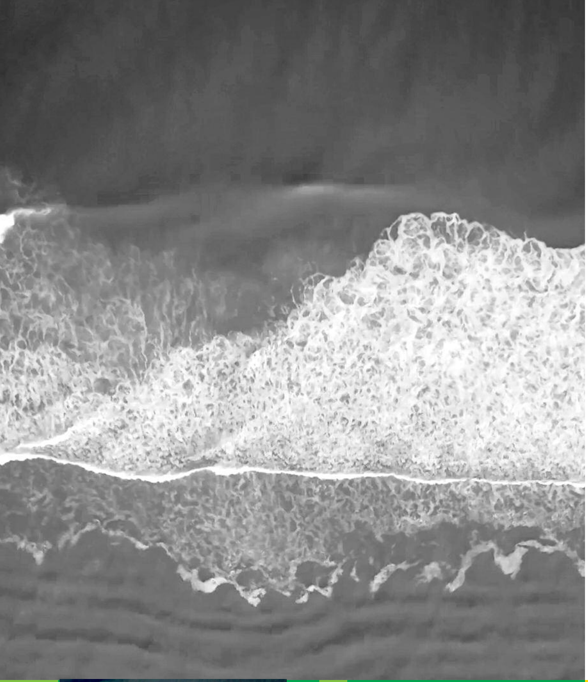

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Ministère de l'Environnement et du Développement Durable

Direction de l'Environnement et des Établissements Classés

Greater Tortue / Ahmeyim Phase 1 Gas Production Project

Environmental and Social Impact Assessment

Consolidated Final Report Including Regulatory Reviews from Mauritania and Senegal

June 2019

Volume 1 of 7

bp

In partnership with

KOSMOS ENERGY
PETROSEN
SMHPM محروقات ومعادن

ESIA report produced by

GOLDER
CSA Ocean Sciences Inc.
Ecodev
ENVIRONMENTAL TROPICA CONSULTANTS

The report on the environmental and social impact assessment for the Greater Tortue/Ahmeyim Phase 1 Gas Production Project is divided into 7 volumes as follows:

Volume 1: The Non-Technical Summary, the list of Main Contributors to the ESIA, the Table of Contents, the list of Abbreviations and Acronyms, as well as Chapters 1 to 6

Volume 2: Chapter 7

Volume 3: Chapters 8 to 11 as well as the Bibliography and References

Volume 4: Appendices A to J

Volume 5: Appendices K to O

Volume 6: Appendices P to R

Volume 7: Appendices S to Y

The present document is **Volume 1** which contains:

- Non-Technical Summary
- Main Contributors to the ESIA
- Table of Contents as well as the lists of tables, figures, photos and appendices
- Abbreviations and Acronyms
- Chapter 1 - Introduction
- Chapter 2 - Description and Justification of the Projet
- Chapter 3 - Regulatory and Institutional Framework
- Chapter 4 - Description of the Host Environment
- Chapter 5 - Analysis of Alternatives and Description of the Chosen Project
- Chapter 6 - Public Consultation

FOREWORD

This document, dated June 2019, is a consolidated version of the Environmental and Social Impact Assessment (ESIA) report submitted in June 2018 and approved by Mauritanian and Senegalese authorities in December 2018.

This consolidated version reflects the comments received in parallel from both the Department of Environmental Control (*Direction du Contrôle Environnemental* – DCE) in Mauritania and the Department of Environment and Classified Establishments (*Direction de l'Environnement et des Établissements Classés* – DEEC) in Senegal during the course of the ESIA review and approval process.

NON-TECHNICAL SUMMARY

1. INTRODUCTION

In 2015 and 2016, gas was discovered in deep water offshore of the Islamic Republic of Mauritania (Mauritania) and the Republic of Senegal (Senegal). It is one of the largest gas discoveries offshore of West Africa in history. The proposed gas production project, called the Greater Tortue/Ahmeyim (GTA) Phase 1 project, is the first step for developing this discovery.

The project will be conducted by a group of partners:

- BP Mauritania Investments Limited (BPMIL) and BP Senegal Investments Limited (BPSIL), together called BP in this document, are the current joint project operators pursuant to the joint operating agreements;
- Kosmos Energy Mauritania (KEM) and Kosmos Energy Investments Senegal Limited (KEISL), together called Kosmos in this document;
- Société des Pétroles du Sénégal (PETROSEN); and
- Société Mauritanienne des Hydrocarbures et de Patrimoine Minier (SMHPM).

An Environmental and Social Impact Assessment (ESIA) has been prepared for this project. It has been conducted by two international environmental consulting firms, Golder Associés Ltée (Golder) and CSA Ocean Sciences Inc. (CSA), in collaboration with a Mauritanian firm, Ecodéveloppement (Ecodev) and a Senegalese firm, Tropica Environmental Consultants (Tropica). Several Mauritanian and Senegalese experts have been involved in the ESIA preparation. Additionally, specialized firms have been contracted for specific studies supporting the ESIA.

The ESIA has been prepared in accordance with requirements detailed in the Terms of Reference approved by the Ministries of Environment and Sustainable Development of Mauritania and of Senegal. It has also been prepared in consideration of International Finance Corporation (IFC) environmental and social performance standards and guidance.

The methodology used for the ESIA included extensive data collection in Mauritania and Senegal to characterize the host environment of the project. This included surveys in the sea along the maritime border of Mauritania and Senegal. Photographs and video of seafloor features were taken. Several photographs are included in the ESIA report. Modelling tasks and quantitative assessments were conducted to support the impact assessment and their results are presented in dedicated reports appended to the ESIA report.

The ESIA report includes 11 chapters, a bibliography, and 25 appendices, organized as follows:

- Chapter 1: Introduction
- Chapter 2: Description and Justification of the Project
- Chapter 3: Regulatory and Institutional Framework
- Chapter 4: Description of the Host Environment
- Chapter 5: Analysis of Alternatives and Description of the Chosen Project
- Chapter 6: Public Consultation
- Chapter 7: Identification and Analysis of Impacts (Including Mitigation Measures)
- Chapter 8: Risk Study and Occupational Risk Assessment
- Chapter 9: Environmental and Social Management Plan

- Chapter 10: Surveillance and Monitoring Plan
- Chapter 11: Conclusion
- Bibliography and References.

The appendices are numbered from A through Y, several of which include more than one document. They are organized as follows:

A. Terms of Reference of the ESIA Approved by the *Direction du Contrôle Environnemental* (DCE) of Mauritania and the *Direction de l'Environnement et des Établissements Classés* (DEEC) of Senegal

B. Technical Specifications of the Project's Infrastructures, Vessels, Helicopters and Other Equipment, and Support Documentation

C. BP's Health, Safety, Security, Environmental & Operating Policy for Mauritania and Senegal

D. Environmental Baseline Survey Report

E. Fishery Resources, Fisheries and Fishing Communities Reports

F. Notes on Protected Areas

G. Biophysical Baseline Support Material

H. Social Baseline Support Material

I. Hydrodynamic (Coastal Erosion) Baseline Situation and Modeling Reports

J. Air Emissions Modeling Report

K. Water Discharges Calculations and Produced Water Modeling Report

L. Muds and Cuttings Dispersion Modeling Report

M. Plankton Entrainment Modeling Report

N. Accidental Events Modeling Reports

O. Risk Study Support Material

P. Indicative List of Project Facilities Classified for Environmental Protection (ICPE)

Q. Public Consultation Reports

R. Material Safety Data Sheets (MSDS)

S. Preliminary Waste Management Plan

T. Preliminary Decommissioning Plan

U. Monitoring Plan of the ESMP and SMP by the Mauritanian and Senegalese Authorities

V. Technical Committee Meetings for the Pre-Validation of the ESIA (Senegal)[1]

W. Public Hearing (Senegal)

X. Public Enquiry (Mauritania)[2]

Y. Environmental Authorizations.

2. DESCRIPTION AND JUSTIFICATION OF THE PROJECT

The objective of the project is to extract, process, and export liquefied natural gas (LNG). Up to 2.5 million tonnes of LNG will be produced per year. The project will also make gas available for use in both countries.

The natural gas will be extracted from rock formations deep under the seabed, located about 125 km from the coast, on each side of the Mauritania and Senegal maritime border. The project will extract the gas from the field and bring it through a pipeline system via a floating production, storage and offloading vessel (FPSO) to a facility in nearshore waters, close to N'Diago and Saint-Louis, where it will be treated, liquefied and exported by large vessels.

The infrastructure and operations required either in Mauritania or in Senegal for that first phase will be part of one project. The justification for this project lies in the interest of the two countries to develop their offshore oil and gas resources. Benefits for the countries will include resource revenues: income revenues through the share of PETROSEN and SMHPM in the project as well as the states' shares of LNG sales, and taxes.

Due to the scale of the gas field, the current project is Phase 1 of a potential larger development. Only Phase 1 is covered in the current document. If expansion is proven to be viable, separate ESIAs will be prepared that will cover the future phases of development.

Key Project Components

The project includes three key components: an Offshore Area, a Pipeline Area and a Nearshore Hub/Terminal Area. Their location is shown on Figure NTS-1.

[1] This appendix includes the official proceedings of the ESIA pre-validation meeting in Senegal held on July 26 and 27, 2018, as well as a tracking table of the responses to the observations noted in the official proceedings and cross-references to the revised ESIA sections. In addition, this appendix also contains the official proceedings of the Select Technical Committee meeting held on October 22, 2018, as well as a tracking table of the responses to the observations noted in these proceedings.

[2] This appendix includes the summary of the Public Enquiry Report for the ESIA of the Greater Tortue/Ahmeyim Phase 1 Gas Production Project dated November 2018 as well as a tracking table of responses to the comments noted in this document.

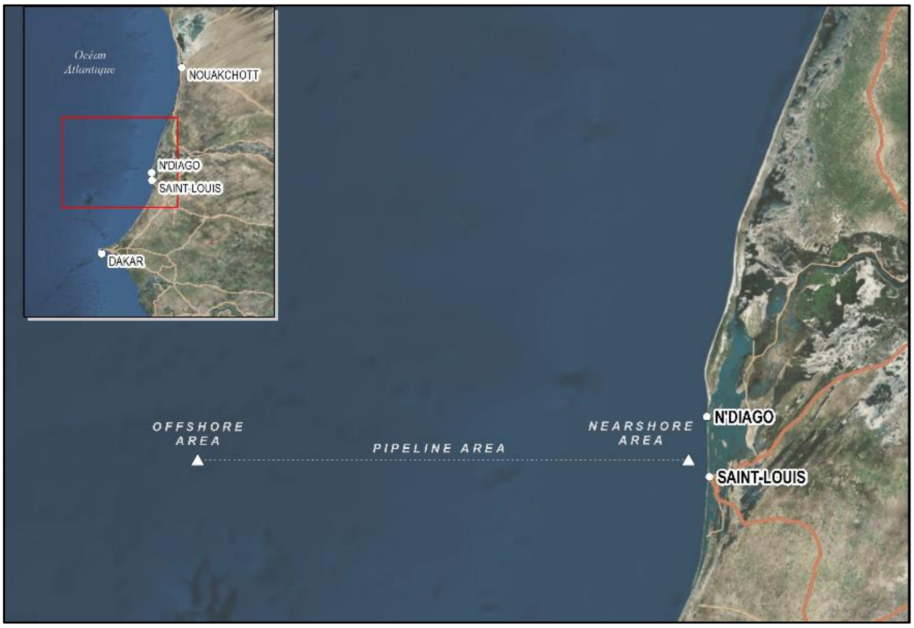

Figure NTS-1. Project Location.

The three key components planned for the project are summarized below and illustrated on Figure NTS-2:

- The Offshore Area: It is located about 125 km from the coast and in about 2,700 m water depth. The Offshore Area is where the gas reservoirs under the bottom of the sea have been identified. The gas will be collected via 12 wells and a subsea production system, then transported via pipeline.
- The Nearshore Hub/Terminal Area: It is located about 10 to 11 km from the coast, in a water depth of about 33 m, on the Mauritania and Senegal maritime border. The Nearshore Hub/Terminal Area is located approximately 16 km from N'Diago and 13 km from Saint-Louis. The nearshore infrastructure will include a breakwater approximately 1 km long, associated berthing facilities and space, a Floating Liquefied Natural Gas processing vessel (FLNG) and a quarters and utilities (QU) platform for workers. Aboard the FLNG, processing will cool the natural gas to temperatures below -160 °C in order to bring it to a liquid state (LNG), thus enabling storage and long-distance transportation. The LNG will be transported and exported to markets by large vessels called LNG carriers. These vessels will visit the Nearshore Hub/Terminal on a periodic basis.
- The Pipeline Area: It is a narrow corridor where pipelines on the seafloor will connect offshore and nearshore infrastructure. In this corridor, the infrastructure will include an FPSO for gas pre-processing including the removal of liquids from the gas. These liquids, called condensate, will be stored aboard the FPSO, then offloaded and exported from the FPSO on a periodic basis by large vessels. The FPSO will be located in 120 m water depth, approximately 40 km from the coast.

The project also includes an on-land component called the Support Operations Areas. These will serve as onshore logistics and supply centers. Current plans envisage a supply base in the Port of Dakar and/or in the Port of Nouakchott, and facilities at the airports of both Dakar and Nouakchott.

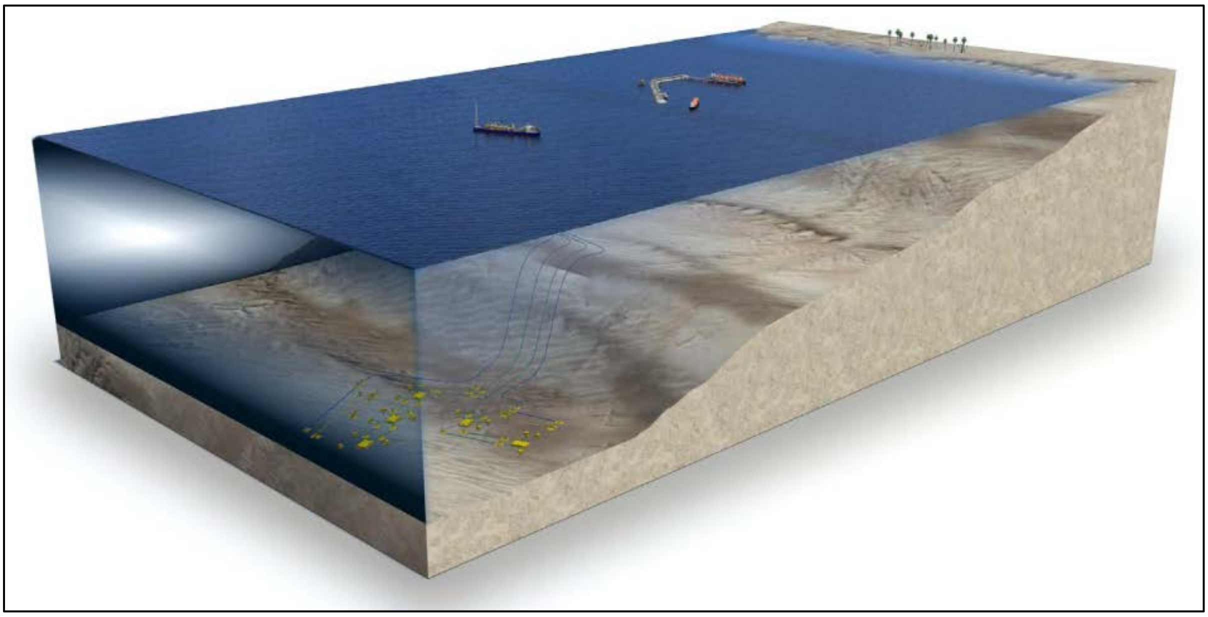

Figure NTS-2. Illustration of the Project Key Components.

Project Phases and Schedule

The GTA Phase 1 project includes three phases:

- The Preparation, Construction and Installation Phase, called Construction Phase in the ESIA: This phase will consist of construction and installation of infrastructures and of drilling of the wells. This phase is expected to start in 2018.
- The Operations Phase: During the Operations Phase gas will be extracted, treated, liquefied and exported. There will also be ongoing development drilling during this phase but for the purpose of the ESIA, drilling has been regrouped under the Construction Phase. The first facilities are expected to be operational on location end of 2021. The Operations Phase of the Phase 1 development is based on an anticipated 20-year contract duration of the FLNG vessel.
- The Decommissioning Phase: Gas production will eventually cease and equipment may be retired (or removed). This phase will start after the Operations Phase and could last several years.

Main Activities during the Project Phases

Construction Phase

During the Construction Phase, installation of subsea equipment, pipeline laying and construction of the breakwater will be completed by several large construction vessels supported by a fleet of smaller vessels. The FPSO and FLNG will be towed or will sail to their locations under their own power. The construction activities will involve marine traffic associated with supply vessels and crew transport. The crew on the construction vessels will be working on rotating shifts of several weeks duration, and the crew will be transported to and from Dakar and/or Nouakchott by crew boats.

Gas extraction will require the drilling of multiple wells by a drillship. Drilling is planned to be conducted from the Ensco DS-12 (formerly the Atwood Achiever; see Photo NTS-1), or a similar drillship. The drillship will be equipped with rooms for personnel, a canteen, a medical unit, a helideck, and emergency systems including fire protection and firefighting equipment and escape, evacuation and rescue systems. Crew will be assigned to the drillship for several weeks at a time, with crew changes to the drillship done by helicopter. The drilling of each well will take about 60 to 70 days. Drilling up to 12 wells may occur over several years.

Photo NTS-1. The Ensco DS-12.

Operations Phase

During the Operations Phase, the wells, subsea production system, pipelines, FPSO and FLNG will be put in operation. This phase will also include tanker movements to export condensate from the FPSO and LNG from the Nearshore/Hub Terminal. Operations activities will involve marine traffic associated with tankers, support vessels and crew transport. Personnel will live aboard the FPSO and on the QU platform at the Nearshore/Hub Terminal Area. They will work on several week assignments and crew changes will be done by boat.

Decommissioning Phase

During the Decommissioning Phase, the wells will be permanently sealed, all systems will be shut-down, and equipment will be retrieved and dismantled as required in accordance with the decommissioning plan to be established. These operations will involve the movement of large construction vessels and smaller support vessels. At the time of the ESIA development, it is envisaged that components of the breakwater will be left in place to serve as an artificial reef. A detailed decommissioning plan will be established prior to this phase. It will describe decommissioning activities in detail including infrastructure to be removed. It will comply with regulatory requirements applicable and to the good international industry practice at the time of decommissioning. However, a preliminary decommissioning plan is included in the ESIA.

Onshore Activities

During the three project phases, the main onshore activities will comprise logistic support and transportation of equipment, supplies, and personnel by vessel from supply bases located in the Ports of Dakar and/or Nouakchott. Additionally, the airports of both Dakar and Nouakchott will be used for arriving and departing project personnel. They will also be used for transportation of personnel to the Offshore Area by helicopter, as needed.

Exclusion Safety Zones and Navigation

During the project, exclusion safety zones will be established around the facilities at sea to minimize the risk of collisions with other sea users and to prevent access to facilities by non-authorized personnel. During the Construction Phase, an exclusion safety zone of about 500 m will be applied around the drillship and around large construction vessels.

During the Operations Phase, an exclusion safety zone of about 500 m X 600 m will be applied around the breakwater and a 500 m exclusion safety zone will be applied around the FPSO. There will also be a moving exclusion safety zone around an LNG carrier in transit, necessary for the safe entry and exit of individual carriers.

The boundaries of exclusion safety zones will be demarcated or communicated to relevant stakeholders. A project patrol boat will stand by the breakwater 24/7 to deter incursions in the exclusion safety zone by non-project vessels. Project personnel aboard the patrol vessel will be unarmed. If non-project vessels make their way through the exclusion safety zone, the project personnel will follow security protocols pre-agreed with Mauritania and Senegal authorities.

Project Vessels

The project involves the use of several vessels, notably during the Construction Phase. All vessels will meet applicable requirements and comply with International Maritime Organization (IMO) standards relevant to their proposed use, for instance double-hulled vessels for LNG and condensate carriers. The IMO is the specialized agency within the United Nations responsible for the safety and security of shipping and the prevention of marine pollution by ships.

For the Construction Phase, current plans envisage a floating accommodation barge (flotel) based close to the Nearshore Hub/Terminal Area. It will accommodate about 250 people and will be used for several months until the QU platform at the Nearshore Hub/Terminal Area is available for workers. The flotel will likely include living quarters, medical office, crane and helideck for medical emergencies.

Demand and Supply of Energy and Water

Limited energy and freshwater will be required for the project from sources in Mauritania and/or Senegal. Most demands for energy will be supplied either by the vessels or by the produced gas while freshwater will mostly be generated from seawater via on-board desalination units.

Demand and Supply of Material and Equipment

For the construction of the breakwater, an estimation of materials required has been detailed in the ESIA. Suitability of materials will be assessed, including for geotechnical and environmental suitability. The FPSO, QU platform, and FLNG will be constructed outside of Mauritania or Senegal, and will be sailed to the project area. For non-specialized equipment, local supply chains may be utilized.

Chemicals and Hazardous Materials

A variety of non-hazardous and hazardous chemicals will be used during the three phases of the project. During the Construction Phase, chemicals will be required for the well drilling process and for pipeline installation. During the Operations Phase, chemicals will be required to allow safe and efficient operations, notably on the FPSO and FLNG. At the Nearshore Hub/Terminal Area, including the QU platform, only minimal volumes of chemicals and hazardous materials are expected. The supply bases at Dakar and/or Nouakchott will be used for temporary storage of chemicals and hazardous materials prior to being shipped offshore via the supply vessels. During the Decommissioning Phase, the selected chemicals will depend on the decommissioning approach at the time.

Air Emissions

Engines used during all phases of the project will produce air emissions which will vary according to the size of the engine, fuel source, engine load, and the duration of engine operation. Detailed emissions forecast for each major operational source have been estimated in the ESIA.

Effluent Discharges

During the three project phases, the operations will involve the discharge of effluents (i.e. waters that need to be evacuated). Treatment, when required, will be done aboard the drillship, FPSO, FLNG, QU platform, and support vessels to meet applicable limits before any effluents are discharged to the sea.

Effluent discharges from the drillship will include drilling muds and cuttings, and general vessel discharges, the latter of which will also occur from other project vessels. These vessel discharges will comply with applicable regulations of the International Convention for the Prevention of Pollution from Ships (MARPOL).

Discharges from the FPSO will include cooling water, treated produced water, desalination brine, and general vessel discharges, with the largest discharge being cooling water. These discharges will meet applicable MARPOL regulations and IFC standards.

Discharges from FLNG operations will notably include cooling water and desalination system discharges. Cooling water will be discharged at a water depth of approximately 3 to 5 m. It will be discharged laterally and the temperature differential between effluent and ambient will be reduced to within 3 °C at the edge of a mixing zone where initial mixing and dilution take place as per IFC requirements. Detailed discharges forecast for each major operational source have been estimated in the ESIA.

Solid Waste

Solid waste composed of non-hazardous and hazardous waste will be generated during the three project phases. Vessels and project facilities will produce a range of solid wastes. Detailed solid waste forecast for each major operational source have been estimated in the ESIA. Those solid wastes requiring disposal will be transported to shore for future disposal or treatment. Measures will be applied to ensure the compliance of the operations with the MARPOL Convention and a detailed waste management plan will be developed and implemented. However, a preliminary waste management plan is included in the ESIA.

Light and Noise Emissions

Light and project-related noise will be generated during all phases of the project. Light sources will primarily be operational lighting on vessels and infrastructures, while sounds in air and underwater will be generated from vessel and equipment operation as well as the occasional helicopter flight.

Personnel and Local Content Approach

Because the project is being conducted at sea, almost all employment opportunities will be offshore and the personnel will be living on the vessels or the QU platform. Manpower needs for offshore activities have been estimated for each of the three project phases in the ESIA.

During the Construction Phase, offshore manpower need is estimated to be 1,500 people, but most of the vessels will be staffed with their own international personnel. However, some of the support vessels could require staffing by Mauritania and/or Senegal nationals. BP's local content approach will be included in the contractor selection process, with an expectation that contractors take local sourcing in terms of people, goods and services into consideration in their final execution plans. During the Operations Phase, offshore manpower need is estimated to be approximately up to 400 people, part of whom will be nationals, with recruitment also targeting local communities, where possible. Offshore manpower needs during the Decommissioning Phase will depend on the technology that will be used at the time of decommissioning.

Onshore direct manpower needs during each of the three phases are estimated to be between 20 to 50 people, part of them Mauritania and/or Senegal nationals. In addition, during the Construction and Operations Phases, up to 20 community and fisheries liaison officers will also be recruited from N'Diago and Saint-Louis communities.

The type of services to be procured in Mauritania and Senegal will vary according to the project phase needs, and the services available in these countries. The in-country employment and procurement opportunities will change and grow through time over the course of the project. It is expected that people from the two countries will progressively be trained to fill positions initially filled by international staff. Similarly, some national companies would be expected to progressively develop and over time provide services initially provided by international companies.

Social Investment

The overall purpose of the GTA Phase 1 project social investment activities is to provide positive benefits through the promotion of sustainable socio-economic development for the local communities located near the GTA Phase 1 project in Mauritania and Senegal. The social investments will aim to create long-term partnerships and build the capacity of local community and authorities.

BP's general approach to social investment is to: 1) consult with relevant stakeholders; 2) select partners for the implementation of social investment activities using a transparent process; 3) use participatory practices to involve local stakeholders as much as possible in the implementation and/or monitoring of these activities.

BP, on behalf of partners, implemented this approach and consulted with a range of stakeholders including communities, NGOs (local and international) and local and national government representatives to develop the focus for GTA Phase 1 project's social investment activities in Mauritania and Senegal. As such, priority of social investment will be given to activities focusing on education, economic development, environmental initiatives, community health and safety activities, and capacity building and institutional strengthening.

Health, Safety, Security and Environment

As project operator, BP will implement operational procedures outlined in its project-specific Health, Safety, Security and Environment (HSSE) Management Plan for the GTA Phase 1 project. Compliance with the GTA Phase 1 project HSSE Management Plan will help enable BP and its contractors to conduct project activities in a safe and environmentally sound manner.

BP is also developing a Source Control Emergency Response Plan (SCERP) to be implemented in the unlikely event of a major accident. Additional operational procedures will include implementation of an Oil Spill Contingency Plan (OSCP) which identifies: 1) lines of communication and control, 2) mechanisms to assess the extent of the spill, and 3) predeployment of available resources for spill response. Should they be required, these procedures would be implemented in coordination with Mauritanian and Senegalese authorities.

3. REGULATORY AND INSTITUTIONAL FRAMEWORK

In February 2018, Mauritania and Senegal signed an Inter-State Cooperation Agreement for the exploitation of the cross-border GTA gas resources. To date, no supranational institution, with its own legal personality, has been created for the project.

In Mauritania, the Ministry of Petroleum, Energy and Mines (*Ministère du Pétrole, de l'Énergie et des Mines*) is the Home Ministry for the project. Key ministries likely to be involved or interested in the project also include the Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et du Développement*) and the Ministry of Fisheries and Maritime Economy (*Ministère des Pêches et de l'Économie Maritime*).

In Senegal, the Home Ministry for the project is the Ministry of Oil and Energies (*Ministère du Pétrole et des Énergies*). Other key ministries and institutions likely to be involved or interested in the project include the Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et* *du Développement Durable*), the Ministry of Fisheries and Maritime Economy *(Ministère des Pêches et de l'Économie Maritime*), the High Authority for Maritime Security, Maritime Safety and Marine Environment Protection (*Haute Autorité chargée de la Coordination de la Sécurité maritime, de la Sûreté maritime et de la Protection de l'Environnement marin* - HASSMAR), and the Strategic Orientation Committee for Oil and Gas (Cos-Petrogaz).

In both countries, a Hydrocarbon Exploration and Production Contract or a Hydrocarbon Exploration and Production Sharing Contract has been signed between the State and the project proponent. These contracts provide a legal framework for the GTA Phase 1 project. They set a series of obligations for the project proponent, including for the protection of the environment. Additionally, several national laws and regulations will apply to the project, notably the Environment Codes (*Lois portant Code de l'Environnement*) of each country.

Furthermore, several international conventions and agreements to which Mauritania and/or Senegal are adherents, are relevant to the project activities. These international conventions and agreements aim to: 1) regulate vessel operations and prevent marine pollution, with for instance, the MARPOL Convention; 2) protect species, heritage and biodiversity, with for instance, the Convention on the Conservation of Migratory Species (Bonn Convention); and 3) regulate hazardous wastes and/or persistent substances, with for instance, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

Finally, the project will comply with good international industry practices for the oil and gas industry. International oil and gas industry standards are reflected in BP's HSSE and social responsibility corporate policies that will apply to the project.

4. DESCRIPTION OF THE HOST ENVIRONMENT

The hosting environment of the project is located in the maritime waters of Mauritania and Senegal. The ESIA study area includes these waters and the coastal zone between Dakar and Nouakchott, particularly the coastal communities of N'Diago and Saint-Louis, neighboring the proposed Nearshore Hub/Terminal Area.

The core study area under consideration in the ESIA includes the areas where the impacts of routine project-related operations could potentially occur. The extended study area encompasses a broader area in recognition that accidentally released hydrocarbons could be transported via ambient currents and winds.

The description of the baseline situation has been prepared using an extensive set of data sources, and supplemented by project-specific field work. An Environmental Baseline Survey (EBS) was conducted in 2016 in Mauritanian and Senegalese waters. EBS data collection included water column profile information, water quality data, sediment quality data, and faunal information including ichtyoplankton, i.e. fish eggs and larvae. A geological and geophysical (G&G) survey conducted in 2017 along the Mauritania-Senegal maritime border provided additional data on fish plankton and zooplankton, and photographic and video data of seafloor features.

Biophysical Environment

The project is located in the southern portion of the Canary Current Large Marine Ecosystem (CCLME). The CCLME is one of the world's major cold water upwelling boundary current large marine ecosystems, ranking third in the world in terms of primary productivity and having the highest fisheries production of any African large marine ecosystem.

Surface currents of offshore waters are variable, but tend to exhibit predominantly west to southwestward movement, due to the influence of the Azores and Canary Currents.

The 400 km coastal shoreline between Dakar and Nouakchott is mostly sandy. The Senegal River delta is one of the most prominent features of the coastline. An extensive sand spit is present, including the Langue de Barbarie, intersected by the mouth of the Senegal River which was cut in 2003. The initial channel cut was 4 m wide, but has expanded to a few kilometers, with associated changes in river outflow, sediment transport, and effects on local hydrography including coastal erosion. The Senegalese coastal zone is considered to be sensitive to any future sea level rise. Similar projections may also apply to the southern Mauritanian coastal environment, which features the same physical geography as northern Senegal.

Major biological resources in the ESIA study areas include plankton, benthic communities, fish and other fishery resources, birds, marine mammals, and sea turtles. Protected areas and other areas of conservation interest have also been characterized in the ESIA.

Plankton

Plankton refers to the microscopic organisms of flora and fauna that are found in the water column, drifting with ocean currents. The ocean waters along the coast of Mauritania and Senegal are generally characterized by high nutrient concentrations and corresponding high phytoplankton biomass due to either year round or seasonal coastal upwelling of cold, nutrient-rich water. The zooplankton sampling conducted during the EBS and G&G survey produced a listing of zooplankton composition and abundance based on day-night, depth strata, and seasonal sampling. During this process, site-specific fish plankton were collected and the results provide data on the composition and abundance of fish eggs and larvae in different water depths along the Mauritania-Senegal border, and at different times of the year.

Benthic Communities

Benthic communities are comprised of organisms that live in and on the bottom of the sea. The sediment samples collected during the EBS provide site-specific data on the diversity, abundance and taxonomic composition of soft bottom fauna living in the sediment. The results show that these organisms were broadly similar to patterns observed for the region.

Identification and characterization of potential hard bottom features (i.e., carbonate mounds) located along the proposed pipeline corridor was initiated during the G&G survey to help ensure avoidance of these potentially sensitive features. Photographs were taken using an autonomous underwater vehicle in water depths up to more than 2,500 m. These regionally unique photographic data were reviewed to characterize substrates and associated biological communities within the study area. Photo NTS-2, was taken at more than 2,500 m water depth in the Offshore Area. At that depth, the visually dominant fauna were sea urchins and sea stars.

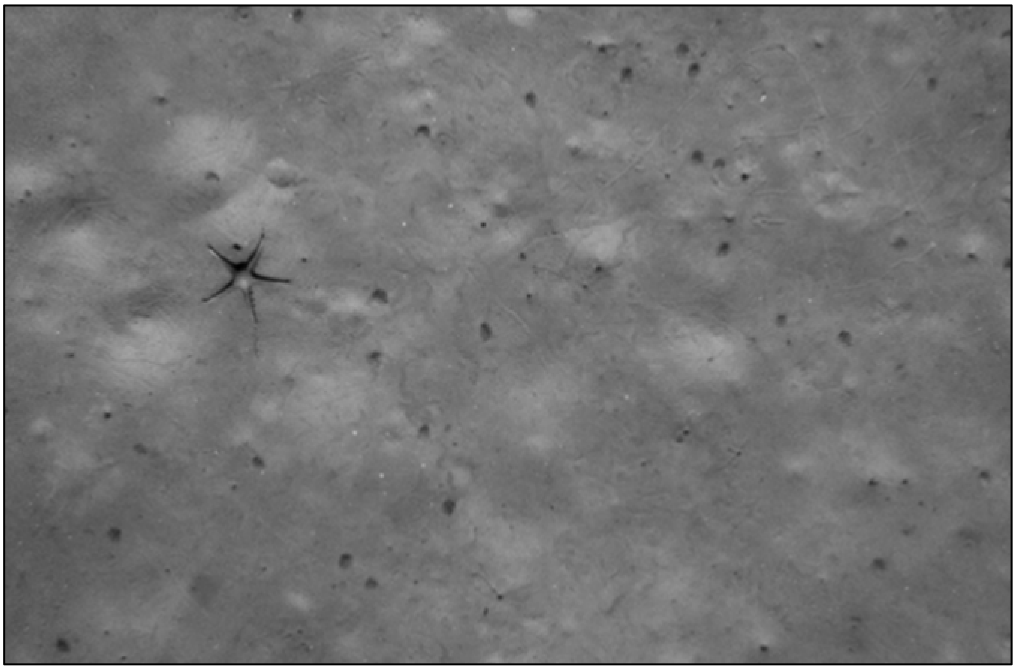

Photo NTS-2. Picture of the Sea Bottom taken in a Water Depth of over 2,500 m.

Fish and Other Fishery Resources

The CCLME creates a highly productive marine ecosystem with high biomass of fishes and invertebrates. Considering their habitat, these resources are categorized into two major groups: species living on or near the seafloor (demersal species) and species living in the water column (pelagic species).

Demersal species include cephalopods (octopus, squid, cuttlefishes), crustaceans (lobsters, shrimps), soft bottom fishes (e.g., some sharks, rays, hakes), and hard bottom fishes (e.g., groupers, sparids).

Pelagic species include coastal fishes (e.g., sardinellas, false shad, Cunene horse mackerel, sardine, anchovy, Atlantic horse mackerel, chub mackerels), oceanic fishes (e.g., yellowfin tuna, bigeye tuna, skipjack tuna, billfishes, swordfishes) and so-called mesopelagic fishes (e.g., lanternfishes, bristlemouths).

Based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species and on IUCN species-specific distribution maps, 6 Critically Endangered and 13 Endangered fish species could occur off Mauritania and Senegal.

Birds

The birds of Mauritania and Senegal include a very large number of species. The coastal zone of the two countries, including coastal waters and shorelines, is important for a number of migratory bird species. There are two marine and coastal bird species in Mauritania that are currently listed on the IUCN Red List as Critically Endangered or Endangered. None of Senegal's marine or coastal bird species are listed as Critically Endangered or Endangered.

There are 25 Important Bird and Biodiversity Areas (IBAs) in Mauritania and 17 IBAs in Senegal. Out of these 42 IBAs, 13 are located within or adjacent to the ESIA extended study area, including one marine IBA in Senegal.

Marine Mammals

There are more than 30 marine mammal species which have historically occurred in Mauritanian and Senegalese maritime waters. Of these, a total of 22 species are known to occur or are likely to occur in the ESIA extended study area waters. Six marine mammal species currently classified on the IUCN Red List as Endangered or Vulnerable could possibly or likely be present in the Mauritanian portion of the ESIA extended study area. Five marine mammal species listed by IUCN as Endangered or Vulnerable may also be present in the Senegal portion of the ESIA extended study area.

Sea Turtles

There are six species of sea turtles in Mauritania and Senegal maritime waters. All these species are currently classified within the IUCN Red List as Endangered or Vulnerable. Five of these species are likely or may possibly be present in the extended ESIA study area.

Protected Areas

There are seven protected areas that are either within or adjacent to the ESIA extended study area. In Mauritania, these protected areas are the Diawling National Park and Chatt Tboul Reserve. In Senegal, the protected areas are the Langue-de-Barbarie National Park, Guembeul Natural Reserve, Saint-Louis Marine Protected Area, Cayar Marine Protected Area, and Parc National des Iles de la Madeleine.

Additionally, the ESIA extended study area includes the United Nations Educational, Scientific and Cultural Organization (UNESCO) Senegal River Delta Transboundary Biosphere Reserve, which includes areas in both Mauritania and Senegal. The Reserve encompasses land and water centered on the Senegal River.

Social Environment

The sea and its resources play an important role in the economy of Mauritania and Senegal. The population of Mauritania is estimated at over 3.5 million people and the population of Senegal is estimated at over 13 million.

The Mauritanian portion of the ESIA core study area includes a coastal strip between the city of Nouakchott (about 1 million inhabitants) and the Mauritania-Senegal border. South of Nouakchott, the coast is sparsely populated and the main human settlement is the fishing village of N'Diago. The village is located on the right bank of the Senegal River, on the northern extension of the Langue de Barbarie, less than 10 km from Saint-Louis in Senegal. The village of N'Diago (about 1,200 inhabitants) belongs to the Commune of N'Diago (about 6,000 inhabitants). Additionally, other villages and fishing camps are located between Nouakchott and N'Diago.

The economic activities in the village of N'Diago are mainly related to artisanal fishing. Some men practice the latter in N'Diago, but the majority operate off the coast of Nouadhibou or Nouakchott where the fishery resources are much more plentiful.

In N'Diago, several dozen women are involved in the fresh fish trade and artisanal processing and sell their products notably in the border city of Saint-Louis.

Fishing is one of the pillars of Mauritania's national economy. Fishery resources are harvested by an industrial fleet (also called *hauturière*, and mainly foreign) as well as a coastal and an artisanal fleet (mainly national).

Fisheries are found throughout the country's maritime waters, though they are heavily concentrated in the North Zone of the country's Exclusive Economic Zone (EEZ), which is well north of the ESIA core study area. This is notably attributable to the high productivity of the waters of this area and the existence of fishing ports in Nouadhibou. More than two-thirds of Mauritania's total production volume is harvested in Mauritania's North Zone. The importance of the North Zone is particularly pronounced with regard to artisanal fishing. On average, from 2012 to 2015, the North Zone generated 76% of artisanal fishing catches in the country.

The Mauritanian artisanal fleet amounted to 6,244 units in 2016. Artisanal fishing is conducted in water depths generally less than 200 m. During the field work of April 2017, the village of N'Diago counted 40 artisanal fishing boats and close to 150 fishermen.

At a national level, fisheries employ between about 20,000 and 55,000 people in Mauritania, both fishermen and people involved in auxiliary or secondary fishing activities (processing, sales, etc.).

The Senegalese portion of the ESIA core study area includes a coastal strip between the city of Dakar (over 3 million inhabitants) and the city of Saint-Louis (over 230,000 inhabitants) located close to the Mauritania-Senegal border. In Saint-Louis, the fishing communities are concentrated on the Langue de Barbarie, which counted over 70,000 inhabitants in 2012. Other fishing communities are located between Dakar and Saint-Louis.

Fishing is one of the pillars of Senegal's national economy. Fishing is organized into two sub-sectors: artisanal fishing and industrial fishing (domestic and foreign vessels). Industrial fishing landings are concentrated in Dakar, though industrial fishing takes place off the entire Senegalese coastline.

Artisanal fishing is practiced by several coastal communities. Those of Saint-Louis are the most important historically and numerically in Senegal. In 2015, Senegal counted 19,009 artisanal fishing boats. As of 2016, Saint-Louis counted over 3,400 artisanal boats and approximately 22,000 fishermen. Fishermen do not limit themselves to waters close to the locality where they live. Senegalese fishermen, notably those from Saint-Louis, are known to travel and fish all along the coast and in neighboring countries. Still, there is an intensive artisanal fishing activity in the coastal waters near Saint-Louis.

Fishermen sometimes venture into the high seas when they are in transit to other fishing grounds in Senegal or other countries of the sub-region. However, fish are generally caught in waters near the coast. Indeed, artisanal fishing techniques do not lend themselves well to fishing in water depths exceeding 200 m, with the main fishing grounds concentrated less than 15 km from the coast.

A number of economic activities related to artisanal fishing are carried out in Saint-Louis. As of 2015, 1,000 women were involved in artisanal fish processing in Saint-Louis. Their products supply local and national demand, and part of their production is exported.

Since early 2017, the social climate in the fishing communities of Saint-Louis has been tense. Three factors especially contribute to this tension: 1) the termination of the fishing agreement between Mauritania and Senegal and the loss of access to fishery resources and associated revenues from fishing in Mauritanian waters: 2) the unresolved problem of the breach of the Langue de Barbarie and associated marine safety issues for fishermen crossing the current mouth of the river; and 3) the unresolved problem of coastal erosion of the Langue de Barbarie.

At a national level, fisheries employ approximately 63,000 fishermen in Senegal, 94% of whom are artisanal fishermen. Auxiliary or secondary fishing activities employ more than 600,000 people.

In addition to being important for the economy of Mauritania and Senegal, fishing is also important for the health of the communities. Fishery resources play an important role in the households' diet and they satisfy an important part of the national population's protein requirements.

In addition to fisheries, maritime shipping is an important economic activity for both Mauritania and Senegal. An international maritime shipping channel of moderate intensity traffic crosses the western portion of the ESIA core study area on a north-south axis. Near the coast, traffic is lighter and it is mainly comprised of artisanal fishing boats except around the Port of Dakar and the Port of Nouakchott, where larger commercial vessels utilize each port.

Other marine-based activities include offshore oil and gas exploration activities, with a potential for them to develop into production operations. Submarine telecommunication cables are present on the sea floor off Mauritania and Senegal. They link other countries with each other or with Mauritania and Senegal. Coastal activities include tourism and beach recreational activities. However, these activities are limited except in Saint-Louis. In this city, tourism revolves around the city's historic and cultural heritage, and beach tourism.

5. ANALYSIS OF ALTERNATIVES AND DESCRIPTION OF THE CHOSEN PROJECT

The chosen project has been designed after studies identified the environmental and social sensitivities in the project area and after surveys and tests provided BP with a more comprehensive understanding of the availability and practicality of various design options.

Several alternatives were considered during project design, for instance regarding the location of the pipeline route, FPSO location, presence of the breakwater and its location, and the LNG processing location.

The pipeline route was chosen to avoid all relict carbonate mounds which were present in the initially selected pipeline corridor, as revealed during the G&G survey.

During project design, BP evaluated whether a breakwater located at the FLNG vessel location in the Nearshore Hub/Terminal Area was necessary. As an alternative to a breakwater, side-by-side loading in both deep and shallow water was considered. However, the necessity of a breakwater was confirmed based on wave height modeling.

Multiple breakwater locations were evaluated based on the distance of the breakwater from shore and potential effects on coastal erosion. The breakwater was modeled at three locations: approximately 4 km, 7 km, and 10 km offshore. Based on shoreline erosion and accretion modeling, it was determined that the breakwater at the 10 km from shore location was the preferred option from an environmental and social perspective, despite the significant additional cost.

The FPSO location about 40 km from shore was chosen after considering a location in the Nearshore Hub/Terminal Area and within the Offshore Area. The 40 km distance from the shoreline is out of sight of land and beyond the extent of the main artisanal fishing activities. The chosen FPSO location also reduces the risk of shoreline oiling in case of an accident and a hydrocarbon release as compared to the FPSO located at the Nearshore Hub/Terminal option.

Various options for the LNG processing location were considered, including an onshore LNG processing facility. However, the onshore LNG processing option presented problems due to the lack of available space to place the LNG facility on the cross-national border, potentially significant environmental issues due to construction of an LNG harbor and continuous dredging of the harbor to enable LNG export, the extended time required to build an onshore LNG processing facility, and the relatively high costs of onshore LNG facilities.

Given the principle of the need for parity either side of the border, the chosen project represents the best possible combination of safety, risk reduction, and minimization of environmental and social impacts while bearing in mind operational flexibility and reliability and certain financial considerations.

6. PUBLIC CONSULTATION

During the initial stage of development of the ESIA, 17 public consultation meetings were held in May and June 2017. More than 2,600 people attended these meetings. The attendees included a wide variety of stakeholders. The public assemblies in local communities included fishermen, fishermen association representatives, fishmongers, women working as artisanal fish processors, women association representatives, youth and youth association representatives, neighborhood councils or other elected representatives, local dignitaries, teachers, local association representatives, retirees and other interested citizens. The institutional stakeholder meetings included governors, prefects, subprefects, mayors, technical department government representatives, municipal and regional elected or appointed officials, scholars, civil society associations, environmental NGOs, media representatives, etc.

In all meetings, stakeholders raised important concerns regarding the project's potential impacts. The majority of the stakeholders shared concerns regarding the risk of negative impacts on the marine environment, fishery resources, fisheries and fishing communities.

Stakeholders stressed the importance of fisheries for the economy of both countries and the local communities of N'Diago and Saint-Louis. Most of the stakeholders were concerned that the project facilities and operations would have negative impacts on fisheries. They indicated that this would entail loss of revenues for fishermen, but also for the whole artisanal fisheries production and commercialization chain, which extends beyond the fishermen. However, a few experienced fishermen in Saint-Louis indicated that artisanal fisheries can live together with oil and gas activities. They gave examples based on their fishing experience in oil producing countries such as Congo, Gabon and Ghana.

In Mauritania and Senegal, stakeholders' concerns included the risk that the breakwater could contribute to the very active erosion process of the Langue de Barbarie. Concerns were also raised around maritime safety for artisanal fishermen due to density of project-related vessel traffic, and the dangers associated with project operations for coastal communities.

In Mauritania, local communities were concerned that the project might have negative social impacts. They indicated that they are still negatively impacted by the Diama dam which was constructed years ago.

In Senegal, some stakeholders highlighted the risk of conflicts between the project proponent and artisanal fishermen, especially those wanting to enter the exclusion safety zones around the project infrastructure because the latter could attract fish.

While stakeholders had concerns regarding the project's potential negative impacts, there was a general trend that the gas discoveries in Mauritania and Senegal were God-given gifts. Some stakeholders indicated that the project could bring wealth to Mauritania and Senegal and it could raise the citizens' standard of living as it has in other oil-producing countries. However, the stakeholders indicated the need for benefit sharing, and for benefits to be realized at a community level.

Several requests were made around training opportunities and local employment. Stakeholders indicated that they expect from the project proponent a sound Corporate Social Responsibility program, with extensive social investments in the local communities.

Finally, some stakeholders raised concerns around the "oil curse". They highlighted that oil development projects have led to conflicts and wars in other countries.

7. IDENTIFICATION AND ANALYSIS OF IMPACTS

The impact assessment considered potential interactions between the proposed project and the host environment, and then classified the significance of each potential impact. Routine activities of the project and potential accidental event scenarios were both considered in the impact assessment.

The detailed review of the project included consideration of a range of Design and Operational Control measures built into the project by BP with the intent to avoid or reduce negative impacts on the environment in line with the mitigation hierarchy. BP has integrated 45 Design and Operational Control measures to avoid or reduce the impacts from routine activities and 19 Design and Operational Control measures to avoid or reduce negative impacts in case of potential accidental events. These measures are listed in the ESIA and have been considered in the impact assessment.

The impact analysis considered impact consequence and impact likelihood to determine overall impact significance. The determination of impact consequence was based on the integration of three criteria: intensity, extent and duration of the impact. Intensity determinations relate to the degree of disturbance associated with each impact: low, moderate or high. Impact extent pertains to how widespread the impact is expected to be: immediate vicinity, local or regional. Impact duration describes the length of time over which the effects of an impact occur: short term or long term. Impact likelihood is the probability of an occurrence of an impact. The various categories of likelihood have been characterized as follows: likely (>50% to 100% or may happen a few times per year), occasional (>10% to 50% or may happen a few times during the lifetime of the project), rare (1% to 10% or may possibly happen once during the lifetime of the project), or remote (<1% or unlikely to happen at all during the lifetime of the project).

The matrix integrating impact consequence with impact likelihood provided the basis for determining overall impact significance. With this matrix, the negative impacts were assigned a numerical rating ranging from 1 through 4: 1 – Negligible, 2 – Low, 3 – Medium, and 4 – High. Beneficial impacts were noted as positive but did not have a numerical rating.

Impacts were assessed on the following biophysical and social resources of the environment: air quality and greenhouse gases; water quality; coastal erosion; sediment quality; benthic communities; plankton, fish and other fishery resources; marine flora; birds; marine mammals; sea turtles; threatened species; protected areas; biodiversity; land and seabed occupation and use; maritime navigation; industrial fisheries; artisanal fisheries and related activities; other coastal and sea-based activities including tourism; employment and business opportunities; population and demography; community livelihoods; community health, safety and security; public infrastructures and services; women and vulnerable groups; cultural and archaeological heritage; landscape and seascape; and social climate.

Potential Impacts of Routine Activities

The assessment of potential impacts identified a series of positive impacts from routine activities, including the following:

- Introduction of hard substrate in areas of unconsolidated sediments around project infrastructures, such as the breakwater, suitable for attachment and colonization by marine flora and fauna.

- Organic input and food source to benthic communities with sloughing associated with the project infrastructures.

- Protection from fishing pressure of fishes and some invertebrates attracted to the project infrastructures where the exclusion safety zones will be applied, and where fishing boats will not be allowed.

- New artisanal fishing ground at the end of the project due to the artificial reef effect of the breakwater, assuming that it will not be removed during the Decommissioning Phase.

- Employment opportunities for: 1) During the Construction Phase up to 25 people on shore in Dakar and/or Nouakchott and up to 30 people on vessels, and up to 20 people from Saint-Louis and N'Diago as community and fisheries liaison officers. In addition, BP's local content approach in the contractor selection process includes an expectation that contractors give consideration to local sourcing in terms of people, goods and services in their final execution plans; 2) 20-40 people in Dakar and/or Nouakchott, progressively up to 400 people from Mauritania and Senegal on offshore facilities, and local Fisheries Liaison Officers or Community Liaison Officers will also be required in N'Diago and Saint-Louis during the course of the Operations Phase. The national recruitment effort will also take into consideration existing resources in local communities, where possible; and 3) 20-40 people in Dakar and/or Nouakchott and an additional number of people from Mauritania and/or Senegal on vessels during the Decommissioning Phase.

- Business opportunities for: 1) up to 3-5 national services providers in Dakar and/or Nouakchott for onshore logistics services and vessels during the Construction Phase; 2) 2-3 national service providers in Dakar and/or Nouakchott for onshore logistics services in addition to the use of service providers for potentially up to 16 vessels during the Operations Phase; and 3) a few national service providers in Dakar and/or Nouakchott for onshore logistics services and additional service providers for vessels during the Decommissioning Phase.

- Additional business opportunities, indirect employment and multiplier effects that could be created through local procurement policy to support the supply chain for the project during each project phase. The exact nature of these additional opportunities will become evident as the project progresses.

However, the most significant benefits of the project for Mauritania and Senegal are at a national level. These benefits include revenues: income revenues through the shares of PETROSEN and SMHPM in the project, the states' shares of LNG sales, and taxes. Additionally, the project will make gas available for use in both countries.

Negative impacts from the project's routine activities were assessed. Over 50 impacts were rated 1 – Negligible. The assessment also identified 34 potential non-negligible impacts: 26 were rated 2 – Low and 8 were rated 3 – Medium or 4 – High prior to implementation of mitigation measures.

The eight potential negative impacts rated 3 – Medium or 4 – High prior to mitigation measures are the following:

- IMP01: Reduction in ambient air quality (NOx and SOx only) during the Construction Phase.

- IMP02: Reduction in ambient air quality during the Operations Phase.

- IMP28: Risk of collision between project vessels and pirogues due to project vessels movements during the Construction and the Operations Phases.

- IMP30: Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones during the Construction and the Operations Phases.

- IMP31: Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level during the Operations and Decommissioning Phases.

- IMP32: Placing additional demands on the public security forces limited resources since they will be required to be available 24 hours per day/7 days per week (24/7) to handle a safety incident with artisanal fishermen or a search and rescue operation if needed during Operations Phase.
- IMP33: Placing additional demands on National security authorities who will need to prevent and be available 24/7 to handle a national security incident at sea resulting from the presence of Project offshore gas production infrastructures during Operations Phase.
- IMP34: Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g., for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels during Construction and Operations Phases.

The ESIA has recommended 46 mitigation measures to reduce the potential negative impacts of routine activities in addition to the 45 Design and Operational Control measures being implemented. The mitigation measures corresponding to these medium or high significance impacts include, for instance, the following:

- M02: Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical, or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.
- M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.
- M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.
- M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.
- M13: Where there is a risk of vessel interaction, using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.
- M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.
- M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.
- M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.
- M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.
- M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).
- M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

- M26: Include in the security stakeholder engagement plan, provisions around response, management and interface with public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

With the implementation of the full set of 45 Design and Operational Control measures and 46 mitigation measures, all the residual impacts of routine activities are deemed 1 – Negligible or 2 – Low. This includes impacts on coastal erosion, fish and other fishery resources, fisheries, maritime safety for artisanal fishermen and fishing communities.

Potential Impacts of Accidental Events Scenarios

As a prelude to the impact assessment, a large number of potential project-specific accidental event scenarios were evaluated for detailed analysis. Three potential accidental event scenarios corresponding to worst credible cases were retained for discussion in the ESIA: a well blowout in the Offshore Area, a collision with the FPSO in the Pipeline Area, and a pipelaying vessel collision in the Nearshore Hub/Terminal Area. These scenarios were considered to represent the most challenging response conditions, due to either location, oil type or volume or highest environmental impact. The likelihood of these three accidental event scenarios occurring during the life of the project are considered remote.

Potential spill scenarios for each of the three accidental events were examined using oil spill modeling to assess the fate of each hydrocarbon spill. While the consequences of a spill in a worst-case scenario could affect several resources, the adverse impacts would be variable depending upon a variety of factors, including spill trajectory, degree of weathering, and volumes reaching the coast. In all cases, spill modeling and predicted fate of spill products did not consider the application of available mitigation measures, the latter of which would certainly be applied in the event of an accidental release, as discussed below.

Since the accidental event scenarios are highly unlikely to happen (remote likelihood), there were several instances where overall impact significance was rated 1 – Negligible. Out of the 34 potential non-negligible impacts, 15 were rated 2 – Low and 19 were rated 3 – Medium. The 19 potential impacts deemed 3 – Medium prior to mitigation measures are the following:

- IMP105: Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.

- IMP106: Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.

- IMP107: Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision.

- IMP108: Exposure of Mediterranean monk seals (an endangered species) to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.

- IMP109: Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.

- IMP110: Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.

- IMP111: Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.
- IMP112: Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.
- IMP114: Oiling of threatened species resulting in mortality from a blowout.
- IMP116: Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.
- IMP118: Oiling of threatened species resulting in mortality from pipelaying vessel collision.
- IMP126: Temporary loss of artisanal fishing catches due to spill impacts on plankton, fish and other fishery resources.
- IMP127: Temporary preclusion of artisanal fishing in the spill response area for up to over 25,000 artisanal fishing units (2017 numbers).
- IMP128: Temporary loss of revenues for up to about 80,000 artisanal fishermen (2017 numbers).
- IMP129: Temporary loss of revenues for up to about 700,000 people involved in activities related to artisanal fisheries (2017 numbers).
- IMP130: Temporary loss of revenues for national economies due to the temporary disruption of artisanal fisheries.
- IMP131: Temporary decrease of the capacity of the coastal communities to cover day to day needs due to the disruption of their revenues, with a risk of sliding into poverty and vulnerability.
- IMP132: Temporary shortage of the main staple of coastal communities due to the disruption of artisanal fish catches, with potential ramifications on the diet of households at a national level.
- IMP133: Increased vulnerability of women and vulnerable groups of fishing communities, and in particular those of the Langue de Barbarie.

The ESIA has recommended 13 mitigation measures to reduce the potential negative impacts in case of accidental events. These mitigation measures are in addition to the 19 Design and Operational Controls measures already planned for the project in case of an accident. The mitigation measures include, for instance, the following:

- M101: In the unlikely event of a spill, tactical response methods that may be considered under the Oil Spill Contingency Plan (OSCP) include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.
- M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.
- M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.
- M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.
- M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as

applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

- M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.
- M109: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.
- M110: In the unlikely event of a spill, prepare and implement, in coordination with national authorities if requested, a Livelihood Restoration Plan for affected communities.
- M111: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency plan to ensure food security of affected vulnerable households and groups if needed.

With the implementation of the full set of 19 Design and Operational Control measures and 13 mitigation measures, the significance of the 34 non-negligible impacts is reduced: 23 residual impacts of accidental events are deemed 1 – Negligible or 2 – Low. The remaining 11 residual impacts rated 3 – Medium will potentially affect birds, marine mammals, sea turtles, threatened species and protected areas, and biodiversity.

It should be noted that the impact assessment of potential accidental events, based on the worst-case oil spill modeling scenarios, is a conservative prediction without the benefit of prevention, preparedness and response activities. In the event of an oil spill, BP would put in place appropriate spill response procedures, as outlined in the OSCP. These procedures would reduce the volume spilled and/or enhance the dispersion of oil, thus reducing the potential of exposure of sensitive resources to the spilled oil.

By identifying a range of representative worst-case oil spill scenarios, the ESIA has provided information to plan and prepare for the entire range of potential spill scenarios. Response strategies are based on a tiered approach which is accepted industry wide. The established three-tiered structure allows the planning of an effective response to any oil spill, from small operational spillages to a worst-case release at sea.

As part of the project overall planning process, an OSCP and supporting documents will be developed by BP. They will provide guidance on how BP will respond to an oil spill within any tier. When proper Design and Operational Control measures and mitigation measures are applied, including an OSCP, the likelihood of a spill and the consequences resulting from a spill are reduced. All these measures are included in the comprehensive Environmental and Social Management Plan included in the ESIA.

Cumulative and Transboundary Impacts

Cumulative Impacts

Cumulative impacts are those resulting from the impacts of the project when added to the impacts arising from other present or planned projects in the same area in the foreseeable future.

In addition to the GTA Phase 1 project, other sources of impact that may contribute to cumulative impacts include on-going and future oil and gas exploratory and development activity in Mauritanian and Senegalese waters and other activities in the offshore and nearshore region, including maritime navigation and shipping, artisanal and industrial fishing, hydrocarbon bunkering, port development, and shoreline stabilization projects. Potential cumulative impacts with possible future phases of the GTA project will be addressed, in due time, in the ESIA reports for these phases.

There are important uncertainties regarding cumulative impacts of the current project when assessed against future oil and gas projects. The current situation of oil and gas-related operations in the area will not remain static. The situation will change as a result of several factors including the results of on-going or planned exploration activities.

Similarly, the current situation of on-going marine uses will not remain static over the project timeframe. There are, notably, important uncertainties around the planned multiservice maritime port being constructed approximately 30 km north of N'Diago, the river ports projects in Saint-Louis, and planned initiatives to control the coastal erosion of the Langue de Barbarie and to stabilize the shoreline. For the time being, the potential biophysical and social impacts of these planned projects are not known.

The assessment of cumulative impacts has been considered for each of the three project phases. Given that the Construction Phase should start in 2018, the level of uncertainty associated with potential cumulative impacts during this phase is relatively limited. Cumulative impacts have been considered separately for: 1) cumulative impact with other oil and gas activities in the area; and 2) cumulative impacts with other marine uses and known marine-related development projects. There is little chance of cumulative impacts with other oil and gas activities in the region. However, there could be cumulative impacts with the maritime port north of N'Diago and the river ports planned on the Senegal River, especially if they are initiated during the Construction Phase of the GTA Phase 1 project.

Assessing the potential cumulative impacts of the project during Operations Phase includes a much greater level of uncertainty. Finally, assessing the potential cumulative impacts of the project during the Decommissioning Phase which is planned after the Operations Phase includes an even larger level of uncertainty.

Transboundary Impacts

Routine activities of the GTA Phase 1 project have no or very limited potential for transboundary impacts. However, accidental events scenarios could potentially have transboundary impacts.

The oil spill modeling results show that the impacts would vary by type of accident and will depend on the period of the year when the spill occurs.

Based on worst case scenarios, the modeling results show the two neighboring countries most likely to be affected in the unlikely event of an oil spill would be Cape Verde and The Gambia. Their surface waters in the respective Exclusive Economic Zones (EEZ) would have a high probability of being affected in these worst case scenarios: a well blowout, or an FPSO failure due to a ship collision happening between the months of October to March. Guinea, Guinea-Bissau, and the Western Sahara have a very low probability of surface oiling in a small area of their EEZ, regardless of season. Finally, none of these countries would be at risk of shoreline impact.

8. RISK STUDY AND OCCUPATIONAL RISK ASSESSMENT

A Risk Study and Occupational Risk Assessment (*Étude de danger et analyse des risques professionnels*) was conducted as part of the ESIA in accordance with the Senegal's (2005) Risk Study Guide (*Guide d'étude de danger*). While this Guide is a distinctive feature of Senegal, the Risk Study considered potential risks in both Mauritania and Senegal.

The identification of major potential hazards was done using a systematic approach including a review of past major accidents and incidents relevant to the GTA Phase 1 project facilities and operations (accidentology). A detailed analysis of major accident events was undertaken through assessment of specific consequence effect distances and calculation of risk levels. For accident events involving major hazards, detailed release, dispersion, fire and explosion modelling was performed to determine likely and realistic worst case consequence effects.

Bowtie analysis was undertaken to assess and verify that suitable and sufficient prevention, control and mitigation measures are in place (or are planned) to manage major accident event risk. Finally, risks were quantified and assessed against industry established and accepted risk tolerability criteria. Following detailed analysis of major hazard risk, review and documentation of key hazard management processes and facilities, including key design engineering and operational controls, was undertaken. This included: 1) major hazard management requirements and processes through the preparation phase of the project; 2) operational safety and environmental management systems;

3) management of safety and environmental critical equipment; and 4) specific control and mitigation measures.

The GTA Phase 1 project occupational hazards and risks were also assessed through a systematic process to identify facilities occupational hazards and associated accidental events. The occupational risk analysis was used to provide a qualitative estimate of occupational risk levels, and to assess and verify that suitable and sufficient prevention, control and mitigation measures are in place (or are planned) to manage personnel safety risk.

The overall conclusion from the Risk Study and Occupational Risk assessment is that risks are below relevant established risk tolerability criteria, with comprehensive GTA Phase 1 project requirements and processes in place so that accident hazards and risks continue to be identified, where possible eliminated, assessed and managed to As Low As Reasonably Practicable (ALARP) through all stages of the project. The GTA Phase 1 project facilities are being designed, and will be operated, in accordance with recognized good international industry practice for the oil and gas industry, regulatory requirements, industry codes and standards. This includes significant emphasis on inherent safety with focus on avoidance and prevention to manage hazards and risks.

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An Environmental and Social Management Plan (ESMP) has been developed as part of the ESIA. The ESMP lists the Design and Operational Control measures built into the project by BP to avoid or reduce the potential impacts of the project and the mitigation measures recommended to further reduce the non-negligible impacts.

The ESMP identifies who will have the primary role for implementing each measure and for monitoring their implementation. It also provides objectively verifiable indicators of the implementation of the measures, suggested source for verification of implementation, and recommended frequency of verification.

A system of verification and oversight will be put in place to evaluate implementation and follow-up of the ESMP. On a periodic basis, BP will prepare ESMP Compliance Reports.

A GTA Phase 1 project HSSE manager will be appointed by BP to oversee the implementation of the ESMP. The GTA Phase 1 project HSSE manager will be responsible for internal reporting of environmental performance for review and as a basis for improving the actions identified in the ESMP.

As a result of continuous improvement, or during the course of the project lifetime, new practices, procedures or technologies may be proposed and adopted that require a revision of currently identified actions or sources and frequencies of verification in the ESMP. The intent of the original action will be taken into consideration in the decision of implementing such new practices, procedures or technologies.

The implementation of the ESMP will be monitored by the Mauritanian and Senegalese authorities. A monitoring plan has been developed for this purpose. It is provided in Appendix U of this report. The plan covers both the monitoring of the implementation of the ESMP and the monitoring of the implementation of the surveillance and monitoring plan.

The ESIA also provides an outline of the capacity building plan for the Mauritanian and Senegalese authorities for the monitoring of the ESMP and surveillance and monitoring plan. A detailed capacity building plan will be prepared by BP in 2019 in collaboration with the relevant authorities. The budget associated with the capacity building plan in the context of the ESIA is presented in the ESIA.

10. SURVEILLANCE AND MONITORING PLAN

In addition to the ESMP, the ESIA includes a Surveillance and Monitoring Plan (SMP). The overall purpose of the SMP is to verify that the mitigation measures identified in the ESMP generate the expected results in regard to avoiding or reducing potential impacts on the biophysical and social environment. A series of monitoring measures have been identified with performance objectives.

During all project phases, the environmental and social performance will regularly be internally reported to BP management. The outcome of specific monitoring programs stipulated in the SMP will also be reported to Mauritanian and Senegalese authorities at a frequency to be agreed with the regulator or in conformance with regulatory requirements.

11. CONCLUSION

Based on the judgment of the ESIA professionals, as supported by the comprehensive ESIA documentation, the proposed GTA Phase 1 project is deemed acceptable considering the assessment of the following: 1) the project description, including the Design and Operational Control measures built into the project; 2) existing regulatory requirements; 3) characterized biophysical and social host environments and their perceived sensitivities to impact; 4) identified potential impacts associated with all phases of the project; and 5) implementation and monitoring of recommended mitigation measures listed in the ESMP and the SMP.

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CH2M	Coastline Modeling
Humiston & Moore Engineers	Regional Characterization of Coastal Processes
OSRL	Oil Spill Modelling
Trinity Consultants	Air Emissions & Modeling Analysis

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ABBREVIATIONS AND ACRONYMS

°	Degree
° C	Celsius degree
>	Greater than
≥	Greater than or equal to
<	Less than
≤	Less than or equal to
±	Plus/minus
%	Percent
µg	Microgram
$\mu g\ g^{-1}$	Microgram per gram
$\mu g\ L^{-1}$	Microgram per liter
µPa	Micropascal
3D	Three-dimensional
24/7	Twenty-four hours per day / 7 days per week
ACE	Africa Coast to Europe (fibre optic system)
AFFF	Aqueous film forming foam
AIS	Universal shipborne automatic identification system
Al	Aluminum
ALARP	As low as reasonably practicable
Am	Americium
ANACIM	National Agency of Civil and Maritime Navigation (*Agence Nationale de la Navigation Civile et Maritime*)
ANAM	National Agency on Maritime Affairs (*Agence Nationale des Affaires Maritimes*)
ANSD	National Agency of Statistics and Demography
API	American Petroleum Institute
APRHN	Agency for Promotion of the National Hydrographic Network (*Agence pour la Promotion du Réseau Hydrographique National*)
AQMI	Al Qaeda in the Islamic Maghreb

As	Arsenic
ATEX	Equipment for explosive atmospheres
AUV	Autonomous underwater vehicle
Ba	Barium
bbl	Barrel
bbl/MMSCF	Barrel per million standard cubic feet
BBS	Behavioural based safety
Be	Beryllium
BGP	Biodiversity, Gas and Petroleum Program
BLEVE	Boiling liquid expanding vapour cloud explosion
BML	Below mud line
BOD	Biological oxygen demand
BOD5	5-day biochemical oxygen demand
BOEM	Bureau of Ocean Energy Management
BOG	Boil-off gas
BOP	Blow out preventer
BPD	Barrel per day
BPEO	Best practicable environmental option
BP plc	BP
BPMIL	BP Mauritania Investments Limited
BPSIL	BP Senegal Investments Limited
BST	Business support team
BTEX	Benzene, toluene, ethylbenzene, xylene compounds
CAP	Civil aviation procedure
CC	Canary Current
CCC	Criterion continuous concentration
CCLME	Canary Current Large Marine Ecosystem
CCTV	Closed circuit television
CCU	Central control unit

Cd	Cadmium
CE	Critically endangered
CETOM	Collection, disposal and processing of household waste
CFC	Chlorofluorocarbon
CFD	Computational fluid dynamics
CH_4	Methane
CLO	Community liaison officer
CLPA	Local Artisanal Fishing Council
cm^2	Square centimeter
$cm\ s^{-1}$	Centimeter per second
CMB	Conservation of Migratory Birds
CNPS	National Collective of Artisanal Fishermen of Senegal
Co	Cobalt
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical oxygen demand
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
CONIPAS	National Inter-professional Council of Artisanal Fishing in Senegal
Cos-Petrogaz	Strategic Orientation Committee for Oil and Gas
CQFMP	Qualification and Training Centre for Fishing Trades (*Centre de Qualification et de Formation sur les Métiers de la Pêche*)
Cr	Chromium
CRD	Regional Development Committee (*Comité regional de développement*)
CRODT	Dakar-Thiaroye Centre for Oceanographic Research (*Centre de Recherches Océanographiques de Dakar-Thiaroye*)
CRS	Containment response system
Cs	Cesium
CSA	CSA Ocean Sciences Inc.
CSIRO	Commonwealth Scientific and Industrial Research Organisation

CSR	Corporate social responsibility
CST	Country support team
Cu	Copper
CUN	Nouakchott Urban Community (*Communauté Urbaine de Nouakchott*)
CWS	Catwalk shuttle system
D&OC	Design and operational control
DAL	Design accidental loads
dB	Decibel
dB_{rms}	Decibel root mean square
dB re 1 µPa	Decibel regarding 1 micropascal
DCE	Department of Environmental Control (*Direction du Contrôle Environnemental*)
DD	Data deficient
DDT	Deflagration to detonation transition
DEEC	Department of Environment and Classified Establishments (*Direction de l'Environnement et des Établissements Classés*)
DLE	Dry low emission
DO	Dissolved oxygen
DOR	Dispersant to oil ratio
DP	Dynamic positioning
DPC	Department of Emergency Preparedness (*Direction de la Protection Civile*)
DPSP	Department of Fisheries Protection and Surveillance (*Direction de la Protection et de la Surveillance des Pêches)*
DPUE	Department of Pollution and Environmental Emergencies (*Département des Pollutions et des Urgences Environnementales*)
DREAM	Dose-Related Risk and Effect Assessments Model
DST	Drill stem testing
DSV	Diving support vessel
E&S	Environmental and social
EBRD	European Bank for Resconstruction and Development

EBS	Environmental baseline survey
EBSA	Ecologically or Biologically Significant Area
ECC	Emergency control centre
Ecodev	Ecodevelopment
EDD	Risk Study (*Étude de dangers*)
EEZ	Exclusive Economic Zone
EFL	Electrical flying lead
EHS	Environment Health and Safety Guidelines
EI	Energy Institute
EIA	Environmental impact assessment
EIG	Economic interest group
EMP	Environmental management plan
EMS	Environmental management system
EMSA	European Maritime Safety Agency
EN	Endangered
ENVIID	Environmental impact identification
EPBR	*Établissement Portuaire de la Baie du Repos*
EPC	Exploration and Production Contract
EPCI	Engineering, Procurement, Construction and Installation
EPIRB	Emergency position indicating radio beacon
EPSC	Exploration and Production Sharing Contract
ERL	Effects range low
ERM	Effects range median
ERP	Emergence response plan
ESD	Emergency shutdown
ESDV	Emergency shutdown valve
ESIA	Environmental and social impact assessment
ESMP	Environmental and social management plan
EST	Executive support team

EU	European Union
FAD	Fish aggregating devices
FAO	United Nations Food and Agriculture Organization
FCFA	*Communauté Financière Africaine* franc
Fe	Iron
FEED	Front-End Engineering and Design
FENAGIE	National Federation of Economic Interest Groups of Fishermen
FERA	Fire and explosion risk analysis
FGC	Flash gas compression
FLACS	Flame acceleration simulator
FLNG	Floating liquefied natural gas production and storage facility
FLO	Fishermen liaison officer
FLPA	Free Federation of Artisanal Fishing (*Fédération Libre de la Pêche Artisanale*)
FMEA	Failure modes and effects analysis
FPSO	Floating production storage and offloading facility
FRC	Fast rescue craft
FROG	Enclosed basket lifted by crane between crew boat and the FPSO
FSU	Floating storage unit
FTA	Field termination assembly
GAIPES	Senegalese Association of Ship Owners and Industrial Fisheries
gal	Gallon
GBq	Gigabecquerel
GCM	Mauritanian Coast Guard (*Garde côte Mauritanienne*)
GDP	Group defined practices
G&G	Geological and geophysical survey
GHG	Greenhouse gas
GIIP	Good international industry practice
GLO-1	Globacom-1 (fiber optic system)
GMDSS	Global maritime distress and safety system

Golder	Golder Associés Ltée
GOM	Gulf of Mexico
GP	Group practice
GPO	Global projects organization
GT	Gross tonnage
GTA	Greater Tortue/Ahmeyim
HAP	Hazardous air pollutant
HASSMAR	High Authority for Maritime Security, Maritime Safety and Marine Environment Protection (*Haute Autorité chargée de la Coordination de la Sécurité maritime et de la Protection de l'Environnement marin*)
HAZID	Hazard identification study
HID	Hazard installations directorate
HFL	Hydraulic flying lead
HFO	Heavy fuel oil
Hg	Mercury
HIV/AIDS	Human immunodeficiency virus/Acquired immunodeficiency syndrome
HLD	Heavy lift device
hp	Horsepower
HP	High pressure
hr	Hour
HSE	Health, safety and environment
HSSE	Health, safety, security and environment
HUC	Hook up and commissioning
HVAC	Heating, ventilation, and air conditioning
HYCOM	Hybrid Coordinate Ocean Model
Hz	Hertz
IADC	International Association of Drilling Contractors
IAPPC	International air pollution prevention certificate
IBA	Important Bird Area
ICA	Inter-State Cooperation Agreement

ICPC	International cable protection committee
ICPE	Classified establishments for environmental protection
ICS	Incident command system
ID	Inner diameter
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IMO	International Maritime Organization
IMROP	Mauritanian Institute of Oceanographic Research and Fisheries (*Institut Mauritanien des Recherches Océanographiques et des Pêches*)
IMT	Incident management team
in.	Inch
in^3	Cubic inch
INDC	Intended nationally determined contribution
IOGP	International Association of Oil and Gas Producers
IPF	Impact producing factor
IPIECA	International Petroleum Industry Environmental Conservation Association
IRPA	Individual risk per annum
ISD	Inherently safe design
ISO	International Standards Organisation
ISPS	International ship and port security
ITCZ	Intertropical convergence zone
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
IWC	International Waterbird Census
JT	Joule Thomson valve
KBq	Kilobecquerel
KEISL	Kosmos Energy Investments Senegal Limited
KEM	Kosmos Energy Mauritania
KES	Kosmos Energy Senegal

KFX	Kameleon Fire Experiment
kg	Kilogram
kg/d	Kilogram per day
kg/hr	Kilogram per hour
kHz	Kilohertz
km	Kilometer
km^2	Square kilometer
km^{-2}	Per square kilometer
kn	Knots
Kosmos	Kosmos Energy LLC
kW	Kilowatt
kWh	Kilowatt hour
L	Liter
LC	Least concern
LC_{50}	Lethal concentration of a chemical in water
LCM	Lost circulation material
LED	Light emitting diode
LEKRAIM	Association created by fishermen in N'Diago
LFL	Lower flammability limit
LLI	Long lead item
LLP	Low low pressure
LMO	Living modified organism
LMRP	Lower marine riser package
LNG	Liquified natural gas
LNGC	LNG carrier
LOA	Length overall
LOPA	Layer of protection analyses
LP	Low pressure
LPG	Liquefied petroleum gas

LQ	Living quarters
LSIR	Location specific individual risk
LTO	Landing and take off
m	Meter
m s^{-1}	Meter per second
m^{-2}	Per square meter
m^3	Cubic meter
m^3/d	Cubic meter per day
m^3/hr	Cubic meter per hour
MAC	Manual alarm call-point
MAH	Monocyclic aromatic hydrocarbon
MAR	Major accident risk
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Manifold center
MDO	Marine diesel oil
MEDD	Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et du Développement Durable*)
MEG	Monoethylene glycol
mg C m^{-2}	Milligram of carbon per square meter
mg kg^{-1}	Milligram per kilogram
mg L^{-1}	Milligram per liter
mg/L	Milligram per liter
MGO	Marine gas oil
MKT	Recreational hunting camp
mm	Millimeter
MMS	Maintenance management system
MMSCFD	Million standard cubic feet per day
mN/m	Millinewton per meter
MOC	Management of change
MODU	Mobile offshore drilling unit

MOL	Molecular
MoU	Memorandum of understanding
MP	Medium pressure
MPA	Marine protected area
MPE	Ministry of Oil and Energies (*Ministère du Pétrole et des Énergies*)
MPEMa	Ministry of Fisheries and Maritime Economy (*Ministère des Pêches et de l'Économie Maritime*)
MPEMi	Ministry of Petroleum, Energy and Mines (*Ministère du Pétrole, de l'Énergie et des Mines*)
MPN	Most probable number
MRCC	Maritime Rescue Coordination Centre (*Centre de Coordination des Secours Maritimes*)
MRO	Code for Ouguiya (currency of Mauritania)
MRT	Mutual response team
MSDS	Material Safety Data Sheet
MSV	Multi service vessel
MT	Metric tonne
MTPA	Metric tonne per annum
MW	Megawatt
nmi	Nautical mile
N	North
Na	Sodium
ng g^{-1}	Nanogram per gram
N_2O	Nitrous oxide
NAAQS	United States National Ambient Air Quality Standards
NADF	Non-aqueous drilling fluid
NAVTEX	Navigational Telex
NBSAP	National Biodiversity Strategies and Action Plan
NGO	Non-governmental organization
Ni	Nickel
NMFS	National Marine Fisheries Service

NO_3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NOEC	No observed effect concentration
NORM	Naturally occurring radioactive material
NO_x	Nitrogen oxide
NSF	National Science Foundation
NT	Near threatened
NTU	Very low turbidity
O&G	Oil and Gas
O_3	Ozone
OBM	Oil-based mud
OCS	Outer continental shelf
OD	Outer diameter
OECD	Organization for Economic Cooperation and Development
OEM	Original equipment manufacturer
OGP	Oil and Gas Producers
OIM	Offshore installation manager
OMA	Oil-mineral aggregation
OMS	Operating management system
OMVS	Organization for the Development of the Senegal River (*Organisation pour la Mise en Valeur du fleuve Sénégal*)
ONAS	Sanitation (*Office National d'Assainissement*)
ONISPA	Office of Sanitary Inspection of Fishery Products and Aquaculture (*Office National d'Inspection Sanitaire des Produits de la Pêche et de l'Aquaculture*)
ONS	National Statistics Office (*Office National de la Statistique*)
OPDF	Organic-phase drilling fluid
OPRC	Oil pollution preparedness, response, and cooperation
ORSEC	National Relief Plan (*Plan National d'Organisation des Secours*)
OSCAR	Oil spill contingency and response
OSCP	Oil spill contingency plan

OSRL	Oil Spill Response Limited
OSR-JIP	Oil Spill Response Joint Industry Project
P&ID	Piping and instrumentation diagram
PAGA	Public address and general alarm
PAH	Polycyclic aromatic hydrocarbons
PANPA	*Port Autonome de Nouakchott* also known as *Port de l'Amitié*
Pb	Lead
PCB	Polychlorinated biphenyl
PCV	Pressure control valve
PEC	Predicted effect concentration
PEMS	Predictive emission monitoring system
PETROSEN	*Société des Pétroles du Sénégal*
PHCA	Potentially high consequence activity
PIC	Person in charge
PLEM	Pipeline end manifold
PLET	Pipeline and termination
PLL	Potential loss of life
PM	Particulate matter
PNBA	*Parc National du Banc d'Arguin*
PNEC	Predicted no effect concentration
PNIUM	National Plan for Emergency Operations at Sea (*Plan National d'Interventions d'Urgence en Mer*)
POB	Persons on board
POI	Senegalese regulatory emergency plan (*Plan d'opération interne*)
POLMAR plan	Pollution response plan
ppb	Part per billion
PPE	Personal protective equipment
ppg	Pound per gallon
ppm	Part per million
ppmv	Part per million in volume

PSU	Practical salinity unit
PTS	Permanent threshold shift
PVC	Polyvinyl chloride
PW	Produced water
QRA	Quantitative risk assessment
QU	Quarters and utilities
R95%	Radius calculated for 95% of modeling exercise
RAMPAO	Regional Network of Marine Protected Areas in West Africa
RBA	Risk based approach
RGPH	General Population and Housing Census (*Recensement Général de la Population et de l'Habitation*)
RIM	Islamic Republic of Mauritania
Rmax	Maximum radius
rms	Root mean square
RO	Reverse osmosis
ROV	Remotely operated vehicle
RPT	Rapid phase transition
RR	Risk ranking
S&OR	Safety and operational risk
S.A.E.D.	National Society for the Development and Exploitation of the Lands of the Senegal River Delta and the Senegal and Falémé Valleys
SAR Plan	Search and rescue plan
SAT-3/WASC	South Atlantic Telephone / West African Submarine Cable
SBDF	Synthetic-based drilling fluid
SBM	Synthetic based mud
SCAT	Shoreline clean-up and assessment technique
SCERP	Source control emergency response plan
scf/hr	Standard cubic feet per hour
SCSSV	Surface controlled sub-surface safety valve
SD	Standard deviation

SDU	Submarine distribution unit
SE	Senior executive
SECE	Safety and environmental critical element
SEL	Sound exposure level
SEL_{cum}	Cumulative sound exposure level
SHP	Shaft horsepower
SIL	Safety integrity level
SIMA	Spill impact mitigation assessment
SIMOPS	Simultaneous operations
SINTEF	Scandinavian Foundation for Scientific and Industrial Research
SIS	Safety instrumented system
SITRAM	*Système Intégré de Transport Multimodal*
SMHPM	*Société Mauritanienne des Hydrocarbures et de Patrimoine Minier*
SMP	Surveillance and monitoring plan
SMR	Single mixed refrigerant
SNEDD	National Strategy for the Environment and Sustainable Development (*Stratégie Nationale de l'Environnement et du Développement Durable*)
SNIM	*Société Nationale Industrielle et Minière*
SO_x	Sulfur oxides
SO_2	Sulfur dioxide
SOC	Safety observation conversation
SOGENAV	Corporation for Management and Operation of Navigation (*Société de Gestion et d'Exploitation de la Navigation*)
SOLAS	Safety of life at sea
SOPEP	Shipboard oil pollution emergency plan
SPJ	Steel pile jacket
SPL	Sound pressure level
SPM	Suspended particulate material
SPS	Subsea production system
SRB	Sulphate-reducing bacteria

SRSD	*Service Régional de la Statistique et Démographie*
SSIV	Subsea isolation valve
SSTV	Subsea stack test valve
STI	Sexually transmitted infection
SURF	Subsea, umbilical, riser and flowline
SURMAR Plan	National security plan
SVOC	Semivolatile organic compound
t	Tonne
t/y	Tonne per year
tCO_2eq	Tonne CO_2 equivalent
tCO_2eq/y	Tonne CO_2 equivalent per year
TCF	Trillion cubic feet
TEMPSC	Totally enclosed motor propelled safety craft
TEU	Twenty-foot equivalent unit
Th	Thorium
TIP	Technical information paper
ToR	Terms of Reference
TPAH (LOEC)	Total polycyclic aromatic hydrocarbon (lowest observed effect concentration)
TPH	Total petroleum hydrocarbon
TR	Temporary refuge
TRA	Tasked-based risk assessment
TRI	Temporary refuge integrity
Tropica	Tropica Environmental Consultants
TRT	Tactical response team
TTS	Temporary threshold shift
UC	Unified command
UK	United Kingdom
ULQ	Utility & living quarter platform
UNCLOS	United Nations Convention on the Law of the Sea

UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	Office of the United Nations High Commissioner for Refugees
UPAMES	National Union of Fishmonger EIGs of Senegal
UPS	Uninterruptible power system
USA	United States of America
USD	United States Dollar
USEPA	United States Environmental Protection Agency
V	Vanadium
VCE	Vapour cloud explosion
VEC	Valued environmental component
VFD	Variable frequency drive
VHF	Very high frequency
VLCC	Very large crude carrier
VMS	Vessel management system
VOC	Volatile organic compound
VP	Vice president
VSAT	Very small aperture terminal
VSP	Vertical seismic profiling
VU	Vulnerable
VVOC	Very volatile organic compound
WBDB	Word bird and biodiversity database
WBM	Water-based drilling mud
WCD	Worst credible discharge
WMP	Waste management plan
WHO	World Health Organization
WOAD	Worldwide offshore accident database

wt	Weight
Zn	Zinc

CHAPTER 1: INTRODUCTION

1.0 INTRODUCTION

This document is the Environmental and Social Impact Assessment (ESIA) report for the first phase of the Greater Tortue/Ahmeyim (GTA)[1] offshore gas production project as described in Chapter 2, also known as the GTA Phase 1 project.

