Myanmar

Address & Registered Office
Ophir Energy plc
4th Floor
123 Victoria Street
London SWE 6DE
United Kingdom

Tel: +44 (0)20 7811 2400
Fax: +44 (0)20 7811 2421
info@ophir-energy.com
www.ophir-energy.com

Registered in England & Wales
No 5047425

Attachment: Block AD-3 Location Map



PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

စာအမှတ်။ PEGC/DMA/Admin/L-087/2014
ရက်စွဲ။ ၂၀၁၄ ခုနှစ် အောက်တိုဘာလ ၂၁ ရက်

သို့

ဦးမောင်မောင်ဦး
ညွှန်ကြားရေးမှူးချုပ်
ရေကြောင်းပို့ဆောင်ရေးညွှန်ကြားမှုဦးစီးဌာန
ပို့ဆောင်ရေးဝန်ကြီးဌာန
ရန်ကုန်

အကြောင်းအရာ။ ဂါရဝပြုတွေ့ဆုံ၍ လုပ်ငန်းလမ်းညွှန်မှုခံယူခွင့် ရရှိနိုင်ပါရန် တင်ပြခြင်း

၁။ ကျွန်တော်များပါရမီစွမ်းအင်ကုမ္ပဏီများအုပ်စုသည် Local Partner အဖြစ် အင်္ဂလန်အခြေစိုက် Ophir Energy Plc ကုမ္ပဏီနှင့်အတူ စွမ်းအင်ဝန်ကြီးဌာန မြန်မာ့ရေနံနှင့်သဘာဝဓာတ်ငွေ့လုပ်ငန်း၏ ကမ်းလွန်လုပ်ကွက် AD-3 အား လုပ်ကိုင်ခွင့်အတွက် ရွေးချယ်ခံထားရပြီးဖြစ်ပါသည်။

၂။ အဆိုပါ ရခိုင်ကမ်းလွန် ရေနက်ပိုင်း AD-3 လုပ်ကွက် PSC Signing Ceremony အား နိုဝင်ဘာလ ပထမပတ်တွင် လက်မှတ်ရေးထိုးနိုင်ရန် ပြင်ဆင်နေပါသည်။ လက်မှတ်ရေးထိုးပြီးသည်နှင့် ပွင့်လင်းရာသီတွင် Initial Environment Evaluation လုပ်ငန်းကို AD-3 လုပ်ကွက်အတွင်း ပူးတွဲဖော်ပြပါ မြေပုံညွှန်းအတိုင်း ဆောင်ရွက်ရန်ရှိပါသဖြင့် ညွှန်ကြားရေးမှူးချုပ်အား တွေ့ဆုံပြီး လုပ်ငန်းလမ်းညွှန်မှုခံယူလိုပါသဖြင့် (၂၄-၁၀-၂၀၁၄)ရက်နေ့မှ (၂၉-၁၀-၂၀၁၄)ရက်အတွင်း သတ်မှတ်ခွင့်ပြုပေးသောအချိန်တွင် ဂါရဝပြုတွေ့ဆုံခွင့် ရရှိနိုင်ပါရန် တင်ပြအပ်ပါသည်။

၃။ ဂါရဝပြုတွေ့ဆုံခွင့်ရရှိပါက တက်ရောက်မည့်အမည်စာရင်းမှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

စဉ်	အမည်	ရာထူး	ကုမ္ပဏီ
(က)	Mr. Robert Maxwell	Country Manager	Ophir Energy Plc
(ခ)	Mr. Charles Bouhelier	Consultant	ATELIA Company
(ဂ)	ဦးဌေးလွင်	General Manager	Parami Energy
(ဃ)	ဦးတင့်ဆွေ	Manager	Parami Energy
(င)	ဦးကျော်စိုး	Chief Geologist	Parami Energy

Myanmar Office: #14-02, #15-07 Sakura Tower, Sule Pagoda Road, Yangon, Myanmar.
Tel: (951) 255104, 255106, 255450, Fax: (951) 255109
Email: energy@parami.biz, Web: http://www.parami.biz

Singapore Office: #31-02, Suntec Tower 2, 9 Temasek Blvd. Singapore, 038989
Tel: (65) 65596236, Fax: (65) 63366610
Email: energy@parami.biz, Web: http://www.parami.biz

PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

ပူးတွဲပါ– Ophir Energy Plc မှ Mr. Robert Maxwell (Country Manager) ၏ တင်ပြစာ

လေးစားစွာဖြင့်

အမှုဆောင်အရာရှိချုပ်(ကိုယ်စား)
ခင်မောင်ဦး
အထွေထွေမန်နေဂျာ
Parami Energy Group of Companies

မိတ္တူကို –

- ဦးနေအေး–ညွှန်ကြားရေးမှူးချုပ် (MOECAF)
- ဦးသန်းထွန်း–ညွှန်ကြားရေးမှူး(ကမ်းလွန်) MOGE
- ဦးသက်ဌေး–ညွှန်ကြားရေးမှူး (ရေကြောင်းပို့ဆောင်ရေးညွှန်ကြားမှုဦးစီးဌာန)
- ရုံးလက်ခံ

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Email: energy@parami.biz, Web: http://www.parami.biz

ophir
energy plc

U Maung Maung Oo
Director General
Department of Marine Administration
Corner of Merchant St. and Thein Byu Road,
Yangon

20th October 2014

Our Ref.:

Subject: Stakeholder Consultation

Dear Sir,

Ophir is a UK based company with a strong experience in offshore gas exploration projects. The company is planning to utilize this expertise to explore for gas accumulations in Myanmar together with our Myanmar partner, Parami Energy Services on the newly awarded block AD-03.

Ophir plans to perform a 3D seismic survey on this AD-03 Block, located on the Rakhine Offshore Area, about 116 km from mainland coastline and 65 km from Mun Aung Island (see attached map).

This kind of project requires an Initial Environmental Examination which includes a public/stakeholder consultation. We therefore would like to request an appointment with you (or any of your colleagues you may wish to nominate) to meet Mr. Robert Maxwell (Country Manager) and Mr. Charles Bouhelier (Consultant, ATELIA) between 23rd and 29th October.

This meeting will help us to gather information and to understand your concerns; your kind assistance is highly appreciated.

Thanking you in anticipation.

Yours sincerely

Robert MAXWELL
Country Manager
OPHIR ENERGY Myanmar

CC:	U Than Tun	Director, Offshore	MOGE
	U Nay Aye	DG	MOECAF
	U Thet Htay	Director	DMA/SSE Dept.

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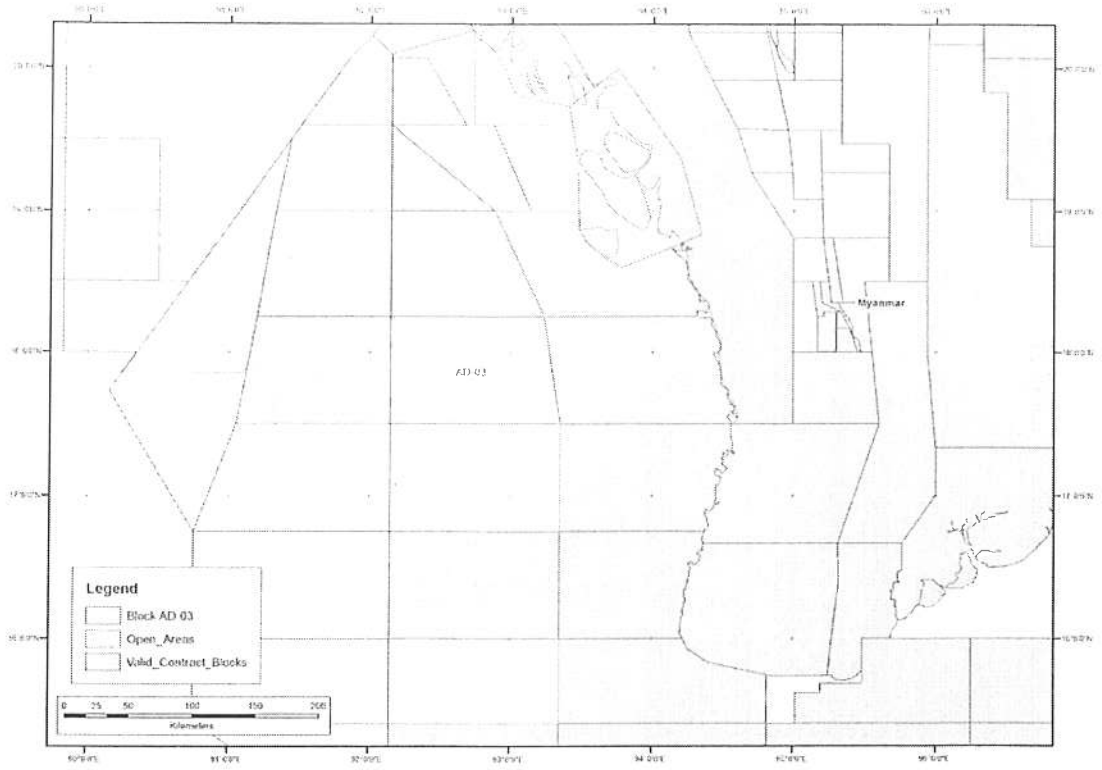
info@ophir-energy.com
www.ophir-energy.com

Registered in England & Wales
No 5047425

[Addressee]
Wednesday, 22 October 2014

Attachment: Location of Offshore Block AD-3



PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

စာအမှတ်။ PEGC/BANCA/Admin/L-085/2014
ရက်စွဲ။ ၂၀၁၄ ခုနှစ် အောက်တိုဘာလ ၂၁ ရက်

သို့

ဥက္ကဋ္ဌ
ဧရိယာမျိုးစုံမျိုးကွဲနှင့်သဘာဝထိန်းသိမ်းရေးအသင်း
ရန်ကုန်

အကြောင်းအရာ။ ဂါရဝပြုတွေ့ဆုံ၍လုပ်ငန်းလမ်းညွှန်မှုရရှိနိုင်ပါရန်တင်ပြခြင်း

၁။ ကျွန်တော်များ ပါရမီစွမ်းအင်ကုမ္ပဏီများအုပ်စုသည် Local Partner အဖြစ် အင်္ဂလန်အခြေစိုက် Ophir Energy Plc ကုမ္ပဏီနှင့်အတူ စွမ်းအင်ဝန်ကြီးဌာန၊ မြန်မာ့ရေနံနှင့်သဘာဝဓာတ်ငွေ့လုပ်ငန်း၏ ကမ်းလွန်လုပ်ကွက် AD-3 အား လုပ်ကိုင်ခွင့်အတွက် ရွေးချယ်ခံထားရပြီး ဖြစ်ပါသည်။

၂။ အဆိုပါ ရခိုင်ကမ်းလွန် ရေနက်ပိုင်း AD-3 လုပ်ကွက် PSC Signing Ceremony အား နိုဝင်ဘာလ ပထမအပတ်တွင် လက်မှတ်ရေးထိုးနိုင်ရန် ပြင်ဆင်နေပါသည်။ လက်မှတ်ရေးထိုးပြီးသည်နှင့် ပွင့်လင်းရာသီတွင် Initial Environment Evaluation လုပ်ငန်းကို AD-3 လုပ်ကွက်အတွင်း ပူးတွဲဖော်ပြပါ မြေပုံညွှန်းအတိုင်း ဆောင်ရွက်ရန်ရှိပါသဖြင့် ဥက္ကဋ္ဌအား တွေ့ဆုံပြီး လုပ်ငန်းလမ်းညွှန်မှု ခံယူလိုပါသဖြင့် (၂၄-၁၀-၂၀၁၄)ရက်နေ့မှ (၂၉-၁၀-၂၀၁၄)ရက်နေ့အတွင်း သတ်မှတ်ခွင့်ပြုပေးသောအချိန်တွင် ဂါရဝပြုတွေ့ဆုံခွင့် ရရှိနိုင်ပါရန် တင်ပြအပ်ပါသည်။

၃။ ဂါရဝပြုတွေ့ဆုံခွင့်ရရှိပါက တက်ရောက်မည့်အမည်စာရင်းမှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

စဉ်	အမည်	ရာထူး	ကုမ္ပဏီ
(က)	Mr. Robert Maxwell	Country Manager	Ophir Energy Plc
(ခ)	Mr. Charles Bouhelier	Consultant	ATELIA Company
(ဂ)	ဦးဌေးလွင်	General Manager	Parami Energy
(ဃ)	ဦးတင့်ဆွေ	Manager	Parami Energy
(င)	ဦးကျော်စိုး	Chief Geologist	Parami Energy

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PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

ပူးတွဲပါ- Ophir Energy Plc မှ Mr. Robert Maxwell (Country Manager) ၏ တင်ပြစာ

လေးစားစွာဖြင့်

အမှုဆောင်အရာရှိချုပ်(ကိုယ်စား)
ခင်မောင်ဦး
အထွေထွေမန်နေဂျာ
Parami Energy Group of Companies

မိတ္တူကို-
- ရုံးလက်ခံ

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Email: energy@parami.biz, Web: http://www.parami.biz

ophir
energy plc

Dr. Saw Mon Theint
Chairperson
BANCA – Biodiversity and Nature Conservation Association

22nd October 2014

Subject: Stakeholder Consultation

Dear Dr. Saw Mon Theint,

Ophir is a UK based company with a strong experience in offshore gas exploration projects. The company is planning to utilize this expertise to explore for gas accumulations in Myanmar together with our Myanmar partner, Parami Energy Services on the newly awarded block AD-03.

As part of this work, Ophir plans to perform a 3D seismic survey on the AD-03 Block, located on the Rakhine Offshore Area, about 116 km from mainland coastline and 65 km from Mun Aung Island (see attached map).

In preparation for the seismic survey, Ophir is undertaking an Initial Environmental Examination which, according to the guidelines that have been provided to us includes a public/stakeholder consultation.

We therefore would like to request an appointment with you (or any of your colleagues you may wish to nominate) to meet Mr. Robert MAXWELL (Country Manager) and Mr. Charles Bouhelier (Consultant, ARTELIA) between 23rd and 29th October.

Your kind assistance is highly appreciated and will help us to acquired useful information as well as understanding our key stakeholders' concerns.