This chapter presents an overview of the project background and its proponents; it explains the purpose of the ESIA, provides details on the ESIA team, summarizes the general methodology used for the ESIA, and describes the structure of the ESIA report.

1.1 Background

In 2015 and 2016, gas was discovered offshore of the Islamic Republic of Mauritania (Mauritania) and the Republic of Senegal[2]. It is one of the largest gas discoveries offshore of West Africa in history. The proposed project is the first step for developing this discovery.

The gas field is located in rock formations under the seabed, about 125 kilometers (km) from the coast, on each side of the maritime border. The gas reserves are divided between both countries.

Mauritania and Senegal have agreed to work together, with partners, to move forward the GTA Phase 1 project.

1.2 Project Proponents

The co-venturers in the GTA Phase 1 project are:

- BP Mauritania Investments Limited (BPMIL) and BP Senegal Investments Limited (BPSIL), together called BP in this document, are the current joint project operators pursuant to the joint operating agreements;
- Kosmos Energy Mauritania (KEM) and Kosmos Energy Investments Senegal Limited (KEISL);
- Société des Pétroles du Sénégal (PETROSEN); and
- Société Mauritanienne des Hydrocarbures et de Patrimoine Minier (SMHPM).

1.2.1 BP

BP plc (BP) is a global energy business, involved in every aspect of the complex energy system that drives the world from exploration, to production, refining and marketing. With almost 75,000 employees, BP operates in more than 70 countries across Europe, North and South America, Australasia, Asia and Africa. BP headquarters are located in London and Houston.

The Upstream segment of BP is responsible for the activities in oil and natural gas exploration, field development and production, as well as midstream transportation, storage and processing. BP also markets and trades natural gas, including liquefied natural gas, power and natural gas liquids. In 2016, BP's Upstream activities took place in 28 countries.

In Mauritania, BPMIL is a wholly owned subsidiary of BP. In Senegal, BPSIL is a wholly owned subsidiary of BP.

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[1] Since the initial stages of the project planning, the project has been known under different names: Greater Tortue/Ahmeyim Phase 1, Greater Tortue/Ahmeyim Phase 1A, Ahmeyim/Guembeul, etc. The other project names have been used in some of the appendices. "Ahmeyim/Guembeul" was a combination of the names given to the discovery wells by the national authorities of Mauritania and Senegal. Ahmeyim was named after a water hole used by camel herders in the *wilaya* of Tiris Zemmour in Mauritania and Guembeul was named after the Guembeul Natural Reserve in Senegal. To shorten the text, the project is often referred to as Greater Tortue/Ahmeyim or GTA in this document.

[2] In this document, the project proponents, the countries and the communities are generally listed in alphabetical order.

1.2.2 Kosmos

Kosmos Energy LLC (Kosmos) is an international oil and gas exploration and production company. Its asset portfolio includes existing production and major project developments offshore Ghana, as well as oil and gas exploration licenses with significant hydrocarbon potential offshore Mauritania, Morocco, Sao Tome and Principe, Senegal, Suriname, and Western Sahara.

Kosmos' operating office is based in Dallas, Texas, U.S.A. The company was formed in 2003. It discovered oil in the Jubilee Field offshore Ghana in 2007 and has been producing oil in that country since 2010.

In Mauritania, KEM is a subsidiary, 100% owned by Kosmos. In Senegal, KEISL is a subsidiary, 100% owned by Kosmos.

1.2.3 PETROSEN

PETROSEN is a parapublic agency in Senegal who participates in joint exploration and development of oil and gas projects.

1.2.4 Société Mauritanienne des Hydrocarbures et de Patrimoine Minier

The SMHPM is a Mauritanian national company responsible for the development of the country's natural resources. It participates in joint ventures for oil and gas and mining projects.

1.3 Purpose of the ESIA

To comply with Mauritanian and Senegalese environmental regulations, a full Environmental Impact Assessment (EIA)[3] has been prepared for this project.

The purpose of the ESIA is to predict environmental effects of the project activities before the project is carried out and to incorporate environmental considerations into decision making.

The ESIA addresses all phases of the project development, which include:

- Preparation, Construction and Installation;
- Operation; and
- Decommissioning.

1.4 ESIA Consultants

The ESIA has been conducted by two international environmental consulting firms, Golder Associés Ltée (Golder) and CSA Ocean Sciences Inc. (CSA), in collaboration with a Mauritanian firm, Ecodéveloppement (Ecodev) and a Senegalese firm, Tropica Environmental Consultants (Tropica).

Founded in 1960, Golder is a consulting firm providing a wide range of independent consulting services notably in engineering, natural resources planning and evaluation, and environmental and social impact assessments for mining and oil and gas companies. One of its main offices is based in Montreal, Canada. Since March 2015, Golder is registered to conduct ESIAs in Senegal in accordance with the Senegalese Ministerial Order No. 9470 MJEHP-DEEC of 28 November 2001, setting the terms of issuance of an agreement for the conduct of EIA-related activities.

CSA was founded in 1970 as an environmental consulting firm, with corporate headquarters in Stuart, Florida, and four regional offices throughout the U.S. and international offices in Doha, Qatar; Port of Spain, Trinidad; Rio de Janeiro, Brazil; Nicosia, Cyprus; Singapore; and Perth, Australia. CSA specializes in multidisciplinary projects to evaluate and mitigate potential environmental impacts,

[3] The EIA has been prepared to include both biophysical and social components. Therefore, it is referred to throughout the current document as an Environmental and Social Impact Assessment (ESIA).

particularly for marine construction and oil and gas activities throughout the world. Most of CSA's energy industry projects, particularly those concerning oil and gas activities, involve environmental baseline (affected environment) characterization, identification of environmental risks, determination of potential environmental impacts, and selection of appropriate mitigation measures to eliminate or reduce environmental impacts.

Ecodev is a Mauritanian development organization founded in 1999. Since its creation, it has been involved in 113 projects to improve the living conditions of local populations. Ecodev specializes in the implementation of local development projects, environmental protection and promotion of access to basic services (electrification, sanitation, waste management, etc.) in several regions of Mauritania. Its expertise includes working with vulnerable populations, engaging with community stakeholders and building local capacities to ensure sustainability of actions.

Tropica is a Senegalese environmental company based in Dakar, legally constituted in accordance with Senegalese law. Over the last 10 years, the company has performed environmental and socioeconomic studies, risk studies, and public consultations in Senegal and other African countries notably for mining and oil and gas projects.

The names and roles of the main contributors to the ESIA are listed at the beginning of the report.

1.5 Methodology of the ESIA

The ESIA has been prepared in accordance with requirements detailed in the Terms of Reference (ToR) approved by the Ministry of Environment and Sustainable Development of Mauritania and by the Ministry of Environment and Sustainable Development of Senegal (see Appendix A).

Overall, the methodology used included the following:

- Literature and document review have been conducted to collect information on the receiving environment and on the project activities.
- To complete this data collection, several field missions have also been conducted: these missions included field surveys and sampling, site visits as well as meetings and interviews with local stakeholders and national institutions. Reports have been prepared on key resources by national experts and these reports are appended to the ESIA.
- The ESIA also used the data collected during the Environmental Baseline Survey (EBS) conducted for Kosmos by CSA, in November 2016, in Mauritanian and Senegalese waters. EBS data include: water column profile information, water quality data, sediment quality data, infauna, and ichthyoplankton and zooplankton. Data from a geological and geophysical (G&G) survey conducted by Gardline for BP in July-August 2017, along the maritime boundary between Mauritania and Senegal was also used. G&G survey data include: ichthyoplankton and zooplankton, and imagery of seafloor features.
- Modeling and quantitative assessments were conducted for several components to assess the extent, level and/or consequences of routine operation of the project (air emissions, drilling muds and cuttings, plankton entrainment, produced water discharges, and hydrodynamic conditions) as well as accidental events. These exercises were used for the impact analysis.
- Several meetings were held with the Mauritanian and Senegalese authorities during the development of the project concept and the ESIA to identify potential issues and concerns. Public consultation meetings were also done during the ESIA to present the project and to note questions, concerns and suggestions related to the project.
- Good international industry practice and professional experience and expertise from the ESIA consultant team were used to recommend applicable mitigation measures and an environmental and social management plan.

Details on the methodology applied are described where appropriate in the ESIA report.

1.6 Structure of the ESIA Report

The ESIA report is organized as follows:

- **Non-Technical Summary**;
- **Chapter 1: Introduction** – introduces the project and its proponent, the ESIA consultant team as well as the purpose, methodology and structure of the ESIA report;
- **Chapter 2: Description and Justification of the Project** – detailed narrative of the proposed project. It describes the project components, processes and their location, the schedule and phases of the project as well as energy and water needs and expected air emissions, effluent discharges, light and noise emissions, solid wastes, personnel requirements, etc.;
- **Chapter 3: Regulatory and Institutional Framework** – overview of applicable Mauritanian and Senegalese laws and regulations, applicable international conventions and protocols, relevant international standards, and the proponents' health, safety, security, and environment standards applicable to the proposed project;
- **Chapter 4: Description of the Host Environment** – description of the baseline situation in the project area: the physical environment, the chemical environment, the biological environment and the social environment;
- **Chapter 5: Analysis of Alternatives and Description of the Chosen Project** – description and assessment of potential variants to the project and description of those retained;
- **Chapter 6: Public Consultation** – summary of the public consultations conducted during the ESIA process;
- **Chapter 7: Identification and Analysis of Impacts (Including Mitigation Measures)** – presentation of the impact assessment methodology, and results of the impact assessment for each phase and each area of the project. Cumulative and transboundary impacts are also discussed;
- **Chapter 8: Risk Study and Occupational Risk Assessment** – results of the risk study analysis, including an assessment of technological accident risks and the proposed safety measures to be employed during the project and presentation of the results of the occupational risk assessment;
- **Chapter 9: Environmental and Social Management Plan** – compilation of mitigation and monitoring measures, including those required by the regulations as well as additional feasible, and cost-effective measures that prevent or reduce significant negative impacts from the proposed project;
- **Chapter 10: Surveillance and Monitoring Plan** – outline of the mechanisms to be used to ensure adherence to mitigation strategies and check their effectiveness (i.e., monitoring);
- **Chapter 11: Conclusion** – summary of the major findings resulting from the impact assessment;
- **Bibliography and References** – list of the sources cited in the ESIA; and
- **Appendices** – relevant supporting documentation to the ESIA.

The appendices are numbered from A through Y, several of which include more than one document. They are organized as follows:

A. Terms of Reference of the ESIA Approved by the *Direction du Contrôle Environnemental* (DCE) of Mauritania and the *Direction de l'Environnement et des Établissements Classés* (DEEC) of Senegal

B. Technical Specifications of the Project's Infrastructures, Vessels, Helicopters and Other Equipment, and Support Documentation

C. BP's Health, Safety, Security, Environmental & Operating Policy for Mauritania and Senegal

D. Environmental Baseline Survey Report

E. Fishery Resources, Fisheries and Fishing Communities Reports

F. Notes on Protected Areas

G. Biophysical Baseline Support Material

H. Social Baseline Support Material

I. Hydrodynamic (Coastal Erosion) Baseline Situation and Modeling Reports

J. Air Emissions Modeling Report

K. Water Discharges Calculations and Produced Water Modeling Report

L. Muds and Cuttings Dispersion Modeling Report

M. Plankton Entrainment Modeling Report

N. Accidental Events Modeling Reports

O. Risk Study Support Material

P. Indicative List of Project Facilities Classified for Environmental Protection (ICPE)

Q. Public Consultation Reports

R. Material Safety Data Sheets (MSDS)

S. Preliminary Waste Management Plan

T. Preliminary Decommissioning Plan

U. Monitoring Plan of the ESMP and SMP by the Mauritanian and Senegalese Authorities

V. Technical Committee Meetings for the Pre-Validation of the ESIA (Senegal)[4]

W. Public Hearing (Senegal)

X. Public Enquiry (Mauritania)[5]

Y. Environmental Authorizations.

[4] This appendix includes the official proceedings of the ESIA pre-validation meeting in Senegal held on July 26 and 27, 2018, as well as a tracking table of the responses to the observations noted in the official proceedings and cross-references to the ESIA sections. It also contains the official proceedings of the Select Technical Committee meeting held on October 22, 2018 as well as a tracking table of the responses to the observations noted in these proceedings.

[5] This appendix includes the summary of the Public Enquiry Report for the ESIA of the Greater Tortue/Ahmeyim Phase 1 Gas Production Project dated November 2018 as well as a tracking table of responses to comments noted in this document.

CHAPTER 2: DESCRIPTION AND JUSTIFICATION OF THE PROJECT

2.0 DESCRIPTION AND JUSTIFICATION OF THE PROJECT

This chapter describes the project components, processes and their location, the schedule and phases of the GTA Phase 1 project as well as the applicable exclusion safety zones for proposed development of the natural gas resources located offshore Mauritania and Senegal and associated infrastructure. It explains the anticipated demand and supply of energy and water, and identifies the typical chemicals and hazardous materials. The expected air emissions, effluent discharges, light and noise emissions as well as generated solid wastes are detailed. The estimated personnel needs, and the health, safety, security and environment procedures that will need to be developed are described.

2.1 Overview of the Project

2.1.1 Project Purpose and Justification

Development is focused around the area defined by the Tortue-1 discovery well, drilled in 2015, located in 2,725 meters (m) of water, offshore Mauritania. The development is based on recovering gas resources from high quality gas reservoirs in the Cenomanian and Albian horizons. The discovery was confirmed to extend into Senegal waters in the Saint-Louis Offshore Profond Block with the drilling of the Guembeul-1 well in early 2016. Jointly, this offshore field which straddles the Mauritania and Senegal maritime border is termed the GTA Field.

The results of appraisal efforts in the GTA Field confirmed the existence of a large natural gas field (i.e., 15 to 20 trillion cubic feet [TCF]). The objective of the project is to produce natural gas for export as liquefied natural gas (LNG). The natural gas will be extracted from offshore reservoirs that extend across both sides of the Mauritania and Senegal maritime border. The infrastructure, equipment and operations required for GTA Phase 1 project either in Mauritania or in Senegal will be part of one project, with the sole purpose of exporting LNG and, providing natural gas for use in Mauritania and Senegal.

The justification for this project lies in the interest of Mauritania and Senegal to develop their offshore oil and gas resources to benefit both countries. Justification for the project co-venturers rests with their interest in developing hydrocarbon resources offshore, in accordance with appropriate health, safety, security and environmental standards.

Benefits for Mauritania and Senegal will include resource revenues: income revenues through the shares of PETROSEN and SMHPM in the project, as well as the states' shares of LNG sales and taxes.

The project will follow a rigorous operating model which maintains safety as the top priority. This model includes reliability, local content, development of the local workforce and benefits to project affected communities through sustainable development initiatives. Priority of social investment will be given to activities focusing on the following areas which align with the result of the ESIA public consultations:

- Education through supporting learning and education initiatives focusing on business skills, language skills, literacy, computing skills, science & technology, including oil and gas related education;
- Economic development opportunities for income and employment through the provision of a mix of instruments (e.g., micro-finance in combination with vocational education, business services for community based-enterprises, fishing cooperatives and wider support for entrepreneurship);
- Environmental initiatives focusing on sustainable management of natural resources, efficient use, environmental awareness and protection and development of bio-diversity and ecosystems;
- Community health and safety activities through health programs and activities focusing on access and quality of health services for communities in close proximity; and
- Capacity building and institutional strengthening in partnership with local government and authorities.

2.1.2 Project Development Concept

Development calls for 505 million standard cubic feet per day (MMSCFD) of gas production from twelve wells with approximately 25 MMSCFD going to facility use; approximately 480 MMSCFD will be available for export using a single floating liquefied natural gas processing vessel (FLNG) and gas for use by Mauritania and Senegal. This development concept allows for the allocation of 35 MMSCFD of gas for use by Mauritania and 35 MMSCFS of gas for use by Senegal. However, the provision of the gas export infrastructure is not part of the current project.

Due to the potential scale of the resource, there is potential for future expansion of the field. However, if expansion is proven to be viable, separate ESIAs will be developed to address impacts associated with future phases of development.

The development concept of the current project comprises wells and a subsea production system (SPS) to collect gas in the GTA Field; this gas will then be transported via flowlines to a floating production offloading and storage vessel (FPSO) to process gas and remove condensate. The processed gas will subsequently be transported from the FPSO via a gas export pipeline to the Nearshore Hub/Terminal Area for further processing (notably liquefaction) and transport/export by LNG carriers (LNGCs). The project system layout is shown in Figure 2-1.

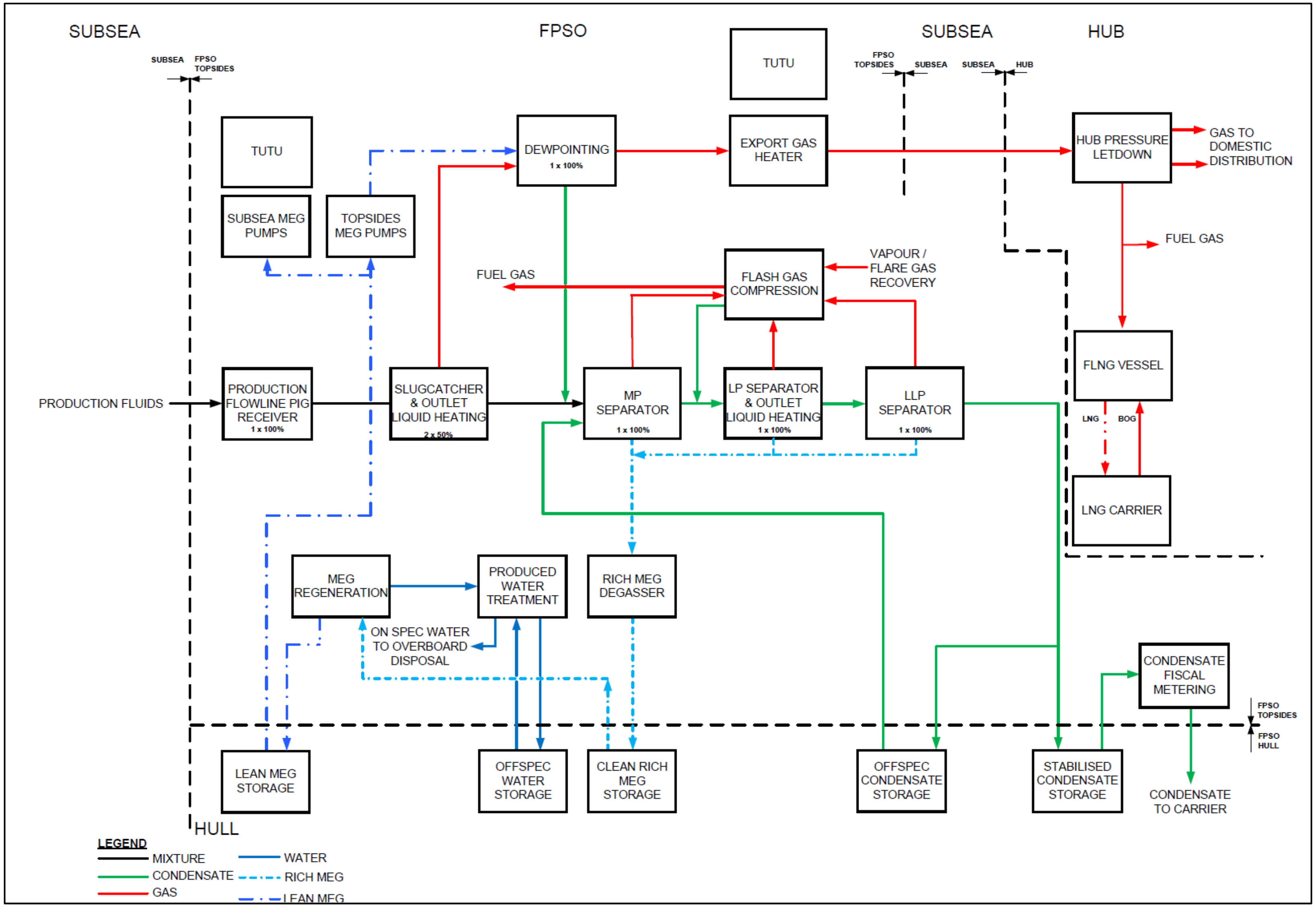


Figure 2-1. GTA Project System Layout.

2.1.3 Project Components and Location

Implementation of the development concept will be conducted within three different but interconnected components, as detailed below, as part of three project phases (i.e., Preparation, Construction and Installation; Operations; and Decommissioning).

Project Components

There are three primary components of the proposed project (Figures 2-2 and 2-3):

- **An Offshore Area**: located about 125 km from the coast and containing the areal extent of the Lower Cenomanian and Albian reservoirs to be developed. These reservoirs will be developed via a Subsea Production System (SPS), including development wells at two manifold centers (MC), production manifolds, and in field flowlines. All of the equipment in the Offshore Area will be located in approximately 2,700 to 2,800 m water depth, on the continental slope and within the bounds of the Mauritania and Senegal Exclusive Economic Zones (EEZs).
- **A Pipeline Area**: a 3 km-wide corridor connecting the Offshore Area with the Nearshore Hub/Terminal Area. Infrastructure within the offshore portion of the Pipeline Area will include: two 16-inch (outer diameter, OD) production flowlines to carry produced gas from the offshore wells to the FPSO; an umbilical which controls the electric, hydraulic, and production chemicals required for the wells within the Offshore Area; a 6-inch OD delivery line carrying monoethylene glycol (MEG) to ensure that produced gas is properly treated to prevent the formation of hydrates; and an FPSO. Prevention measures, detailed in Table 2-1, will be implemented to protect subsea infrastructure from fishing damage. Between the FPSO and Nearshore Hub/Terminal Area, a 30-inch OD export pipeline will deliver processed gas to the nearshore facility. The Pipeline Area extends from the continental slope across the continental shelf, all of which are within the bounds of the Mauritania and Senegal EEZ.
- **A Nearshore Hub/Terminal Area**: a constructed area of approximately 0.165km^2 (excluding safety zone) containing a breakwater, associated berthing facilities for tugs, a FLNG and berthing space for visiting LNG carriers (LNGC). The Nearshore Hub/Terminal Area will be located about 10 to 11 km from the coast, in water depth of about 33 m, on the continental shelf and within the bounds of the Mauritania and Senegal EEZ. LNG processing aboard the FLNG will cool the gas to temperatures below -160° C in order to bring it to a liquid state, thus enabling storage and long-distance transportation. The FLNG will liquefy and store the gas for export, the latter of which will occur via periodic visits from an LNGC.

The project also comprises an on-land component called the **Support Operations Areas**. It includes a supply base in the Port of Dakar, a supply base in the Port of Nouakchott and facilities in the airports of Dakar and Nouakchott[6].

[6] The supply bases will be located inside existing port facilities. As a result, no land acquisition will be required by the project in Dakar, Nouakchott or any other locations in Mauritania or Senegal. Therefore, it is not anticipated that the project will involve resettlement of inhabitants.

Table 2-1. Prevention Measures to Protect Subsea Infrastructure from Fishing Damage.

<table>
<tr><th rowspan="2">Subsea Facility</th><th colspan="2">Fishing Protection</th></tr>
<tr><th>Water Depth < 1,000 m</th><th>Water Depth > 1,000 m</th></tr>
<tr><td>Well Tie-Ins, Production Flowline and Gas Export Pipeline and MEG Pipeline</td><td>Design for fishing gear impact, pull-over and hooking in accordance to DNVGL-RP-F111.
Note – MEG Pipeline likely to require trenching – to be confirmed during Front End Engineering and Design (FEED).</td><td rowspan="11">None required</td></tr>
<tr><td>Riser (on seabed)</td><td rowspan="3">Trenched. Protection by over-trawlable mattresses or rock dumping where trenching is not possible.</td></tr>
<tr><td>Umbilicals (on seabed)</td></tr>
<tr><td>Fibre Optic</td></tr>
<tr><td>Pipelines at crossings</td><td rowspan="2">Mattresses or rock dumping</td></tr>
<tr><td>Umbilicals at crossing</td></tr>
<tr><td>Subsea Structures</td><td rowspan="2">Design for fishing gear impact, pull-over and hooking in accordance to NORSOK U-001. Protection structures shall be over trawlable.</td></tr>
<tr><td>Trees and Wellheads</td></tr>
<tr><td>Spools and Jumpers</td><td>Design for fishing gear impact, pull-over and hooking in accordance to DNVGL-RP-F111.</td></tr>
<tr><td>Flying | Control Leads</td><td>Protection by SDU structure at connections; protection by mattresses or equivalent on seabed.</td></tr>
</table>

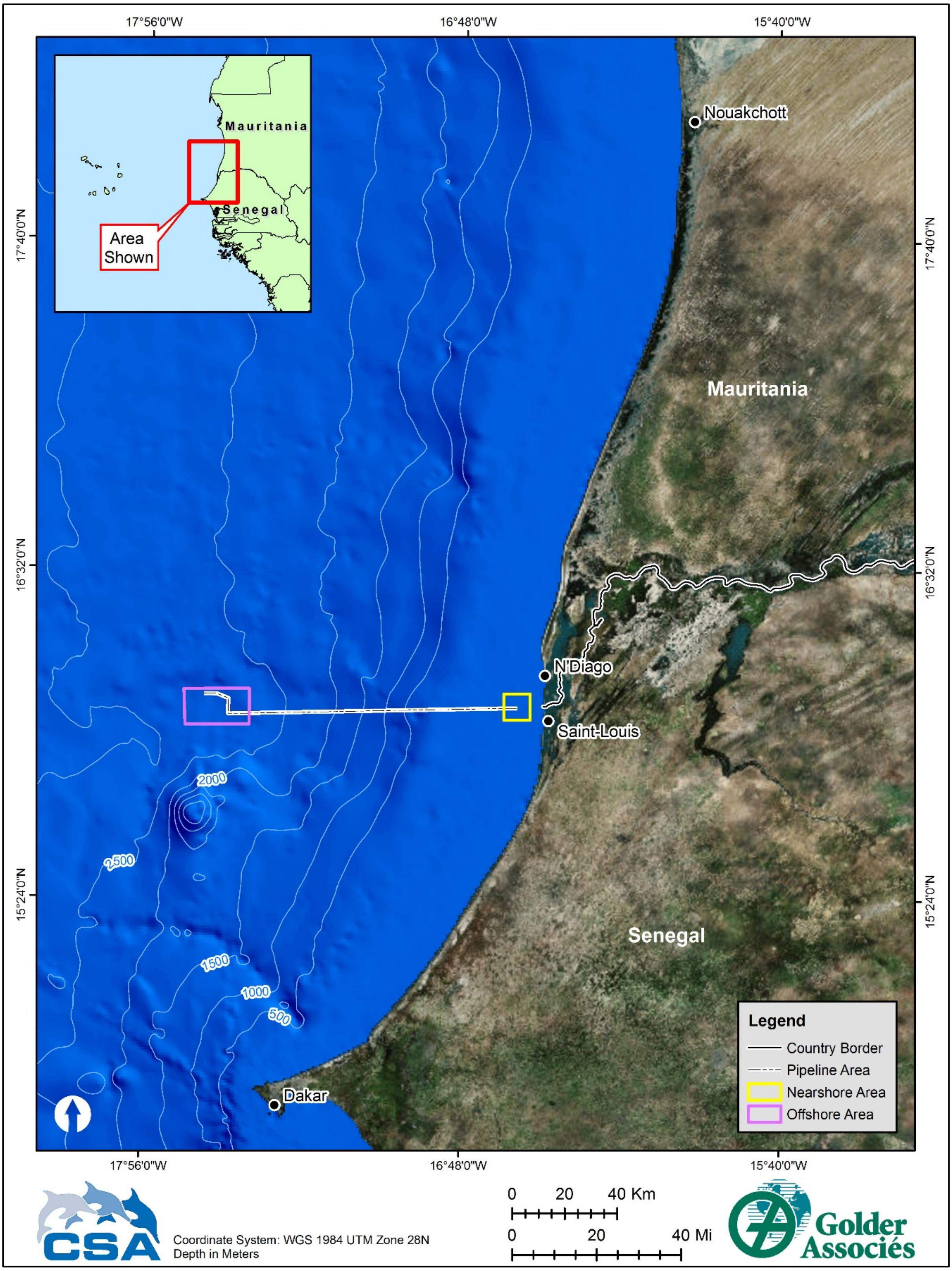


Figure 2-2. Location of the Primary Components of the Proposed Project.

Project Location

The subsea pipeline system is configured into one production loop that can accommodate up to twelve wells in two manifold centers. The two proposed manifold centers are:

- MC1 (Tortue-1), located at 2,725 m water depth; and
- MC3 (Guembeul-1A), located at 2,790 m water depth.

At present, a total of twelve production wells are proposed, with first gas to be produced from the four wells at MC1, a further two at MC1 and six potential future wells at MC3.

The FPSO will be located at the 120 m depth contour, within the Pipeline Area (298,261 m E and 1,777,231 m N). The FPSO is located close to the GTA Field for gas flow assurance. Water, condensate and MEG, are removed before the pre-treated gas flows to the Nearshore Area. The FPSO will be located approximately 40 km from the coast.

The Nearshore Hub/Terminal, where LNG processing and export will occur, is located in 33 m of water on the Mauritania and Senegal maritime border, at approximately 328,504 m E and 1,776,823 m N; a major component of the Nearshore Hub/Terminal is the breakwater, designed as an L-shaped structure to protect the liquefaction and export operations (Figure 2-4). The Nearshore Hub/Terminal facility is located approximately 10.1 km from the shoreline, approximately 13.2 km from Saint-Louis, approximately 16 km from N'Diago, approximately 177 km from the Port of Dakar and approximately 222 km from the Port of Nouakchott.

The current development plan for the project does not include any onshore facilities except for the Support Operations Areas (i.e. supply base facilities inside the ports of Dakar and/or Nouakchott, and facilities in the airports of these two cities).

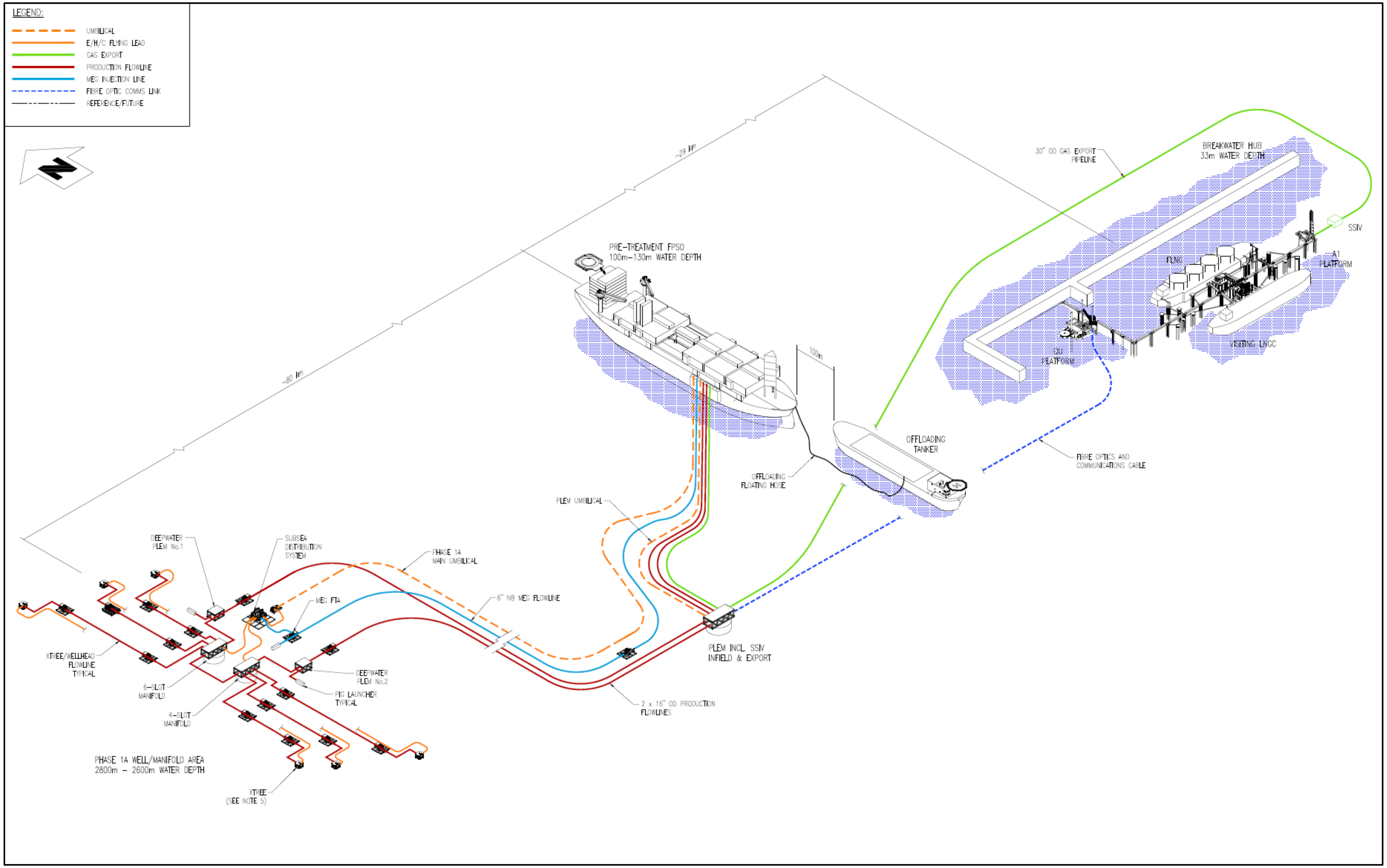


Figure 2-3. Current Full field Layout (not to scale).

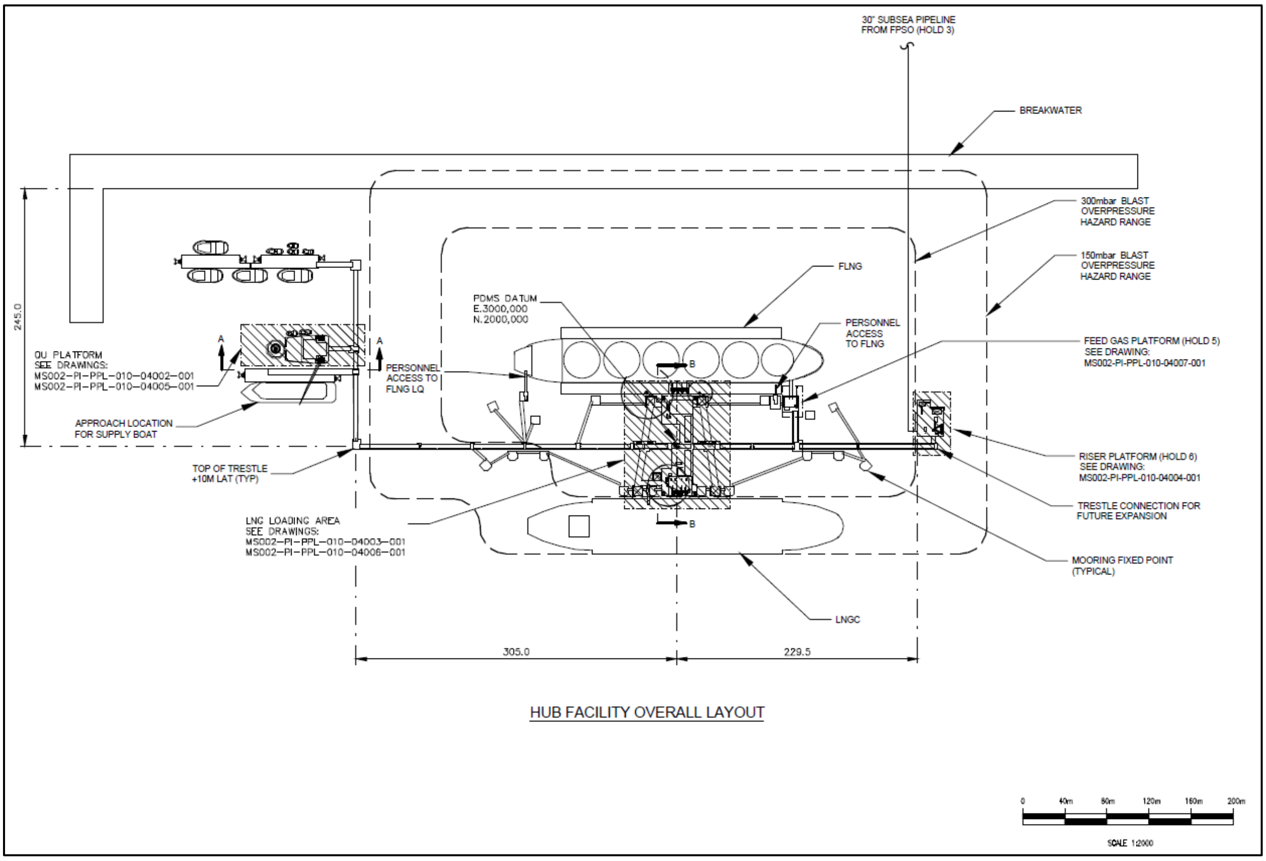


Figure 2-4. Anticipated Concept Design for the Nearshore Hub/ Terminal Area.

2.1.4 Operations and Processes by Phases

The project phases include: 1) Preparation, Construction and Installation; 2) Operations; and 3) Decommissioning. Major activities of these project phases include the following:

Preparation, Construction and Installation

- The drilling and completion of twelve wells, including the completion and production of two existing wells (i.e., exploratory wells drilled previously);
- The installation of infrastructure for the SPS to connect the wells, including wellheads, jumpers, manifold centres and flowlines;
- The laying of production flowlines, an export pipeline, umbilical lines and flying leads, a MEG flowline, and pipe conductors;
- Seafloor preparation for, and construction of, the breakwater at the Nearshore Hub/Terminal Area location;
- The construction of the FLNG and FPSO vessels which will be conducted in international fabrication yards out of the region;
- The installation of the FLNG vessel at the Nearshore Hub/Terminal Area location and installation of the FPSO within the Pipeline Area;

- Commissioning activities; and
- The use of supply and support vessels and specialized vessels to support preparation, construction and installation activities.

Operations

- The operation of the SPS, FPSO and FLNG;
- The use of supply and support vessels as well as tugboats to support operations;
- The export of LNG and condensate via LNGC and condensate tankers, respectively;
- Well maintenance;
- Pipeline and flowlines pigging; and
- Maintenance operations for the vessels and facilities.

Decommissioning

Likely decommissioning operations include:

- Plugging and abandonment of wells;
- Flushing and abandonment of flowlines and burial of flowline ends;
- Pigging and flushing of production flowlines and export pipeline;
- Shut-down of all systems, cleaning and making safe topsides, jackets, pipelines and all other materials;
- Purging of topsides to remove hydrocarbons and removal of topsides;
- Their transportation to an onshore site(s) for reuse, recycling or disposal; and
- Removal of the FLNG and FPSO vessels.

A detailed decommissioning plan will be established prior to decommissioning describing operations and measures that will be implemented to reduce impact on the marine environment and other sea users. The project proponent will evaluate technically feasible options for facilities and pipeline decommissioning and will undertake decommissioning activities in compliance with regulatory requirements in force, and Good International Industry Practice (GIIP), at the time of decommissioning. A preliminary decommissioning plan is presented in Appendix T. When preparing the final version of this plan, the relevant authorities of Mauritania and Senegal, notably including Senegal's National Agency on Maritime Affairs (*Agence Nationale des Affaires Maritimes* - ANAM), will be consulted.

2.2 Detailed Project Components

The following discussion characterizes details of proposed project components and methods for the Preparation, Construction and Installation, Operations, and Decommissioning Phases.

2.2.1 Offshore Area

Well Drilling

Well drilling is planned at two manifold centers – The manifold centers are located in 2,700 to 2,850 m of water and approximately 3,800 m from one another. Each manifold center has capacity to tie-back six wells; these wells will be drilled within approximately 5,000 m of the manifold centers.

Two wells will be re-entries and therefore do not require any further drilling operations. The other ten wells will be newly drilled – five wells around the northern manifold center and five wells at the southern manifold center. For the first four wells at the northern manifold centre drilling will commence in January 2021 and finish in September of 2021. For the remaining ten wells, three will be drilled in the first half of 2025, two will be drilled in 2028 and the final three will be drilled in 2032.

Drilling is planned to be conducted from the Ensco DS-12 (formerly the Atwood Achiever), a 238-m long and 42-m wide drillship, or similar drillship. It will be fitted with a dynamic positioning (DP) system which is capable of automatically maintaining the position and heading of the vessel. The drillship should not be visible from the coast due to its distance offshore. A picture of the Ensco DS-12 is provided in Photo 2-1.

Photo 2-1. Typical Drillship- Ensco DS-12.

It is proposed that all drilling operations will be conducted from the drillship. Two reservoirs will be developed, the Lower Cenomanian and the Albian. The reservoirs are not comingled and each reservoir requires dedicated wells. A typical well schematic is provided in Figure 2-5 for a Lower Cenomanian gas producer.

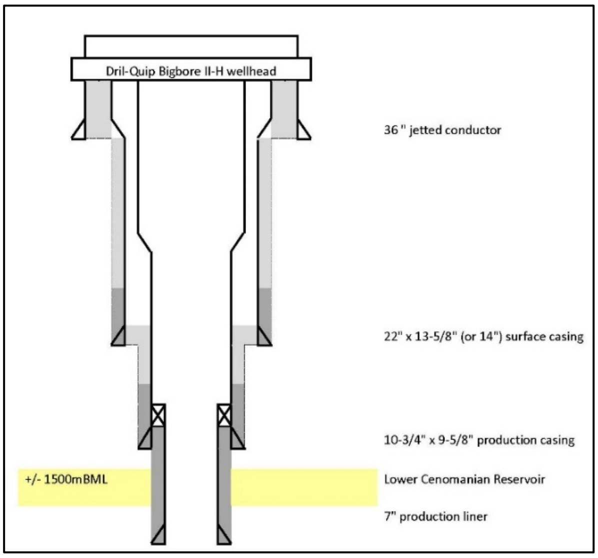


Figure 2-5. Typical Well Schematic.

The operation requires the use of drilling muds, cement, and various chemicals. During drilling of the first two well sections, water based drilling muds and cuttings will be deposited on the seafloor at the bore hole. Subsequent sections will be drilled with surface returns, where drilling muds and cuttings are brought back to the surface through the marine riser. Drilling muds and cuttings returned to the drillship will be processed to remove cuttings; treated cuttings will be discharged, and drilling muds will be reused.

Additional wells will be drilled and completed and added to the Subsea Production System. The initially installed system will be designed for minimal disruption as additional wells are brought online. Therefore, the additional work scope beyond drilling and completion will be to install jumpers from the wellheads to the manifolds, and flying lead umbilicals for controls and chemical injection. Estimated time to drill and complete a well is estimated at 60 days, plus 10 days to install blow out preventer (BOP), jumpers and umbilicals.

During the initial development stage, a well maintenance schedule (workover), if required, would be timed in conjunction with other well drilling and completion activities. If well maintenance is required beyond the initial development stage, it would be accomplished using similar vessels to the drillship and possibly a dynamically positioned well service vessel. Support services would entail use of existing operational vessels and additional offshore vessels and helicopters, depending on the nature of the well work.

If required, a deepwater drilling rig can be deployed to intervene on the wells. Depending on the nature of the operation conducted to remedy an issue, the rig could be on location, accessing a well, between 20 and 60 days.

For decommissioning the wells, a dynamically positioned drillship will plug and permanently abandon subsea wells. A multipurpose subsea construction vessel with a remotely operated vehicle (ROV) will be used to decommission the subsea production flowline.

Subsea Production System

The SPS is anticipated to be installed by several installation vessels. The system will include up to twelve wells. The system will include wellheads, jumpers, trees, manifolds, flowline jumpers, and in-field flowlines connecting two manifold centers located. Well controls and chemical injection lines will be supplied to the field through an umbilical tied back to the FPSO. MEG will be delivered to the field through a 6” diameter pipeline. Controls and chemical injection, including MEG, will be distributed between manifold centers by infield umbilicals and flying leads.

Initial production may come from discovery and appraisal wells already drilled in 2015 and 2016. Up to 60 days will be required to restart operations in these wells, as well as test and complete them. New wells are anticipated to require between 60 and 70 days for drilling, testing and completion, depending upon the targeted geological formation. Total installation time for the SPS to initial gas production is estimated between ten and fourteen months.

Wells will be equipped with chokes, isolation valves, production flowmeters and chemical injection metering valves. During operation of the SPS, each well will be routinely monitored for well flow and water production measurement by personnel aboard the FPSO. MEG and other flow assurance chemicals will be piped from the FPSO to each well or manifold, injected into the gas production stream to manage flow assurance risks (e.g., hydrates formation and wax).

Decommissioning of the SPS will be described in the Decommissioning Plan mentioned in Section 2.1.4 and follow applicable regulatory requirements and GIIP at the time of abandonment. Wells will be capped and sealed per GIIP.

2.2.2 Pipeline Area

Pipelines

A dual production 16” (OD) flowline will extend from the Offshore Area (GTA Field) to the FPSO. The following will also run parallel to this production flowline:

- An umbilical which controls the electric and hydraulics; and
- 6” (OD) MEG injection flowline.

The production flowline will arrive at the FPSO where it will undergo gas treatment and condensate processing. Once processed, gas will be transported via a separate 30” (OD) export pipeline to the Nearshore Hub/Terminal Area for liquefaction into LNG, storage, and export. A fiber optic cable will also be laid parallel to the gas export pipeline.

The laying of the flowlines and pipeline will require multiple installation vessels and potentially installation aids. Dynamically positioned pipelay vessels are expected to be used to install the production flowline from the deepwater field location to the 1200 m water depth contour and will then install the export pipeline from 120 m to roughly 33 m terminating at the Nearshore Hub/Terminal. Pipeline and flowline installation and commissioning time is estimated between 10 and 14 months pending weather availability. Pipeline maintenance will include periodic pigging and inspection operations. Pigging operations could be conducted approximately every 3 months during the Operations Phase to remove wax and maintain production from the subsea manifold to the FPSO. A slug volume associated with the pig will be processed through a combination of gas separation and temporary fluid storage on the FPSO. Captured fluids will be processed within the processing facilities. Any residual solids or impurities removed from the flowlines will be stored and treated according to applicable regulations. Periodic usage of vessels are anticipated during pigging operations. Inspection of the flowlines and export pipeline will be undertaken, in the order of once every 5 years.

At the Decommissioning Phase, it is expected that the flowlines/pipeline from subsea wells to the FPSO will be pigged and flushed of hydrocarbons and left in situ. As mentioned in Section 2.1.4, a decommissioning plan will be developed assessing the technically feasible decommissioning options and their impacts. Decommissioning activities will need to comply with regulatory requirements, applicable at the time of completion and GIIP.

FPSO

The FPSO will be constructed outside of Mauritania and Senegal and it will be towed to the final location. The FPSO pre-commissioning is anticipated to be completed before arriving on site and finalized once mooring and the pipework is connected. The connection piping will be tested at facility startup. The overall mooring spread footprint in 120 m water depth will be approximately 1.0 km by 2.0 km and will use driven piles to anchor the ends of the mooring chains. The FPSO is expected to have the following capabilities as a minimum to process the well fluids and treat gas prior to export to FLNG facility:

- Pigging launcher/receiver for the incoming flowlines;
- Condensate reception, stabilization and storage;
- Gas processing to remove liquid hydrocarbons and water to meet a FLNG and domestic gas specification;
- Gas export including fiscal metering and heater;
- MEG filtration, regeneration, and storage for use in the subsea injection and process system;
- Chemical storage and injection;
- Condensate offloading/sales;
- Produced water treatment and disposal;
- Production and subsea control systems for the SPS;
- Accommodation facilities for the personnel working on the FPSO (approximately 150 personnel);
- Will be self-contained with all utilities and safety systems; and
- Various FPSO marine operations.

Condensate removed from the gas and stored aboard the FPSO will be offloaded periodically to a condensate tanker. The condensate tankers are expected to arrive every 65-70 days and offload approximately 733,000 barrels (bbls) of condensate within a 24-hour period. The lightship weight of condensate tankers is anticipated to be approximately 20,000 tons. Between one and three tug boats will need to be employed to assist offtake tanker maneuvering, hook-up and disconnect during condensate offloading.

For the lifetime of the project subject of the ESIA it is assumed there will be no breakthrough of formation water from the reservoir. If in the unlikely event formation water >1 bbl/MMSCF is produced, lean and rich MEG containing salts will be stored on FPSO and will be transported for regeneration and reclamation at an offsite facility. If rates of >5 bbls water /MMSCF are encountered the project will choke back the well or apply other mitigation measures.

During normal operations, the pilot on the FPSO flare will be lit and have a nitrogen purge supply. There will be no routine flaring.

The FPSO will be sized to supply, via export pipeline to the Nearshore Hub/Terminal, 480 MMSCFD of natural gas for liquefaction, along with facility/project gas demands of 25 MMSCFD.

For decommissioning of the FPSO, it is expected that the flowlines from the subsea wells will be pigged, flushed and left in situ. Mooring lines and risers will be removed. It is expected that the FPSO will be towed from the site for either repurposing or recycling.

2.2.3 Nearshore Hub/Terminal Area

The breakwater will provide protected berthing for the FLNG, LNGC, personnel accommodation and miscellaneous marine support vessels. It will include a system of piping, controls and access to enable the safe and efficient transfer of export gas to the FLNG for processing. Components and activities include:

- Gas receiving facilities;
- Utilities, controls, safety systems;

- FLNG and LNG offloading;
- Export pipeline pigging;
- Metering;
- Accommodation facilities for the personnel working at the hub/terminal/ FLNG (around 160 personnel); and
- Berthing/docking facilities for tug boats.

The Nearshore Hub/Terminal Area will use a variety of vessels during installation. Installation of the breakwater will require support of a heavy construction vessel to drive foundation piles[7], and for breakwater construction. The breakwater is envisioned as a rubble mound foundation built around metallic or concrete caissons. The rubble mound foundation will require a significant amount of foundation material (rock and sand).

A potential local rock sourcing option is to source rock from Mauritania or Senegal[8]. If rocks are sourced from an out of the country location they will be transported directly to the breakwater location using a specialist rock dumper vessel.

Irrespective of rock sources locations, the barge/rock transfer operation will likely operate 24 hours/day for 12-18 months for breakwater installation.

In addition to the quarry rock, the breakwater is also anticipated to require either metallic or concrete caissons. The caissons could be sourced in Mauritania or Senegal or internationally. From the designated port, the project would transport the caissons to the final breakwater location for installation.

The breakwater will require seafloor preparation and a foundation of rock. Ballast material will be required to fill the caissons (estimated quantity detailed in Section 2.7.2) and sand for potential replacement of the soft ground as founding stratum. Dredging of unsuitable seabed material[9] and the sourcing of sand may be required during this preparation. Sources of sand will be from permitted and approved areas outside of the project area offshore or onshore, either within Mauritania or internationally sourced.

Offshore or onshore sources of sand and offshore dredging disposal locations will be selected based on:

- National regulatory requirements for such operations;
- Ability to meet technical specifications;
- Accessibility of locations; and
- Avoidance of significant environmental and social sensitive sites.

The heavy construction vessel will also be utilized to install piping, walkways, and other components of the Nearshore Hub/Terminal Area.

[7] The steel pile currently envisaged for the hub area are as following: 1) 1.830 m dia; 50 mm w.t for approximately 174 piles; and 2) 1.830 m dia; 25 mm w.t for approximately 104 piles.

[8] With the advancement of project engineering, the sources of supply of breakwater construction materials have become more defined. As of September 2018, it is expected that the caissons will be manufactured within the Dakar port and that this will be the subject of a separate ESIA. Sand, with appropriate geotechnical characteristics, will be used as ballast material of the caissons. This sand will be extracted in Mauritania, probably from an offshore source, which guarantees, de facto, its suitability to the marine aquatic environment. Potential sources of sand extraction are currently being analyzed by the contractor responsible for the construction of the breakwater. Rocks will be required for the foundation of the breakwater. These rocks will come from a quarry in Mauritania and this will be the subject of an environmental and social impact assessment.

[9] Dredging depth is estimated from seabed to a maximum approximate depth of 36.5 m LAT. The dredging material will be disposed offsite.

The anticipated proposed dimensions at the top of the breakwater are: 1) 1 km long by 32 m wide along the longer leg of the breakwater; and 2) 150 m long by 32 m wide along the shorter leg of the breakwater. At the base of the breakwater, dimensions are approximately 1.12 km long by 127 m wide; the overall footprint of the breakwater facilities is approximately 0.16 km^2.

The Nearshore Hub/Terminal will be comprised of a pile-supported trestle, riser platform, and a quarters and utility (QU) platform. The pile-supported trestle will provide a permanent berth for the FLNG and a temporary berth for the visiting LNGC. The riser platform will serve as the primary location for flaring gas. The QU platform will provide accommodation for the following: diesel fuel storage to support tugs; firewater pumps; electric power for lighting and power; instrument air; nitrogen generation; potable water; and seawater cooling, if required. The QU platform will also provide space for a control room; harbor master’s office; security office; medical center; spares and warehousing capability; a light mechanical workshop, and accommodation for up to 160 personnel.

The commissioning strategy will seek to minimize offshore commissioning activities by maximizing the amount of commissioning at their respective manufacturing bases prior to arrival onsite where practicable. This will maximize production ramp-up and minimize discharges and flaring requirements.

It is anticipated that installation of the FLNG will require minimal operations. This vessel is anticipated to sail to site with all topsides systems and equipment in place. Installation will require pulling alongside the Nearshore Hub/Terminal with assist from two to three tug vessels. Once alongside the Nearshore Hub/Terminal, the mooring lines and connecting pipework will be deployed between the Nearshore Hub/Terminal and vessel. Mooring and pipework installation time should be on the order of four to eight weeks.

In the gas liquefaction process aboard the FLNG, pre-treated gas is passed through heat exchangers, cryogenically refrigerating the gas to minus 160 degrees Celsius. At these temperatures, natural gas exists in liquid form and has an energy density 600 times greater than its gaseous state – enabling commercial export to global markets. Once liquefied, up to 125,000 cubic meters of LNG will be stored in 6 insulated spherical tanks aboard the FLNG, with offloading operations occurring approximately 50 times per annum (i.e., on average 10.7 days) onto visiting Liquefied Natural Gas Carriers. Emissions and discharges resulting from the operation of the liquefaction facility are detailed in Sections 2.9 and 2.10, respectively. During normal operations at the FLNG, the pilot will be continuously lit and flaring will occur under abnormal or emergency conditions.

During normal operations on the hub, the flare (located on the riser platform) will be purged with nitrogen and normally lit. During abnormal or emergency conditions, flaring may be required.

Ongoing support operations for the FLNG activities and the FPSO would require typical operations associated with offshore installations. This includes regular rounds of supply vessels for equipment and crew transfer. It is anticipated that primary crew changes will be done with crew vessels based from either Dakar or Nouakchott.

A few tug vessels may be based at the Nearshore Hub/Terminal Area at a small vessel dock to be available for on-demand support operations. Four tugs would be used in normal operations to assist arrival and departure of the LNGC, along with a project patrol vessel. The LNGC is expected to have cargo carrying capacity of between 125,000 cubic meters (m^3) and 180,000 m^3, with a deadweight of approximately 100,000 tons. LNG exports are expected roughly every 10.7 days on average at full production rate.

It is anticipated that all power generation for the Nearshore Hub/Terminal facilities, excluding FLNG, will be contained on the QU platform.

Decommissioning of the nearshore facilities will take on multiple forms following applicable regulatory requirements and GIIP at the time of abandonment. Technically feasible options will be described and assessed in the Decommissioning Plan to be developed prior to entering into the Decommissioning Phase.

Pipeline near the Nearshore Hub/Terminal may be removed and sent to onshore site(s) for reuse, recycle or disposal. The FLNG will be towed from site for either repurposing, recycling or decommissioning. Hydrocarbons and hazardous materials will be removed from the Nearshore Hub/Terminal to mitigate environmental contamination. Piping, lighting, and other materials will be removed from the location. The fate of the breakwater structure will be assessed and discussed with authorities at the time of the development of the decommissioning plan. It is currently expected that caissons will be removed and the rubble mound foundation be left in place to act as an artificial reef. Marine hazard buoys will be deployed on site to mark location of the breakwater at abandonment.

2.2.4 Support Operations Areas

During the three phases of the project, support operations will include transportation of equipment, supplies and personnel by vessel. The support operations will be conducted from supply bases located at the Port of Dakar and/or the Port of Nouakchott. Additionally, the airports of Dakar and/or Nouakchott will be used for helicopter transportation of personnel if needed[10].

Supply bases in the Port of Dakar and/or the Port of Nouakchott

It is anticipated that the supply bases will be located in existing areas inside the port facilities.

The supply bases, whether in Dakar and/or Nouakchott, will likely include:

- Equipment and material storage;
- Operations and maintenance centers;
- Arrival and departure of support vessels; and
- Loading/offloading supplies and equipment being transported to and from the drillship, the FPSO and the hub/terminal area.

One of the purposes of the supply base is to provide short-term transit and cross-over facilities for the arriving and departing personnel working at the FPSO and the Nearshore Hub/Terminal. Operations staff will live on the FPSO and the Nearshore Hub/Terminal, probably on a 4 weeks on/4 weeks off basis. There are expected to be two or three transfers per week for the FPSO and the hub/terminal, with a maximum of 60 persons per trip. Arriving personnel will arrive at either the Dakar or Nouakchott airport and be transferred by crew bus to the supply base where they will be transported to the FPSO and the hub/terminal area by a crew boat. If required, they will spend a night in a hotel in Dakar or Nouakchott until their allotted transfer time.

The supply bases will be designed to permit uninterrupted operation of the crew boat on a 24 hour per day, 7 days per week, 365 days per year basis. The facilities will include an access trestle; a quay/jetty for embarkation and disembarkation of personnel (floating or fixed); wave protection for berth, depending on location; a reserved area on quay/jetty for a 2-tonne crane to load/unload vessel and space for truck; a security hut; a storage area for light goods in transit; vehicle parking (for base vehicles, cars etc.); and a waiting room.

The other purposes of the supply base are for equipment and material storage and maintenance centers.

[10] The airports serving Dakar and Nouakchott have been selected on the basis of project requirements. An important part of the project staff, especially in the first years of the project, will come from abroad. They will fly in/out of Mauritania and/or Senegal to their home countries on a rotation basis. Daily flights from/to international destinations was therefore a requirement for the selection of the project airports. The Saint-Louis airport did not meet this requirement. The ports of Dakar and Nouakchott were also selected on the basis of technical requirements of the supply bases as described in this Chapter for the GTA Phase 1 project. The Saint-Louis fluvial port did not meet these requirements. The Government of Senegal has a rehabilitation program for the Saint-Louis airport. As this rehabilitation is not yet effective, the possibility of using this airport for the GTA project once rehabilitation is completed will be examined later during project implementation.

Airports at Dakar and Nouakchott

The Blaise Diagne Airport of Dakar, located at approximately 50 km from Dakar, has opened in December 2017, with a planned capacity of 3 million passengers per year. Nouakchott–Oum Tounsy International Airport, with a similar capacity, is located 25 km north of the city. Commercial flights into the airports serving Dakar and Nouakchott will be utilized every four weeks to accommodate rotations for Nearshore Hub/Terminal personnel.

There will also be helideck for air transfer of personnel as needed, with expected flights from Dakar in Senegal and Nouakchott in Mauritania. Helicopter personnel transfer is only expected for changeout during well drilling (i.e., airport to the drillship), or during emergencies (e.g., landing aboard the FPSO or QU Platform). Routine helicopter operations are not expected during FPSO or Nearshore Hub/Terminal operations.

2.3 Schedule and Phases

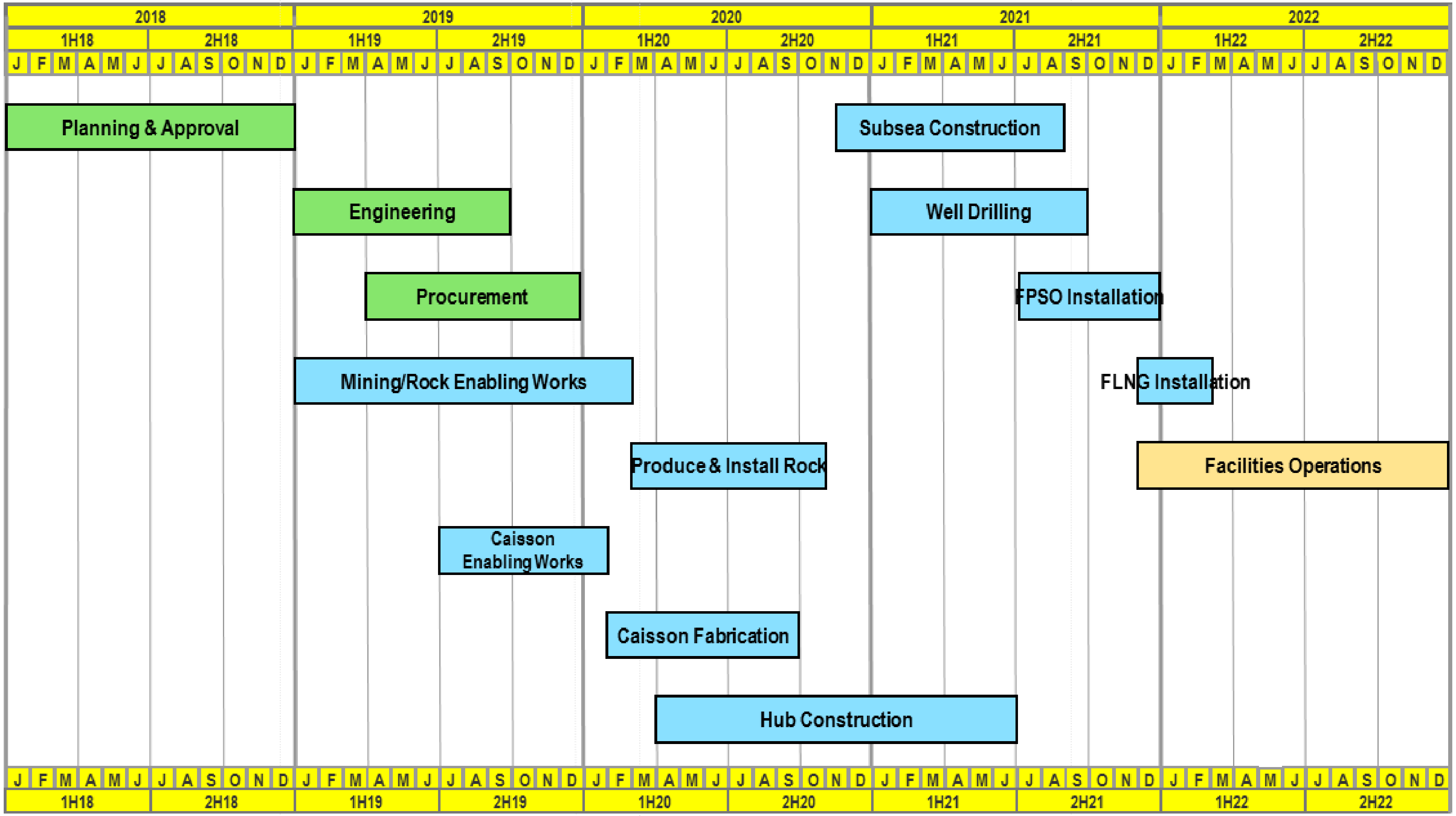
2.3.1 Overall Calendar

As mentioned in Section 2.1.4, the project includes three phases:

- The first phase will consist of preparation, construction and installation (also referred to as the Construction Phase in the ESIA). It includes development well drilling. This phase is expected to start in 2018 and is expected to last 3 to 5 years.
- The second phase will be the production operations phase. The first facilities are expected to be operational on location end of 2021. Development drilling of the first phase will be continuing in parallel. The duration of the Operations Phase is based on an anticipated 20 year contract duration of the FLNG vessel.
- The last phase will be project closure and decommissioning, during which production will eventually cease and equipment may be retired or removed. This phase will start after the Operations Phase and could last several years.

The partners in the project are working to have the first facilities operational on location at the end of 2021 to start generating revenues to the two countries. The overall project construction schedule has been developed with a view to achieving that. Some construction activities are also constrained by certain weather conditions for safety and technical reasons. In that schedule, the construction of the breakwater is currently planned between March to October 2020 with caisson installations at breakwater location in the nearshore area between June to October which corresponds to the low fishing season.

The Preparation, Construction and Installation Phase estimated project schedule is shown in Figure 2-6.



Based on Master Control Schedule (MCS), March 18

Figure 2-6. Preparation, Construction and Installation Estimated Schedule.

2.3.2 Preparation, Construction and Installation Phase

Drilling of each new well is expected to require between 59 and 63 days. Drilling the 12 wells could last up to about 700 days, discontinuously over a period of several years. Drilling or completion of the first four wells is expected to be initiated in Q1 2021 and extend over a period of approximately nine months (Figure 2-6).

Engineering design, construction of the breakwater, installation of the FPSO, laying of pipeline, and SPS installation is expected to require approximately three to five years.

2.3.3 Operations Phase

The production scenario during early field life is driven by the available FLNG capacity. Initial production is 505 MMSCFD:

- 410 MMSCFD to the FLNG;
- Allocation of 70 MMSCFD for use in Mauritania and Senegal;
- 25 MMSCFD for use by the FPSO and Nearshore Hub/Terminal facilities; and
- The first facilities are expected to be operational on location end of 2021.

2.3.4 Decommissioning Phase

The Decommissioning Phase starts after the Operations Phase. A schedule for the Decommissioning Phase will be prepared and presented for approval at a future date as per the requirements of the hydrocarbon exploration and production contract in Mauritania and the hydrocarbon exploration and production sharing contract in Senegal.

2.4 Exclusion Safety Zones and Navigation

Safety zones refer to permanent or temporarily designated maritime areas around fixed, floating or subsea structures where certain restrictions or special advisories apply to maritime users. This includes precautionary areas, designated tanker waiting areas, exclusion safety zones and, during construction periods, development areas. The project will work with relevant flag state or coastal state authorities on the designation and notification of such areas in line with generally accepted international practice.

Exclusion safety zones will be established around the facilities to minimize exposure to radiant heat during flare events, to minimize collision potential of vessels, and to prevent access to facilities by non-authorized personnel. Non-project vessels will not be allowed within the exclusion safety zones.

During all phases (preparation, construction, installation, operations, and decommissioning), it is expected that a 500 m exclusion safety zone will be established around the drillship. A similar 500 m exclusion safety zone will be established around the FPSO during these phases.

During the Preparation, Construction and Installation Phase, a 500 m exclusion safety zone will be established around all the construction and pipeline installation related vessels and construction marker buoys deployed.

During all phases (preparation, construction, installation, operations, and decommissioning), it is expected that the exclusion safety zone around the Nearshore Hub/Terminal will cover a surface of 3.243 km^2 with currently planned distances of 500 m X 600 m. These distances could be slightly modified prior to the Operations Phase but the exclusion safety zone footprint will remain unchanged.

No exclusion safety zone is associated with the wells, SPS and pipelines during the Operations Phase.

Radar, facility lighting, and designated travel and approach plans will be used to manage support vessel traffic as well as the LNGC, condensate carrier, tug boats, and supply vessels. A notice to mariners will be issued. The designated exclusion safety zones will be enforced with project patrol boats during Preparation, Construction and Installation, Operations, and Decommissioning Phases. Information will be provided to the local fishing communities to communicate and record the exclusion safety zones and applicable navigational charts. Navigation simulation modelling will be performed to assist in managing vessel collision risk.

To reduce the risk of vessels colliding or interfering with project vessels using the Nearshore Hub/Terminal, the following zones will be established:

Zone 1: Permanent safety zone (no unauthorized vessel shall enter this zone) – typically a minimum of 500 m/600 m from breakwater and other jetty structures.

During the Construction Phase, the zones/boundaries will be demarcated through the use of:

- Marker buoys equipped with audio and visual warnings effective by both day and night in the prevailing sea conditions;
- Long life (LED or similar) bulbs;
- Anchored at pre-set intervals;
- Positioned to demarcate shipping lanes used for entry/exit and safety areas around fixed assets; and
- Tamper-proof design, anti-climb and not suitable for small vessels to use as a mooring.

The use of the above methods of demarcation will be reviewed during the Operations Phase based on performance and traffic planned in that phase.

Zone 2: Moving safety zone around an LNGC in transit – typically 2000 m in front of, 1000 m behind and 500 m either side of the vessel.

To deter incursion to the maritime zone around the Nearshore Hub/Terminal, a minimum of one project patrol boat will be required. Project personnel aboard the project patrol boat will be unarmed.

2.5 Vessel Characteristics

Preparation, Construction and Installation Phase

It is anticipated that the vessels and their respective crews utilized during preparation, construction and installation will be sourced from outside of Mauritania and Senegal but they will be operating from the Dakar and/or Nouakchott ports. A summary of typical vessel types to be utilized during this phase are presented below. Details regarding vessel specifications are provided in Appendix B. All vessels will need to comply with applicable IMO standards relevant to their proposed use (e.g., double-hulled vessels for tankers, etc.). Additionally, the applicable project vessels will have an anti-fouling system (biofouling) compliant with the 2001 International Convention on the Control of Harmful Anti-fouling Systems in Ships (AFS 2001). The project does not plan for the cleaning of FLNG and FPSO hulls. The management of biofouling will be done through the application of anti-fouling paints used to coat the hulls of ships to prevent sea-life such as algae and molluscs, to attach to the hull.

The construction of the breakwater is forecast to take approximately 25 to 30 months. The typical vessels required for the breakwater construction are dredgers, rock dumpers, crane barge, heavy lift vessel, anchor vessels for FLNG, tugs, standby vessel, supply vessels and crew boats. The typical vessels used and expected working days during that construction period for each vessel are provided in Table 2-2.

It is currently anticipated that during this time construction related personnel will live on a flotel. This is a vessel that can accommodate the personnel offshore and will be used during the Construction Phase for several months until quarters and utilities at the Nearshore Hub/Terminal are available for workers. The approximate sizing of the flotel will accommodate 250 people, and will be based close to the Nearshore Hub/Terminal construction area. The flotel will likely consist of living quarters including recreational areas, a small number of offices, medical office, crane and helideck for medical emergencies.

Table 2-2. Typical Vessel Usage for Preparation, Construction and Installation of the Nearshore Hub/Terminal.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
Dredger	2	90	20
Rock dumper	2	130	50
Support boat	6	660	6
Crane barge	3	130	20
HLD barge	1	65	60
Anchor vessel	3	20	15
Tug boat	4	20	6
Project patrol boat	1	660	7
Standby vessel	1	660	15
Supply vessel	2	220	15
Crew boat	2	110	4
Flotel	1	210	250
Piling vessel	1	540	30

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

Notes/Assumptions: 1) 20 days require for anchor handling; 2) tug boats on station 20 days to maneuver FLNG until anchored; 3) rock dumpers required for 130 days for preparation, construction, and installation of the breakwater and 24-hour operation; 4) Supply vessels every 3 days; 5) crew change every 6 days; 6) Flotel in place for 7 months until living quarters at the Nearshore Hub/Terminal is commissioned. 7) Piling activity to occur over an 18-month period.

As previously mentioned, the FPSO will be constructed outside of Mauritania or Senegal and will be towed to the final location. The typical number of vessels required for hook up and commissioning (HUC) of the FPSO is summarized in Table 2-3. It is estimated that hook up and commissioning (HUC) of the FPSO will require 60 days. Vessels assumed to be used for FPSO HUC are anchor handling vessels, tug boats, project patrol/standby vessels, supply vessels and crew boats.

Table 2-3. Typical Vessel Usage for FPSO Hook Up and Commissioning.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
Anchor vessel	3	36	16
Tug boat	4	30	10
Project patrol boat	1	60	7
Standby vessel	1	60	14
Supply vessel	2	20	14
Crew boat	2	20	4
Derrick barge	1	18	50
Multi Service Vessel (MSV)	1	36	25

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

Notes/Assumptions: 1) Supply vessel every 3 days; 2) Tug boats in position for 30 days for maneuvering and anchoring of FPSO; 3) Crew change every 6 days.

The installation of the production flowline and export pipeline is scheduled to take approximately 171 days. During that period, it has been assumed there will be one pipelay vessels, one umbilical installation vessel, one remote operated vehicle (ROV) survey vessel and a dive support vessel (Table 2-4).

Table 2-4. Typical Vessel Usage for Subsea Installation.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
S-Lay vessel	1	120	300
J-Lay vessel	1	90	200
Heavy Lift Vessel	1	290	60
ROV survey vessel	1	50	50
Pipe Carrier vessel	1	160	80
Dive support vessel	1	16	80
Multi Service Vessel	1	180	25
Supply vessel	1	30	22
Umbilical Installation Vessel	1	34	50
Project patrol boat	1	56	7

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

Notes/Assumptions: 1) Pipelay will require 171 days; 2) ROV survey will require 40 days; 3) Dive support vessel will be required for 7 days.

The drilling of the twelve wells is scheduled to take about 700 days on a discontinued period, with drilling to occur between January 2021 and September 2021; during the first half of 2025, in 2028 and in 2032. As mentioned before, drilling is planned to be conducted from the Ensco DS-12 or similar drillship. The drillship will be equipped with rooms for personnel, a canteen, a medical unit, a heliport, emergency systems including fire protection and firefighting equipment and escape, evacuation and rescue systems. Approximately 200 people will be living and working aboard the drillship at any time. Crew changes to the drillship will be done by helicopter. Transportation by helicopter will occur from the airports of Dakar and/or Nouakchott. During that period, it has been assumed there will be one supply vessel being used to support drilling operations (Table 2-5).

Table 2-5. Typical Vessel Usage for Drilling or Completion of Development Wells.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
Drillship	1	About 700	200
Supply vessel	1	76-81	30 (estimated)
Standby vessel	1	76-81	20 (estimated)

Notes/Assumptions: 1) Well completion at one well will require 60 days; 2) Drilling of eleven new development wells will require 59 to 63 days per well; 3) Supply vessel runs will occur every 7 days.

Operations Phase

Beside the FLNG and FPSO vessels which are permanent facilities of the project, other vessels will be utilized during operations and will generally transit from the Port of Dakar and/or the Port of Nouakchott to the project locations (e.g., Nearshore Hub/Terminal, FPSO, etc.). It is anticipated that these vessels will be sourced from outside of Mauritania and Senegal, and include tugs and supply vessels. Tugs, once deployed, are likely to remain on site to assist berthing and departure of LNGCs and condensate carriers. Supply vessels and crew boats will routinely transit between the offshore facilities and ports.

Crew changes to both the FLNG and the FPSO will likely be by fast crew boat from either Dakar or Nouakchott to avoid the need for routine helicopter flights. Helidecks will be provided on the QU platform and FPSO for emergency use. Crew transfer at the FPSO will be achieved by a 10 person FROG lifted by a suitably certified crane on the FPSO to/from a crew boat. It is expected that a helideck will be available for use on the FLNG but primacy will be to use the QU platform helideck where possible. Details regarding typical vessel usage during the Operations Phase are provided in Table 2-6.

Other operation vessels will include the LNG carrier (LNGC) and condensate carriers.

Table 2-6. Typical Vessel Usage during Operations.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
Tug boat	4	Every 2 days	10
Supply vessel	2	Every 2 -3 days	22
Crew boat	3	Every 2-3 days	4
LNGC[1]	1	Every 10-11 days	22
Condensate carrier[1]	1	Every 65- 70 days	22
Mooring Line vessel	3	Every 2 days	4
Project patrol boat	2	365	7

[1] LNGC and Condensate Carrier will be third party vessels. Therefore, the POB for these vessels have not been included in the Operations Phase.

Decommissioning Phase

The vessels likely utilized during decommissioning will include tugs, supply vessels, heavy lift vessels, and a drillship. These vessels will generally transit from the Port of Dakar and/or the Port of Nouakchott to the project locations, or will transit from outside the project area (e.g., from another country). Details regarding typical vessel usage during the Decommissioning Phase are provided in Table 2-7.

Table 2-7. Typical Vessel Usage during Decommissioning.

Vessel	Number Used	Days Used	Crew Compliment per Vessel
Drillship	1	21	200
Standby vessel	2	24	20 (estimated)
Supply vessel	2	24	30 (estimated)
ROV survey vessel	1	15	50
Anchor vessel	2	64	16
Crane vessel	2	64	20
Tug boat	8	80	6
Crew boat	1	90	4
Multi-service vessel	2	24	25

2.6 Demand and Supply of Energy and Water

2.6.1 Overview

Limited energy and freshwater will be required from local sources; most demands for energy will be supplied either by the vessels or by the produced gas while freshwater will mostly be supplied via on-board desalination units.

2.6.2 Preparation, Construction and Installation Phase

During the Preparation, Construction and Installation Phase, energy and water will be required to support the supply bases in the Port of Dakar and/or the Port of Nouakchott during construction. Generators will be used to supply most of the energy, and local water supplies will be utilized. Offshore facilities during this phase will require diesel to be delivered offshore.

The service and construction vessels will produce their needed energy and water from on-board systems. The Flotel will require a supply boat to provide diesel offloads for energy.

2.6.3 Operations Phase

During the Operations Phase, electricity and water will be generated by the FPSO, FLNG and QU platform via consumption of project-produced gas and from on-board desalination units, respectively. As previously mentioned, 25 MMSCFD of the 505 MMSCFD produced will be used to supply the project facilities. It is anticipated that no electricity or water supply will need to be required from outside sources for the offshore infrastructure.

2.6.4 Decommissioning Phase

No electricity or water supply is expected to be needed from outside sources, as they will be generated by the facilities and vessels used during decommissioning. Offshore facilities during this phase will require diesel to be delivered offshore. However, energy and water will likely be required to support the supply bases in the Port of Dakar and/or the Port of Nouakchott during Decommissioning Phase.

2.7 Demand and Supply of Material and Equipment

2.7.1 Overview

Demands and available supply of materials and equipment are detailed in the following sections.

2.7.2 Preparation, Construction and Installation Phase

For the construction of the breakwater approximate volumes and weight of materials are listed below in Table 2-8.

Table 2-8. Estimation of Materials Required for the Construction of the Breakwater.

Material	Volume (m^3)	Mass (t)
Core rock	840,000	1,762,000
Underlayer rock, M_{50} = 300 kg	307,000	643,000
Armour layer rock, 3-6 t	220,000	462,000
Granular regulating layer	22,000	45,000
Sandfill for caisson	603,000	1,224,000
Reinforced concrete for caisson	227,000	-
Dredge material at the foundation of breakwater	250,000	-
Sand fill material for founding Breakwater	250,000	-
Reinforced concrete deck slab	14,000	-

All rock sourced shall be dense sound material quarried from an approved source. Suitability of rock will be assessed within and out of country, including the completion of various geotechnical tests and environmental assessment[11]. Geological and geotechnical literature studies were conducted to identify an appropriate quarry taking into account environmental requirements. The nature of the rocks will be confirmed by an analysis of their mineralogy. According to the results of this mineralogy, an analysis of the rock reactivity in the water will be conducted. This will confirm the suitability of the rocks for their intended use. See Section 2.2.3 for additional descriptions of the rubble mound foundation and caisson.

Construction of the FPSO, QU Platform, riser platform and FLNG will be undertaken outside of Mauritania or Senegal. The vessels and platform will be sailed round to position with topsides installed. Any specialized equipment required for the facilities will be shipped to the supply base storage locations prior to being sent offshore via supply vessels. For non-specialized equipment, local supply chains may be utilized.

2.7.3 Operations Phase

Specialized materials such as replacement valves, pipework and chemicals will be sourced from OEMs/oilfield suppliers. The Operations team will look to local supply chains for non-specialized materials when reasonably practicable subject to meeting the necessary requirements.

2.7.4 Decommissioning Phase

It is not anticipated that any additional materials and equipment to those used in Operations would be required in Decommissioning.

[11] The mode of transportation of rocks will be determined at a later stage of the project preparation once the source of rock is selected.

2.8 Chemicals and Hazardous Materials

2.8.1 Overview

A variety of chemicals, including both non-hazardous and hazardous chemicals, will be employed during all three phases of the project. Chemicals for each phase are detailed in the following sections. The selection of chemicals will be completed based on technical, environmental and economic considerations[12]. Chemical use will be optimized taking into account operational performance, safety requirements, toxicological properties and reduction of discharges into the environment.

Hazardous wastes are materials that can potentially be harmful to human health and/or could potentially damage the natural environment if not managed and disposed of appropriately. They exhibit one or more of the following characteristics: ignitable, corrosive, reactive, toxic, mutagenic, teratogenic, infectious, irritant, carcinogenic, flammable, explosive or the ability to bioaccumulate/biomagnify. In addition to hazardous waste, special categories of hazardous waste include biohazards such as medical waste (e.g., sharp objects such as syringes or scalpels; soft waste such as soiled medical dressings).

Section 2.11 presents information on proposed solid waste generation by the project, including hazardous waste.

2.8.2 Preparation, Construction and Installation Phase

Well Drilling

Chemicals are required for the well drilling process, including: 1) chemicals used during drilling; and 2) cement and associated chemicals used during cementing operations (e.g., while setting pipe). Table 2-9 summarizes the chemicals expected to be used, based on the estimates for drilling in the Offshore Area.

[12] The GTA Phase 1 project will follow OSPAR Harmonised Mandatory Control System (HMCS; OSPAR Recommendation 2000/2 as amended by OSPAR decision 2005/1) and OSPAR Guidelines for Completing the Harmonised Offshore Chemical Notification Format (HOCNF) (OSPAR Agreement: 2010/3, as amended by OSPAR recommendation 2014/7) for the selection and use of production chemicals.
The project will also use a number of chemicals that are listed on the OSPAR List of Substances/Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR).

Table 2-9. List of Typically Expected Routine Drilling Mud Chemicals.

Drilling Mud Chemicals (Function)	Unit Size	Quantity Available for Use aboard the Drillship	Quantity Used per well
Weighting agent	MT	2,676	339
Viscosifying agent	MT	34	34
Alkalinity control	25-kg can	52	0
Antifoam agent	55-gal drum	3	0
Viscosifying agent	25-kg sack	219	38
Synthetic base oil	55-gal drum	1,439	1,439
Biocide	25-L can	96	0
Fluid loss control agent	25-kg sack	335	3
Hardness control agent	25-kg sack	58	58
Lost circulation material	25-kg sack	1127	1127
Lost circulation material	11-kg sack	95	95
SBM emulsifier	55-gal drum	64	64
SBM emulsifier	25-kg sack	735	735
Alkalinity control	25-kg sack	430	430
Water phase salinity agent	25 kg sack	640	640
Fluid loss control agent	25-kg sack	196	196
Rheology modifier	55-gal drum	24	24
Drilling detergent	55-gal drum	7	7
Drilling mud	Bbl	10,804	10,804

Adapted from: Kosmos Exploratory EIA (Environmental Impact Assessment for Exploratory Drilling, Saint-Louis Offshore Profond and Cayar Offshore Profond Blocks, Offshore Senegal; Kosmos, 2015)

bbl = barrel; gal = gallon; kg = kilogram; L = liter; MT = metric ton; SBM = synthetic based mud.

Cement and cement additives are also used during drilling. Table 2-10 identifies the cement and cement chemicals that are expected to be used, based on previous drilling in the Offshore Area.

Table 2-10. Summary of Typically Expected Cement and Cement Chemicals during Drilling Activities.

Cement and Cement Chemicals (Function)	State (Phase)	Unit	Quantity Used per Well
Cement G	Solid	MT	160
Cement G + 35 % silica	Solid	MT	160
Antifoam	Liquid	Gallon	399
Dispersing agent at low temperature	Liquid	Gallon	483
Setting accelerator of the cement	Liquid	Gallon	90
UNIFLAC – control of fluid loss	Liquid	Gallon	439
GASBLOK	Liquid	Gallon	5,000
GASBLOK LT-Emergency	Liquid	Gallon	2,480
Dispersing agent	Liquid	Gallon	3
Self-timer	Liquid	Gallon	267
Dye	Liquid	Gallon	100
Self-timer	Liquid	Gallon	160
Stabilizer agent	Solid	Lb	250
CemNET (LCM)	Solid	Bbl	500
Losseal w/o	Solid (fiber)	Bbl	480
Losseal W	Solid (fiber)	Bbl	480
Barite MUDPUSH II	Solid	Lb	2,225
Self-timer	Liquid	Gallon	0
Extender	Liquid	Gallon	4,500
Surfactant	Liquid	Gallon	576
Mutual solvent	Liquid	Gallon	576

Adapted from: Kosmos Exploratory EIA (Environmental Impact Assessment for Exploratory Drilling, Saint-Louis Offshore Profond and Cayar Offshore Profond Blocks, Offshore Senegal; Kosmos, 2015)

bbl = barrel; Lb = pound; MT = metric ton.

Other chemicals found aboard a typical drillship include: 1) completion fluids; 2) radioactive materials; and 3) dispersants.

Completion fluids are solids-free liquids used to complete a well. The fluid is placed in the well to facilitate final operations prior to initiation of production, such as setting screens, production liners, packers, and downhole valves. The fluid enables control of a well should downhole hardware fail, without damaging the producing formation or completion components. Completion fluids are typically brines (chlorides, bromides) and formulations with a number of additives.

Radioactive materials are limited to small amounts of radioactive elements found within specialized tools used during the drilling and well evaluation process; most of these radioactive materials are sealed within tools (Table 2-11). No naturally occurring radioactive materials (NORM) are expected to be encountered during drilling.

Table 2-11. Expected Summary of Radioactive Sources.

Radioactive Element	Number of Tools on the Drillship	Units	Physical Form	Function
Am-241/Be	2	GBq	Solid/sealed	Monitoring of the bottom of the hole
Co-60	5	GBq		
Cs-137	1	KBq		
Na-22	2	KBq		
Th-232	1	KBq		

From: Kosmos Exploratory EIA (Environmental Impact Assessment for Exploratory Drilling, Saint-Louis Offshore Profond and Cayar Offshore Profond Blocks, Offshore Senegal; Kosmos, 2015)

Am = americium; Be = beryllium; Co = cobalt; Cs = cesium; GBq = gigabecquerel, 109 Bq; KBq = kilobecquerel, 103 Bq; Na = sodium; Th = thorium.

Dispersants are typically stored aboard the drillship while in the field to provide for immediate response in the event of an oil spill. Additional stores of dispersant are located onshore at the supply bases and on the support vessels. Dispersant kits will be placed aboard one or more of the support vessels, with kits containing pumps, spray kits, and dispersant for boat application. Dispersant is stored in industrial bulk containers with an individual volume of 1,000 L. Total estimate of dispersant volume aboard the support vessels is presented in Table 2-12.

Table 2-12. Summary of Oil Spill Dispersant Typically Stored aboard the Support Vessels.

Product Name	Common Name	Function	Phase	Unit Size	Units
Corexit 9500	Corexit 9500	Dispersant, for treatment in the event of an oil spill	Liquid	Liters	8,000

From: Kosmos Exploratory EIA (Environmental Impact Assessment for Exploratory Drilling, Saint-Louis Offshore Profond and Cayar Offshore Profond Blocks, Offshore Senegal; Kosmos, 2015)

Pipeline Installation and Commissioning

The flowlines/pipeline will be flooded with seawater containing chemicals (e.g., biocides, oxygen scavengers and corrosion inhibitors) and hydrotested. Before startup, the production flowlines and export pipeline will be dewatered.

Table 2-13 outlines the nature of the chemicals that may be used during pipeline installation and commissioning.

Table 2-13. Typical Subsea and Pipeline Pre-Commissioning Chemicals.

	Type	Chemical Function	Estimated Discharged Volumes
Precommissioning chemicals	Combined chemicals	Combined Biocide, Oxygen Scavenger & Corrosion Inhibitor	38 m^3
		Liquid dye	4 m^3
		MEG	858 m^3

All chemicals shall be approved for use by BP prior to the pre-commissioning operations commencing. BP will develop discharge plans and seek to comply with applicable regulatory and permitting requirements to obtain discharge approval. Discharge plans will describe the chemical selection process and measures implemented to reduce the use of chemical additives. Table 2-13 presents the representative chemicals used to treat filtered seawater that do not contain hydrocarbons that will be discharged to sea when pipeline testing and commissioning is conducted.

Supply Bases

For storage of well equipment and supplies, supply bases in both Mauritania and Senegal will be used depending on the location of the drillship. The drilling team may store drilling tubulars, wellheads, trees and other drilling equipment at these onshore locations. Some inventories of pipe grease, fluids and chemicals may be stored by third party vendors; this may be within country or out depending on chosen vendors. Storage facilities and storage containers will meet GIIP.

2.8.3 Operations Phase

FPSO

Chemicals are required during process operations to allow safe and efficient activities, including 1) chemicals used within the MEG system, 2) chemicals used within production system topsides and 3) subsea chemical injection. The table below summarizes typical chemicals with preliminary expected injection rates used on the FPSO.

MEG is required for flow assurance to avoid the formation of hydrates. Other chemicals are added to produced fluids for specific purposes, such as inhibition of corrosion on the topsides or to aid the separation process. Information relating to the produced fluids and the MEG system available at the time of the ESIA is summarized in the table below. Prior to commencement of operations, these chemical functions will be reviewed and final chemical products/commercial brand selected based on an assessment taking into account technical, environmental and commercial considerations.

Hydraulic fluid will be used to control topside and subsea valves on the Phase 1 wells of the GTA project. It is anticipated that subsea hydraulic fluid usage and discharge, on average, will be approximately 50 L per day.

Table 2-14. Typical Chemicals with Preliminary Expected Injection Rates Used on the FPSO.

Chemical Function	Storage (days)	Injection Rate	Basis	Working Volume (bbl)	Maximum Storage Volume	Bulk Fluid	Location
MEG Chemicals							
Lean MEG[1]	14 days	-	Continuous	16	7900 – 55,300 m^3	-	MEG flowline
pH stabilizer	3 months	100 – 500 ppmv	Intermittent	18.5 m^3	23 m^3	Produced Water & Lean MEG	Produced Water & Lean MEG
O_2 scavenger	3 months	8 - 10 ppmv per 1 ppmv of dissolved O_2	Intermittent	41 m^3	46 m^3	-	Lean MEG
Anti-foam	3 months	1 - 10 ppmv	Intermittent	4.5 m^3	5 m^3	Total fluids	Upstream of MEG flash drum
Production Chemicals							
Biocide	14 days	1000 ppmv	Intermittent	10.5 m^3	11.5 m^3	Total fluids	Closed / Open Drains
Anti-foam (Condensate)	3 months	1 - 10 ppmv	Continuous (contingency)	4.5 m^3	5 m^3	Total fluids	Upstream of slugcatcher
Emulsion breaker	28 days	20 - 100 ppmv	Continuous (contingency)	6 m^3	7.4 m^3	Total fluids	Upstream of slugcatcher
Flocculants or Coagulants (PW treatment system)	3 months	10 ppmv	Continuous	4.5 m^3	5 m^3	Produced Water	Produced Water
Subsea Injection Chemicals							
Corrosion inhibitor	3 months	5 - 200 ppmv	Continuous	60 m^3	64 m^3	Total fluids	Upstream of slugcatcher
Scale inhibitor	3 months	5 - 20 ppmv	Continuous	4.5 m^3	5 m^3	Produced water	Upstream of Liquids Heater
Methanol	-	-	Intermittent	Only used intermittently, for an estimated two complete shutdown and startup events			
Wax inhibitor	16	-	Intermittent	155 m^3	160 m^3	Total fluids	Upstream of slugcatcher

Ref: Functional FPSO Specification MS002-EM-PE-010-03001 B02

[1] MEG will be circulated within a closed system with no anticipated discharge to sea. The storage volumes stated relate to the maximum allocated hull cargo tanks.

Other chemicals and hazardous materials found onboard the FPSO relate to maintenance activities and the accommodation facilities onboard, these cover such items as HVAC cooling medium, fire-water systems, paints, detergents, lubricants, potable water additives and clinical waste.

Nearshore Hub/Terminal

The Nearshore Hub/Terminal, including the QU platform, are expected to hold minimal chemicals and hazardous materials onboard. These predominately relate to maintenance activities and the accommodation facilities. An overview of such items includes hypochlorite for water treatment, HVAC cooling medium, fire-water systems, paints, detergents, lubricants, diesel filters and clinical waste.

Onboard the FLNG process chemicals and hazardous waste will exist, a list below highlights the typical key materials:

Table 2-15. Typical Chemicals Stored on the FLNG

Material/ Chemical	Quantity	Replacement Frequency
Amine	25m^3	1 per year
Ethylene	20m^3	3 per year
Propane	25m^3	6 per year
Iso-pentane	25m^3	12 per year
Amine charcoal filter	40m^3	2 per year
Mol. Sieves	520m^3	1 every 4 years
Hypochlorite	Produced onboard	
Anti-foam	240m^3	When required

Supply Bases

The supply bases of Dakar and Nouakchott will be used for temporary storage of chemicals and hazardous materials listed above prior to being shipped offshore via the supply vessels.

2.8.4 Decommissioning Phase

A variety of chemicals, including both non-hazardous and hazardous chemicals, will likely be employed during the decommissioning of the project. The selected chemicals will depend on the decommissioning approach agreed at the time. Following the GIIP and complying with applicable legislation at the time of abandonment will support chemical selection. Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on FPSO, QU platform and FLNG to enable safe sail away.

2.9 Air Emissions

2.9.1 Overview

Engines used during all phases of the project will produce air emissions based on the size of the engine, the fuel source, engine load, and the time the engine is operated. These emissions have been calculated for the Preparation, Construction and Installation, Operations and Decommissioning Phases and are presented in the following sections.

2.9.2 Preparation, Construction and Installation Phase

Well Drilling

Activities expected to occur during drilling will produce emissions from internal combustion engines, including greenhouse gases (GHGs) and varying amounts of other pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), and particulate matter (PM). The location and duration of these operations are variable. For example, the drillship will maintain station at each drill site, while support vessels and helicopters will travel between the onshore Support Operations Areas and the Offshore Area.

Initial positioning activities and drilling operations will produce air emissions from internal combustion engines. As previously mentioned, a drillship similar to the Ensco DS-12 is expected to be used. The Ensco DS-12 is equipped with six HHI 14H32/40V 14 cylinder engines rated 7,000 kW (9,387 hp) each, driving six Siemens HSJ71209 10P generators rated at 6,750 kW each. The drillship has a single Caterpillar 3516B 16-cylinder emergency diesel engine rated 1,889.2 kW (1,594.7 hp), driving a single Leroy Somer Brushless/Revolving Field generator rated at 1,765 kW.

Support vessels will provide routine loading and offloading of personnel, supplies, and equipment. Given the deepwater location for drill sites, vessels in the 75 to 100 m size range with 3,200- to 9,600-hp ratings are required. Helicopter support will be provided by an appropriate aircraft (e.g., AgustaWestland AW 139).

A summary of daily maximum projected air emissions from project-related sources, under worst case conditions, is provided in Table 2-16, based on data prepared for previous exploratory drilling in the Offshore Area, which used values from the Ensco DS-12. Worst case conditions are defined as all engines operating under maximum capacity.

Table 2-16. Summary of Maximum Daily Air Emissions Forecast, by Source, for Drilling Activity at a Single Well.

Source	Emissions (tons/day)				
	PM	SO_x	NO_x	VOCs	CO
Drilling and Well Logging					
Drillship (Drilling) – Ensco DS-12					
Prime movers – 6 diesel generators (6 @ 9,387 hp [maximum] each)	0.48	2.19	10.06	0.49	3.57
Support Vessel					
Small work boat (1 vessel, 75- to 100-m size class, 3,200- to 9,600-hp range)	0.19	0.22	0.99	0.05	0.36
Helicopters					
AgustaWestland AW 139 (3,358 SHP)	-	0.0011	0.0174	-	-
Flaring (Drill Stem Testing)					
Gas flare (4,000,000 SCF/hr)	0.00	1.1	129.7	109.2	705.0

From: Kosmos Exploratory EIA (Environmental Impact Assessment for Exploratory Drilling, Saint-Louis Offshore Profond and Cayar Offshore Profond Blocks, Offshore Senegal; Kosmos, 2015)

CO = carbon monoxide; NOx = nitrogen oxides; PM = particulate matter; SOx = sulfur oxides; VOCs = volatile organic compounds; SHP = shaft horsepower; SCF/hr = standard cubic feet per hour. Emissions calculations, maximum daily:

- Based on updated U.S. Mineral Management Service Air Quality Emissions Spreadsheet (BOEM-0138 and 0139), effective March 2015.
- Ensco DS-12 daily calculations based on 6 engines operating at 24 hours per day at maximum capacity.
- Thrusters aboard the Ensco DS-12 utilize electrical power derived from the drillship's electrical system, the latter of which has been accounted for under prime movers; no emissions are directly associated with thrusters.
- Support vessels daily calculations based on a 24-hour day operating at maximum capacity.
- Helicopter daily calculations based on two landings and take offs (LTOs) per day, using emission factors for heavy twin engine aircraft (Billings and Wilson, 2004).
- Flaring duration: 72 hours (estimated); entries adjusted for daily emissions.

At the end of each well completion phase, it is expected that the wells will be cleaned up / flowed back through the completion to the drilling rig. The completion clean up / flow back operation is designed to remove wellbore completion fluids and solids and establish initial well performance characterization prior to handover to production. The duration of the clean up / flow back operation is expected to last several days. These test rate calculations reflect the maximum capabilities of typical well test equipment. For completion clean up /flow back operations, gas flaring will occur, depending upon the nature of the hydrocarbons encountered; in any case, total emissions associated with well testing is not expected to exceed the daily emissions noted in Table 2-16.

FPSO, Breakwater, and Subsea Pipeline Installation

The total emissions forecast for FPSO during preparation, construction and installation activities (i.e., HUC) are summarized in Table 2-17. Emissions forecast for the Nearshore Hub/Terminal installation and subsea pipeline installation are outlined in Table 2-18 and Table 2-19, respectively. Emissions calculations are based on vessel numbers and activity levels outlined previously. Total emissions forecast are presented in Appendix B-4.

Table 2-17. Annual Emissions Forecast from FPSO HUC Vessels.

CO_2 t/y	CH_4 t/y	N_2O t/y	NO_x t/y	CO t/y	VOC t/y	SO_2 t/y	GHG tCO_2eq/y
29,312	1.8	0.9	577	154	14.8	183	29,614

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compounds; SO_2 = Sulphur dioxide; GHG = greenhouse gases; t/y = tons per year; tCO_2eq/y = tons CO_2 equivalent per year.

Table 2-18. Annual Emissions Forecast from Preparation, Construction and Installation of the Nearshore Hub/Terminal.

CO_2 t/y	CH_4 t/y	N_2O t/y	NO_x t/y	CO t/y	VOC t/y	SO_2 t/y	GHG tCO_2eq/y
182,667	11.4	5.4	3,596	959	92.5	1,142	184,552

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

This includes installation of the FLNG
CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compounds; SO_2 = Sulphur dioxide; GHG = greenhouse gases; t/y = tons per year; tCO_2eq/y = tons CO_2 equivalent per year.

Table 2-19. Annual Emissions Forecast from Subsea and Pipeline Installation.

CO_2 t/y	CH_4 t/y	N_2O t/y	NO_x t/y	CO t/y	VOC t/y	SO_2 t/y	GHG tCO_2eq/y
76,346	4.77	2.2	1,503	401	38.7	477	77,133

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

CO_2 = carbon dioxide; CH4 = methane; N_2O = nitrous oxide; NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compounds; SO_2 = Sulphur dioxide; GHG = greenhouse gases; t/y = tons per year; tCO_2eq/y = tons CO_2 equivalent per year.

2.9.3 Operations Phase

During the Operations Phase, the FPSO, FLNG and Nearshore Hub/Terminal operations will generate air emissions. Visits by LNGC and condensate carriers, and assist vessels (e.g., tugs, crew and supply vessels, etc.) will also produce emissions on a periodic basis. Occasional well maintenance activities will also occur during the life of the field. Annual emissions forecast for each major operational source are summarized in Table 2-20. Total emissions forecast are presented in Appendix B-4.

Table 2-20. Summary of Annual Emissions Forecast for Operations, by Major Source.

Source	CO_2 t/y	CH_4 t/y	N_2O t/y	NO_x t/y	CO t/y	VOC t/y	SO_2 t/y	GHG tCO_2eq/y
FPSO	106,025	30	3	267	81	13	7	107,679
Start-up Flaring*	198,056	959	16	99	538	462	-	226,773
HUB	10,364	44	1	198	4	15	1	12,180
FLNG	548,919	38	14.2	264	178	51	-	554,133
Vessel Ops	19,655	1	0.6	387	103	10	123	19,858
TOTAL	**883,015**	**1,072**	**35**	**1,215**	**905**	**550**	**131**	**920,536**

From: Project, Energy Usage and Air Emissions Forecast MS002-EV-REP-010-01002 B02

* Start-up flaring predicted forecast from the process flows only.
CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; NO_x = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compounds; SO_2 = Sulphur dioxide; GHG = greenhouse gases; t/y = tons per year. tCO_2eq/y = tons CO_2 equivalent per year.

2.9.4 Decommissioning Phase

Air emissions will be generated by project vessels during the Decommissioning Phase. Decommissioning is expected at the FPSO and at the Nearshore Hub/Terminal (e.g., FLNG). Well plugging and abandonment is expected at each development well. SPS infrastructure will be removed, while some flowlines/pipeline are expected to be flushed and abandoned in place.

FPSO

Emissions resulting from the decommissioning of the FPSO would be expected to be similar to emissions resulting from installation, as summarized in Table 2-21. Emissions will be spread out over the time required for decommissioning. Total emissions forecast are presented in Appendix J.

Nearshore Hub/Terminal

Emissions from decommissioning of the QU platform and FLNG will be similar to emissions resulting from installation as the current plan is to disconnect and sail away for decommissioning or re-use out of country (see Table 2-18). Estimated emissions for decommissioning of the Nearshore Hub/Terminal are provided in Table 2-21.

The limited breakwater topside facilities including riser platform will be removed; this includes piping and cables. The removal of these items will occur via an assist vessel similar size to a supply vessel.

Table 2-21. Total Air Emissions Forecast for FPSO and Support Vessels, Decommissioning Phase.

Activity	NOx t	CO t	PM t	VOC t	SOx t	GHG tCO_2eq
Well Abandonment, SPS removal (Offshore Area)	286.15	101.85	18.65	14.00	62.45	17,561
Hub decommissioning	202.52	16.91	10.55 (PM10) 10.06 (PM2.5)	7.62	45.76	10,488.19
Subsea equipment removal (Pipeline Area)	171.36	45.64	-	4.41	54	8,793
FPSO decommissioning	56.42	15.05	-	1.45	18	2,897

CO = carbon monoxide; NO_x = nitrogen oxides; VOC = volatile organic compounds; SO_x = Sulphur oxides; GHG = greenhouse gases; t = tons; tCO_2eq = tons CO_2 equivalent.

2.10 Effluent Discharges

2.10.1 Overview

Discharges will occur during Preparation, Construction and Installation and Decommissioning Phases from the vessels utilized for the project activities. During the Operations Phase, in addition to vessels discharges, there will be discharges from the FPSO and the Nearshore Hub/Terminal complex including the FLNG[13]. Phase-specific details of effluent discharges are outlined in the following sections.

2.10.2 Preparation, Construction and Installation Phase

Well Drilling

Drilling activities will produce effluents that will be discharged following treatment to meet applicable limits. Effluent discharges will occur during drilling and other well work (e.g., well testing). Effluent discharges will include drilling muds and cuttings, completion fluids, cement, sanitary and domestic wastes, deck drainage, and other miscellaneous discharges.

Bulk densities of the drilling muds are expected to range from 9.0 to 12.0 pounds per gallon (ppg). Drilling program characteristics and mud characteristics are provided in Table 2-22 for a representative Cenomanian well. The table presents the cuttings volumes and weights, by section. Volume and weights are expected to be similar for each Cenomanian well.

Albian wells will also be drilled, with a similar drilling program. Total cuttings volumes are expected to be slightly higher for the Albian representative well (Table 2-23).

The term "section," as presented in Table 2-22, refers to individual portions of a single wellbore. Each borehole will be drilled using water based drilling muds (WBM) in the upper two sections (i.e., shallow portions) of the well; a synthetic based drilling fluid (SBDF) will be used in the lower (deeper) sections of the well.

- WBM: WBM will be used in the first two sections (Table 2-22) of each well. The release of muds and cuttings at the wellbore (i.e., at the seafloor) is expected to occur during jetting and drilling, over a period of several days. For each well, the release of muds and cuttings at the seafloor is expected to amount to 297 and 422 m^3, respectively.

[13] There will also be, for limited duration, discharges from condensate carriers and LNG carriers, mainly treated sewage/ballast.

- SBDF: SBDF will be used for the lower four well sections. After treatment, SBDF cuttings will only be discharged once the performance target of an average of 6.9 g/100 g retained “synthetic on cuttings” on wet solids averaged over the whole well discharge can be satisfied. SBDF cuttings will be discharged from the drillship at -10 m subsurface (Table 2-22). The discharge of treated SBDF cuttings from the drillship for each well will amount to approximately 219 m^3.

Several different chemicals may be employed during drilling and cementing operations at each well. A summary listing of drilling muds, cement, and mud and cement additives and their projected volumes expected to be used have been outlined in Section 2.8.2.

Cenomanian and Albian wells will require approximately 60 and 70 days to drill, respectively.

Table 2-22. Cuttings Volumes and Weights, by Section, for a Representative Cenomanian Well.

Section Number	Casing Size (in.)	Hole Size (in.)	Casing Setting Depth BML (m)	Section Length (m)	Hole Volume (m^3)	Wash-out Factor	Cut-tings Volume (m^3)	Mud Type	Maxi-mum Mud Weight (ppg)	Days to Drill (Dis-charge) Section	Dis-charge Location
1	36	36.00	75	75	49	1.00	49	WBM	9.0	0.5	Wellbore
2	22	26.00	800	725	248	1.50	373	WBM	9.0	2	Wellbore
3	14	17.50	1,400	600	93	1.20	112	SBDF	12.0	3	Drillship; -10 m subsurface
4	9-5/8	12.25	2,400	1,000	76	1.20	91	SBDF	12.0	4	Drillship; -10 m subsurface
5	7	8.50	2,800	400	15	1.10	16	SBDF	12.0	3	Drillship; -10 m subsurface
Total Cuttings Volume/Well Released at the Wellbore (m^3)							422				
Total Cuttings Volume/Well Discharged from the Drillship (m^3)							219				

BML = below mud line. Blue and green shading represents sections and cuttings volumes drilled using WBM and SBDF, respectively.

Table 2-23. Preliminary Comparison of Albian and Cenomanian Drilling Programs.

Target	Number of Well Sections	Drilling Muds	Hole Volume (m^3)	Cuttings Volume (m^3)
Albian	6	WBM, SBDF	516	683
Cenomanian	6	WBM, SBDF	481	641

General Vessel Discharges

Sanitary waste (i.e., also known as black water or sewage) consists of sanitary wastes from toilets and urinals. All sanitary waste will be treated using a marine sanitation device, producing an effluent with low residual chlorine concentrations (i.e., 1.0 mg/L or less), with no visible floating solids or oil and grease. Treated black water discharges will need to comply with International Convention for the Prevention of Pollution from Ships (MARPOL) requirements. Applicable discharges allowed under MARPOL will also need to comply, as appropriate, with applicable Mauritanian and Senegalese regulations.

Domestic waste (i.e., also known as grey water) consists of the water generated from showers, sinks, laundries and galleys, safety showers, and eye wash stations. Domestic wastewater is typically screened to remove any floating solids before discharge; domestic waste does not require treatment before discharge under MARPOL requirements. Daily generation rates for sanitary and domestic wastes are variable, but maximum volumes are expected to be approximately 0.123 and 0.177 m^3/person, respectively.

Deck drainage is applicable to project vessels, including the drillship and support vessels during drilling, and barges and support vessels during FPSO and Nearshore Hub/Terminal installation. Deck drainage consists of all waste resulting from rainfall, spillage, deck washings, and runoff from drains and gutters, including drip pans and work areas. Vessels and infrastructure have been, or will be, designed to contain runoff and prevent oily drainage from being discharged. Project vessels and surface infrastructure will be equipped with catchments (drip pans) in machinery areas.

Typically deck drainage on board support vessels is routinely routed directly overboard, except in areas where hydrocarbons may be released; in these latter cases, deck drainage is directed to the oil skimmers/oily water separators for treatment prior to discharge. Threshold maxima for the discharge will be 15 mg/L (parts per million, ppm) of hydrocarbons, per MARPOL requirements. Clean water (below 15 ppm hydrocarbons) is discharged overboard; separated oil is transferred to the contaminated drain waste oil tank.

Miscellaneous discharges typically occur from numerous sources on vessels. Examples may include desalinization unit discharge; uncontaminated ballast water; uncontaminated bilge water, and treated cuttings at the seafloor; uncontaminated fresh water; uncontaminated seawater; source water; subsea wellhead preservation fluids; subsea production control fluid; hydrate control fluids; brine used as piping or equipment preservation fluids (pipeline brines); and aqueous film forming foam (AFFF). These discharges will need to meet IFC and MARPOL requirements and will be managed using GIIPs.

To reduce the risk of introduction of alien species, when transitioning from one region to another, a ballast water exchange takes place at a specified distance from shore before entering a new body of water. Before entering Mauritanian and Senegalese waters, the drillship, FPSO and FLNG will need to comply with these operational procedures before entering Mauritanian and Senegalese waters, and make sure that all discharges will meet IFC/MARPOL requirements.

Bilge and drain systems are monitored for hydrocarbon contamination. Oily water separators will process bilge and contaminated drain system water. Threshold maxima for the discharge will be 15 mg/L (parts per million, ppm) of hydrocarbons, per MARPOL Annex I requirements. Clean water (below 15 ppm) is discharged overboard; separated oil is transferred to the waste oil tank.

Food wastes are generated from galley and food service operations. It is anticipated that food waste, a type of domestic waste, will be ground prior to discharge (i.e., comminuted) to <25 mm diameter to meet discharge requirements, in accordance with MARPOL (i.e., for vessels 400 gross tonnage and above). When ground to these specifications, food waste discharges are allowed if the vessel is 3 nmi (5.6 km) or more from land, or 12 nmi (22.2 km) or more from land when within special areas.

Table 2-24 outlines expected volumes for discharges from the drilling activities, exclusive of drilling muds and cuttings discharges. Water discharge calculations are presented in Appendix K.

Hub/Terminal

The effluent discharge estimate during construction and installation of the Nearshore Hub/Terminal is 43,242m^3 over a period of a maximum construction time of approximately 25-30 months (see Figure 2-6). All numbers are representative for typical vessel types including the flotel which will house the construction personnel until the quarters and utilities platform is commissioned, refer to Table 2-25 for detail.

FPSO and Subsea Production System

The effluent discharge estimate during the installation of the FPSO and subsea system is 30,798 m^3 over a period of 12 months (see Figure 2-6). All discharges are from the various vessels being used for the construction activities, and are based on typical vessel POB data from representative vessels, refer to Table 2-25 for detail.

Table 2-24. Summary of Effluent Discharges Forecast, Exclusive of Drilling Muds and Cuttings, for Drilling of Production Wells.

Effluent	Expected Volumes – Treatment or Processing	Source
Sanitary and Domestic Wastes	Total volumes depend on number of personnel (see Note, below) Sanitary wastes: 0.123 m^3/person/day – macerate, chlorinate, discharge Domestic wastes: 0.177 m^3/person/day – remove floating solids, discharge Sanitary wastes will be collected and treated, and domestic wastes will be collected prior to discharge in compliance with MARPOL 73/78, Annex IV Drillship: 200 persons on board maximum; 0.123 m^3/person/day black water; 0.177 m^3/person/day gray water; total volume: 24.6 m^3/day black water; 35.4 m^3/day gray water Support vessels: 50 persons maximum; 0.123 m^3/person/day black water; 0.177 m^3/person/day gray water; total volume: 6.15 m^3/day black water; 8.85 m^3/day gray water	Drillship Support Vessels
Deck Drainage	Total volume depends on rainfall; remove oil and grease and discharge (not to exceed 15 ppm) for hydrocarbons. All discharges will be in compliance with MARPOL 73/78, Annex I	Drillship Support Vessels
Cooling Water	Effluent should result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution take place.	Drillship Support Vessels
Bilge Water	Variable volumes, depending on vessels used. Processed through an oil-water separator. Discharged in compliance with MARPOL 73/78, Annex I. Drillship: estimated at 12.5 m^3 (79 bbl) per week Support vessels: 48 bbl/day per vessel	Drillship Support Vessels
Ballast Water	Variable; compliance with vessel operator's ballast water management system requirements (e.g., drillship); ballast water exchange at sufficient distance offshore/out of area to effectively eliminate the potential for the introduction of alien (invasive) species. Contaminated ballast water processed through an oil-water separator to meet 15 ppm limits. Discharged in compliance with MARPOL 73/78, Annex I Drillship: estimated at 620 bbl/day Support vessels: Not applicable	Drillship
Food Waste	Food waste will be ground and passed through a 25-mm mesh screen prior to disposal overboard outside the 12-nmi zone as required by MARPOL 73/78, Annex V. Estimated 1 kg per person per day Drillship: 200 persons, 200 kg food waste/day Support vessels: 50 persons, 50 kg food waste/day	Drillship Support Vessels

bbl = barrel; kg = kilogram; m = meter; m^3 = cubic meter; MARPOL = International Convention for the Prevention of Pollution from Ships; mm = millimeter; nmi = nautical mile; ppm = part per million. Note: For the purposes of this table and worst-case analysis, the maximum number of personnel (200) has been used.

Table 2-25. Effluents Discharges Forecast during the Preparation, Construction and Installation Phase.

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate (kg/d)	Average Daily Hazardous Waste Generation Rate (kg/d)	Per Capita Daily Non-Haz Waste Generation (kg/d)	Wastewater Generated during Construction Period: Average Daily Wastewater Generation Rate (m^3)	Wastewater Generated during Construction Period: Per Capita Daily Wastewater Generation Rate (m^3/d)	Wastewater Generated during Construction Period: Total Wastewater Generation (m^3)
FPSO - Transportation Integration, Installation, Hook-Up and Commissioning	Shipment of supplies	Supply Vessel	2	20	14	---	---	2	---	0.3	168
	Wet-tow FPSO to Offshore Site	Tug	4	30	10	---	---	2	---	0.3	360
	Installation of Piles for Mooring System	Derrick Barge	1	18	50	---	---	2	---	0.3	270
	Installation and HUC of mooring lines	MSV	1	36	25	---	---	2	---	0.3	270
		Anchor vessel	3	36	16	---	---	2	---	0.3	518

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Wastewater Generated during Construction Period		
									Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(kg/d)	(kg/d)	(kg/d)	(m^3)	(m^3/d)	(m^3)
Subsea System Installation	Transport of Subsea Equipment and Installation	Umbilical Installation Vessel	1	34	50	94	5	---	15	0.3	510
	Installation of 16" dual production flowline and risers, 6" MEG pipelines and risers, suction piles	S-Lay Vessel (Medium)	1	120	300	94	5	---	90	0.3	10800
		Pipe Carrier Vessel	1	160	80	---	---	---	---	0.3	3840
		Heavy Lift vessel	1	290	60	---	---	---	---	0.3	5220
		J-Lay Vessel	1	90	200	---	---	---	---	0.3	5400

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Wastewater Generated during Construction Period		
									Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(kg/d)	(kg/d)	(kg/d)	(m^3)	(m^3/d)	(m^3)
Subsea System Installation	Installation of SW export spool tie-ins, SSIV umbilical, pre- and post-lay surveys	Remotely Operated Vehicle (ROV) Vessel	1	50	50	98	5	---	20	0.3	750
	Installation of Well jumpers, flowline jumpers, HFLs, EFLs	MSV	1	180	25	98	5	2	---	0.3	1350
	Support for subsea hook-up and commissioning (HUC) activities	DSV	1	16	80	98	5	---	20	0.3	384

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Wastewater Generated during Construction Period		
									Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(kg/d)	(kg/d)	(kg/d)	(m^3)	(m^3/d)	(m^3)
General Support	Supply	Supply Vessel	1	30	22	---	---	2	---	0.3	198
	General Support during HUC Activities of FPSO and Subsea System	Crew Boat	2	110	4	---	---	2	---	0.3	264
		Project patrol boat	1	116	7	---	---	---	---	0.3	244
		Standby vessel	1	60	14	---	---	---	---	0.3	252
Total Subsea and FPSO installation									**30,798**		

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Wastewater Generated during Construction Period		
									Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(kg/d)	(kg/d)	(kg/d)	(m^3)	(m^3/d)	(m^3)
Marine Structures construction	Sand sourcing for caissons and seabed preparations	Dredger	2	90	20	---	---	2	---	0.3	1080
	Installation of breakwater base	Rock dumper	2	130	50	---	---	2	---	0.3	3900
		Crane barge	2	130	20	---	---	---	---	0.3	1560
		HLD barge	1	65	60	---	---	2	---	0.3	1170
		Tug boat	2	20	6	---	---	2	---	0.3	72
	Installation of caissons	Piling vessel	1	540	30	---	---	2	---	0.3	4860
Quarters and utilities platform installation	Platform installation in field	Anchor vessel	1	20	15	---	---	2	---	0.3	90
		Crane barge	1	130	20	---	---	---	---	0.3	780
FLNG Installation	Transportation of FLNG from a yard to site for installation	Tug	2	20	6	---	---	2	---	0.3	72
	HUC and Mooring	Anchor vessel	2	20	15	---	---	2	---	0.3	180

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Wastewater Generated during Construction Period		
									Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(kg/d)	(kg/d)	(kg/d)	(m^3)	(m^3/d)	(m^3)
General Support	General support activities for construction of breakwater, installation of QU platform and FLNG	Project patrol boat	1	660	7	---	---	2	---	0.3	1386
		Supply vessel	2	220	15	---	---	2	---	0.3	1980
		Crew boat	2	110	4	---	---	2	---	0.3	264
		Flotel	1	210	250	---	---	---	---	0.3	15750
		Standby vessel	1	660	15	---	---	2	---	0.3	2970
Total Nearshore Hub/Terminal construction and installation									**36,114**		

Notes and Assumptions:

1. Average daily waste water generation per person is averaged at $0.3m^3$.

Pipelines

The pipelines will be flooded with seawater containing chemicals (e.g., biocides, oxygen scavengers and corrosion inhibitors) and hydrotested. These chemicals are used for pipeline integrity preservation. Before startup, the pipeline will be dewatered. Forecast discharge volumes can be seen in Table 2-26.

Table 2-26. Provisional Fluid Discharge Volumes for Pipeline Installation and Commissioning.

System	Between	Activity	Approximate Discharge Volume (m^3)
Production flowline	MC to Pipeline End Manifold (PLEM)	Flood, clean, and gauge	2,472
Production flowline	MC to PLEM	Hydrotest	210
Production flowline	MC to MC	Flood, clean, and gauge	156
Production flowline	MC to MC	Hydrotest	2.6
Production flowline	MC to FPSO	Leak test	223
Production flowline	MC to FPSO	Dewater	13,182
Gas export pipeline	Nearshore Hub/Terminal to PLEM	Flood, clean, and gauge	2,968
Gas export pipeline	Nearshore Hub/Terminal to PLEM	Hydrotest	252
Gas export pipeline	Nearshore Hub/Terminal to FPSO	Leak test	253
Gas export pipeline	Nearshore Hub/Terminal to PLEM	Dewater	14,842
Gas export risers	Nearshore Hub/Terminal to FPSO	Dewater	45
MEG pipeline	FPSO Field Termination Assembly (FTA) to In-Field FTA	Flood, clean, and gauge	162
MEG pipeline	FPSO FTA to In-Field FTA	Hydrotest	14
MEG pipeline	FPSO to In-Field FTA	Leak test	15
MEG pipeline	FPSO to In-Field FTA	Dewater	813

Notes: 1) 20%-line volume over-fill to flood; 2) All the above volumes are an approximation for information purposes.

2.10.3 Operations Phase

It is anticipated that on the FPSO and FLNG, rainwater will be processed through an oil-water separator. Other deck drainage that may contain oil is diverted to the oil/water separation system for processing. The total volume of deck drainage is dictated by the amount of rainfall realized and the available surface area, specifically in those areas where the potential for oil- or chemical-contaminated surfaces are present.

In addition, it is proposed that the vessels will have the following three separate systems covering drainage:

- Contaminated drain system – covering drilling areas and machinery spaces;
- Non-contaminated drain system – covering accommodation areas, main decks; and
- Bilge system – covering below decks machinery systems.

FPSO

Effluents will be generated by the FPSO as presented in Table 2-27. It is anticipated that a total of approximately 96,146 m^3 per day will be generated, consisting of treated produced water, cooling water, desalination brine, treated sewage, and deck drains.

The largest single component of the effluent discharge is cooling water, accounting for approximately 4.1 m^3 per hour. As shown in Table 2-27, the temperature increase will be limited to 3°C at the edge of the mixing zone.

Produced water will only be generated at the FPSO. The project will not be undertaking atmospheric distillation of the condensate stream on board the FPSO. The natural gas received on the FPSO will be conditioned to prevent the formation of gas hydrates in the Subsea flowlines and FPSO Gas Dewpointing, via the injection of monoethylene glycol (MEG). This MEG will have affinity to the produced water and this aqueous phase (sometimes referred to as rich MEG) will be recovered from the gas reception, condensate processing and gas dewpoint plant. The MEG will be recovered for reuse via a regeneration process on board the FPSO. This involves atmospheric distillation of the rich MEG to boil off the produced water vapour. The produced water vapour will be condensed and treated through the produced water treatment system prior to discharge in the sea at the FPSO location.

Other effluent discharges will be regulated to conform to the listed parameters to meet applicable regulations and requirements.

Table 2-27. Typical Effluents from the FPSO during the Operations Phase.

Location	Waste Material	Flow Rate		Frequency of Generation	Disposal	Effluent Characteristics
		m^3/hr	m^3/d			
FPSO	Treated Produced Water	4.1	99	Daily	Treated effluent discharged overboard to sea	Oil and Grease concentration not to exceed: 42 mg/L (daily maximum), and 29 mg/L (monthly average).
FPSO	Seawater used as cooling water, and Desalination Brine streams from Potable Water and Demineralized Water Packages	4000	96000	Daily	Discharged to sea through the Seawater Disposal Caisson	Temperature increase of no more than 3°C at edge of the zone where initial mixing and dilution, from seawater discharge, take place after the seawater. The process of potable water generation from seawater will generate a concentrated brine at the project locations. The potable water generation via the Reverse Osmosis process does add chemicals to remove residual free chlorine, assist filtration and prevent scaling (to be confirmed with Vendor based on seawater propertied); however, these chemicals would not cause an increase in the Naturally Occurring Radioactive Material in the brine beyond potentially existing background levels. Therefore, it was deemed not necessary to include radioactive elements analysis in the seawater baseline analysis.
FPSO	Treated Sewage and macerated food waste (Grey and Black Wastewater)	1.04	25	Daily	Treated effluent discharged overboard to sea	To meet MARPOL 73/78 Annex VI, Resolution MEPC.2(VI) Standards: Fecal Coliforms not to exceed 250 MPN per 100 mL, BOD5 not to exceed 50 mg/L, Suspended Solids not to exceed 50 mg/L when tested onshore, Suspended Solids not to exceed 100 mg/L above suspended solids content in water used for flushing when tested aboard FPSO.
FPSO	Deck Drains	0.91	21.9	Intermittent	Overflow from drains system will discharged to sea through hull main deck scuppers	To meet MARPOL 73/78 Annex I requirements. Oil and grease concentration in treated oily water to be limited to 15 ppm
	Total	**4,006**	**96,146**			

Notes and Assumptions:

1. Data collated from Project Discharges and Waste Inventory B01.
2. The FPSO topside module drains are collected in the Non-hazardous and Hazardous Open Drain Tanks and then sent to the hull slops tanks for gravity separation of free oil in the tanks. Hull machinery space drains are collected in bilge holding tanks and batch transferred to the hull slops tanks for gravity separation. Recovered oil is routed back to processing and separated water is passed through a slops water polishing unit before being discharged to sea. During heavy rain or firewater deluge testing, overflow of the open deck drain inlets can occur with subsequent intermittent discharged to sea via the hull main deck scuppers.

Nearshore Hub/Terminal

Discharges from the FLNG operations will include cooling water as well as ballast and bilge water, sewage and grey water, deck drainage, and desalination system discharge. During operations, deck drainage is applicable to the FPSO, Nearshore Hub/Terminal structure (breakwater/ jetty), FLNG, tugs, crew and supply vessels, and LNGC and condensate carriers while on site.

A FLNG running four liquefaction trains with a combined LNG production volume of around 2.5 MTPA has a total seawater cooling water requirement of about 54,000 m^3/hr under normal operations. This includes a continuous demand for topside LNG liquefaction process cooling of approximately 38,000 m^3/hr, and a variable demand of about 12,500 m^3/hr steam main condenser and dumping condenser cooling. A further ~2,000 m^3/hr is required for cooling of forward Gas Engines and another ~1,000 m^3/hr for the port and starboard sponson engine rooms central freshwater cooling systems for miscellaneous equipment.

The cooling water will be discharged at a water depth of approximately 3-5 m. The design rate for the increase in the cooling water temperature from the steam main condenser between the point of intake and the point of discharge is 7°C. The cooling water is discharged laterally and the temperature differential between effluent and ambient is reduced to within 3°C within the zone of initial mixing as per IFC requirements. The seawater cooling water streams will contain a hypochlorite solution to control marine growth. This protection system will be designed to ensure a recommended hypochlorite dosage of 1 ppm at all seawater pump suction points. Cooling water discharge concentrations from the FLNG will need to comply with the IFC discharge limits associated with chlorine of 0.2 ppm.

The FLNG desalination process will result in a discharge of seawater with an elevated salinity (depending on the desalination process used) and containing very low concentrations of hypochlorite. The FLNG vessel will have three reverse osmosis freshwater generation machines (RO plants), with two operating at any one time and the third as backup. The machines are each expected to produce 120 t/d of freshwater, consume 12.2 m^3/hr of seawater, and discharge 7.2 m^3/hr of brine[14]. The discharged water is expected to have a salinity of around 60 ppt (parts per thousand). Hypochlorite may be added to inhibit marine growth in the systems, although only low dose rates can be used to avoid damage to the sensitive membranes in the reverse osmosis units. Drainage aboard the FLNG is estimated at 22m^3/day.

Sewage volumes generated on the QU platform will vary depending on the number of personnel on board the facility. On average, the treated sewage based on POB 160 is 20m^3/day; grey water discharges from the QU platform are estimated at 28m^3/day. Total wastewater to be discharged from the QU platform is estimated at 48 m^3/day. Sewage will be treated prior discharge to meet applicable national regulations and IFC requirements. The treated water from the QU Platform sewage plant will be discharged to the sea below the water line.

A non-hazardous open drain will also be provided on the QU platform. The drains will be collected in Non-Hazardous Open Drains Tank and pumped to Open Drains Caisson. Deck box drains will be provided on the Nearshore Hub/Terminal Riser Platform to collect rainwater and route it overboard via a network of headers. A daily volume for deck drainage from the QU platform is estimated at 5 m^3, with discharges only expected for 30 days/year.

2.10.4 Decommissioning Phase

A total of approximately 2,315m^3 of wastewater effluents will be discharged during the decommissioning of the FPSO and SPS, and approximately 3,554m^3 from the FLNG, QU Platform, Hub and General Support Vessels during the Decommissioning Phase (Tables 2-28 and 2-29).

[14] The process of potable water generation from seawater will generate a concentrated brine at the project locations. The potable water generation via the Reverse Osmosis process does add chemicals to remove residual free chlorine, assist filtration and prevent scaling (to be confirmed with Vendor based on seawater propertied); however, these chemicals would not cause an increase in the Naturally Occurring Radioactive Material in the brine beyond potentially existing background levels. Therefore, it was deemed not necessary to include radioactive elements analysis in the seawater baseline analysis.

Table 2-28. Typical Effluents from the FPSO, Subsea Infrastructure, and General Support Vessels during the Decommissioning Phase.

Decommissioning Location	Specific Activity	Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Typical Representative Vessel	Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
							(m^3/d)	(m^3/d)	(m^3)
Wellheads	Decommission Wells	Drillship	1	21	200	DS-12	--	0.3	1260
FPSO and Subsea System	Unmooring of FPSO	MSV	2	24	25	Damen Construction Support Vessel 8019	---	0.3	360
		Tug	2	10	10	Crowley Titan Class Tug	---	0.3	60
	Support for subsea decommissioning activities	ROV/DSV	1	15	50	Subsea 7 Rockwater 2	20	0.3	225
General Support	General Support during Decommissioning Activities of FPSO	Crew Boat	1	90	4	Damen Fast Crew Supplier 5009	---	0.3	108
	Supply	Supply Boat	1	24	22	Damen Platform Supply Vessel 3300 CD	---	0.3	158
	Support	Standby vessel	1	24	20	---	---	0.3	144
Total									**2,315**

Notes and Assumptions:
Decommissioning activities for the FPSO will involve decommissioning of the topsides facilities, unmooring and float-out of the FPSO from the offshore site to an onshore port. Average daily waste water generation per person is averaged at 0.3 m^3.

Table 2-29. Typical Effluents from the FLNG, QU Platform, Hub and General Support Vessels during the Decommissioning Phase.

Decommissioning Location	Specific Activity	Typical Marine Vessels/ Equipment Used	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Wastewater Generation Rate	Per Capita Daily Wastewater Generation Rate	Total Wastewater Generation
						(m^3/d)	(m^3/d)	(m^3)
FLNG, QU platform and Hub area	Removal of QU platform	Tug vessel	3	80	10	---	0.3	720
		Anchor vessel	1	64	15	---	0.3	288
	Removal of FLNG	Tug vessel	3	80	10	--	0.3	720
		Anchor vessel	1	64	15	---	0.3	288
	Hub removal	Crane barge	2	64	20	---	0.3	768
		MSV	2	24	25	---	0.3	360
General Support	General Support during Decommissioning Activities of FPSO	Crew boat	1	90	4	---	0.3	108
	Supply	Supply vessel	1	24	22	---	0.3	158
	Support	Standby vessel	1	24	20	---	0.3	144
Total								**3,554**

Well Abandonment and Field Infrastructure

Plugging and abandonment of wells will likely consist of a multi-phase programme to fully isolate the well. Each well will need to be assessed to carefully select the type of barrier material and the placement technique due to unique characteristics of each producing well. In general, a drillship will be required, as well as ROV and support vessel to undertake the activities. During abandonment operations small discharges of cement, condensate, MEG and brine may escape from the well head. Although there will be discharges associated with this activity, they will be short-term and have only a localized effect at the seafloor therefore any associated risk is considered to be negligible.

Pipelines

It is anticipated that the subsea production flowlines from well head to FPSO will be pigged approximately 2-3 times prior to abandonment. The pigging process will remove the contents assumed to be condensate, gas, water, MEG and wax, routing to the processing facility at the FPSO. The pipeline will then be flooded with seawater and left in situ. The assumptions are that the well will still be online with minimal flow to be able to push the pigs through the line, as well as the FPSO being in location to receive the flowlines contents. There is no expected effluent release to sea as part of this process.

The export pipeline from the FPSO to the Nearshore Hub/Terminal will be pigged through the entire length, then may be lifted and sailed away for reuse or recycled.

2.11 Solid Waste

2.11.1 Overview

Solid waste composed of both non-hazardous and hazardous waste will be generated during the Preparation, Construction and Installation, Operations, and Decommissioning Phases. A preliminary waste management plan is included in Appendix S.

2.11.2 Preparation, Construction and Installation Phase

Different waste streams will be segregated by type and will not be mixed together or stored in the same container. Non-hazardous wastes will not be allowed to be mixed in the same container with hazardous or regular wastes. If this did occur, the entire mixture would be considered hazardous or scheduled waste.

On all project facilities, waste storage areas will be designated in areas isolated from other operation. Waste containers will be stored in these areas prior to processing or shipment to the contract waste management vendor. All waste materials will be stored properly in containers that are non-leaking and compatible with the waste being stored. All containers should have their lids, rings, covers, bungs and other means of closure properly installed at all times, except when waste is being added or removed.

Well Drilling

Representative volumes and disposition of various drilling-related wastes for a representative well are outlined in Table 2-30. Actual volumes and disposition were derived from a 3-month program conducted by Kosmos off Morocco. Projected values have been recalculated for a 60-day well and are considered to be realistic estimates of volumes to be generated aboard the drillship and support vessels and at the supply base.

Table 2-30. Summary of Projected Maximum Waste Volumes for a Single Well.

Source	Disposition	Projected (Tons)
Drillship		
Hazardous Waste by Disposal Route	Recycled (primarily waste oil)	54
Non-hazardous Waste by Disposal Route	Landfill	5
	Recycled (metal and plastic)	12
	Incineration or reuse/recycle (wood)	27
Support Vessels		
Hazardous Waste by Disposal Route	Recycled (mostly waste oil)	24
Non-hazardous Waste by Disposal Route	Landfill (discharged ashore)	25
	Recycled (metal and plastic)	11
Supply base and Port Operations		
Hazardous Waste by Disposal Route	Recycled (mostly waste oil)	3
	Treated	0.5
Non-hazardous Waste by Disposal Route	Landfill	165
	Recycled (metal and plastic)	80
	Incineration or reuse/recycle (wood)	102

FLNG, FPSO, Subsea Installation, and Support Vessels

A total of 220 MT of non-hazardous waste and 161 MT of hazardous waste is estimated to be generated from the FPSO and associated vessels during installation. Table 2-30 summarizes typical sources and volumes of waste projected during installation.

Onboard the FPSO and FLNG, hazardous waste will be generated during all phases of development. General hazardous waste may include:

- Recovered solvents;
- Used process absorbents;
- Excess or spent chemicals;
- Paints and paint cans;
- Oil contaminated materials (e.g., sorbents, filters, rags);
- Batteries;
- Biological waste from medical facilities;
- Fluorescent light tubes; and
- Waste oils.

Hub, FLNG installation and Nearshore Support Vessels

Dredging prior to breakwater construction will generate dredged material consisting primarily of seabed sediments which will need to be removed from the construction location (See Section 2.7.2 for quantities). Other construction waste materials will be generated by the completion of the breakwater and jetty and the installation of the ULQ facilities.

A total of 320 MT (excluding dredged materials) of non-hazardous waste and 229 MT of hazardous waste is estimated to be generated from the Nearshore Hub/Terminal area during construction and installation. Table 2-31 summarizes typical sources and volumes of waste projected from these sources during installation.

Table 2-31. Estimate of Solid Waste from the FPSO, Subsea Installation, General Support Vessels, Nearshore Hub/Terminal and FLNG during the Preparation, Construction and Installation Phase.

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Waste Generated during Construction Period		
									Non-Hazardous Waste	Hazardous Waste	Total Waste
						(kg/d)	(kg/d)	(kg/d)	(MT)	(MT)	(MT)
FPSO - Transportation Integration, Installation, Hook-Up and Commissioning	Shipment of FPSO Piles from Fabrication Yard to Offshore Installation Site	Supply Vessel	1	35	14	80	50	2	3	1.75	5
	Wet-tow FPSO to Offshore Site	Tug	4	80	10	30	20	1	2	1.6	16
	Installation of Piles for Mooring System	Derrick Barge	1	18	50	200	150	2	4	2.7	6
	Installation and Hook-Up of mooring lines to FPSO	MSV	1	36	25	150	80	2	5	2.88	8
		Tug	3	36	10	30	20	2	1	0.72	5
		Anchor vessel	3	36	16	200	150	2	7	5.4	38

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Waste Generated during Construction Period		
									Non-Hazardous Waste	Hazardous Waste	Total Waste
						(kg/d)	(kg/d)	(kg/d)	(MT)	(MT)	(MT)
Subsea System Installation	Transportation of Subsea Equipment and Installation	Umbilical Installation Vessel	1	34	50	200	150	2	7	5.1	12
	Installation of 16" dual production flowlines and risers, 6" MEG pipelines	S-Lay Vessel (Medium)	1	120	300	200	150	2	25	18	43
		J- Lay Vessel	1	90	200	200	150	2	18	13.5	32
		Heavy Lift Vessel	1	290	60	200	150	2	58	43.5	102
		Pipe Carrier Vessel	1	160	80	200	150	2	32	24	56

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate (kg/d)	Average Daily Hazardous Waste Generation Rate (kg/d)	Per Capita Daily Non-Haz Waste Generation (kg/d)	Waste Generated during Construction Period: Non-Hazardous Waste (MT)	Waste Generated during Construction Period: Hazardous Waste (MT)	Waste Generated during Construction Period: Total Waste (MT)
Subsea System Installation	Installation of SW export spool tie-ins, SSIV umbilical, pre- and post-lay surveys	Remote Operating Vessel (ROV)	1	50	50	200	150	2	10	7.5	18
	Installation of Well jumpers, flowline jumpers, HFLs, EFLs	MSV	1	180	25	200	150	2	36	27	63
	Support for subsea hook-up and commissioning (HUC) activities	DSV	1	16	80	200	150	2	3	2.4	6
General Support	General Support during HUC Activities of FPSO and Subsea System	Supply Vessel	1	30	22	80	50	2	2	1.5	4
		Project patrol boat Vessel	1	56	7	30	20	1	2	1.12	3
		Crew Boat	2	120	4	30	20	1	4	2.4	12
Total Subsea and FPSO installation									**428**		

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Waste Generated during Construction Period		
									Non-Hazardous Waste	Hazardous Waste	Total Waste
						(kg/d)	(kg/d)	(kg/d)	(MT)	(MT)	(MT)
Marine Structures construction	Sand sourcing for caissons and seabed preparations	Dredger	2	90	20	200	150	2	18	14	63
	Installation of breakwater base	Rock dumper	2	130	50	200	150	2	26	20	91
		Crane barge	2	130	20	200	150	2	26	20	91
		HLD barge	1	65	60	200	150	2	13	10	23
		Tug boat	2	20	6	30	20	1	1	0	2
	Installation of caissons	Piling vessel	2	540	30	200	150	2	108	81	378
Quarters and utilities platform installation	Platform installation in field	Anchor vessel	1	20	15	80	50	2	2	1	3
		Crane barge	1	130	20	150	80	2	20	10	30
FLNG Installation	Transportation of FLNG from a yard to site for installation	Tug	2	15	6	30	20	1	0	0	2
	Hook-up and Mooring of FLNG	MSV	1	10	25	150	80	2	2	1	2
		Anchor vessel	2	20	15	80	50	2	2	1	5

Construction Activity Category	Specific Activity	Marine Vessels/ Equipment	Number of Vessels	Operating Days	Persons on Board (POB)	Average Daily Non-Hazardous Waste Generation Rate	Average Daily Hazardous Waste Generation Rate	Per Capita Daily Non-Haz Waste Generation	Waste Generated during Construction Period		
									Non-Hazardous Waste	Hazardous Waste	Total Waste
						(kg/d)	(kg/d)	(kg/d)	(MT)	(MT)	(MT)
General Support	General support activities for construction of breakwater, installation of QU platform and FLNG	Project patrol boat	1	660	7	30	20	2	20	13	33
		Supply vessel	2	220	15	80	50	2	18	11	57
		Crew boat	2	110	4	30	20	1	3	2	11
		Flotel	1	210	250	200	150	2	43	32	74
		Standby vessel	1	660	15	30	20	1	20	13	33
Total Nearshore Hub/Terminal construction and installation									**898**		

Note: Average non-hazardous and hazardous waste generation taken from representative vessels working in the North Sea fields during construction and installation.

2.11.3 Operations Phase

During the Operations Phase, the facilities will produce a range of wastes requiring treatment and disposal onshore, including:

- Oily sand;
- Pig wax;
- MEG;
- LSA Scale;
- Lube oil;
- Batteries;
- Biological waste from medical facilities;
- Fluorescent light tubes;
- Waste oils;
- Replaced filter cartridges from Mercury Dust Filter (may contain traces of mercury);
- Oily sludges (including pigging waste);
- Filters;
- Paints;
- Chemicals;
- Packaging / paper; and
- Domestic waste.

With the exception of packaging / paper and domestic wastes most of the above may be classified as hazardous wastes. These are summarized in Table 2-32. The quantities are based on operational experience from other BP operational facilities for other wastes.

The total non-hazardous waste generated annually is approximately 293 MT, while approximately 270 MT of hazardous waste will be generated annually (Table 2-32).

Table 2-32. Estimate of Wastes Generated from the FPSO, FLNG and QU Platform and General Support Vessels during the Operations Phase.

Location	Waste Material	Per Capita Waste Generation (Note 3)	Persons on Board (POB)	Opera-tional Days per Year	Annual Waste Generation	Disposal
		(kg/d)			(t/y)	
FPSO	Garbage (Non-hazardous waste)	2.00	150	365	73	Sent onshore for appropriate disposal
FPSO	Hazardous wastes from routine operations and maintenance[1]	---	---	---	111	Sent onshore for appropriate disposal
FPSO	Other non-hazardous waste from routine operations and maintenance[2]	---	---	---	89	Sent onshore for appropriate disposal
FPSO	Hazardous waste-Sand from Production	---	---	365	1-8	Sent onshore for appropriate disposal
FLNG	Hazardous wastes from routine operations and maintenance[2]	---	---	365	111	Sent onshore for appropriate disposal
QU Platform	Garbage (Non-hazardous waste)	2.00	160	365	131	Sent onshore for appropriate disposal
QU Platform	Hazardous wastes from small routine maintenance	---	---	365	40	Sent onshore for appropriate disposal
				Total	**563**	

Notes:
1. Waste generation value is assumed and indicative. Hazardous wastes include molecular sieves, spent dryer desiccants, spent lube oil, seal oil and engine oils, oil contaminated wastes, used filters and cartridges, spilled oils and contaminated water. Some of the wastes such as molecular sieves, desiccants, etc. will be generated only during planned maintenance activities which could be once in 3 to 5 years depending on the useful life of these materials.
2. Waste generation value is assumed and indicative. Other non-hazardous wastes include metal waste, gasket materials (e.g., silicone, rubber, neoprene), and general waste other than garbage.
3. Data based on representative data from BP North Sea assets.

2.11.4 Decommissioning Phase

FPSO and Subsea Infrastructure

A relatively small amount of waste may be generated during the decommissioning of the FPSO, and subsea infrastructure. During this phase, approximately 14.5 MT of non-hazardous waste would be expected to be generated along with approximately 0.1 MT of hazardous waste for a total of approximately 14.6 MT of waste.

Nearshore Hub/Terminal area and FLNG

A small amount of waste may be generated during the decommissioning of the QU platform, riser platform and FLNG, to enable the facilities to be towed away safely. Estimated amount of non-hazardous waste is 8 MT along with approximately 0.2MT of hazardous waste.

The breakwater will generate approximately 20 MT of non-hazardous waste from the topsides equipment which will need to either be reused or properly disposed; a small amount (0.1 MT) of hazardous waste is also estimated.

If the marine structures are to be removed, they will generate an additional approximate value of 50,000 T of predominantly steel and concrete to be to be reused or recycled.

The breakwater will generate approximately 673,000 m^3 of ballast (most likely sand) which will require removal from the caissons before they are refloated and removed. The caissons themselves would be towed to another location to be demolished or properly disposed.

2.12 Light and Noise Emissions

2.12.1 Overview

Light and sound will be generated during all phases of activity. The light sources will primarily be operational lighting on vessels and surface infrastructure (i.e., FPSO, breakwater, FLNG) and visiting tankers, while the sound (both ‘in air’ and ‘underwater’) will be generated from vessel and equipment operation as well as the occasional helicopter flight.

Sound is typically measured and referenced using a decibel (dB) scale, which is a logarithmic scale that expresses the ratio of two values of a physical quantity. It is used to measure the amplitude or ‘loudness’ of a sound.

As the dB scale is a ratio, it is denoted relative to some reference level, which must be included with dB values if they are to be meaningful. The reference pressure level in underwater acoustics is 1 micropascal (μPa). Whereas the reference pressure level used in air is 20 μPa, which was selected to match human hearing sensitivity. As a result of these differences in reference standards, sound levels in air are not equal to underwater levels. To compare sound levels in water to sound levels in air, it is necessary to subtract 62 dB from the sound level in water to account for the difference in reference levels and absorption characteristics of the two mediums.

2.12.2 Airborne Sound

The primary sources of airborne sound from vessels and construction facilities are use of machinery, such as engines, generators, pumps, cranes, diggers, and impact piling. Airborne sound generated by any activities associated with the facilities will be managed. The airborne sound levels at all facilities are required to meet the applicable occupational health working limits which in turn is unlikely to result in unacceptable sound level at onshore receptors.

2.12.3 Underwater Sound

The primary sources of underwater sound from vessels are propeller cavitation, propeller singing, and propulsion; other sources include water flow along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant source of underwater sound. The intensity of which is generally related to vessel size, speed and loading characteristics. Large vessels tend to produce higher sound levels than small ones, and vessels underway with a full load (or towing or pushing a load) produce more sound than unladen vessels. For a given vessel, sound also tends to increase with increased speed. Broadband (wide frequency range) Sound Pressure Level (SPL) source levels for most small vessels (a category that would include tugs and supply vessels) are anticipated to be in the range of 170 to 180 dB re 1 μPa at 1 m (Richardson et al., 1995; Hildebrand, 2009; McKenna et al., 2012). Sound levels would generally decrease with distance from the source.

Table 2-33 provides underwater sound source information based on reviews of measurements for various example vessel types that are typically involved in E&P activities such as the Preparation, Construction and Installation, Operations, and Decommissioning Phases of the GTA offshore gas production project.

Table 2-33. Underwater Sound Source Measurements for Project Vessels.

Vessel Type	Sound Measurement (dB re 1µPa)	Distance of Sound measurement or calculation[5] (m)
Tug boat	160-190	1
Anchor vessel[4]	170-190	1
Project patrol boat	130-140	20
Standby vessel	130-140	20
Pipelay vessel (J-Lay/S-Lay)[4]	170-190	1
Diving support vessel	170-190	1
ROV survey vessel	170-190	1
Crew boat	---	---
Supply vessel	190-200	20
Crane barge/Jack-up	---	---
Heavy lift vessel	*No field measurements available, but likely to be similar to DP vessel. Low frequency.*	
Rock dumper	---	---
Small working boat	---	---
Riser tie in vessel[4]	170-190	1
Drillship	200-210	1
Piling vessel[1]	210-250	1
Dredger[2]	168-186	1
Flotel	*Likely to be similar to DP vessel if flotel makes use of dynamic positioning. If not, little sound expected.*	
MSV	160-190	1

(From: Typical sound source levels vessels, citing Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. 2011. Genesis Oil and Gas Consultants report for the Department of Energy and Climate Change.)

[1] Sounds measurements are available for piles with diameters ranging from 0.75-4.2 m.
[2] Of the studies available in the report, dredging noise characteristics are typically of low frequency below 1 kHz.
[3] "---" indicates no data available.
[4] Typical vessel.
[5] Back measured to 1 m.

2.12.4 Preparation, Construction and Installation Phase

Airborne and underwater sound during construction and installation will primarily be generated by drilling activities and infrastructure construction. Sound sources include drilling, piling, use of machinery, vessel and helicopter traffic.

Typically, sound emanating from propellers and thrusters is predominately a result of cavitation. Cavitation will occur while the drillship is moving on to each wellsite location and between manifold centers. Cavitation from thrusters will occur while the vessel is positioned over each wellsite, maintaining the drillship position. Similar sound sources are expected for barges and other installation vessels, as characterized below.

Sound from drillship and support vessels is typically continuous and broadband (wide frequency range) with low frequency tonal peaks. Drillship source levels are variable depending upon the activity being conducted, but may be expected to range from 180 to 190 dB (re 1 µPa @1 m), possibly as high as 195 dB. Supply vessels in transit to and from the drillship will produce similar types of sounds, with predominant low-frequency components; source levels for supply vessels is estimated to be in the range of 170 to 180 dB re 1 µPa at 1 m (Richardson et al., 1995). It is anticipated that the supply vessel remaining on standby near the drillship will produce lower but continuous sound levels, as it is expected to be idling while on station[15].

Vertical Seismic Profile (VSP) surveys may be required after 2025 to refine the geological prognosis and calibrate the Cenomanian structure. VSP operations involve deploying an acoustic sound source from the MODU or support vessel, while a number of receivers (geophones) are positioned at different levels within the drilled hole to measure the travel time.

Typically, six air guns are used during a VSP to form a small source array, each element typically has a volume of between 150 - 250 cubic inches. The sources are tuned to effectively simulate one larger sound source. The sound source array is generally positioned at 5 to 10 m below the water surface. VSP sound source arrays are typically smaller (fewer numbers of source elements) than those used for conventional marine seismic surveys. VSP operations are typically of short duration, normally taking not more than a day to complete.

Airborne sound (e.g., from a helicopter) is refracted when it is >13° from vertical; when the sound source is overhead or within 13° of vertical, direct sound enters the ocean and is refracted due to the difference in sound speeds in the two media. Helicopters produce predominantly low frequency (SPL) sound source levels of 162 dB (re 1 µPa @1 m), with highest sound levels to be experienced directly below the aircraft. Underwater sound caused by an overhead airborne source will be highest at the surface and decrease with depth.

Sound from operating machinery is often continuous and of low frequency and often becomes dominant for vessels when stationary or moving at low speeds. Sound sources include large machinery, such as large power generation units (e.g., diesel engines), compressors, and fluid pumps.

Mechanical sounds can be transmitted through various pathways, depending upon its source type and the location or mounting of the equipment onboard the vessel. Sound can enter the water (i.e., machine to hull to water) and become airborne (i.e., machine to air to hull to water). The nature of sound is dependent on a number of variables, including the size and number of equipment pieces operating. Sound characteristics of a typical drillship conducting routine drilling activities and various support operations (e.g., support vessels, helicopters) have previously been summarized by Richardson et al. (1995) and Kyhn et al. (2011). Noise is produced from equipment in water, such as drill string and riser. Sound emanating from a drillship can be expected to be continuous, at levels between 145 and 191 dB (re 1 µPa @ 1 m) SPL while drilling, with most energy in the low-frequency bands. During non-drilling periods, sound source levels from the drillship will originate from thrusters, diesel generators, cranes, and crew activity aboard the drillship.

2.12.5 Operations Phase

Airborne and underwater sound during operations will primarily be generated by the operation of the FPSO and Nearshore Hub/Terminal. Sound sources include use of machinery, vessel and helicopter traffic (thought primary mode of transportation to the FPSO will be by water & transfer (walk-to-work or FROG)).

At the FLNG during normal operations, underwater sound arising from the FLNG vessel is expected to be dominated by sound from onboard machinery (including power generation, compressors and pumps located within the hull) and topside process equipment (including compressors, turbines and motors).

[15] Range of dredging noise levels are estimated on the basis of a 8,500 m^3 dredger.

In addition to support vessels and tugs, larger tanker vessels will transport LNG and condensate to and from the facility sites. Overall sound levels during the Operations Phase are anticipated to be considerably less compared to the Construction/Installation Phase because the heavy construction and drilling vessels will no longer be present.

Underwater vessel noise from tugs and other supply vessels is a combination of narrow band (tonal) and broadband sound (Richardson et al., 1995). Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Broadband source levels for most small ships (a category that would include tugs and supply vessels) are anticipated to be in the range of 170 to 180 dB re 1 μPa at 1 m (Richardson et al., 1995; Hildebrand, 2009; McKenna et al., 2012). Noise levels would dissipate quickly with distance from the source. FPSO source levels range from 173-188 dB re 1 μPa, generally in the 20-2500 Hz range (Erbe et al., 2013).

Light sources will emerge from security lighting on each facility and vessel to enable safe operation. Each vessel in field will need to comply with MARPOL in providing navigational aid lighting. Lighting on facilities will be provided by a mixture of fluorescent fittings and discharge flood lights, as per established offshore methodologies. A minimal amount of light will be produced from pilot flare and through flaring, but in the latter case only during abnormal or emergency events.

2.12.6 Decommissioning Phase

Noise will be generated during decommissioning from the vessels used to remove the equipment from the Nearshore Hub/Terminal, and from the activities associated with plugging and abandoning the wells. The noise levels and characteristics will be similar to those described for the Preparation, Construction and Installation Phase.

2.13 Personnel and Local Content Approach

2.13.1 Contract Strategy and Local Content Approach in Mauritania and Senegal

For BP, Local Content is represented by the integration of the following three pillars of sustainable supply chain in delivering all aspects of their work:

1) Contracting with Local Suppliers;
2) Local Workforce Development; and
3) Social Investment.

BP's local content approach will be included in their contractor selection process for the Construction Phase and the Operations Phase.

Construction Phase

BP has completed a framework for its local content plan which will be developed into clear targets as the project progresses and the contractors are selected and mobilized. Local content targets will be established to align with the project objectives and activities selected based on bringing a sustainable impact to the region.

The project contract strategy has been built around technical capability, predictable execution and a competitive outcome. Primary enquiries to the market will be around Subsea, Gas Processing, Hub Terminal and FLNG where the full EPCI capability only rests with international contractors.

The Hub Terminal provides the greatest opportunity for local content during GTA Phase 1 project execution. The hub terminal represents the biggest opportunity for local content and will be a significant element of the evaluation for initial contractor selection.

In the other main EPCI packages, local content opportunities have been identified as part of contractor selection which will be further developed during FEED to allow targets to be included in final execute contracts. It will be informed by the main contractor's market enquiries which will be assured by BP.

The project is committed to maximum integration of suitably qualified local suppliers with proven quality and safety performance. The contracting strategy required to support project execution means that the majority of this will be accomplished as subcontracts through the Tier 1 suppliers.

Milestones have been set around developing these final targets in the EPCI contracts before sanction.

Activities which could be undertaken and will be assessed in FEED include for the:

- Subsea contractor scope:
  - Movement of personnel and goods offshore to vessels;
  - Provision of food and other provisions;
  - Bunkering for construction vessels;
  - Final fabrication and load-out of spools; and
  - Storage, spares inventory management & logistics.
- FPSO contractor scope:
  - Logistic services for equipment, materials for offshore commissioning activities;
  - Personnel mobilization and demobilization travel, inland transportation, onshore accommodation and security services;
  - Bunkering and fuels for construction vessels;
  - Provision of food and other consumables during Offshore commissioning activities; and
  - Administrative services such as VISA, Meet and Greet, immigration process, etc.
- Hub/Terminal contractor scope. The first 5 opportunities are agreed during Contractor Selection; the rest will be developed during FEED:
  - Caisson fabrication;
  - Rock supply;
  - Soil replacement material supply;
  - Ballasting materials supply;
  - Logistics bases;
  - Installation and Construction support services;
  - Movement of personnel and goods offshore to vessels;
  - Provision of food and other provisions;
  - Bunkering for construction vessels;

- Hotels & Accommodation; and
- Environmental monitoring program.

Operations Phase

A suite of contracts will be required to support the development once in operation. Some of these will be specialist in content but many including marine, hotel services, fabric maintenance and security are in areas where capability is expected to be available locally and the use of local content can be prioritized.

A formal contracting strategy will be created and implemented as part of the operations and regional readiness programmes. This will identify those areas where sourcing, engaging and potentially developing local content is a priority and will lay out a plan to put such contracts in place such that they are functioning by the time the development moves into operation.

2.13.2 Employment

Generally speaking and across the world, offshore oil and gas projects do not generate a lot of employment and the employment generated are high skilled. This is due to the high level of automatization required due to the remoteness of operations and limited space available offshore. BP, as operator of the project, has set practices around people and procurement management, which is applicable to Mauritania and Senegal. Recruitment will follow BP diversity and inclusion principles to target diverse candidates for example female, and personnel from different background. Recruitment will be open at National level, however, where possible will target local communities talents. Application will be opened through different channels to increase awareness and accessibility to job offers.