Thanking you in anticipation.

Yours sincerely

Robert Maxwell
Country Manager
Ophir Energy plc

CC:	U Than Tun	Director, Offshore	MOGE
	U Nay Aye	DG	MOECAF
	U Myint Tin Htoo	Director	DoF

Address & Registered Office
Ophir Energy plc
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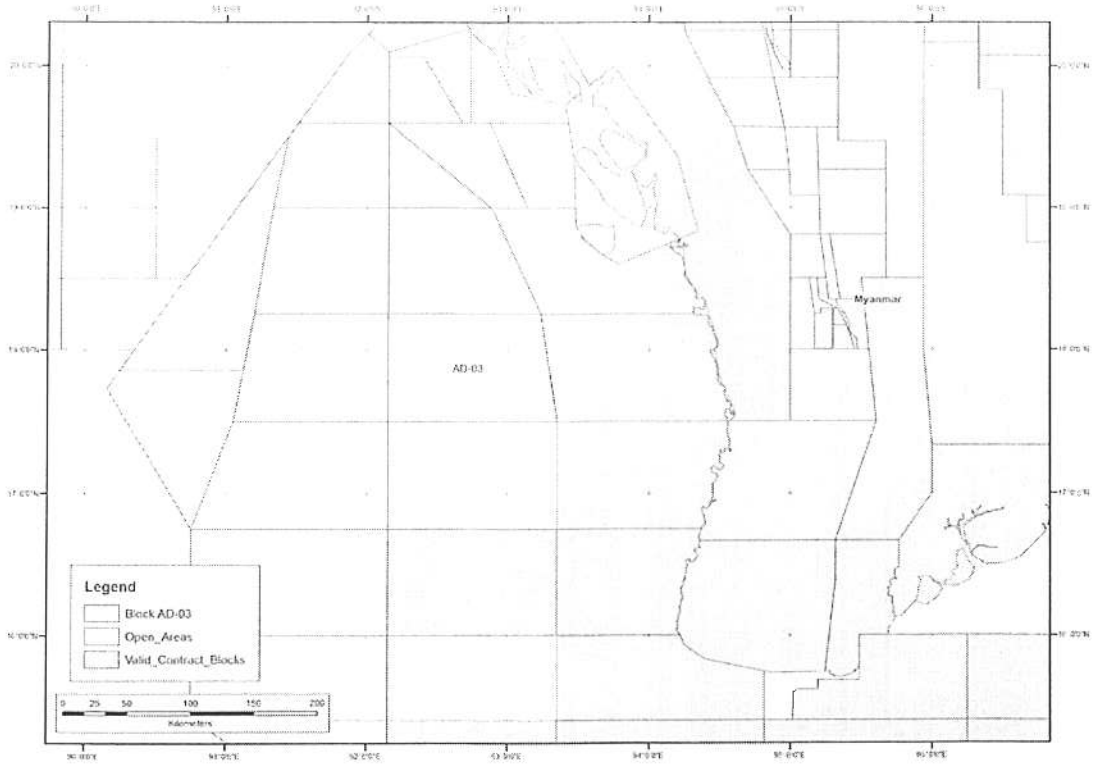
Attachment: Block AD-3 Location Map



PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

စာအမှတ်။ PEGC/DOF/Admin/L-086/2014
ရက်စွဲ။ ၂၀၁၄ ခုနှစ် အောက်တိုဘာလ ၂၁ ရက်

သို့

ညွှန်ကြားရေးမှူးချုပ်
ငါးလုပ်ငန်းဦးစီးဌာန
မွေးမြူရေးနှင့်ရေလုပ်ငန်းဝန်ကြီးဌာန
နေပြည်တော်

အကြောင်းအရာ။ ဂါရဝပြုတွေ့ဆုံ၍လုပ်ငန်းလမ်းညွှန်မှုရရှိနိုင်ပါရန်တင်ပြခြင်း

၁။ ကျွန်တော်များ ပါရမီစွမ်းအင်ကုမ္ပဏီများအုပ်စုသည် Local Partner အဖြစ် အင်္ဂလန်အခြေစိုက် Ophir Energy Plc ကုမ္ပဏီနှင့်အတူ စွမ်းအင်ဝန်ကြီးဌာန၊ မြန်မာ့ရေနံနှင့်သဘာဝဓာတ်ငွေ့လုပ်ငန်း၏ ကမ်းလွန်လုပ်ကွက် AD-3 အား လုပ်ကိုင်ခွင့်အတွက် ရွေးချယ်ခံထားရပြီး ဖြစ်ပါသည်။

၂။ အဆိုပါ ရခိုင်ကမ်းလွန် ရေနက်ပိုင်း AD-3 လုပ်ကွက် PSC Signing Ceremony အား နိုဝင်ဘာလ ပထမအပတ်တွင် လက်မှတ်ရေးထိုးနိုင်ရန် ပြင်ဆင်နေပါသည်။ လက်မှတ်ရေးထိုးပြီးသည်နှင့် ပွင့်လင်းရာသီတွင် Initial Environment Evaluation လုပ်ငန်းကို AD-3 လုပ်ကွက်အတွင်း ပူးတွဲဖော်ပြပါ မြေပုံညွှန်းအတိုင်း ဆောင်ရွက်ရန်ရှိပါသဖြင့် ညွှန်ကြားရေးမှူးချုပ်အား တွေ့ဆုံပြီး လုပ်ငန်းလမ်းညွှန်မှု ခံယူလိုပါသဖြင့် (၂၄-၁၀-၂၀၁၄)ရက်နေ့မှ (၂၉-၁၀-၂၀၁၄)ရက်နေ့အတွင်း သတ်မှတ်ခွင့်ပြုပေးသော အချိန်တွင် ဂါရဝပြုတွေ့ဆုံခွင့် ရရှိနိုင်ပါရန် တင်ပြအပ်ပါသည်။

၃။ ဂါရဝပြုတွေ့ဆုံခွင့်ရရှိပါက တက်ရောက်မည့်အမည်စာရင်းမှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

စဉ်	အမည်	ရာထူး	ကုမ္ပဏီ
(က)	Mr. Robert Maxwell	Country Manager	Ophir Energy Plc
(ခ)	Mr. Charles Bouhelier	Consultant	ATELIA Company
(ဂ)	ဦးဌေးလွင်	General Manager	Parami Energy
(ဃ)	ဦးတင့်ဆွေ	Manager	Parami Energy
(င)	ဦးကျော်စိုး	Chief Geologist	Parami Energy

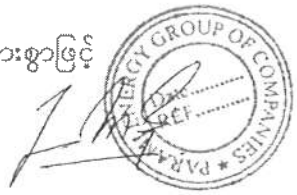
Myanmar Office: #14-02, #15-07 Sakura Tower, Sule Pagoda Road, Yangon, Myanmar.
Tel: (951) 255104, 255106, 255450, Fax: (951) 255109
Email: energy@parami.biz, Web: http://www.parami.biz

Singapore Office: #31-02, Suntec Tower 2, 9 Temasek Blvd. Singapore, 038989
Tel: (65) 65596236, Fax: (65) 63366610
Email: energy@parami.biz, Web: http://www.parami.biz

PARAMI ENERGY **PARAMI ENERGY GROUP OF COMPANIES**

ပူးတွဲပါ– Ophir Energy Plc မှ Mr. Robert Maxwell (Country Manager) ၏ တင်ပြစာ

လေးစားစွာဖြင့်



အမှုဆောင်အရာရှိချုပ်(ကိုယ်စား)
ခင်မောင်ဦး
အထွေထွေမန်နေဂျာ
Parami Energy Group of Companies

မိတ္တူကို–
- ဦးနေအေး– ညွှန်ကြားရေးမှူးချုပ် (MOECAF)
- ဦးသန်းထွန်း– ညွှန်ကြားရေးမှူး (ကမ်းလွန်) MOGE
- ဦးမြင့်တင်ထူး– ညွှန်ကြားရေးမှူး (ငါးလုပ်ငန်းဦးစီးဌာန)
- ရုံးလက်ခံ

Myanmar Office: #14-02, #15-07 Sakura Tower, Sule Pagoda Road, Yangon, Myanmar.
Tel: (951) 255104, 255106, 255450, Fax: (951) 255109
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Tel: (65) 65596236, Fax: (65) 63366610
Email: energy@parami.biz, Web: http://www.parami.biz

ophir
energy plc

Director General
Department of Fisheries
Bldg.36,
Nay Pyi Taw

20th Sept 2014

Our Ref.: Ophir 2014/ 862

Subject: Stakeholder Consultation

Dear Sir,

Ophir is a UK based company with a strong experience in offshore gas exploration projects. The company is planning to utilize this expertise to explore for gas accumulations in Myanmar together with our Myanmar partner, Parami Energy Services on the newly awarded block AD-03.

As part of this work, Ophir plans to perform a 3D seismic survey on the AD-03 Block, located on the Rakhine Offshore Area, about 116 km from mainland coastline and 65 km from Mun Aung Island (see attached map).

In preparation for the seismic survey, Ophir is undertaking an Initial Environmental Examination which, according to the guidelines that have been provided to us includes a public/stakeholder consultation.

We therefore would like to request an appointment with you (or any of your colleagues you may wish to nominate) to meet Mr. Robert MAXWELL (Country Manager) and Mr. Charles Bouhelier (Consultant, ARTELIA) between 23rd and 29th October.

Your kind assistance is highly appreciated and will help us to acquired useful information as well as understanding our key stakeholders' concerns.

Thanking you in anticipation.

Yours sincerely

Robert Maxwell
Country Manager
Ophir Energy plc

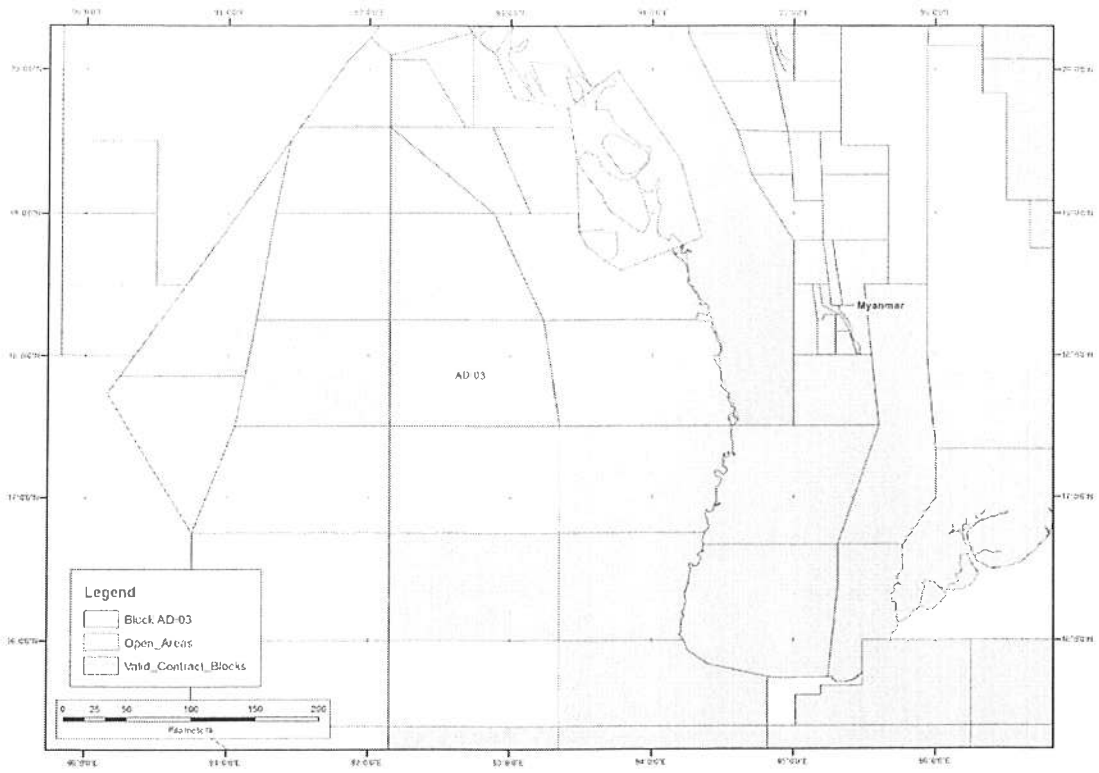
CC:	U Than Tun	Director, Offshore	MOGE
	U Nay Aye	DG	MOECAF
	U Myint Tin Htoo	Director	DoF

Address & Registered Office
Ophir Energy plc
4th Floor
123 Victoria Street
London SWE 6DE
United Kingdom

Tel: +44 (0)20 7811 2400
Fax: +44 (0)20 7811 2421
info@ophir-energy.com
www.ophir-energy.com

Registered in England & Wales
No 5047425

Attachment: Location of Offshore Block AD-3



ARTELIA

Notification of Consultation

State/Region.....

District.....

Township.....

City/town/village.....Yangon.....

Date.....12...../.....Nov...../2014

The consultants (Artelia / Parami), in charge of the Initial Environmental Examination (IEE) and the public consultations for the project of deep offshore seismic campaign on AD3 Block executed by OPHIR ENERGY PLC company, accompanied by the representative of OPHIR ENERGY PLC:

Names/surnames	Functions
Robert MAXWELL	Country Manager - OPHIR

Have met today:

Names/surnames	Functions
Dr. SAN THA TUN	Professor and Head
	Department of Marine Science
	Mawlamyaine University

And have informed this/these person(s) and the institutions they represent on the Project (its location, main technical characteristics, the planning of operations) and the environmental and social impact assessment study currently ongoing. The participants to this meeting had the opportunity to discuss and express their views on the potential environmental and social impacts, whether they are positive or negative, of the project. They were also presented with the proposed mitigation measures which they approved or enhanced based on their knowledge and experience. Participants were encouraged to express their opinions and fears towards the project, if any.

The participants to this meeting and the institutions they represent have therefore been informed, and will be continuously informed during the project implementation based on the Union of Myanmar laws and regulations and international best practices and standards.