The types of talent required that could be filled in Mauritania and Senegal will vary for each of the three project phases. The focus will be on development opportunities which may be capable of supporting the supply chain for the project, at the appropriate tier of the supply chain. This approach would ultimately create a multiplier effect within the local communities and promote retained value in country. The project will aim to support growth of qualified talent either directly for project or indirectly through supporting activities (e.g., logistics and services) during the Operations Phase.

It is assumed that in-country employment and procurement opportunities will change and grow through time during the course of the more than the 20-year project. It is expected that local people from the two countries will progressively be trained to fill positions initially filled by expatriates. Similarly, some national companies would be expected to progressively develop and over time provide services initially provided by international companies.

2.13.2.1 Offshore Employment

As the project is being conducted at sea, much of the employment will be offshore. Manpower needs for offshore activities have been estimated for each of the three phases of the project. These are based on the planned type and number of marine vessels and their operating days. The persons on board (POB) data is assumed from typical representative vessel providers.

Preparation, Construction and Installation Phase

The total amount of manpower required on vessels for the Preparation, Construction and Installation Phase is estimated to be 1,500 and will mainly consist of service providers as described above.

Provision of all the primary vessels will be through the Engineering, Procurement, Construction and Installation (EPCI) contractors. Specialist vessels will generally be owned by the selected EPCI contractor but they will conduct market exercises for some of the support vessels. Infrastructure and logistics support from onshore will be required to allow this activity to take place effectively and safely offshore.

Fishermen Liaison Officers will be recruited from local communities.

Operations Phase

The manpower needs on vessels for the Operations Phase is estimated to be approximately 130 people. The total number of people living on the QU platform and FPSO providing variety of services are approximately 270 people. The total number of employees required during that phase directly is estimated at up to approximately 400 individuals with variety of skills, between different countries. The intent is to have local technician workforce that is trained and ready for the startup of operations, aligned with acceptable standards.

It is not known at this time how many and what type of vessels could be rented in Mauritania and Senegal during the Operations Phase.

Decommissioning Phase

Decommissioning activities will require the use of several vessels in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area. If current technology was to be used, it is estimated that the manpower needs during decommissioning would be slightly smaller than during the Preparation, Construction and Installation Phase. However, the type and number of vessels required for decommissioning and their manpower needs will depend on the technology that will be used in more than 20 years from now.

2.13.2.2 Onshore Employment

While most of project activities will be conducted offshore, some support operations will be conducted at the supply bases in the ports of Dakar and Nouakchott during the three phases of the project. Airports in Dakar and Nouakchott will also be used for arriving and departing project personnel.

Onshore, the project will require resources for support operations in Dakar and Nouakchott. The project will need manpower for its base operations, including at the office and port. These can be direct employees as well as third party contractors. Based on the project proponent experience in other countries, an estimation of the manpower needs are listed in Table 2-34 below for each of the three phases of the project.

Table 2-34. Estimation of Onshore Manpower Needs.

Type of Employment	Estimated Manpower Needs*
Preparation, Construction and Installation Phase	
In-Country Offices and Port Operations	20 – up to 50
Operations Phase	
In-Country Offices and Port Operations	20– up to 40
Decommissioning Phase	
In-Country Offices and Port Operations	20– up to 40

* Manpower needs could be direct BP employees or contracted through agencies.

In addition, Community Liaison Officers will be recruited from local communities.

2.14 Social Investment

The project will follow a rigorous operating model which maintains safety as the top priority. This model includes reliability, local content, development of the local workforce and benefits to project affected communities through sustainable development initiatives.

The overall purpose of the GTA Phase 1 social investment activities is to provide positive benefits through the promotion of sustainable socio-economic development for the local communities located near to the Tortue project in Mauritania and Senegal. All social investments will aim to create long-term partnerships and build the capacity of local community and authorities.

BP’s general approach to social investment is to:

- Consult with relevant stakeholders to identify needs and potential focus and themes of social investment. Use a range of implementing partners – including NGOs, civil society and other development groups to assist in the implementation and management of its social investment strategy.
- Select implementing partners using a transparent Request For Proposal process and criteria for selection based on the international community’s social investment best practices.
- Use participatory practices to involve local stakeholders as much as possible in the implementation and/or monitoring of social investment projects.

This approach will be followed in Mauritania and Senegal for GTA Phase 1 social investment.

In 2018, BP on behalf of partners consulted with a range of stakeholders including communities, NGOs (local and international) and local and national government representatives in order to develop the focus for Tortue project’s social investment activities in Mauritania and Senegal. A study was also undertaken to assess the experience and capability of potential national and international implementing partners in both countries. Based on these consultations in addition to the public consultations conducted for the ESIA and on comments received during the ESIA Technical Committee review, priority of social investment will be given to activities focusing on the following areas:

- **Education** through supporting learning and education initiatives focusing on business skills, language skills, literacy, computing skills, science & technology, including oil and gas related education;
- **Economic development** opportunities for income and employment through the provision of a mix of instruments (e.g., micro-finance in combination with vocational education, business services for community based-enterprises, fishing cooperatives and wider support for entrepreneurship);
- **Environmental initiatives** focusing on sustainable management of natural resources, efficient use, environmental awareness, waste management, protection and development of bio-diversity and ecosystems and academic research on the offshore marine environment;
- **Community health and safety activities** through health programs and activities focusing on access and quality of health services for communities in close proximity; and
- **Capacity building and institutional strengthening** in partnership with local government and authorities.

The GTA Phase 1 Social Investment program detailing the proposed projects to be completed or continued will be defined and approved by the GTA project’s partners including National Oil Companies at the beginning of each year with the aim of ensuring parity between Mauritania and Senegal in how GTA Phase 1’s social investment budget is allocated.

The Social investments projects identified and approved by GTA Phase 1 partners for year 2018 include:

Mauritania

- Health:
  - Provision of health-care equipment following the identification of priority needs of the regional health directorate and health facilities of N'Diago;
  - Six advanced medical campaigns (each campaign 4 days) estimated to have an average of 300 consultations per day;
  - Home visits and follow-up system for monitoring people with chronic diseases;
  - Training of 30 community relays on behaviour change communication (BCC) on priority health topics; and
  - 120 educational talks on priority health topics and public sessions - the format is to set up a tent in one of the villages from morning to evening to sensitize the population on health issues. A total of 25 public sessions will be carried out during the 12 months of the project.
- Economic Development:
  - Conduct fishing sector diagnostic study;
  - Conduct trainings to fishing community on HSE standards and marine safety;
  - Provide equipment to fishermen with safety related equipment and communication tools;
  - Organize study visits for artisanal fishermen to enhance fishing related productivity;
  - Capacity-building of artisanal fishermen on fish processing techniques;
  - Provide equipment in the identified high need areas of the artisanal fishermen in N'Diago;
  - Provide access to finance for the women cooperatives and artisanal fishermen;
  - Conduct a water feasibility study in N'Diago area; and
  - Conduct diagnostic study of the agricultural and pastoral sector in N'Diago area.

Senegal

- Community health:
  - Provision of ambulance for Guet Ndar health centre;
  - Rehabilitation and provision of equipment to the health posts in Langue de Barbarie;
  - Support the access to universal governmental health coverage programme for the poorest population in Langue de Barbarie;
  - Training of health care providers (nurses and midwifes) in Saint-Louis District and community actors (relays and community leaders);
  - Conduct door to door health campaign activities for prevention activities, monitoring of child and maternal health; and
  - Provision of comprehensive package of preventive activities at community level focused on maternal and child health and hygiene and sanitation.

- Economic Development:
  - Provide access to finance for the women cooperatives and the artisanal fishermen;
  - Provide capacity building to strengthen the institutional capacity of the organizations relevant to artisanal fishing and provide key equipment for marine safety and monitoring of fishing activities;
  - Organize a study visit for the CLPA members to learn the experience from other CLPAs in Senegal in terms of fishery resources management and revenue-generating activities;
  - Provide capacity-building for fish-processing cooperatives on fish processing techniques on the development of new products;
  - Training for the women engaged in food processing on the labelling of fish-based products at the ECOWAS level;
  - Provide capacity-building on entrepreneurship, marketing, accounting, sales and financial skills;
  - Provide equipment to the women cooperatives on fish processing; and
  - Setting-up semi-industrial units for processing fruit, vegetables, and cereals for the women in Langue de Barbarie who are engaged in food processing.
- Environment:
  - Conduct environmental education at local schools in Saint-Louis;
  - Conduct information-sharing activities and develop a common guide and tools between Djoudj, and Diawling National Parks on biodiversity conservation;
  - Provide capacity building to strengthen the institutional and technical capacity of elected representatives and territorial actors on the management of environment;
  - Provide capacity building to increase the capacity of territorial actors (e.g. elected representatives, technicians, fishermen, economic actors) on the management of the ecological challenges; and
  - Community awareness-raising about the environmental RESILIENCE project.

The implementing partners have been identified through a Request For Proposals (RFP) process. The RFP forms the basis of the design, implementation and management of the social investment activities. The criteria for selection, based on the international community's social investment best practices as well as local experience gathered through the implementation of existing BP programs, included the following:

- Community needs based: programmes and projects designed and delivered with the engagement of communities and other stakeholders;
- Impact: material delivery of programmes and projects with social, economic and/or environmental benefits to local communities near to the GTA Phase 1 project;
- Legacy and/or Sustainability: programmes and projects designed to deliver lasting benefits and/or have the ability to self-finance beyond the end of funding or involvement by applicant;
- Transparency: programme and project processes that are open to internal and external scrutiny, allowing potential beneficiaries, NGOs, and governments to understand the approach;
- Prevention of duplication: in selecting projects, avoiding duplication with the efforts of other companies, international and local agencies or government departments;

- Local participation: encouraging participation of, and contributions by local communities;
- Local implementation: maximizing the use of local entities in project implementation and management;
- Theme based: addresses one or more of the themes and objectives specified in the RFP;
- Cost: detailed, well thought out and justified. Robust mechanisms for control and oversight;
- Partnerships: programmes and projects that encourage partnerships by proposing activities in both countries as a consortium;
- Measurement: robust monitoring and measurement of programme and project success; and
- Best practice: programmes and projects that use international “best practice”.

A series of workshop on Oil & Gas industry aiming at providing information on LNG and key project infrastructures have also been delivered in Saint-Louis and N’Diago in 2018 focusing on local authorities, local media and key community leaders.

Finally, in addition BP and partner Kosmos recently announced a multi-million dollar commitment to support Senegal’s National Institute of Oil and Gas (INPG). The aim is to utilize the INPG for industry related capacity building, including with the Technical Committee.

BP and its partner Kosmos also announced a multi-million dollar commitment for capacity building in Mauritania which includes construction of a long distance learning centre for training and national capability building in the oil and gas sector. Similarly, the aim is to utilize the facility to support industry related trainings for DCE.

2.15 Health, Safety, Security and Environment

As project operator, BP will implement operational procedures outlined in its project-specific Health, Safety, Security and Environment (HSSE) management plan for the GTA project. The purpose of the GTA project HSSE Management Plan is to define how the project-specific HSSE impacts and risks will be managed in conformance with applicable company-wide HSSE requirements. Due to the size and complexity of the GTA project, delivery-specific HSSE plans may be developed to cover discrete activities (e.g., FPSO HUC, breakwater construction, etc.). Compliance with the GTA project HSSE Management Plan will enable BP and its contractors conduct project activities in a safe and environmentally sound manner.

BP is also developing a Source Control Emergency Response Plan (SCERP) to be prepared for the unlikely event of a major accident. The operation procedures include an Oil Spill Contingency Plan (OSCP), which identifies: 1) lines of communication and control, 2) mechanisms to assess the extent of the spill, and 3) predeployment of available resources for spill response. Should they be required, these procedures would be implemented in coordination with Mauritanian and Senegalese authorities. Chapter 8 provides further details regarding project-associated risks and response.

In the case of an emergency situation[16] the project will deploy an Incident Management Team (IMT) which will be located in dual locations; in country, with a small, core team, supported by a larger IMT based in London, UK. All IMTs base their response structure and processes on ICS (Incident Command System). Support to the in-country IMT may be provided via the Country Support Team (also based in country) but can also draw on resources beyond the region, particularly the Mutual Response Team (MRT). The MRT comprises approximately 100 experienced IMT responders, based in entities around the BP world who are trained and ready to support an incident in any region. For business continuity and other business issues there is a Region Business Support Team based in London, UK, plus support from the Executive Support Team in BP Head Quarters should the situation require. Figure 2-7 below illustrates the organizational structure and capabilities.

[16] When an incident of a serious and urgent nature is ongoing demanding immediate action to bring it under control or it could escalate to injury to persons, environment or asset

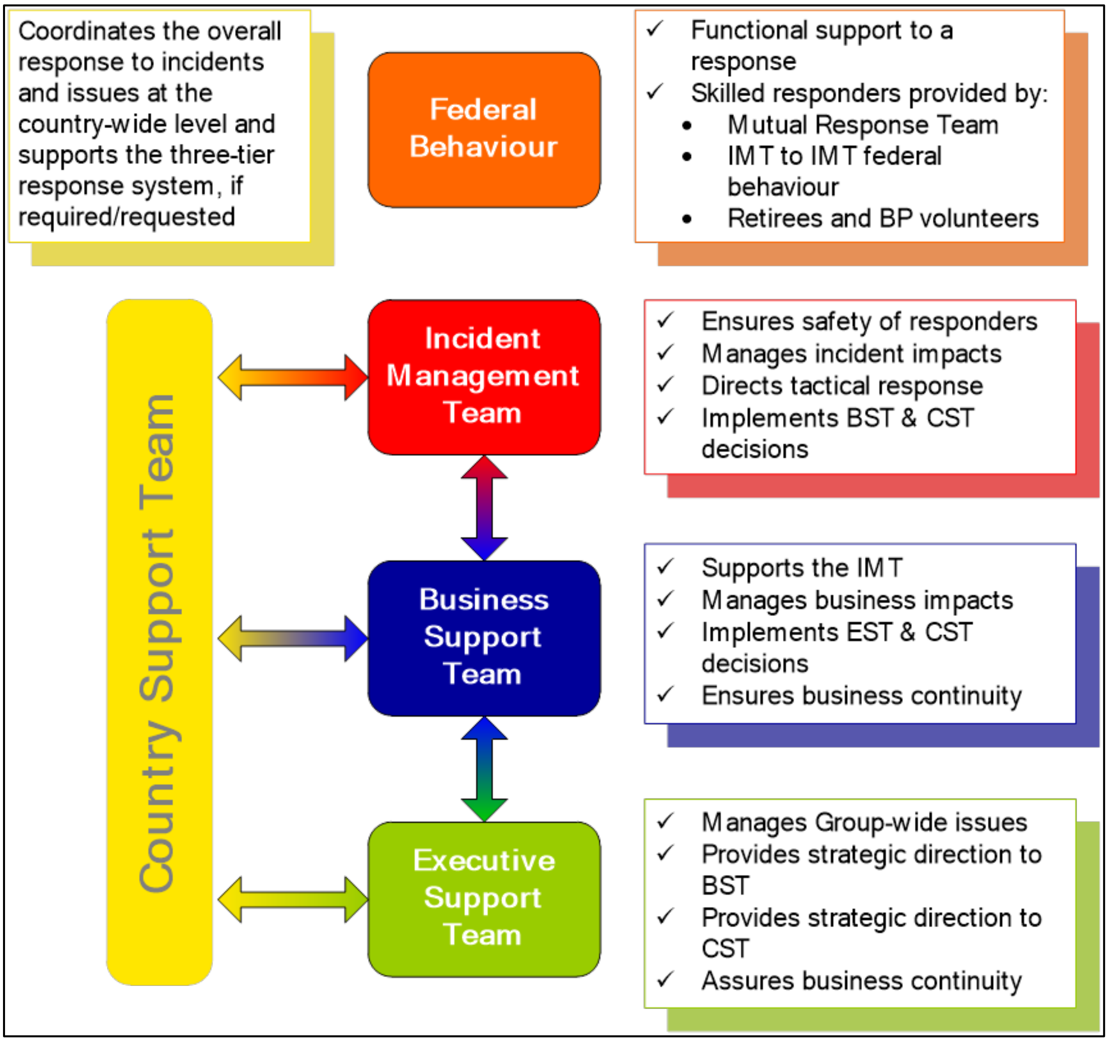


Figure 2-7. Incident Management Team Diagram.

As part of BP's spill preparedness and response requirements there is a need to keep the items below in country for preparedness and quick response and deployment in the case of an emergency:

- Dispersant and application systems on-board each of the appropriate vessels in the fleet; and
- Dispersant, dispersant application systems, surveillance and shoreline protection and clean-up kits stored ashore at the supply bases.

2.16 Establishments Classified for the Protection of the Environment

To comply with the regulation of Senegal in regards to classified establishments for environmental protection (*Installations Classées pour la Protection de l'Environnement* / ICPE)[17], the planned activities for the GTA project and an indicative list of equipment and products potentially used and subject to the regulation have been identified.

[17] The Environment Code of Mauritania also provides for the future issuance of decrees and orders related to establishments classified for the protection of the environment, but it seems that they have not been issued yet.

The ICPEs notably include activities, equipment and products aboard the drillship, the support vessels, the FPSO, the nearshore hub/terminal and the onshore supply bases.

The types of ICPE mainly include the following headings:

- Production and distribution of electricity, gas, vapor and hot water, combustion, compression and refrigeration;
- Corrosive substances;
- Oxidizing substances;
- Radioactive substances;
- Substances toxic for the environment;
- Explosives and explosive substances;
- Flammable liquids; and
- Flammable gas.

Appendix P provides an indicative list of the project's ICPEs. Based on the ICPEs already identified in this appendix, the GTA project is categorized as a first class exploitation according to the ICPE regulation since it includes at least one facility bound to an authorization. As a result, the project will therefore be subjected to an ICPE authorization.

CHAPTER 3: REGULATORY AND INSTITUTIONAL FRAMEWORK

3.0 REGULATORY AND INSTITUTIONAL FRAMEWORK

This chapter describes both Mauritanian and Senegalese national regulatory and institutional frameworks relevant to the proposed project; it lists key international conventions, agreements and protocols signed and/or ratified by these countries which are pertinent to the project. The Inter-State Cooperation Agreement between the two countries is also briefly discussed. This chapter also presents an overview of the Good International Industry Practices relevant to the project. Finally, it presents BP's policies regarding Health, Safety, Environment and Security as well as its Corporate Social Responsibility Policies applicable to the project.

3.1 Mauritania and Senegal Governmental Inter-State Cooperation Agreement

In early 2016, a Memorandum of Understanding (MoU) was entered into between SMHPM, PETROSEN, KEM, and KEISL, setting out the principles of the intergovernmental cooperation agreement for the joint development of the cross-border resource. SMHPM and PETROSEN are the national oil companies of Mauritania and Senegal, respectively. BP acceded to the MoU in 2017.

The MoU enabled these parties to work together toward development of the gas field. Since February 2018, Mauritania and Senegal have an established Inter-State Cooperation Agreement for the exploitation of the cross-border Greater Tortue/Ahmeyim resource.

However, no supranational institution, with its own legal personality, has been created to date for the gas production project. For the purposes of this analysis, it has been assumed that the project will be conducted under the institutions and regulations of each country.

3.2 Mauritania's Administrative Framework

Various Mauritanian institutions are involved in the planning, management and monitoring of offshore oil and gas exploration and exploitation activities. Below is a list of key ministries and related public agencies and institutions which are likely to be involved or interested in the proposed project.

3.2.1 Ministry of Petroleum, Energy and Mines

The Ministry of Petroleum, Energy and Mines (*Ministère du Pétrole, de l'Énergie et des Mines* - MPEMi) has as a general mission, the development and implementation of the Government's policy in the areas of oil and gas, energy and mining.

The MPEMi is the Home Ministry for all oil and gas exploration and exploitation projects and the department overseeing these projects is the General Department of Hydrocarbons (*Direction Générale des Hydrocarbures*). Therefore, the MPEMi is the Home Ministry for the proposed project in Mauritania.

In Mauritania, when a project requires an environmental impact assessment (EIA), the Home Ministry of the project transfers the Terms of Reference (ToR) prepared by the proponent of the proposed project, and later, the EIA report, to the Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et du Développement Durable* - MEDD) which provides its opinion on the environmental feasibility of the project. The authorization of feasibility is granted by the Home Ministry, on the basis of the opinion of the MEDD.

Further, the MPEMi is the responsible ministry for several organizations and companies, including SMHPM.

Initially created in 2004 under the name *Groupe GPC* to monitor the Chinguetti project, SMHPM is now the national company with a goal of maximizing the value of natural resources while contributing to the sustainable development of the country (SMHPM, 2017). As previously mentioned in Chapter 1, SMHPM is a co-venturer in the proposed project.

3.2.2 Ministry of Environment and Sustainable Development

The MEDD has a general mission to prepare, coordinate, implement and/or enforce, monitor and evaluate the Government's environmental policy while taking into account the objectives of sustainable development in the various public policies as well as in the management of the territory and natural resources.

Several departments of the MEDD could be involved in the proposed project, particularly the Department of Environmental Control (*Direction du Contrôle Environnemental* - DCE) and the Department of Pollution and Environmental Emergencies (*Direction des Pollutions et des Urgences Environnementales* - DPUE). The DCE is involved in the guidance and review of EIAs in addition to ensuring the effective implementation of environmental management plans (EMPs). The DPUE prepares and coordinates the implementation of the national strategies against chemical, biological, radioactive, and acoustic pollution and nuisances. It is also responsible for the development and implementation of emergency response plans (ERPs).

3.2.3 Ministry of Fisheries and Maritime Economy

The Ministry of Fisheries and Maritime Economy (*Ministère des Pêches et de l'Économie Maritime* - MPEMa) has a general mission to design, coordinate, promote, and ensure the monitoring of the Government's policy implementation in the areas of fisheries, oceanography, merchant marine activities, and maritime training, in order to strengthen the contribution of the sector within the country's development. It is also the competent national authority in the fields of quality control, hygiene and safety of the establishments, products and production areas of fishing.

Several of the MPEMa departments could be involved in the proposed project, including the Department of Merchant Marine Activities (*Direction de la Marine Marchande*) and particularly its Service for the Preservation of the Marine Environment and Public Domain (*Service de la Préservation du Milieu Marin et du Domaine Public Maritime*). This Service is responsible for the implementation of the national policy for the prevention of marine environment pollution and management of the public maritime domain. Its responsibilities include (but are not limited to) the prevention of marine environment pollution caused by ships discharging hydrocarbons and other harmful substances. In addition, this Service is responsible for the prevention of releases from sea bottom or subsurface exploration or exploitation operations and the harmonization of oil and gas companies marine pollution prevention plans (POLMAR plans) with the national POLMAR plan.

The Mauritanian Coast Guard (*Garde côte Mauritanienne* - GCM) is placed under the authority of the Minister of Fisheries and Maritime Economy. The GCM is responsible for the follow-up, control, and civil monitoring of fishing activities, as well as search and rescue at sea in the waters under Mauritanian jurisdiction.

The MPEMa also exercises a technical guardianship on several institutions and public bodies including the following:

- The *Institut Mauritanien des Recherches Océanographiques et des Pêches* (IMROP) - a public establishment created more than 50 years ago as the *Laboratoire des Pêches* (Laboratory of Fisheries). Its mission is to provide authorities and users with the necessary knowledge for the management and sustainable exploitation of the aquatic resources and environment. This process contributes to the sustainable development of fisheries and improves understanding of the functioning of aquatic ecosystems (IMROP, 2016).

- The *Office National d'Inspection Sanitaire des Produits de la Pêche et de l'Aquaculture* (ONISPA) - responsible for the application of the national and international regulations regarding quality, hygiene and safety of fishery products, establishments and production zones.

3.3 Mauritania's Legal Framework

The national instruments which are applicable to the oil and gas projects include a series of Mauritanian laws and regulations as well as Hydrocarbon Exploration and Production Contracts (EPCs) signed between the State and oil and gas companies.

3.3.1 Exploration and Production Contracts

Effective June 15, 2012, Kosmos entered into an EPC covering offshore Mauritania Block C8 with the Islamic Republic of Mauritania. Block C8 is where the Mauritanian portion of the proposed project is to be conducted. This contract is overseen by the Minister of Petroleum, Energy and Mines. KEM, BPMIL and SMHPM are the current "Contractor" parties under the EPC.

The EPC gives the Contractor parties the exclusive right to carry out petroleum operations in Block C8 in accordance with the terms and conditions of the contract. Obligations listed in the EPC that are relevant for the ESIA include:

- Compliance with good oilfield practice of the international petroleum industry and taking all reasonable measures in order to:
- Ensure that all facilities and equipment utilized for operations are in good repair and in compliance with applicable norms, including those which result from international conventions ratified by Mauritania and relative to the prevention of pollution;
- Avoid losses and dumping of hydrocarbons, including the flaring of natural gas;
- Generally prevent pollution of the soil and subsoil, of the water and the atmosphere, and prevent harm to fauna and flora;
- Put in place appropriate means for prevention, rapid response and handling of risks, including blow-out; and
- Put in place measures for information, training and means adapted to the risks encountered including therein individual protective equipment, fire-fighting materials as well as means of first-aid and prompt evacuation of victims.
- Compliance with norms and standards decreed by Mauritanian regulations in matters of industrial safety, protection of the environment, and operational techniques, including particularly the following:
- For any petroleum operation subject to prior authorization according to the Mauritanian environmental regulations, submit to the Responsible Ministry, the studies or notices of environmental impact required for this type of operation; and
- Then carry out the measures and comply with restrictions set forth in the EMP, furnish the declarations and submit to the oversight provided for in the Mauritanian regulations.
- Ensure the employment on a priority basis, with equal qualification, of Mauritanian personnel and ensure contribution to the training of such personnel, in order to allow their accession to all employment as qualified workers, supervisors, management, engineers and directors.
- Once exploitation operations are surrendered, expired or terminated, rehabilitate the site to its original condition in conformance with a Remediation Plan drawn up as per the requirements of the EPC.
- Dismantle facilities which are no longer necessary to the Petroleum Operations and return the sites to their original condition.

Moreover, as stated in the Exploration-Production Contract for Block C8, the Contractor has the following obligations:

- To compensate and hold harmless any person, including the State, for any damage or loss that the Contractor, his employees or his subcontractors and their employees may cause to the person, property or rights of other persons, by reason of or during Petroleum Operations (clause 24.1).
- To obtain and maintain in force, and cause his subcontractors to obtain and maintain in force, all insurance coverages relative to Petroleum Operations of the type and amounts in use in international petroleum industry, in particular (a) general third party liability coverage, (b) coverage for environmental risks pertaining to Petroleum Operations, (c) coverage for employee work-related accidents, and (d) any other insurance coverage required by the regulations in force. The insurance coverages in question shall be obtained from top tier insurance companies pursuant to the applicable regulations. The Contractor shall provide the Minister with certificates proving the obtaining of insurance coverage and the maintenance in force of the above-cited insurance coverages (clause 24.2).

3.3.2 Laws and Regulations

In Mauritania, legal texts relating to the environment and the management of natural resources are numerous and scattered between various laws, decrees and orders. As mentioned in the National Action Plan for the Environment (*Plan d'action national pour l'environnement 2012-2016 – PANE 2*) (Ministère Délégué auprès du Premier Ministre chargé de l'Environnement et du Développement Durable, 2012)[18], there are no specific standards for the protection of the environment. The most important national environmental laws and regulations applicable to the proposed project are briefly described below.

In Mauritania, the environmental framework law is Law Nº 2000-045, dated July 26, 2000, Environment Code (*Loi portant Code de l'Environnement*). It establishes the basis for the national policy of the environment, and the basis for the harmonization of the ecological requirements with those of sustainable socio-economic development.

It includes five main parts:

- *Titre* I: General provisions
- *Titre* II: Management of the national policy on the environment

  Titre II comprises sections on the National Action Plan for the Environment and on EIAs.

  Mauritania's current National Action Plan for the Environment (*Plan d'Action National pour l'Environnement*) is called PANE 2 and it covers the 2012-2016 period. It should be noted that one of the many action items of PANE 2 is the development of a system of environmental standards including limit values (air, soil and water), a system of taxation and a penalty grid.

  Decree N° 2004-094, dated November 24, 2004 and Decree N° 2007-105, dated April 13, 2007 provide details on the legal regime applicable to EIAs, supporting Articles 14 to 20 of the Environment Code. Activities requiring a notice of impact or a comprehensive EIA are identified as well as the expected content of such documents.

[18] A new National Strategy for the Environment and Sustainable Development (*Stratégie Nationale de l'Environnement et du Développement Durable* [SNEDD]) for the period of 2017-2030 along with an Action Plan for the period of 2017-2021 have been announced by the Minister of Environment and Sustainable Development to Mauritania's Council of Ministers on September 25, 2017 (AMI, 2017). However, details regarding this Action Plan are not available as of October 2017.

- *Titre* III: Protection of the resources and the natural environment

  Titre III provides for the future issuance of decrees relating to air emissions, water quality and soil quality. To date, no such decree has been issued to define air, soil or water quality criteria or standards.

- *Titre* IV: Fight against nuisances and various degradations of the environment

  Titre IV provides for the future issuance of a decree and orders related to classified establishments. It also comprises chapters on waste, on noise and vibrations, on odors, dust and light, on environmental aesthetics, and on heritage protection. To date no decrees have been issued to define criteria or standards for them.

- *Titre* V: Penal provisions

Another important law in the context of the proposed project is Law Nº 2011-022, dated March 8, 2011, Prevention and Fight against Marine Pollution Act (*Loi relative à la prévention et à la lutte contre la pollution marine*) that ensures the transposition into the national legal framework of the international conventions/protocols regarding the prevention of and fight against marine pollution (i.e., MARPOL[19], OPRC[20], etc.). It includes provisions on harmful substances, waste and water management on ships as well as the obligations in case of an accidental release or discharge. It contains 16 main parts:

- *Titre* I: General principles - definitions
- *Titre* II: Prevention and fight against marine pollution by ships
- *Titre* III: Repression of marine pollution by ships other than the platforms
- *Titre* IV: Prevention and repression of marine pollution by dumping of wastes and other contents
- *Titre* V: Prevention and repression of marine pollution by the incineration of waste and other contents
- *Titre* VI: Prevention and repression of land-based sources of marine pollution
- *Titre* VII: Prevention and repression of marine pollution of radioactive origin
- *Titre* VIII: Prevention and repression of marine pollution by drilling platforms
- *Titre* IX: Prevention and repression of marine pollution in the ports and port facilities
- *Titre* X: Provisions common to the repression of various forms of marine pollution
- *Titre* XI: Civil liability and insurance obligation of the ship owner for damage caused by oil pollution
- *Titre* XII: Obligation of financial contribution to the international fund for oil pollution damage compensation of the receiver of such hydrocarbons
- *Titre* XIII: Control and observation of offenses
- *Titre* XIV: Jurisdiction, and administrative and judicial procedures
- *Titre* XV: Advisory committee for the protection of the marine environment
- *Titre* XVI: Miscellaneous provisions

A Marine Environment Code has been expected since 2008, but it has not yet been published by the Mauritanian authorities.

[19] International Convention for the Prevention of Pollution from Ships (MARPOL), 1973/1978
[20] International Convention on the Preparation, Response, and Cooperation in Case of Oil Pollution (OPRC), 1990

The Crude Hydrocarbons Code (*Loi portant Code des Hydrocarbures Bruts*) – Law Nº 2010-033, dated July 20, 2010, as modified by Law N° 2011-044, dated October 25, 2011 and Law N° 2015-016, dated July 29, 2015 – although not containing a specific part on environmental protection, also contains environmental requirements. Note that a Decree setting the Standards for Oil and Gas Industry Activities in Mauritania was also expected, but this decree is still in a draft stage and it cannot yet be used as a reference.

Finally, Law Nº 2015-017, dated July 29, 2015, Maritime Fisheries Code (*Loi portant Code des Pêches Maritimes*), and Law Nº 1997-006, dated January 20, 1997 replacing Law N° 1975-003, Hunting and Nature Protection Code (*Loi portant Code de la Chasse et de la Protection de la Nature*) also contain environmental provisions.

Table 3-1 below presents a summary of the national environmental laws and regulations specifically relevant for the current ESIA, i.e., pertaining to the environment and the anticipated project activities and effects.

Table 3-1. Mauritanian Environmental Laws and Regulations Relevant to the Proposed Project.

Regulation Number	Regulation Title	Relevance to the Project
Law N°2010-033, dated July 20, 2010, as modified by Law N° 2011-044, dated October 25, 2011 and Law N° 2015-016, dated July 29, 2015	Crude Hydrocarbons Code (*Loi portant Code des Hydrocarbures Bruts*)	This law defines the legal and tax regime of operations related to exploration, exploitation, and transportation by pipeline and storage of crude hydrocarbons. It also describes the rights and obligations associated with carrying out such activities, including a series of environmental requirements.
Law Nº 2000-045, dated July 26, 2000	Environment Code (*Loi portant Code de l'Environnement*)	This is the framework environmental law. It establishes the basis for the national policy of the environment, and the basis for the harmonization of the ecological requirements with those of sustainable socio-economic development. The general principles of the national policy of the environment include: ▪ The conservation of biological diversity and the rational use of natural resources; ▪ The fight against desertification; ▪ The fight against pollution and nuisances; ▪ The improvement and the protection of living conditions; and ▪ The harmonization of the development with the safeguarding of the natural environment.
Decree Nº 2004-094, dated November 24, 2004	Decree regarding Environmental Impact Assessments (*Décret relatif à l'Étude d'Impact Environnemental*)	These decrees provide details on the legal regime applicable to EIAs, supporting Sections 14 to 20 of the Environment Code.
Decree Nº 2007-105, dated April 13, 2007	Decree modifying and completing Decree 2004-094 (*Décret modifiant et complétant certaines dispositions du décret 2004-094 relatif à l'Étude d'Impact sur l'Environnement*)	
Order Nº 2007-037, dated April 17, 2007	Order regarding the Coastline (*Ordonnance Nº 2007-037 relative au littoral*)	This order addresses the development, protection and management of the Mauritanian coastline.
Law Nº 2011-022, dated March 8, 2011	Prevention and Fight against Marine Pollution Act (*Loi relative à la prévention et à la lutte contre la pollution marine*)	This law ensures the transposition into the national legal framework of the international regulations/conventions regarding the prevention of and fight against marine pollution. It includes provisions on harmful substances, waste and water management on ships as well as the obligations in case of an accidental release or discharge.

Regulation Number	Regulation Title	Relevance to the Project
Law N° 2015-017, dated July 29, 2015	Maritime Fisheries Code (*Loi portant Code des Pêches Maritimes*)	This law defines the rules applicable to the fisheries in Mauritanian waters. It also contains provisions prohibiting the use or discharge of toxic substances that could affect or kill fish or pollute the marine environment; it also regulates fishing and prohibits capturing or holding marine mammals, sea turtles and marine birds.
Law Nº 2013-029, dated July 30, 2013	Merchant Marine Code (*Loi portant Code de la Marine Marchande*)	This law governs the legal aspects related to maritime navigation as well as maritime commerce.
Law Nº 1997-006, dated January 20, 1997 replacing Law Nº 1975-003	Hunting and Nature Protection Code (*Loi portant Code de la Chasse et de la Protection de la Nature*)	This law contains measures for the conservation and protection of wildlife, lists protected species and also covers hunting activities and protected area designation (national parks, nature reserves, etc.).

3.4 Senegal Administrative Framework

Various Senegalese institutions might be involved in the planning, management, and monitoring of offshore oil and gas exploration and exploitation activities. Below is a list of key ministries and related public agencies and institutions which are likely to be involved in the proposed project.

3.4.1 Ministry of Oil and Energies

The Ministry of Oil and Energies (*Ministère du Pétrole et des Énergies* - MPE) implements and enforces the State's regulation and policy regarding land and sea energy resources, both during exploration and production activities. This Ministry is responsible for oversight of energy production and use in Senegal and, therefore, it oversees businesses whose activities relate to importation, exportation and trading of hydrocarbons. In addition, the MPE promotes development of renewable energy and is also responsible for technological research and communication in this sector.

The MPE is the Home Ministry for the proposed project in Senegal. Further, the MPE works jointly with PETROSEN.

Created in May 1981, PETROSEN is a parapublic agency that prepares and negotiates petroleum conventions and exploration and production sharing contracts between the State of Senegal and private corporations. Its mission includes evaluation of oil potential in Senegal River Basin; promotion of Senegal's oil potential to international oil companies; participation in exploration and production activities, together with the operating companies; technical management and control of oil operations; and participation in joint operations in the various sectors of the industry. As noted previously in Chapter 1, PETROSEN is a co-venturer in the proposed project.

3.4.2 Ministry of Environment and Sustainable Development

The Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et du Développement Durable* - MEDD) develops, implements, and enforces national regulations and policies on environmental protection and sustainable development. This Ministry oversees potentially polluting activities to ensure they do not damage the environment or the well-being of the population.

The main department of the MEDD is the Department of Environment and Classified Establishments *(Division de l'Environnement et des Établissements Classés* - DEEC). The DEEC is responsible for implementing Senegal's governmental regulations regarding the environment and classified establishments, specifically to protect the natural environment and people against pollution and nuisance. The DEEC, as the authority providing environmental permits, will be responsible for providing all required environmental permits for the proposed part of the project in Senegal.

3.4.3 Ministry of Fisheries and Maritime Economy

The Ministry of Fisheries and Maritime Economy *(Ministère des Pêches et de l'Économie Maritime* – MPEM) is in charge of developing and implementing national regulations and policies on the fishing industry, the exploitation of seabed, aquaculture, port infrastructure, and maritime transport. This Ministry controls the management and sustainable exploitation of fisheries resources by artisanal and industrial fisheries.

One of the main departments of the Ministry is the National Agency on Maritime Affairs (*Agence Nationale des Affaires Maritimes* - ANAM). ANAM manages the maritime market in the public sector and enforces compliance of port infrastructure and boat evaluations/audits. ANAM is also reviewing the Merchant Navy Act and various guidelines to provide support to users of the sea.

The MPEM is responsible for overseeing the effects of any project, including the proposed project, on fisheries resources.

3.4.4 Ministry of Armed Forces

The Ministry of Armed Forces (*Ministère des Forces Armées*) protects the territory and national interests of Senegal. The Ministry of Armed Forces participates in the monitoring and intervenes in the maritime area in collaboration with the High Authority for Maritime Security, Maritime Safety and Marine Environment Protection (*Haute Autorité chargée de la Coordination de la Sécurité maritime, de la Sûreté maritime et de la Protection de l'Environnement marin* - HASSMAR).

3.4.5 High Authority for Maritime Security, Maritime Safety and Marine Environment Protection (HASSMAR)

Created in 2006 (n° 2006-322 of April 7, 2006), HASSMAR is linked to the Primature (Prime Minister's office) and placed under the technical supervision of the Ministry of Armed Forces; it has an operational assignment to fulfill its mandate.

In case of a disaster or an emergency at sea, HASSMAR coordinates all services including those of other ministries and public agencies. HASSMAR has a significant assignment for security (prevention of illicit activities), safety (rescuing people), and environment protection at sea and on river waters under Senegal's jurisdiction.

HASSMAR has developed and is responsible for the National Plan for Emergency Operations at Sea (*Plan National d'Interventions d'Urgence en Mer* - PNIUM). This Plan includes three specific plans: the Search and Rescue Plan (SAR Plan), the National Security Plan (SURMAR Plan), and the Pollution Response Plan (POLMAR Plan). HASSMAR is responsible for coordinating responses to hydrocarbon spills at the national level.

HASSMAR's operational organization for operation at sea is divided into regional delegations according to three sea areas: 1) North; 2) Central; and 3) South. HASSMAR's national coordination of search and rescue operations is placed under the responsibility of a specific department, the Maritime Rescue Coordination Center (*Centre de Coordination des Secours Maritimes* - MRCC).

3.4.6 Ministry of Internal Affairs

Through its Department of Emergency Preparedness (*Direction de la Protection Civile* - DPC), the Ministry of Internal Affairs (*Ministère de l'Intérieur*) ensures protection and conservation of people, facilities, resources, and public property.

The DPC is responsible for the national relief plan called the *Plan National d'Organisation des Secours* – ORSEC) and it manages the various emergency preparedness services at all levels, such as the Fire Brigade National Guard (*Brigade nationale des sapeurs-pompiers*).

The DPC and the Fire Brigade National Guard are both involved in the approval process of risk studies and emergency response plans when required for a project.

3.4.7 Cos-Petrogaz

In October 2016, the Strategic Orientation Committee for Oil and Gas (Cos-Petrogaz) was created. This new Authority's assignment is to support the President of Senegal and the Government, and its assignment includes:

- The definition of an oil and gas development policy;
- The follow-up of the implementation of this policy;
- The preparation of an oil and gas development plan; and
- The preparation of a law regarding the use of oil and gas revenues for the development of the country.

3.5 Senegal Legal Framework

The national instruments include Senegalese laws and regulations as well as Hydrocarbon Exploration and Production Sharing Contracts (EPSCs) signed between the State, PETROSEN and international oil and gas companies.

3.5.1 Exploration and Production Sharing Contracts

KEISL, BPSIL and PETROSEN are the "Contractor" parties under the EPSC. This contract is overseen by the Minister of Energy and Sustainable Energy Development.

The EPSC gives the Contractor parties the exclusive right to carry out oil and gas exploration and exploitation activities in the Saint-Louis Offshore Profond Block in conformance with the terms and conditions of the contract. Obligations listed in the EPSC that are relevant for the ESIA include:

- Perform all works necessary for the oil and gas exploration and exploitation activities, according to the rules of the art in use in the international oil industry, particularly:
  - Ensure that all of the facilities and equipment used in the operations are in good operating condition and are properly maintained and repaired during the duration of the EPSC;
  - Avoid that any hydrocarbons, sludge or any other product used in the operations may be wasted and may pollute the underground water; and
  - Ensure the protection of the environment, prevent accidents and limit the consequences thereof, and in particular, prevent, reduce and control the pollution of the environment and, if applicable, restore the sites and undertake the abandonment project upon completion of each operation.
- Ensure that all work and facilities erected in the marine areas of Senegal are constructed, indicated and marked with buoys so as to leave at all times, and in total safety, free passage for navigation and fitted with navigational aids approved by the appropriate Senegalese authorities and maintained in good operating condition.
- The Contractor may employ on a priority basis, with equal qualifications, the citizens of the Republic of Senegal and contribute to the training of this personnel in order to enable their promotion to any positions as qualified workers, specialty officials, clerks and managers.
- Submit for approval to the Minister a preliminary plan of the abandonment or site restoration works at the end of operations; this plan should be in line with generally accepted good workmanship in use in the international oil industry.

In addition, as per the Hydrocarbon Exploration and Production Sharing Contract for the Saint-Louis Offshore Profond Block, the Contractor has the following obligations:

- To compensate and indemnify the State and any person in the event of damage caused by the oil and gas operations or due to the employees or officials of the Contractor during the Operations (Clause 4.5).
- To sign and have its subcontractors sign all insurance policies in use in the international oil industry concerning its obligations and liabilities and specifically the liability insurance policies with respect to third parties, property damage insurance policies to the property and the environment, and the insurance policies that might be required by the regulations in effect in the Republic of Senegal, and to provide the certificates proving the signing of said insurance policies to the Minister (Clause 4.6).

3.5.2 Laws and Regulations

The main environmental law in Senegal is Law Nº 2001-01, dated January 15, 2001, Environmental Act (*Loi portant Code de l'Environnement*), supported by Decree Nº 2001-282, dated April 12, 2001, Enforcement Decree of the Environmental Act (*Décret portant Code de l'Environnement*).

The Environmental Act includes four main parts:

- *Titre* I: General provisions
- *Titre* II: Prevention and fight against pollution and nuisances

  Titre II defines classified establishments for environmental protection (ICPE) and their legal requirements (permitting, taxes, inspections, etc.). It also includes provisions regarding waste management, dangerous and deleterious substances management, EIAs, and emergency plans (National emergency plan, plan for the fight against sea and coastal pollution and POIs)[21].
- *Titre* III: Receiving environment protection and development

  Titre III generally provides for the issuance of decrees relating to water pollution, air and odor emissions, soil pollution, and noise.
- *Titre* IV: Sanctions and miscellaneous dispositions

The Enforcement Decree of the Environmental Act provides details on the Environmental Act. It is subdivided into six parts covering the main areas of environmental concern: 1) ICPE and POI processes and permitting applications; 2) EIAs; 3) Water Pollution; 4) Water Policing; 5) Air Pollution; and 6) Noise Pollution. For EIAs, it identifies projects that need a mandatory EIA and mentions that a series of orders will specify the requirements for the EIA procedure. The orders regarding the requirements for the EIA procedure are listed in Table 3-2 below. Regarding emission and discharge standards, it indicates maximum noise levels not to be exceeded in Article L R84 (55 to 60 dB during the day and 40 dB at night). It also stipulates that other standards will be published through orders.

Classified establishments for environmental protection (ICPE): Chapter I of Title II ("Prevention and fight against pollution and nuisances") of the Environmental Act gives a framework for the ICPEs; Articles L9 to L27 define the typology of ICPEs, the modalities to be respected for their opening and exploitation; the fees and taxes to which the operator of an ICPE is subject.

Water pollution is regulated by the provisions of Chapter I of Title III ("Receiving environment protection and development") of the Environmental Act. These provisions cover "direct or indirect spills, flows, discharges and deposits of any kind and more generally any situation likely to cause or increase the degradation of waters by modifying their physical, chemical, biological or bacteriological characteristics…" (Article 59).

[21] The POI (*Plan d'opération interne*) is the Senegalese regulatory emergency plan applicable to facilities subjected to the ICPE regulation. It describes in detail the management rules and all the resources in place on an industrial site to handle the consequences of a disaster on people, environment and properties. It focuses on disasters such as a fire, an explosion, the spill of liquids, and the atmospheric dispersion of toxic chemicals.

According to Article L61, the Minister in charge of the environment, in relation to the relevant Ministers, has the prerogative to state: 1) the list of the substances that the direct or indirect release, spill, deposit, dumping or introduction in inland and marine waters must be either proscribed or subject to authorization from the environment and sanitation authorities and 2) the compliance criteria for discharged effluents.

Article L64 states: "Without prejudice to the special provisions of international conventions for the prevention and fight against marine pollution ratified by Senegal, are prohibited spills, dumping and burning in marine waters under Senegalese jurisdiction, of substances of all kinds likely to (1) adversely affect public health and marine living resources; (2) adversely affect maritime activities, including navigation and fishing; (3) alter the quality of marine waters from the point of view of their use and (4) degrade the amenity values and tourism potential of the sea and coastline."

Waste management is regulated by the provisions of Chapter III of Title II ("Waste management") of the Environmental Act.

Article L31 states: "Anyone who produces or holds waste must self-dispose or recycle or have it disposed of or recycled at companies approved by the Minister in charge of the environment. Failing this, he must hand over the waste to the local community or to any state-approved company for waste management."

According to Article L37, the disposal of waste by industrial structures must be made on authorization and supervision of the Ministry in charge of the environment which sets requirements; while Article L41 prohibits the dumping, incineration or disposal, by any process whatsoever, of waste in inland, maritime or fluvio-maritime waters under Senegalese jurisdiction.

Document NS 05-061, dated July 2001, Wastewater Discharge Standards (*Norme Sénégalaise Eaux Usées : Normes de Rejets*) establishes standards on wastewater discharges in surface water, groundwater or marine water. It defines the level of pollution based on dilution, lists substances that cannot be discharged, identifies discharge point design and sampling requirements, includes standards for some substances and parameters, etc.

Document NS 05-062, dated October 2013, Air Pollution Discharge Standards (*Norme Sénégalaise Pollution Atmosphérique : Norme de Rejets*) establishes standards on air emissions. It notably identifies discharge point design and monitoring requirements and includes standards for some parameters. Appendix V of Document NS 05-062 lists other reference documents regarding sampling methods and air emission calculations.

The main legislation related to oil and gas activities is Law Nº 98 05, dated January 8, 1998, the Oil Act (*Code Pétrolier*) and its Enforcement Decree, Decree Nº 98-810 of October 6, 1998. This legislation gives directions and guidelines for prospecting licenses, exploration, exploitation, transportation, taxes, duties, and obligations of companies. In particular, operators must guarantee the protection of national resources and the environment. The act states that the operators are financially responsible for the cost of environmental protection measures implemented to mitigate the impact of their activities.

Several other Senegalese laws, such as the Water Act (*Loi portant Code de l'Eau*), the Sanitation Act (*Loi portant Code de l'Assainissement*), the Merchant Navy Act (*Loi portant Code de la Marine Marchande*), the Act on Hunting and Wildlife Protection (*Loi portant Code de la Chasse et de la Protection de la Faune*), and the Maritime Fisheries Act (*Loi portant Code de la Pêche Maritime*) also contain environmental provisions. Table 3-2 presents those specifically relevant for this ESIA, i.e., pertaining to the environment and the anticipated project activities and effects.

Article 25-1 of the Constitution Act No. 2016-10 of April 5, 2016 on the revision of the Constitution (*Loi constitutionnelle n^o^ 2016-10 portant révision de la Constitution*) says that "the natural resources belong to the people. They are used for the improvement of conditions of life. The exploitation and management of natural resources must be done in transparency and in such a way to generate economic growth, to promote the well-being of the population in general and to be environmentally sustainable. The State and the local authorities have the obligation to ensure the preservation of the heritage of the land." However, no details are provided on how these principles are to be implemented.

In terms of labor legislation, Law N° 2002-22, dated August 16, 2002, of the Merchant Navy Act, applies to "all vessels registered in Senegal, crews and passengers on board…", as opposed to foreign-flagged vessels unless otherwise expressly stated in the Act. Law N° 97-17, dated December 1, 1997, on the Labor Code, regulates, amongst other things, the working conditions in Title X: work duration, night work, work of women and children, weekly rest, etc. Hygiene and safety in workplaces are covered in Title XI.

Article L. 171 states: "The employer must ensure that workplaces, machinery, materials, substances and work processes under the employer's control do not pose a risk to the health and safety of workers". To this end, the employer must take: 1) technical measures 2) arrangement of occupational medicine measures and 3) work organization measures. If these measures are insufficient, the employer must implement individual protection measures against occupational risks and monitoring of worker's health.

Several decrees are issued for the applications of Labor Code provisions:

- Decree N° 2006-1251 dated November 15, 2006, on work equipment: establishes minimum health and safety requirements for the use of work equipment by workers, such as machinery, devices, gear and other equipments used to perform work.
- Decree N° 2006-1252 dated November 15, 2006, establishes minimal requirements for the prevention of some physical environmental conditions: establishes minimum requirements for the prevention of physical environmental factors such as lighting, temperature and noise.
- Decree N° 2006-1253 dated November 15, 2006, establishes occupational health inspections and determining their functions: ensures the application of legislation and regulation provisions relating to the health and safety at work and to the protection of workers in the workplace by controlling the functioning of occupational health services.
- Decree N° 2006-1256 dated November 15, 2006, establishes the obligations of employers in terms of work safety: sets the obligations of employers for improving the health and safety of workers.
- Decree N° 2006-1257 dated November 15, 2006, establishes the minimum requirements for protection against chemical risks: applies to employers and workers and set rules for protecting workers from health and safety risks.
- Decree N° 2006-1258 dated November 15, 2006, establishes the missions and organization and operation rules for occupational health services: regulates the procedures for the recruitment of occupational physicians and the organization, operation and financing of occupational health services.
- Decree N° 2006-1259 dated November 15, 2006, on safety signaling measures at work to warn workers: of the presence of a risk or a hazard, of the prohibition of behavior likely to present a risk, of the obligation to adopt specific behavior, of the location of firefighting equipments, escape routes and exits, as well as first-aid treatments.
- Decree N° 2006-1260 dated November 15, 2006, on ventilation and sanitation conditions of workplaces: establishes the standards and the measures to be taken to respect those standards.
- Decree N° 2006-1261 dated November 15, 2006, establishes the general hygiene and safety measures in establishments of any kind: regulates the quality of places and workstations, the quality and order in the workplace, the services and premises provided for workers (work clothes, locker rooms and lockers), ways of insuring personal hygiene, the provision of toilets, protection and prevention services, first-aid measures, fire-fighting equipment and the evacuation of workers.

Table 3-2. Senegalese Environmental Laws and Regulations Relevant to the Proposed Project.

Regulation Number	Regulation Title	Relevance to the Project
Law Nº 98-05, dated January 8, 1998	Oil Act (*Loi portant Code Pétrolier*)	Main law on prospecting, exploration, exploitation and transportation of hydrocarbons and the tax treatment of these activities.
Decree Nº 98-810, dated October 6, 1998	Enforcement Decree of the Oil Act (*Décret Fixant les Modalités et Conditions d'Application de la Loi portant Code Pétrolier*)	Provides details and procedures for enforcement of the Oil Act.
Law Nº 2001-01, dated January 15, 2001	Environmental Act (*Loi portant Code de l'Environnement*)	Main environmental law of Senegal.
Decree Nº 2001-282, dated April 12, 2001	Enforcement Decree of the Environmental Act (*Décret portant Code de l'Environnement*)	Provides details on Environmental Act enforcement, notably on classified establishments for environmental protection and projects that need a mandatory EIA.
Ministerial Order Nº 9468 MJEHP-DEEC, dated November 28, 2001	Ministerial Order on Public Participation during EIA Processes (*Arrêté Ministériel portant Réglementation de la Participation du Public à l'Étude d'Impact Environmental*)	Provides requirements regarding public consultation during the EIA approval process.
Ministerial Order Nº 9469 MJEHP-DEEC, dated November 28, 2001	Ministerial Order on the Organization and Functioning of the Technical Committee (*Arrêté Ministériel portant Organisation et Fonctionnement du Comité Technique*)	Provides information on the organization and procedures of the Technical Committee in charge of assisting the Ministry of Environment in reviewing EIA reports.
Ministerial Order Nº 9470 MJEHP-DEEC, dated November 28, 2001	Ministerial Order Setting the Terms of Issuance of an Agreement for the Conduction of EIA Related Activities (*Arrêté Ministériel Fixant les Conditions de Délivrance de l'Agrément pour l'Exercice des Activités Relatives aux Études d'Impact sur l'Environnement*)	Provides details on the requirements and procedures for a person or a company to be allowed to conduct EIAs in Senegal.
Ministerial Order Nº 9471 MJEHP-DEEC, dated November 28, 2001	Ministerial Order on the Content of the Terms of Reference for EIA (*Arrêté Ministériel portant Contenu des Termes de Références des Études d'Impact*)	Specifies the compulsory content of the terms of reference for an EIA.

Regulation Number	Regulation Title	Relevance to the Project
Ministerial Order Nº 9472 MJEHP-DEEC, dated November 28, 2001	Ministerial Order on the Contents of an EIA Report (*Arrêté Ministériel portant Contenu du Rapport de l'Étude d'Impact Environnementale*)	Specifies the compulsory content of an EIA report.
NS 05-061 dated July 2001	Wastewater Discharge Standards (*Norme Sénégalaise Eaux Usées : Normes de Rejets*)	Establishes standards on wastewater discharge and is complementary to the Enforcement Decree of the Environmental Act.
NS 05-062, dated October 2013	Air Pollution Discharge Standards (*Norme Sénégalaise Pollution Atmosphérique : Norme de Rejets*)	Establishes standards on air pollution and is complementary to the Enforcement Decree of the Environmental Act.
Law Nº 81-13, dated March 4, 1981	Water Act (*Loi portant Code de l'Eau*)	Establishes principles for good water management, particularly on sanitation and pollution prevention.
Law Nº 2009-24, dated July 8, 2009	Sanitation Act (*Loi portant Code de l'Assainissement*)	Determines the responsibilities, offenses and penalties regarding sewerage, spills, discharges, deposits, direct or indirect landfill, and dumping of liquid waste.
Law Nº 2015-18, dated July 13, 2015	Maritime Fisheries Act (*Loi portant Code de la Pêche Maritime*)	Statutes on fisheries and provides information such as provisions on persons engaged in fishing within maritime waters under Senegalese jurisdiction, as well as equipment and fishing vessels, fishing areas, and protected species.
Law Nº 2002-22, dated August 16, 2002	Merchant Navy Act (*Loi portant Code de la Marine Marchande*)	Provides details on maritime transport, maritime insurance, auxiliary transport, conflicts between industrial and artisanal fisheries, and transportation of passengers and goods.
Law Nº 86-04, dated January 24, 1986	Act on Hunting and Wildlife Protection (*Loi portant Code de la Chasse et de la Protection de la Faune*)	Covers general principles and procedures regarding hunting, permit system, use of weapons, confiscations and seizures, actions and proceedings, transactions, offenses, and penalties.
Decree N° 86-844, dated July 14, 1986	Enforcement Decree of the Act on Hunting and Wildlife Protection (*Décret portant Code de la Chasse et de la Protection de la Faune*)	Provides details on the enforcement of the Act on Hunting and Wildlife Protection, notably with provisions for protection of certain species.
Decree Nº 87-1044, dated August 18, 1987	Decree Establishing the List of Protected Species (*Décret Fixant la Liste des Animaux Protégés*)	Establishes the list of species whose catch, detention, and sale are prohibited.

Regulation Number	Regulation Title	Relevance to the Project
Decree Nº 2004-1408, dated November 4, 2004	Decree on the Creation of Marine Protected Areas (*Décret portant Création d'Aires Marines Protégées*)	Statutes on the creation of marine protected areas, including establishment of five marine protected areas: Saint-Louis, Kayar, Joal-Fadiouth, Abene, and Bamboung.
Joint Ministerial Order Nº 009311, dated October 5, 2007	Ministerial Order on Waste Oil Management (*Arrêté Interministériel portant Gestion des Huiles Usagées*)	Provides information and requirements for waste oil management for owners (*détenteurs*), collectors (*ramasseurs*), and eliminators (*éliminateurs*) of waste oil.
Decree Nº 89-1539 dated December 19, 1989	Decree Regulating the Manufacturing, Import, Storage, Transportation and Use of Explosive Substances	Defines the terms of application of Law Nº 88-06 dated August 26, 1989 on the Mining Code with regards to administrative procedures, safety rules and conditions to comply with concerning explosive substances. It revokes all contrary provisions, including the Decrees N° 61-356 M.T.P.H.U.IG dated September 21, 1961 fixing the exploitation mode of quarries and dated January 11, 1929 regulating explosive substances in French West Africa, and their orders of application.

3.6 International Conventions, Protocols and Agreements

In addition to the Inter-State Cooperation Agreement described in Section 3.1, Mauritania and Senegal have signed and/or ratified a number of conventions, protocols, and bilateral, regional, and international agreements. Many of these relate to natural resources protection and conservation and need to be taken into account in planning and conducting oil and gas exploration and exploitation activities.

A series of conventions, protocols and agreements potentially relevant to the proposed project are identified in Table 3-3. In this table, entries have been organized by application scope:

- Vessel operation and pollution prevention;
- Species, heritage and biodiversity protection; and,
- Hazardous wastes and/or persistent substances.

This table does not identify all conventions, protocols and agreements to which Mauritania and Senegal are adherents, but rather is limited to conventions, protocols and agreements related to the project.

Table 3-3. International Conventions, Agreements, and/or Protocols with Applicability to the Proposed Project.

Conventions/Agreements/ Protocols	Objectives	Accessed, Ratified or Signed[1] by	
		Mauritania	Senegal
Vessel Operation and Pollution Prevention			
International Convention for the Prevention of Pollution from Ships (MARPOL Convention), 1973/1978	Prohibits the release of sources of pollution from ships, including petroleum substances, waste, wastewater, noxious liquids, and hazardous substances and provides measures for the prevention of pollution from these sources. The provisions of the MARPOL Convention's Annexes applicable to the proposed project are summarized below. Annexes II and III are not applicable to the proposed project, as neither the drillship nor support vessels will be transporting noxious liquid substances in bulk or harmful substances in packaged form. <u>Annex I (Oil Pollution):</u> This Annex pertains to the discharge of oil as a component of routine discharges (e.g., drainage water), with varying requirements dictated by vessel size (tonnage). Any discharge into the sea of oil or oily mixtures from project vessels is prohibited except when all the following conditions are satisfied: 1) the ship is proceeding en route; 2) the oily mixture is processed through oil filtering equipment which meets specific requirements; and 3) oil content of the effluent without dilution does not exceed 15 parts per million (ppm). Other requirements of this Annex do not apply to project vessels. <u>Annex IV (Sewage):</u> The discharge of sewage into the sea is prohibited, except when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than 3 nautical miles from the nearest land. When discharging sewage which is not comminuted or disinfected, the ship must be more than 12 nautical miles from the nearest land before discharges are allowed. Such discharges should not be instantaneous, but at a moderate rate when the ship is en route. Discharges are also allowed when the ship has an approved sewage treatment plant in operation which meets specific requirements. Furthermore, all sewage discharge effluents should not produce visible floating solids or cause discoloration of the surrounding water.	Yes	Yes

<table>
<tr><th rowspan="2">Conventions/Agreements/ Protocols</th><th rowspan="2">Objectives</th><th colspan="2">Accessed, Ratified or Signed[1] by</th></tr>
<tr><th>Mauritania</th><th>Senegal</th></tr>
<tr><td></td><td>Annex V (Garbage): This Annex is applicable to all ships in the jurisdiction of the International Maritime Organization (IMO) and provides, when the vessel is located outside of special areas, among other things:
▪ No discharge of any form of plastics (ropes, fishing nets, synthetic fibers, plastic bags, incinerated plastic ash, etc.), domestic wastes, cooking oil, incinerator ashes, operational wastes, and fishing gear.
Discharge allowed at 12 nautical miles or more from shore:
▪ food waste, not comminuted or ground; and
▪ cargo residues either contained or not contained in water; cargo residues include those materials that cannot be recovered using commonly available techniques; cargo residues must not be harmful to the environment.
Discharges allowed at 3 nautical miles or more from shore:
▪ food waste, comminuted or ground to 25 mm or less.
Annex VI (Air Pollution): This Annex establishes limits on the emission of certain internal combustion by-products, including sulfur oxides (SOx) and nitrogen oxides (NOx), as well as the intentional release of ozone-depleting substances (e.g., chlorofluorocarbons, halons). This Annex also prohibits the incineration of specific substances (e.g., polychlorinated biphenyls (PCBs), polyvinyl chloride (PVC), plastics and garbage containing more than traces of toxic residues or heavy metals, etc.).</td><td></td><td></td></tr>
<tr><td>United Nations Convention on the Law of the Sea (UNCLOS), 1982</td><td>Establishes international basic principles and rules on cooperation, technical assistance, environmental monitoring and assessment, both at global and local levels through accession to international norms and standards and to national legislation concerning all sources of marine pollution and enforcement of such provisions.</td><td>Yes</td><td>Yes</td></tr>
</table>

Conventions/Agreements/ Protocols	**Objectives**	**Accessed, Ratified or Signed[1] by**	
		Mauritania	**Senegal**
International Convention on the Preparation, Response, and Cooperation in Case of Oil Pollution (OPRC), 1990	Prevents marine oil pollution according to the precautionary principle, proposes the adoption of adequate response measures in the event of an oil spill, and the reporting of all leaking/spill incidents to national competent authorities.	Yes	No
Species, Heritage and Biodiversity Protection			
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention), 1971	Avoids progressive encroachment and loss of wetlands, recognizing their essential ecological functions and their scientific, cultural, economic, and recreational value. In Mauritania, there are four Ramsar sites; in Senegal, there are five Ramsar sites.	Yes	Yes
Convention for the Protection of the World Cultural and Natural Heritage (World Heritage Convention), 1972	Establishes mechanisms for designation of World Heritage protected areas; establishes an effective system of collective protection of the cultural and natural heritage of outstanding universal value, offering both urgent and long-term protection. There are two areas inscribed on the World Heritage List in Mauritania, and there are seven sites inscribed in Senegal.	Yes	Yes

Conventions/Agreements/ Protocols	Objectives	Accessed, Ratified or Signed[1] by	
		Mauritania	**Senegal**
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), 1979	Conserves migratory species such as the blue whale, humpback, bowhead and right whales, porpoises and dolphins of several species whose life cycles cross national borders; provides a framework for cooperation among states for scientific research, habitat rehabilitation and removal of barriers to the migration of the species listed in the Bonn Convention. As a corollary to its acceptance of the Bonn Convention, Mauritania has also signed four separate MoUs as part of this Convention, including: 1) Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia; 2) Conservation Measures for the Eastern Atlantic Populations of the Mediterranean Monk Seal; 3) Conservation Measures for Marine Turtles of the Atlantic Coast of Africa; and 4) Conservation of Migratory Sharks. Senegal has signed five MoUs: 1) Conservation Measures for Marine Turtles of the Atlantic Coast of Africa; 2) Conservation Measures for the Aquatic Warbler; 3) Conservation Measures for the West African Populations of the African Elephant; 4) Conservation of Migratory Birds of Prey in Africa and Eurasia; and 5) Conservation of Migratory Sharks.	Yes	Yes
Convention on Cooperation for the Protection, Management and Development of Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region (Abidjan Convention), 1981	Provides an overarching legal framework for all marine-related programs in West, Central and Southern Africa. Under its articles, the Abidjan Convention lists the sources of pollution that require control (ships, dumping, land-based activities, exploration and exploitation of the seabed, atmospheric pollution) and identifies environmental management issues.	Yes	Yes
Convention on Biological Diversity (Rio Convention), 1992	Preservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits derived from the use of its genetic resources. According to Article 26 of the Rio Convention, each party is obligated to submit periodic national reports (i.e., a National Biodiversity Strategies and Action Plan - NBSAP) to the secretariat.	Yes	Yes

Conventions/Agreements/ Protocols	**Objectives**	**Accessed, Ratified or Signed[1] by**	
		Mauritania	**Senegal**
Convention on the Cooperation of Fishing Companies from African States Bordering the Atlantic Ocean, 1995	Promotes food self-sufficiency through rational use of resources and stimulates national economic sectors related to fishing industry.	Yes	Yes
Cartagena Protocol on Biosafety, 2000	To ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health.	Yes	Yes
Agreement for the Implementation of the UNCLOS Relating to the Conservation and Management of "Overlapping" Fish and Highly Migratory Fish Stocks, 2001	Ensures long-term conservation and sustainable use of fish stocks straddling territories and highly migratory fish stocks by encouraging a more efficient implementation of management measures by individual states.	Yes	Yes
African Convention on the Conservation of Nature and Natural Resources, 1968, and the Maputo Revisions, 2003	Objectives of this Convention are to enhance environmental protection; to foster the conservation and sustainable use of natural resources; and to harmonize and coordinate policies in these fields with a view to achieve ecologically rational, economically sound and socially acceptable development policies and programs.	Yes	Yes
Hazardous Wastes and/or Persistent Substances			
Vienna Convention for the Protection of the Ozone Layer (Vienna Convention), 1985	Framework convention. Objectives of the Vienna Convention were for Parties to promote cooperation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.	Yes	Yes
Montreal Protocol on Substances that Deplete the Ozone Layer, 1987	A global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances.	Yes	Yes

Conventions/Agreements/ Protocols	Objectives	Accessed, Ratified or Signed[1] by	
		Mauritania	Senegal
United Nations Framework Convention on Climate Change (UNFCCC), 1992 and Paris Agreement, 2015	The UNFCCC is the first international treaty with legal obligations and specific targets to limit greenhouse gas (GHG) emissions. By joining the UNFCCC, countries have committed to comply, inter alia, with three main obligations: ▪ GHG reduction especially for developed countries; ▪ Preparation by all countries of a national presentation including the inventory of GHG emissions, a vulnerability study and a mitigation study; and ▪ Ethical commitment to implement GHG emissions mitigation policies as part of a sustainable development perspective. Mauritania submitted its new climate action plan to the UNFCCC in September 2015. Termed the Intended Nationally Determined Contribution (INDC), it was submitted in advance of the universal climate change agreement reached at the United Nations climate conference in Paris in December 2015. Termed the Paris Agreement, it builds upon the UNFCCC by bringing all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries. One of the primary goals of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C.	Yes	Yes
Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movements and Management of Hazardous Wastes within Africa, 1991	Countries should ban the import of hazardous and radioactive wastes as well as all forms of ocean disposal. For intra-African waste trade, parties must minimize the transboundary movement of wastes and only conduct it with consent of the importing and transit states among other controls. They should minimize the production of hazardous wastes and cooperate to ensure that wastes are treated and disposed of in an environmentally sound manner.	Yes	Yes

Conventions/Agreements/ Protocols	**Objectives**	**Accessed, Ratified or Signed[1] by**	
		Mauritania	**Senegal**
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), 1992	Addresses the control and reduction of transboundary movements of hazardous waste; requires the treatment, recovery and disposal of hazardous wastes in an environmentally sound manner and as close as possible to where they are generated; limits the production of wastes to the source by using clean production techniques; minimizes the volume and toxicity of produced wastes; ensures their management by respecting the environment and also by their treatment and disposal as close as possible to their source of generation; and outlines assistance to countries through respect for the environment, in the management of hazardous waste and other generated wastes. Transboundary movements are generally approved, if: ▪ The state of export does not have the capability of managing or disposing of the waste in an environmentally sound manner, and ▪ The receiving state has appropriate, environmentally sound facilities, and agrees to accept the waste.	Yes	Yes
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention), 2004	Regulates international trade of certain hazardous chemicals and pesticides. It was adopted at the initiative of the United Nations Program for the Environment and the United Nations Food and Agriculture Organization (FAO) as an extension of the principles adopted at the Earth Summit in Rio in 1992.	Yes	Yes
Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention), 2004	Protects human health and the environment from persistent organic pollutants with toxic properties, which resist degradation, accumulate in living organisms and are transported in the air, water, and migratory species, across international borders and deposited far from their place of origin, where they accumulate in terrestrial and aquatic ecosystems.	Yes	Yes

Conventions/Agreements/ Protocols	Objectives	Accessed, Ratified or Signed[1] by	
		Mauritania	Senegal
Minamata Convention on Mercury, 2013	The obligations of this Convention aim to control anthropogenic emissions and discharges of mercury into the air, water and soil. The Convention also covers the storage and disposal of mercury, mercury compounds as well as waste containing mercury.	Yes	Yes

Notes:
[1] Accession is the act whereby a state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states. It has the same legal effect as ratification. Accession usually occurs after the treaty has entered into force. While signatory means that a representative may sign a treaty "ad referendum", i.e., under the condition that the signature is confirmed by his/her state. In this case, the signature becomes definitive once it is confirmed by the responsible organism. Where the signature is subject to ratification, acceptance or approval, the signature does not establish the consent to be bound.

3.7 Good International Industry Practices

Several good international industry practices (GIIP) guidelines are available for the development of sustainable projects in general and also specifically for the oil and gas industry. Some of the most relevant GIIP guidelines that are used as references for the proposed project are presented below.

3.7.1 IFC Environmental and Social Performance Standards

The International Finance Corporation (IFC) has developed general and specific performance standards and policies as well as guidelines on environmental and social sustainability in order to minimize the adverse environmental and social impacts of development projects it supports, and to optimize the benefits of these projects.

Even though the proponents are not currently looking for IFC funding for the proposed project, the IFC Performance Standards will be considered as good practice guidance for the project design and ESIA development.

There are eight standards of performance defining the standards to be followed during the entire duration of the life of a project funded by the IFC (IFC, 2012):

- Performance Standard 1 (PS1): Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2 (PS2): Labor and Working Conditions;
- Performance Standard 3 (PS3): Resource Efficiency and Pollution Prevention;
- Performance Standard 4 (PS4): Community Health, Safety and Security;
- Performance Standard 5 (PS5): Land Acquisition and Involuntary Resettlement;
- Performance Standard 6 (PS6): Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Performance Standard 7 (PS7): Indigenous Peoples; and
- Performance Standard 8 (PS8): Cultural Heritage.

PS1 establishes the importance of the following elements:

- An integrated analysis to identify the environmental and social impacts, risks and opportunities inherent in a project;
- An effective community engagement thanks to the disclosure of information relating to the project and the consultation with local communities on the issues that affect them directly; and
- A management of the environmental and social performance by the promoter of the project throughout its duration.

PS2 to PS8 set the objectives as well as the requirements to avoid, minimize, and in areas where residual impacts remain, to compensate (put in place "offsets") for the risks and impacts on the workers, on the affected communities and on the environment.

PS1 applies to all projects that have environmental and social risks and impacts. Depending on project circumstances, other Performance Standards may apply as well. For the present project, in addition to PS1, PS2 through PS4, PS6 and PS8 are relevant. PS5 is not relevant as no land acquisition or involuntary resettlement are planned in the project[22]. PS7, relating to indigenous people, will not be relevant either because there are no Aboriginal peoples to meet the definition of the IFC in Mauritania and Senegal[23].

3.7.2 IFC Environmental, Health, and Safety Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents published by the IFC and containing performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

The General EHS Guidelines are designed to be used with the relevant industry sector EHS Specific Guidelines. The EHS General Guidelines (IFC, 2007a) are organized in the following manner:

- Environmental (air emissions and ambient air quality, energy conservation, wastewater and ambient water quality; water conservation, hazardous materials management, waste management, noise, contaminated land);
- Occupational Health and Safety (general facility design and operation, communication and training, physical hazards, chemical hazards, biological hazards, radiological hazards, personal protective equipment, special hazard environments, monitoring);
- Community Health and Safety (water quality and availability, structural safety of project infrastructure, life and fire safety, traffic safety, transport of hazardous materials, disease prevention, emergency preparedness and response); and
- Construction and Decommissioning (environment, occupational health and safety, community health and safety).

In this case, the relevant specific EHS Guidelines as GIIP for the project could include:

- EHS Guidelines for Ports, Harbors, and Terminals (IFC 2017a);
- EHS Guidelines for LNG facilities (IFC, 2017b);

[22] PS5 does not apply to impacts on livelihoods where the project is not changing the land use of the affected groups or communities. In the current ESIA, potential impacts on coastal fishing communities will be covered by PS1.

[23] According to IFC's definition, "Indigenous Peoples" refer to a distinct social and cultural group possessing the following characteristics in varying degrees: 1) self-identification as members of a distinct indigenous cultural group and recognition of this identify by others; 2) collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories; 3) customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; 4) a distinct language or dialect, often different from the official language or languages of the country or region in which they reside. No indigenous people meeting IFC's definition are present in the ESIA study area.

- EHS Guidelines for Offshore Oil and Gas Development (IFC, 2015); and
- EHS Guidelines for Shipping (IFC 2007b).

3.7.3 Oil and Gas Industry Specific Good International Industry Practices

The Oil and Gas industry specific GIIP most widely used include the international industry practices and standards of the International Association of Oil and Gas Producers (IOGP), the International Petroleum Industry Environmental Conservation Association (IPIECA) and the American Petroleum Institute (API).

These and other GIIP may be applied, either in part or in their entirety, to various parts of the proposed project. Numerous other industry standards are reflected in BP's internal documents, guidelines and procedures.

International Association of Oil and Gas Producers

The IOGP is the voice of the global upstream oil and gas industry. Its members produce more than a third of the world's oil and gas. They operate in all producing regions: the Americas, Africa, Europe, the Middle East, the Caspian, Asia and Australia. It is an internationally recognized source of industry information. Many of the IOGP guidelines have been recognized and used by international authorities and safety and environmental bodies.

Several relevant IOGP guidelines include:

- Report No. 412: Managing Naturally Occurring Radioactive Material (NORM) in the Oil and Gas Industry (IOGP, 2016a);
- Report No. 413: Guidelines for Waste Management with Special Focus on Areas with Limited Infrastructure (IOGP, 2008);
- Report No. 457: Offshore Environmental Monitoring for the Oil and Gas Industry (IOGP, 2012);
- Report No. 459: OGP Life-Saving Rules (IOGP, 2013);
- Report No. 529: Overview of IOGP's Environmental-Social-Health Risk and Impact Management Process (IOGP, 2014);
- Report No. 543: Environmental Fate and Effects of Ocean Discharge of Drill Cuttings and Associated Drilling Fluids from Offshore Oil and Gas Operation (IOGP, 2016b);
- Report No. 554: Biodiversity and Ecosystem Services Fundamentals Guidance - Guidance Document for the Oil and Gas Industry (IPIECA/IOGP, 2016); and
- Report No. 557: Drilling Waste Management Technology Review (IOGP, 2016c).

International Petroleum Industry Environmental Conservation Association

The IPIECA is the global oil and gas industry association for environmental and social issues. Its global membership covers both the upstream and downstream oil and gas industry. It develops, shares and promotes good practice and knowledge to help the industry and improve its environmental and social performance.

The IPIECA-IOGP Oil Spill Response Joint Industry Project (OSR-JIP) was established to implement learning opportunities with respect to oil spill preparedness and response following the April 2010 well control incident in the Gulf of Mexico (i.e., Macondo spill). As part of this effort, the OSR-JIP has produced more than 20 good practice guides.

American Petroleum Institute

The API is a recognized reference in establishing and maintaining standards for the worldwide oil and natural gas industry.

Several relevant API guidelines include:

- Recommended Practice 75 for Development of a Safety and Environmental Management Program for Offshore Operations and Facilities (API, 2004);
- Recommended Practice 96, Deepwater Well Design and Construction (API, 2013); and
- Standard 53, Blowout Prevention Equipment Systems for Drilling Wells (API, 2012).

3.8 Operator's Health, Safety, Security and Environment, and Corporate Social Responsibility Policies

BP corporate policies related to health, safety, security and environment (HSSE), and to social responsibility are summarized below.

3.8.1 BP's Health, Safety, Security, and Environment Policy

BP's HSSE goals are no accidents, no harm to people and no damage to the environment. BP's HSSE & Operating Policy for the Mauritania and Senegal Region is included in Appendix C.

To help deliver these goals, BP has developed a systematic approach to safe, reliable and responsible operations: the Operating Management System (OMS). The OMS provides a framework for managing BP operations and is currently being implemented on projects globally including the GTA Phase 1 project. OMS covers all operational areas including process safety, personal health, environmental and social performance and management.

BP internal requirements and recommendations in the OMS cover projects' life cycle from design to construction and transition into operations to closure.

The purpose of BP's internal requirements in relation to environmental and social impact assessment is to help projects to:

- Identify and manage potential environmental and social impacts; and
- Deliver environmental and social commitments.

In developing its requirements BP has:

- Reviewed and clarified its external commitments relating to the management of environmental and social issues;
- Reviewed and considered environmental and social standards and practices generally accepted in the international oil and gas industry;
- Reviewed and drawn upon its experience of delivering projects and operating globally; and
- Reviewed and benchmarked the practice against the Equator Principles and the environmental and social requirements of the IFC and the European Bank for Reconstruction and Development (EBRD).

The resulting Group Practice, includes key elements of the standards, requirements and GIIP that are appropriate to BP's business. It sets out a rigorous, consistent methodology for early identification of potential environmental and social impacts, referred to as "Screening". The identification of issues and understanding of the consequent risks during screening are then used to inform option selection in projects, as well as feeding into and shaping future ESIAs. It also sets out environmental and social requirements in nine key areas that are derived predominantly from external commitments as follows:

- Drilling, completions and workover wastes and discharges;
- Greenhouse gas and energy management;
- Impact assessment;
- Indigenous people;
- International protected areas;
- Moving communities;
- Ozone depleting substances;
- Security and human rights; and
- Water management.

Environmental Impact Identification (ENVIID) workshops are carried out at key stages of projects. Various representatives from the project engineering and construction teams discuss and analyze the project activities and the risks associated with each activity. This facilitates early discussions between project engineers and the environmental assessment team about the potential impacts, and any appropriate mitigating actions that could be taken by the design team to minimize or eliminate these potential impacts/risks. The ENVIID outputs are refreshed and updated through key stages of the projects.

BP operating sites are expected to have an Environmental Management System that is certified against the ISO14001 standard for Environmental Management Systems within a reasonable time period from the commencement of Operations.

3.8.2 BP’s Corporate Social Responsibility Policy

BP’s Code of Conduct states that BP works together with governments and communities to contribute to sustainable growth, create jobs and invest in people.

BP intends to support local development through its core business activities (local workforce development and local suppliers) and its community investments.

BP also contributes to the growth of local business in the region where it operates. In addition, helping build the skills of local companies for its projects also helps these companies improve their competitiveness when bidding for work with international firms.

BP also seeks to make meaningful community investments that meet local needs and align with its business activities. One of these investments publicly announced on 31 August 2018 relates to BP’s multi-million dollar financial commitment for the development of the Senegalese National Institute of Oil and Gas (INPG) to help building national capacity in the sector.