Name of the main consultant from Artelia/Parami

Charles BOUHELIER

Signature

Name of the representative of the consulted persons

Dr. SAN THA TUN

Signature

12/11/2014

ARTELIA

Notification of Consultation

State/Region.....
District.....
Township.....
City/town/village.....Yangon.....
Date....14..../.....11...../2014

The consultants (Artelia / Parami), in charge of the Initial Environmental Examination (IEE) and the public consultations for the project of deep offshore seismic campaign on AD3 Block executed by OPHIR ENERGY PLC company, accompanied by the representative of OPHIR ENERGY PLC:

Names/surnames	**Functions**
.....	.....
.....	.....
.....	.....

Have met today:

Names/surnames	**Functions**
Capt. THET HTAY	Director
Capt. KO KO NAING	Deputy Director
.....	Dept of Marine Administration
.....	.....

And have informed this/these person(s) and the institutions they represent on the Project (its location, main technical characteristics, the planning of operations) and the environmental and social impact assessment study currently ongoing. The participants to this meeting had the opportunity to discuss and express their views on the potential environmental and social impacts, whether they are positive or negative, of the project. They were also presented with the proposed mitigation measures which they approved or enhanced based on their knowledge and experience. Participants were encouraged to express their opinions and fears towards the project, if any.

The participants to this meeting and the institutions they represent have therefore been informed, and will be continuously informed during the project implementation based on the Union of Myanmar laws and regulations and international best practices and standards.

Name of the main consultant from Artelia/Parami
Charles BOUHELIER

Signature

Name of the representative of the consulted persons
Capt. Thet Htay

Signature

4/11/14

DEPARTMENT OF MARINE ADMINISTRATION

Capt. Thet Htay
Director (Nautical)
Maritime Safety, Security and Environmental Protection Section

ARTELIA

Notification of Consultation

State/Region.....
District.....
Township.....
City/town/village...Nay Pyi Taw...
Date.....21../...11...../2014

The consultants (Artelia / Parami), in charge of the Initial Environmental Examination (IEE) and the public consultations for the project of deep offshore seismic campaign on AD3 Block executed by OPHIR ENERGY PLC company, accompanied by the representative of OPHIR ENERGY PLC:

Names/surnames	Functions
Charles Bambelier	Environmental engineer

Have met today:

Names/surnames	Functions
U Myint Zin Htoo	Director
U Saw Aung Ye Htut Lwin	Deputy Director
Nilar Kyaw	Deputy Director
Aye Aye Zaw	"
U Hla Htun, Director / U Saw Lah Phar Wah	Director

And have informed this/these person(s) and the institutions they represent on the Project (its location, main technical characteristics, the planning of operations) and the environmental and social impact assessment study currently ongoing. The participants to this meeting had the opportunity to discuss and express their views on the potential environmental and social impacts, whether they are positive or negative, of the project. They were also presented with the proposed mitigation measures which they approved or enhanced based on their knowledge and experience. Participants were encouraged to express their opinions and fears towards the project, if any.

The participants to this meeting and the institutions they represent have therefore been informed, and will be continuously informed during the project implementation based on the Union of Myanmar laws and regulations and international best practices and standards.

Name of the main consultant from Artelia/Parami
.....Charles Bambelier

Signature

Name of the representative of the consulted persons
.....

Signature

Date .....

Name	Job	Signature
အမည်	အလုပ်အကိုင်	လက်မှတ်
① ဦးဖေဦးဖေ ဝေ	လယ်ယာစိုက်ပျိုးရေး	
② ဒေါ်မြမြဝင်း	〃	
③ ဦးစိုးဝေဆင်ဦး	ဆိုင်ရှင်	
④ ဦးဝေဝေထွဋ်	လယ်ယာစိုက်ပျိုးရေး	
⑤ ဦးဘဘိုင်	〃	
⑥ ဦးဘသိန်းဝေဆင်	〃	
⑦ ဦးစံလှဝင်း	〃	
⑧ ဦးအောင်ဘန်းဝင်း	〃	
⑨ ဦးတင်ထွန်း	〃	
⑩ ဦးကြေးခဲ့ဘိုင်	〃	
⑪ ဦးဖေဖေ	〃	
⑫ ဦးကျော်ဇံ	〃	
⑬ မှူးဇွဲ	〃	
⑭ ဒေါ်ခင်ဦးစိုးဦးဆွေ	ကားဒရိုင်ဘာလယ်ယာစိုက်ပျိုးရေး	
⑮ ဒေါ်ခင်ခင်ထူး	〃	
⑯ ဦးကဉ်ဖဲဝင်းဝင်းမြင့်	〃	
⑰ ဦးထွန်းမင်းထိုက်	စက်ပြင်	
⑱ ဦးထွန်းဇော		
⑲ ဦးစိုးမိုင်	ကားဒရိုင်ဘာ၊ ငါးဖမ်း	
⑳ ဦးကျော်သောင်း	〃	
㉑ ဦးဘသိန်းဇော	〃	
㉒ ဦးကျော်တောတော	〃	
㉓ ဦးခင်ဇော်ဆင်ဦး	〃	
㉔ ဦးထွန်းထွန်း	〃	
㉕ ဦးထွန်းကားကျော်	〃	
㉖ ဦးဘသန်းမိုင်	〃	

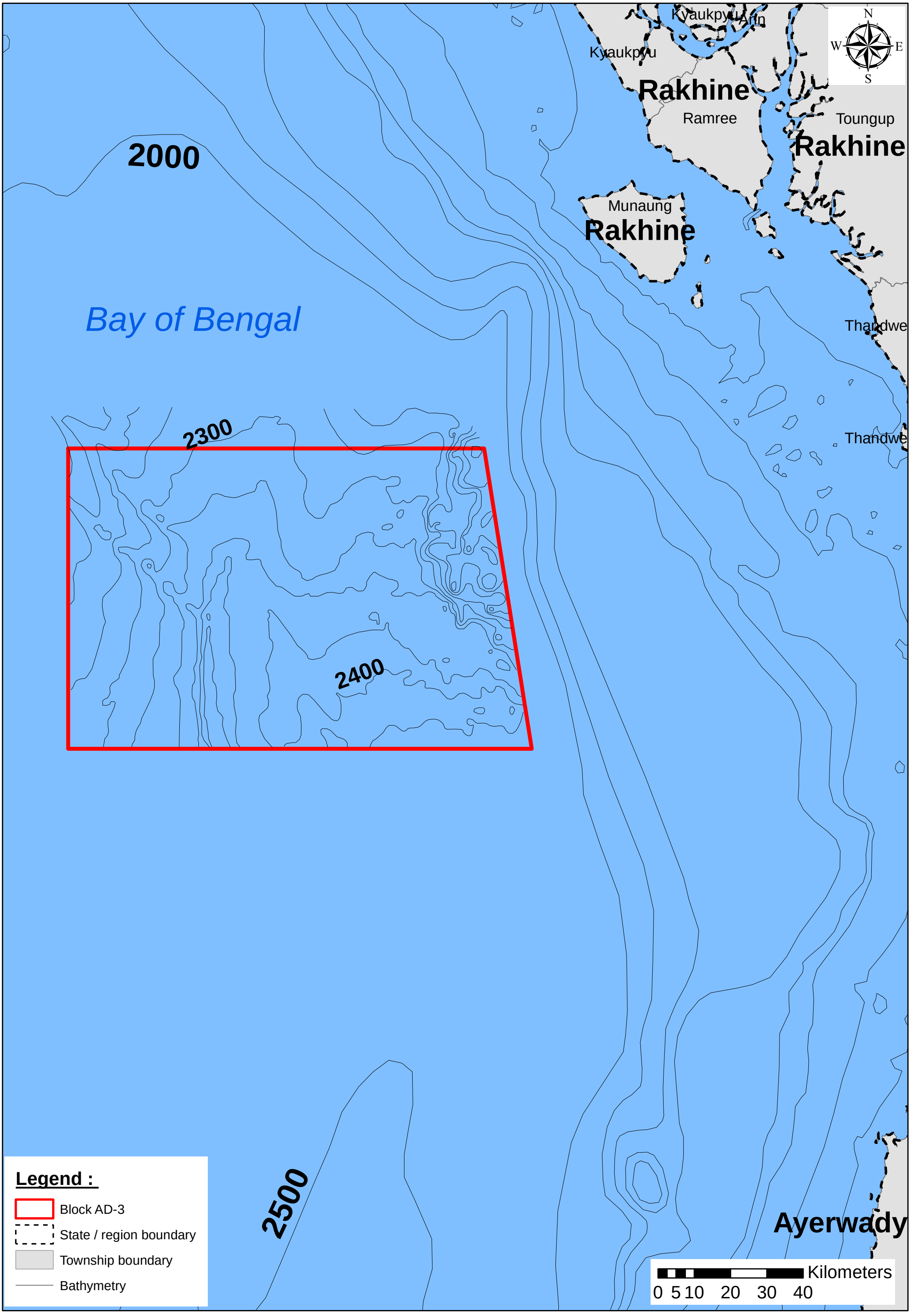
ELEVEN

Date .....

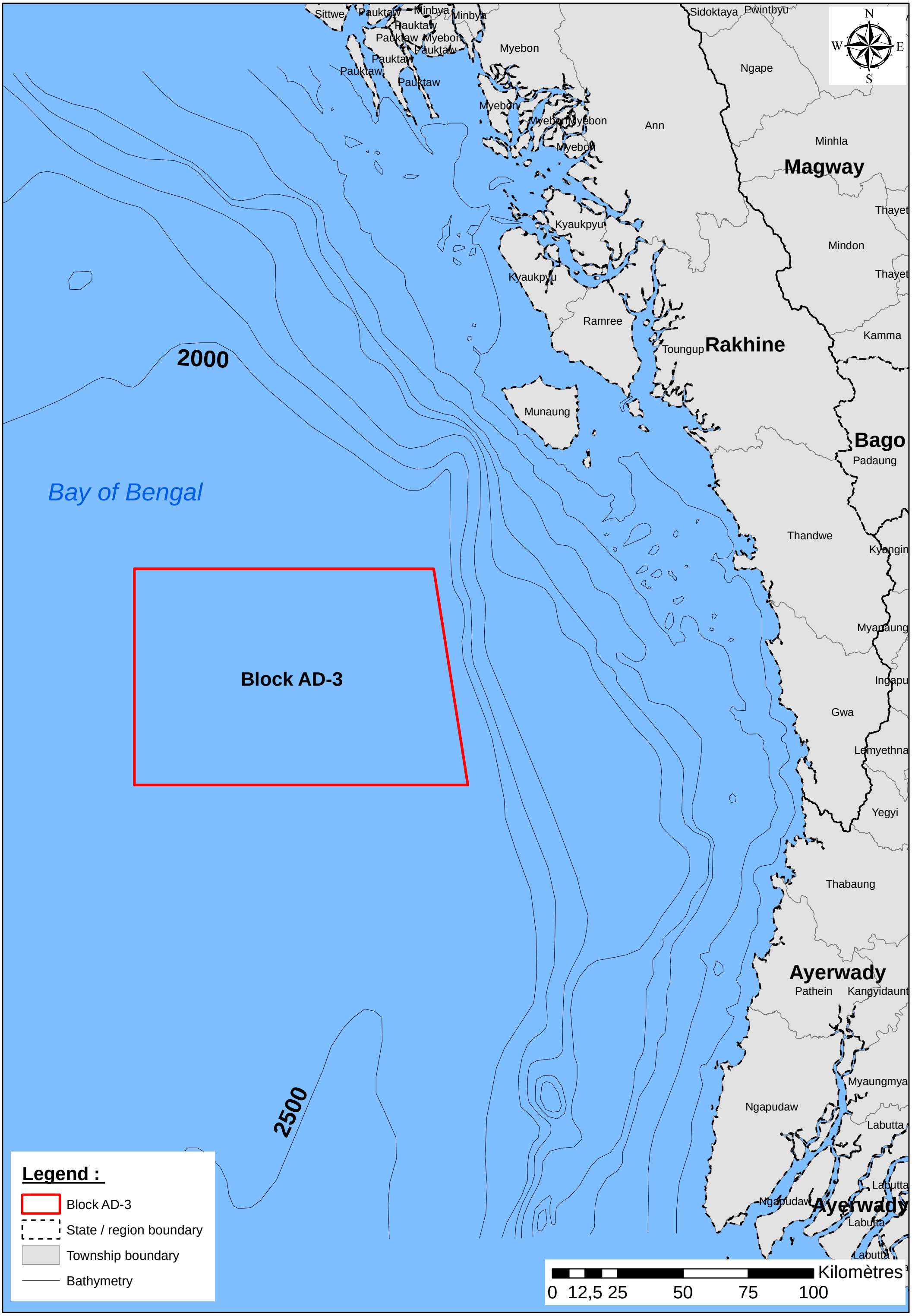
Name	Job	Signature
အမည်	အလုပ်အကိုင်	လက်မှတ်
(၂၅) ဦးအောင်ကျော်ဇင်း	ဂျီးပေမီးသတော်	
(၂၆) ဒေါ်သောဇာ.	~~အိုးစျေးသည်~~	
(၂၈) ဦးအောင်မြင့်	ဂုံမြို့	
(၂၉) ဦးဝေဘင်ဝင်း	ပုလင်ခွဲ၊ ကွင်း	
(၃၀) ဦး သန်းမိုင်	ဆူပိုးမှုပ် ရောင်းမှုန့် (ဖိတ်ကား)	
(၃၁) ဦးဘသိန်းစောင်	ကားဒရိုင်ဘာ ပုလင်ခွဲ၊ ကွင်း	
(၃၂) ဦးတင်မြင့်	"	
(၃၃) ဦးမြဝေထွန်းဆွေ	"	
(၃၄) ဦးမြင့်ဦးဘအောင်	(၂၅)/၀ တောက် အလှူငွေ ရောင်းမှုန့်	
(၃၅) ဦးစိုးလွင်	" ပဲကြီ့.	
(၃၆) ဦးတင်မိုး	လက်ဖက်ရည်ဆိုင်ရောင်းမှုန့်	
	ဘို့ကြီးမြို့နယ်၊ မံတွဲ.	