3.9 Standards Applicable to the Project

As described in this chapter, the main environmental requirements for the proposed project can be summarized as follows:

1) Compliance with applicable Mauritanian and Senegalese laws and regulations at all times, notably (but not exclusively):
    - The Exploration and Production Contracts of each country – requirements regarding industrial safety, protection of the environment and operational techniques;

- The Environment Code of Mauritania and the Environmental Act of Senegal along with their decrees and orders – requirements regarding the preparation of the ESIA as well as air and water quality standards;
- The Crude Hydrocarbons Code in Mauritania and the Oil Act in Senegal – rights and obligations associated with oil and gas exploration and exploitation activities;
- The Prevention and Fight Against Pollution Act of Mauritania, and orders and decrees associated with the Environmental Act in Senegal – requirements pertaining to routine discharges (oily water, sewage) and waste management as well as requirements listed in Title VIII, specifically addressing prevention and repression of marine pollution of drill rigs in Mauritania and/or to air emissions and wastewater discharges in Senegal; and
- The Merchant Marine Code in Mauritania and the Merchant Navy Act in Senegal – requirements related to maritime navigation.

2) Compliance with international conventions, agreements and/or protocols of which Mauritania and Senegal have signed and/or ratified, notably (but not exclusively):

   - The MARPOL Convention – for requirements pertaining to routine discharges (oily water, sewage), waste management and air emissions;
   - The UNCLOS – for basic principles and rules concerning all sources of marine pollution;
   - The Abidjan Convention – for sources of pollution requiring control and environmental management;
   - The OPRC – for the implementation of adequate response measures in the event of a hydrocarbon spill;
   - The Bonn Convention – for the conservation of migratory species;
   - The Basel Convention – for requirements concerning transboundary movements of hazardous wastes; and
   - The Ballast Water Management Convention – for the ship management of their ballast water sediments.

3) Application of BP's HSSE Policies relating to their employees, contractors, and the communities as well as to the environment.

4) Use of GIIP as references for project design and ESIA development.

CHAPTER 4: DESCRIPTION OF THE HOST ENVIRONMENT

4.0 DESCRIPTION OF THE HOST ENVIRONMENT

This chapter presents a description of the environment before the project's realization. The methodology, regional setting and ESIA study areas are presented first; the physical and chemical environment, and the biological environment descriptions follow. Separate descriptions by country were not prepared for these environments as they are very often similar in both Mauritania and Senegal, but relevant differences are mentioned when appropriate. As for the social environment, separate subsections have been prepared for each country.

4.1 Methodology

The following characterization of the biophysical and social environment of the marine and coastal resources present within the GTA project area has been developed from a variety of sources, including a review of available peer-reviewed literature, conference proceedings, data synthesis efforts, and gray literature (e.g., government reports; non-governmental organization research summaries, etc.). Of particular interest is the recent compendium prepared by Ramos et al. (2017a) which focuses on the deep water environment off Mauritania, but also characterizes regional physical, chemical, and biological attributes of west Africa region. Consultation with, and guidance provided by, in-country experts has also resulted in the identification, summarization, and citation of unpublished data sources from various national institutions.

Both Mauritania and Senegal experts have authored separate, stand-alone reports on select resources, as well providing critical review of synthesized material contained within the following baseline characterization. Expert reports have been referenced throughout Chapter 4 and can be found in the following appendices:

- Fishery Resources, Fisheries and Fishing Communities Reports:
  - Appendix E-1, Fisheries and Fisheries Resources in the Mauritanian Portion of the Core Study Area of the Project;
  - Appendix E-2, Fishery Resources and Fisheries in the Senegalese Portion of the Core Study Area of the Project;
  - Appendix E-3, Fishing Communities in Mauritanian Portion of Core Study Area of the Project; and
  - Appendix E-4, Fishing Communities in Senegalese Portion of Core Study Area of the Project.
- Protected Areas:
  - Appendix F-1, Note on Protected Areas in the Mauritanian Portion of the Extended Study Area of the Project; and
  - Appendix F-2, Note on Protected Areas in the Senegalese Portion of the Extended Study Area of the Project.

Site-specific physical, chemical, and biological surveys have also been conducted in the vicinity of the proposed project, with survey results summarized in the following sections and full reporting provided as appendix material (see Appendix D: Environmental Baseline Survey Report).

Social field data collection was conducted by national experts. The objective of this field work was the characterization of potentially impacted communities, for instance, number and characteristics of inhabitants, social organization, economic conditions, employment and livelihood, sea and coastal based activities, existing public infrastructure and services, public health and safety, gender situation, vulnerable groups, etc.

The following baseline characterization summarizes each biophysical and social resource that may be affected by the proposed project. In some cases, resource topics may affect presence, distribution, or abundance of other resources, or may be required to understand the complex interaction of physical, chemical, biological, and social components of the environment. Each of the following sections outline key resource characteristics and sensitivities, including current status and important spatial and temporal trends, based on available information. In the absence of site-specific data, regional characterizations are provided concurrently with interpolations of regional information to the project area.

4.2 Regional Setting

4.2.1 Overview

The proposed project is situated offshore Mauritania and Senegal, with the gas field located in rock formations under the seabed, about 125 km from the coast on each side of the maritime border.

This offshore area is located within the economic exclusive zones (EEZs) of Mauritania and Senegal and within the broader Canary Current Large Marine Ecosystem (CCLME).

4.2.2 Mauritania

Mauritania lies on the coast of West Africa. Bordered by the Atlantic Ocean to the west, the country is bounded by Mali to the south and east, by Senegal to the south, and by Algeria, Morocco and Western Sahara to the north. The country covers an area of 1,030,700 km². Administratively, Mauritania's territory is divided into 15 *wilayas* (regions).

The coast of Mauritania stretches between 16°04' N and 20°36' N in two distinct sections. To the north, between Cape Blanc and Cape Timiris, the coastline is comprised of irregular, rocky headlands and several large bays (e.g., Lévrier; Arguin). In this section, the continental shelf is wide and it reaches its maximum width in front of the Banc d'Arguin. The southern section of the Mauritanian coast is smooth and nearly unbroken, extending south from Cape Timiris to the Senegal River. No rocky headlands or deep embayments are found along this portion of the west African coast (Vermeer, 2010).

According to the latest general census (ONS, 2015), the total population of Mauritania is estimated at 3,537,368 people. The average density is 3.4 inhabitants per km^2, which represents one of the lowest densities in the world. The average annual population growth was 2.8% between 2000 and 2013. The population comprises 1,743,074 men (49.3%) and 1,794,294 women (50.7%), that is to say, 97 men for 100 women. The population is young, with 30.0% of the total population being under 10 years old, 44.2% being under 15 years old, 50.2% being between 15 and 59 years old, and only 5.6% being 60 years old and more. A significant part of the population is concentrated in Nouakchott, the capital, which has a population estimated at 958,399 inhabitants. Mauritania is a country that has experienced rapid changes since its independence in 1960. For instance, the percentage of nomads among the total population in Mauritania declined from 75% in 1962 (Shine et al., 2001) to 1.9% in 2013 (ONS, 2015). This significant drop is partly explained by the speed of the settling process and internal migration to urban areas. The rural population, which is 49.8% of the total population, is mainly composed of semi-nomadic pastoralists and sedentary agro-pastoralists (ONS, 2015).

In 2015, Mauritania's gross domestic product (GDP) was 4.5 US billion dollars (BAD, 2016) with an annual growth of 3.1% (AEO, 2016). The economy of the country is mostly based on the primary sector, especially on natural resources exploitation by the extractive industries and the fisheries. For instance, iron ore represents 40% of Mauritania's export and the country is one of the largest exporters of iron ore in Africa and the 13th iron ore producer in the world (Ateliers, 2014). Oil and gas activities are a growing economic sector since the first oil discovery in 2001. Mauritania's coastal waters are amongst the richest fishing areas in the world, and fish products are among the main export products. Recently, the fisheries sector benefited from the finalization in July 2015 of a long negotiated bilateral agreement with the European Union (EU). Fishing is practiced by industrial, coastal and artisanal fleets (Banque Mondiale, 2016). Trade, livestock-rearing, and agriculture (the latter being conducted essentially along the Senegal River) complete the economic base.

The economy of Mauritania is liberalized and has been growing since 2010 (MAED, 2014). Mauritania has benefited from a significantly accelerated poverty reduction in the past few years. In particular, during 2008-2014, Mauritania's poverty rate dropped from 44.5% to 33.0%. In the same period, extreme poverty halved, with the rate declining from 10.8% to 5.6%. Cross-country benchmarking confirms that Mauritania's performance in poverty reduction was above average in Africa. (World Bank, 2017a).

However, despite this performance, poverty levels remain high, as well as unemployment and a large part of the population faces difficulties in accessing basics services and goods such as drinkable water. The country is ranked 131 out of 180 in the 2017 Index of Economic Freedom (The Heritage Foundation, 2017) and is ranked 157 out of 188 in the 2016 Human Development Index (HDI) of the United Nations Development Program (UNDP).

4.2.3 Senegal

Senegal occupies the westernmost tip of the African continent. The country extends 600 km from north to south with a maximum width of 400 km and covers an area of 196,192 km^2. It is bordered to the west by the Atlantic Ocean (with a 531-km coastline), to the north by Mauritania, to the east by Mali, and to the south by Guinea and Guinea-Bissau.

The Gambia, consisting of a long strip of land that extends 350 km along the Gambia River, is an enclave in Senegal's territory. Administratively, Senegal is divided in 14 regions. As for the Senegalese maritime domain, it extends from 18°00 N, 20°00 W, to 16°30 E, 12°15 S.

Senegal has four natural geographic areas (Direction de la Coopération Décentralisée au Sénégal, 2015): 1) the Sahel area, located in the northern portion of the country and south of the Sahara desert, which is a very dry area where vegetation is poor, except around the Senegal River valley; 2) the Sudanese area, located south of the Sahel area, which comprises Eastern Senegal and Upper Casamance. It is mostly composed of forest and savannah areas; 3) the Subtropical area, situated in Casamance, that is a fertile region, characterized by a developed river system; and 4) the Coastal area (from Saint-Louis to The Gambia), which is a sandy and straight-lined coastal strip from the northern border of Senegal to the south of the Cap-Vert peninsula. North of the peninsula, the coast is called Grande Côte (Big Coast) and the southern coast is called Petite Côte (Small Coast). It is estimated that 60% of Senegal's population lives in the coastal area, in a 60-km wide land strip parallel to the coast.

In the latest national census, Senegal had 13 207 873 inhabitants[24] (49.9% men and 50.1% women). The average density is 68 inhabitants per km^2. In total, 55.0% of the Senegalese population is rural. The population is growing rapidly, with a growth rate of 2.7% observed between 2002 and 2012, and 50.0% of the population is aged less than 20 years old. The average age of the population is 22.4 and the life expectancy at birth is 59.6 years old.

With a GDP of 14.7 US billion dollars in 2016, Senegal is the fastest growing economy in West Africa, behind Côte d'Ivoire (World Bank, 2017b). However, poverty remains high in Senegal and affects 46.7% of the population, with acute geographic disparities between poor rural areas versus the capital. The unemployment rate in Senegal is estimated at 25.7% (ANSD/RGPHAE, 2014).

The primary sector (15% of GDP) is characterized by the high vulnerability of agriculture (due mostly to climate hazards, volatility of global prices, and locust pest threats). The activities of the secondary sector (21% of GDP) are mostly phosphate and gold mining[25], processing of peanuts and sea products, cement production, and construction. The tertiary sector (64% of GDP), mostly related to trade and tourism, benefits from telecommunications infrastructures, but remains heavily dominated by the informal sector. In fact, the Senegalese government estimates that the informal sector represents at least 10.7% of the GDP (Senegal Ministry of Trade, 2015). Fishing and associated activities (e.g., fish processing, marketing, services, other part-time activities) constitute a major economic sector that is estimated to provide more than 600,000 jobs in Senegal, accounting for 15% of the national labor force (CSRP-Sénégal, 2017).

Still, there are high levels of poverty in the country and therefore, employment issues, cost of living, quality of public services, supply, and cost of electricity and water remain the primary concerns of the Senegalese people. The country is ranked 120 out of 180 in the 2017 Index of Economic Freedom (The Heritage Foundation, 2017) and is ranked 162 out of 188 in the 2016 HDI of the UNDP.

24 For 2017, the projections indicate a population of 15 256 346 (ANSD, 2017).

25 While mining activities are usually considered part of the primary sector, the available data have included the mining sector in the secondary sector.

4.2.4 Canary Current Large Marine Ecosystem

The CCLME is defined as the ocean space (including afferent estuaries) extending southward from the Moroccan Atlantic coast to the Bijagos Archipelago of Guinea Bissau, and westward to the Canary Islands (autonomous community of Spain) and the western extent of the northwestern African continental shelf (corresponding approximately with the respective EEZ of the coastal states). The countries within the recognized limits of the CCLME are Guinea Bissau, Mauritania, Morocco, Senegal, Republic of Cabo Verde (the Cape Verde Islands), Spain (Canary Islands), and The Gambia. The CCLME lies within the Food and Agriculture Organization of the United Nations (FAO) Fisheries Area 34 (Sherman and Hempel, 2009; Heileman and Tanstad, 2009).

The CCLME is one of the world's major cold water upwelling boundary current large marine ecosystems (LME), ranking third in the world in terms of primary productivity and having the highest fisheries production of any African LME (i.e., annual production ranges from 2 to 3 million tons). The CCLME is classified as a Class I, highly productive ecosystem; primary production is >300 g C m^{-2} y^{-1}. Pelagic species found in this highly productive region include migratory fishes (e.g., tunas) in offshore waters and small pelagics (e.g., chinchards; sardinellas; sardines; mackerels) which primarily have a coastal distribution. These resources are the subject of exploitation by industrial and artisanal/coastal fisheries in both Mauritania and Senegal. As previously mentioned, fisheries are an important sector of the Mauritania and Senegal's economies.

4.2.5 Climate Change

As coastal and ocean systems play a large role in the economics and livelihoods of many African countries, projections for changes to physical climate parameters could increase the challenges from existing stressors, such as overexploitations of resources, habitat degradation, loss of biodiversity, salinization, pollution, and coastal erosion (Niang et al., 2014). According to the IPCC, observed impacts include changes in terrestrial, freshwater, and marine species geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC, 2014). Coastal systems would likely be affected by any rise in sea level that occurs concomitant with increased wave exposure (Hoegh-Guldberg et al., 2014). Predictions in sea level rise (SLR) are as much as 0.6 m by 2100 (Nicholls et al., 2007). By utilizing a linear extrapolation of Nicholls et al. (2007), an approximate SLR of 0.3 m could be realized by the estimated end of the operational life of the proposed project. Other potential impacts to coastal systems may arise from storm swells, flooding of river deltas, and potential social and economic conflicts exacerbated by people forced to abandon their land or communities toward coastal towns.

The Canary Current, which flows along the North West African coast including offshore Mauritania and Senegal has warmed since the early 1980's and is projected to increase in temperature (Niang et al., 2014). This warming along with ocean acidification could potentially influence a number of biological processes. This recent ocean warming has also resulted in Mauritanian waters becoming more suitable as feeding and spawning areas for some fisheries species (e.g., *Sardinella aurita*) (Zeeburg et al., 2008). However, a study that examined the potential vulnerabilities of national economies to the effects of projections for climate change on fisheries, in terms of exposure to warming, relative importance of fisheries to national economies and diets, and limited societal capacity to adapt, concluded that a number of African countries - Angola, Democratic Republic of Congo, Mauritania and Senegal - are most vulnerable (Allison et al., 2009).

Projections for future climate change may have substantial impacts on Northwest African ecosystems. The potential impacts include shifting habitat ranges for some species and ecosystems; negative and potentially cascading effects on economic sectors, such as fisheries, from negative impacts to estuarine nursery grounds; amplifying stresses on water availability, which in turn adversely affects a number of economic sectors (e.g., agriculture and fisheries); and increased health vulnerabilities (e.g., malnutrition, disease transmission).

The Senegalese coastal zone is considered to be extremely sensitive to any future sea level rise with potential impacts ranging from saltwater intrusion into freshwater aquifers, land use changes leading to changes on hydrological process and water resources, and erosion (Karambiri et al., 2010, Niang et al., 2010). Projections for sea level rise would result in land losses along the Senegalese coastline which will enhance coastal erosion. In addition, high density areas of Senegal are considered to be particularly sensitive to coastal erosion processes which may compound the projected socioeconomics impacts (i.e. southern coastline of Dakar [Niang et al. 2010]). As stated earlier in Allison et al. (2009), Senegal in particular has been ranked fifth among 132 countries whose national economies are most vulnerable to the potential impacts of projections for climate change. This is mainly associated with the fact that fisheries in Senegal plays an important role in Senegal's economy and food stock. Whereas, Senegal has the highest level of fish consumption in West Africa (FAO, 2016a) where fish protein contributes 80% of the total animal derived protein in Senegalese coastal populations (Failler and Lecrivain, 2003.). Senegal's main fisheries are based on small pelagic species such as sardinella (*Sardinella aurita* and *Sardinella maderensis*) which account for 64 % of the total catch in Senegal; these small pelagic species are inherently susceptible to changes in their pelagic environment and vulnerable to climate changes effects (Cury and Roy, 1989).

Similar projections may also apply to the southern Mauritanian coastal environment, which features the same physical geography as northern Senegal.

Key potential climate-related regional risks identified for NW Africa include:

- **Biome distribution**. With any increase in temperature, modeling studies focusing on vegetation responses indicate that the biome distribution would be modified (Niang et al., 2014).
- **Reduction in fisheries landings**. Any changes in annual atmospheric wind patterns would be expected to drive changes in upwelling events and distribution and abundance in fish populations in the Mauritania-Senegalese zone.
- **Reduced crop productivity**. Projections for increased temperatures and changes in precipitation, may reduce crop productivity, which would be expected to result in adverse effects on household livelihood and food security (Niang et al., 2014).
- **Adverse effects on livestock**. The multiple stressors to livestock systems in Africa that interact with any changes to climate parameters may amplify the vulnerability of livestock-keeping communities. These stressors include rangeland degradation, access to water, and fragmentation of grazing areas (Niang et al., 2014)
- **Vector- and water-borne diseases**. With any increase in temperatures, risks from vector- and water-borne diseases potentially increase due to the extension of the infection areas and season; however, some infection areas may be reduced if temperatures become too hot for disease vectors (IPCC, 2014).
- **Undernutrition**. Risks of undernutrition may increase in poor regions linked to the potential changes to fisheries, crop productivity and livestock discussed above.
- **Migration**. Any increase in the frequency or severity of extreme weather events (e.g., floods and droughts) that results in displacement and involuntary migration may be more likely to make that migration permanent (IPCC, 2014).

4.3 ESIA Study Areas

The area where proposed project operations are expected to occur are coincident with several environmental or social resources which may be affected. Because this analysis considers impacts and mitigation measures associated with both routine, project-related activities, and potential accidents, the ESIA study area boundaries have been determined separately for each.

4.3.1 ESIA Core Study Area

The core study area includes those areas where impacts of routine project-related operations could potentially occur. The core study area includes: 1) the area immediately around the proposed infrastructure and operations in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area; 2) the transit corridors to shore used by support vessels and helicopters; 3) the ports, docking and storage facilities occupied or located near the supply bases in Dakar and Nouakchott; 4) the facilities of the Dakar and Nouakchott airports used to support helicopter operations; 5) the maritime corridor between the proposed infrastructure and the port of Nouadhibou from where rocks might be shipped during the construction phase; and, 6) the coastal communities between Dakar and Nouakchott, particularly those of N'Diago and Saint-Louis, neighboring the proposed nearshore infrastructure. The core study area is outlined on Figure 4-1.

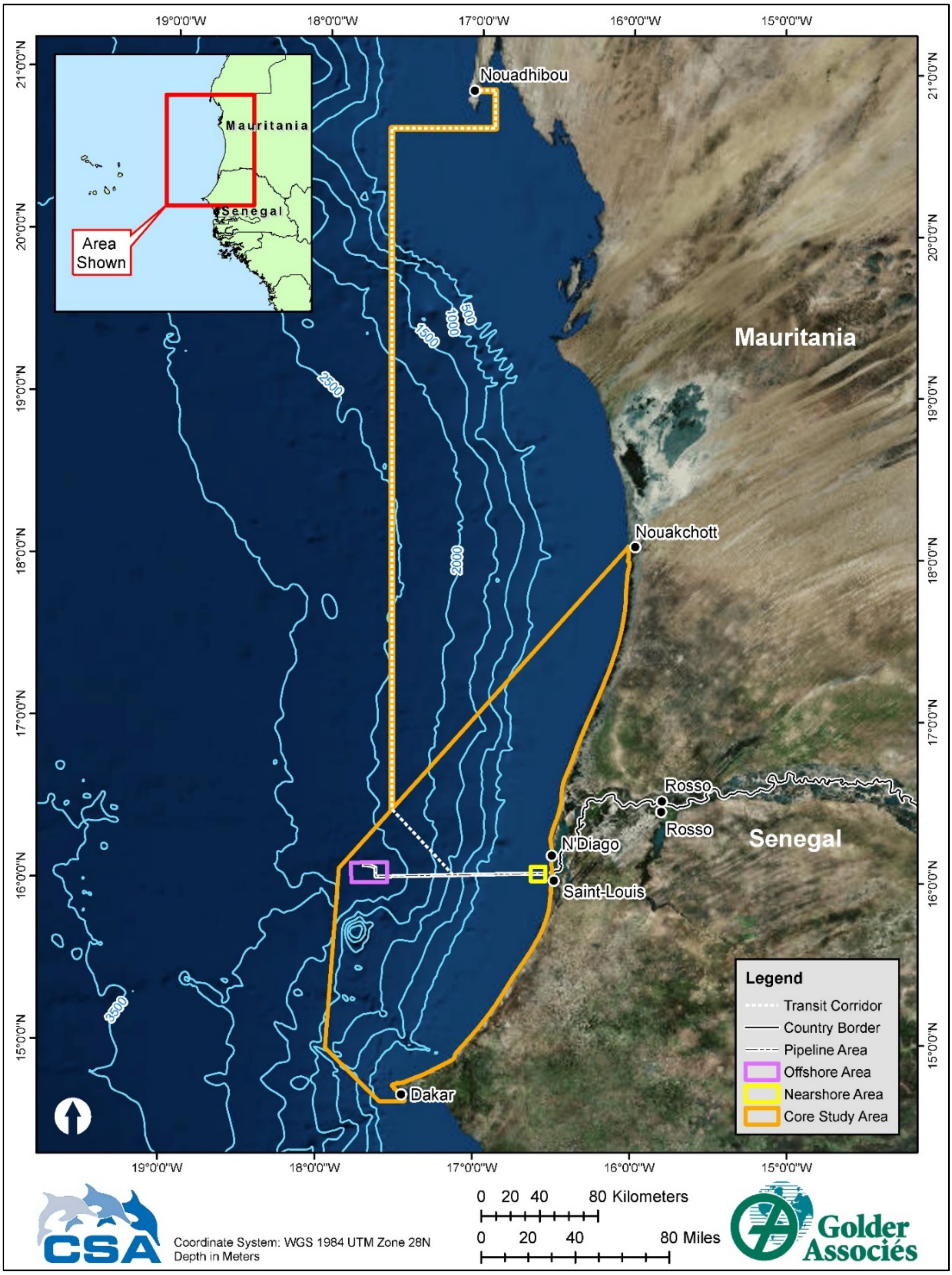


Figure 4-1. Boundaries of the Core Study Area.

4.3.2 ESIA Extended Study Area

The extended study area encompasses a broader area, in recognition that air emissions from nearshore routine operations could be carried onshore by winds and, in recognition that accidentally released hydrocarbons could be transported via ambient currents and winds. The extended study area also encompasses nearby protected areas in recognition of their importance for national stakeholders, even though these areas are unlikely to be affected by the project. For the purpose of this analysis, the extended study area includes: 1) a broader area around the proposed infrastructure and operations in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area; 2) a broader area towards the west in offshore waters; 3) a larger area along the maritime corridor linking the proposed infrastructure and Nouadhibou; and 4) the Senegal River delta and the protected areas partly or totally inside the delta, namely the Diawling National Park (and its peripheral area), the Djoudj National Bird Sanctuary, the Langue-de-Barbarie National Park, the Chatt Tboul Reserve, the Guembeul Natural Reserve, and a part of the Senegal River Delta Transboundary Biosphere Reserve. The extended study area is outlined in Figure 4-2.

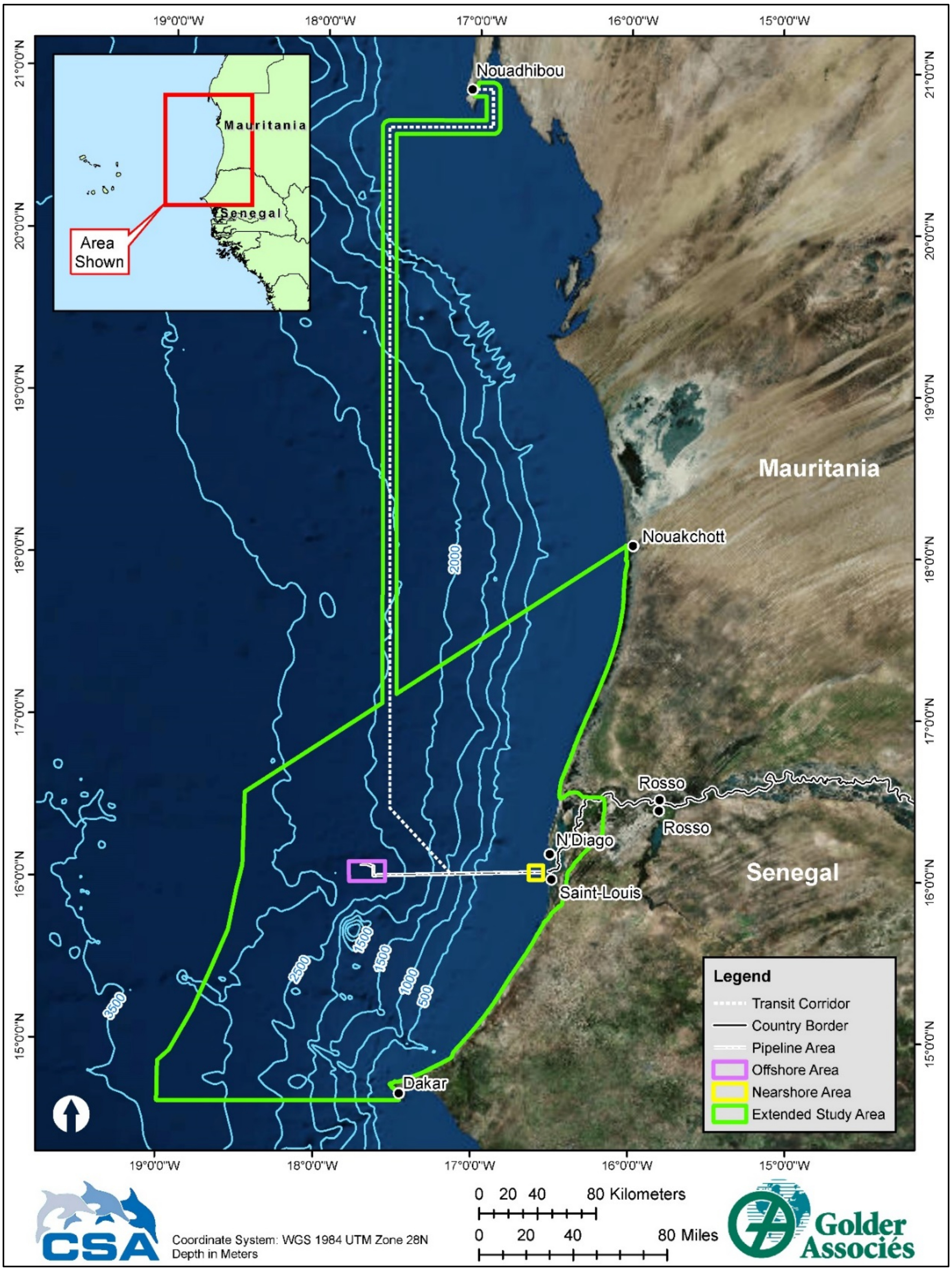


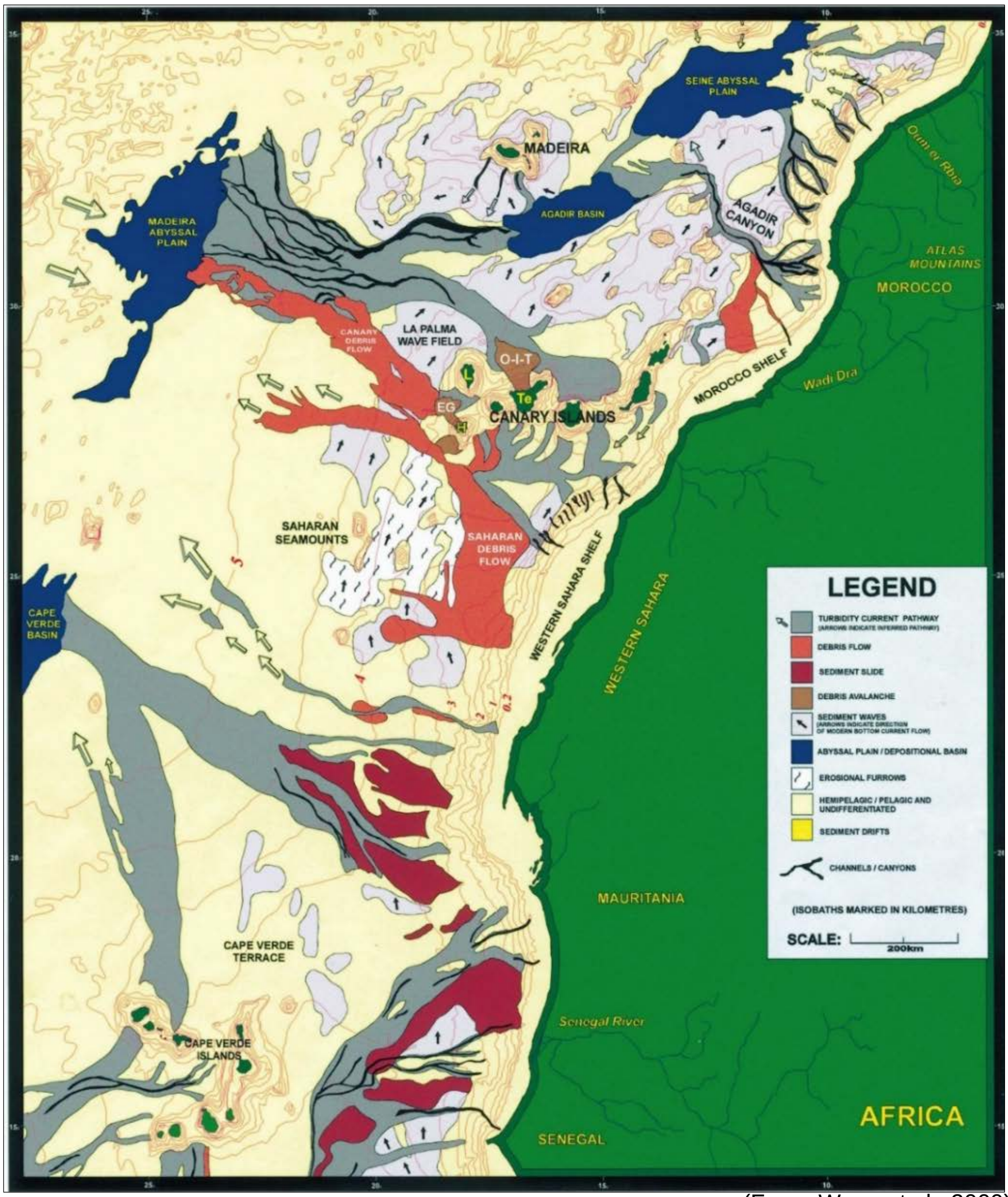
Figure 4-2. Boundaries of the Extended Study Area.

4.4 Physical and Chemical Environment

Key sensitivities in the physical and chemical environment include air quality, sediment quality, water quality, local hydrography, and offshore features, given the potential effects of the project resulting from emissions and discharges. Local hydrography, and potential changes arising from facility presence, is of elevated importance because of coastal erosions present along the west Africa coast.

4.4.1 Continental Shelf and Slope

The project area lies within the larger northwest African margin, which is bordered by a continental shelf that is generally 40 to 60 km wide, with exceptions at the Banc d'Arguin area where the shelf is more extensive. The shelf break occurs at a water depth of approximately 100 to 200 m. Beyond the shelf break, the continental slope has a width of 50 to 250 km and displays slope angles of 1° to 6° (Wynn et al., 2000). Major processes influencing local sediments include sediment flow and turbidity currents (Figure 4-3).



(From: Wynn et al., 2000)

Figure 4-3. Sediment Process Map of the Northwest African Margin.

4.4.1.1 Bathymetry

The continental shelf is located between the coast and approximately 15 to 50 km offshore, inclusive of the Pipeline Area corridor and the Nearshore Area. From the coast towards offshore, water depths gradually increase until about the 100 m contour, after which they sharply increase. Water depths within the Offshore Area range from 2,750 to more than 3,000 m. Detailed bathymetry for the project area is provided in Appendix G.

4.4.1.2 Substrates

The northwest African margin is dominated by fine grained sediments, with sands occurring inshore of the shelf break, in distributary channels on the slope and rise, and on basin floors (Meyer et al., 2011). Along the Mauritanian portion of the margin, there is a dearth of fluvial input given the absence of major river discharges in the area. Along the Senegalese portion of the margin, fluvial input is dominated by terrigenous sediments from the Senegal River. Sediment from this source is transported to the head of a major turbidity current pathway. In addition to localized terrigenous sediment input, hemipelagic particle flux from coastal upwelling and Aeolian dust supply (predominantly Saharan in origin) are currently major sources of sediment along the northwest African continental margin (Henrich et al., 2010).

The dominant bottom sediment types in the core study area include predominantly silty-sandy sediments in the nearshore, grading to clays and fine-grained calcareous sediments in deeper water. The sediment is not uniform and local variations in sediment gradation exist owing to differences in hydrodynamic conditions. Dutkiewicz et al. (2015) describe clay as unconsolidated sediment dominated by a fine fraction and characterized by low carbonate and low biogenic content. Sediments in the Offshore Area are clayey-silt dominated by fine fractions, based on visual observations in deepwater and sediment analyses conducted on samples recently collected in this portion of core study area.

Deep cold water coral formations offshore Mauritania have been documented along the edge of the continental slope extending over 400 km in water depths >400 m (Ramos et al., 2017b). Relict carbonate reefs have also been documented in the 400 to 550 m depth ranges along the Pipeline Area corridor, within northern Senegal waters. These deep coral formations are also described by Domain (1985) along the continental slope to the north of the Cape Timiris; a compact and nearly continuous coralian rocky outcrop, part of this extensive relict carbonate, was recently discovered that extended south along the coast starting at Cape Timiris until approaching the maritime border with Senegal. These large deepwater coral formations have been generally described by Colman et al. (2005), Westphal et al. (2007, 2013), and Mauritanian Institute for Oceanographic Research and Fisheries (Institut Mauritanien de Recherches Océanographiques et de Pêches, 2013).

4.4.1.3 Offshore Features

Important offshore features may include canyons, hard bottom areas and escarpments, and deep water coral reef formations. These formations may include a coral assemblage, occupied by deep water corals; local species may include *Lophelia pertusa*; *Madrepora oculata*; *Desmophyllum cristagalli*; *Dendrophyllia cornigera*; and *Solensmilia variabilis*.

Mauritania

To the south of Banc d’Arguin, several deep canyons are present at 18°40' N, 18°05' N and 16°50' N (Domain, 1985). No large canyon features are evident within the Offshore Area, although smaller canyons, channels, and infilled palaeochannels exist. In addition, there are a series of historic submarine landslides that cover large parts at the base of the continental slope. No other significant offshore features are evident within the Mauritania portion of the core or extended study areas, with the exception of the relict carbonate reef structure located in 440 to 550 m water depths along the Pipeline Area corridor.

Senegal

Two distinct offshore features are located off the Grande Côte of Senegal, including 1) Cayar Canyon; and 2) Cayar Seamount.

The Cayar Canyon is located off the coast of Senegal, originating near the shoreline (10 to 20 m deep) on the upcurrent side of the Cap-Vert peninsula and extends downslope to the oceanic basin. The canyon trends in a northwest direction from shore. Its channel remains a prominent feature at 3,294 m; its maximum width is 9 km (Dietz et al., 1968).

The Cayar Seamount is located off Cayar, 100 km north-northwest of the Cap-Vert peninsula and Dakar, between 17.5° and 17.9° W longitude and 15.4° and 15.8° N latitude. The seamount is located between 200- to 500-m water depths. This complex comprises three mounts: Cayar Mount, Petit Cayar Mount, and Medina Mount. The Cayar Seamount is one of the rare seamounts off the coast of west Africa characterized by high biodiversity and strong hydrodynamics. The positive consequences of this dynamic water flow include high biodiversity and primary productivity (United Nations Environment Programme, 2014a). Detailed morphology of the Cayar Seamount is presented in Hansen et al. (2008).

4.4.1.4 Sediment Quality

CSA Ocean Sciences Inc. (CSA) collected 31 sediment samples in the project area during an Environmental Baseline Survey (EBS) conducted from November to December 2016 along the Mauritania-Senegal maritime boundary; sampling included five stations each within or in close proximity to the Offshore Area and Nearshore Area, and 21 stations within the Pipeline Area. A detailed discussion of the EBS results and mapped sampling locations are presented in Appendix D.

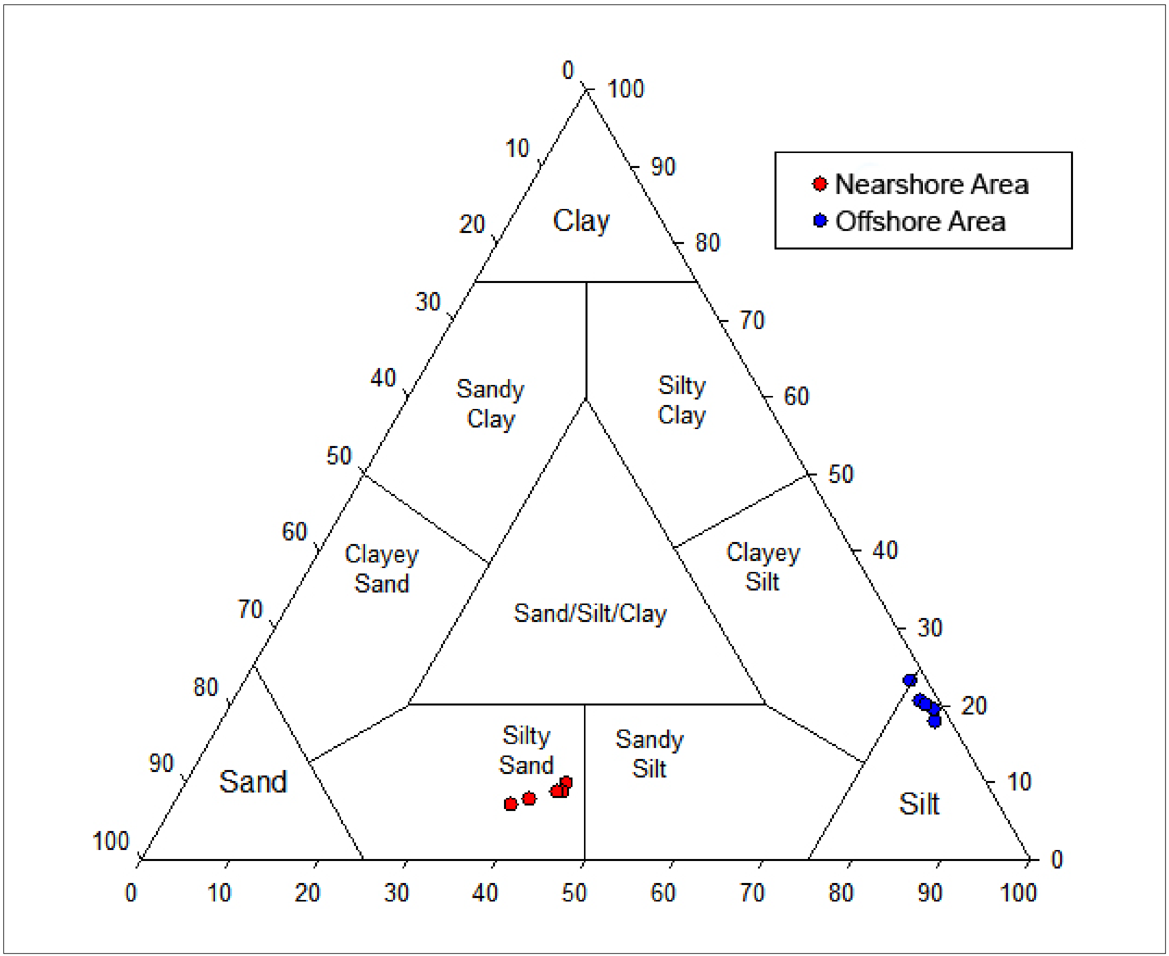
Offshore Area

Sediments in the Offshore Area are primarily composed of silts and clayey silts (Figure 4-4). These determinations are consistent with regional sediment characterizations (e.g., Förster, 2010).

Analysis of sediment metals included aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb), vanadium (V), and zinc (Zn)[26]. Metal concentrations in sediments of the Offshore Area were variable, with this variability attributed to corresponding variations in sediment grain size, organic carbon content, and mineralogy. Higher metal concentrations are typically associated with fine-grained aluminosilicates (clays) and lower metal concentration with coarse-grained quartz sand.

Summary sediment metals data are presented in Table 4-1. Sediment chemistry results were interpreted in the context of the actual values relative to benchmark values to evaluate their biological relevance. Metals concentrations were compared to the U.S. Environmental Protection Agency (USEPA) sediment quality benchmarks to determine the potential for adverse ecological effects (i.e., sediment quality guidelines are based on marine sediment chemistry paired with sediment toxicity bioassay data). The USEPA recommends benchmark values such as the effects range low (ERL) and effects range median (ERM) to assess the potential risk to fish and other marine life (Long and Morgan, 1990). ERL is indicative of concentrations below which adverse effects rarely occur, whereas ERM is indicative of concentrations above which adverse effects frequently occur. It has been noted, however, that no account is taken of grain-size when determining ERLs, and that therefore ERL exceedances can be expected to increase in proportion to the fine-grained portion of sediment without any increase in toxicity (O'Connor, 2004).

[26] The choice of parameters is based on metals potentially associated with offshore oil and gas activities.



(From: Appendix D)

Figure 4-4. **Ternary Diagram for Sediment Grain Size for Samples Collected in or Adjacent to the Nearshore Area and Offshore Area.**

Table 4-1. Sediment Metal Concentrations (mg kg^{-1}, unless indicated otherwise) in the Vicinity of the Offshore Area and Benchmark Values.

Bolded values are above the ERL; bolded values in red text are above the ERM.

Station	Al (%)	As	Ba	Cd	Cr	Cu	Fe (%)	Hg	Ni	Pb	V	Zn
OA-1	7.99	4.6	610	0.20	**107**	29.9	4.11	0.0633	**48.5**	14.5	70.4	65.6
OA-2	7.91	6.0	709	0.24	**137**	**39.1**	4.05	0.005*	**61.6**	19.9	94.0	83.8
OA-3	7.72	6.2	661	0.21	**140**	**39.6**	4.00	0.060	**63.5**	21.1	95.7	85.4
OA-4	7.73	5.1	597	0.17	**114**	32.4	3.95	0.026	**51.4**	16.1	77.3	68.9
OA-5	7.67	6.3	612	0.22	**128**	**35.9**	4.05	0.020	**58.0**	18.0	87.7	76.7
Average ± SD	7.804 ± 0.1168	5.64 ± 0.632	637.8 ± 37.76	0.208 ± 0.018	125.2 ± 11.76	35.38 ± 3.384	4.032 ± 0.046	0.042 ± 0.019	56.6 ± 5.32	17.92 ± 2.096	85.02 ± 8.936	76.08 ± 7.064
ERL	--	8.2	--	1.2	81	34	--	0.15	20.9	46.7	--	150
ERM	--	70	--	9.6	370	270	--	0.71	51.6	218	--	410

Al = Aluminum; As = arsenic, Ba = barium, Cd = cadmium, Cr = chromium, Cu = copper, ERL = effects range low; ERM = effects range median Fe = iron, Hg = mercury, Ni = nickel, OA = offshore area; Pb = lead, SD = standard deviation; V = vanadium, Zn = zinc.

(From: Appendix D; Buchman, 2008)

Average concentrations of most sediment metals within the Offshore Area were below ERL benchmarks, with the exception of Cr, Cu, and Ni. Concentrations of Ni at several deepwater stations were elevated above the ERM benchmark. Sediment metal concentrations are considered regionally ambient and do not likely represent a hazard to marine organisms and the general offshore marine ecosystem (Appendix D).

Sediment hydrocarbons concentrations were also determined from several stations in the Offshore Area. Results are provided in Table 4-2.

Table 4-2. Sediment Hydrocarbon Determinations in the Offshore Area.

Station	Total Alkanes ($\mu g\ g^{-1}$)	Total Petroleum Hydrocarbons ($\mu g\ g^{-1}$)	Extractable Organic Matter ($\mu g\ g^{-1}$)	Polycyclic Aromatic Hydrocarbons ($ng\ g^{-1}$)
OA-1	4.4	28	136	43.1
OA-2	--	29	--	--
OA-3	5.5	28	150	67.5
OA-4	4.8	25	127	45.6
OA-5	4.5	27	112	41.6
Average ± SD	4.8 ± 0.28	27.4 ± 0.93	131.25 ± 9.4	49.45 ± 7.22

OA = Offshore Area; SD = standard deviation.

(From: Appendix D)

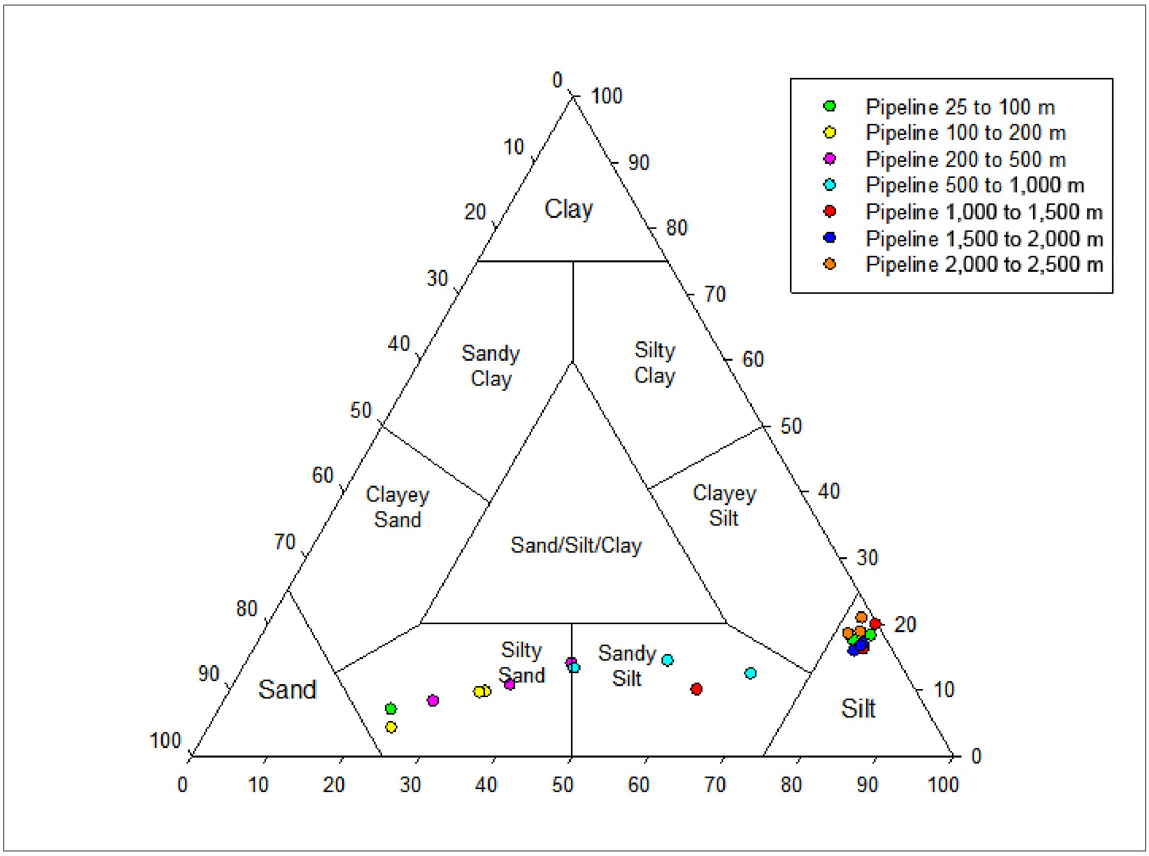
Hydrocarbons analyzed in sediments included alkanes, total petroleum hydrocarbons (TPH), extractable organic matter (EOM), and polycyclic aromatic hydrocarbons (PAHs). Alkanes are saturated hydrocarbons in the carbon range C9 through C40. Alkanes are a component of TPH and are considered relatively nonreactive. TPH is a group of several hundred organic compounds that originate from crude oil. The TPH value as presented is the collective total of extractable petroleum hydrocarbons from carbon range C9 through C40, similar to the alkane group. EOM is an operationally defined parameter that is equivalent to, or an index of, oil and grease content. PAHs are constituents of crude oil; PAHs found in the marine environment are divided into two groups – petrogenic and pyrogenic. Petrogenic PAHs are present in oil and oil products. Typically, the presence of petrogenic PAHs in offshore environments are associated with naturally occurring oil seeps, oil spills, and chronic discharges containing hydrocarbons. PAHs are a component of the TPH value.

There are no defined standards or guidelines for alkanes, TPH, and EOM/total oil and grease levels in marine sediments. The lack of defined standards for these hydrocarbons is related to difficulties associated with developing standards for parameters that are operationally defined and vary depending on location, anthropogenic activities, natural seeps of hydrocarbons, and, where applicable, the nature or composition of the hydrocarbons. There are ERL and ERM thresholds for PAHs (Buchman, 2008). Comparison of these results (Table 4-2) to similar west Africa deepwater environments indicates that sediment TPH, EOM, and PAH levels in the Offshore Area are lower than reference stations offshore Ghana (CSA, 2016). All sediment PAH concentrations were below the ERL (4,022 $ng\ g^{-1}$) and well below the ERM (44,702 $ng\ g^{-1}$) values for total PAHs in marine sediment (Buchman, 2008).

In general, sediment quality in the Offshore Area is considered to be good based on sediment metal and hydrocarbon determinations of adjacent locations (Appendix D).

Pipeline Area

The Pipeline Area traverses a water depth differential of nearly 2,500 m and subsequently the sediment grain size composition is quite variable. Most of the deeper Pipeline Area stations in water depths >1,000 m had fine textured sediments classified as silt similar to the Offshore Area. The sediment sand component of the Pipeline Area stations increased with decreasing water depth with the shallower stations in water depths <500 m having coarser textured sediments classified as silty sand (Figure 4-5).



(From: Appendix D)

Figure 4-5. Ternary Diagram for Sediment Grain Size for Samples Collected in the Pipeline Area.

Summary sediment metals data for stations in the Pipeline Area are presented in Table 4-3. Average metals concentrations at stations in the Pipeline Area were generally below ERL benchmarks, with the exception of As, Cr, and Ni. Concentrations of Ni at several deepwater stations (>1,000 m water depth) in the Pipeline Area were above ERM benchmarks. Based on a regression analysis that correlated sediment percent aluminum with other metal concentrations to assess the potential for influence by anthropogenic inputs, it was concluded that sediment metal concentrations in the Pipeline Area are considered regionally ambient and do not likely represent a hazard to marine organisms and the general offshore marine ecosystem.

Sediment TPH, EOM, and PAH concentrations at stations in the Pipeline Area were consistent with values from those in the Offshore Area and were lower than reference stations offshore Ghana (CSA, 2016). TPH, EOM, and PAH values were generally higher at deeper stations within the Pipeline Area, though all PAH values from the Pipeline Area were well below the ERL (4,022 ng g^{-1}) and ERM (44,702 ng g^{-1}) benchmark values for total PAHs in marine sediment (Buchman, 2008) (Table 4-4).

Table 4-3. Sediment Metal Concentrations (mg kg^{-1}, unless indicated otherwise) in the Pipeline Area and Reference Values. Bolded values are above the ERL; bolded values in red text are above the ERM.

Station	Al (%)	As	Ba	Cd	Cr	Cu	Fe (%)	Hg	Ni	Pb	V	Zn
Pipeline Area, Stations PA-1 thru PA-6 (25 to 200 m Depth)												
PA-1	3.90	**12.4**	272	0.18	98.5	15.1	2.33	0.0027*	**29.1**	15.2	67.3	34.9
PA-2	5.70	**11.8**	209	0.24	**107**	18.0	3.34	0.015	**37.9**	12.3	70.0	39.1
PA-3	1.74	**12.9**	87.3	0.21	48.4	7.62	2.46	0.0058	**21.1**	5.50	30.7	27.5
PA-4	1.56	**11.2**	83.8	0.29	50.1	7.99	2.38	0.0070	20.0	4.85	29.8	34.7
PA-5	1.77	**15.0**	88.7	0.24	54.0	7.73	2.85	0.0062	**22.1**	5.11	35.0	**35.5**
PA-6	1.54	**9.9**	81.0	0.23	50.7	8.31	2.11	0.0068	**20.5**	5.21	31.9	33.3
Average ± SD	2.7 ± 1.7	12.2 ± 1.7	137 ± 83	0.23 ± 0.04	68.1 ± 27.0	10.8 ± 4.6	2.58 ± 0.45	0.008 ± 0.004	25.1 ± 7.1	8.3 ± 4.5	44.1 ± 19.1	34.2 ± 3.8
Pipeline Area, Stations PA-7 thru PA-12 (200 to 1,000 m Depth)												
PA-7	1.86	**10.8**	88.8	0.08*	**82.7**	6.78	3.27	0.0034	17.8	6.36	31.5	43.5
PA-8	2.21	**15.5**	97.9	0.08*	**117**	7.23	4.26	0.0072	18.6	7.22	38.7	48.8
PA-9	2.77	**8.5**	164	0.22	**89.0**	11.8	2.59	0.0042	**24.9**	10.6	42.1	37.7
PA-10	3.87	**8.9**	241	0.22	**88.6**	16.8	2.27	0.0093	**35.2**	13.3	53.8	39.4
PA-11	2.66	**13.2**	177	0.08*	**104**	10.4	4.71	0.0014	**23.4**	10.9	51.3	44.5
PA-12	3.80	7.4	285	0.21	**81.9**	15.9	2.66	0.0022	**33.4**	13.1	50.8	40.7
Average ± SD	2.9 ± 0.8	10.7 ± 3.1	176 ± 77	0.15 ± 0.08	93.9 ± 13.8	11.5 ± 4.23	3.29 ± 0.98	0.005 ± 0.003	25.6 ± 7.3	10.3 ± 2.9	44.7 ± 8.7	42.4 ± 4.0
Pipeline Area, Stations PA-13 thru PA-21 (> 1,000 m Depth)												
PA-13	3.49	7.8	261	0.22	**86.0**	19.0	2.09	0.0258	**37.6**	15.8	59.1	45.5
PA-14	6.06	**10.3**	410	0.28	**136**	32.5	3.4	0.0046*	**63.2**	21.8	86.8	72.6
PA-15	6.08	**8.2**	414	0.22	**112**	27.1	3.23	0.0316	**52.0**	17.1	70.7	60.7
PA-16	5.85	7.3	437	0.23	**107**	27.2	3.33	0.026	**51.0**	15.6	69.4	60.6
PA-17	6.50	7.2	461	0.26	**120**	30.3	3.37	0.028	**56.0**	17.4	76.8	67.4
PA-18	6.58	5.9	487	0.19	**93.8**	24.6	3.43	0.027	**44.5**	13.0	61.2	53.9
PA-19	6.50	6.7	492	0.25	**113**	30.4	3.42	0.030	**54.4**	16.2	74.1	66.0
PA-20	7.08	7.5	529	0.24	**133**	**36.2**	3.73	0.030	**63.7**	19.2	86.6	77.8
PA-21	7.33	6.3	534	0.18	**122**	33.3	3.77	0.032	**55.4**	16.4	77.8	70.5
Average ± SD	6.2 ± 1.1	7.5 ± 1.3	447 ± 83	0.2 ± 0.03	114 ± 16.5	29.0 ± 5.2	3.3 ± 0.5	0.03 ± 0.002	53.1 ± 8.3	16.9 ± 2.5	73.6 ± 9.8	63.9 ± 9.9
ERL	--	8.2	--	1.2	81	34	--	0.15	20.9	46.7	--	150
ERM	--	70	--	9.6	370	270	--	0.71	51.6	218	--	410

Al = aluminum; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Cu = copper; Fe = iron; Hg = mercury; Ni = nickel; Pb = lead; V = vanadium; Zn = zinc; PA = Pipeline Area; SD = standard deviation; * = calculated using one half of the method reporting limit (MRL).

(Modified from: Appendix D)

Table 4-4. Sediment Hydrocarbon Concentrations in the Pipeline Area.

Station	Total Alkanes ($\mu g\ g^{-1}$)	TPH ($\mu g\ g^{-1}$)	EOM ($\mu g\ g^{-1}$)	PAHs ($ng\ g^{-1}$)
Pipeline Area, Stations PA-1 thru PA-6 (25 to 200 m Depth)				
PA-1	3.3	19	118	39.2
PA-2	8.4	79	396	83.7
PA-3	1.8	15	88	25.2
PA-4	2.5	16	84	28.1
PA-5	2.7	19	116	28.3
PA-6	2.2	15	112	27.1
Average ± SD	3.5 ± 2.2	27.2 ± 23.2	152.3 ± 109.8	38.6 ± 20.7
Pipeline Area, Stations PA-7 thru PA-12 (200 to 1,000 m Depth)				
PA-7	1.8	12	88	22.2
PA-8	1.8	12	74	18.0
PA-9	2.3	13	118	31.0
PA-10	2.6	19	128	35.6
PA-11	2.2	16	116	32.2
PA-12	3.3	40	198	55.8
Average ± SD	2.3 ± 0.9	18.7 ± 17.1	120.3 ± 67.8	32.5 ± 20.9
Pipeline Area, Stations PA-13 thru PA-21 (> 1,000 m Depth)				
PA-13	3.2	32	144	60.5
PA-14	6.5	75	313	107
PA-15	6.2	81	310	108
PA-16	3.9	81	244	108
PA-17	5.0	60	244	90.8
PA-18	6.2	72	275	88.9
PA-19	6.2	68	224	84.1
PA-20	6.7	70	188	82.6
PA-21	6.1	55	161	74.1
Average ± SD	5.6 ± 1.2	66.0 ± 15.4	234 ± 60.8	89.3 ± 16.4

EOM = extractable organic matter; PA = Pipeline Area; PAHs = polycyclic aromatic hydrocarbons; SD = standard deviation; TPH = total petroleum hydrocarbons.

(Modified from: Appendix D)

Nearshore Area

Site-specific sediment sampling was conducted in the Nearshore Area from November to December 2016 (Appendix D). Five sediment stations were randomly located in the vicinity of the proposed nearshore infrastructure. Sediments in the Nearshore Area are composed of silty sand (Figure 4-4), though most samples had nearly equal parts silt and sand with a very low clay fraction.

Summary sediment metals data for stations in the Nearshore Area are presented in Table 4-5. Average metals concentrations from the Nearshore area were below ERL benchmark values for all metals analyzed (Table 4-5).

Table 4-5. Sediment Metal Concentrations (mg kg^{-1}, unless indicated otherwise) in the Nearshore Area and Benchmark Values.

Bolded values are above the ERL.

Station	Al (%)	As	Ba	Cd	Cr	Cu	Fe (%)	Hg	Ni	Pb	V	Zn
NA-1	1.95	5.4	278	0.04	31.6	4.16	1.16	0.00425*	7.3	5.79	17.0	11.9
NA-2	2.32	**8.5**	285	0.08	50.6	7.00	1.30	0.00425*	12.9	9.27	29.4	20.4
NA-3	2.02	6.9	260	0.08	41.0	5.32	1.06	0.0047*	9.8	7.99	23.4	16.5
NA-4	2.22	8.0	268	0.06	48.2	6.27	1.14	0.00395*	11.4	9.37	27.3	18.4
NA-5	2.41	**9.7**	285	0.07	50.6	7.39	1.24	0.0065*	13.2	10.2	31.0	21.0
Average ± SD	2.2 ± 0.2	7.7 ± 1.6	275 ± 11	0.07 ± 0.02	44.4 ± 8.2	6.0 ± 1.3	1.2 ± 0.1	0.005 ± 0.001	10.9 ± 2.4	8.5 ± 1.7	25.6 ± 5.6	17.6 ± 3.7
ERL	--	8.2	--	1.2	81	34	--	0.15	20.9	46.7	--	150
ERM	--	70	--	9.6	370	270	--	0.71	51.6	218	--	410

* - calculated using one-half of the method reporting limit (see Appendix D).
ERL = Effects Range Low; ERM = Effects Range Median; Al = aluminum; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Cu = copper; Fe = iron; Hg = mercury; Ni = nickel; Pb = lead; V = vanadium; Zn = zinc

(Modified from: Appendix D)

In results similar to those from the vicinity of the Offshore Area and the Pipeline Area, TPH, EOM, and PAHs from samples in the Nearshore Area were well below the ERM (44,702 ng g^{-1}) values for total PAHs in marine sediment (Buchman, 2008) (Table 4-6). It should be noted that TPH, EOM, and PAH concentrations from the Nearshore Area are substantially lower than concentrations observed along the deepwater portions of the Pipeline Area and in the Offshore Area.

Table 4-6. Sediment Hydrocarbon Determinations in the Nearshore Area.

Station	Total Alkanes (µg g^{-1})	Total Petroleum Hydrocarbons (µg g^{-1})	Extractable Organic Matter (µg g^{-1})	Polycyclic Aromatic Hydrocarbons (ng g^{-1})
NA-1	2.2	13	62	12.3
NA-2	1.8	10	38	11.5
NA-3	1.4	8	28	10.1
NA-4	1.7	7	54	10.3
NA-5	1.3	6	50	8.35
Average ± SD	1.7 ± 0.3	8.8 ± 2.5	46.4 ± 12.0	10.5 ± 1.3

NA = Nearshore Area; SD = standard deviation.

(From: Appendix D)

4.4.2 Coastal Geology and Geomorphology

Mauritania

The coastline of Mauritania extends almost 720 km between 16°04’ N and 20°36’ N. The Mauritania shoreline is mostly sandy south of Nouakchott. Review of satellite imagery for the Mauritanian portion of the coast south of Nouadhibou produced five different shoreline types, including exposed rocky shore; exposed rocky cliff with boulder talus base; sandy beach; man-made riprap and seawall; and wetlands. The predominant shoreline type along this portion of the Mauritanian coast is sandy beach (Table 4-7). Additional graphic information on shoreline types in Mauritania is presented in Appendix G.

Table 4-7. Summary of Shoreline Types between Nouakchott and the Mauritania-Senegal Border.

Shoreline Type	Description	Shore Length (km)	Percentage of Shore Length
1A	Exposed Rocky Shore	27.93	2.21
1C	Exposed Rocky Cliff with Boulder Talus Base	9.24	0.73
4	Sandy Beach	1,181.67	93.48
6B	Man-made Riprap and Seawall (boulders, cobbles, bulkheads)	6.53	0.52
10	Wetlands	38.71	3.06

The continental shelf, which covers a surface area of 39,000 km^2, extends to the north of Cape Timiris and is 60 to 90 km wide; to the south of the Cape, the shelf narrows and ranges from 15 to 50 km in width.

Along the northern continental shelf, Lévrier Bay incises the continent and exhibits a deep channel near Nouadhibou (Reyssac, 1977). In addition to this deep channel, where depths can reach 20 m, there is a shallow bank (Banc d'Arguin) where average water depths are 4 m. The bank occupies a large surface area within the bay and limits water exchange between the littoral zone and open ocean. Consequently, environmental conditions within this region are extreme, with considerable variability in temperature and salinity.

The Mauritanian continental shelf edge is not well defined. Near Banc d'Arguin, the shelf edge is incised with many canyons, where water depths can reach 300 to 400 m (Maigret and Ly, 1986; Domain, 1985; Dedah, 1995). To the south of Cape Timiris, the width of the continental shelf varies from 15 km opposite the Cape to >50 km further south. Off the southern Mauritania coast, canyons occur much less frequently than to the north of Cape Timiris.

Senegal

The coastline of Senegal extends 531 km, including both northern and southern coastal segments which are separated by The Gambia (Brown et al., 2011). The coastal morphology of Senegal comprises sandy, deltaic (i.e., Senegal River delta in the north), estuarine (i.e., Saloum and Casamance River estuaries) coasts and small lengths of rocky shoreline (Dennis et al., 1995).

The Senegal River delta, one of the most prominent features of this region, has an expansive delta covering an area of approximately 4,254 km^2. Sadio et al. (2017) characterize this region as a mud-rich delta plain bounded by massive sandy barriers, the latter of which have been built over time by waves propagating over loose Aeolian deposits on the submerged narrow shelf. These coarse-grained barriers are separated by swales comprising abandoned river courses. South of Saint-Louis, an extensive sand spit is present (including the Langue de Barbarie), intersected by the mouth of the Senegal River which was cut in 2003. The initial channel cut was 5 m wide, but has expanded to >5 km, with associated changes in river outflow, sediment transport, and effects on local hydrography including coastal erosion along the coastline (Niang and Kane, 2014). Additional discussion of coastal erosion is presented in Section 4.4.3.

The shoreline between Saint-Louis and Dakar is primarily unconsolidated sediment with occasional hard rock outcrops. Review of satellite imagery for the Senegalese portion of the coast south of the Mauritania-Senegal border to Dakar produced five different shoreline types, including exposed rocky shore; exposed rocky cliff with boulder talus base; sandy beach; man-made riprap and seawall; and sheltered, rocky shore. Not evaluated in this imagery review is the extensive estuarine environment of the Senegal River. The predominant shoreline type along this portion of the Senegal coast is sandy beach (Table 4-8). Additional graphic information on shoreline types in Senegal is presented in Appendix G.

Table 4-8. Summary of Shoreline Types Present between the Mauritania-Senegal Border and Dakar.

Shoreline Type	Description	Shore Length (km)	Percentage of Shore Length
1A	Exposed Rocky Shore	19.41	7.69
1C	Exposed Rocky Cliff with Boulder Talus Base	11.43	4.53
4	Sandy Beach	199.66	79.08
6B	Man-made Riprap and Seawall (boulders, cobbles, bulkheads)	21.37	8.47
8	Sheltered, Rocky Shore	0.61	0.24

Aeolian deposits are the predominant component of the coastal dunes, subdivided into two systems of different stages; the yellow (older) and the white dunes, forming a unique body without any separation. This system runs along the high tide mark, oriented in a northeast to southwest direction, forming a band of 500 to 2,000 m in width. Beach sediments are reworked and sorted by wave action. Beach deposits are formed by well-sorted, white fine sand that extends to 200 m inland. Dunes are characterized by a level to slightly undulating topography with irregular crests succession, about 25 to 30 m high, having an undulated summit and low, wide interdunal zones with a flat bottom. The material forming the dunes is typical Aeolian sand, well sorted with fine texture. The swale passage to the flat area is abrupt and is marked by the steep slope of the dune. The active, predominant morphological processes that are linked to wind action include erosion in the dunal crest that is not covered by vegetation and sand deposition in the interdunal areas (Istituto Agronomico per l'Oltremare, 2015).

4.4.3 Coastal Erosion

Coastal erosion is a significant issue along the west Africa coast. The Centre de Suivi Ecologique (CSE) has implemented a coastal protection activity in Senegal (Adaptation to Coastal Erosion in Vulnerable Areas). Various researchers (e.g., Khattabi and Bellaghmouch, 2009; Goussard and Ducrocq, 2014) have documented coastal erosion within the context of sea level rise.

Humiston & Moore Engineers (H&M) have developed a general description of the coastal processes along a 402 km stretch of coastline between Nouakchott and Dakar. Their analysis, presented in Appendix I-1 was based on review of available bathymetry, historical aerial photographs, wave records, and pertinent documentation and studies. Shoreline evolution in the core study area was evaluated through study of historical satellite aerial photographs from 1984 to 2016 and review of available publications.

The core study area was split into three coastline regions with similar behaviors. Summary determinations for each coastline region include:

- South Mauritania Region: Coastal region is comprised of a linear, dry windy beach associated with a 5 to 10 m high sand dune bounding and protecting vast low-lying salty depressions. The mild sloping beach profile reaches 9 m at about 400 m offshore, while the upland beach has narrow sand dunes that can be flooded during periods of high swell. The shoreline has mostly remained stable during the time period evaluated. However, historical images show that the coastal/dune vegetation line has been consistently retreating towards the southeast, potentially as a result of overwashing during high swell events. Coastal vegetation is typically a sign of a stable environment. The recession observed suggests that the shoreline in this region may not remain as stable in the future if vegetation retreat continues.

- Senegal River Delta Region: This region is characterized, predominantly, by a sandy shoreline represented by a continuous vegetated sand spit. The Senegal River has one inlet to the Atlantic Ocean located at the south end of the delta and south of Saint-Louis. The shoreline has overall remained fairly stable north of the inlet since 1984 with similar vegetation line recession as observed in the rest of South Mauritania, with the exception of occasional sand waves making their way along the coastline. The vegetation line retreat also follows a south to southeast pattern consistent with general southward longshore transport. The area of the inlet mouth and south of the inlet has experienced significant changes in the last three decades, most likely the largest changes in the study area; these changes are attributed, to a large extent, to the artificial breach created along the southern portion of the river delta.
- North Senegal Region: This region spans from the south end of the Senegal River delta to Dakar. The shoreline in the region appears to be stable for the most part. In opposition to the trends evident along the Mauritanian coastline, the vegetation of the North Senegal Region has progressively increased and become more established, indicating some level of stability for the coastline.

Detailed discussion of the coastal processes and erosion characteristics as well as hydrodynamic modeling of potential effects of the breakwater structure at the Nearshore Hub/Terminal on the dynamic coastline are presented in Appendix I.

4.4.4 Climatology

4.4.4.1 Climate

Mauritania

The southern one-third of the country, from Nouakchott to the Senegal River, has a Sahelian climate, while the climate of the northern portion is Saharan. As a result, the climate of the northern portion of the core study area is a Sahelian climate, while the climate at Nouadhibou is Saharan. Trade winds moderate the temperature in the arid coastal region. It is characterized by two alternating seasons – a dry season (November to June) and a rainy season (July to October).

The coastal zone of Mauritania is influenced by three major atmospheric phenomena (Diagana, 1998), including the Azores anticyclone, St. Helena anticyclone, and Saharan anticyclones. The climate of Mauritania is arid, with weather conditions dictated by the Intertropical Convergence Zone (ITCZ). The influence of the ITCZ produces two seasons: a relatively cold and dry season; and a relatively hot and wet season.

Senegal

The climate of Senegal is characterized by two seasons determined by the latitudinal migration of the ITCZ: a dry season between November and June and a rainy season between July and October. The coastal zone is influenced by the Atlantic Ocean and is composed of three main littoral climatic zones (Malou et al., 1998):

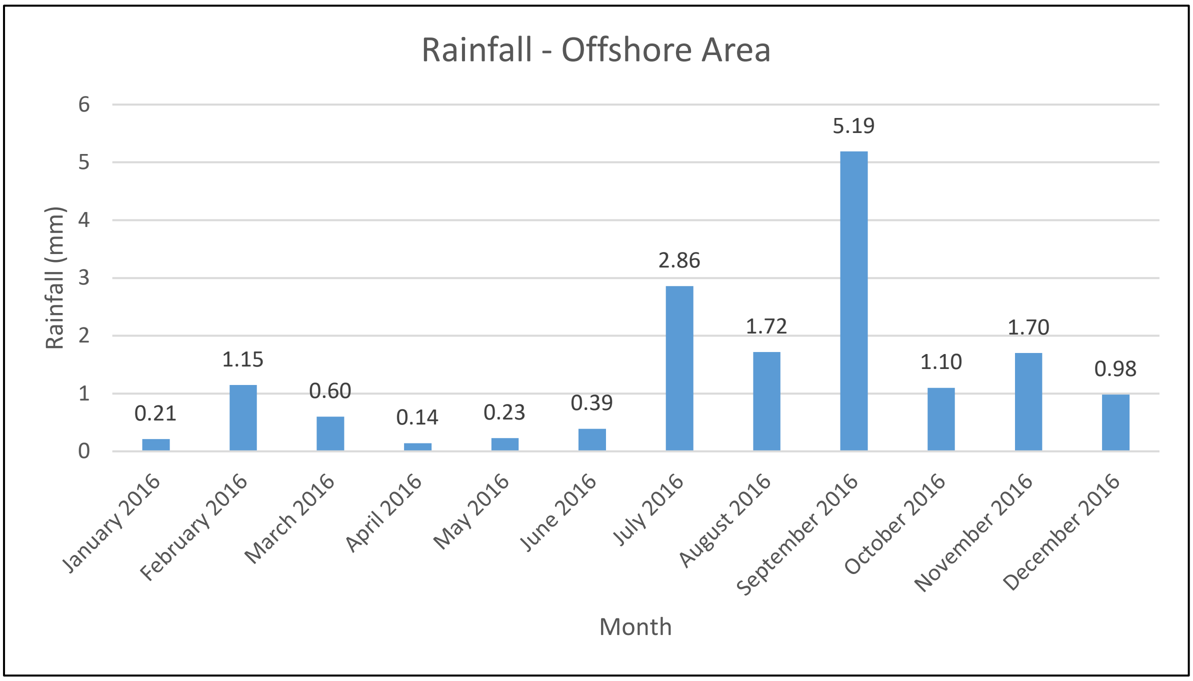
- The Grande Côte zone, extending from Saint-Louis to Dakar;
- The Petite Côte zone, extending from Dakar to the border between Senegal and The Gambia, near the Saloum estuary; and
- The Low Casamance, extending from the border between Senegal and The Gambia along the Casamance River estuary.

During boreal summer (June to August), the ITCZ and associated tropical rain belt migrate northward (19° N) and bring moisture-laden air over the Senegal River basin. In Senegal, during summer (27°C and 254 mm precipitation during August on average), strong ground level turbulence is associated with the monsoonal front system. During winter (December to February), the ITCZ migrates toward the south (5° N), which induces cool and dry conditions over the Senegal River basin (Leroux, 2001). During this season (22°C and no precipitation in January on average), the northeast tradewinds are the dominant atmospheric feature (Nicholson, 2000; Mhammdi et al., 2014).

4.4.4.2 Rainfall

Nearly all rainfall in coastal Mauritania falls between August and October, with the majority falling during August and September. Along the Grande Côte in Senegal, Malou et al. (1998) characterized the littoral zone rainfall as ranging from 413 mm in Dakar to 265 mm in Saint-Louis.

Rainfall data from the Offshore Area (centered at 16.43° N; Longitude: 18.14° W; Coordinate System WGS 1984) from January 2016 through December 2016 are presented in Figure 4-6 (National Oceanic and Atmospheric Administration [NOAA], 2017). Nearly 96% of rainfall between January and December 2016 fell in July, August, and September 2016, although notably high levels were evident in February and November.



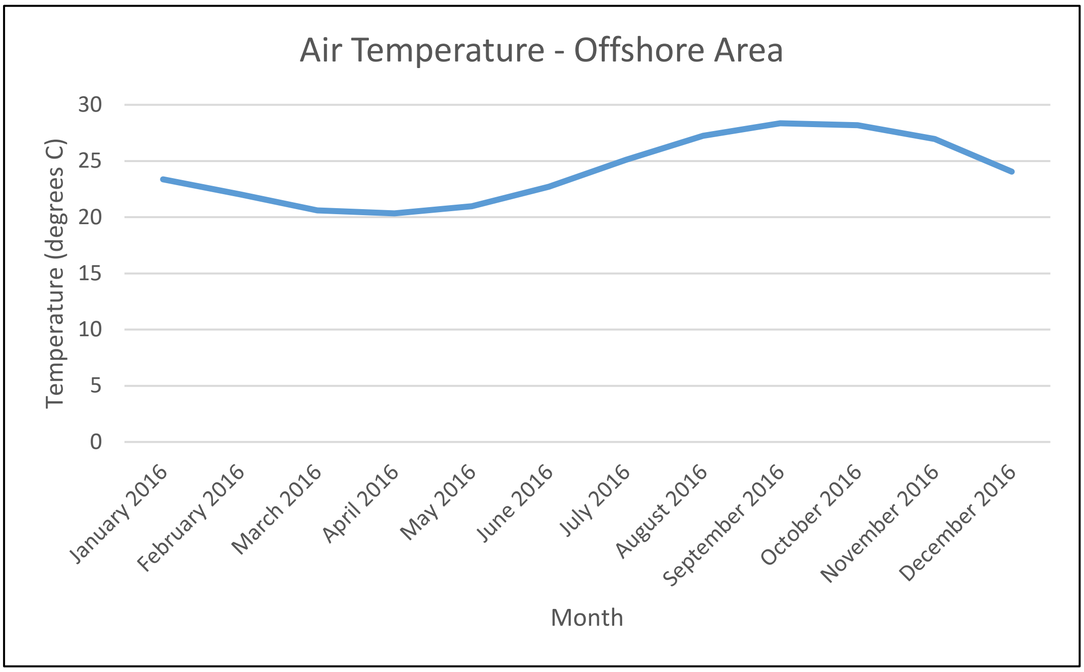
(From: National Oceanic and Atmospheric Administration [NOAA], 2017)

Figure 4-6. Monthly Total Rainfall in the Offshore Area between January and December 2016.

4.4.4.3 Temperature

Temperatures in Mauritania are typically extreme, as about two-thirds of the country has a Saharan climate with daytime temperatures that exceed 38°C for over 6 months of the year. While annual temperature variations are small, diurnal variations can be extreme, with radiative cooling that significantly reduces high daytime temperatures, especially in the December to March period. Mean temperature along the Grande Côte range from 25°C in Dakar to 27.5°C in Saint-Louis.

Figure 4-7 presents monthly mean temperatures for the Offshore Area (centered at 16.43° N; Longitude: 18.14° W; Coordinate System WGS 1984) from January through December 2016 (European Centre for Medium-Range Weather Forecasts [ECMWF], 2017). It should be noted that Figure 4-7 does not indicate the daily temperature extremes.



(From: European Centre for Medium-Range Weather Forecasts [ECMWF], 2017)

Figure 4-7. Monthly Average Temperatures in the Offshore Area between January and December 2016.

4.4.4.4 Wind

The winds play a role in determining the displacement of surface water, the transport of sand, and variations in upwelling intensity. Several types of winds are present, particularly in the northern portion of the core study area (Dubrovin et al., 1991):

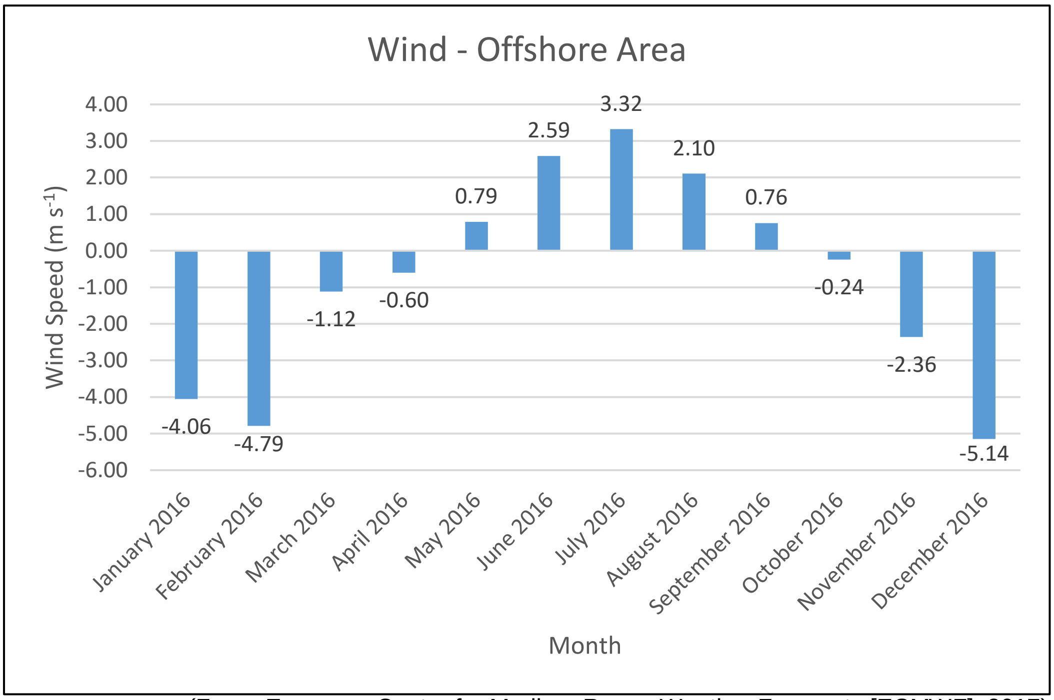
- Maritime tradewinds which originate in the high pressure area from the anticyclone present near the Azores. This fresh, more perceptible wind occurs primarily north of Cape Timiris, with mean velocities of 6 to 8 m s^{-1}, and maximum speeds of 15 m s^{-1};
- Continental tradewinds or Harmattan are created by the high pressure area located over the Maghreb in December through February and the Mediterranean in June through August. This dry, hot wind is more frequent to the south of Cape Timiris; it can be very intense and plays a significant role in Aeolian transport and sedimentation of sand and dust;

- Winds of the ITCZ which result from the meeting of northern cold air masses with tropical temperatures; and
- Cyclones of nontropical origin which generally blow from the west towards the east.