No.	Name	Job	Signature
1	Daw Myint Myint Zaw	Owner	xxxxxx
2	Daw Hla Hla Win	Owner	xxxxxx
3	U Khin Maung Yee	MFF	xxxxxx
4	U Maung Htwe	Owner	xxxxxx
5	U Than Naing	Owner	xxxxxx
6	U Than Maung	Owner	xxxxxx
7	U Soe Win	Owner	xxxxxx
8	U Aung Than Win	Owner	xxxxxx
9	U Tin Tun	Owner	xxxxxx
10	U Kyaw San Khine	Owner	xxxxxx
11	U Myint Phay	Owner	xxxxxx
12	U Kyaw Soe	Owner	xxxxxx
13	U Hla Shwe	Owner	xxxxxx
14	U Soe Nyunt	Offshore owner	xxxxxx
15	U Zaw Zaw Tun	Offshore owner	xxxxxx
16	U Kyi Min Thein	Offshore owner	xxxxxx
17	U Tun Min Htike	Mechanic	xxxxxx
18	U Tun Nwel		xxxxxx
19	U Soe Naing	Offshore fisherman	xxxxxx
20	U Hla Thaung	Offshore fisherman	xxxxxx
21	U Than Shwe	Offshore fisherman	xxxxxx
22	U Kyaw Tay Zar	Offshore fisherman	xxxxxx
23	U Khin Maung San	Offshore fisherman	xxxxxx
24	U Tun Tun	Offshore fisherman	xxxxxx
25	U Tun Aye Kyaw	Offshore fisherman	xxxxxx
26	U Than Naing	Offshore fisherman	xxxxxx
27	U Aung Kyaw Soe	Offshore fisherman	xxxxxx
28	U Aung Myint	Police Officer	xxxxxx
29	U Maung Win	Owner	xxxxxx
30	U Than Naing	Chief administrator (Gyate-taw)	xxxxxx
31	U Than Aung	Owner (offshore)	xxxxxx
32	U Tint Lwin	Owner (offshore)	xxxxxx
33	U Moe Zaw Htike	Owner (offshore)	xxxxxx
34	U Phoe Yee Aung	Secretary (Township support)	xxxxxx
35	U Soe Myint	Chairman (Township support)	xxxxxx
36	U Tin Thein	Assistant director (Planning-district, Thandwe)	xxxxxx

ANNEX 4 Marine traffic maps, AIS Data, other maps



Source : Myanmar Information Management Unit (MIMU)



Source : Myanmar Information Management Unit (MIMU)

Environmental coastal environment

CHIN STATE
Mandalay
MAGWAY REGION
RAKHINE STATE
Bago
AYERWADY REGION

Buthidaung
Maungdaw
Kyauktaw
Rathedaung
Mrauk-U
Ponnagyun
Minbya
Pauktaw
Sittwe
Myebon
Ann
Kyaukpyu
Ramree
Toungup
Munaung
Thandwe
Gwa

Block AD-3

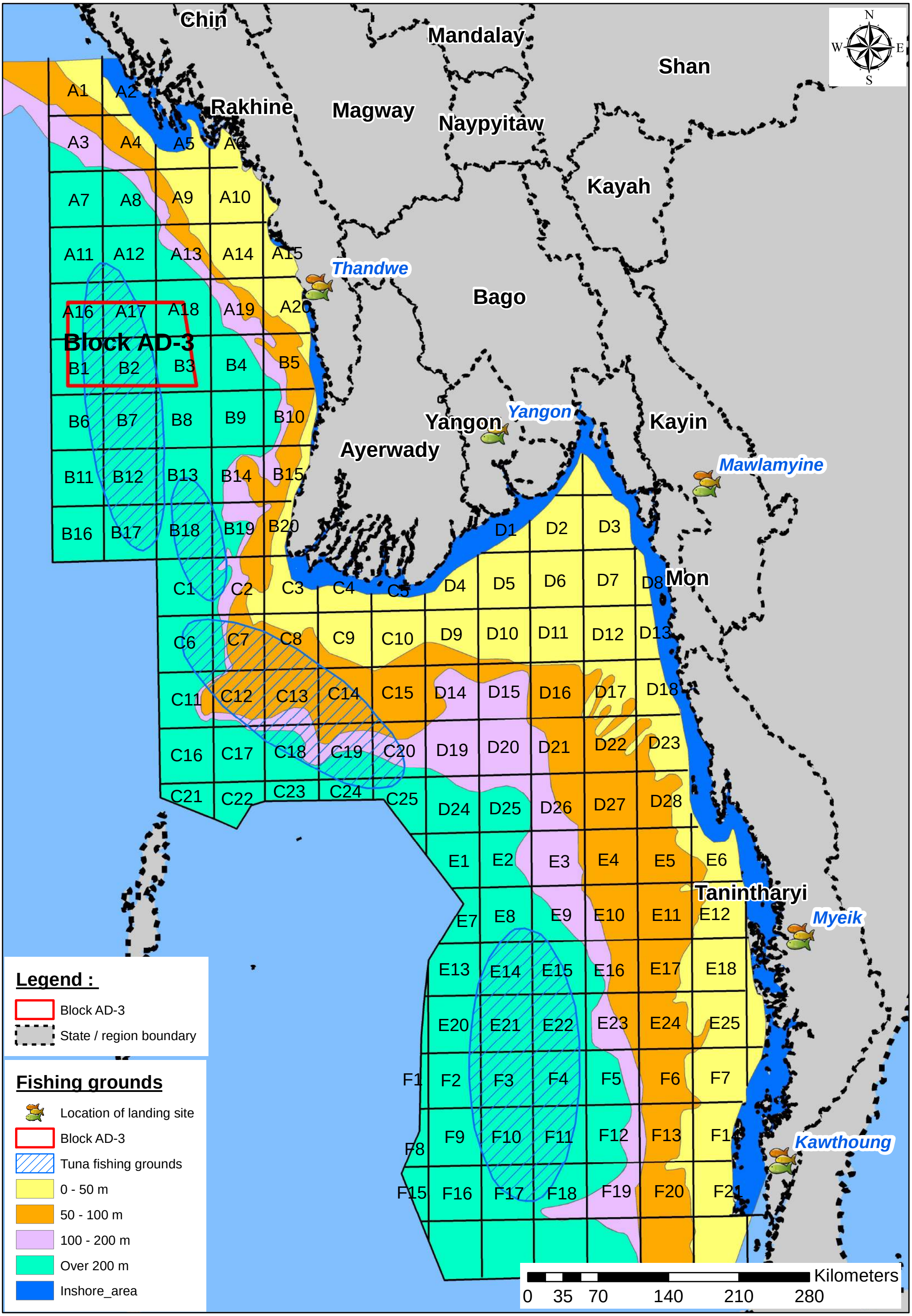
N
W
E
S

Legend :

- Block AD-3
- State / region boundary
- Township boundary
- Coral reefs
- Mangroove
- Pelagic province

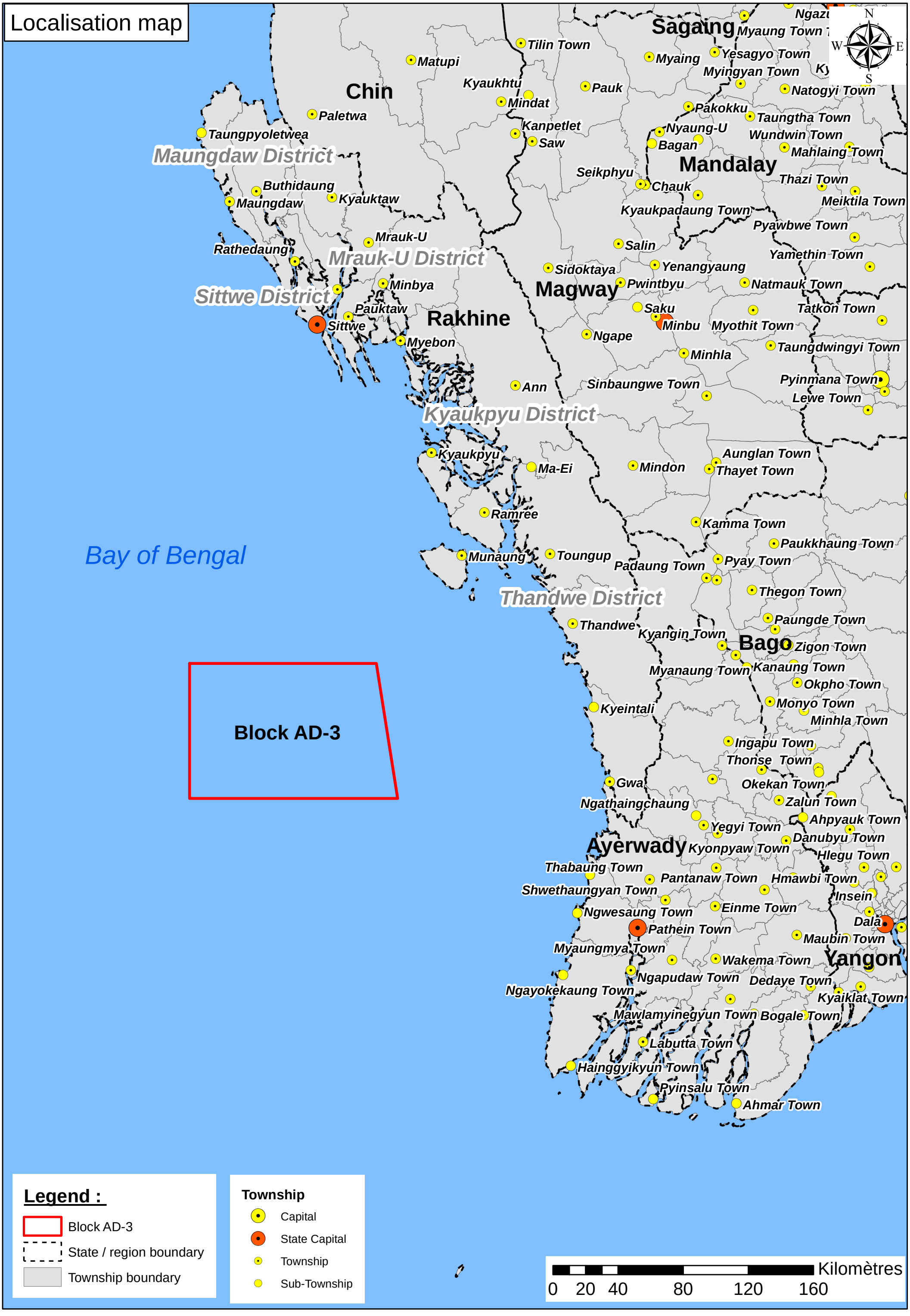
Kilomètres
0 15 30 60 90 120

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

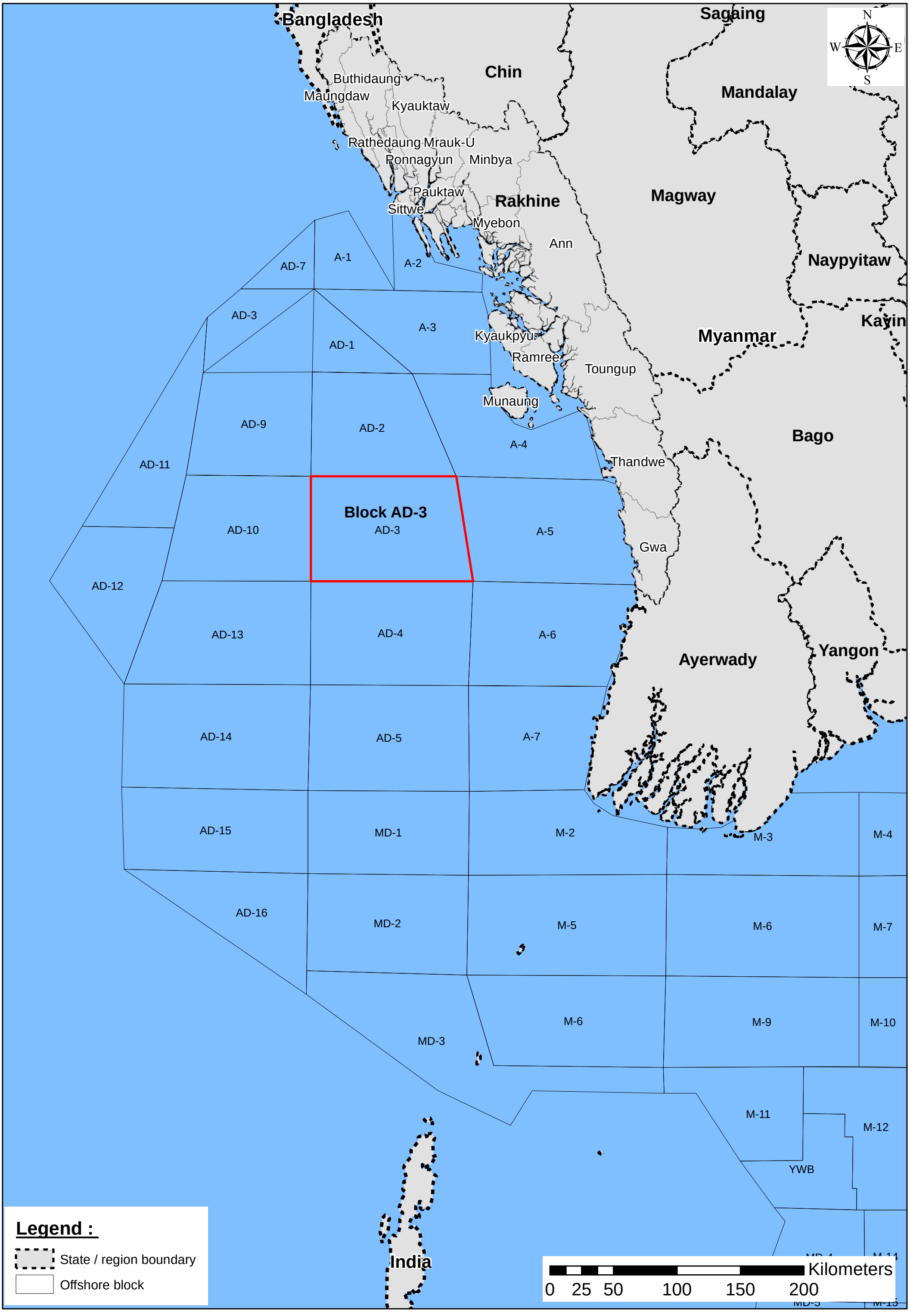


Source : Myanmar Information Management Unit (MIMU)

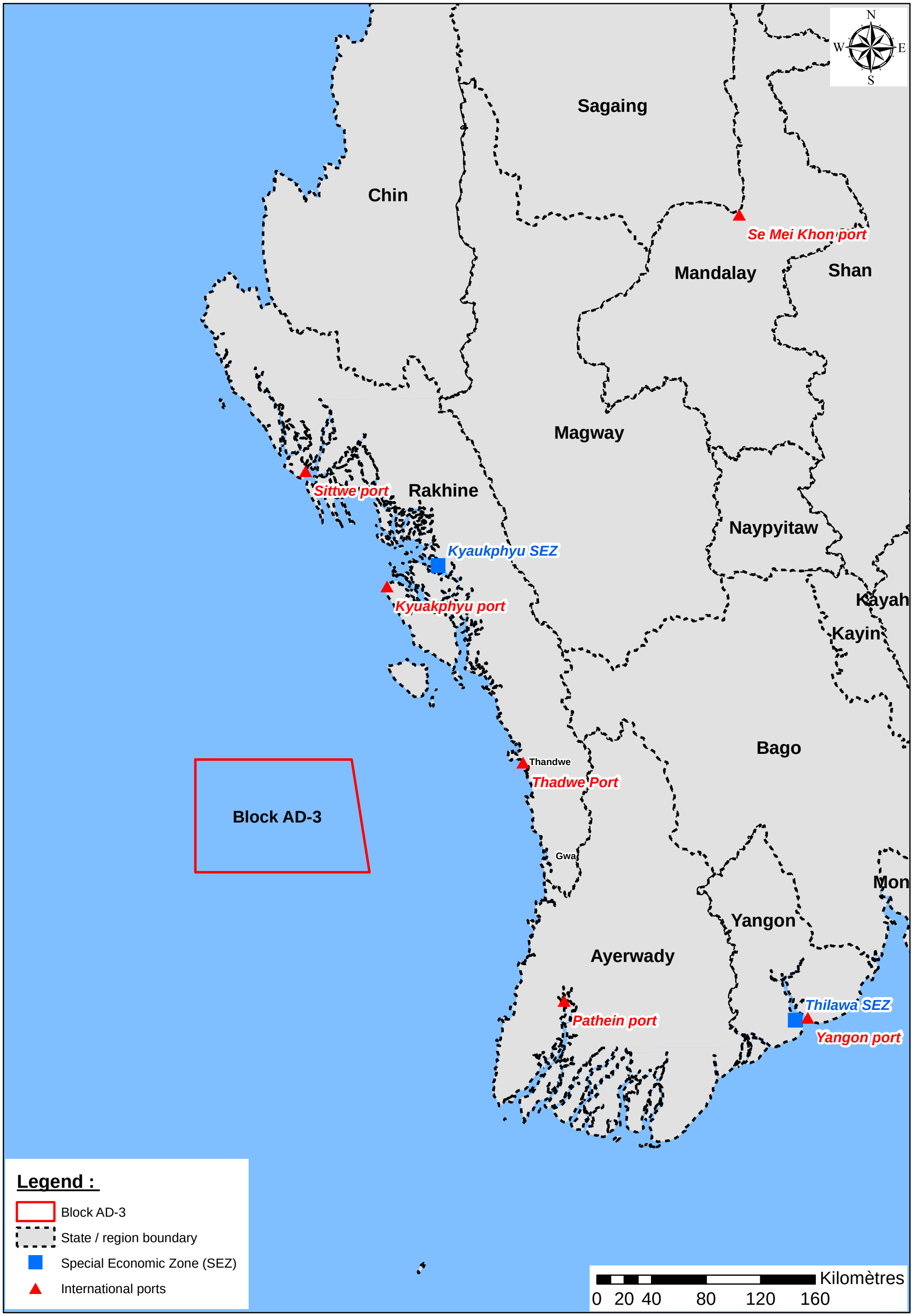
Localisation map



Source : Myanmar Information Management Unit (MIMU)

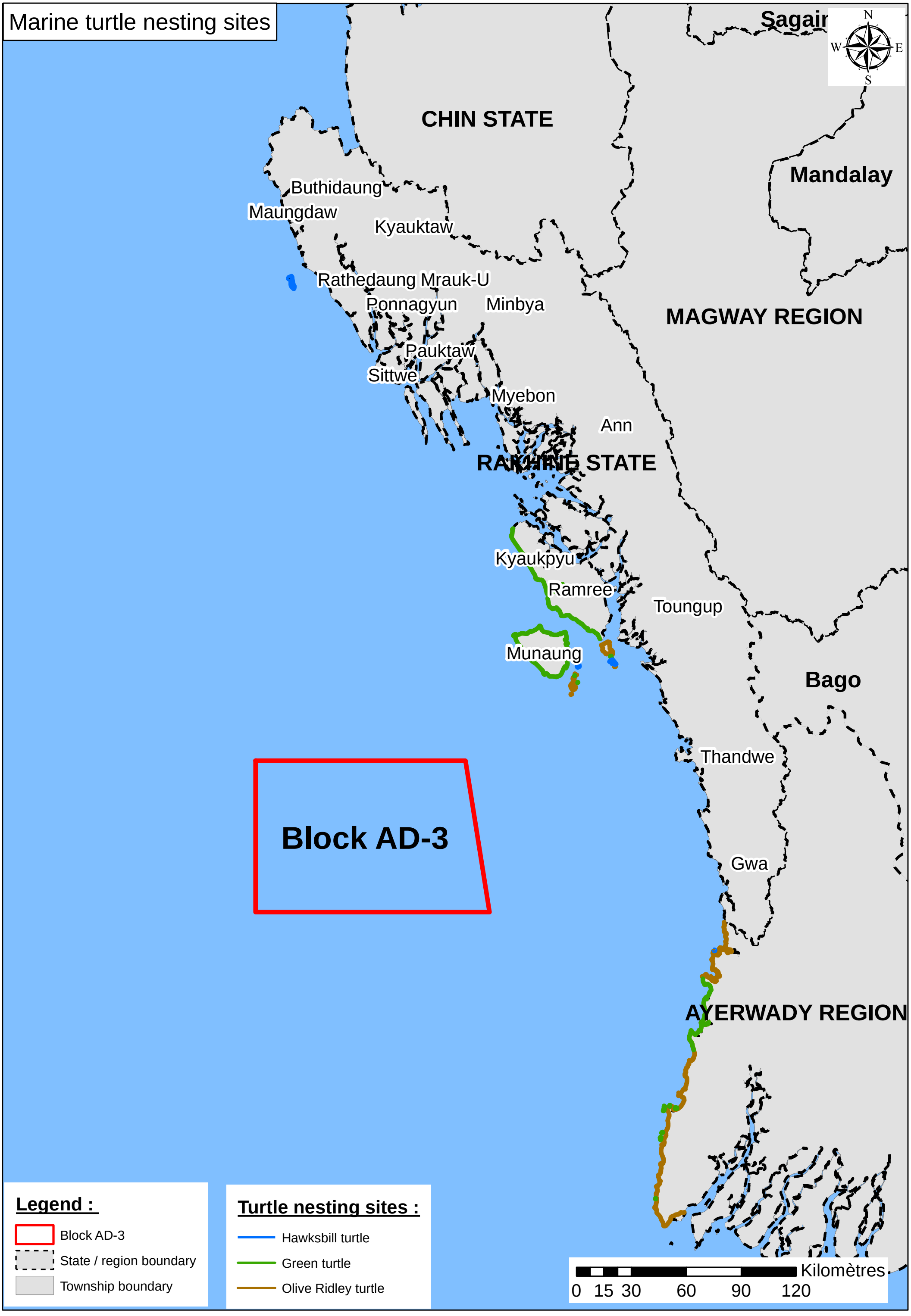


Source : Myanmar Information Management Unit (MIMU)



Source : Myanmar Information Management Unit (MIMU)

Marine turtle nesting sites



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

Meteorology station

N
W
E
S

Sagain

Chin

Mandalay

Maungdaw District

Mrauk-U District

Magway

Sittwe District

Rakhine

Kyaukpyu District

Bay of Bengal

Thandwe

Thandwe District

Bago

Block AD-3

Yangon

Ayerwady

Legend :

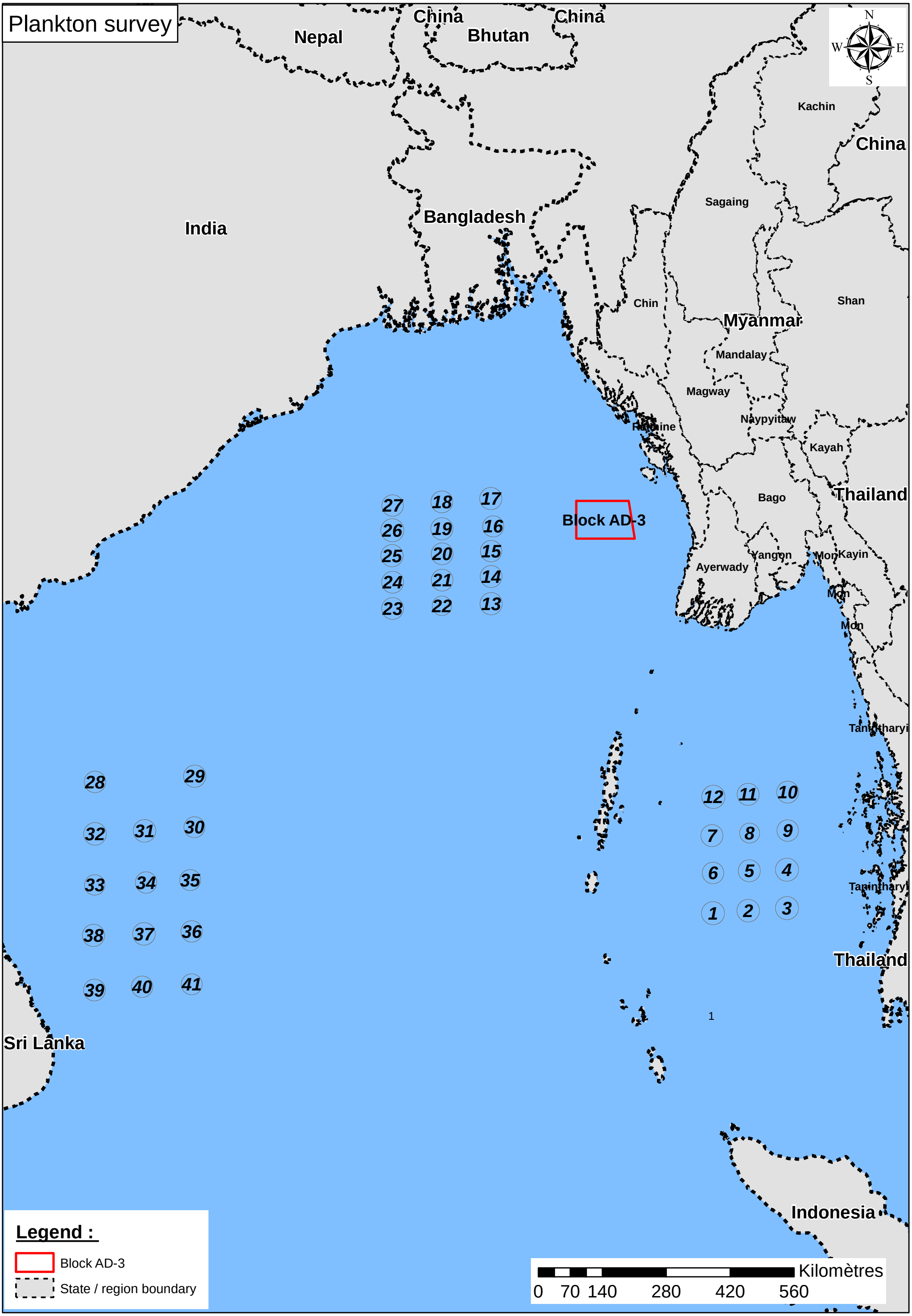
- Block AD-3
- State / region boundary
- Township boundary
- Meteorology station

Kilomètres

0 20 40 80 120 160

Source : Myanmar Information Management Unit (MIMU)

Plankton survey



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

N
W E
S

56 682
483 350
Maungdaw

21 919
287 607
Buthidaung

21 384
192 914
Kyauktaw

8 048
158 669
Rathedaung

10 834
141 521
Ponnagyun

35 860
184 554
Mrauk-U

29 856
168 756
Minbya

152 544
151 070
Sittwe

19 457
161 283
Pauktaw

12 905
128 835
Myebon

19 965
94 520
Ann

41 025
130 699
Kyaukpyu

9 733
102 453
Ramree

27 477
119 029
Toungup

5 362
58 934
Munaug

18 488
104 657
Thandwe

13 818
48 253
Gwa

Bay of Bengal

Block AD-3

Legend :