In the southern portion of the core study area, climate in general, and winds in particular, are affected by the latitudinal migration of the ITCZ. During boreal summer (June to August), the ITCZ and associated tropical rain belt migrate northward (19°N) and bring moisture-laden air over the Senegal River basin. In Senegal during summer, strong ground level turbulence is associated with the monsoonal front system. During winter (December to February), the ITCZ migrates toward the south (5°N), which induces cool and dry conditions over the Senegal River basin (Leroux, 2001). During this season, the northeast tradewinds are the dominant atmospheric feature (Nicholson, 2000; Mhammdi et al., 2014).

Several recent studies (e.g., Barton et al., 2013) have addressed the issue of global warming and its resultant effects on climatology, including increased wind velocities (and lowered sea surface temperatures) in major eastern boundary current systems, the latter of which includes the upwelling system present off northwest Africa and the Offshore Area. Wind speed and direction in the core study area are related to the north-south seasonal variations in the positions of the Azores, St. Helena, and Saharan anticyclones. However, few direct observations of wind velocity are available from the sparse coastal meteorological network along the northwest African coast.

Wind speed data from the Offshore Area (centered at 16.43° N and 18.14° W; Coordinate System WGS 1984) from January through December 2016 show monthly average wind speed (as derived from daily average wind speeds) varied from approximately 0.24 m s^{-1} in October to >5 m s^{-1} in December (Figure 4-8) (ECMWF, 2017). Generally, wind speeds were higher between November and February and June and August; winds were lower between March and May and September and October, although the monthly differences are minor.



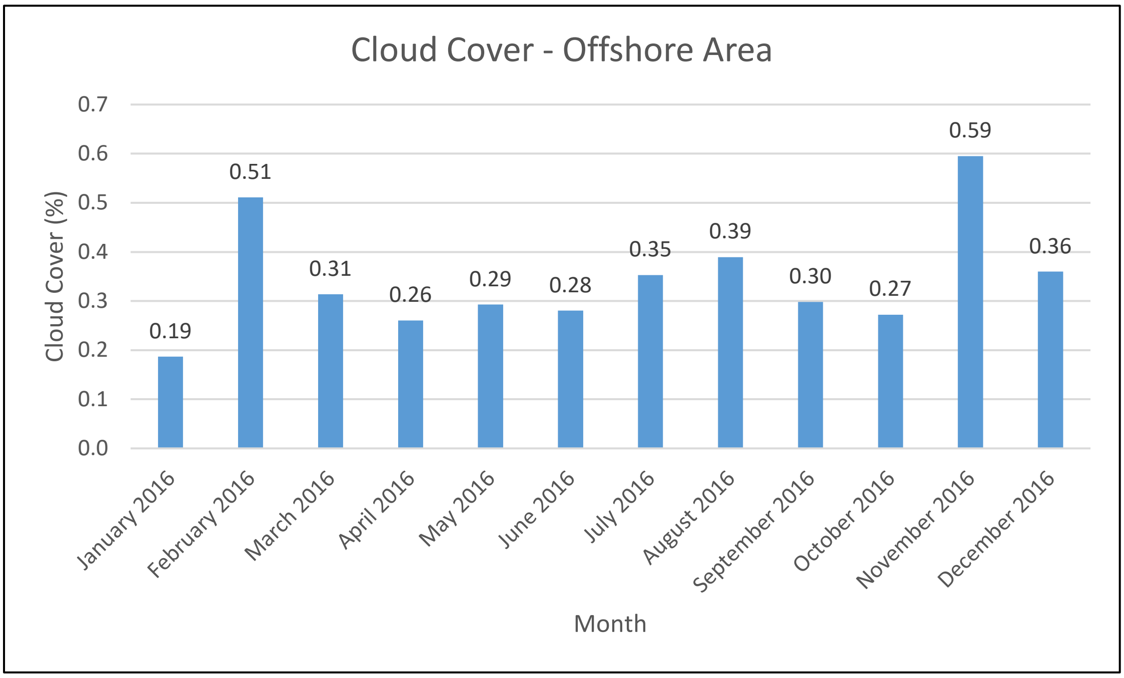
(From: European Centre for Medium-Range Weather Forecasts [ECMWF], 2017)

Figure 4-8. Monthly Mean Wind Speed Data in the Offshore Area between January and December 2016.

Negative values indicate that the wind is from the east; positive values indicate that the wind is from the west.

4.4.4.5 Cloud Cover

Cloud cover is very low year-round in the nearshore portion of the core study area due to dominant high pressure systems associated with the Azores, St. Helena, and Saharan anticyclones. Data from the Offshore Area (centered at 16.43° N; Longitude: 18.14° W; Coordinate System WGS 1984) from January through December 2016 show mean monthly cloud cover was less than 0.6% for every month of the year (Figure 4-9) (ECMWF, 2017).



(From: European Centre for Medium-Range Weather Forecasts [ECMWF], 2017)

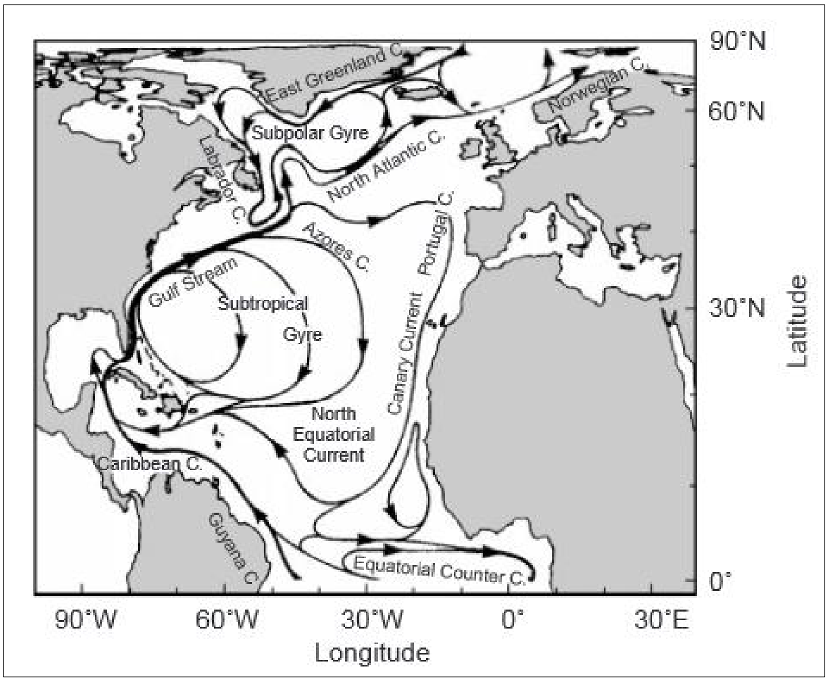
Figure 4-9. Monthly Mean Cloud Cover (%) in the Offshore Area between January and December 2016.

4.4.5 Hydrodynamics and Oceanography

4.4.5.1 Regional Physical Oceanography

The following summary of regional physical oceanography was developed by Applied Science Associates (2014), and Horizon Marine, Inc. (2015) and is supplemented by key data sources, as noted.

Circulation off the coast of southern Mauritania and northern Senegal is primarily dominated by the Canary Current (CC), an eastern boundary current that makes up the eastern branch of the North Atlantic subtropical gyre and flows equatorward along the African coast between 30° N and 10° N (Figure 4-10).



(From: Barton, 2001)

Figure 4-10. General Near-Surface Circulation of the North Atlantic Ocean.

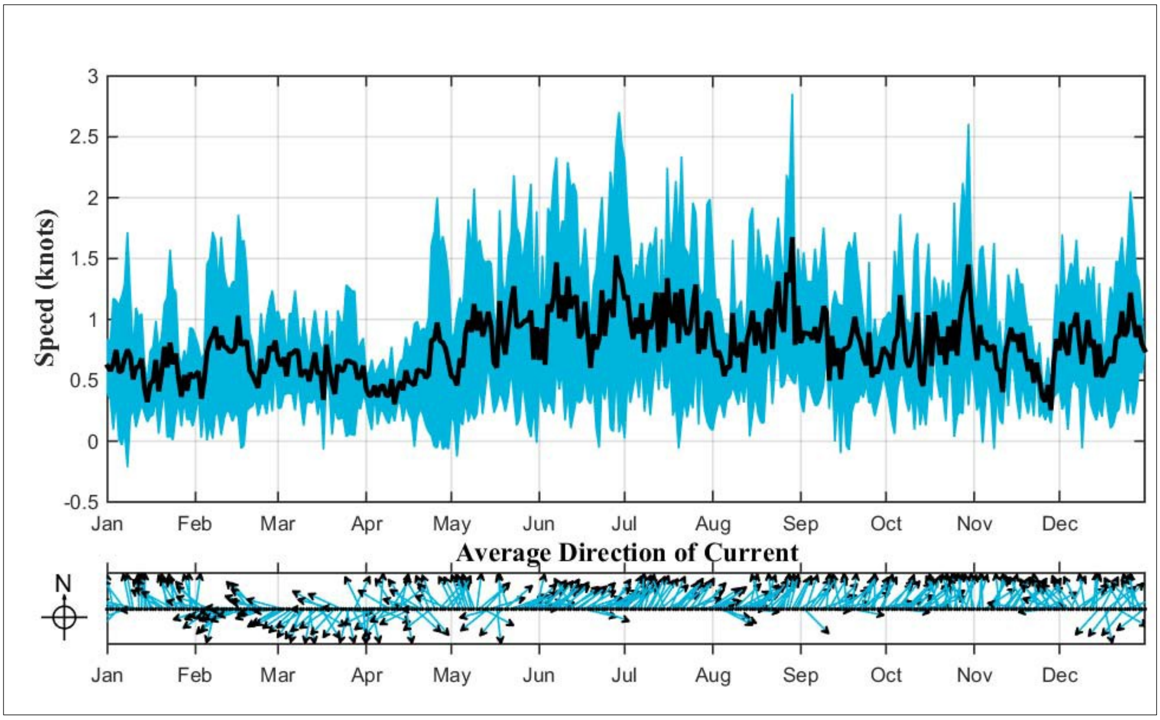
The CC is fed by the eastward-flowing Azores Current as it turns southward along the continental slope between the Madeira Plateau and the Canary Islands. On average, the CC is about 1,000 km wide, extends 500 m deep, and has speeds ranging from 10 to 15 cm s^{-1} (Zhou et al., 2000). The surface water is cool due to entrainment of upwelled water from the coast. The CC moves parallel along the African coast up to about 20° N, where it forms cyclonic eddies along the coastal boundary with length scales of 100 to 300 km (Mittelstaedt, 1991).

4.4.5.2 Upwelling

As the Northern Equatorial Counter Current (NECC) meets the African coast, some of its flow is directed northward and is referred to as the Mauritanian Current (MC), responsible for the transport of warm oligotrophic equatorial water to the tropical eastern Atlantic. The MC shows a seasonal behavior associated with the NECC. From December through March, the MC only reaches latitudes of about 14° N (immediately south of the Cap-Vert peninsula). During this period of the year, the wind field off the African coast south of 20° N is favorable to the appearance of coastal upwelling. This cold and nutrient-rich upwelled water is transported southward and is responsible for the high biological productivity of the region (Mittelstaedt, 1991). In June through September, due to the strengthening of the NECC and the relaxation of northeast trade winds, with its southern boundary in its northernmost limit (at about 21° N off the coast), the MC reaches latitudes of about 20° N, just south of Cape Blanc, and is responsible for the suppression of coastal upwelling south of 20° N (Mittelstaedt, 1991). In general, the seasonally occurring upwelling between 15° N and 21° N has its strongest intensity and expansion between January and May whereas upwelling is persistent throughout the year north of 21° N.

According to Fischer et al. (2016), south of about 20° N, a recirculation gyre drives a poleward coastal current fed by the NECC during summer. The MC flows northward along the coast to about 20° N, bringing warmer surface water from the equatorial region into the area. As the CC departs from the coast, a northeast-southwest orientated salinity front in subsurface waters is observed (Zenk et al., 1991), which separates the salty and nutrient-poor North Atlantic Central Water from the nutrient-richer and cooler South Atlantic Central Water. Both water masses may be upwelled and mixed laterally and frontal eddies develop off Cape Blanc (Meunier et al., 2012). The region between approximately 10° N and 20° N, including the Offshore Area, is termed the Mauritania-Senegalese Upwelling Zone. In latitudes between 16° N to 18° N, including the Offshore Area, seasonal upwelling is characteristically strong during January to May (Fischer et al., 2016).

Horizon Marine, Inc. (2015) summarized the oceanographic characteristics of the core study area based on a review of the global Hybrid Coordinate Ocean Model (HYCOM) data sets and Oregon State University's TPXO 8.0-atlas global tide model; data from 2010 through 2014 were used to develop the following figures. Figure 4-11 illustrates the interannual mean and standard deviation of surface current intensity at this site. These statistics were also reported in tabular format for both speed and direction (Horizon Marine, Inc., 2015).

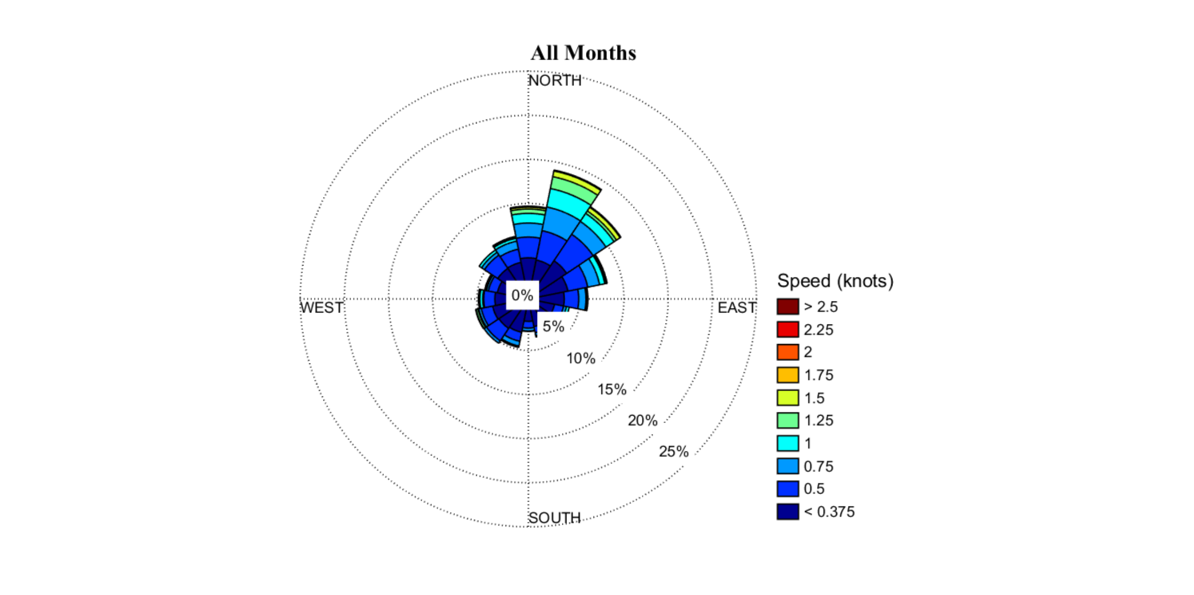


(From: Horizon Marine, Inc., 2015)

Figure 4-11. Interannual Variation of Surface Current Intensity and Directional Flow in the Offshore Area.

Mean (black) and standard deviation (blue) of surface currents are depicted in the upper graph; unit vectors indicating flow direction (direction toward) are shown in the lower graph.

A graphical representation for speed and direction during all months is presented in Figure 4-12. The predominant surface currents during the year are towards the north-northeast. Additional data in 2-month groupings are presented in Appendix G.



(From: Horizon Marine, Inc., 2015)

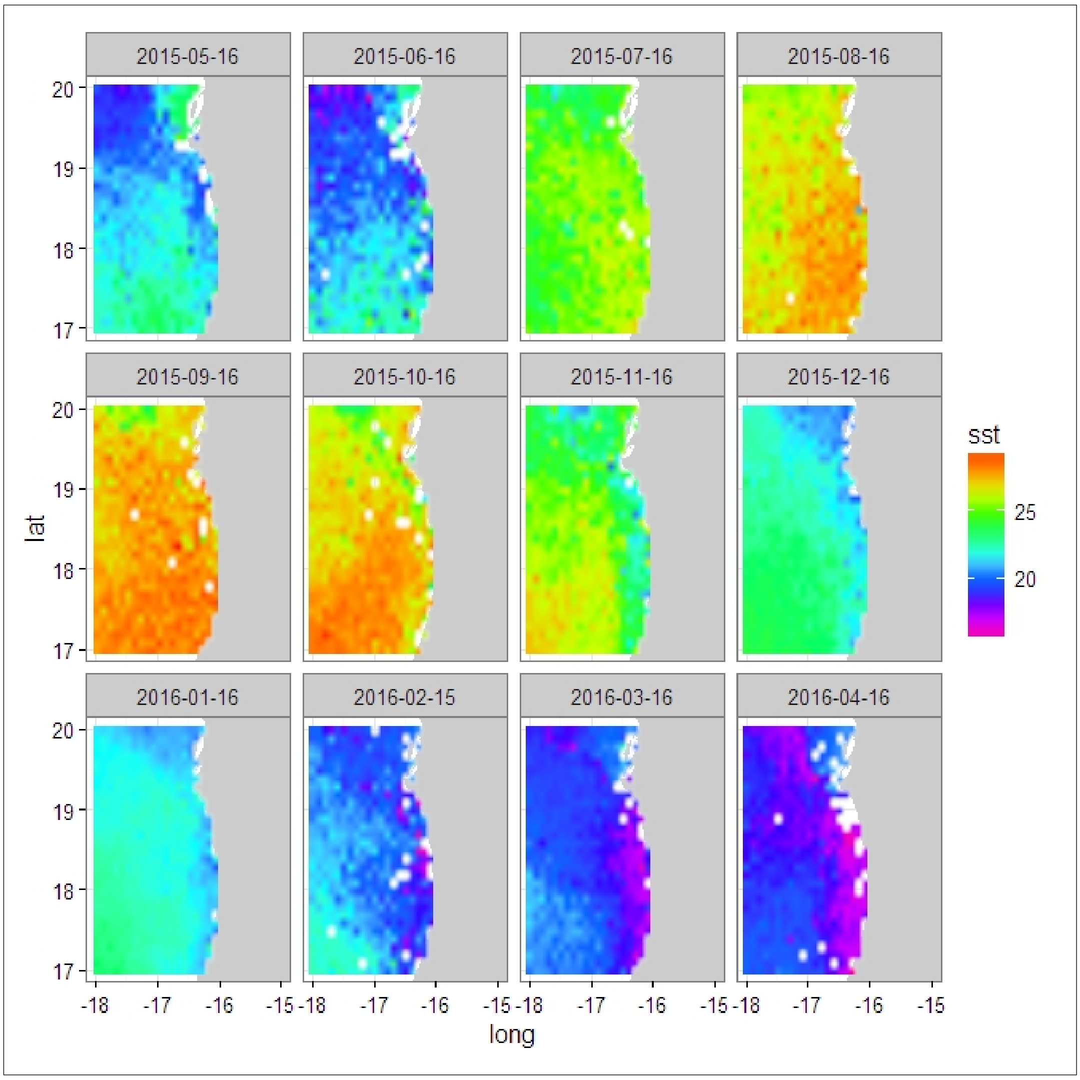
Figure 4-12. Distribution of Surface Current Speed and Direction in the Offshore Area (15.57° N, 17.61° W) from global Hybrid Coordinate Ocean Model Data for all Months.

4.4.6 Physico-Chemical Parameters

4.4.6.1 Sea Surface Temperature

Sea surface temperatures offshore within the core study area vary seasonally and are highly dependent on the intensity of upwelling events. As presented in Figure 4-13, water temperatures are the coolest during March and April, months that typically have strong upwelling events.

Based on the most recent NOAA (2016a) data, sea surface temperatures were regionally consistent and highest during August through October. The sea surface temperature regional variability was approximately 12°C ranging from 18°C to nearly 30°C.



(From: National Oceanic and Atmospheric Administration [NOAA], 2016a, as adapted via Mendelssohn, 2017)

Figure 4-13. Mean Monthly Sea Surface Temperature (°C) offshore Mauritania and Senegal during 2015 and 2016.

4.4.6.2 Local Currents

To capture the complex circulation in the offshore waters of southern Mauritania, Applied Science Associates (2014) derived outputs from the HYCOM global circulation model and applied them during spill modeling for another Kosmos project in Mauritania (offshore Block C8), that is within the Offshore Area. HYCOM data were used to define the temporally and spatially-varying surface and subsurface currents that would influence pollutant (i.e., oil) transport. In this area, surface currents are variable, but tend to exhibit predominantly west to southwestward movement, due to the influence of the Azores and Canary Current. Based on the HYCOM dataset, average monthly surface current velocities were between 12 and 27 cm s^{-1}, with maximum near-surface values near 40 cm s^{-1}. Current speeds increase during the rainy season and are likely to dominate transport due to the weaker winds observed during this period. The subsurface current velocities weaken with depth at 2,700 m to less than 2 cm s^{-1}, with variable direction.

4.4.6.3 Local Hydrography

Offshore Area

Water column profiling conducted in the Offshore Area provides data on local hydrographic conditions within the November-December 2016 timeframe (Appendix D). The water column profile acquired in a water depth >2,500 m indicated the following features:

- pH ranged from approximately 7.5 to <8;
- Turbidity was extremely low and relative constant throughout the water column;
- Fluorescence had a peak signal at a water depth of about 50 m, with fluorescence limited to the upper portion of the photic zone with no indication of fluorescence below approximately 80 m; and
- Distinct shallow thermocline below about 20 m water depth. Water temperature within the thermocline feature had a rapid decline from >25°C to <15°C at about 90 m water depth. Below 90 m water depth, water temperature had a steady decline with depth below the thermocline feature with minimum temperatures below 5°C.

A wedge of lower salinity water (<35 practical salinity units [psu]) was observed at the surface down to a halocline at approximately 35 m. Below the halocline, salinity decreased to a minimum near 35 PSU at a depth of approximately 700 m, below which salinity remained relatively constant to near bottom depths (Appendix D).

The dissolved oxygen (DO) profile reflects water column processes of primary productivity, respiration, and mineralization. Typically, in the open ocean DO is highest at the near-surface where sunlight allows the highest rates of primary production (resulting in oxygen evolution). DO is greatest not at the surface but just below the water surface (i.e., centimeters) due to the actinic effects of sunlight on photosynthesis (i.e., inhibition of photosynthesis very near the ocean surface due to ultraviolet light). Below the surface-mixed layer, decreasing light availability depresses primary productivity and mineralization of organic matter results in lower DO concentration down to the oxygen minimum at a water depth of approximately 350 m. DO decreases with depth as organic matter from the productive photic surface layers is mineralized and oxygen is consumed in the process. Below the DO minimum, DO increased gradually with depth; in the Offshore Area, where water depths are >2,000 m, DO levels exceeded those at the surface. A representative hydrographic profile from the Offshore Area is presented in Appendix D.

Nearshore and Pipeline Areas

Due to the large depth gradient within the Pipeline Area, hydrographic conditions vary considerably depending on location and depth. In depths >1,000 m, water column profiles conducted in November-December 2016 were similar to the above description of the Offshore Area, with pH between 7.5 and 8, very low turbidity (<1 NTU), low fluorescence except in the top 50 m of the water column where small peak occurred, and a thermocline at approximately 20 m water depth.

Salinity ranged between approximately 35 and 36 PSU for the entire water column, with a peak of just over 36 PSU coinciding with the depth of the thermocline. DO levels are highest just below the surface, with a rapid decrease to the oxygen minimum at approximately 100 m water depth. DO maintained near the oxygen minimum levels to approximately 500 m, where it began to increase before reaching the seafloor. Due to shallower depths than were found in the Offshore Area, the overall DO maximum occurred near the surface instead of near the seafloor.

Water column profiles of Nearshore Area showed relatively uniform conditions throughout the water column for temperature (approximately 20°C), salinity (approximately 35.6 PSU), pH (approximately 7.7), and DO (approximately 7 mg L^{-1}). The fluorescence signal and turbidity are indirectly correlated with decreasing fluorescence associated with increasing turbidity. There is a noticeable increase in turbidity at about 5 m water depth which consequently reduces light penetration and the fluorescence signal near the seafloor.

4.4.6.4 Water Quality

Water quality measurements in coastal and offshore waters of Mauritania and Senegal are limited. Wolff et al. (1993) documented metal levels in organisms from the northern and southern continental shelf regions near Banc d'Arguin, attributing elevated metals in organisms to differences in water quality, specifically levels of dissolved metals and suspended particulate load in nearshore waters. Off Senegal, pollution from land-based sources is particularly severe in coastal hotspots (e.g., Hann Bay, Dakar), where coastal waters are polluted and anoxic, causing losses in fishery resources and marine biodiversity, human health risks, and loss of amenity value. While only very limited data exist for the CCLME, global modeling studies of nitrogen and other river-born inputs to LMEs predict that total inputs of dissolved organic carbon, nitrogen and phosphorous are extremely low in the arid countries of the CCLME (Cape Verde Islands, Mauritania, Morocco) and higher in the wetter countries (Guinea, Guinea Bissau, Senegal, The Gambia). The current anthropogenic contribution to nitrogen and phosphorous inputs ranges from 50% to 100% in the north to 0% to 10% in the south, while natural sources of dissolved organic carbon, nitrogen, and phosphorous still account for an estimated 90% to 100% of inputs overall (Canary Current LME Project, 2009).

Analyses of water samples in the Offshore Area, Pipeline Area, and Nearshore Area indicated that dissolved metal concentrations were lower than the criterion continuous concentration (CCC) toxicity reference values (Buchman, 2008) with a single exception of a sample analyzed for lead that was considered to be contaminated from an unknown source. Levels of all metals were relatively consistent throughout the EBS survey area, including both offshore, pipeline, and nearshore locations. Dissolved Hg and V were undetectable in all samples (below method detection limits). Concentrations of dissolved Cd, Cr, and Zn were very low and typically below method detection limits. Similarly, several observations were noted: 1) concentrations of total metals for all stations from samples in the vicinity of the Offshore Area, and within the Pipeline and Nearshore Areas, were below the CCC toxicity reference values (Buchman, 2008); 2) total Hg was undetectable in all samples; and 3) all V concentrations were below the method detection limit. Concentrations of Cd, Cr, and Zn were below method detection limits for some samples. A summary of metals concentrations in water samples is presented in Appendix D.

It was also determined during the 2016 EBS that hydrocarbon levels in seawater, measured as alkanes, TPH, and EOM, from deepwater samples were extremely low. Individual alkanes were at levels below the method detection limits at all stations which precluded the calculation of total alkanes. TPH concentrations were low throughout the study area (including stations in the Offshore, Pipeline and Nearshore Areas) and were below the method detection limit. While EOM levels were variable, ranging from 94 to 333 µg L^{-1}, the total PAH levels were relatively consistent among all stations sampled; EOM values ranged from 25 to 44.3 ng L^{-1}. A summary of hydrocarbons concentrations in water samples is presented in Appendix D.

4.4.7 Air Quality

Air quality measurements in the core study area are very limited, although regional and Africa-wide analyses have been conducted (e.g., OECD Development Centre, 2016). Specialized, local studies have also been identified on both anthropogenic and natural air pollutants. Doumbia (2012) conducted research assessing the aerosol (particulate matter [PM]) effects on human health in the Dakar region, as did Dieme (2011). Ozer et al. (2006) estimated air quality degradation in Nouakchott from Saharan dust.

According to Doumbia (2012), a series of measurements have been acquired since 1986 upon which assessments of the atmospheric chemistry in west African rural areas and within intertropical ecosystems was completed, including a series of single year or multi-year programs: DECAFE (1986-1992), IDAF (IGAC/DEBITS/Africa, since 1994), EXPRESSO (1996), and AMMA (2005-2006). Summary results of these programs are presented in Lacaux et al. (1993), Galy-Lacaux et al. (2001), Delmas et al. (1999), and Liousse et al. (2010). In summary, however, particulate emissions or air pollution, in general, in urban areas of west Africa are poorly studied.

In Dakar, a series of five air quality monitoring stations have been acquiring daily air quality information since 2010, focusing on PM, nitrogen oxides (NO_x), sulfur dioxide (SO_2), volatile organic compounds (VOCs), ozone (O_3), and carbon monoxide (CO). Annual, quarterly, and monthly bulletins are available from 2010 through 2015 or 2016 from the air-dakar.org website. In general, air quality in Dakar reflects seasonal variability. Air quality ranges from average to bad or very bad between January and the end of May. Air quality improves to good between June and October with arrival of the rainy season, transitioning between the end of October to mid-November, and returning to average to bad between the end of November and the end of December (Ministry of the Environment and Sustainable Development, 2015).

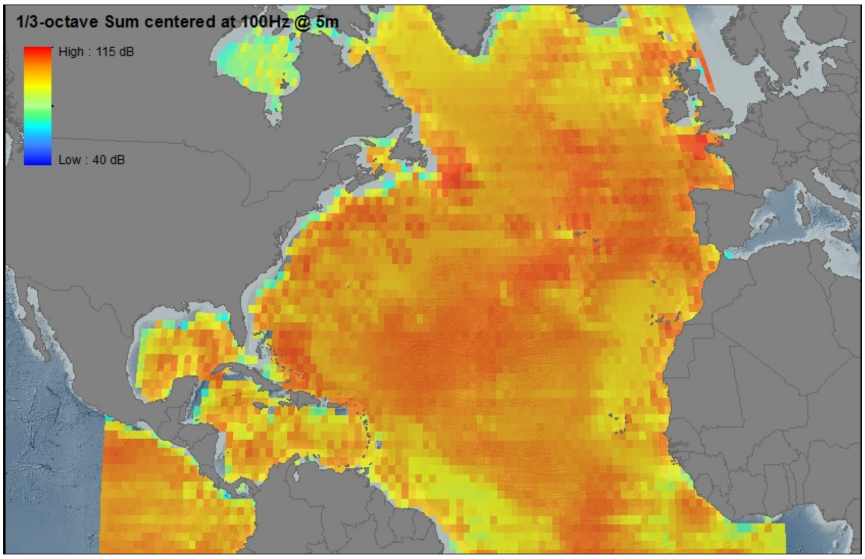
The current air quality of the urban areas of Nouakchott and Dakar is expected to present elevated levels of PM and other combustion-related pollutants as a result of vehicles, many of which utilize diesel. Dust and associated elevated PM levels may also be expected in Nouakchott. Saint-Louis may also be expected to exhibit elevated PM concentrations due to vehicle traffic and other sources (e.g., waste incineration, land clearing, dust). Coastal villages beyond the influence of these urban areas are expected to exhibit good to excellent air quality.

4.4.8 Ambient Sound Levels

Sound in the marine environment is the result of both natural and anthropogenic sources. Natural sources of underwater sound include processes such as earthquakes, wind-driven waves, rainfall, bioacoustic sound generation, and thermal agitation of the seawater. Anthropogenic noise[27] is generated by a variety of activities, including commercial shipping, oil and gas operations, naval operations, fishing, research, and other activities (e.g., construction; recreational boating, if any). Sources of anthropogenic noise are becoming both more pervasive, increasing oceanic background sound levels as well as peak sound intensity levels. Many sources of sound are located along well-traveled paths in the sea and encompass coastal and continental shelf waters (Hildebrand, 2009).

No site- or block-specific sound measurements are available for the Offshore Area, nor have sound measurements been documented in Mauritania or Senegal offshore waters. The Offshore Area is located within a prominent north-south shipping transit corridor (see Sections 4.6.7.1 and 4.7.7.1). Cumulative sound measurements from various sources (e.g., commercial vessels) have been mapped by the U.S. National Oceanic and Atmospheric Administration. The cumulative sound field within the North Atlantic basin, centered at 100 Hz at 5 m water depth, is shown in Figure 4-14. Low frequency imagery has been chosen given the low frequency nature of the various equipment to be used in the project. Measured levels of sound off Mauritania and Senegal are in the moderate to high range.

[27] The terms “sound” and “noise” are used throughout the baseline and impacts sections, but are not interchangeable. For this ESIA, we follow the general approach outlined by Popper and Hawkins (2016). The term “sound” is used to characterize the inclusive acoustic characteristics of the environment (e.g., ambient sound levels; soundscape), the characteristics of equipment, vessels, and marine fauna (e.g., sound source levels; species- or group-specific vocalizations, communication), and how the acoustic emissions from various sources travel through the marine environment (e.g., sound propagation, attenuation). The term “noise” is used within the context of impact analysis for project-specific sound sources that are anthropogenic (e.g., seismic airguns, vessels, drilling, sonar, etc.) that are assessed, mitigated, and monitored because of the potential effects these project-specific anthropogenic sound sources have on marine life.



(From: National Oceanic and Atmospheric Administration [NOAA], 2016b)

Figure 4-14. Cumulative Sound Field in the North Atlantic basin, Centered at 100 Hz at 5 m Water Depth.

4.4.9 Ambient Light Levels

Aside from the urban areas of Dakar and Nouakchott, and the coastal city of Saint-Louis and smaller coastal fishing villages, ambient light levels in the core study area are expected to be extremely low. No offshore infrastructure is present near the Offshore Area, Pipeline Area, or Nearshore Area. In local fishing grounds, lighted pirogues may be visible at night (e.g., off N'Diago or Saint-Louis).

4.5 Biological Environment

The following section characterizes the biological environment of the core and extended study areas using three different approaches to describe the complex relationship between the biological and physical/chemical environment.

On a resource-specific basis, individual functional components of the marine and coastal ecosystem are characterized. Major resources addressed include plankton, marine flora, benthic communities, fish and other fishery resources, birds, marine mammals, and sea turtles (Sections 4.5.1 through 4.5.7).

Key considerations of this approach include species designated on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2017a). The IUCN Red List is widely recognized as the most comprehensive and objective global approach for evaluating the conservation status of plant and animal species. Under the IUCN Red List, species are classified according to their extinction risk using nine categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient, and Not Evaluated (IUCN, 2017b). Critically Endangered species (i.e., considered to be facing an extremely high risk of extinction in the wild) and Endangered species (i.e., considered to be facing a very high risk of extinction in the wild) are of primary importance for conservation.

On a habitat-specific basis, protected areas and other areas of interest (i.e., designated or recognized areas of importance) are described (Sections 4.5.9 and 4.5.10). Key components for this approach include a) nationally- or internationally-designated national parks, reserves, and marine protected areas; and b) areas recognized by international conservation groups (e.g., BirdLife International and their designation of Important Bird and Biodiversity Areas [IBAs]). This approach also includes characterization of the physical environment which supports biological communities within these protected areas and areas of interest (i.e., coastal habitat characterization – sandy beaches, rocky headlands, etc.).

On an ecosystem-wide basis, biodiversity is characterized based on resource-specific and habitat-specific assemblages, protected status, and perceived sensitivities (Section 4.5.11). This approach integrates the key biological elements with important physical characteristics (e.g., restricted habitats; upwelling features, etc.) to describe biodiversity attributes.

The information presented in this section on the biological environment has been compiled from a review of peer-reviewed and gray literature, as well as from data collected and summarized by Mauritanian and Senegalese researchers, the results of which are presented in a series of appendices: Appendix E-1 for Mauritanian fisheries and fishery resources; Appendix E-2 for Senegal fisheries and fishery resources; Appendix F-1 for Mauritania protected areas; and Appendix F-2 for Senegal protected areas. These reports provide in-depth data on the topics addressed. Additional supporting documentation is provided in Appendices D (EBS Results) and G (Biophysical Baseline Support Material).

Key sensitivities in the biological environment include fishery resources important for national economies and local communities, listed species (i.e., including fish and fishery resources, marine mammals, sea turtles, birds), benthic communities, areas of conservation interest, and protected ecologically or biologically significant areas.

4.5.1 Plankton

Plankton refers to those flora and fauna that are found in the water column, drifting with ocean currents. Plankton types includes phytoplankton, zooplankton, and bacteria. Plankton are transported primarily by local currents and winds, but not all are immobile; some types of plankton can swim weakly, either horizontally or vertically, in the water column. Among zooplankton, diurnal (daily) vertical migration from deeper to shallower portions of the water column at night and their subsequent return to deeper waters during daylight hours have been well documented (e.g., see Hernandez-Leon et al., 2002). Vertical migration of certain phytoplankton groups (e.g., dinoflagellates) has also been observed (e.g., see Bollens et al., 2012).

As part of their life history, some marine fauna have a planktonic stage, termed meroplankton, before they transition into free-swimming or benthic organisms. Once they acquire the ability to swim on their own, they are considered nekton. Fauna that have a meroplankton stage include corals, echinoderms (e.g. sea stars), and molluscs (e.g., mussels).

4.5.1.1 Phytoplankton

Other than Zindler et al. (2012) discussed below, there is a general lack of information in the literature relative to studies specifically identifying phytoplankton offshore Mauritania and Senegal; most phytoplankton studies are regional in nature. However, due to the regional nature of phytoplankton distribution and the hydrodynamics that influence populations, studies from nearby offshore areas of northwest Africa can be considered applicable to and representative of the phytoplankton off Mauritania and Senegal.

In offshore areas of Mauritania and Northern Senegal (i.e., from 16°N to 21°N), Zindler et al. (2012) reported that the major phytoplankton group in upwelling areas were diatoms which contributed 60% to 90% of the total phytoplankton. Cyanobacteria (including the genera of *Synechococcus*, *Prochlorococcus*, and *Trichodesmium*) were the major phytoplankton groups in the oligotrophic open ocean waters west of 18° W. Dinoflagellates and Haptophytes (including coccolithophorids) occurred mainly in the transition areas between nutrient-rich upwelled waters and open ocean nutrient-poor waters. Zindler et al. (2012) also determined that during a February 2008 upwelling event, nutrient-rich water brought to the surface near the coast resulted in a phytoplankton population dominated by diatoms. Farther offshore, when nutrients became depleted (i.e., especially nitrate [NO_3-]), cyanobacteria were the most abundant phytoplankton.

Elghrib et al. (2012) assessed phytoplankton distribution within upwelling areas off the Atlantic Moroccan coast between 32°30' N and 24°00’ N. They identified a total of 142 phytoplankton taxa, with the highest species richness being found at the southern extent of the study area (i.e., 24°00’ N) both in June through August and December through February. The most species-rich populations were situated in the coastal areas and relatively homogeneous within the water column. The highest phytoplankton densities were due to the permanent upwelling activity that occurs in southern Morocco and Mauritania. Based on remote sensing data (Figure 4-15), phytoplankton densities offshore Mauritania and Senegal are likely higher than were observed offshore Morocco during seasonal blooms (e.g., March through August).

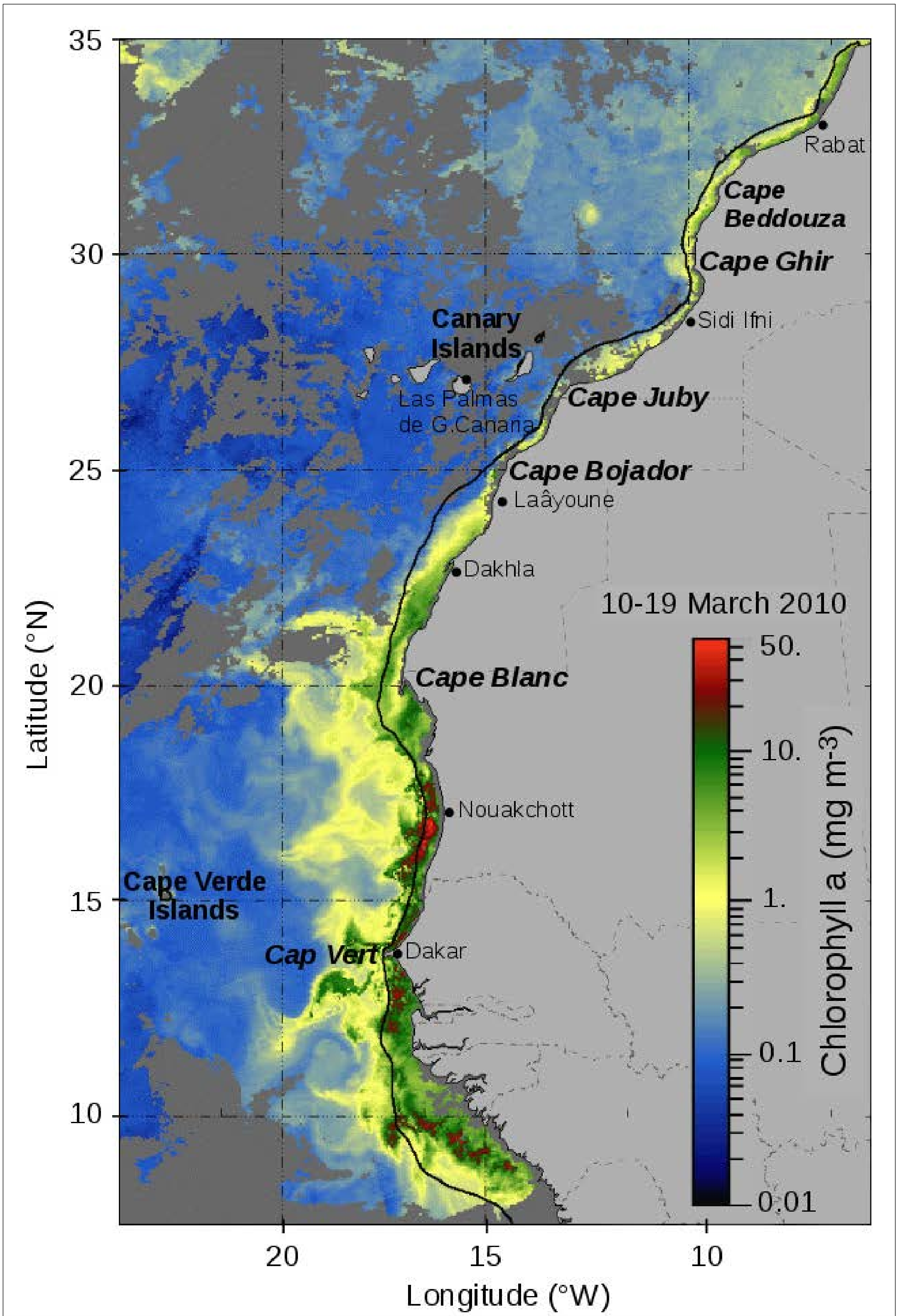


Image from: Demarcq and Somoue (2015); using data from NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group (2014)

Figure 4-15. Average Chlorophyll-*a* Concentration in the Spring Peak from 10 to 19 March 2010 as Estimated by the MODIS Sensor Data.

The phytoplankton taxa *Thalassionema nitzschioides*, *Asterionellopsis glacialis*, *Melosira*, *Chaetoceros*, and *Leptocylindrus minimus* were identified as upwelling indicator species in areas north of the drilling area (Elghrib et al., 2012), and due to regional proximity most likely applicable to the Offshore Area.

A significant amount of work has been conducted in the region and is applicable to the Offshore Area (e.g., Pacheco and Hernandez-Guerra, 1999; Davenport et al., 1999; Basterretxea and Aristegui, 2000; Elghrib et al., 2012; Zindler et al., 2012). These studies are incorporated by reference.

4.5.1.2 Primary Productivity

The ocean waters along the Atlantic coast of Mauritania and Senegal are generally characterized by high nutrient concentrations and corresponding high phytoplankton biomass due to either year round or seasonal coastal upwelling of cold, nutrient-rich water (Filipsson et al., 2006; Fischer et al., 2016). The areas offshore southern Mauritania and northern Senegal lie with the southern portion of the CCLME, a Class I, highly productive ecosystem, with primary production >300 g C m^2 y^{-1} (Sherman and Hempel, 2009). Aquatic productivity in the CCLME is driven by the combined influences of the wind-driven upwelling system centered between Morocco and Mauritania and the substantial seasonal inputs of nutrients from rivers draining into the southern part of the CCLME (i.e., Senegal, Gambia, Corubal, and Kogon Rivers). Nutrient-enriched waters are entrained by the CC southward from Morocco to Guinea (extending as far as Sierra Leone in February to March) and westward toward the Cape Verde Islands.

Persistent coastal upwelling typically occurs offshore Mauritania and Senegal in an area referred to as the Mauritania-Senegalese upwelling zone between 12° N and 19° N (Cropper et al., 2014). Chlorophyll-*a* concentrations estimated using remote sensing show that chlorophyll-*a* concentrations can peak at more than 50 mg m^{-3} during the March to June bloom (Figure 4-15) (Demarcq and Somoue, 2015).

Another upwelling feature (i.e., local seasonal upwelling) occurs near the coast between 15° N and 21° N, as discussed previously. This coastal upwelling occurs within the project study area and has its strongest intensity and expansion between January and May (Mittelstaedt, 1991).

Effects of the upwelling on nutrient and phytoplankton concentrations is limited to the continental shelf and upper slope; deep offshore waters are typically oligotrophic (Eisele et al., 2011). However, waters in very-nearshore areas may exhibit low primary production due to turbid water limiting available light for producers (Blackburn, 1979). Results of the EBS water column profiling in the Nearshore Area indicated relatively uniform conditions for temperature, salinity, pH, and dissolved oxygen. A noticeable increase in turbidity at about 5 m water depth was observed which reduces light penetration and fluorescence (see Appendix D).

4.5.1.3 Zooplankton

Mauritania

The hydrological factors of the environment, such as temperature, salinity, and circulation of water masses, and the areal distribution of phytoplankton, are the key elements that control the richness and variability of zooplankton populations. Several studies have described zooplankton distributions and species offshore Mauritania.

Net hauls of zooplankton collected offshore Mauritania predominantly consisted of copepods on the continental shelf and euphausiaceans (krill) and thaliaceans (tunicates) on the continental slope. Zooplankton biomass historically has been substantially lower on the inner shelf, possibly due to poor phytoplankton productivity as a result of turbid waters (Huntsman and Barber, 1977; Blackburn, 1979).

Kuipers et al. (1993) sampled zooplankton at the beginning of the spring upwelling season (March) along the Banc d'Arguin and reported a total of 35 species of copepods, including neritic species *Oncaea* sp. and *Acartia clausi*. Oceanic copepod species such as *Rhincalanus nasutus*, *Candacia armata* were found exclusively at deeper locations, while oceanic/neritic species such as *Centropages chierchiae, Paracalanus parvus*, and *Temora turbinatata* appeared primarily on the continental slope (Kuipers et al., 1993).

Sirota et al. (2004) reported that copepods comprised between 70% and 80% of zooplankton abundance during June to August surveys conducted between 1998 and 2011 offshore Mauritania, with calanoid families (Paracalanidae; Temoridae; Clausocalanidae; Acartiidae) and cyclopoid families (Corycaeidae; Oithonidae; Oncaeidae) being the most numerically abundant. Sirota et al. (2004) also noted that the structure of the zooplankton community composition and diversity were affected by strength of upwelling currents on which zooplankton depend for food. During their surveys, coastal upwelling was decreasing during the survey period which resulted in fewer observations of species typically seen in higher abundances during strong upwelling events (e.g., *Calanoides carinatus*) as the surveys progressed. Oceanic species that can occur in shallow water during strong upwelling events were not observed in surface waters (Sirota et al., 2004).

Somoue et al. (2005) collected zooplankton north of the Offshore Area (between Cape Blanc [21°0'N] and Cape Boujdour [26°30'N]) in March and July of 1998 that was largely composed of two groups: 1) holoplankton, and 2) meroplankton, including annelids, mollusks, cirripeds, and decapods. Holoplankton are characterized as drifters unable to swim against a current and include appendicularians, chaetognaths, euphausiaceans, ostracods, cladocerans, and amphipods, copepods, mysidaceans, hydrozoans, siphonophores, salpids, doliolids, and isopods. Similar to other studies in the region, copepods comprised a majority of zooplankton species in both March to June (86% of all zooplankton) and June-September (73% of all zooplankton). Somoue et al. (2005) conducted a regional study and collected 78 species of copepods from 24 families.

Senegal

Diouf (1991) summarized previous zooplankton surveys off Senegal. At a seasonal scale, zooplankton abundance is strongly related to upwelling fluctuations. The upwelling period corresponds to a decrease in species diversity and to an increase in zooplankton abundance, particularly for herbivorous Copepoda (e.g., *Calanoides carinatus*).

Site-Specific Sampling

No site-specific zooplankton sampling has been reported in the literature for the project area. As a result of this data gap, sampling in the Offshore Area and within the Nearshore Hub/Terminal Area was conducted by CSA in winter (November and December) 2016 (see Appendix D). During summer (July and August) 2017, these two areas and another mid-depth area were re-sampled as part of a geophysical/geotechnical survey effort. These combined efforts produced a summary listing of zooplankton composition and abundance based on day-night, depth strata, and seasonal sampling.

Offshore Area – Winter

Samples from the Offshore Area acquired during winter produced 27 higher level taxa (i.e., groups) representing nine phyla. The most abundant group was the copepods accounting for 77% of the density followed by chaetognaths (11%), shrimps (2.3%), and siphonophores (2.2%).

Samples from the Offshore Area yielded densities of zooplankters which averaged 427.0 individuals m^{-3} and ranged from 118.7 to 848.2 individuals m^{-3}. Higher zooplankton densities were evident in the day-time samples for both depth strata (i.e., 0 to 15 m and 15 to 30 m), as compared to night-time samples. Overall, densities in the upper stratum were higher than those from the lower stratum. Significant differences were only evident between day and night samples. A two-way analysis of variance found zooplankton density differed significantly between day and night in both the 0 to 15 m and 15 to 30 m depth strata.

Offshore Area – Summer

A total of 27 major planktonic groups were collected at the Offshore Area in summer. Copepods (63.4%), chaetognaths (13.6%), siphonophores (3.1%), hydrozoans (3.0%), cnidarians (2.7%), copepod eggs (2.5%), and radiolarians (2.3%) contributed the most to total abundance. Sample zooplankton densities for the offshore area in summer averaged 142.5 and ranged from 9.6 to 213.3 individuals m^{-3}. Two-way analysis of variance indicated no differences in zooplankton density between depth strata (i.e., 0 to 10 and 10 to 20 m) or day/night.

Nearshore Hub/Terminal Area – Winter

In the Nearshore Hub/Terminal Area, zooplankton sampling during winter produced 24 higher level taxa (groups) from several phyla including arthropods, mollusks, cnidarians, and chaetognaths. Copepods had the highest densities. Individual taxa or groups with highest contributions to total density at the nearshore location were copepods (64.0%), *Lucifer spp.* (12.7%), chaetognaths (8.3%), shrimps (2.5%), and ostracods (2.3%).

Total zooplankton densities at the Nearshore Hub/Terminal Area in winter averaged 522.5 individuals m^{-3} and ranged from 179.6 to 1345.3 individuals m^{-3}. The highest densities of zooplankton were collected at night from both the 0 to 10 m and 10 to 20 m depth strata. Mean numbers of zooplankton per m^3 were higher in the 0 to 10 m stratum during both day and night sample periods; however, these differences were not statistically significant.

Nearshore Hub/Terminal Area – Summer

Nearshore Hub/Terminal Area samples collected in summer produced 19 major planktonic groups. The greatest contributors to overall abundance were *Lucifer* sp. (57.2%), copepods (16.9%), caridean shrimps (7.6%), doliolids (4.5%). Cladocerans (3.2%), chaetognaths (3.0%), and crab larvae (2.9%). Zooplankton densities ranged from 51.9 to 2363.1 and averaged 1047.0 individuals m^{-3}. No differences in zooplankton density between depth strata (i.e., 0 to 10 and 10 to 20 m) or day/night were detected with two-way analysis of variance (Appendix M).

Pipeline (Mid-Depth) Area – Summer

Samples from the Pipeline (Mid-Depth) Area collected during summer yielded 22 major groups represented in order of abundance by Copepods (49.5%), Chaetognaths (8.2%), gastropods (7.7%), *Lucifer* sp. (7.4%), copepod eggs (6.4%), Cnidaria (5.3%), and siphonophores (3.3%). Zooplankton densities in the samples averaged 179.0 ranging from 70.3 to 351.9 individuals m^{-3}. Densities of zooplankton did not differ significantly between depth strata or day and night (Appendix M).

Additional discussion and tabular presentation of data for zooplankton species composition, relative abundance, day-night presence, and depth strata presence is provided in Appendices G and M.

It is to note that no site-specific zooplankton sampling was conducted in the Pipeline Area (Mid-Depth area) during the winter season.

4.5.1.4 Ichthyoplankton

Historically, there have been no site-specific ichthyoplankton (i.e., fish eggs and larvae) collections from the nearshore or offshore sites but regional scale investigations do exist. Consequently, site-specific surveys were conducted in 2016 and 2017 to address this data need, as discussed below following a brief summary of relevant regional study efforts.

Samples were collected by Tiedemann (2017) near the project area (~16° N) during 2014 and 2015. Collections of larvae of small pelagics such as *Sardinella* spp., *Trachurus* spp, and *Engraulis encrasicola* were also described by Tiedemann et al. (2017) and Badji et al (2017). Arkhipov (2009) documented eggs and larvae of 120 taxa in 71 families from broad ichthyoplankton surveys conducted from 1997 to 2008 at regularly spaced stations between latitudes 16° 05' to 20° 50' N off Mauritania. Samples were dominated numerically by Spanish sardine (*Sardinella aurita*), round sardine (*Sardina pilchardus*), horse mackerels (*Trachurus trecae* and *T. trachurus*), jack mackerel (*Caranx rhonchus*), Atlantic bonito (*Sarda sarda*), and chub mackerel (*Scomber japonicus*) all members of the small pelagic assemblage found in shelf waters as adults (see Appendices E-1 and E-2). Abundance of eggs and larvae of these species varied seasonally with respect to peak spawning times. These samples were collected in shelf waters less than 200 m deep. In another regional study, Olivar et al. (2016) sampled along the shelf break and down to 200 m. They found that the offshore ichthyoplankton was composed primarily of mesopelagic lanternfishes and bristlemouths.

Site-specific Sampling

Site-specific ichthyoplankton were collected along the Mauritania-Senegal maritime boundary in November and December 2016 (winter) and in July and August 2017 (summer), with several samples collected in the Offshore Area and Nearshore Hub/Terminal Area, as summarized below. Details of the winter and summer sampling efforts are provided in Appendices D and G. Results of entrainment modeling and effects on plankton are outlined in Appendix M.

Offshore Area – Winter

Sampling within the Offshore Area occurred at two depth strata – 0 to 15 m and 15 to 30 m. Samples from the Offshore Area produced 34 taxa representing 17 families and nine orders. The most abundant family was the lanternfishes (Myctophidae) which accounted for 48% of the mean density. Four lanternfish taxa – *Myctophum affine*, *Myctophum nitidulum*, *Diaphus* sp., and *Hygophum macrochir* – accounted for 35% of the total abundance.

Members of the mesopelagic group typically migrate from deep waters towards the surface at night. Lanternfishes and bristlemouths numerically dominate midwater assemblages worldwide. Most (60%) of the taxa collected in the Offshore Area could be classified as mesopelagic. The oceanic pelagic group includes tunas, billfishes, and dolphinfishes, but only halfbeaks and flying fishes were collected from this group during the 2016 EBS.

The upper stratum (0 to 15 m) produced the higher total densities of fish eggs and larvae compared to the lower stratum (15 to 30 m). However, larval density did not differ significantly among the depth strata or photoperiod. The density of fish eggs collected at the Offshore Area averaged 5.8 eggs 100 m^{-3} and ranged from 0 to 19.6 eggs 100 m^{-3}, with significant variation in egg densities evident between the 0 to 15 m and 15 to 30 m strata. A phylogenetic listing of larval fish collected in the Offshore Area is presented in Appendix D.

Offshore Area – Summer

Summertime collections for the Offshore Area yielded 2,429 individuals from 95 taxa in 45 families and 16 orders. The most abundant taxa included frigate mackerel (*Auxis* sp.) contributing 21.5% to the total followed by Gobies (Gobiidae; 14.8%); mackerels (Scombridae; 7.4%); anchovies (Engraulidae; 5.4%); lightfishes (*Vinciguerria nimbaria*; 5.4%); scorpionfishes (Scorpaenidae; 4.6%) and lanternfishes (*Diaphus* sp.; 3.0%). Several of these numerically dominant taxa, including gobies, some mackerels, and anchovies, may have originated in shallow waters. Many of the taxa were mesopelagic, including lanternfishes, bristlemouths, and light fishes typical of offshore waters. During summer, the larvae of several members of the oceanic pelagic group were collected including tunas (*Thunnus* sp., *Euthynnus* sp., *Auxis* sp.), billfishes (*Istiophorus* sp.), dolphinfishes (*Coryphaena hippurus*, *C*. *equiselis*), and wahoo (*Acanthocybium solandri*).

Samples from the offshore location yielded larval densities ranging from 2.3 to 216.4 individuals 100 m^3. The average density for these samples was 75.7 individuals 100 m^{-3}. The density of fish eggs collected at the Offshore Area averaged 19.3 and ranged from 2.2 to 58.2 eggs 100^{-3}.

Nearshore Hub/Terminal Area – Winter

Twelve ichthyoplankton samples from the Nearshore Hub/Terminal Area yielded 110 individuals from 32 fish taxa in 20 families and nine orders. The most species-rich orders were the perch-like fishes (Perciformes) and the flatfishes (Pleuronectiformes) represented by 11 and nine taxa, respectively. The taxonomic composition and abundance of larval fishes taken at the Nearshore Area was dominated numerically by the larvae of soft bottom species which collectively contributed about 50% of the numbers of larvae collected. Soft bottom species were represented by Sciaenidae (drums, croakers, and seatrouts), Paralichthyidae (sand flounders), Sparidae (porgies), and Aulopiformes (lizardfishes). The coastal pelagic species (sardines, anchovies, jack mackerels) contributed an additional 16% of the larvae collected.

The highest numbers of larvae were collected at night from both 0 to 10 and 10 to 20 m depth strata. Mean numbers of larvae per 100 m^3 were higher in the 0 to 10 m stratum during both day and night sample periods. The number of fish eggs in the samples from the nearshore area averaged 22.3 eggs 100 m^{-3}. Egg densities were significantly higher in the 0 to 10 m depth stratum. A phylogenetic listing of larval fish collected in the Nearshore Area is presented in Appendix G.

Nearshore Hub/Terminal Area – Summer

Samples taken in summer months produced 4,222 individuals from 46 taxa in 22 families and 9 orders. The most species-rich orders were the perch-like fishes (Perciformes) and the flatfishes (Pleuronectiformes) represented by 28 and 13 taxa, respectively. Individual taxa contributing most to the total larval density were Atlantic bumper (*Chloroscombrus chrysurus*) contributing 37.7%, grunts (Haemulidae; 11.7%), jacks (*Caranx*/*Lichia amia*; 11.3%), drums and croakers (Sciaenidae; 10.6 %), horse mackerels (*Trachurus* spp.; 8.4%), and tonguefishes (*Symphurus* sp.; 4.1%). The taxonomic composition and abundance of larval fishes taken at the Nearshore Area was dominated numerically by the larvae of coastal pelagic species which accounted for greater than 50% of the overall abundance. Large numbers of larval Atlantic bumper, leerfish, and jack mackerel were responsible for the dominance of this group. Soft bottom species were represented by grunts, tonguefishes, drums, croakers, spot, and Aulopiformes (lizardfishes).

Larval densities did not differ among depth strata or sampling period (day vs. night). Densities ranged from 2.4 to 1,213.2 and averaged 564.5 eggs 100 m^{-3}. The number of fish eggs in the samples collected in summer ranged from 7.3 to 2,018.7 eggs 100 m^{-3} and averaged 486.0 eggs 100 m^{-3}.

Pipeline (Mid-Depth) Area – Winter

No known site-specific ichthyoplankton samples have been collected during winter in the Pipeline (Mid-Depth) Area. However, it is likely that the ichthyoplankton assemblage in the deepwater (>1,000 m) areas of the Pipeline Area are similar to the Offshore Area, as described above. Within the shallower portions of the Pipeline Area, the ichthyoplankton assemblage is expected to be similar to the characteristics identified for the Nearshore Hub/Terminal Area, discussed above.

Pipeline (Mid-Depth) Area – Summer

Mid-Depth samples were similar in composition to those taken at the Offshore Area during summer. A total of 96 taxa were collected representing families in 16 orders. Taxa contributing most to the overall abundance were sardines (*Sardinella* sp.; 17.4%); frigate mackerels (*Auxis* sp.; 6.0%); sardines and anchovies (Clupeiformes; 5.8%); gobies (Gobiidae; 5.1%); and driftfishes (*Cubiceps* sp.; 5.1%), mackerels (Scombridae; 5.1%), jacks (*Caranx* sp.; 4.4%), and lanternfishes (*Diaphus* sp.; 3.9%). Larval densities ranged from 28.8 to 277.1 individuals 100 m^{-3} with a mean of 100.3 individuals 100 m^{-3}. Egg densities at the mid-depth area averaged 694.5 100 m^{-3} and ranged from 6.6 to 7,715.0 individuals 100 m^{-3}.

4.5.2 Marine Flora

Marine flora include seagrasses and macroalgae. Seagrasses are flowering plants (angiosperms) belonging to four families (Posidoniaceae, Zosteraceae, Hydrocharitaceae, and Cymodoceaceae) which grow in marine, fully saline environments (den Hartog, 1970; Green and Short, 2003). Macroalgae comprise a diverse group of multicellular photosynthetic organisms that do not possess various structures that characterize seagrasses and terrestrial plants. These macro-autotrophs include three major divisions: Chlorophyta (green algae), Ochrophyta, class Phaeophyceae (brown algae), and Rhodophyta (red algae) (Koch et al., 2013). Macroalgae are, by definition, of sufficient size to be seen by the naked eye.

Seagrass communities are one of the most productive and dynamic ecosystems. They provide habitats and nursery grounds for many marine animals, and stabilize seafloor substrate. Seagrass meadows are important as they provide sheltered refuges and feeding areas for numerous invertebrates and juvenile fish (Hemminga and Duarte, 2000). The rhizomes and roots of the grasses bind sediments on the bottom, where nutrients are recycled by microorganisms back into the marine ecosystem. The leaves of the grasses slow water flow, allowing suspended material to settle on the bottom. This increases the amount of light reaching the seagrass bed and creates a calm habitat for many species (Hogarth, 2007). Seagrass meadows are a major food source for species such as the green turtle (*Chelonia mydas*). An adult green turtle eats about two kilograms of seagrass a day (Hemminga and Duarte, 2000).

Marine macroalgae are found from intertidal to shallow subtidal zones. Macroalgae communities along with seagrasses are part of the base of the food web in marine coastal ecosystems with a vital role in nutrient cycling processes. They also support the diverse assemblages of associated species by providing them a physical structure (Koch et al., 2013; Leopardas et al., 2014).

Mauritania

The coast of Mauritania consists of sandy beaches and dunes, along with some rocky islets, including Chickchitt, Iouik, and Kiaone. Within areas where sand and other unconsolidated sediments predominate, the presence of macroalgal flora is poor (Marcot-Coqueugniot, 1991). Lawson and John (1977) reported 158 macroalgal taxa from the green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta). Marcot-Coqueugniot (1991) reported an additional 57 taxa collected during surveys conducted on Banc d'Arguin during April 1987, October 1987, and May 1988. During these surveys, algae was collected in water depths between 2 and 6 m. A total of 57 taxa were recorded for the first time in Mauritania, representing a 36% increase in the known marine algal flora from Mauritania. In addition, 20 of these 57 taxa represented first records from the tropical west African coast.

The Banc d'Arguin is a non-estuarine area of shallows and intertidal flats off the tropical Saharan coast of Mauritania, and is characterized by extensive intertidal and subtidal beds of the seagrass *Zostera noltii* (or dwarf eelgrass) (van der Laan and Wolff, 2006). *Z. noltii* is distributed from Europe to west Africa. Mauritania represents the southern limit of its distribution in west Africa. At Banc d'Arguin, half of the intertidal area which is emergent at low tide (500 km²) is covered by dense beds of this species (Honkoop et al., 2008). Other seagrasses such as *Cymodocea nodos*a with *Halodule wrightii* are found in the subtidal zone at Banc d'Arguin (UNEP, 2016).

Senegal

Relatively few studies have been conducted to characterize the marine algae present along the Senegal coast and within its offshore waters. Harper and Garbary (1997) characterized the algal flora of northern Senegal (from MBour to Joal, south of the core study area), based on literature review and field surveys. They identified 80 species out of 242 known species for this area. Among the 80 species identified by Harper and Garbary (1997), collections were dominated by Rhodophyta (52 taxa), followed by Chlorophyta (16 taxa) and Phaeophyta (12 taxa).

No recent studies of marine flora were identified for the northern coastline of Senegal. However, peripheral references include published sources for west Africa marine flora which provide species-specific information on distribution between Senegal and Gabon (e.g., Anderson et al., 2012).

The Réseau Régional d'Aires Marines Protégées en Afrique de l'Ouest (RAMPAO, 2017) has noted that one of the primary characteristics of the Saint Louis Marine Protected area is the extensive mudflats, where dominant species include eelgrass (*Zostera noltii*), slender seagrass (*Cymodocea nodosa*) and shoalgrass (*Halodule wrightii*).

4.5.3 Benthic Communities

Benthic communities may be broadly classified as soft bottom or hard bottom depending on the predominant substrate type foundational to the associated biological assemblages.

4.5.3.1 Soft Bottom Communities

Regional Patterns

The project area lies within the highly productive CCLME (Mauritania Strategic Environmental Assessment, 2011) region under the influence of strong seasonal upwelling. High surface primary productivity, and subsequent elevated secondary and tertiary production (i.e., zooplankton, fishes, higher trophic levels), produces organic material which sinks through the water column and subsequently elevates benthic standing stock.

Soft bottom communities are composed of infauna (species living in the seabed), epifauna (species living on or above the seabed) and megafauna (larger taxa living on or just above the seafloor, including some fishes). Infauna, epifauna, and megafauna are further delineated based on size, as defined below. Sediment type and grain size are major factors determining benthic community composition. However, other factors influence the structure of the benthic ecosystem, including water depth, temperature, organics (i.e., food availability), and currents, the latter of which transport terrigenous material to the deep benthos. In the Offshore Area where water depths range from 2,750 to >3,000 m, clay and silt fractions are expected to predominate the surficial sediments. Woodside (2005) indicated silt dominated sediments east of the Offshore Area in a water depth of approximately 800 m at the Chinguetti Field.

Meiofauna

Meiofauna, due to relative high abundance, diversity, and secondary production, are an important component in benthic food webs. Meiofaunal samples usually contain diverse assemblages that include annelids, nematodes, harpacticoid copepods, and foraminiferans. Meiofauna are typically considered to be those infaunal organisms that are <500 micrometers (µm) and greater than 63 µm in size; in deepwater environments, where infauna are generally smaller, the upper size limit for meiofauna may be 300 µm. Although several meiofaunal studies have been conducted in the deep water region off the west African coast, there are only a few studies documenting meiofauna off the Mauritania and Senegal coasts.

Galéron et al. (2000), sampling in deep water off Cape Blanc (approximately 315 km north-northwest of the Offshore Area), provided extensive details regarding meiofauna in water depths similar to the Offshore Area. Mean meiofaunal densities (±1 SD) from stations in water depths of 1,600 to 2,100 m ranged from 78.0 ± 24.3 to 103.9 ± 35.3 individuals cm^{-2}. Meiofaunal density was dominated by nematodes (>90% of total density). Copepods were also well represented, contributing 6% of total density. Polychaetes were found regularly and accounted for about 1% to 3% of total density. Less abundant taxa included tardigrades, kinorhynchs, molluscs, ostracods, and tanaids. No seasonality (i.e., temporal variation) was observed in the meiofauna density between sampling surveys. These taxa were present but did not occur regularly in the samples. In terms of biomass, copepods and nematodes were dominant, accounting for approximately 55.5% and approximately 44.6% of the total meiofauna, respectively. Mean meiofaunal biomass ranged from 79 to 96 µg C 10 cm^{-2} (Galéron et al., 2000). The results summarized by Galéron et al. (2000) are considered to be representative of the meiofaunal community likely present in the vicinity of the Offshore Area. Other relevant meiofaunal studies also include Lutz and Coulbourn (1984) and Reymond et al. (2014).

Macrofauna

Macrofauna (or macroinfauna), as part of the infaunal community, typically include those organisms that are >500 µm in size within shelf and slope environments; in deeper water environments, the lower size limit for macrofauna is 250 to 300 µm. The upper size limit for macrofauna is generally considered to be 2 centimeters (cm).

Off Cape Blanc, with sampling at 11 stations located between 1,600 and 2,100 m, Galéron et al. (2000) determined that the infaunal/macrofaunal community represented by 21 taxa was dominated by polychaetes, followed by crustaceans (i.e., tanaids, isopods) and molluscs (i.e., bivalves). Total macrofaunal mean density (±1 SD) and mean biomass (±1 SD) ranged from 996 ± 319 to 1,357 ± 276 individuals 0.25 m^{-2}, and from 251 to 405 mg C m^{-2}, respectively. No temporal variation was observed in the macrofauna density between sampling surveys. Benthic standing stock of macrofauna noted by Galéron et al. (2000) in the area of strong upwelling was particularly high, supporting earlier findings from the region by Nichols and Rowe (1977), Thiel (1978, 1982), and Aldred et al. (1979).

Megafauna

Megafauna associated with the benthos are typically considered to be >2 cm, and are routinely visible in benthic photographs or videotapes.

Approximately 136 km east northeast of the Offshore Area along the Mauritania slope, Jones and Brewer (2012) conducted video surveys of megafauna between 1,000 and 1,500 m. A total of 29 megafaunal taxa were observed in remotely operated vehicle (ROV) video covering 17,199 m^2 of seabed, with an overall average faunal density of 0.34 individuals m^{-2}. Taxa observed were predominantly fish (9 taxa, 0.148 individuals m^{-2}), echinoderms (6 taxa, 0.233 individuals m^{-2}), cnidarians (5 taxa, 1.044 individuals m^{-2}), and arthropods (5 species, 0.259 individuals m^{-2}). Other observed megafauna included cephalopod molluscs, polychaete worms, and sponges.

Various megafauna exhibited bathymetric trends, including depth-related changes in population densities (Jones and Brewer, 2012). High densities were observed for asteroids, ophiuroids, anemones, and small macrourids (rattails or grenadiers) in the shallower portion; *Benthothuria funabris*, black cerianthid anemone, and munidid squat lobster in the intermediate portion; and holothurians *Enypniastes eximia*, and *Elipidia echinata* in the deeper portion of the 1,000 to 1,500 m deep study area. Other species showed no clear patterns with depth (*Phormosoma placenta*, *Actinoscyphia aurelia*, *Paralomis africana*, cephalopods, and most fish) (Jones and Brewer, 2012).

Galéron et al. (2000) reported findings from a megafauna survey conducted off Cape Blanc in a water depth range between 1,600 and 2,100 m and approximately 315 km north-northwest of the Offshore Area. Invertebrate megafauna included 22 taxa that were numerically dominated by actiniarians (i.e., sea anemones) and various class of echinoderms. Megafauna collected using deepwater trawl techniques had densities that ranged from 0.8 to 2.5 individuals m^{-2}.

In summary, soft bottom benthic communities present in the Offshore Area may be expected to exhibit similar levels of density and biomass as noted by Galéron et al. (2000) and summarized in Table 4-9.

Table 4-9. Total Mean Density and Total Mean Biomass for Meiofauna, Macrofauna, and Megafauna in Mauritania Offshore Area.

Parameter and Size Class	Mean Value
Total Mean Density (individuals m^{-2})	
Meiofauna	1,039,000
Macrofauna	5,436
Megafauna	0.8221
Total Mean Biomass (mg C m^{-2})	
Meiofauna	96.3
Macrofauna	251
Megafauna	430

(Adapted from: Galéron et al., 2000)

Ramil and Ramos (2017) have summarized the results of a series of cruises conducted off the Mauritania coast (i.e., along the continental margin) by the R/V *Vizconde de Eza* to characterize benthic megafauna. During four annual cruises conducted in late fall and early winter (November-December) of 2007-2010, the demersal megafauna present at 291 stations were sampled via otter trawl in depths between 79 and 1,867 m. Results of statistical analyses highlighted the differences in megafauna between various depth strata. Four major taxa were considered unique in the deep-shelf assemblage (80-100 m), including cephalopods (*Octopus vulgaris*, *Sepia elegans*), decapods (*Munida speciosa*, *Macropipus rugosus*, *Parapenaeus longirostris*), hydrozoans (*Sertularella gayi gayi*), and sea urchins (*Centrostephanus longispinus*). The upper slope assemblage (180-440 m) had several unique species of decapods (*Parapenaeus longirostris*, *Plesionika heterocarpus*, *Solenocera africana*, *Munida speciose*, *Pasiphaea semispinosa*). The middle slope assemblage (460-1,200 m) was characterized by seven other decapod species (*Aristeus varidens*, *Glyphus marsupialis*, *Acanthephyra pelagica*, *Hymenopenaeus chacei*, *Nematocarcinus africanus*, *Stereomastis talismani*, *Systellaspis debilis*). Other non-decapod species (*Phormosoma placenta*, *Benthoctopus* sp.) were also noted. In the deep slope assemblage (1,200-1,900 m), holothuiroids (i.e., deep sea cucumbers; *Enypniastes eximia*, *Benthoturia funebris*, *Paelopatides grisea*), decapods (*Acanthephyra pelagica*, *Pasiphaea tarda*, *Glyphus marsupialis*, *Neolithodes asperrimus*, *Stereomastis talismani*, *Hymenopenaeus chacei*, *Benthesicymus bartletti*), anthozoans (anemones; *Phelliactis* sp., *Actinaria* indeterminant), and starfish (echinoderm; *Pseudarchaster gracilis*) were prevalent.

Area-Specific Soft Bottom Characterization – Benthic Infaunal Sampling

In November and December 2016, CSA collected multiple sediment samples during an EBS in each of these areas to provide site-specific data on infauna, in addition to sediment grain size and chemistry. Detailed EBS results are presented in Appendix D. The following discussion summarizes the key findings on an area by area basis.

Offshore Area

The top ten most abundant infauna in five sediment samples collected from within the Offshore Area offshore along the Mauritania-Senegal maritime boundary are summarized in Table 4-10. Samples yielded a total of 1,274 individuals representing 100 taxa from eight phyla, dominated by polychaetes, crustaceans, molluscs, and ribbon worms. An analysis of species diversity suggested that the offshore, deepwater environment of the Offshore Area is composed of a diverse infaunal assemblage with most species present in low numbers and no numerical dominance. Polychaetes contributed about 12% more to the total abundance than crustaceans and about 30% more than molluscs. The top ten most abundant taxa accounted for just over 50% of the overall abundance. Infaunal densities ranged from 1,559 to 2,441 individuals m^{-2}, with an average density of 2,080 individuals m^{-2}.

The diversity, abundance, and taxonomic composition of the deepwater samples collected offshore in deepwater along the Mauritania-Senegal maritime border were broadly similar to patterns observed for the region (Thiel, 1982; Duineveld et al., 1993; Le Loeuff and von Cosel, 1998; Dabi, 2015; CSA, 2016). The proportional abundance of polychaetes, crustaceans, and molluscs reflects the general phylogenetic pattern found off west Africa and other shelf-slope areas with similar substrates and water depths (Thiel, 1982; Duineveld et al., 1993; Le Loeuff and von Cosel, 1998; Michel et al., 2011), with qualification. The aforementioned studies pertain primarily to coastal and shelf (<200 m) and upper slope (<1,300 m) waters. Only limited information is available regarding regional infauna in deepwater environments (e.g., Galéron et al., 2000).

Pipeline Area

Results of 11 sediment samples collected in the Pipeline Area produced 7,854 individuals from 279 taxa and eight phyla. The top ten most abundant infaunal taxa from each depth strata in the Pipeline Area are summarized in Table 4-11.

Mean number of taxa per sample varied from shallow to deep water. The lowest mean number of taxa (47.5) was recorded for the 500 to 1,000 m stratum and the highest (75.0) in the 100 to 200 m stratum. Numbers of individuals also varied considerably across the depth strata but generally decreased with increasing water depths. Mean Shannon-Wiener diversity (H') ranged 2.7 in the 200 to 500 m stratum to 3.6 in the 2,000 to 2,500 m stratum. Evenness (J') was lowest (0.7) in the 200 to 500 m and highest (0.9) in the 2,000 to 2,500 m strata.

Polychaete worms, crustaceans (Malacostraca), and bivalve mollusks, accounted for an average of 88.1% of the total individuals in stations within the Pipeline Area. Percent numerical contribution of polychaetes ranged from 35.9% in the 1,000 to 1,500 m stratum to 85% in the 200 to 500 m stratum. Percentage of crustaceans was lowest (2.9%) at the 200 to 500 m stations and highest (32.3%) in the 2,000 to 2,500 m stratum. The ten most abundant taxa differed among the depth strata, but some such as the polychaetes *Prionospio* sp., *Aricidea* sp. and Cirratulidae were found in most strata. Others including the mollusks, Thyasiridae and *Prochaetoderma* sp. were more abundant in the deeper strata. The percent contribution of different phylogenetic classes to abundance in the samples from all seven pipeline strata is presented in Table 4-11. The relative contribution of polychaetes decreases with increasing water depth as the abundance of bivalves and malacostracans increases with increasing water depth.

Table 4-10. Top Ten Most Abundant Infaunal Taxa Collected from the Offshore Area (OA) and Relative Density Determinations.

Phylum	Common Definition	Taxon	Density (individuals m^{-2}) by Station					Mean	SD
			OA-1	OA-2	OA-3	OA-4	OA-5		
Polychaeta	Polychaete, segmented marine worm	*Prionospio sp.*	106.1	155.1	163.3	318.4	195.9	187.8	79.8
Malacostraca	Crustacean, tanaid	Paratanaoidea	32.7	204.1	212.2	269.4	187.8	181.2	88.6
Polychaeta	Polychaete, segmented marine worm	*Aricidea sp.*	81.6	146.9	146.9	122.4	57.1	111.0	40.2
Polychaeta	Polychaete, segmented marine worm	*Cirrophorus sp.*	73.5	89.8	155.1	81.6	138.8	107.8	36.7
Polychaeta	Polychaete, segmented marine worm	*Abyssoninoe sp.*	155.1	32.7	16.3	89.8	220.4	102.9	85.3
Malacostraca	Crustacean, tanaid	*Leptognathiella sp.*	24.5	179.6	81.6	98.0	65.3	89.8	57.1
Malacostraca	Crustacean, tanaid	*Pseudotanais sp.*	16.3	155.1	89.8	65.3	32.7	71.8	54.6
Anopla	Nemertean, ribbon worm	Tubulanidae	65.3	32.7	49.0	106.1	98.0	70.2	31.4
Caudofoveata	Mollusc, aplacaphore (no shell)	*Niteomica sp.*	49.0	32.7	57.1	114.3	89.8	68.6	33.0
Polychaeta	Polychaete, segmented marine worm	*Cirratulidae*	24.5	89.8	16.3	98.0	106.1	66.9	43.0
		Total Density (all infauna)	**1,559.2**	**2,032.7**	**2,195.9**	**2,440.8**	**2,171.4**	**2,080.0**	**326.1**

SD = standard deviation

(From: Appendix D)

Table 4-11. Top Ten Most Abundant Taxa for the Nearshore Area (<25 m) and Seven Depth Strata within the Pipeline Area.