- Block AD-3
- State / region boundary
- Township boundary

Population

- 240 000
- Urban
- Rural

13 818 / 48 253 Urban population / Rural population

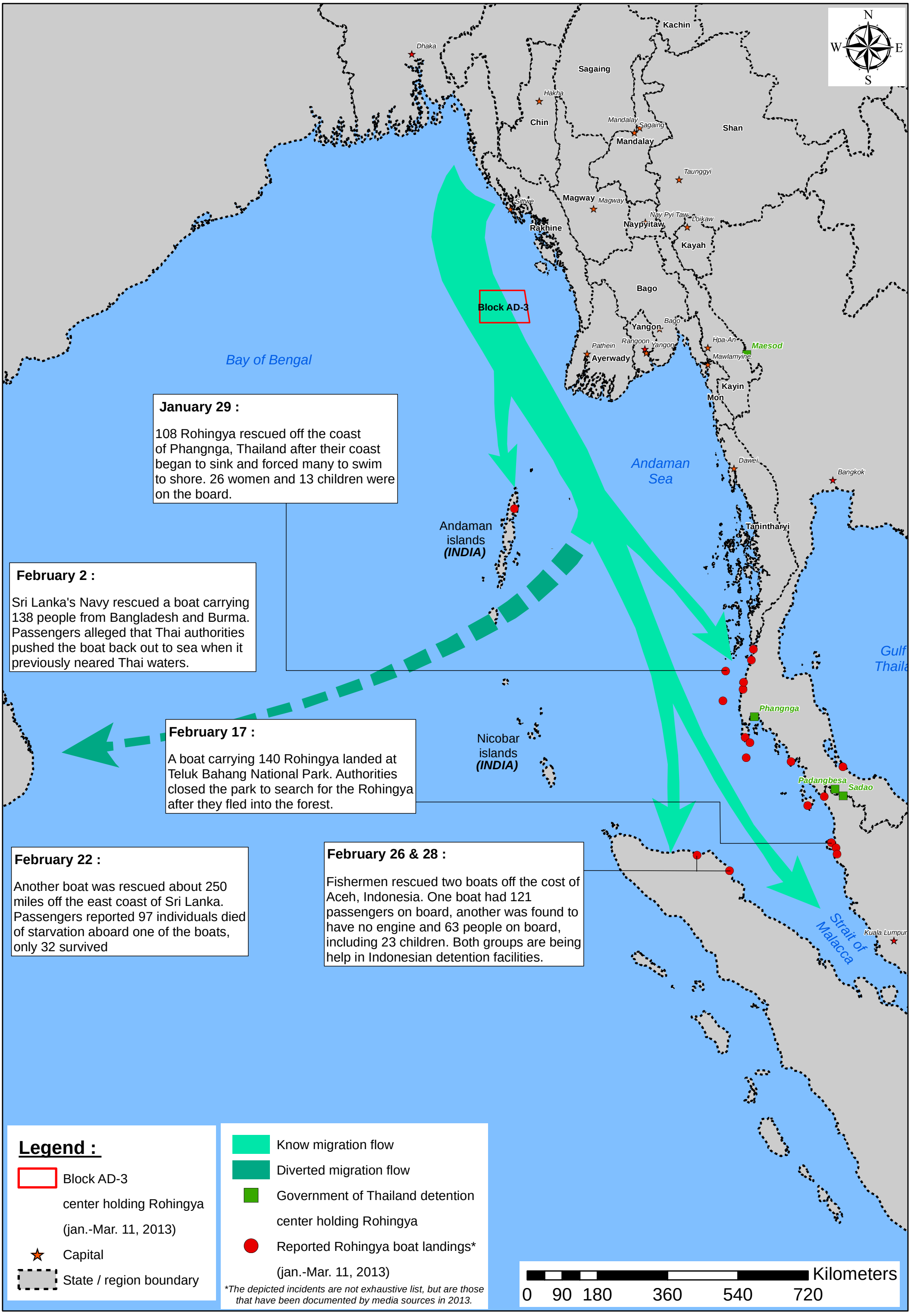
Population density

- < 30
- 30 - 100
- 100 - 200
- 200 - 400
- 400 - 1386

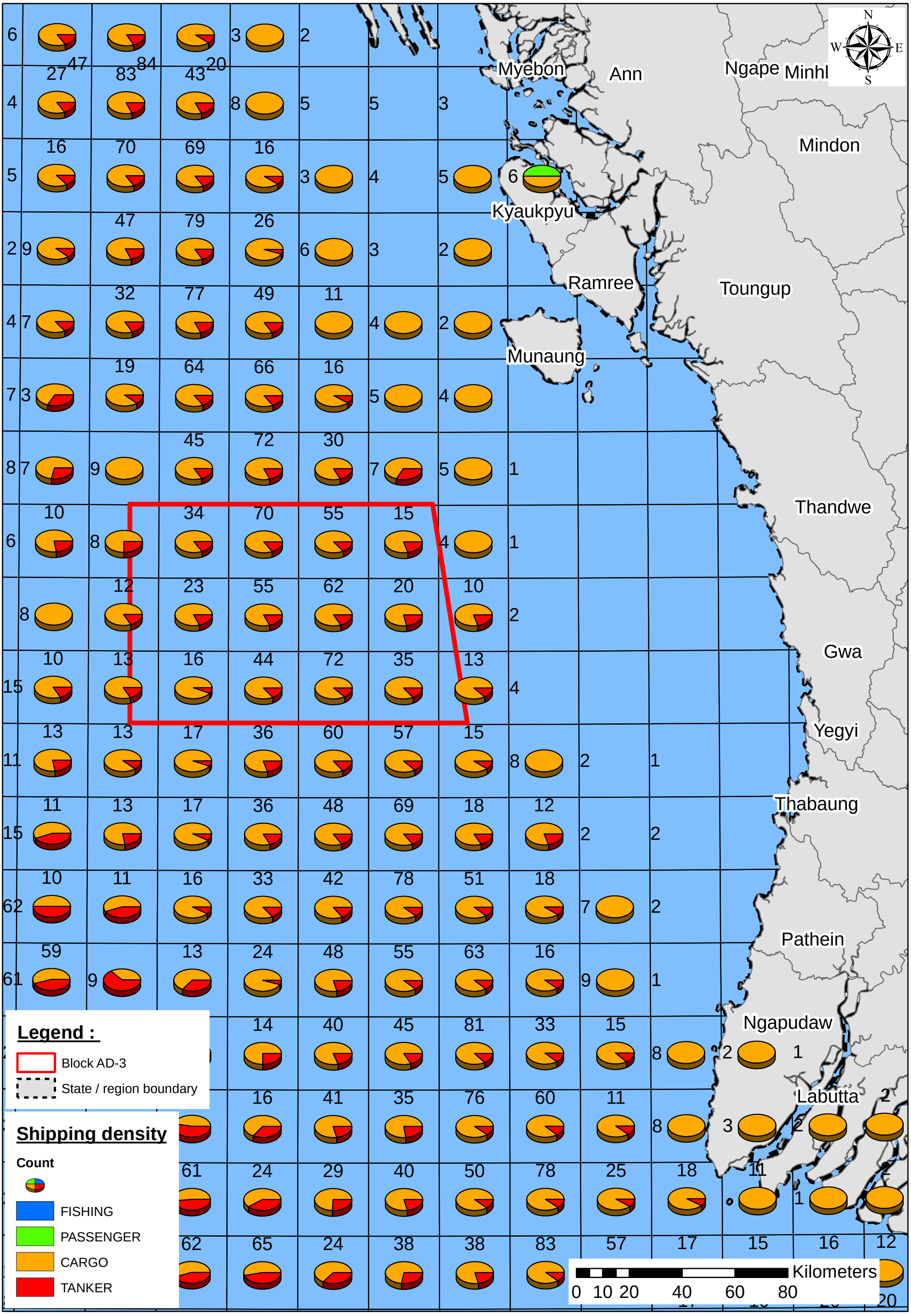
0 12,5 25 50 75 100 Kilomètres

Source : Myanmar Information Management Unit (MIMU)

Source : Myanmar Information Management Unit (MIMU)



Source : Myanmar Information Management Unit (MIMU), USG, Regional Press, UNHCR, UN OCHA, Govt. of Thailand



Source : Myanmar Information Management Unit (MIMU)

Pauktaw
Myebon
Ann
Ngape
Mi
Mindon
Kyaukpyu
Ramree
Toungup
Munaung
Thandwe
Gwa
Yegyi
Thabaung
Pathein
Ngapudaw
Labutta

Legend :

Block AD-3

State / region boundary

Shipping density

Count

FISHING

PASSENGER

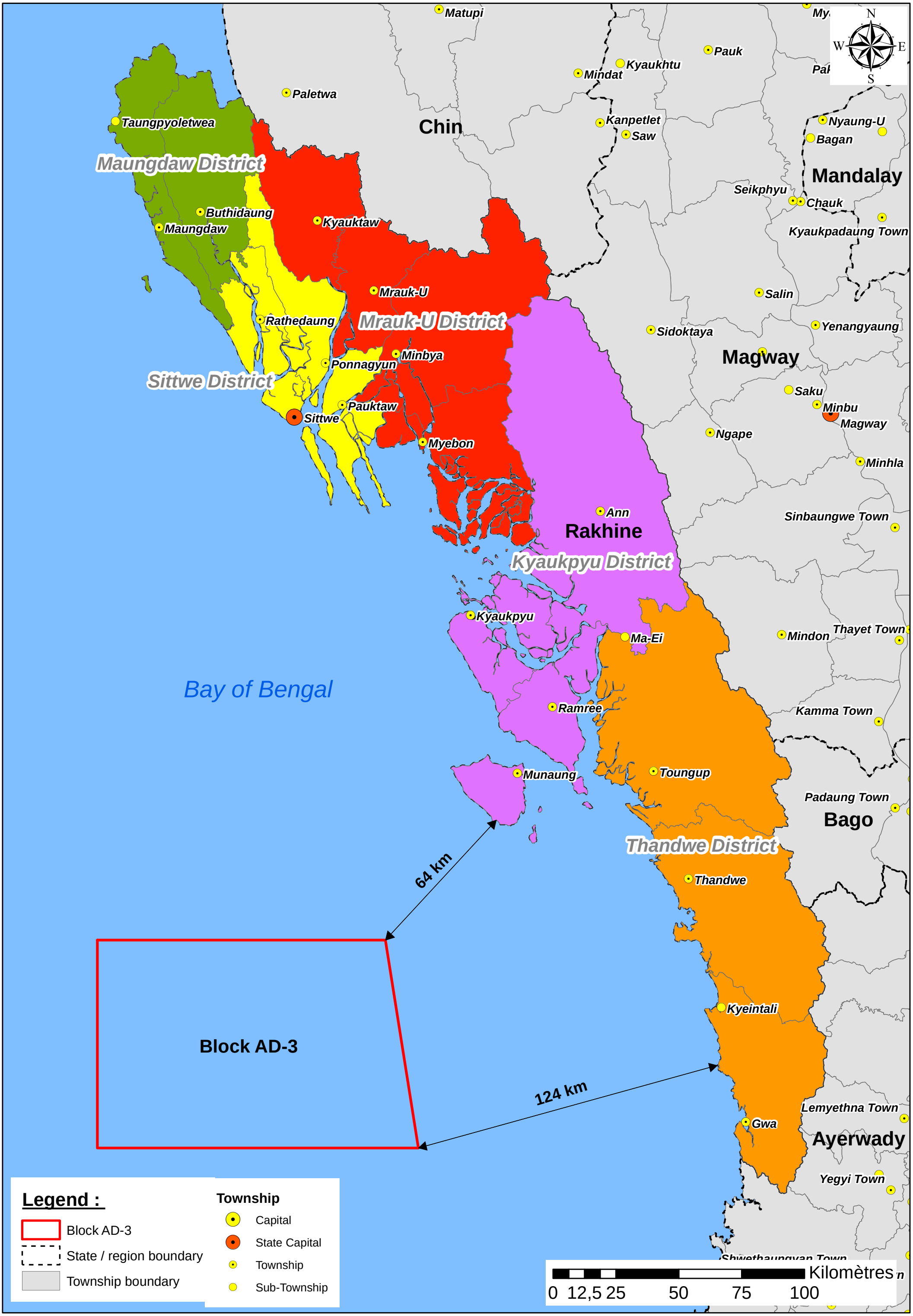
CARGO

TANKER

Kilometers

0 10 20 40 60 80

Source : Myanmar Information Management Unit (MIMU)



Source : Myanmar Information Management Unit (MIMU)

ANNEX 5 Cyclone Contingency Plan

Section 11

Meteorological Conditions

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Contents

Section 11
Meteorological Conditions

11.0.0 METEOROLOGICAL CONDITIONS

11.1.0 WEATHER CONDITIONS

11.2.0 DANGERS TO NAVIGATION

11.3.0 TROPICAL STORMS

11.3.1 Precursory Signs
11.3.2 Avoiding Tropical Storms
11.3.3 In the N. Hemisphere
11.3.4 In the S Hemisphere
11.3.5 If in Harbour
11.3.6 Definition
11.3.7 Characteristics
11.3.8 Formations

Annex A Typical Paths of Tropical Storms
Annex B Examples of Tracks followed by Tropical Storms
Annex C Principal Areas Affected and Months in Which Tropical Storms Normally Occur

Author	*DPA*				
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11.0.0 METEOROLOGICAL CONDITIONS

11.1.0 WEATHER CONDITIONS

Masters of Company operated ships are to ensure that all appropriate weather forecasts are received and monitored. In extreme weather conditions or if extreme weather conditions are expected or forecast, inter alia;

- Ensure that any equipment is adequately secured.
- Check that any loose/portable equipment is adequately secured. Do not rely on technical or charterers personnel.
- Secure all weather-tight and watertight openings.
- Check that cabin deadlights are secure.
- Fix storm plates to bridge windows if available.
- Warn all personnel and restrict access to deck.
- Liaise with Charterer, Client Company Representative and Technical Supervisor so that operations may be halted and any over-side equipment recovered without risk to ship, associated equipment, or personnel in the process.
- Warn galley.
- Safety lines rigged.
- Inform Charterer/Client Company Representative and Technical Supervisor on availability of shelter for ship.

See Bridge Procedures Guide Checklist No. B10.

11.2.0 DANGERS TO NAVIGATION

Chapter (V) of SOLAS requires Masters to report any danger to navigation to all stations (C.Q.) and to the nearest Competent Coast Authority (Officers will report any danger to navigation to the Master, see Section 7.3.4 'Calling the Master').

a) Ice, derelicts, or other dangers to navigation.

Message Content:

- Kind of ice, derelict or danger to navigation
- Position of ice, derelict or danger when last observed
- Time and date when last observed. U.T.C. (Universal Co-ordinated Time)

b) Tropical Storms (Tropical Revolving Storms, Hurricane West Indies and Eastern North Pacific, Typhoons in China Sea and Western North Pacific and Cyclones in North and South Indian Oceans and South Pacific.)

Message Content:

- Tropical Storms encountered or suspected
- Time (U.T.C.) date and position of ship
- Barometric pressure
- Barometric tendency
- True wind direction
- Wind force Beaufort scale
- Sea state
- Swell
- True course and speed of ship

When a Master has reported a tropical or other dangerous storm it is desirable but **not obligatory** to make further hourly or not more than three hourly reports.

c) Winds of force 10 or above on Beaufort scale for which no storm warning has been received.

d) Sub-zero air temperatures associated with gale force winds causing ice accretion.

Message Content:

- Time (U.T.C.)
- Air temperature
- Sea temperature (if practicable)
- Wind force and direction

See Company standing orders and operational instructions, ship stability, icing conditions in high latitudes.

11.3.0 TROPICAL STORMS

Masters of Company operated ships are reminded of the necessity to be vigilant of the signs indicating the onset of a Tropical Storm. The Admiralty list of Radio Signals Volume 3 give stations and transmission schedule for the nearest Coast Station which transmits Tropical Storm warnings. Storm Warnings of the position, intensity and expected movement of each storm are broadcast at frequent and regular intervals. Details of stations which transmit warnings, the areas covered and transmission schedules are given in Admiralty List of Radio Signals Vol. 3.

The following terms are in general use to describe tropical circulations at various stages of intensity:

Tropical Depression	Winds of force 7 or less;
Tropical Storm	Winds of force 8 and 9;
Severe Tropical Storm	Winds of force 10 and 11;
Typhoon, Hurricane, Cyclone	Winds of force 12.

Annex B shows examples of tracks followed by tropical storms and Annex C gives the area, and main season/months when storms may be expected.

Detection and Tracking of tropical storms is greatly assisted by weather satellites and most storms are detected at a very early stage of development; thereafter each storm is carefully tracked and in some areas are monitored by weather reconnaissance aircraft which fly into the circulation's to record observations.

Masters are however advised that although Weather Centres are manned by experts with years of experience forecasting tropical storms, weather centres often still experience great difficulty exactly locating the storm centre, hence the predicted paths/manoeuvre(s) of storms for any significant time ahead is often subject to appreciable error. ***Therefore due seaman-like diligence and observations are required in order to avoid Tropical Storms.***

Action(s) taken by Masters to avoid Tropical Storms must therefore be based on a combination of forecasted information and own ship observations.

Masters of Company Operated ships in the proximity of a Tropical storm will adhere to the procedures for Adverse Weather Conditions in checklist B10 Additionally Masters will regularly plot storms centre and predicted path and thence a route for the ship to avoid storm centre by at least eighty miles if practicable. See diagrams and advice for avoiding tropical storms.

11.3.1 Precursory Signs

The following signs may be evidence of a storm in the locality; the first of these observations is a very reliable indication of the proximity of a storm within 20° latitude (approx.) N or S of the equator.

I.S.M.

Author	***DPA***				
Approved	***MARINE***				
Issue No.	***1***				
Issue Date.	***17/6/2010***				
Rev No	***0***				

It should be borne in mind, however, that very little warning of the approach of an intense storm of small diameter may be expected.

If a corrected barometer reading is 3 mb/hPa or more below the mean for the time of year, as shown in the climatic atlas or appropriate volume of Admiralty Sailing Directions, suspicion should be aroused and action taken to meet any development. The barometer reading must be corrected not only for height, latitude, temperature and index error (if mercurial) but also for diurnal variation, which is given in climatic atlases or appropriate volumes of Admiralty Sailing Directions. If the corrected reading is 5 mb/hPa or more below normal it is time to consider avoiding action for there can be little doubt that a tropical storm is in the vicinity. ***Because of the importance of pressure readings it is wise to take hourly barometric readings in areas affected by tropical storms;***

An appreciable change in the direction or strength of the wind; A long low swell is sometimes evident, proceeding from the approximate bearing of the centre of the storm. This indication may be apparent before the barometer begins to fall;

Extensive cirrus cloud followed, as the storm approaches, by altostratus and then broken cumulus or scud.

N.B. Pressure is usually expressed in millibars (mb) but occasionally in Hectopascals (hPa), which are numerically equal.

11.3.2 Avoiding Tropical Storms

In whatever situation a ship may find herself the matter of vital importance is to avoid passing within 80 miles or so of the centre of the storm. It is preferable but not always possible to keep outside a distance of 250 miles. If a ship has about 15- 20 knots at her disposal and shapes a course that will take her most rapidly away from the storm before the wind has increased above the point at which her movement becomes restricted it is seldom that she will come to any harm. Sometimes a tropical storm moves so slowly that a ship, if ahead of it, can easily outpace it or, if astern of it, can overtake it.

If a ship is in an area where the presence or development of a storm is likely, frequent barometer readings should be made and corrected. If the barometer should fall 5 mb/hPa below normal or if the wind should increase to force 6 when the barometer has fallen at least 3 mb/hPa, there is little doubt that a storm is in the vicinity. If and when either of these criteria is reached the ship should act as recommended in the following paragraphs until the barometer has risen above the limit just given and the wind has decreased below force 6.

Author	*DPA*				
Approved	*MARINE*				
Issue No.	*1*				
Issue Date.	*17/6/2010*				
Rev No	*0*				

Should it be certain, however, that the ship is behind the storm or even in the navigable semicircle it will evidently be sufficient to alter course away from the centre keeping in mind the tendency of tropical storms to re-curve towards N and NE in the N hemisphere, and towards S and SE in the S hemisphere.

11.3.3 In the N Hemisphere

a) If the wind is veering the ship must be in the dangerous semicircle. The ship should proceed with all available speed with the wind 10°-45°, depending on speed, on the starboard bow. As the wind veers the ship should alter course to starboard thereby tracing a course relative to the storm as shown in diagram on Annex A.

b) If the wind remains steady in direction or nearly steady so that the ship should be in the path of the storm or very nearly in its path she should bring the wind well on to the starboard quarter and proceed with all available speed. When well within the navigable semicircle act as at (c) below.

c) If the wind backs the ship is in the navigable semicircle. The ship should bring the wind on the starboard quarter and proceed with all available speed turning to port as the wind backs to follow a track as shown in the diagram in Annex A.

11.3.4 In the S Hemisphere

a) If the wind is backing the ship must be in the dangerous semicircle. The ship should proceed with all available speed with the wind 10°-45°, depending on speed, on the port bow. As the wind backs the ship should alter course to port thereby tracing a course relative to the storm as shown in diagram in Annex A.

b) If the wind remains steady in direction or nearly steady so that the ship should be in the path of the storm or very nearly in its path she should bring the wind well on to the port quarter and proceed with all available speed. When well within the navigable semicircle act as at (c) below.

c) If the wind veers the ship is in the navigable semicircle. The ship should bring the wind on to the port quarter and proceed with all available speed turning to starboard as the wind veers to follow a track as shown in the diagram in Annex A.

If there is insufficient room to run when in the navigable semicircle and it is not practicable to seek shelter, the ship should heave-to with the wind on her starboard bow in the N hemisphere or on her port bow in the S hemisphere.

11.3.5 If in Harbour

When a tropical storm approaches it is preferable to put to sea if this can be done in time to avoid the worst of the storm. Riding out a tropical storm, the centre of which passes within 80 miles or so, in a harbour or anchorage is an unpleasant and hazardous experience especially if there are other ships in company. ***Even if berthed alongside and special moorings are used a ship may be far from secure.***

11.3.6 Definition

Tropical storms are intense depressions, which develop in tropical latitudes; they are often the cause of very high winds and heavy seas. Although the pressure at the centre of a tropical storm is comparable to that of an intense middle latitude depression, the diameter of a tropical storm is much smaller (typically some 500 miles compared with 1500 miles) and thus the related pressure gradients and the wind speeds are correspondingly greater. The wind blows around the centre of a tropical storm in a spiral flow inwards, anticlockwise in the N hemisphere and clockwise in the S hemisphere: hence the occasional alternative name 'revolving storm'.

Within the circulation of a tropical storm the wind is often very violent and the seas are high and confused; considerable damage may be done even to large and well-found ships. The danger is especially enhanced when ships are caught in restricted waters without adequate room to manoeuvre and early action may be essential to preclude such a situation arising.

11.3.7 Characteristics

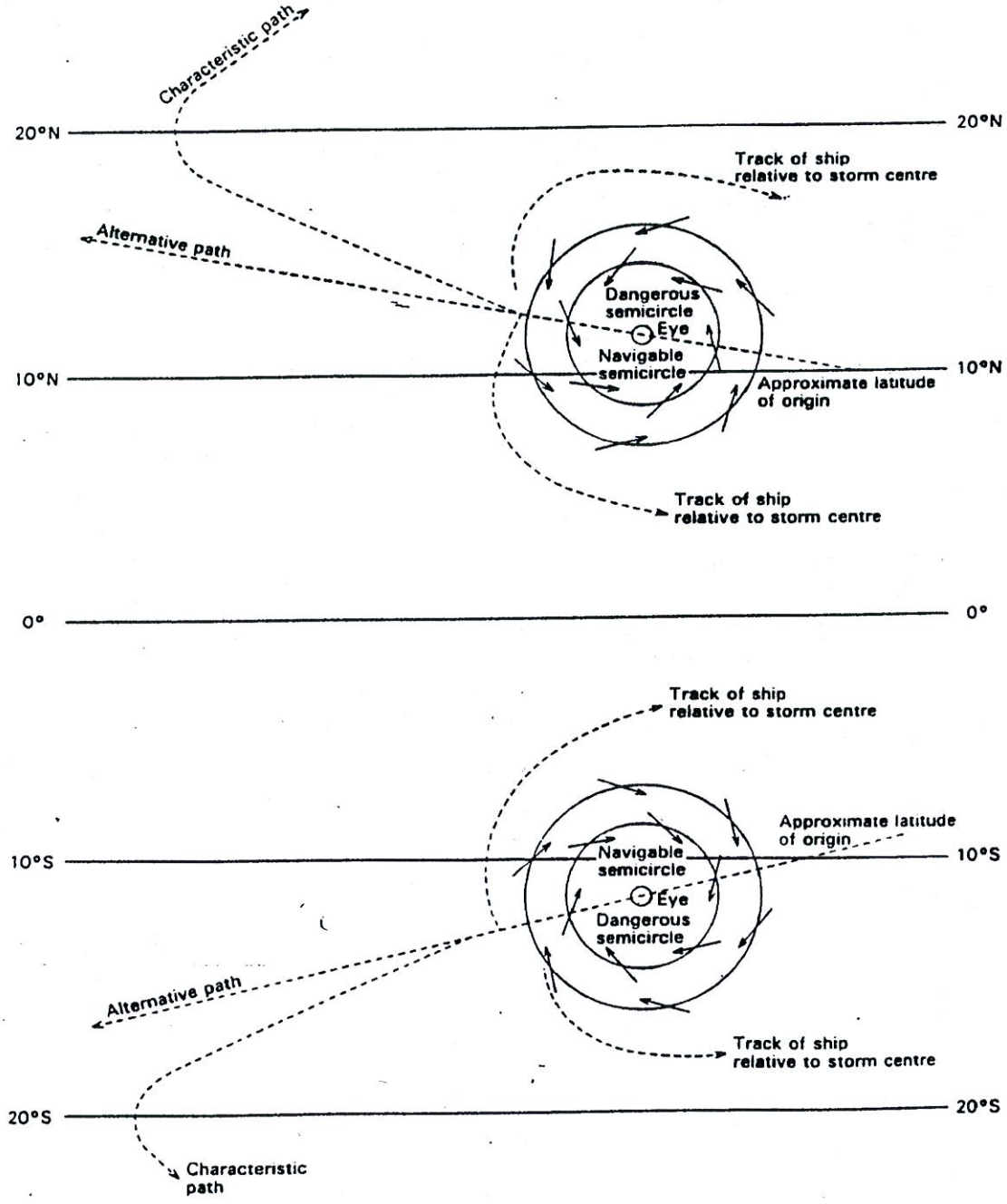
Winds of gale force (<34 knots) are likely up to 100-200 miles from the centre of a storm at latitudes of less than 20°; as a storm moves to higher latitudes it tends to expand and by the time a system has reached 30°-35° (N or S) these distances may be doubled. Hurricane force winds (<64 knots) are likely within 80 miles of a storm centre in the tropics and mean wind speeds of well over 100 knots have been recorded in major storms. Winds are extremely gusty and the wind speeds in gusts may be some 30-50% higher than the mean; gusts exceeding 175 knots have been reported. At the centre of a well-developed storm is a characteristic area, known as the 'eye' of the storm, within which winds are light or moderate variable, the sky partly cloudy but with a heavy sometimes mountainous, and confused swell. The diameter of the eye can vary from less than 10 miles in small intense storms to 30-40 miles in the very large storms. Surrounding the eye is the dense dark wall cloud extending to a great altitude and with very heavy rain beneath; maximum wind speeds are attained at the inner margin of the wall cloud in a belt averaging about 5-15 miles in width. In this zone visibility is almost nil due to the spray and torrential rain.

11.3.8 Formations

Tropical storms develop only over oceans, and origination is especially frequent near the seasonal location of the Equatorial Trough. In the N hemisphere storms form mostly in the belt 5°-15°N early and late in the storm season, and between 10°N and 25°N at the height of the season; in the N Atlantic Ocean storm formation between 25°N and 30°N is fairly common. In the S hemisphere most storms develop between 5°S and 18°S. Those which affect the W Pacific, S Indian and N Atlantic Oceans are usually first reported in the W part of these oceans; there are exceptions such as in the N Atlantic Ocean during August and September when an occasional storm originates near Arquipélago de Cabo Verde.

Tracks followed are very variable in all areas and individual tracks may be quite erratic, but very generally, in the N hemisphere a storm will move off in a direction between 275° and 350° though most often within 30° of due W. When near latitude 25°N storms usually re-curve away from the equator and by the time they reach 30°N movement is in a NE direction. In the S hemisphere initial movement is between WSW and SSW (usually the former) to re-curve between 15°S and 20°S and thence follow a SE path. Many storms, however, do not re-curve but continue in a WNW direction in the N hemisphere, or WSW in the S hemisphere. When a storm moves inland it weakens and eventually dissipates; but if it should re-emerge to follow an ocean track again it may re-intensify. The speed of storms is usually about 10 knots in their early stages increasing slightly with latitude but seldom exceeding 15 knots before re-curving. A speed of 20-25 knots is usual after re-curving though speeds of over 40 knots have been recorded. When storms move erratically, sometimes making one or more complete loops, their speed of movement is usually slow; less than 10 knots.