Sample size for Nearshore Area was n=5; for all Pipeline Area strata n=3; all samples sieved with 0.5 mm screen mesh. Bold entries represent the top ten abundance rank (R) for each sampling location (Nearshore Area and Pipeline Area strata).

Class	Taxon	Depth Strata (m)																	
		Nearshore Area		Pipeline Area															
		<25	R	25-100	R	100-200	R	200-500	R	500-1,000	R	1,000-1,500	R	1,500-2,000	R	2,000-2,500	R	Total	Frequency
Polychaeta	*Prionospio* sp.	**103**	**4**	**190**	**1**	**199**	**2**	**67**	**7**	**19**	**7**	13	--	**25**	**8**	**34**	**4**	650	8
Polychaeta	*Aricidea* sp.	46	--	**28**	**9**	**226**	**1**	**144**	**3**	**37**	**4**	**18**	**8**	15	--	**32**	**5**	546	8
Polychaeta	Cirratulidae	11	--	26	--	**151**	**4**	**74**	**6**	**17**	**9**	15	--	9	--	**22**	**8**	325	8
Polychaeta	*Levinsenia* sp.	**3**	--	3	--	**72**	**9**	**79**	**5**	**40**	**2**	15	--	7	--	1	--	220	8
Polychaeta	Tubulanidae	**88**	**6**	18	--	16	--	15	--	9	--	3	--	8	--	9	--	166	8
Polychaeta	*Sigambra* sp.	**87**	**7**	2	--	1	--	3	--	1	--	4	--	1	--	1	--	100	8
Polychaeta	*Spiophanes* sp.	2	--	2	--	16	--	16	--	**36**	**5**	13	--	5	--	3	--	93	8
Polychaeta	*Notomastus* sp.	5	--	3	--	19	--	3	--	3	--	2	--	7	--	**24**	**7**	66	8
Bivalvia	Thyasiridae	0	--	15	--	11	--	**138**	**4**	**39**	**3**	**198**	**1**	**92**	**1**	**49**	**3**	542	7
Malacostraca	*Ampelisca* sp.	**103**	**5**	12	--	49	--	17	--	**16**	**10**	**30**	**5**	1	--	0	--	228	7
Malacostraca	Paratanaoidea	0	--	1	--	31	--	1	--	**65**	**1**	**16**	**9**	**28**	**6**	17	--	159	7
Polychaeta	*Aglaophamus lyrochaeta*	19	--	**46**	**5**	14	--	19	--	3	--	0	--	**10**	--	11	--	122	7
Polychaeta	*Heteromastus* sp.	**80**	**9**	0	--	7	--	7	--	7	--	1	--	**2**	--	1	--	105	7
Polychaeta	*Lumbrineris* sp.	0	--	2	--	26	--	4	--	8	--	6	--	**2**	--	**21**	**9**	69	7
Polychaeta	*Ampharete* sp.	0	--	11	--	**83**	**7**	**150**	**2**	0	--	13	--	**25**	**9**	20	--	302	6
Malacostraca	*Harpinia* sp. 1 EcoA	0	--	1	--	8	--	0	--	**24**	**6**	**38**	**4**	**20**	**10**	20	--	111	6
Polychaeta	*Spiochaetopterus* sp.	55	--	**93**	**2**	57	--	**27**	**10**	1	--	1	--	0	--	0	--	234	6
Polychaeta	*Magelona* sp.	**221**	**2**	5	--	11	--	**32**	**9**	4	--	0	--	0	--	0	--	273	5
Polychaeta	*Monticellina* sp.	22	--	4	--	**59**	**10**	**41**	**8**	1	--	0	--	0	--	0	--	127	5
Bivalvia	*Cadulus* sp.	0	--	0	--	0	--	10	--	8	--	**16**	**10**	2	--	2	--	38	5
Caudofoveata	*Prochaetoderma* sp.	0	--	0	--	0	--	0	--	3	--	**104**	**3**	**46**	**3**	**53**	**2**	206	4
Polychaeta	*Scoloplos* sp.	**230**	**1**	**46**	**4**	21	--	2	--	0	--	0	--	0	--	0	--	299	4
Polychaeta	Fauveliopsidae	0	--	0	--	0	--	0	--	5	--	**123**	**2**	**29**	**5**	4	--	161	4
Scaphopoda	Dentaliida	0	--	0	--	0	--	0	--	8	--	**22**	**7**	16	--	6	--	52	4

Class	Taxon	Depth Strata (m)																	
		Nearshore Area		Pipeline Area															
		<25	R	25-100	R	100-200	R	200-500	R	500-1,000	R	1,000-1,500	R	1,500-2,000	R	2,000-2,500	R	Total	Frequency
Polychaeta	*Tachytrypane* sp.	0	--	0	--	0	--	0	--	3	--	**30**	**6**	7	--	2	--	42	4
Polychaeta	*Eunice* sp.	0	--	**34**	**7**	**160**	**3**	14	--	0	--	0	--	0	--	0	--	208	3
Polychaeta	*Chone* sp.	0	--	**37**	**6**	**95**	**6**	4	--	0	--	0	--	0	--	0	--	136	3
Malacostraca	*Apseudopsis* sp.	0	--	**66**	**3**	0	--	0	--	**19**	**8**	2	--	0	--	0	--	87	3
Bivalvia	*Saccella* sp.	0	--	0	--	0	--	0	--	1	--	0	--	**53**	**2**	**20**	**10**	74	3
Malacostraca	Desmosomatidae	0	--	0	--	0	--	0	--	0	--	16	--	**27**	**7**	**24**	**6**	67	3
Polychaeta	*Eusyllis* sp.	4	--	4	--	**75**	**8**	0	--	0	--	0	--	0	--	0	--	83	3
Bivalvia	Veneridae	0	--	0	--	0	--	0	--	1	--	13	--	**43**	**4**	0	--	57	3
Polychaeta	*Diopatra* sp.	3	--	**31**	**8**	3	--	0	--	0	--	0	--	0	--	0	--	37	3
Polychaeta	*Paradiopatra* sp.	0	--	6	--	0	--	**347**	**1**	0	--	0	--	0	--	0	--	353	2
Polychaeta	*Isolda* sp.	0	--	5	--	**107**	**5**	0	--	0	--	0	--	0	--	0	--	112	2
Polychaeta	*Lysippe bipennata*	**85**	**8**	8	--	0	--	0	--	0	--	0	--	0	--	0	--	93	2
Malacostraca	Haploniscidae	0	--	0	--	0	--	0	--	0	--	1	--	0	--	**86**	**1**	87	2
Malacostraca	*Gammaropsis* sp.	0	--	**28**	**10**	15	--	0	--	0	--	0	--	0	--	0	--	43	2
Malacostraca	*Ogyrides rarispina*	**104**	**3**	0	--	0	--	0	--	0	--	0	--	0	--	0	--	104	1
Malacostraca	Anthuridae sp. 2 EcoA	**57**	**10**	0	--	0	--	0	--	0	--	0	--	0	--	0	--	57	1
	Total top ten	1,073		599		1,227		1,099		312		579		388		365		6,834	
	Total	1,753		1,118		2,157		1,461		599		1,002		771		746		9,607	
	Percent (%)	61.2		53.6		56.9		75.2		52.1		57.8		50.3		48.9		71.1	

"--" – not ranked.

(From: Appendix D)

Nearshore Area

Five nearshore samples yielded a total of 1,753 individuals and 70 taxa from seven phyla. Densities of infauna among the five nearshore samples ranged from 2,147 to 2,988 individuals m^{-2}. The top ten most abundant infaunal taxa from the Nearshore Area are summarized in Table 4-11.

The total number of taxa per sample ranged from 39 to 56 with a mean of 46.4. Total individuals per sample averaged 350.6 and ranged from 263 to 476. The Shannon-Wiener diversity index (H') averaged 3.12. Mean evenness (J') per sample was high (0.82) indicating equitable relative abundance per species.

Annelida, Arthropoda, and Mollusks collectively contributed over 91% of the total individuals in the nearshore area samples. The annelids were represented mostly by polychaetes and, to a much lesser extent (<1% of total abundance), oligochaete worms (Class Clitilleta). Arthropods were predominantly represented by members of the class Malacostraca, which includes shrimps, crabs, lobsters, and other crustaceans (e.g., amphipods, isopods, tanaids, etc.). Mollusks were represented by gastropods, bivalves and scaphopods (tusk shells).

The ten most abundant taxa recorded from the Nearshore Area accounted for 61.2 % of the total number of individuals (1,753). The three most abundant species included two polychaetes (*Scolopsis* sp. and *Magelona* sp.) and the shrimp-like crustacean *Ogyrides rarispina*.

4.5.3.2 Hard Bottom Communities

Hard bottom communities develop where exposed hard substrate provides an attachment surface for sessile invertebrates (and algae in shallow water), such as sponges, soft corals, hard corals, and tunicates. If hard bottom communities were present within the Offshore Area, they likely would not support colonial reef-building scleractinian hard corals since these types of hard corals are typically limited to depths of less than 2,000 m (Freiwald et al., 2004). Regional hard bottom features, referred to as relict carbonate mounds (or carbonate mud mounds and coral reef features; Colman et al., 2005), have been documented offshore Mauritania to the north and east of the Offshore Area. These features have been characterized as carbonate mud mounds, previously inhabited by dense communities of cold water corals, including the reef-forming species *Lophelia pertusa*. Their designation as relict features is attributed to their physical structure, as well as their current characterization as carbonate mud mounds comprised of fossilized and dead coral fragments with few living reef-forming coral species present. Recent geophysical survey data and subsequent drop camera imagery have confirmed the presence of live bottom (i.e., exposed rock and lithoherm) within and adjacent to the Pipeline Area (see Section 4.5.3.3).

These carbonate mounds, restricted to water depths between 450 and 550 m (Colman et al., 2005; de Mol et al., 2009; Eisele, 2010; Eisele et al., 2011), are comprised of coral rubble embedded in a fine sediment matrix substrate that supports an overlaying biological assemblage. Age dating of these carbonate mound structures extends to 2.4 million years before present, with three distinct periods which supported coral growth and several hiatus periods (Eisele et al., 2011). Deepwater hard bottom formations, such as carbonate mounds, alter sediment deposition, provide complex structural habitat, and are the subject of growth and bioerosion processes (Somoza et al., 2014). In general within northern Atlantic waters, the principal coral species that contribute to hard bottom formation are *Lophelia pertusa*, *Oculina varicosa*, *Madrepora oculata*, *Desmophyllum cristagalli*, *Enallopsammia rostrata*, *Solenosmilia variabilis*, and *Goniocorella dumosa*. Offshore Mauritania, Colman et al. (2005) identified four coral species from dead fragments, including *Lophelia pertusa*, *Madrepora oculata*, *Solenosmilia variabilis* and *Desmophyllum* sp., suggesting that these carbonate mounds had previously been formed by reef-building corals (e.g., during the mid-Pleistocene). Colman et al. (2005) also observed live hard coral polyps, a single live coral colony (i.e., *L. pertusa*), tube worms, pencil urchins (?*Cidaris cidaris*), and portunid and galatheid crabs, typically on the upper portions of the mounds. Deepwater hard bottom formations provide a substrate and shelter for many other species, thus contributing to local and regional biodiversity (CSA, 2015).

Eisele et al. (2014) characterized the cold water coral mounds off Mauritania, referring to the structures as the Banda Mound Province. This Province, located in water depths between 450 and 550 m, is part of a 200 km-long chain of coral mounds which run parallel to slope bathymetry (Colman et al., 2005). The coral mounds extend southward from north of the Timiris Canyon system (Krastel et al., 2004) along the undisturbed central Mauritanian slope and on the uppermost edge of the Mauritania Slide Complex (Wien et al., 2007). Coral mounds are arranged in elongated clusters or are merged into highly complex composite structures; they can reach heights of up to 100 m with a diameter of >500 m at the foot of the mounds (Eisele et al., 2014).

4.5.3.3 Photographic Characterization

Drop Camera Imagery

Study area-specific visual data were collected through a geotechnical survey by Gardline in July/August 2017 at various locations within and adjacent to the Pipeline Area (Figure 4-16). Previous geophysical research by Oceaneering in March-April 2017 had mapped the seabed along both sides of the maritime border using multi-beam echosounders, side scan sonar and AUV. This survey was conducted along the proposed pipeline corridor which straddles the Mauritania-Senegal maritime boundary. The study revealed canyons and carbonate mounds within the wider area. Following the proposed pipeline corridor, Gardline remotely sensed seafloor anomalies in water depths where relict carbonate mounds had been documented further north (Colman et al., 2005). Identification and characterization of potential carbonate mounds along the proposed pipeline corridor was initiated to ensure avoidance of this potentially sensitive feature (Figure 4-16). Visual data were subsequently collected along and adjacent to the pipeline corridor, in water depths ranging between approximately 220 and 700 m to document conditions along the pipeline route, a canyon feature north and generally parallel to the pipeline, and an isolated ridge and mound south of the pipeline corridor. Photographic data were acquired using a drop camera system. General characterizations of benthic habitats (i.e., substrate types and associated biological communities) within the study area based on drop camera observations are provided below.

Habitats along the pipeline route were documented at 100-m intervals between water depths of 300 and 700 m. Habitat in the pipeline route at 300-m water depth was documented to be soft substrate predominately composed of fine fractions of silt and clay. There was no indication of any seafloor features other than minor topographic irregularities associated primarily with bioturbations such as small burrows, surficial depressions, and track marks. No hard bottom substrate was observed at this location along the pipeline. The most visually dominant biota was a particular species of squat lobster (*Munida speciosa*; Photo 4-1) which was documented in relatively high abundance. Other observed biota included deepwater swimming crab (*Bathynectes piperatus),* shrimp, serpulid polychaete and fish. Fish included snake eel (Ophichthidae), scorpionfish (*Helicolenus dactylopterus* and unidentified Scorpaenidae), tonguefish (*Symphurus* sp.), rattail (Macrouridae), and the mora (Moridae).

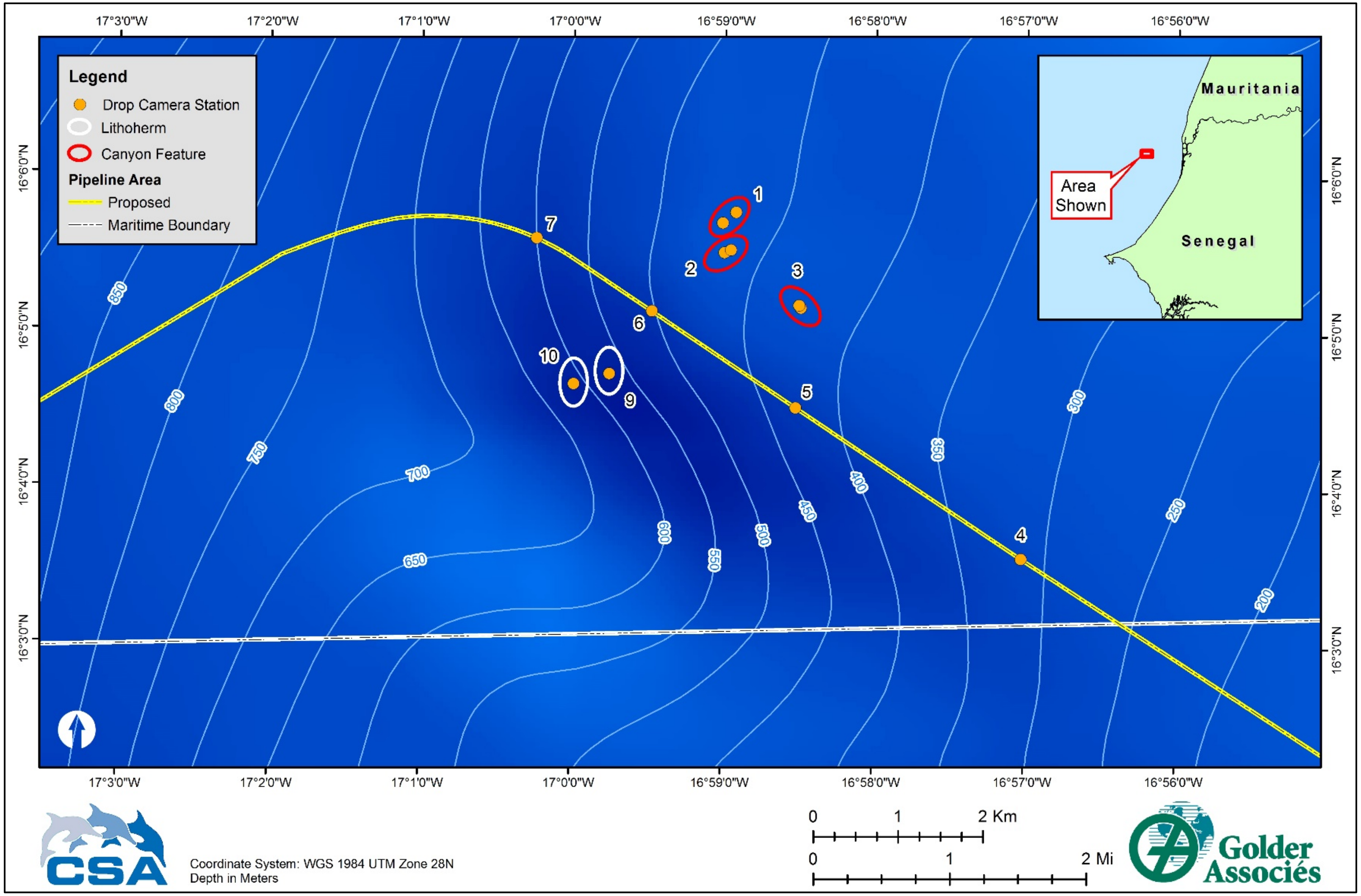


Figure 4-16. **Location of Photographic Stations Sampled along Portion of the Proposed Pipeline Corridor to Characterize Substrates and Associated Biological Communities.**

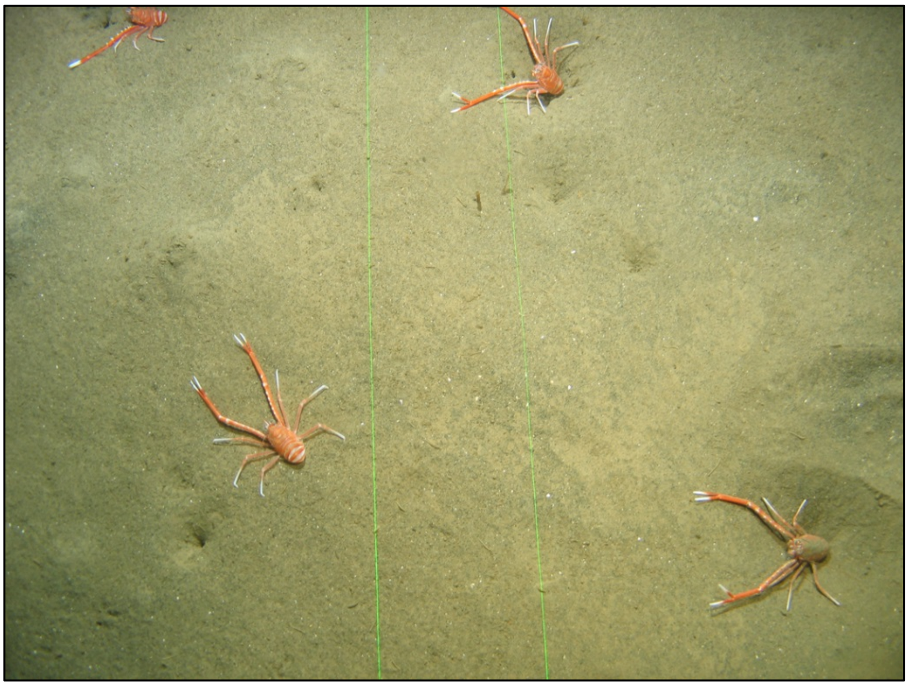


Photo 4-1. The visually dominant biota along the pipeline route in a water depth of approximately 300 m was the Anomurid squat lobster, *Munida speciosa*, which was documented in relatively high abundance.

Habitat along pipeline route between 400-m and 600-m water depths were visually similar. Substrates were documented to be soft sediment predominately composed of fine fractions of silt and clay, with what appears to be embedded organic material. Seafloor features indicate a relatively active microbenthic community with bioturbations such as maintained burrows, sediment mounds, and track marks (Photo 4-2). No hard bottom substrate was observed at these locations along the proposed pipeline route. The most visually dominant biota were shrimp (multiple taxa) which were documented in relatively high abundance, in particular at the more shoreward location (i.e., 400-m water depth). Other observed biota included carrier shell snail (*Xenophora* sp.), octopus, deepwater carrier crab (*Paromola cuvieri),* a type of angular crab (?*Goneplax* sp.), mud crabs, hermit crab, burrowing anemones (Cerantharia)*,* sea pen octocorals (Pennatulacea), and fish. Fish included scorpionfish (Scorpaenidae), snake eel (Ophichthidae), catshark (Scyllorhinidae) (Photo 4-3), codling (*Laemonema* sp.), and mora (Moridae).

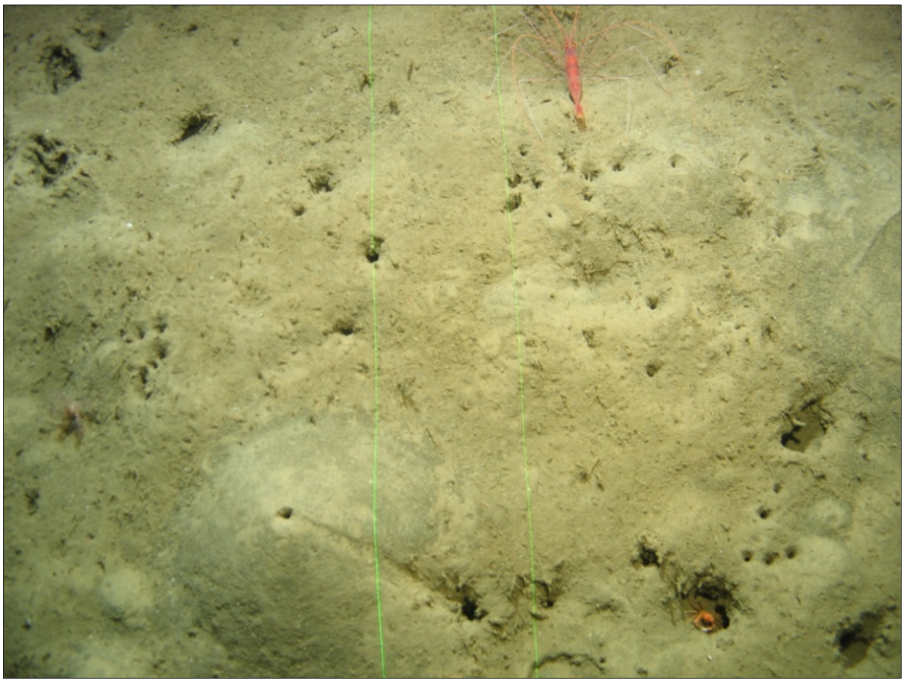


Photo 4-2. Seafloor features, along the pipeline route in a water depth range between 400 m and 600 m, indicated a relatively active microbenthic community with bioturbations such as maintained burrows, sediment mounds, and track marks.

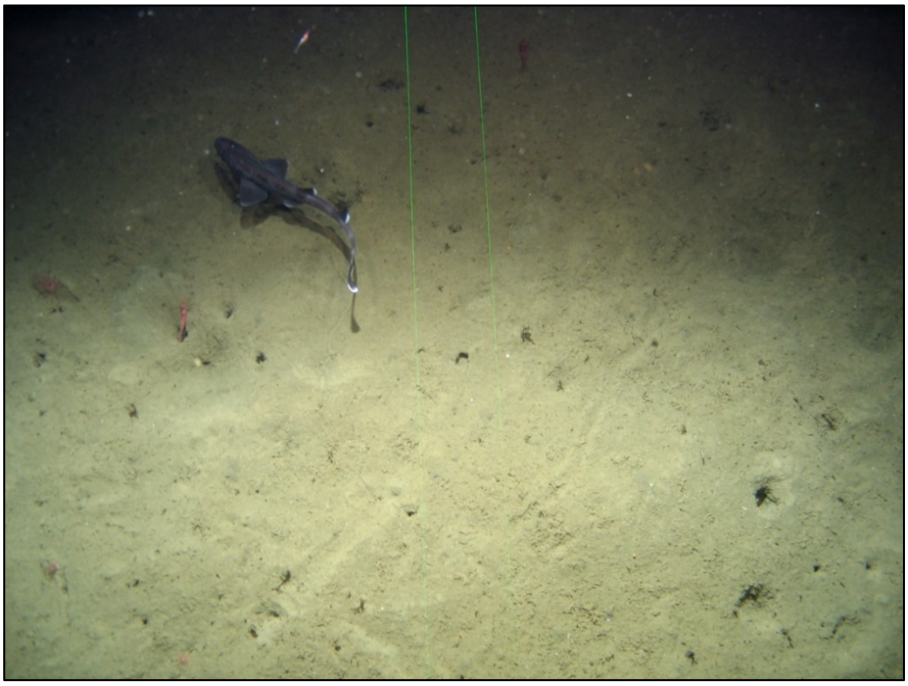


Photo 4-3. A catshark (Scylorhinidae) was observed swimming over the soft bottom substrate along the pipeline route in a water depth of approximately 500 m.

Study area visual data was further collected at three particular locations along a canyon feature north of the proposed pipeline; locations included a steeply sloping canyon wall, canyon floor, and shoreward sloping head of the canyon. Much of the canyon wall was characterized by soft substrate predominantly composed of fine fractions of silt and clay. Soft bottom seafloor features included minor topographic irregularities associated primarily with bioturbations such as small burrows, surficial depressions, and track marks (Photo 4-4). Some areas of soft bottom substrate along the canyon wall included coarse calcareous materials such as shell hash and relict hard coral embedded into the clay sediment matrix (Photo 4-5). Small and relatively isolated patches of exposed hard substrate were observed along the portions of the canyon wall (Photo 4-6). These small hard bottom features had minimal vertical relief just barely exposed above the surrounding soft sediments. Epibiota observed to be most closely associated with the dominant fine sediment substrate included shrimp (multiple taxa), West African geryon crab (*Chaceon maritae*), hermit crabs, deepwater swimming crab (*Bathynectes piperatus),* deepwater carrier crab (*Paromola cuvieri),* seapens (Pennatulacea), burrowing anemones (Ceranthraria), and a seastar (Goniasteridae). Sessile biota observed in association with exposed hard bottom and embedded calcareous debris included lobate sponges, anemones (multiple taxa of *Actinaria*), gorgonian octocorals (multiple taxa of Alcyonacea), solitary ahermatypic hard corals, seapen octocorals (Pennatulacea), serpulid polychaete, bryozoan (including *Crisia* sp.), and encrusting ascidians. Observed fish included scorpionfish (Scorpaenidae), codling (*Laemonema* sp.), rattail (Macrouridae), and mora (Moridae).

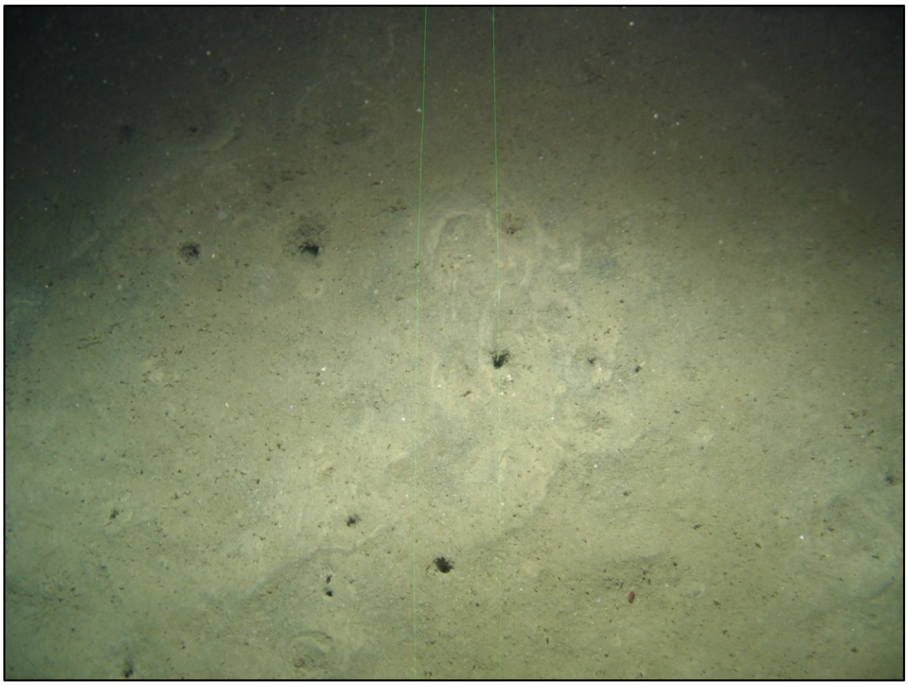


Photo 4-4. Much of the canyon wall was characterized by soft substrate predominantly composed of fine fractions of silt and clay. Soft substrate topographic irregularities were bioturbations such as small burrows, surficial depressions, and track marks.

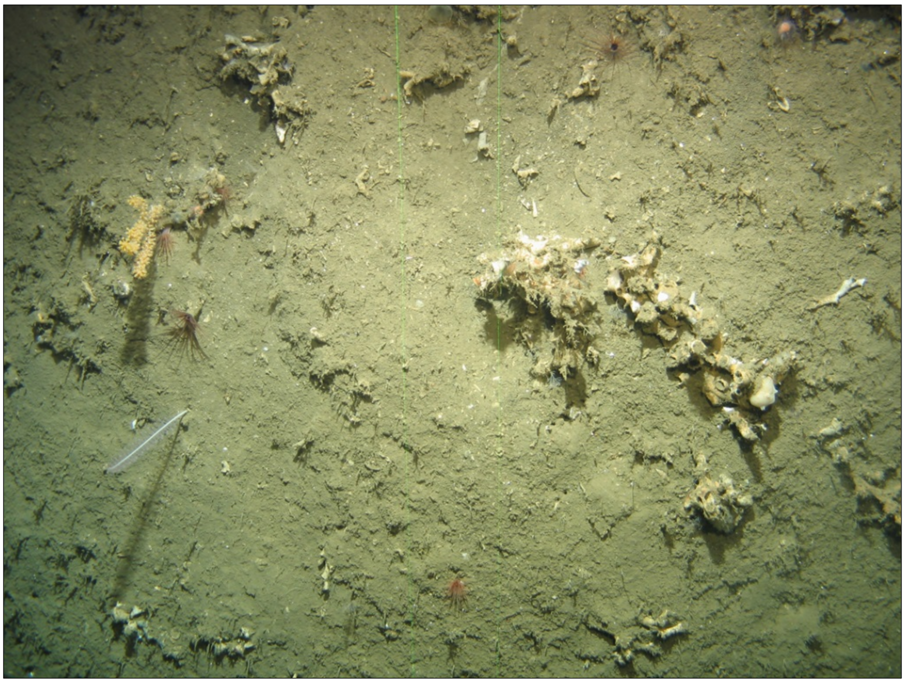


Photo 4-5. Some areas of soft bottom substrate along the canyon wall included coarse calcareous materials such as shell hash and relict hard coral embedded into the clay sediment matrix. Sessile biota include lobate sponge, anemones (Actinaria), gorgonian octocoral (Alcyonacea), solitary hard coral (Scleractinia), seapen octocoral (Pennatulacea), and encrusting ascideans (Ascidiacea).

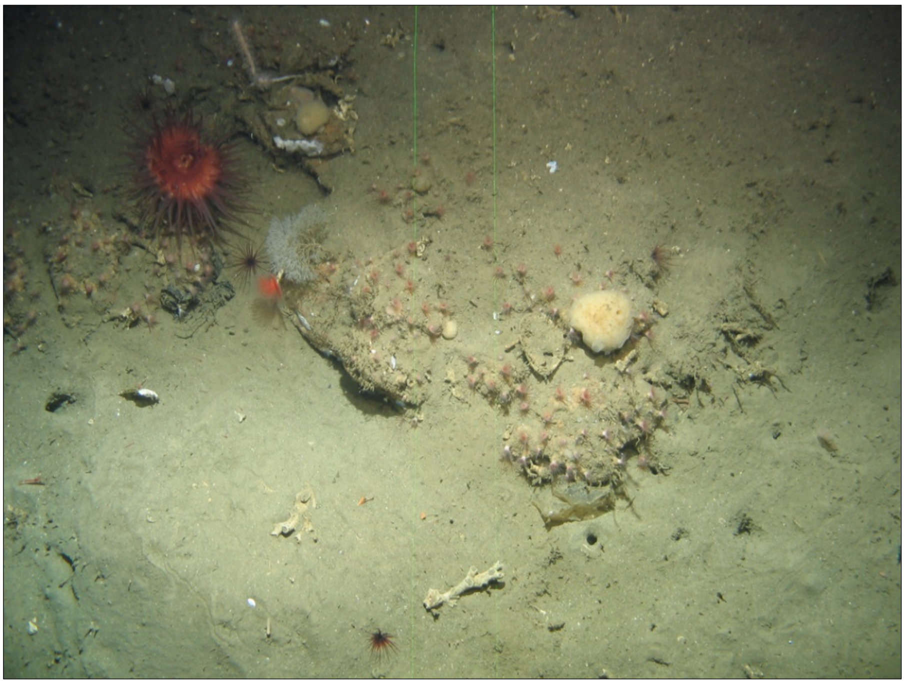


Photo 4-6. Small and relatively isolated patches of exposed hard substrate were observed along the portions of the canyon wall. Sessile biota include lobate sponges, anemones (multiple taxa of Actinaria), gorgonian octocoral (Alcyonacea), serpulid polychaete, bryozoan (*Crisia* sp.), and encrusting ascideans (Ascidiacea).

Observed substrate along the canyon floor was predominantly live bottom habitat formed by depositional processes where coarse calcareous materials (primarily relict hard coral) is embedded into the clay sediment matrix. This habitat type is characterized by low vertical relief, soft substrate with exposed calcareous rubble facilitating the settlement and establishment of a faunal community that appears dominated by sponges, gorgonian octocorals (various taxa of Alcyonacea), and burrowing anemones (Ceriantharia) (Photo 4-7).

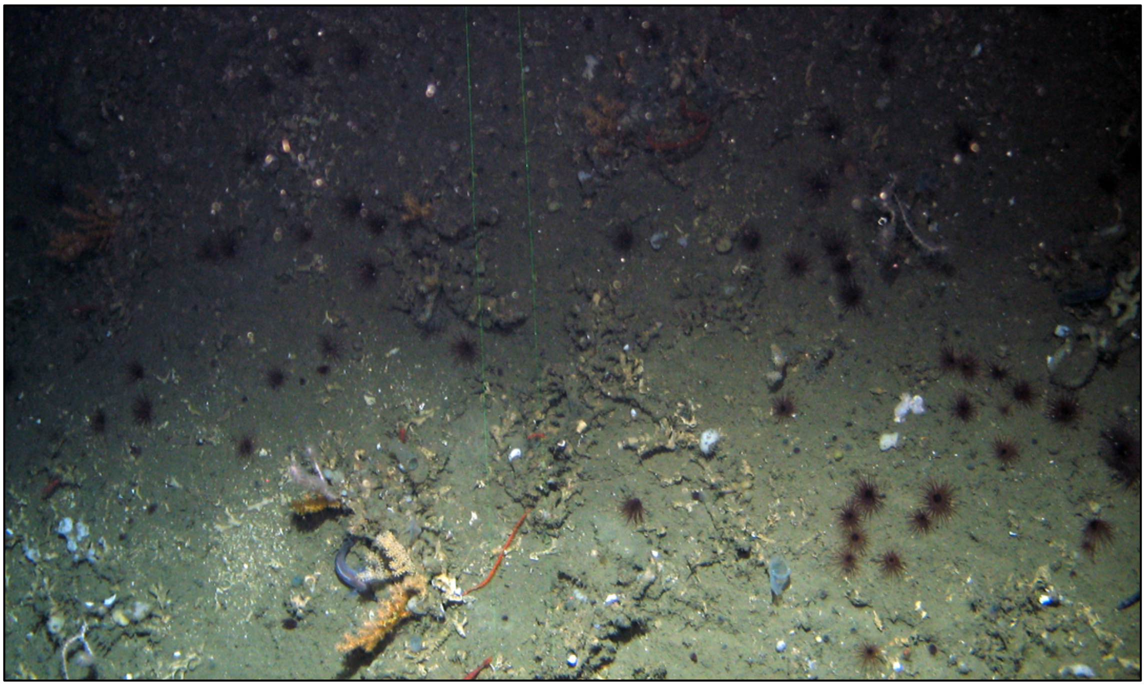


Photo 4-7. Canyon floor was predominantly live bottom habitat formed primarily by relict hard coral embedded into the clay sediment matrix. This exposed calcareous rubble facilitated the settlement and establishment of a faunal community that appears dominated by sponges, gorgonian octocorals (various taxa of Alcyonacea), and burrowing anemones (Ceriantharia).

The head of the canyon feature is characterized by substrates predominantly composed of fine fractions of silt and clay. The majority of observed fine sediment substrate was soft bottom habitat with a relatively small portion of semi-consolidated substrate composed of stiff clay material (Photo 4-8).

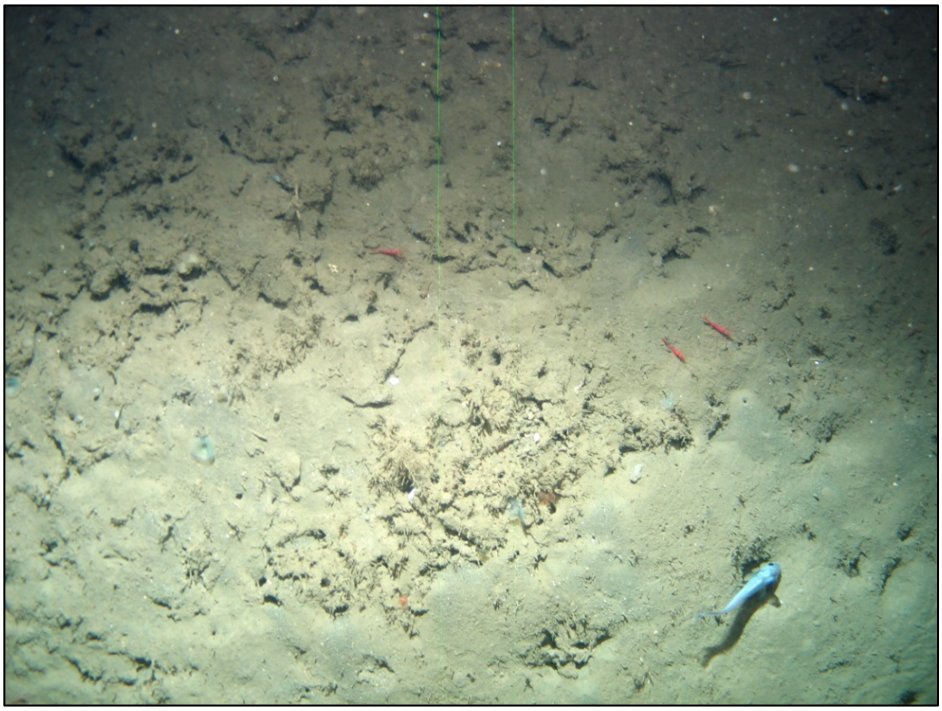


Photo 4-8. Semi-consolidated substrate composed of stiff clay material was observed along the head of the canyon.

Similar to the canyon wall, there were some small and relatively isolated patches of exposed hard substrate observed along the canyon head (Photo 4-9). Contrary to what was documented along the canyon wall, there were no observations of soft bottom habitat comprised of incorporated coarse calcareous materials (i.e., relict hard coral) into the clay sediment matrix. The observed biological communities associated with the various substrates observed along the head of the canyon were generally similar in composition to the canyon wall. The soft bottom habitat appeared to support a relatively productive benthic community visually dominated by shrimp (multiple taxa) which were documented in relatively high abundance. Observed fish included scorpionfish (*Helicolenus dactylopterus* and unidentified Scorpaenidae), snake eel (Ophichthidae), rattail (Macrouridae), halosaur (Halosauridae), catshark (Scylorhinidae), codling (*Laemonema* sp.), goosefish (*Lophius* sp.) (Photo 4-10), and mora (Moridae).

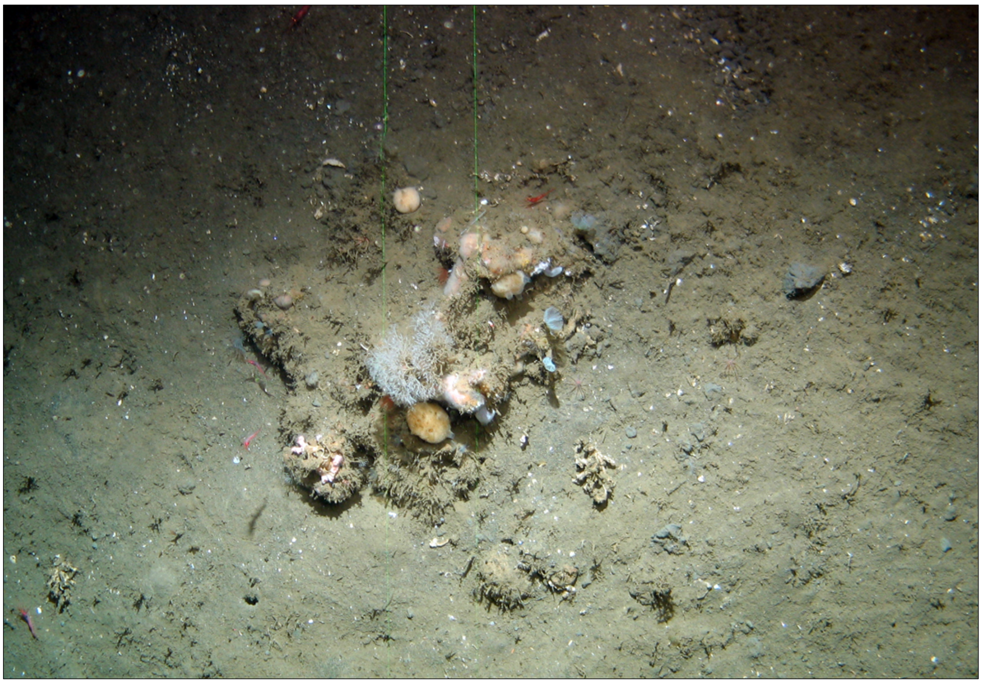


Photo 4-9. Small and relatively isolated patches of exposed hard substrate were observed along the canyon head. Sessile biota include sponges (including Hexactinellid "glass" sponges), bryozoan (*Crisia* sp.), and possibly hard coral.

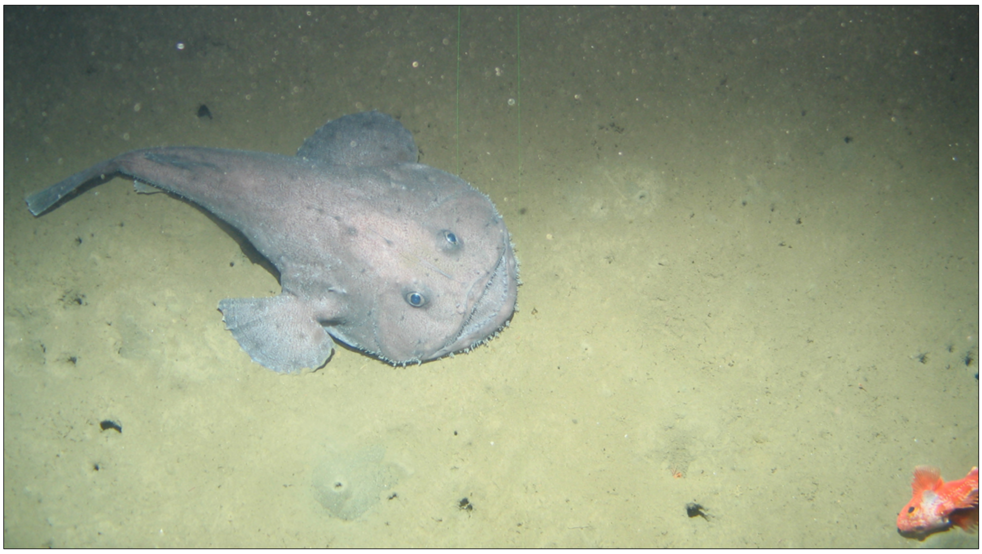


Photo 4-10. Goosefish (*Lophius* sp.) and Scorpionfish (Scorpaenidae) on Unconsolidated Fine Sediment Substrate.

Based on the visual data, the isolated ridge formation south of the pipeline appears to be a lithoherm, which is a mound structure formed by the accumulation of relic coral and depositional sediment (Photo 4-11). Carbonate mud mounds and coral banks have been discovered along the continental shelf and slope of the Northeast Atlantic margin including offshore Mauritania (Colman et al., 2005). Similar to substrates observed along the floor and portions of canyon slopes, much of the ridge feature is characterized by live bottom habitat formed by the incorporation of relict hard coral into the clay sediment matrix.

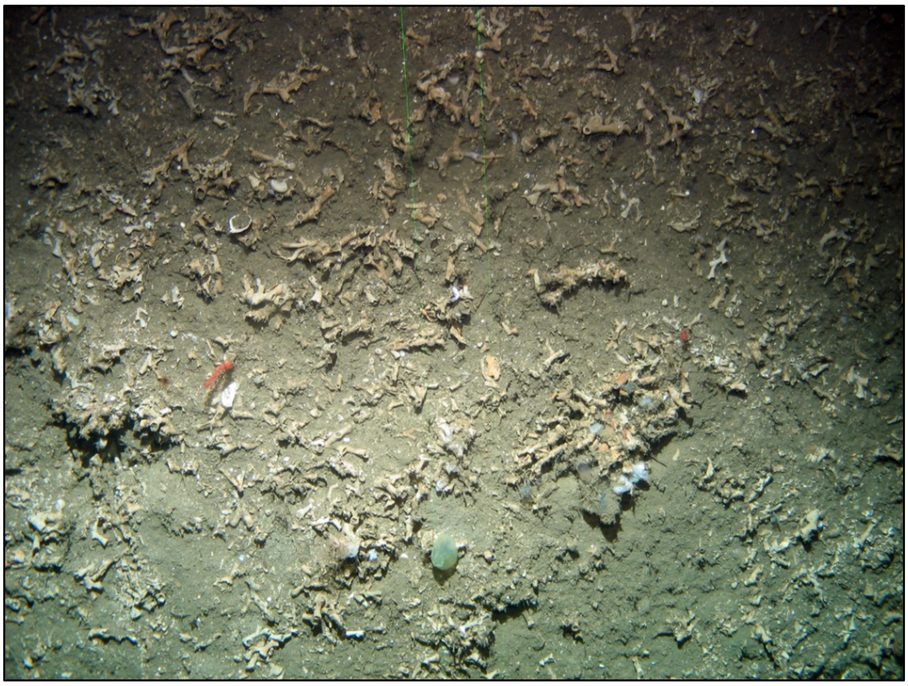


Photo 4-11. The documented ridge formation south of the pipeline appears to be a lithoherm, which is a mound structure formed by the accumulation of relic coral and depositional sediment.

No consolidated exposed hard bottom substrate was observed on the ridge feature. The lithoherm live bottom habitat is characterized by exposed calcareous coral rubble that provides stable hard substrate for the establishment of a deepwater faunal community. The faunal community is visually dominated by various sponges, gorgonian octocorals (various taxa of Alcyonacea), burrowing anemones (Ceriantharia), seapen octocorals (Pennatulacea), and hard corals (Photo 4-12). Observed hard corals were solitary ahermatypic cup corals and colonies of branching coral, *Solenosmilia variabilis* (Photo 4-13). Observed mobile fauna other than fish were predominantly crustaceans including shrimp (various taxa), squat lobsters (*Eumunida* sp.), deepwater swimming crab (*Bathynectes piperatus),* and carrier crab (*Paromola cuvieri).* Observed fish included scorpionfish (*Helicolenus dactylopterus* and unidentified Scorpaenidae), rattail (Macrouridae), sea toad (*Chaunax* sp.), halosaur (Halosauridae), mora (Moridae), codling (*Laemonema* sp.), tonguefish (*Symphurus* sp.), and cusk-eel (?Ophidiidae).

Photo 4-12. The lithoherm live bottom habitat faunal community is visually dominated by various sponges, gorgonian octocorals (various taxa of Alcyonacea), burrowing anemones (Ceriantharia), seapen octocorals (Pennatulacea), and hard corals. No seapens are present in this photo.

Photo 4-13. Observed hard corals of lithoherm live bottom habitat were solitary hard corals and colonies of branching coral, *Solenosmilia variabilis* (bright orange colonies with large cupped polyps). Various gorgonian octocorals, colored orange, are present in the photo and can be differentiated from the hard corals by the smaller polyps.

Autonomous Underwater Vehicle Imagery

A second set of imagery was collected within the Pipeline Area and Nearshore Area during 2017. Photographic data, collected using an autonomous underwater vehicle (AUV), were comprised of black and white images (TIF image format file) and of variable quality depending primarily on underwater turbidity and AUV height above the seafloor. The AUV was operated during photographic data collection at approximately 12 m above the seafloor and provided a relatively low-resolution image with an estimated field of view of 17 m^2 (4.5 x 3.7 m). The low-resolution photographic data was adequate for identifying visually obvious objects due to size or tonal contrast within the image. Observed invertebrates and fish were either unidentifiable or identified at the higher taxonomic groupings (e.g., class).

This very regionally unique photographic data were reviewed to generally characterize substrates and associated biological communities within the study area. For presentation purposes and to avoid redundancy to the extent possible, the photographic data were grouped based on bathymetric ranges as follows:

- 200 to 1,000 m (shallow Pipeline Area);
- 1,000 to 2,500 m (deep Pipeline Area); and
- >2,500 m (Offshore Area).

Photographic data indicated soft bottom substrates along the proposed pipeline route comprised predominantly of fine sediment fractions (i.e., silts, clays). Underwater visibility was quite variable within the overall study area with locations within each of the specified bathymetric ranges being characterized by high near-bottom turbidity that generally precluded observations of soft bottom topographic features and associated biota. The seafloor topography within this survey area was relatively smooth with soft bottom features which included bioturbations consisting of small depressions and burrows indicative of infaunal and megabenthic activity (Photo 4-14).

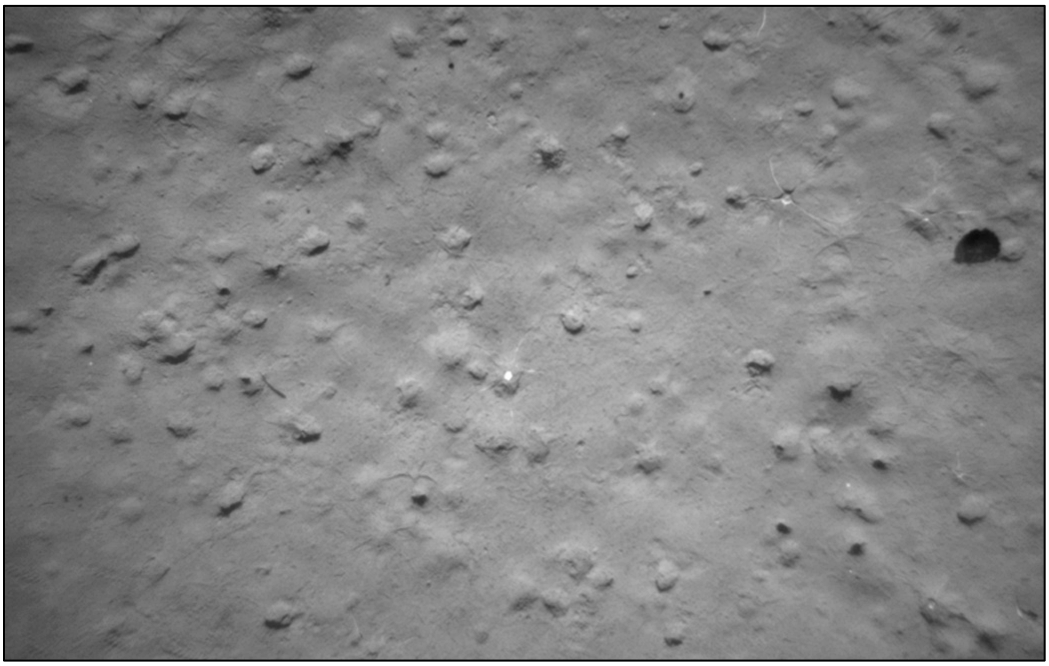


Photo 4-14. The seafloor topography along the proposed pipeline route was relatively smooth with soft bottom features which included bioturbations consisting of small depressions and burrows indicative of infaunal and megabenthic activity.

Bathymetric Range of 200 to 1,000 m

The 200 to 1,000 m bathymetric range extended approximately 16 km along the more shoreward portion of the proposed pipeline route. The seafloor topography was relatively smooth soft bottom with a small isolated area of hard bottom substrate. This hard substrate was most likely not exposed rock but partially buried man-made debris that was been colonized by epibiota (Photo 4-15). What was thought to be a large derelict commercial trawl net and rigging was observed in a water depth of 750 m; numerous deepwater carrier crab (*Paromola cuvieri) were associated with the derelict trawl net (Photo 4-16).*

The observed soft bottom substrate supported a megabenthic/demersal ichthyofaunal community with biotal components typical of deepwater soft bottom assemblages. Observed soft bottom epibiota that were distinguishable from the AUV imagery included anemones (most likely *Actinoscyphia aurelia*), crabs (including *Chaceon maritae*), squid, and echinoderms (Asteroidea [seastars], Echinoidea [urchins], and Ophiuroidea [brittlestars]). A relatively large aggregation of urchins were observed in a water depth of approximately 900 m. Fish observed within the survey area included rattail macrourids (Photo 4-17), goosefish (Lophiidae), synaphobranchid eel, and a skate (Rajiidae). Several unidentified benthopelagic specimens were observed in the water column just above the seafloor.

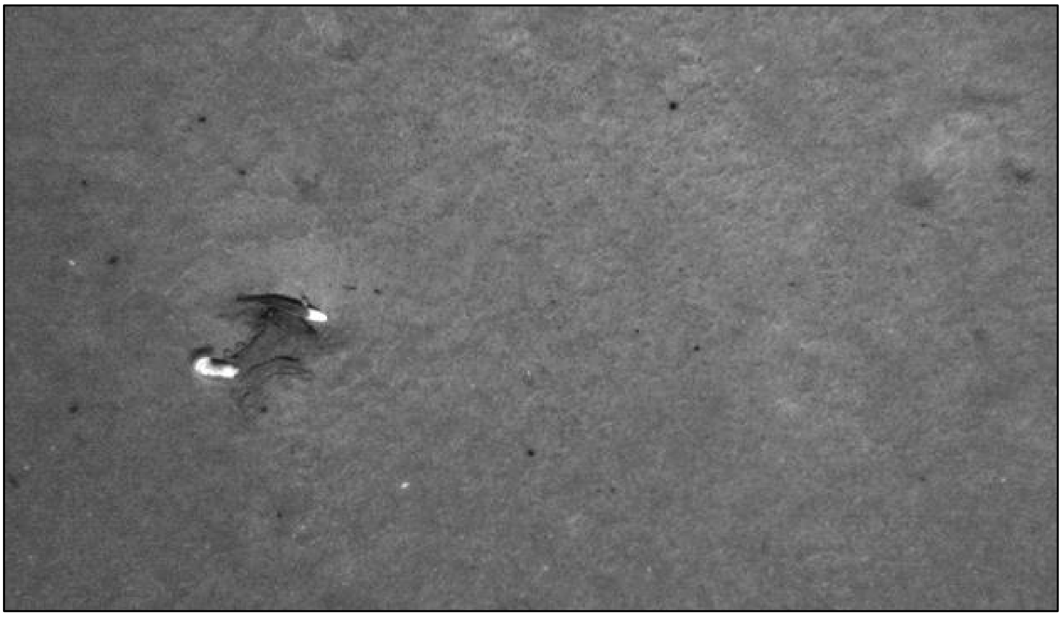


Photo 4-15. A small isolated area of hard bottom substrate that is most likely partially buried man-made debris colonized by a flytrap anemone (?*Actinoscyphia aurelia*).

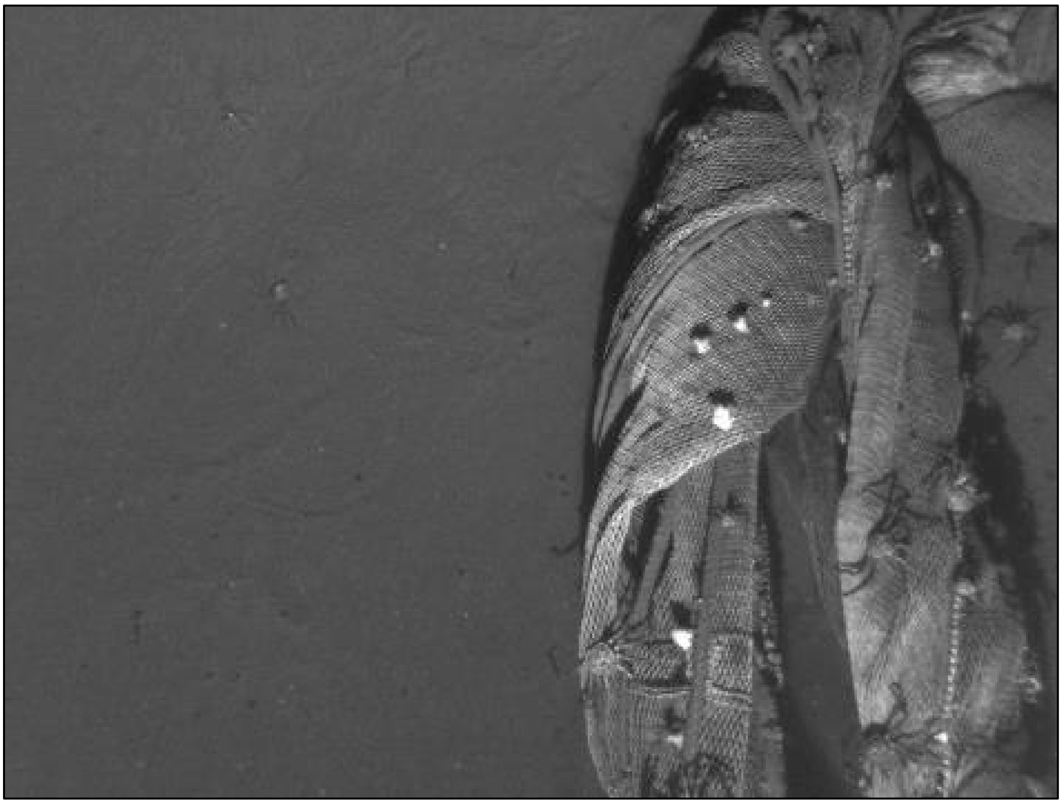


Photo 4-16. In a water depth of 750 m, a large derelict trawl net and rigging was observed with numerous deepwater carrier crabs (*Paromola cuvieri) foraging on the trawl net*.

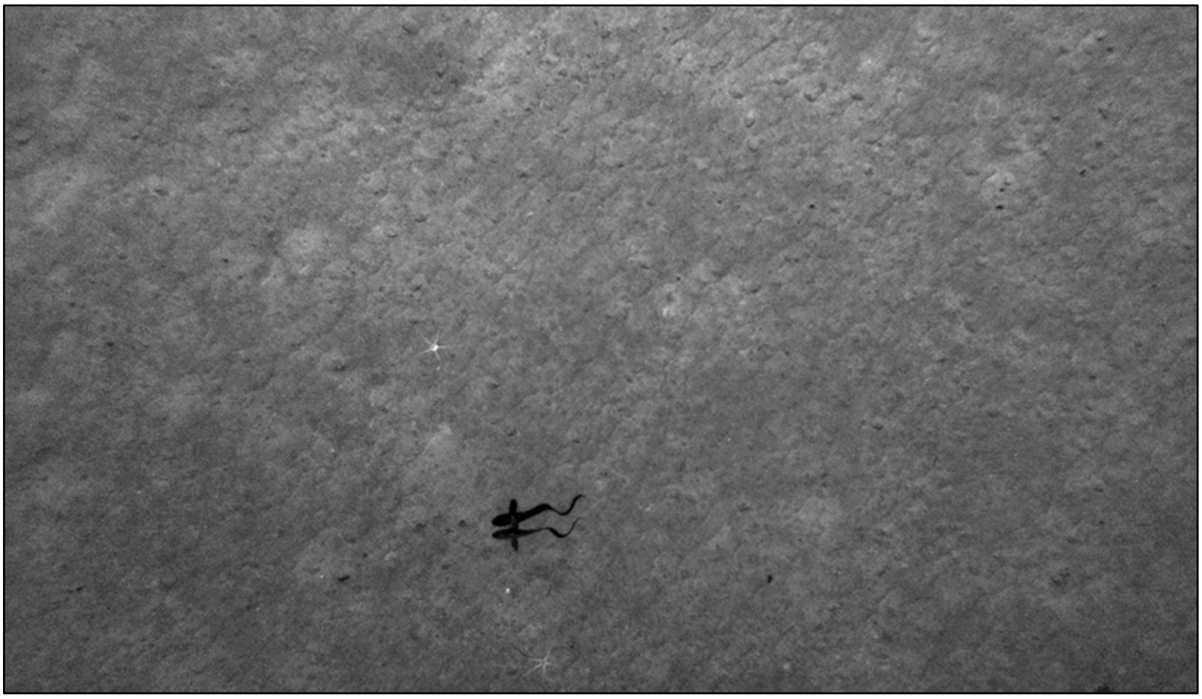


Photo 4-17. A rattail macrourid swims above soft bottom substrate in proximity to brittlestars (Ophiuroidea) which are visible on the surface of the substrate.

Bathymetric Range of 1,000 to 2,500 m

The 1,000 to 2,500 m bathymetric range extended approximately 38 km along the seaward-most portion of the proposed pipeline route. No discernable man-made debris was observed along this portion of the pipeline route. The distinguishable megafauna associated with the soft bottom substrate were relatively sparse and predominantly echinoderms including Asteroidea (seastars), Echinoidea (spatangoid urchins, ?*Pourtalesia miranda*), Ophiuroidea (brittlestars), and Crinoidea (feather stars) (Photo 4-18). Other identifiable epibiota that were very rarely observed included what appears to be glass sponges (Hexactinellida). Unique to this portion of the pipeline route was the relatively continuous presence of a benthopelagic invertebrate assemblage that may have included a pelagic holothuroid (Photo 4-19); this assemblage was dense at some sampling locations. No identifiable fish were observed along this portion of the pipeline route from the AUV imagery data.

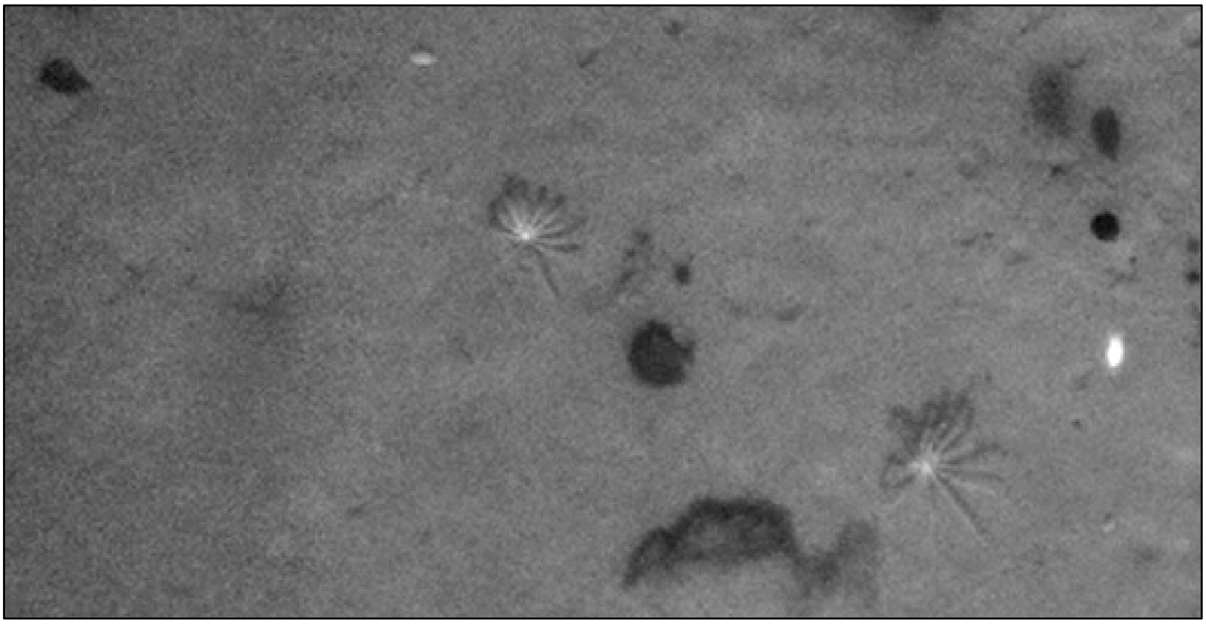


Photo 4-18. The distinguishable megafauna associated with the soft bottom substrate in the 1,000 to 2,500 m bathymetric range were predominantly echinoderms including the feather stars (Crinoidea) with upward projecting pinnate arms.

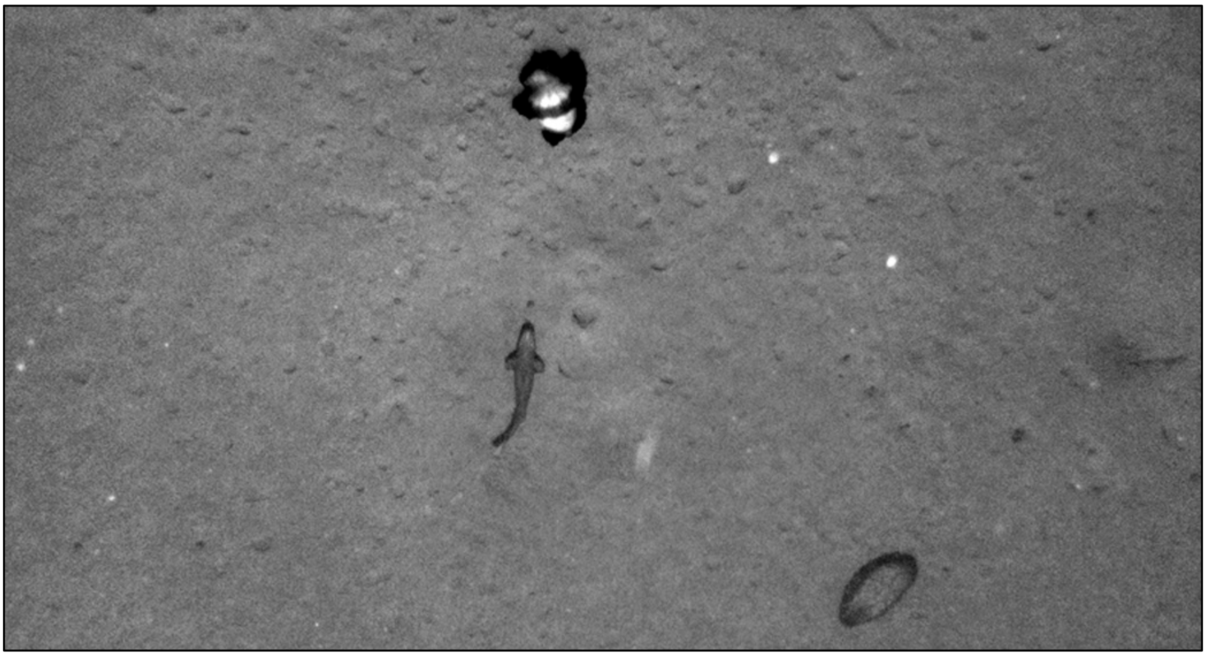


Photo 4-19. A pelagic holothuroid (top of image) was observed as part of the benthopelagic invertebrate assemblage. An irregular spatangoid urchin, ?*Pourtalesia miranda*, is visible along the lower portion of the image.

Bathymetric Range of >2,500 m

The Offshore Area is located in a water depth range of >2,500 m. The visually dominant megafauna associated with the soft bottom substrate were echinoderms including Asteroidea (seastars) (Photo 4-20), Holothuroidea (sea cucumbers), Ophiuroidea (brittlestars), and Crinoidea (feather stars). What appears to be glass sponges (Hexactinellida) were observed on numerous occasions in this depth range (Photo 4-21). Other notable observations in this deepwater portion of the study area included derelict trawl net debris and skeletal remains of a humpback whale (Photo 4-22). Most observed fish in this portion of the study area were unidentifiable with the exception of some of the larger specimens observed in association with the whale carcass. The aggregation of fish in the vicinity of the whale carcass included cusk-eels (Ophidiidae, *Bassozetus* sp.), grenadiers (Macrouridae), cutthroat eels (*Synaphobranchus* sp.) and a chimera (*Hydrolagus* sp.).

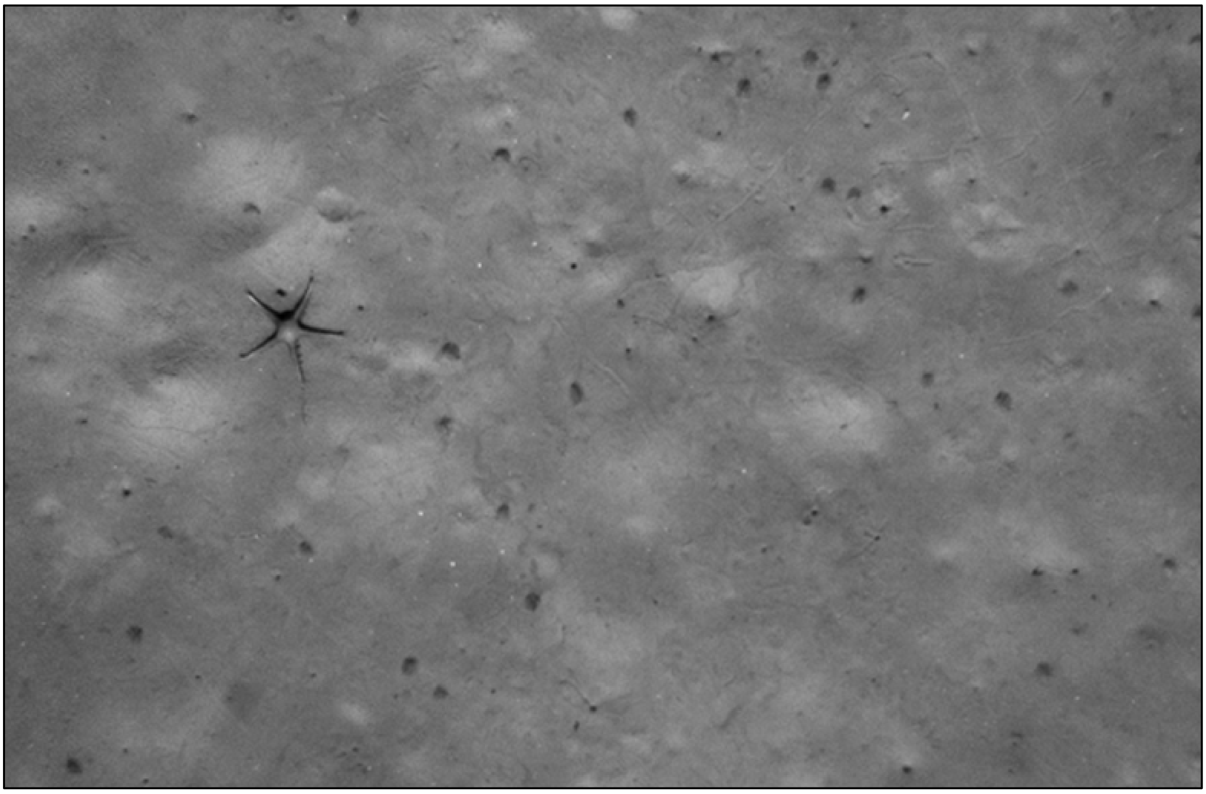


Photo 4-20. Visually dominant megafauna associated with the soft bottom substrate in the Offshore Area were echinoderms including seastars (Asteroidea).

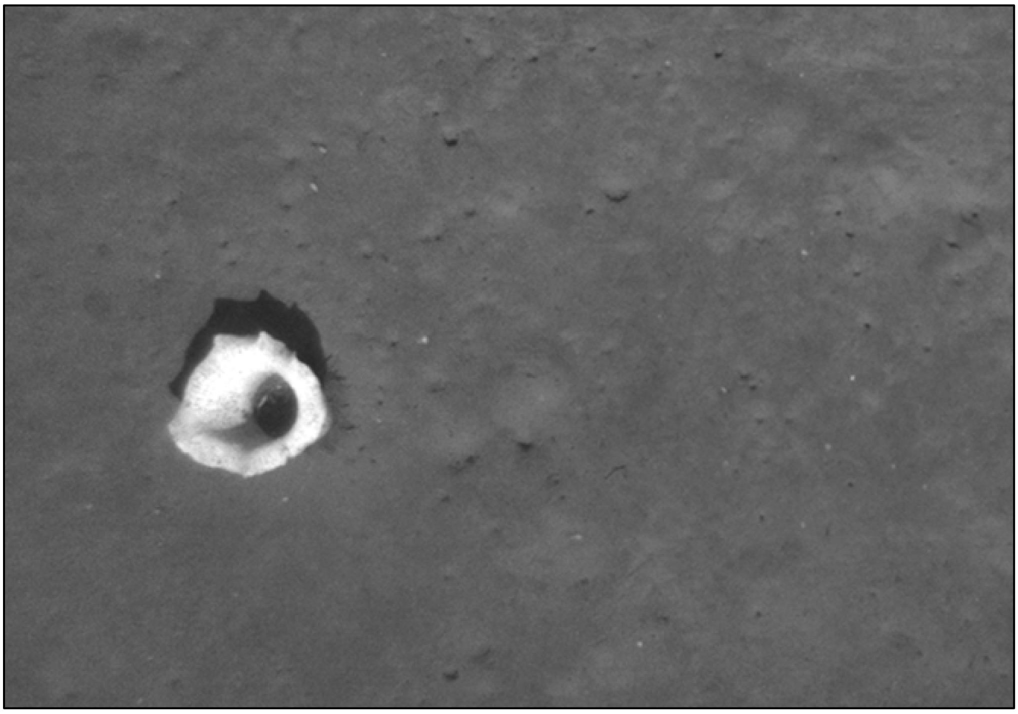


Photo 4-21. Glass sponges (?Hexactinellida) were observed on numerous occasions in the Offshore Area.

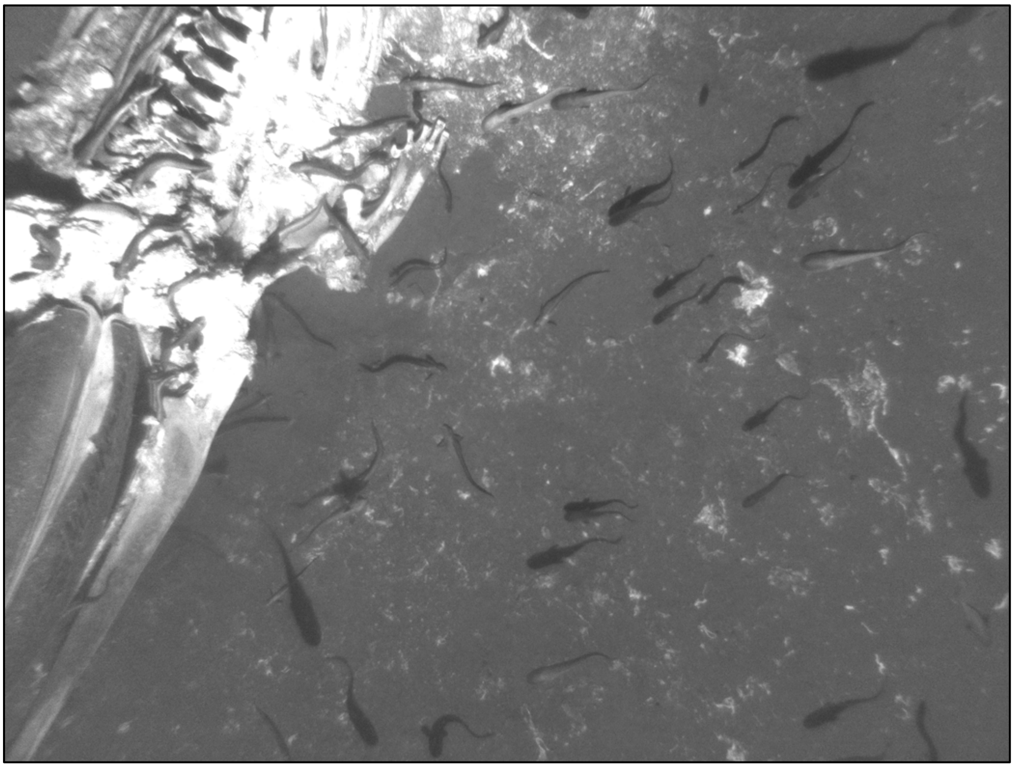


Photo 4-22. The aggregation of fish in the vicinity of the humpback whale carcass included cusk-eels (Ophidiidae, *Bassozetus* sp.) and grenadiers (Macrouridae).

4.5.4 Fish and Other Fishery Resources

The regional marine environment that encompasses the project area and the EEZ of Mauritania and Senegal is known as the CCLME which extends from the Strait of Gibraltar (around 36°N 5°W) to Bissagos Islands in the South of Guinea-Bissau (around 11°N 16°W). The CCLME is characterized by cold water upwelling which creates a highly productive marine ecosystem with high biomass of fishes and fishery-related invertebrates (Pauly and Christensen, 1995; Valdes and Denis-Gonzalez, 2015).

The origin of this high productivity is mainly due to the remobilization of minerals, deposited at the bottom of the ocean that rise to the surface of the water, under the action of coastal upwelling phenomena. These nutrients are the foundation of the food chain that leads to fishery production. Mauritania's waters also support high biodiversity and represent a biogeographical transition area, particularly in the area bounded by Cape Blanc and Cape Timiris, where dozens of tropical and temperate species at all levels of the animal and plant kingdoms coexist (Inejih et al., 2014).

Off Senegal the shelf is more narrow and the upwelling is seasonal with peaks from January to March. The fish fauna off Senegal is more tropical.

For Mauritania, marine fishing is a relatively recent but important element of the country economy, contributing to the fight against unemployment and poverty, and meeting protein needs of the population (Appendix E-1). The preservation of these renewable fisheries resources is a major concern for the government and other stakeholders. In Senegal, fishing has long been a part of the culture and is an important industry for the coastal population. This section first characterizes general demersal and pelagic fish and invertebrate assemblages then discusses target species, gear, and activity of the major fisheries sectors. Detailed information on fishes and invertebrates inhabiting the waters of Mauritania and Senegal is provided in Appendices E-1 and E-2.

4.5.4.1 Marine Fishes and Fishery-Related Invertebrates

Fishes inhabiting CCLME waters are distributed broadly from the coast across the shelf to the continental slope. From a zoogeographic perspective, the region represents a transition between temperate (Saharan) and tropical (Guinean) ichthyofaunas. The presence of a persistent cold water upwelling along the outer continental shelf of the region greatly influences the distribution of many species. Major elements of the ichthyofauna are described below based on broadly defined habitat preferences: demersal (bottom dwellers) and pelagic (water column dwellers). Further subdivisions will be used within demersal and pelagic sections to identify cross-shelf or depth-related assemblages. For the purposes of this characterization, non-fish fishery resources (e.g., invertebrates – octopus, squids, cuttlefishes, and shrimps) are also evaluated, as appropriate.

Demersal Species

Bottom dwelling or demersal species change their distribution patterns in response to substrate type, water depth, temperature, and other environmental factors (Jouffre and Inejih, 2005; Kidé et al., 2015; Fernandez-Peralta and Sidibe, 2015). Kidé et al. (2015) classified the demersal fauna by water depth and substrate as follows: coastal (0 to 20 m), upper shelf (20 to 50 m), mid-shelf (50 to 80 m), and outer shelf (80 to 200 m). Species characterizing these assemblages are listed in Appendix G.

Less is known about species occurring on the upper continental slope in water depths greater than 200 m. Most of the seafloor habitat on the CCLME shelf and slope is sedimentary ranging from coarse sand to fine muds. Fishes and invertebrates associated with soft and hard bottoms are characterized separately below. Detailed tabular listings of demersal species are presented in Appendix G.