Annex A - Typical paths of Tropical Storms



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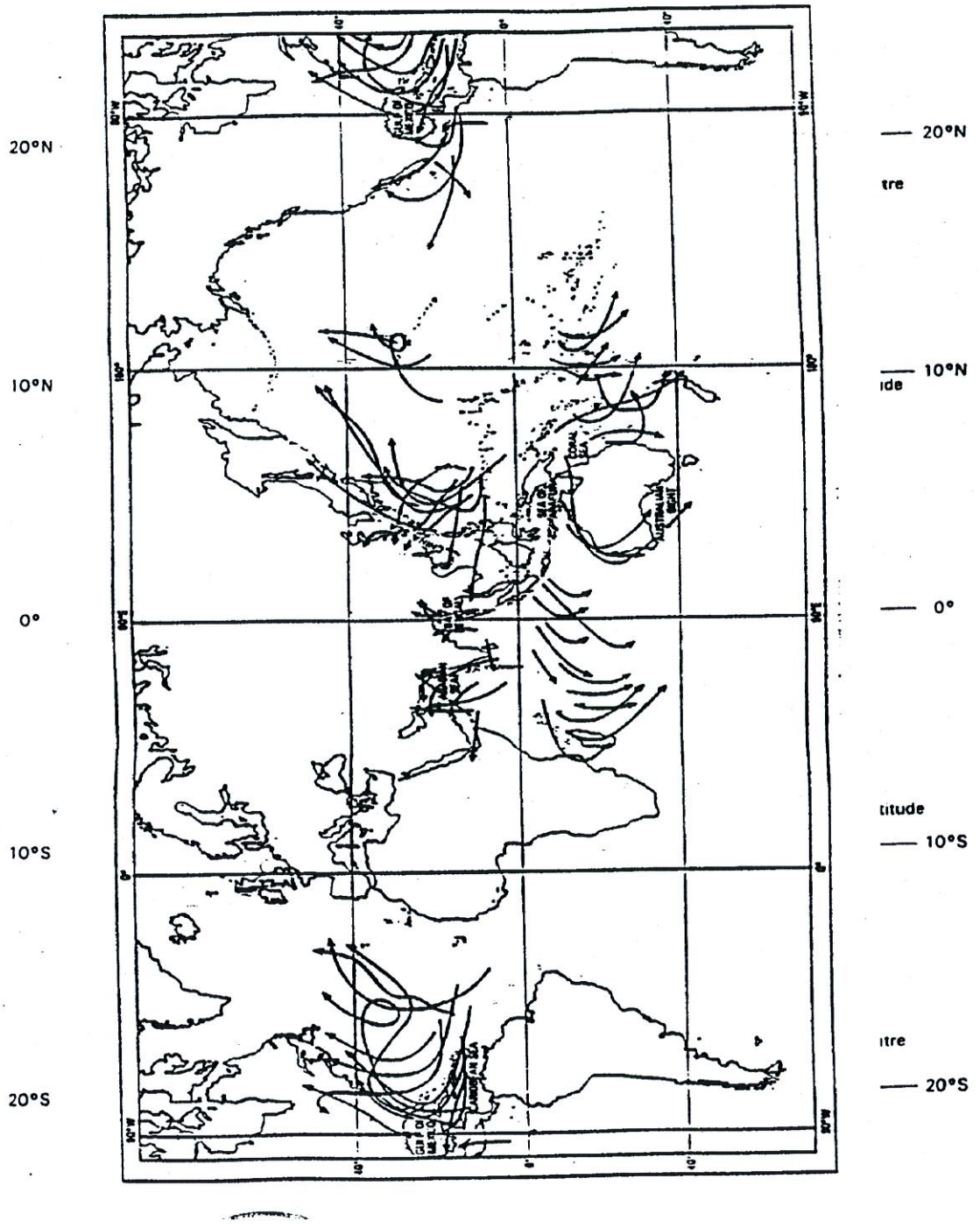
Issue No.	*1*				
Issue Date.	*17/6/2010*				
Rev No	*0*				

Annex B - Example(s) of tracks followed by Tropical Storms



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Issue No.	*1*				
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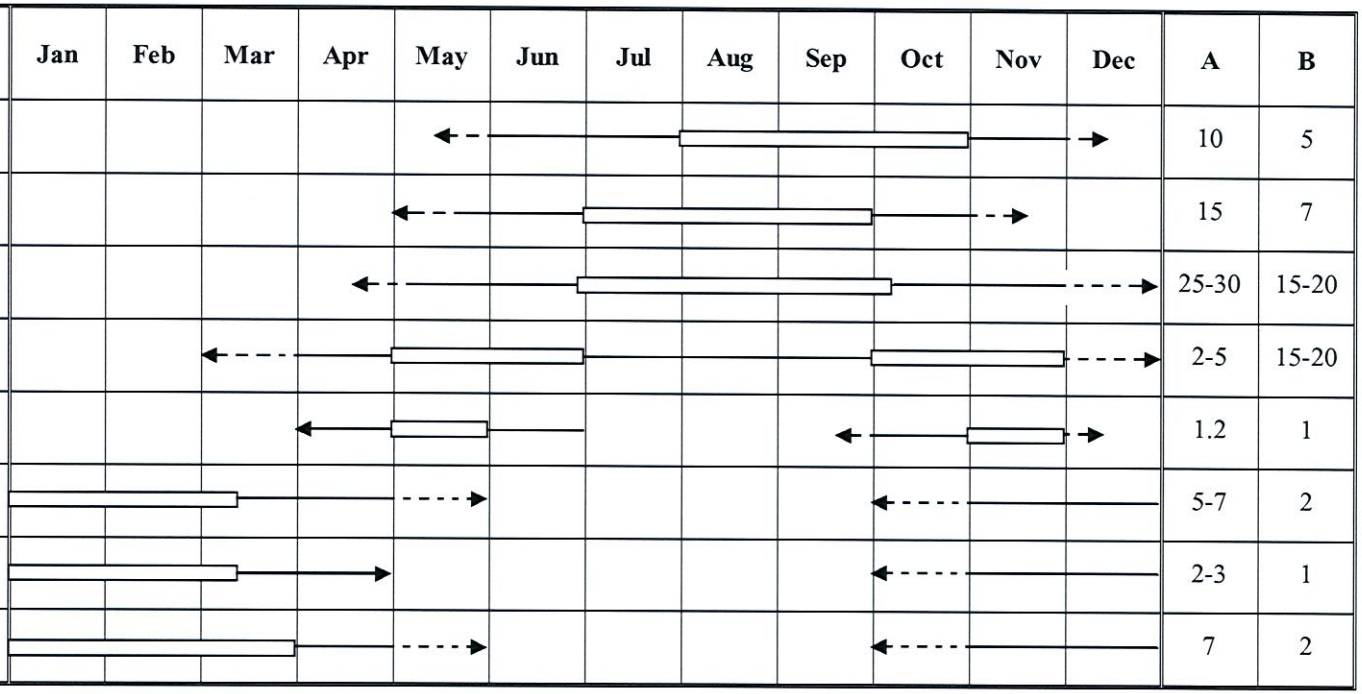
Rev No	*0*				

Annex C - Principal Areas Affected and Months in which Tropical Storms Normally Occur

Area and Local name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	A	B
North Atlantic, West Indies region (hurricane)													10	5
North-East Pacific, (hurricane)													15	7
North-West Pacific, (typhoon)													25-30	15-20
North Indian Ocean Bay of Bengal (cyclone)													2-5	15-20
North Indian ocean Arabian Sea (cyclone)													1.2	1
South Indian ocean W of 80°E (cyclone)													5-7	2
Australia E, NW, N coasts and Queensland coast (hurricane)													2-3	1
Fiji, Samoa, New Zealand (North island) (hurricane)													7	2



Column A: Approximate average frequency of tropical storms each year.
Column B: Approximate average frequency of tropical storms each year which develop Force 12 winds or stronger

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Issue No.	***1***				
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Rev No	***0***				

ANNEX 6 Information Sheet for Fishermen

Ophir Myanmar AD-03 Block Seismic Survey

Ophir Energy Myanmar (Block AD-3) Limited (Myanmar Branch) (Ophir) proposes to conduct a three-dimensional seismic survey in the AD-03 Block offshore from the Rakhine region in Myanmar, in the eastern Bay of Bengal.

The AD-03 Block is approximately 10,000 km^2 in area and is located at 124 km west of Myanmar's north-western coast (64 km from Mung Aung Island). Boundary coordinates of the AD-03 Block are provided on the map overleaf. The survey will cover the entire block.

The survey is planned to commence in mid-March 2015 and is expected to take approximately 105 days to complete (longer if there is down time due to weather). It is expected that the survey will be completed by the end of June 2015.

The survey will be undertaken using the seismic survey vessel M/V S*anco Sword*, operated by Dolphin Geophysical.

The *Sanco Sword* will be supported by a support vessel, the M/V *Rig Andromeda*, and also by two additional chase vessels, the M/V *7-Waves* and the M/V *Swissco Synergy*, to manage interactions with shipping traffic and fishing vessels.

The survey will comprise a 3D seismic acquisition area of ~9,898 km² (i.e. complete block coverage). The 3D seismic data will be performed via towed streamer technique, using airgun arrays as seismic sources.

The *Sanco Sword* will be towing a cable (streamer) array consisting of 12 streamers each 7 km in length. The maximum width of the streamer array is 2 km.

The Sanco Sword will be moving through the survey area at a speed of 4 knots (8-9 km per hour) and will have an extremely limited capability to maneuver.

For more information please contact either the Dolphin or Ophir representatives in Myanmar (contact details opposite).

Sanco Sword

Sanco Sword Contact Details

Call sign:	ZDNE7
VSAT:	+47 23 67 30 63
INMARSAT B:	+870 773169876
INMARSAT C:	423600873
MMSI:	236111902
Email:	Bridge.sword@sanco.no

The *Sanco Sword* and the support/chase vessels will all be monitoring VHF and HF on the normal channels

Dolphin Geophysical and Ophir Energy Contact Details

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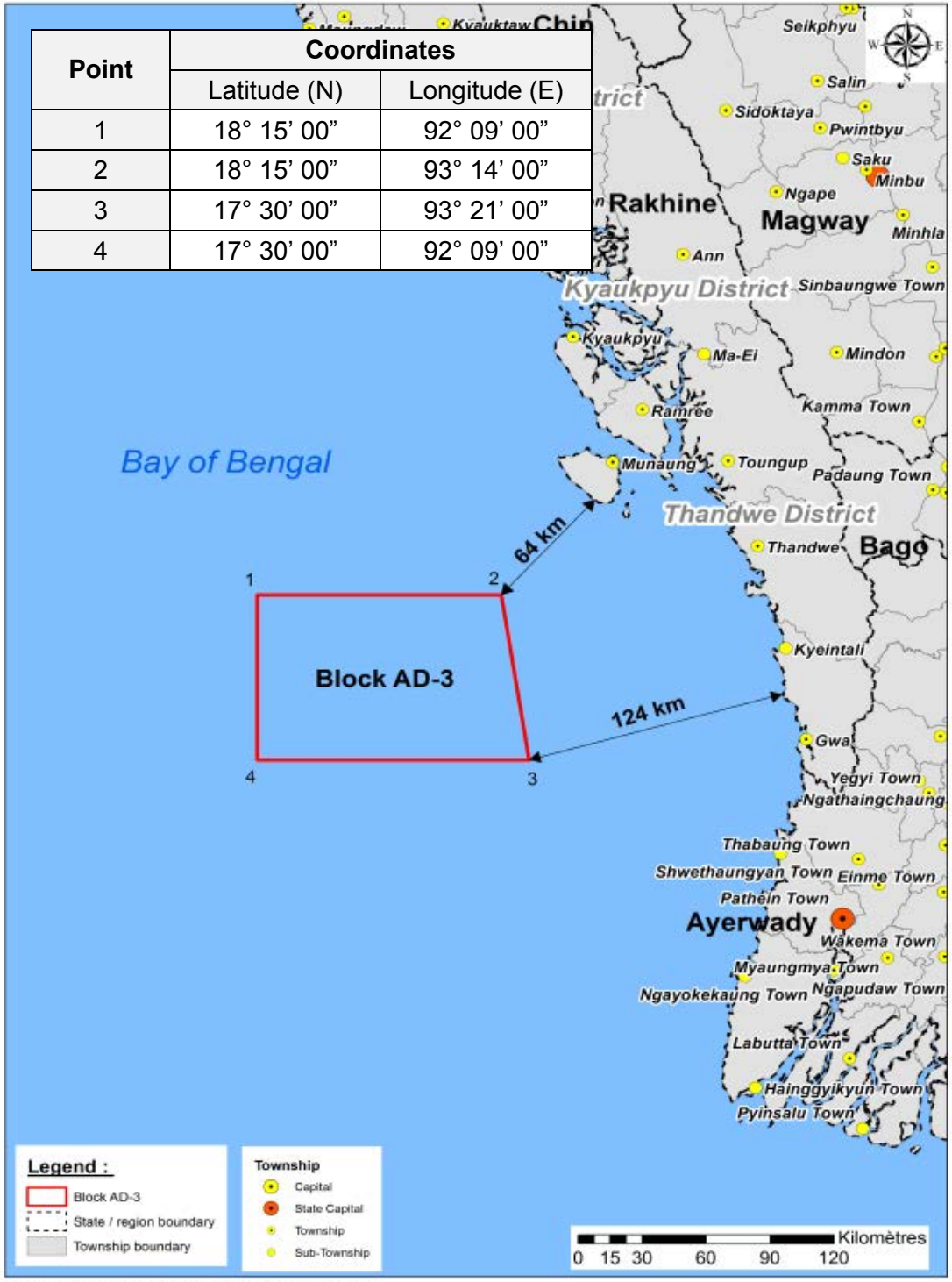
Tel: +95 1 255197
M: +95 94202 20776 / +95 9 7349 4357 / +65 9233 8356
E-mail: andrew.chapman@ophir-energy.com

Point	Coordinates	
	Latitude (N)	Longitude (E)
1	18° 15’ 00”	92° 09’ 00”
2	18° 15’ 00”	93° 14’ 00”
3	17° 30’ 00”	93° 21’ 00”
4	17° 30’ 00”	92° 09’ 00”



Source : Myanmar Information Management Unit (MIMU)

Support/Chase Vessels

Rig Andromeda

7-Waves

Swissco Synergy

Towed Seismic Array