Invertebrates

The main invertebrate species targeted are cephalopods including octopus (*Octopus vulgaris*), squid (*Loligo vulgaris*), cuttlefishes (*Sepia* spp., *S. officinalis*, *S. bertheloti*, and *S. hierredda*). The cuttlefish *S. bertheloti* is an important fishery species that is marketed under the name "sepiola."

Octopus is a strategic species for the Mauritanian fishing economy. It has a very broad distribution across the continental shelf, occupying different types of bottom with water depths to about 200 m (Inejih and Deddah, 2002). It is considered rare south of 18°00’ N, in shallow depths (<30 m), and in areas where fish are abundant (Inejih et al., 2002).

Among coastal cephalopods, octopus is the most abundant and commercially valuable species of the region, accounting for 65% to 75% of the total landings (FAO, 2012). Octopus is ubiquitous occurring from nearshore to depths as great as 200 m. Its importance decreases towards southern Mauritania where proportions of *S. hierredda* are higher in the fishery landings. Squids also virtually disappear from the landings in southern Senegal.

For cephalopods, three major fishing grounds lie along the coast of Western North Africa and generally coincide with the distribution areas of the three stocks of octopus that appear in the region (FAO, 2012). From the North to the South, the three fishing grounds include: 1) the area off Mauritania between Cape Boujdour (26° N) and Cape Blanc (21° N); 2) the area off Mauritania and Senegal between Cape Blanc (21° N) and the mouth of the Senegal River (16° N); and 3) the area off Senegal between the mouth of the Senegal River (16° N) and the border with Guinea-Bissau (12° N). The cephalopod species are generally restricted to coastal and shelf waters <200 m.

Oceanic or deep water cephalopods (especially the family Ommastrephidae) live permanently on the bottom or near the bottom layer, or descend to the bottom only in adulthood to lay eggs (Nesis, 2003). Thus, the squid *Todarodes sagittatus*, which is widely distributed in the Eastern Atlantic (70° N to 10° S), was captured incidentally by Russian trawlers looking for horse mackerel (pelagic) and hake (demersal) off Mauritania. Between Cape Blanc (north of Mauritania) up to 23°30' S (off Morocco), the peak of catches between 300 and 500 kg fishing day^{-1} were recorded between June and July (Arkhipkin et al., 2015). In 1974, according to Arkhipkin et al. (2015), Russian trawlers caught 18,000 tonnes of this species off Cape Blanc. Scientific surveys conducted from 1995 to 1998 by the research vessel *AtlantNIRO* reported the main concentrations were between 18° N and 32° N in the 400 and 800 m depth range. Waters less than 300 m are occupied by different ommastrephid species. These authors also note that this species was also occasionally caught by the Russian fleet in Mauritania until 1983, the date upon which the country introduced an accessory ban on catches of cephalopods.

The small flying squid *Todaropsis eblanae* is widely distributed between 61° N and 36° S in the Eastern Atlantic. It is a medium-sized demersal species, associated with sandy and silty sediments. This species prefers temperatures between 9°C to 18°C in water depths ranging from 20 to 850 m (Arkhipkin et al., 2015). Typically, it is associated with the continental shelf break and upper continental slope. No seasonal migration or any other type of major migration has been documented. It is probably the least mobile of ommastrephid squid.

The next most important invertebrate group is shellfish (crustaceans), consisting of coastal shellfish (royal spiny lobster and coastal shrimps) and deep shellfish (deep shrimp, pink lobster, and deep crab). Two lobster species are present in Mauritanian waters: royal spiny lobster (*Panulirus regius*) and pink lobster (*Palinurus mauritanicus*). The royal spiny lobster was fished for decades by Mauritanian artisanal fleets from La Guerra, near Nouadhibou to the region south of Cape Timiris (Pencalet-Kerivel, 2008). The stocks of royal spiny lobster collapsed in the early 1990s leading to the abandonment of this fishery in 1993 (Julien, 2002). However, catches began to increase in 2006 and continued until a decline in 2015 (IMROP, unpublished data).

Coastal shrimps are mainly represented by the species *Penaeus notialis*. This species lives on the muddy or sandy bottoms up to 100 m deep, but prefers water depths between 10 and 75 m. The main concentrations are observed between Cape Timiris and the southern boundary of the Mauritanian EEZ between 50 to 100 m depths. The 19° N to 20° N sector contributes more than 70% of catches for two species of "langostino" (*P. notialis* and *P. kerathurus*) in the coast stratum (0 to 80 m depths). Two stocks are generally recognized: a Southern stock between Nouakchott and Saint-Louis (Senegal), which is in relation to that of Senegal, and a Northern stock between 18°50' N and 20°00' N derived from an area of nurseries on the shallows of the Arguin shelf. Coastal shrimps are especially abundant at the mouth of the Senegal River shallower than 20 m.

Soft Bottom Fishes

The demersal fish fauna associated with soft bottoms is composed of a great variety of species. Most feed on invertebrates that live on or within the sedimentary substrate (Longhurst, 2007). Soft bottom species are distributed from the surf zone across the shelf to the upper slope. Individual species segregate in groups with similar environmental preferences, usually water depth and temperature.

Over the continental slope in water depths of 140 to 750 m, the demersal assemblage is composed of shark and rays (Elasmobranchs), hakes (Merlucciidae), porgies (Sparidae), and tilefishes (Malacanthidae). This assemblage is composed of Senegalese hake (*Merluccius senegalensis*), blackbelly rosefish (*Helicolenus dactylopterus*), and greeneye (*Chlorophthalmus agassizi*). With the exception of hake which is distributed along the coast of northwest Africa in depths of 18 to 500 m (Sanyo, 2002; Meiners et al., 2010), none of these species are presently being harvested.

The hake fishery (*M. senegalensis* and *M. polli*) undertaken by Spanish trawlers working – in the context of the European Union (EU) agreements with Mauritania and Senegal – in water depths from 80 to 1,800 m provides information on the composition of the demersal fish assemblage at these depths. A description of trends in incidental catch of this fishery by Fernández et al. (2005) provides insight into the composition of the demersal fish fauna of the upper slope (140 to 750 m). Incidental catch of this fishery included sparids (*Dentex macrophthalmus*, *D. angolensis*, *D. gibbosus*, and *Pagellus* spp.); lophiids (*Lophius kempi* and *L. vaillianti*); scorpaenids (*H. dactylopterus* and *Scorpaena elongata*); zeids (*Zeus faber* and *Zenopsis conchifera*); sciaenids (*Argyrosomus regius*); ophidiids (*Brotula barbata*); and malacanthids (*Branchiostegus semifaciatus*). Sharks and rays (elasmobranchs) represented an appreciable component of the bycatch in this fishery including centrophorid sharks (*Centrophorus granulosus* and *C. squamosus*), *Centroscymnus coelolepis*, *C. crepidater*, dalatids (*Dalatias licha*, *Deania calcea* and *Galeus polli*), heptranchids (*Heptranchias perlo*), *Oxynotus centrina*, and *Scymnodon ringens*. Rays common in this fishery include rajids (*Raja straeleni*, *R. miraletus*, *Leucoraja leucosticte*, and *Rostroraja alba*).

Additional data on demersal fishes occurring within the 80 to 1,800 m depth range reported 75 families and 155 species (Fernandez-Peralta and Sidibe, 2015). A table summarizing this group of fishes is provided in Appendix G.

Hard Bottom Fishes

Structured hard bottom composed of carbonate paleo-shoreline outcroppings occurs over the shelf. The term hard bottom generally refers to exposed rock, but can include other substrata such as coral, clay, or even artificial structures. Floeter et al. (2008) listed 250 reef (hard bottom) fishes from northwest Africa. On the west African shelf, hard bottom assemblages were dominated by snappers, groupers, grunts, porgies, squirrelfishes, angelfishes, damselfishes, butterflyfishes, surgeonfishes, and wrasses (Floeter et al., 2008).

Available information (Kidé et al., 2015) indicated that species associated with rocky bottom have been found in deep water, such as scorpionfishes, snappers, and groupers. Common species in the area include groupers (*Epinephelus guaza, E. goreensis*, and *E. aeneus*), sparids (*Sparus caeruleosticus*, *Lithognathus mormyrus*, *Dentex canariensis*, and *Diplodus bellotii*), and sole (*Solea* spp. and *Synaptura punctatissima*). Some species (groupers, porgies, pageot, and grey bream) migrate across the shelf between the coast and offshore waters. These migrations are generally related to reproduction or feeding.

Pelagic Species

Pelagic fishes inhabit the water column and, as is the case with demersal species, form broad groups based on depth: coastal pelagic, oceanic pelagic, and mesopelagic.

Coastal Pelagic Fishes

Coastal pelagic species migrate along the shore depending on the season. Two coastal pelagic assemblages occur in the region. One is composed of small tropical species such as sardinellas (*Sardinella aurita* and *S. maderensis*), false shad (*Caranx ronchus*), Cunene horse mackerel (*Trachurus trecae*), and Ethmalose shad (*Ethmalosa fimbriata*). Members of this group are caught mostly during the warm season with highest abundances south of Cape Timiris.

The second assemblage consists of species with temperate affinities including the sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), Atlantic horse mackerel (*Trachurus trachurus*), chub mackerels (*Scomber japonicus*), and the silver sword (*Trichiurus lepturus*). They are distributed mainly north of Cape Timiris in the cold weather season (Braham and Corten, 2015).

Abundance of coastal pelagic species will depend upon season and levels of temperature, turbidity, salinity, and dissolved oxygen. The upwelling that occurs off CCLME greatly influences movements and reproductive activities of small pelagic species such as round sardinellas (*S. aurita*). The spatial and temporal distribution patterns for the key coastal pelagic species off the CCLME are summarized in Appendix G.

Olivar et al. (2016), assessed ichthyoplankton larval distribution off northwest Africa relative to Mauritania. Specifically, they noted that the effect of latitudinal temperature gradients is in evidence through larval distribution of coastal fish species. Previous information for the CCLME region indicated that, over the central part of the CC system, the most abundant species are the small pelagic sardine (*S. pilchardus*) and anchovy (*E. encrasicolus*) (Ettahiri et al., 2003; Machu et al., 2009; Rodríguez et al., 2009). Further south in the CCLME, off the coasts of Mauritania and Senegal, sardinellas (*S. aurita* and *S. maderensis*) dominate (Ettahiri et al., 2003). Olivar et al. (2016) note that the larvae of *S. pilchardus*, *E. encrasicolus*, *Trachurus* spp., and Sparidae were common in waters with temperatures <18°C, while nearly absent in the warmer southern coast, where larvae of the tropical *S. aurita* were present. The 18°C isotherm is a limiting threshold for spawning of some clupeid species; *S. pilchardus* spawns below and *S. aurita* above 18°C (Ettahiri et al., 2003; Mbaye et al., 2015).

Oceanic Pelagic Fishes

Oceanic pelagic species are migratory inhabiting the upper 200 m of the water column beyond the continental shelf edge (approximately 200 m). This assemblage includes several shark species (e.g., mako, silky, or blue), tunas (yellowfin [*Thunnus albacares*] and bigeye [*Thunnus obesus*]), skipjack tuna (*Katsuwonas pelamis*), billfishes, swordfishes, wahoo, and dolphinfishes. Other species found in oceanic surface waters include flyingfishes, halfbeaks, opahs, oarfishes, bluefish, scads, jacks, pilotfishes, dolphin, remoras, pomfrets, butterfishes, molas, and triggerfishes. Oceanic pelagic species associate with drifting *Sargassum* algae and miscellaneous flotsam (logs, boards, hawser ropes, or floats). Juvenile jacks, filefishes, and triggerfishes shelter under these floating objects attracting larger, predatory species such as tunas, dolphins, and wahoos.

Mesopelagic Fishes

Below the epipelagic zone in water depths ranging from 200 to 1000 m is the mesopelagic zone. In this zone, fish assemblages are numerically dominated by myctophids (lanternfishes), gonostomatids (bristlemouths), and sternoptichyds (hatchetfishes). Lantern fishes are small silvery fishes that can be extremely abundant, often responsible for the deep scattering layer in sonar images of the deep sea. Backus (1977) recognized a Mauritanian upwelling area as a distinct province of lanternfish zoogeography for the western Atlantic Ocean; the assemblage in this area was composed of tropical, subtropical, and temperate-subtropical species (Olivar et al., 2017).

The most abundant species included *Diaphus holti, D. taaningi, Hygophum hygomii, Lampedema pontifix, Lampanyctus cuprarius, Lowenia rara*, and *Taaningichthys bathyphilus*. Lanternfishes, and other mesopelagic fishes, spend the daytime in depths of 200 to 1,000 m, but migrate vertically at night into food rich, near-surface waters. Mesopelagic fish, while less commonly known and of no fishery importance, are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. The lanternfishes are important prey for meso- and epipelagic predators (e.g., tunas), and particularly the mesopelagic dragonfishes (Hopkins et al., 1996; Olivar et al., 2017).

In summary, the diverse ichthyofauna of the CCLME has three species assemblages (oceanic pelagic, mesopelagic, and deep demersal) that may occur within the boundaries of the project area. Oceanic pelagic species are highly migratory in the upper 200 m of the water column. Mesopelagic species migrate vertically each night through the water column from as deep as 1,000 m to as shallow as 10 m depending on the species (Backus, 1977; Olivar et al., 2017).

Threatened Fish Species

The IUCN Red List (2017a) identifies fishes that have been designated as Endangered and Critically Endangered within the east central Atlantic. Based on a review of IUCN species-specific distribution maps, each species were examined to remove species not known to occur off Mauritania or Senegal. Results produced 6 Critically Endangered and 13 Endangered species (Table 4-12).

Atlantic Goliath grouper (*Epinephelus itajara*), two sawfishes (*Pristis pectinatus*, *P. pristis*), two angel sharks (*Squatina aculeata*, *S. oculatus*), and a skate (*Dipturus batis*) were listed as Critically Endangered for the region. All of these species are bottom dwellers. The goliath grouper associates with hard, rocky bottoms and the other five fish species associate with soft sedimentary bottoms.

IUCN Endangered species from the region included one hard bottom dweller, the dusky grouper (*Epinephelus marginatus*) and eight soft bottom associates including cassava croaker (*Pseudotolithus senegalensis*), Senegalese hake (*M. senegalensis*), guitarfishes (*Glaucostegus cemiculus*, *Rhyncobatus luebberti*, *Rhinobatos rhinobatos*), skates (*Rostroraja alba, Raja undulata*), and a whiptail ray (*Fontitrygon margarita*). Four pelagic fishes were listed as endangered: whale shark (*Rhincodon typus*), scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), and bluefin tuna (*Thunnus thynnus*). Any of these pelagic species could occur in coastal waters but their preferred habitat would be near the shelf edge or in oceanic waters.

Table 4-12. Summary of IUCN-listed Fish Species that May Be Present in the Core or Extended Study Areas.

Species listed by IUCN as Critically Endangered are highlighted in red.

Common Name	Common Name – French	Scientific Name	IUCN Designation	Presence
Fishes (demersal, hard bottom)				
Atlantic Goliath Grouper	Mérou géant	*Epinephelus itajara*	CR (A2d)	Likely
Dusky Grouper	Mérou de Méditérannée	*Epinephelus marginatus*	EN (A2d)	Likely
Fishes (demersal, soft bottom)				
Common Skate	Flotte, Pocheteau gris, Pochette	*Dipturus batis*	CR (A2bcd+4bcd)	Unlikely
Smalltooth Sawfish	Poisson-scie	*Pristis pectinata*	CR (A2cd)	Possible
Largetooth Sawfish	Poisson-scie commun	*Pristis*	CR (A2cd)	Unlikely
Sawback Angel Shark	Ange de mer épineux	*Squatina aculeata*	CR (A2bcd+3cd+4cd)	Possible
Smoothback Angel Shark	Ange de mer jaune	*Squatina oculata*	CR (A2bcd+3cd+4bcd)	Possible
Daisy stingray	Pastenague marguerire	*Fontitrygon margarita*	EN (A2bd+3bd+4bd)	Unlikely
Blackchin Guitarfish	Guitare de mer fouisseuse	*Glaucostegus cemiculus*	EN (A4bd)	Likely
Senegalese Hake	Merlu du Sénégal	*Merluccius senegalensis*	EN (A2bd)	Likely
Cassava Croaker	Otholithe nain	*Pseudotolithus senegalensis*	EN (A2bd)	Likely
Undulate Skate	Raie brunette	*Raja undulata*	EN (A2bd+3d+4bd)	Unlikely
Common Guitarfish	Guitare de mer commune	*Rhinobatos*	EN (A4cd)	Likely
African Wedgefish	Guitare à taches	*Rhynchobatus luebberti*	EN (A2ad+3d+4ad)	Possible
White Skate	Raie blanche	*Rostroraja alba*	EN (A2cd+4cd)	Unlikely
Fishes (pelagic)				
Whale Shark	Requin-baleine	*Rhincodon typus*	EN (A2bd+4bd)	Likely
Scalloped Hammerhead	Requin-marteau halicorne	*Sphyrna lewini*	EN (A2bd+4bd)	Likely
Great Hammerhead	Grand requin-marteau	*Sphyrna mokarran*	EN (A2bd+4bd)	Likely
Atlantic Bluefin Tuna	Thon rouge de l'Atlantique	*Thunnus thynnus*	EN (A2bd)	Possible

1 IUCN Category: CR = critically endangered; EN = endangered. Under the criteria for Critically Endangered and Endangered, there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the category. Alphabetic or alphanumeric entries associated with CR and EN entries per IUCN (2017b) descriptions (http://www.iucnredlist.org/static/categories_criteria_3_1). Presence: "Likely" – IUCN geographic and water depth ranges overlap project site; "Possible" – IUCN geographic range but not water depth range overlaps project site; "Unlikely", neither IUCN geographic or water depth ranges overlap project site; "Very Unlikely" – not reported from Northwest Africa.

(From: IUCN, 2017)

4.5.4.2 Fisheries

CCLME waters support diverse and productive fisheries that target a range of invertebrate and fish species. Fishing in Mauritania and Senegal consists of two primary sectors: industrial (also called *hauturière*) and artisanal. These fishery sectors are briefly discussed below in the context of fish stocks and pressure from the fisheries (see also Sections 4.6.6 and 4.7.6). Detailed information for these fisheries from Mauritania and Senegal are found in Appendix E-1 through E-4.

Industrial Fishing

The industrial fishery is composed of large boats (65 to 100 m) that trawl the seafloor, water column, or both. Most boats are from the EU, Russia, or China. These countries have exclusive agreements with the Mauritanian and Senegalese governments to fish in waters of the EEZ and land and export fish from the area. Mauritania recently signed new industrial agreements with the EU (and others) in 2015 that would permit fishing through the 2019. Senegal has different license categories for foreign boats: coastal demersal, deep demersal, coastal pelagic, and deep sea pelagic.

Industrial fisheries of the region by target species, gear type, fishing season, and area are provided in Appendices E-1 and E-2.

The number of fishing units (boats) engaged in industrial fishing off Mauritania dropped from 300 units to about 175 units between 2012 and 2015, a decrease of 43%. This decrease exclusively affected the foreign segment, since the number of domestic units remained roughly stable at around 100 units. This reduction occurs at a time that Mauritanian authorities want to progressively reserve coastal fisheries resources for national artisanal and coastal fisheries.

In 2015, 35 foreign and 105 domestic industrial boats were involved in industrial fishing off Senegal. The number of domestic industrial boats has been relatively stable (~100 boats) since 2005 but foreign boats have fluctuated below 40 for the same periods. In 2015, foreign boats landed 37,651 tonnes whereas the domestic boats landed 47,444 tonnes.

Hauturière fishing is conducted by boats originating mostly from Europe and Asia. The countries owning these boats have bilateral agreements with the Mauritanian government to fish in waters of the EEZ, allowing them to land and export fish to destinations outside Mauritania.

The industrial fishing segment employs a pelagic and demersal trawling practice almost exclusively. Trawling of the seafloor has a direct impact on benthic habitat. The level of bycatch realized by industrial fishing interest exceeds the thresholds allowed, with bycatch that can reach 45% of the total catch. Monitoring fishing activities in the Mauritanian and Senegalese EEZ is difficult because of under reporting and illegal fishing (Belhabib et al., 2013).

Industrial Fishing of Small Pelagics

After catching (and retaining) nearly 900,000 tonnes in 2011, the catch of small pelagics by industrial boats in Mauritania dropped 61% between 2012 and 2015. This was due largely to the change in the fishing effort, including a reduction in the size of foreign fleets in the area. This decline is more pronounced in the case of catches per fishing effort (43%). Regulatory measures and the remoteness of fishing areas could explain the overall decline in yields. Senegalese industrial boats landed 461 tonnes of small pelagics (mostly sardines) in 2015 which was a 71% decline from the 1604 tonnes landed in the previous year (2014). For all areas, the highest catches of small pelagics occurs during cold weather, early in the year. A gradual decline in catch is evident for other seasons (Appendix E-2).

Over the past 25 years an increasing south-north gradient is evident for small pelagic catches (Table 4-13). When catches of small pelagic species were averaged over 25 years by latitude of fishing area, the proportions were highest in the northern Mauritanian zone (19° N and 20° N) t accounting for 59% of the catch. Catches in the centre zone (18° N), represented 19%. The catch of sardines is restricted to waters closer to shore (Taleb Ould Sidi, 2000). Off Senegal (16° N) catches represented only 9% of the 25-year average.

Table 4-13. Distribution of Average Catches of Small Pelagics by Latitude for the Industrial Fleet in Mauritanian Zone.

Latitude (° N)	Small Pelagic Catches (tonnes)	Contribution (%)
16	50,555	9
17	74,970	13
18	106,087	19
19	114,312	20
20	218,562	39
Total	564,487	100

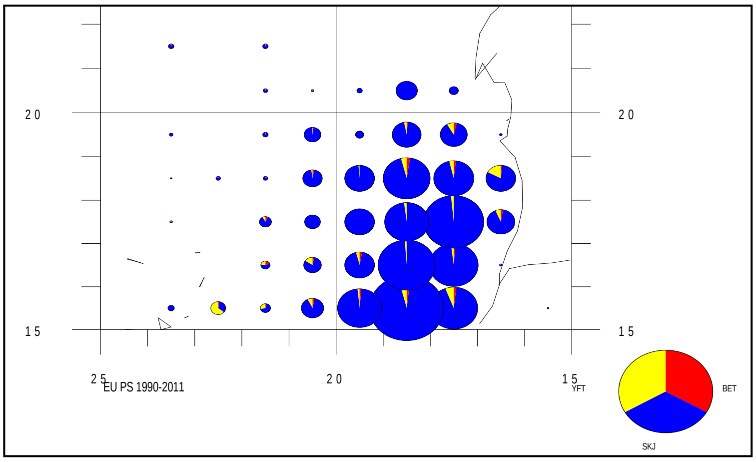
Industrial Fishing of Large Pelagics

Offshore Mauritania, three species of deep-sea tuna were previously being exploited exclusively by foreign fleets (EU, Japan, and Senegal) operating under the fisheries agreement. Species include skipjack (*Katsuwonus pelamis*), which dominates the catches (94% on average), followed by yellowfin tuna, and bigeye.

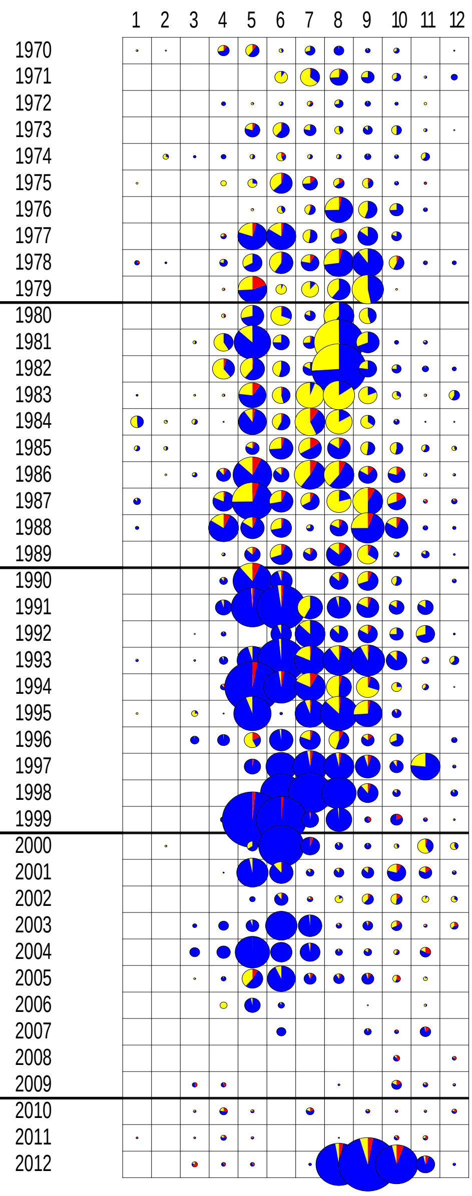
Improved catches of these species have been particularly noticeable in 2012 and 2013. The catch, which was negligible in 2011, reached more than 21,000 tonnes in 2012 before exceeding 47,000 tonnes in 2013, an increase of 123% (Taleb Ould Sidi, 2015). In Senegal tunas accounted for 37,002 tonnes in 2014 and 48,082 tonnes in 2015 (Appendix E-2).

Fishing activity during 2014 and 2015 was very limited due to the non-renewal of the agreement with Japan in December 2013. The Sustainable Fisheries Partnership Agreement between Mauritania and the EU remained unsigned between mid-December 2014 and mid-December 2015. In 2016, industrial fishing activity resumed for both fleets due to the finalization of new agreements (Appendix E-1).

The seasonal movement of tuna is notable. Given the tropical nature of the tuna that migrate from the Gulf of Guinea to Mauritania, abundance decreases from south to north (Figure 4-17a). Average catches occur in the vicinity of the Offshore Area. Figure 4-17b, however, shows that the peak production period for tropical tunas, located for several years between June and August, has shifted later in the year.



a)



b)

(From: Taleb Ould Sidi, 2015)

Figure 4-17. a) Spatial distribution of purse seine catches (average: 1990-2012) from Dakar (15° N) north to Cape Blanc (22° N) and; b) seasonal distribution of catches by longliners and purse seiners from 1970 to 2012.

Rows represent years (1970 to 2012) and columns represent months from January (1) to December (12). Red = bigeye tuna; blue = skipjack tuna; yellow = yellowfin tuna.

Offshore, tuna are naturally drawn to objects floating on the sea surface (Robert et al., 2012), whether man-made or not. Known as fish aggregating devices (FAD), it has been estimated that there are 91,000 FAD in the Atlantic Ocean. The French boats involved in tuna fishing off Mauritania may have up to 150 FAD onboard (Maufroy, 2012). This figure may reach several hundred in the case of Spanish ships. FAD are routinely used by domestic, Spanish, and French tuna boats off Senegal as well.

Over the past several decades, tuna fishers catch rates have been enhanced through the construction and deployment of FAD (e.g., Dagorn et al., 2013; Lopez et al., 2014). FAD will attract skipjack tuna, yellowfin tuna, bigeye tuna, billfishes, and dolphinfishes. FAD are constructed with rafts often with a weighted line hanging beneath. The most recent innovations being added to FAD are satellite-linked tracking units to allow for the monitoring of fish schools. On multiple fishing grounds, FAD may be released with only one equipped with a GPS unit. The release site will depend on sea surface temperature at the time of release. Often FAD are abandoned after fishes are caught.

Coastal tunas, whose movement patterns are less extensive than those of offshore species, primarily include Atlantic bonito (*Sarda sarda*), bullet tuna (*Auxis rochei*), bonito (*Orcynopsis unicolor*), and false albacore (*Euthynnus alletteratus*). Catches ranging from 16,000 tons in 2011 to 3,000 tons in 2015 are recorded for this group. This group is incidental to fishing (bycatches) by industrial boats of small pelagics along with round sardinella (*S. aurita*) which is their preferred prey (Appendices E-1 and E-2).

In Senegal, the primary target species are yellowfin tuna, skipjack, and bigeye tuna, as well as sardines. In addition, small coastal tuna (e.g., little tunny, frigate mackerel, and bonito) and billfish (e.g., swordfish, marlin, and sailfish) are also caught by tuna fishermen. Although, the exploitation of these small tuna and related species is dominated by the artisanal fisheries.

Industrial Fishing of Demersal Species

Different types of demersal industrial fleets operate in Mauritania. National trawler fleets mainly target octopus. In general, Chinese ships working under the Mauritanian flag and target demersal fishes and octopus. Foreign fleets (including EU) target mainly shrimp and hake. Since 2012, the segment of the EU which was fishing cephalopods has left the Mauritanian zone. Beyah (2013) reported that higher national catches of cephalopods occur in coastal waters as compared to foreign cephalopod landings within the EEZ.

Between 2011 and 2015, catches have been reduced by 50%, from 40,000 tons to approximately 21,000 tons, respectively. This is due, among other factors, to revisions in the fishing agreement between Mauritania and the EU (RIM/EU) in July 2012, which excluded the EU from fishing for cephalopods in Mauritanian waters. Reductions in catch are also attributed to the recent irregularity of activity of EU shrimp trawlers and the aging of the national demersal fishing fleet, all of which has resulted in a decrease in production.

These are also deep demersal (>200 m water depths) species (e.g., crabs, hake, pink spiny lobster, and deep-water pink shrimp) which could be targeted by fishing fleets from both Mauritania and Senegal. The crab *Geryon maritae* is present in water depths of 400 to 500 m, although its distribution is quite dispersed. In recent years, deep crab fishing has become specialized. Currently, only one crab boat is allowed to fish. The capture potential estimated by IMROP is around 300 tons per year (Appendix E-1). Deep-water pink shrimp, *Parapenaeus longisrostris*, is localized mainly off southern Mauritania and Senegal in sandy-muddy bottoms between 150 and 600 m deep, preferably around 200 to 300 m.

Artisanal Fishing

Artisanal fishers target a variety of species using common methods as follows:

- Purse seine (small pelagic species);
- Gill net (coastal pelagic and small pelagic);

- Handline (hard and soft bottom demersal species); and
- Traps (octopus).

These methods are briefly discussed below. Although each method that is employed targets a particular species or species group, there can be considerable overlap in the composition of the catches from several types of gear in both Mauritanian and Senegalese fisheries (Detailed information on these topics are in Appendices E-1 and E-2).

Purse Seine

Artisanal purse seining usually employs two boats within the 16 to 21 m size range, powered by outboard motors (40 to 55 horse power [hp]). Purse nets range from 300 to 400 m long and are deployed by a boat that encircles fish schools sighted from the surface. A second boat often retrieves the net. Fishing areas are along the entire coast but tend to be concentrated near Nouakchott and Nouadhibou in water depths less than 40 m. Some purse seiners will fish year round with peak times during February to April. This fishery targets small pelagic species such as sardinellas (*S. aurita* and *S. maderensis*), mackerels (*S. japonicus*), mullets (*Mugil cephalus* and *M. capurrii*), jacks (*T. tracae*, *C. carangus*, and *C. rhonchus*), and grunts (*Pomadasys rogeri*) (Belhabib et al., 2013; Dedah et al., 1999).

Gill Net

Gill nets are set from boats about 16 m long with a capacity of 5 tons, propelled by an outboard motor of at least 40 hp. Gill nets range from 300 to 500 m long. Mesh size of the net will vary depending on the target species. A wide mesh is used to catch Ethmalose (shad), whereas the narrow mesh is more adapted to catching the more slender sardinellas (Belhabib et al., 2013). The peak season extends from August to April. Gill nets are set close to shore in water depths less than 20 m. In addition to the small pelagic species, gill nets will also catch sharks (Carcharhinidae), rays (Myliobatidae), jack crevalles (*C. hippos*), and other species (Appendices E-1 and E-2).

Handline

The boats used for handline fishing are motorized pirogues 16 to 18 m long. These boats are equipped with an icebox. Handlines are made of nylon or monofilament and may be 100 to 200 m long depending on the depth of the fishing grounds. The terminal end of the handline consists of several consecutive baited hooks regularly spaced above a weight. Target species include catfishes (*Arius gambiensis*), groupers (*E. aenus* and *E. goreensis*), snappers (*Lutjanus fulgens*), and porgies (Sparidae). This fishery extends all year with some fishing locations changing by seasons and sea conditions. Most handline fishing occurs in shelf waters less than 200 m deep (Appendix E-2).

Artisanal Fishing Summary

During their 30 years of data collection, IMROP studies have highlighted the development of the Mauritanian artisanal fishing community. The active pirogue fleet increased from 530 units in 1982 to 4,182 boats in 2010. The size of the fleet subsequently increased, with a workforce of more than 6,300 pirogues in 2016. Factors affecting this increase in fishing power include increasing the size of pirogues, engines, and navigational aids. It has been estimated that the artisanal fleet fishing effort has increased more than 15 times over the past 30 years (Appendix E-1).

In Senegal, the Saint-Louis artisanal fishery is composed of nearly 1,000 pirogues, 4 to 25 m long boats powered by 40 to 60 hp engines. The artisanal subsector in the Saint-Louis region accounted for 11.9 billion Communauté Financière Africaine franc (FCFA) in landings in 2016, with the Thiès region contributing approximately 60 billion FCFA in the same year.

The spatial distribution of catches of artisanal fisheries is very heterogeneous. Fishing in the Mauritanian northern zone contributes more than 73% of total catches in this segment, followed by landings in Nouakchott (22%). In Senegal, the Thiès region contributed 65% of the landings followed by Saint-Louis with 19% and the Dakar region with 15%. The contribution of other areas remains low (Table 4-14).

Table 4-14. Distribution of Average Catch (in tons) of Artisanal Fisheries by Zones or Regions.

Port/Landing	2010	2011	2012	2013	2014	Total	Total Contribution (%)
Mauritania							
Nouadhibou	115,532	107,041	119,074	291,597	248,422	881,666	73.2
Banc d'Arguin National Park	3,986	3,626	3,791	2,972	2,950	17,324	1.4
Centre	6,228	2,954	4,019	6,809	6,512	26,522	2.2
Nouakchott	68,803	44,254	60,077	27,734	60,761	261,630	21.7
Sud Nouakchott	2,317	1,867	3,934	3,574	5,513	17,205	1.4
Total	**196,866**	**159,742**	**190,895**	**332,687**	**324,158**	**1,204,348**	**100**
Senegal							
Region of Louga	1,695	2,214	2,264	2,652	3,523	12,348	0.8
Region of Saint-Louis	38,623	60,944	79,854	70,707	58,017	308,145	19.1
Region of Thiès	230,319	215,911	209,797	209,693	190,016	1,055,736	65.3
Region of Dakar	50,487	42,955	54,087	45,519	46,447	239,495	14.8
Total	**321,124**	**322,024**	**346,002**	**328,571**	**298,003**	**1,615,724**	**100**

(From: IMROP, unpublished data [Mauritania]; Appendix E-1 [Senegal])

4.5.4.3 Fish and Other Fishery Resources Summary

Mauritania

Artisanal and industrial fleets predominantly fish in northern Mauritania. The landings made by artisanal fishing in this northern area represents about 73% of all catches of this fishing sector. Industrial fleets, despite a range of action that allows them to exploit all of the Mauritanian area, also concentrate their efforts on this area where they make 59% of their catches. This interest in the northern area is partly explained by historical considerations, but it is mostly related to the fact that this area has a high productivity (width of the continental shelf; permanent upwelling) and has fishing ports (artisanal and coastal fishing port, and industrial fishing port). An additional factor is the relative mildness of oceanic conditions in this area compared to the southern area where a dangerous shoal is present. In this regard, the Mauritanian coast presents a strong north-south gradient (Appendix E-1).

In the Mauritanian EEZ, the last five years were characterized by a restructuring of industrial and artisanal fishing fleets, causing the beginning of an adjustment of fishing capacity. Artisanal fishing, being more accessible to national investments and inexperienced local workforce, and also having greater social and economic advantages (fresh fishery products of better quality and higher price), benefits from multiform incentives from the government. Its relatively small footprint compared to the industrial fishing mode (limited impact on fish habitats, greater selectivity of fishing gear in terms of species and size, lower fuel consumption) also advocates for the development of artisanal fishing (Appendix E-1).

The interest for artisanal fishing has resulted in very significant productivity gains following the increased number of fishing boats, which exceeds 6,200 boats in 2016, and following the accelerated introduction of new fishing techniques (purse seine). Production of artisanal fishing, still insignificant fifteen years, now comes level with industrial fishing. This evolution has been accompanied by the strengthening of the vertical integration process and the control of the sector by Mauritanian boat owners through the domiciliation of catches' valuation on Mauritanian territory (Appendix E-1).

Senegal

In Senegal, artisanal fishing is an important component of the history and culture of the coastal people. The major artisanal fishing regions include Dakar, Saint-Louis, Louga, and Thiès. Most artisanal fishermen work within 10 km of shore and concentrate just south of Dakar and off Saint-Louis, including the area around the mouth of the Senegal River. Many of the Senegalese artisanal fishermen follow migrating fish north and south of Dakar and Saint-Louis. Until early 2017, about 300 Senegalese pirogues were allowed to fish in Mauritanian waters, but the agreement was not renewed. Artisanal fishermen target a diversity of species using purse nets, gill nets, and hook-and-line. The most important fish landed are the small pelagic fishes which include sardinellas, mackerels, cutlassfishes, and others.

Many of Senegal's major fishery stocks were designated over-exploited or fully-exploited by the FAO working group for small pelagic fishes in Northwest Africa (FAO, 2016b). The working group considered ethmalose (bonga) shad, European anchovy, round sardine, and cunene horse mackerel to be overexploited as catches have increased considerably between 2009 and 2014, Overexploited indicates that the fisheries are above the level of long term sustainability and further depletion could result in collapse of the stocks. The working group recommended reducing the allowable catches for these species in the future. The chub mackerel was considered fully exploited which indicates that the fisheries are operating at the optimal yield levels and should not be expanded. Overfishing coupled with pollution, habitat degradation (some caused by fishing), climate change, and other environmental factors has exerted considerable stress on these stocks (Appendix E-2).

4.5.5 Birds

Marine birds include species that live in saltwater or interact closely with the marine environment on a regular basis. This includes seabirds and shorebirds. Coastal birds are those that occur in coastal non-marine habitats, including coastal vegetation, and freshwater and brackish wetlands. The following discussion addresses regional patterns in marine and coastal bird distribution, followed by separate discussions of their presence and distribution within the region, IUCN-listed species, and important bird and biodiversity areas (IBAs).

4.5.5.1 Regional Patterns

The West African coastal zone, including some coastal waters and shorelines within the project area, is important for a number of migratory bird species. BirdLife International (2013) defines a migratory bird species as one where a substantial proportion of the global or regional population makes regular cyclical movements beyond the breeding range, with predictable timing and destinations. As part of their Conservation of Migratory Birds (CMB) project, BirdLife International lists 326 species that that are either fully migratory or undertake significant seasonal movements within seven West African countries (Mauritania, Senegal, Gambia, Guinea Bissau, Guinea, Sierra Leone, and Cape Verde) (BirdLife International, 2013). These include terrestrial species (Passerines), waterbirds (such as shorebirds, waterfowl, and wading birds), and marine species. Key habitats for these migrant species include various terrestrial habitats (e.g., grasslands, inland wetlands, terrestrial artificial habitats, shrublands, savanna, and forests), as well as coastal and marine habitats (e.g., marine coastal habitats [supratidal and intertidal], artificial aquatic and marine habitats, and neritic and oceanic habitats).

From a regional perspective, the distribution and relative density of marine bird species within Mauritania and Senegal are strongly influenced by regular seasonal upwelling, which is considered to be the most intense oceanic upwelling event in the Western Palearctic. In general, the distribution and abundance of seabirds are directly related to the availability of food. Areas of high productivity at sea, such as areas of upwelling and oceanographic fronts, often support large numbers of seabirds, whereas unproductive areas, such as areas in tropical oceans, are often devoid of seabirds (Leopold, 1993). From regional studies, a similar suite of seabird species aggregate within and utilize common offshore habitats in both Mauritania and Senegal, depending on the presence of upwelling events and frontal zones.

Waters offshore Mauritania and Senegal experience persistent and seasonal upwelling, which is considered to be the most intense oceanic upwelling event in the Western Palearctic (comprising Europe, North Africa, northern and central parts of the Arabian Peninsula, and part of temperate Asia, roughly to the Ural Mountains). These offshore waters are an important wintering area for high-latitude migrant seabird species, such as Leach's Storm-petrel (*Oceanodroma leucorhoa*), Grey Phalarope (*Phalaropus fulicarius*), Pomarine Skua (*Stercorarius pomarinus*) and Common Tern (*Sterna hirundo*), as summarized by Cramp and Simmons (1977), Furness (1987), Snow and Perrins (1998), and Wernham et al. (2002). In addition to their presence during winter, large numbers of immature skuas and terns spend one or more summers in these offshore waters until they reach sexual maturity. In spring and autumn, this region is used as a feeding stopover by migrating birds that winter farther south, such as Long-tailed Skua (*Stercorarius longicaudus*), Sabine's Gull (*Larus sabini*), and Black Tern (*Chlidonias niger*), as detailed by Cramp and Simmons (1977), Lambert (1980), Furness (1987), Leopold (1993), Snow and Perrins (1998), and Wernham et al. (2002).

4.5.5.2 Mauritania Marine and Coastal Birds

Presence and Distribution

The avifauna of Mauritania include a total of 559 species (Avibase, 2016). One species has been introduced by humans (House Sparrow [*Passer domesticus*]) and 84 are classified as rare or accidental (Avibase, 2016). Approximately 300 species show regular seasonal movements but do not breed in Mauritania. There are 185 Palearctic migrant species that occur in Mauritania (Shine et al., 2001; Lamarche, 1988).

Marine and coastal birds of Mauritania include representatives of the following 10 taxonomic orders, as derived from multiple sources (Atkinson and Caddick, 2013; BirdLife International, 2016a; eBird, 2016; Dowsett, 1993; Lamarche, 1988):

- Anseriformes – Ducks and Geese;
- Podicipediformes – Grebes;
- Phoenicopteriformes – Flamingos;
- Procellariiformes – Shearwaters, Petrels, and Storm-Petrels;
- Phaethontiformes – Tropicbirds;
- Suliformes – Frigatebirds, Boobies and Gannets; Cormorants, and Darters;
- Pelecaniformes – Pelicans, Hammerkop, Bitterns, Herons, Egrets, Ibises, and Spoonbills;
- Accipitriformes – Osprey;
- Gruiformes – Cranes, Rails, Crakes, Moorhens, Gallinules, Coots, Sungrebe, and Finfoots; and
- Charadriiformes – Plovers, Jacanas, Painted Snipe, Oystercatchers, Avocets, Stilts, Thick-knees, Pratincoles, Coursers, Plovers, Lapwings, Sandpipers and allies, Skuas and Jaegers, Gulls, Kittiwakes, Terns, and Skimmers.

Terrestrial bird groups, such as members of the Orders Passeriformes and Accipitriformes, may also inhabit coastal habitats.

Marine birds that may occur within oceanic and continental shelf waters of the core study area include members of the Orders Procellariiformes, Phaethontiformes, Suliformes, Pelecaniformes, and Charadriiformes. The distributions of marine bird species and their relative densities in offshore waters of Mauritania (including waters of the core study area) have been described in a number of investigations (Cramp and Simmons, 1977; Furness, 1987; Snow and Perrins, 1998; Wernham et al., 2002).

A ship-based seabird and marine mammal survey was conducted along the Mauritanian continental shelf (neritic zone) and slope (shelf break) between Nouadhibou (Mauritania) and Saint-Louis (Senegal) during September 2014 (Camphuysen et al., 2015). At least 30 species of marine birds were recorded during this survey (Table 4-15).

Table 4-15. Seabird Species Observed during the 2014 Survey off the Mauritanian Coast by Camphuysen et al. (2015).

Nomenclature and taxonomic order follow Gill and Donsker (2015). Species that breed in Mauritania are marked with an asterisk (*).

Common Name		Scientific Name
English	French	
Wilson's Storm-Petrel	Océanite de Wilson	*Oceanites oceanicus*
European Storm Petrel	Océanite tempête	*Hydrobates pelagicus*
Band-rumped Storm Petrel	Océanite de Castro	*Oceanodroma castro*
Swinhoe's Storm Petrel	Océanite de swinhoe	*Oceanodroma monorhis*
Leach's Storm Petrel	Océanite culblanc	*Oceanodroma leucorhoa*
Scopoli's Shearwater	Puffin cendré (Méditerannée)	*Calonectris diomedea*
Cory's Shearwater	Puffin cendré (Atlantique)	*Calonectris borealis*
Cape Verde Shearwater	Puffin du Cap-Vert	*Calonectris edwardsii*
Sooty Shearwater	Puffin fuligineux	*Ardenna grisea*
Great Shearwater	Puffin majeur	*Ardenna gravis*
Manx Shearwater	Puffin des Anglais	*Puffinus puffinus*
Balearic Shearwater	Puffin des Baléares	*Puffinus mauritanicus*
Barolo Shearwater	Puffin de Macaronésie	*Puffinus baroli*
Bulwer's Petrel	Pétrel de Bulwer	*Bulweria bulwerii*
Great White Pelican*	Pélican blanc	*Pelecanus onocrotalus*
Red Phalarope	Phalarope à bec large	*Phalaropus fulicarius*
Sabine's Gull	Mouette de Sabine	*Xema sabini*
Audouin's Gull	Goéland d'Audouin	*Ichthyaetus audouinii*
Lesser Black-backed Gull	Goéland brun	*Larus fuscus*
Caspian Tern*	Sterne caspienne	*Hydroprogne caspia*
Royal Tern*	Sterne royale	*Thalasseus maximus*
Sandwich Tern	Sterne caugek	*Thalasseus sandvicensis*
Little Tern*	Sterne naine	*Sternula albifrons*
Bridled Tern*	Sterne bridée	*Onychoprion anaethetus*
Common Tern*	Sterne pierregarin	*Sterna hirundo*
Black Tern	Guifette noire	*Chlidonias niger*
South Polar Skua	Labbe Antarctique	*Stercorarius maccormicki*
Pomarine Skua	Labbe pomarin	*Stercorarius pomarinus*
Parasitic Jaeger	Labbe parasite	*Stercorarius parasiticus*
Long-tailed Jaeger	Labbe à longue queue	*Stercorarius longicaudus*

Data collected during this survey were limited to the September (2014) period, only. These observations, albeit of great value, are limited and do not address seasonal variability in species richness and abundances within the region. Survey results found that the shelf-break was the area of greatest species diversity and relative abundance for both seabirds and cetaceans (Table 4-16).

Table 4-16. Species Diversity and Overall Densities (individuals km^{-2}) for Groups of Seabirds Observed over the Neritic Zone, the Shelf-Break, and in Deep Waters (oceanic) during the 2014 Survey.

Group	Species Diversity			Overall Densities (Individuals km^{-2})		
	Oceanic	Shelf Break	Neritic	Oceanic	Shelf Break	Neritic
Shearwaters	7	7	6	0.15	0.19	0.10
Storm-petrels	4	5	4	0.13	1.75	1.20
Pelicans	0	0	1	0	0	0.02
Phalaropes	1	1	1	0.11	0.69	0.40
Skuas	3	3	4	0.01	0.72	0.55
Gulls	1	1	3	8.4	0.09	0.04
Terns	4	5	7	1.78	3.42	2.89

(From: Camphuysen et al., 2015)

Several species (a mix of mostly shearwaters and phalaropes) and overall biodiversity peaked in the northern part of the study area (offshore Nouadhibou, Mauritania), within areas of upwelling where cool, subsurface water reached the surface. Further south, areas with high numbers of foraging seabirds were dominated by Black Terns and to a lesser extent Common Terns. Additional results for prior offshore and nearshore bird surveys (e.g., Camphuysen et al., 2013; Wynn and Knefelkamp, 2004) are provided in Appendix G.

The Programme de Gestion des Ressources Naturelles (GIZ), in conjunction with IMROP, coordinated a systematic survey of Mauritanian shelf and slope waters during November 2016, following the survey design and protocols used by Camphuysen et al. (2015, 2013). Data collected during this survey and previous surveys will be compiled to prepare an atlas of selected resources (i.e., marine mammals, marine birds, and sea turtles) in the pelagic environment offshore Mauritania. As of March 2017, the 2016 survey summary report was unavailable. However, Abdallahi (2016) presented preliminary survey findings at an IMROP workshop in December 2016. Survey transects crossed shelf and slope waters along a series of 185 km long transects generally oriented east-west between Cape Blanc in the north to near N'Diago in the south. Marine and coastal bird observations included 25,851 individuals representing 41 species; observations included Cory's shearwater (*Calonectris borealis*, 5,049 individuals); Pomarine skua (*Stercorarius pomarinus*, 3,520 individuals), black tern (*Chlidonias niger*, 3,018 individuals), Eastern storm petrel (*Hydrobates pelagicus*, 2,858 individuals), Common tern (*Sterna hirunddo*, 2,604 individuals), Northern gannet (*Morus bassanus*, 4,024 individuals), and Leach's storm petrel (*Oceanodroma leucorhoa*, 13,029 individuals). Based on the frequency of observations, highest faunal densities were typically evident in the northern portion of the survey area, near Banc d'Arguin. However, Pomarine Skuas, Black Terns, Leach's Storm Petrels, and Cory's Shearwaters were sighted frequently along the southern transects. Several survey lines completed in southern offshore Mauritanian waters were approximately 25 to 30 km east (inshore) of the Offshore Area.

Threatened Marine and Coastal Birds

Avibase (2016) and BirdLife International (2016a) identify 14 marine and coastal bird species that occur within Mauritania that are currently listed on the IUCN Red List of Threatened Species as Critically Endangered, Near Threatened, and Vulnerable (Table 4-17).

Table 4-17. Mauritania Marine and Coastal Bird Species with IUCN Red List Status.

Order presented in the table is by taxonomic order (From: Avibase, 2016). Species categorized as Critically Endangered by the IUCN are identified in red.

Common Name		Scientific Name	IUCN Red List Category[1]
English	French		
Ferruginous Duck	Fuligule nyroca	*Aythea nyroca*	NT
Lesser Flamingo	Flamant nain	*Phoeniconaias minor*	NT
Zino's Petrel	Pétrel de Zino	*Pterodroma madeira*	NT
Sooty Shearwater	Puffin fuligineux	*Ardenna grisea*	NT
Cape Verde Shearwater	Puffin du Cap-Vert	*Calonectris edwardsii*	NT
Yelkouan Shearwater	Puffin yelkouan	*Puffinus yelkouan*	VU
Balearctic Shearwater	Puffin des Baléares	*Puffinus mauretanicus*	CR (A4bcde)
Northern Bald Ibis	Ibis chauve	*Geronticus eremita*	CR (C2a[ii])
Eurasian Curlew	Courlis cendré	*Numenius arquata*	NT
Black-tailed Godwit	Barge à queue noire	*Limosa*	NT
Semipalmated Sandpiper	Bécasseau semipalmé	*Calidris pusilla*	NT
Great Snipe	Bécassine double	*Gallinago media*	NT
Audouin's Gull	Goéland d'Audouin	*Ichthyaetus audouinii*	NT
African Skimmer	Bec-en-ciseaux d'Afrique	*Rynchops flavirostris*	NT

[1] IUCN Category: CR = critically endangered; VU = vulnerable; NT = near threatened. Under the criteria for Critically Endangered and Vulnerable, there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the category. Alphabetic or alphanumeric entries associated with CR and VU entries per IUCN (2017) descriptions (http://www.iucnredlist.org/static/categories_criteria_3_1)

(From: IUCN, 2017)

Areas of Conservation Interest for Marine and Coastal Birds

Important Bird and Biodiversity Areas (IBAs)

An Important Bird and Biodiversity Area (IBA) is an area or site identified as being globally important for the conservation of bird populations using an internationally agreed set of criteria (BirdLife International, 2017c). Specific IBA thresholds are set by regional and national governing organizations. Global IBA criteria are divided into four categories based on vulnerability and/or responsibility (National Audubon Society, 2017).

By definition, IBAs are sites that support:

1) Species of conservation concern (e.g. threatened and endangered species);

2) Range-restricted species (species vulnerable because they are not widely distributed);

3) Species that are vulnerable because their populations are concentrated in one general habitat type or biome; or

4) Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their congregatory behavior.

Many IBAs include diverse physical habitats that support a variety of bird populations and may also support diverse assemblages of other biota as well, serving as biodiversity 'hotspots' within the region. IBAs are not protected areas, per se. Once designated, BirdLife Partners in various countries monitor the state of their IBAs to provide up to date information on pressures to their most threatened IBAs that can be used to direct enhanced conservation efforts for these sites, Government-controlled protected areas may also be or include IBAs as well as other areas of concern. Protected areas, including IBAs within protected areas, are presented in Section 4.5.9 (Protected Areas).

There are 25 IBAs within Mauritania and they cover approximately 2,473,300 ha of the area of the country (African Bird Club, 2016). Fourteen of the IBAs are principally wetland habitats, and five are located along the coast (Cap Blanc, Banc d'Arguin National Park, Aftout Es Saheli, Chatt Tboul, and Diawling National Park) (Table 4-18) (Shine et al., 2001). A sixth IBA, Canary Current Shelf-Break South, lies just offshore. Four IBAs are present near the core study area – Canary Current Shelf-Break South, Aftout Es Saheli, Chatt Tboul, and Diawling National Park. These IBAs include important foraging habitats for coastal species and some marine species within the region. The Chatt Tboul and Diawling National Park IBAs occur near the core study area and are found within protected areas. All pertinent IBAs are discussed in Section 4.5.9. The key species present and the location of pertinent IBAs in Mauritania is depicted in Table 4-19 and Figure 4-18, respectively.

Table 4-18. Summary of Mauritania Important Bird and Biodiversity Areas (IBAs) within or adjacent to the Core or Extended Study Areas.

IBA National Name	IBA Code	IBA Area (ha)	IBA Category
Cap Blanc	MR006	310,000	A4i, A4iii
Banc d'Arguin National Park	MR004	1,173,000	A1, A3, A4i, A4iii
Canary Current Shelf-Break South	Not assigned	489,745	A4i, A4ii
Aftout Es Saheli	MR012	120,000	A1, A3, A4i, A4iii
Chatt Tboul	MR017	15,500	A1, A4i, A4iii
Diawling National Park	MR021	15,600	A1, A3, A4i, A4iii

A1: Globally threatened species. Criterion: The site is known or thought regularly to hold significant numbers of a globally threatened species, or other species of global conservation concern.
A3: Biome-restricted species. Criterion: The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.
A4: Congregations. Criteria: A site may qualify on any one or more of the following four criteria:
- A4i: Site known or thought to hold, on a regular basis, >1% of a biogeographic population of a congregatory waterbird species.
- A4ii: Site known or thought to hold, on a regular basis, >1% of the global population of a congregatory seabird or terrestrial species.
- A4iii: Site known or thought to hold, on a regular basis, > 20,000 waterbirds or >10,000 pairs of seabirds of one or more species.
- A4iv: Site known or thought to exceed thresholds set for migratory species at bottleneck sites.

(From: BirdLife International, 2018)

Table 4-19. Important Bird and Biodiversity Areas (IBAs) for Mauritania including Key Species Present.

IBA Name	Key Species: Abundance; IBA Criteria; and Occurrence
Cap Blanc	Ruddy Turnstone: 1,000 individuals; A4i criteria; winter presence Slender-billed Gull: 150 individuals; A4i criteria; winter presence Lesser Black-backed Gull: 15,000 individuals; A4i criteria; winter presence Caspian Tern: 10,000 individuals; A4i criteria; winter presence Sandwich Tern: 20,000 individuals; A4i criteria; winter presence A4iii Species group – waterbirds: 20,000-49,999 individuals; A4iii criteria; winter presence
Banc d'Arguin National Park	Greater Flamingo: 12,940 breeding pairs; A4i criteria; resident Greater Flamingo: 118,200 individuals; A4i criteria; winter presence Nubian Bustard: no population estimate; A1, A3 criteria; resident Eurasian Spoonbill: 1,610 breeding pairs; A4i criteria; breeding Eurasian Spoonbill: 18,591 individuals; A4i criteria; winter presence Little egret: 4,418 individuals; A4i criteria; winter presence Western reef heron: 745 breeding pairs; A4i criteria; breeding/resident Western reef heron: 2,899 individuals; A4i criteria; winter presence Great White Pelican: 3,080 breeding pairs; A4i criteria; breeding Great White Pelican: 3,763 individuals; A4i criteria; winter presence Long-tailed Cormorant: 7,787 individuals; A4i criteria; winter presence Great Cormorant: 4,260 breeding pairs; A4i criteria; breeding Great Cormorant: 9,395 individuals; A4i criteria; winter presence Oystercatcher: 9,176 individuals; A4i criteria; winter presence Kentish plover: 17,380 individuals; A4i criteria; winter presence Grey Plover: 23,425 individuals; A4i criteria; winter presence Common Ringed Plover: 133,055 individuals; A4i criteria; winter presence Whimbrel: 25,000 individuals; A4i criteria; winter presence Eurasian Curlew: 25,000 individuals; A4i criteria; winter presence Bar-tailed Godwit: 542,965 individuals; A4i criteria; winter presence Ruddy Turnstone: 17,081 individuals; A4i criteria; winter presence Red Knot: 365,880 individuals; A4i criteria; winter presence Curlew Sandpiper: 226,023 individuals; A4i criteria; winter presence Sanderling: 20,556 individuals; A4i criteria; winter presence Dunlin: 919,895 individuals; A4i criteria; winter presence Little Stint: 43,899 individuals; A4i criteria; winter presence Common Greenshank: 4,030 individuals; A4i criteria; winter presence Common Redshank: 102,266 individuals; A4i criteria; winter presence
Banc d'Arguin National Park	Gull-billed tern: 1,180 breeding pairs; A4i criteria; breeding Slender-billed Gull: 1,610 breeding pairs; A4i criteria; breeding Slender-billed Gull: 4,305 individuals; A4i criteria; winter presence Lesser Black-backed Gull: 14,936 individuals; A4i criteria; winter presence Caspian Tern: 2,575 breeding pairs; A4i criteria; breeding Caspian Tern: 5,069 individuals; A4i criteria; winter presence Common Tern: 40 breeding pairs; A4i criteria; breeding Sandwich Tern: 9,180 individuals; A4i criteria; winter presence Royal Tern: 5,630 breeding pairs; A4i criteria; breeding Royal Tern: 3,340 individuals; A4i criteria; winter presence Pharaoh Eagle-owl: no population estimate; A3 criteria; resident Dunn's lark: no population estimate; A3 criteria; resident Greater Hoopoe-lark: no population estimate; A3 criteria; resident Bar-tailed Lark: no population estimate; A3 criteria; resident Desert Lark: no population estimate; A3 criteria; resident Pale Rock Martin: no population estimate; A3 criteria; resident White-crowned Wheatear: no population estimate; A3 criteria; resident African desert sparrow: no population estimate; A3 criteria; resident Trumpeter Finch: no population estimate; A3 criteria; resident A4iii Species group – waterbirds; 2,500,000-4,999,999 individuals; A4iii criteria; winter presence A4iii Species group – waterbirds: 50,000-99,999 individuals; A4iii criteria; breeding

IBA Name	Key Species: Abundance; IBA Criteria; and Occurrence
Canary Current Shelf-Break South	Band-rumped Storm-petrel: 8,000 individuals; A4ii criteria; non-breeding Cory's Shearwater: 13,000 individuals; A4ii criteria; non-breeding (?) Audubon's Shearwater: 900-4,000 individuals; A4ii criteria; non-breeding (?) Northern Gannet: 65,000 individuals; A4ii criteria; non-breeding Red Phalarope: 109,800 individuals; A4i criteria; non-breeding Pomarine Jaeger: 26,250 individuals; A4ii criteria; non-breeding Great Skua: 3,000 individuals; A4ii criteria; non-breeding
Aftout Es Sahli	Great White Pelican: 1,945 individuals; A4i criteria; winter presence Great White Pelican: 2,100 individuals; A4i criteria; breeding Great Cormorant: 3,200 individuals; A4i criteria; breeding Caspian Tern: 640 individuals; A4i criteria; winter presence Little Tern: 1,500 individuals; A4i criteria; winter presence Grey-headed Gull: 1,500 individuals; A4i criteria; winter presence Slender-billed Gull: 1,880 individuals; A4i criteria; winter presence
Chatt Tboul	Caspian Tern: 986 individuals; A4i criteria; winter presence Slender-billed Gull: 800 individuals; A4i criteria; winter presence
Diawling National Park	Great White Pelican: 24,613 individuals; A4i criteria; winter presence Caspian Tern: 595 individuals; A4i criteria; winter presence Slender-billed Gull: 200 individuals; A4i criteria; winter presence

(Adapted from: BirdLife International, 2017a,b,c, 2018)

Critical Sites for Waterbirds

Critical Sites for migratory waterbirds were first identified for populations in the African-Eurasian region in 2010 on the basis of combined data from BirdLife International's World Bird and Biodiversity Database (WBDB), and Wetlands International's International Waterbird Census (IWC) database (BirdLife International, 2013). Two criteria were used to identify Critical Sites:

1) The site is known or thought to hold significant numbers of a population of a globally threatened waterbird species on a regular or predictable basis.

2) The site is known or thought to hold >1% of a flyway or other distinct population of a waterbird species on a regular or predictable basis.

In Mauritania, there are 13 designated Critical Sites. Three sites are located along the Mauritania coastline: Banc d'Arguin National Park, Cap Blanc, and Chatt Tboul. Banc d'Arguin National Park is the most important site in the region, considering the percentage of the global population represented at each site for all recorded waterbird species (BirdLife International, 2013). Each site is discussed in Section 4.5.9 (Protected Areas).

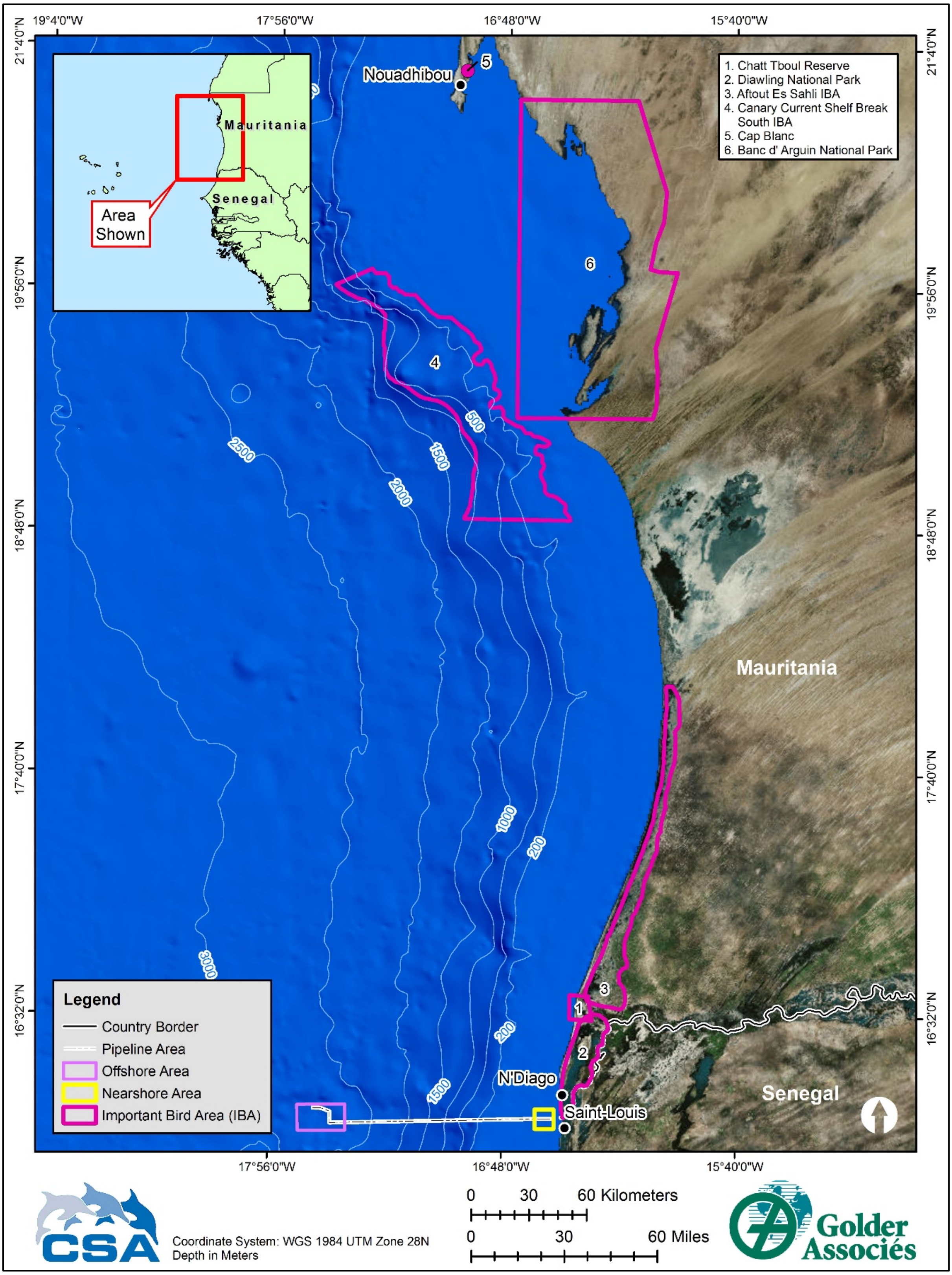


Figure 4-18. Important Bird and Biodiversity Areas (IBAs) in Mauritania.

4.5.5.3 Senegal Marine and Coastal Birds

Presence and Distribution

Coulthard (2001) reported the presence of 612 bird species present in Senegal. The list includes 357 resident species, of which 210 species (59%) breed in Senegal, and 207 seasonal migrant species, of which 144 species are Palearctic. Additional species are noted but not formally categorized by Coulthard (2001).

Of particular note for Senegal avifauna are the huge congregations of migrant and resident waterbirds found within the wetlands in the Senegal floodplain. These Senegal wetlands, together with wetlands in neighboring Mauritania and those in the inland delta of the River Niger in Mali and Lake Chad, are the first available stopover places for migratory waterbirds after a 2,000-km crossing of the Sahara desert. It is estimated that 3 million migrant birds pass through the protected areas in the Senegal River delta each year (Hughes and Hughes, 1992). In addition, the Senegal coastline is recognized as important to resident and passage seabirds, with observations of tens of thousands of migrant terns, gulls and shearwaters moving along the coast, especially around the Cap-Vert peninsula (Coulthard, 2001).

Marine and coastal birds of Senegal include representatives of the following taxonomic orders (from Lepage, 2007):

- Podicipediformes – Grebes;
- Procellariiformes – Shearwaters, Petrels, and Storm-Petrels;
- Pelecaniformes – Pelicans, Cormorants, Frigatebirds, Boobies and Gannets, and Darters;
- Ciconiiformes – Bitterns, Herons, Egrets, Hammerkop, Storks, Ibises, and Spoonbills;
- Phoenicopteriformes – Flamingos;
- Anseriformes – Ducks, Geese, and Swans;
- Falconiformes – Osprey, Hawks, Kites, and Eagles;
- Gruiformes – Cranes, Rails, Crakes, Gallinules, Coots, Sungrebe, and Finfoots; and
- Charadriiformes – Jacanas, Painted Snipe, Oystercatchers, Avocets, Stilts, Thick-knees, Pratincoles, Coursers, Plovers, Lapwings, Sandpipers and allies, Gulls, Terns, and Skimmers.

The avifauna of the coastal strip of Senegal is relatively well known, as estuaries and wetlands associated with the Senegal, Gambia, Saloum, and Casamance Rivers have been the subject of research and ringing campaigns in recent decades, and are regularly visited by European and African ornithologists (Zwarts et al., 2010).

Census efforts to estimate bird populations over coastal and offshore waters off Senegal are extremely limited. Marine birds of waters offshore of Senegal include members of the Order Procellariiformes, Pelicaniformes, and Charadriiformes. A limited number of marine bird census studies have been carried out within the upwelling zone associated with the Canary Current off Mauritania and Senegal (e.g., Brown, 1979; Leopold, 1993; Camphuysen, 2000).

Threatened Marine and Coastal Birds

BirdLife International (2015) identifies 32 seabird species found in Senegal that are currently listed on the IUCN Red List of Threatened Species, with 29 of these species listed as species of Least Concern and three species listed as Near Threatened (Table 4-20). None of Senegal’s marine or coastal bird species are listed as Critically Endangered or Endangered.

Table 4-20. Senegal Marine Bird Species and Current IUCN Red List Status. Order presented in the table is alphabetical by scientific name.

Scientific Name	Common Name	Red List Category[1]
Bulweria bulwerii	Bulwer's Petrel	LC
Calonectris borealis	Cory's Shearwater	LC
Calonectris diomedea	Scopoli's Shearwater	LC
Calonectris edwardsii	Cape Verde Shearwater	NT
Chlidonias niger	Black Tern	LC
Gelochelidon nilotica	Common Gull-billed Tern	LC
Hydrobates castro	Band-rumped Storm-petrel	LC
Hydrobates leucorhous	Leach's Storm-petrel	LC
Hydroprogne caspia	Caspian Tern	LC
Larus audouinii	Audouin's Gull	NT
Larus cirrocephalus	Grey-headed Gull	LC
Larus dominicanus	Kelp Gull	LC
Larus fuscus	Lesser Black-backed Gull	LC
Larus genei	Slender-billed Gull	LC
Larus ridibundus	Black-headed Gull	LC
Morus bassanus	Northern Gannet	LC
Oceanites oceanicus	Wilson's Storm-petrel	LC
Onychoprion anaethetus	Bridled Tern	LC
Onychoprion fuscatus	Sooty Tern	LC
Pelagodroma marina	White-faced Storm-petrel	LC
Pelecanus onocrotalus	Great White Pelican	LC
Phaethon aethereus	Red-billed Tropicbird	LC
Phalacrocorax carbo	Great Cormorant	LC
Pterodroma feae	Cape Verde Petrel	NT
Puffinus puffinus	Manx Shearwater	LC
Stercorarius parasiticus	Arctic Jaeger	LC
Stercorarius pomarinus	Pomarine Jaeger	LC
Sterna hirundo	Common Tern	LC
Sternula albifrons	Little Tern	LC
Thalasseus maximus	Royal Tern	LC
Thalasseus sandvicensis	Sandwich Tern	LC
Xema sabini	Sabine's Gull	LC

[1]IUCN Categories : LC = least concern; NT = near threatened.

(From: BirdLife International, 2015)

Areas of Conservation Interest for Marine and Coastal Birds

Important Bird and Biodiversity Areas (IBAs)

Senegal has a total of 17 designated IBAs (Table 4-21); four are located along the coast inshore of the core study area and one (North Senegal Shelf Break) is a marine IBA (located in offshore waters). The Niayes IBA (IBA SN009) occurs within coastal areas adjacent to the study area but is not included in this analysis. This IBA consists of a string of permanent freshwater lakes and additional temporarily wet depressions (niayes) lying inshore of coastal dunes along a line running north-east from the outskirts of Dakar to around 60 km south-west of Saint-Louis.

The Guembeul Avifaunal Reserve and Saint-Louis Lagoons IBA, and Parc National de la Langue de Barbarie, and Parc National des Iles de la Madeleine IBA are also Senegal protected areas. All pertinent IBAs are discussed in Section 4.5.9. The key species present and the location of pertinent IBAs in Senegal is depicted in Table 4-22 and Figure 4-19, respectively.

Table 4-21. Summary of Senegal Important Bird and Biodiversity Areas (IBAs) within or adjacent to the Core or Extended Study Areas.

IBA National Name	IBA Code	IBA Area (ha)	IBA Category
Guembeul Avifaunal Reserve and Saint-Louis lagoons	SN005	1,500	A4i
Langue de Barbarie National Park	SN006	2,000	A4i
Langue de Barbarie National Park – marine	Not assigned	103,906	A4i
Niayes (from Dakar to Saint-Louis)	SN009	4,000	A4i
Magdalen Islands National Park	SN010	45	A4ii
Cap-Vert (Cape Verde [peninsula])	SN017	3,800	A1, A4i, A4ii
Northern Senegal Shelf Break	Not assigned	778,844	A4ii

A1: Globally threatened species. Criterion: The site is known or thought regularly to hold significant numbers of a globally threatened species, or other species of global conservation concern.
A3: Biome-restricted species. Criterion: The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.
A4: Congregations. Criteria: A site may qualify on any one or more of the following four criteria:
- A4i: Site known or thought to hold, on a regular basis, >1% of a biogeographic population of a congregatory waterbird species.
- A4ii: Site known or thought to hold, on a regular basis, >1% of the global population of a congregatory seabird or terrestrial species.
- A4iii: Site known or thought to hold, on a regular basis, > 20,000 waterbirds or >10,000 pairs of seabirds of one or more species.
- A4iv: Site known or thought to exceed thresholds set for migratory species at bottleneck sites.

(From: BirdLife International, 2018)

Table 4-22. Important Bird and Biodiversity Areas (IBAs) for Senegal including Key Species Present.

IBA Name	Key Species: Abundance; IBA Criteria; and Occurrence
Guembeul Natural Reserve (including Saint-Louis lagoons)	Greater Flamingo: 4,500 individuals; A4i criteria; winter presence Eurasian Spoonbill: 477 individuals; A4i criteria; winter presence Pied Avocet: 7,000 individuals; A4i criteria; winter presence Slender-billed Gull: 678 individuals; A4i criteria; winter presence Grey-headed Gull: 1,050 individuals; A4i criteria; winter presence
Langue de Barbarie National Park	Gull-billed tern: 200 breeding pairs; A4i criteria; breeding Slender-billed Gull: 1,000 individuals; A4i criteria; winter presence Slender-billed Gull: 2,850 breeding pairs; A4i criteria; breeding Grey-headed Gull: 1,838 individuals; A4i criteria; winter presence Grey-headed Gull: 3,000 breeding pairs; A4i criteria; breeding Little Tern: 35 breeding pairs; A4i criteria; breeding Caspian Tern: 424 individuals; A4i criteria; winter presence Caspian Tern: 150 breeding pairs; A4i criteria; breeding Royal Tern: 2,650 breeding pairs; A4i criteria; breeding
Langue de Barbarie National Park – marine	Slender-billed Gull: 17,100 individuals; A4i criteria; breeding Grey-headed Gull: 18,000 individuals; A4i criteria; breeding Little Tern: 105-200 individuals; A4i criteria; breeding Caspian Tern: 450-765 individuals; A4i criteria; breeding Royal Tern: 5,400-9,000 individuals; A4i criteria; breeding
Niayes (from Dakar to Saint-Louis)	Little Grebe: 250 breeding pairs; A4i criteria; breeding Little Grebe: 500 individuals; A4i criteria; winter presence Purple Swamphen: 104 individuals; A4i criteria; winter presence Black Heron: 250 breeding pairs; A4i criteria; breeding Slender-billed Gull: 145 individuals; A4i criteria; winter presence White-winged Tern: 2,000 individuals; A4i criteria; winter presence
Magdalen Islands National Park	Red-billed Tropicbird: 30 breeding pairs; A4ii criteria; breeding
Cap-Vert	Audouin's Gull: 280 individuals; A1 criteria; winter presence Black Tern: 23,923 individuals; A4i criteria; migrant (passage) Sandwich Tern: 13,000 individuals; A4i criteria; winter presence
Northern Senegal Shelf Break	Cape Verde shearwater: 3,966-9,018 individuals; A4ii criteria; incubation

Critical Sites for Waterbirds

In Senegal, there are 12 Critical Sites for migratory waterbirds. Five sites are located along the Senegalese coastline: Delta du Saloum National Park, La Petite Côte, Langue De Barbarie, Cap Vert, and Joal-Fadiouth. Two of the sites are found within the project's core study area: the Langue de Barbarie National Park and Cap Vert Peninsula.

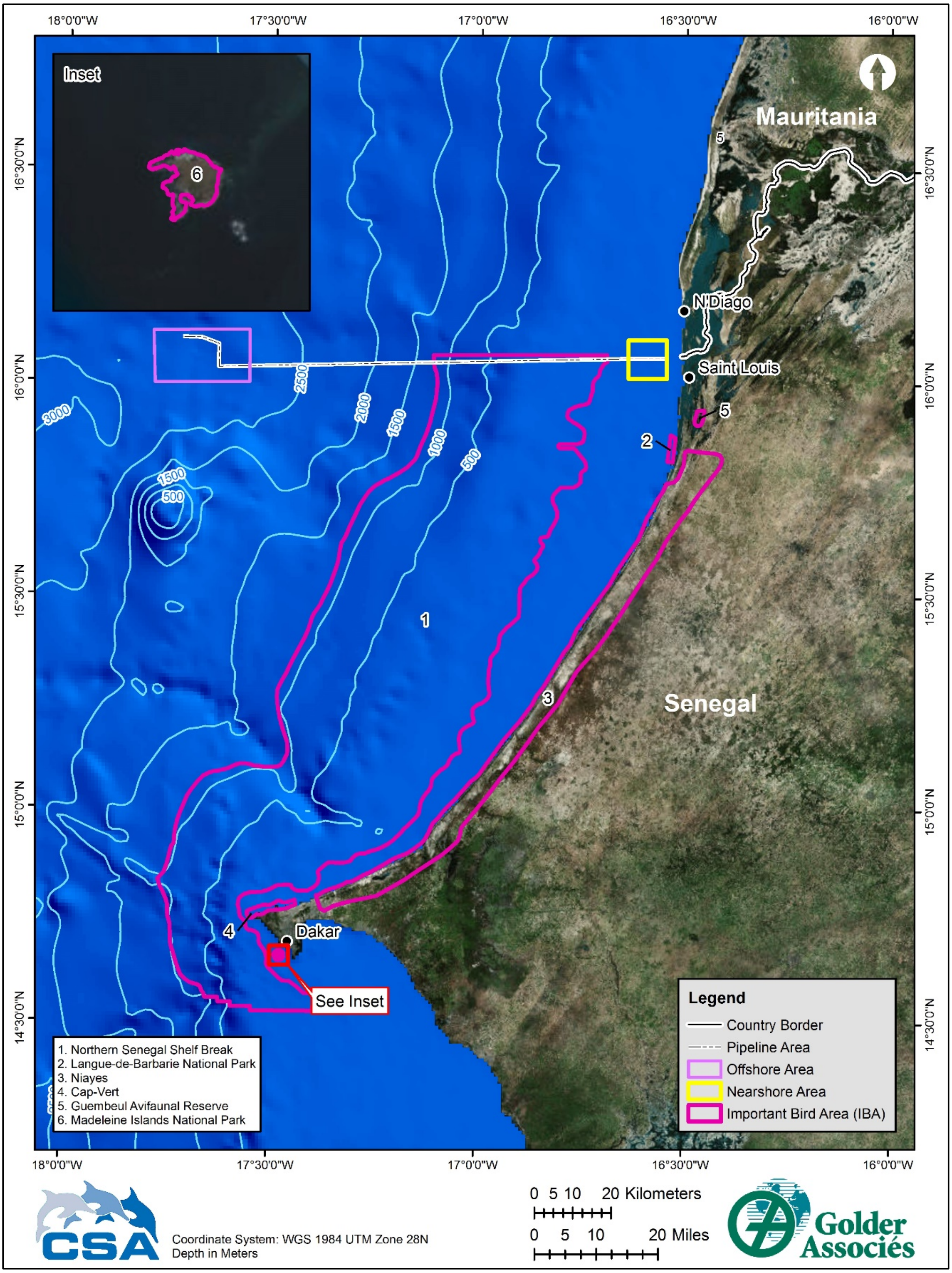


Figure 4-19. Important Bird and Biodiversity Areas (IBAs) in Senegal.

4.5.6 Marine Mammals

4.5.6.1 Regional Patterns

Based on the best available information, including regional and worldwide sightings records, there are more than 30 marine mammal species that may occur in this region (Jefferson et al., 2015). These include constituents of three major taxonomic groups: Order Cetacea (whales, dolphins, and porpoises), Suborder Pinnipedia (sea lions and seals), and Order Sirenia (manatees and dugong). The Order Cetacea is further subdivided into Suborders Mysticeti (baleen whales) and Odontoceti (toothed whales, dolphins, and porpoises) (Mead and Brownell, 2005). Pinnipeds comprise a diverse clade of carnivorous, semiaquatic marine mammals, including three taxonomic families: Otariidae (eared seals and sea lions), Odobenidae (walrus), and Phocidae (earless seals) (Jefferson et al., 2015).

Marine mammals recorded off Guinea, Guinea-Bissau, Mauritania, Senegal, and The Gambia display similar regional patterns in terms of species presence, and spatial and temporal abundances (Abdallahi, 2016; Camphuysen et al., 2013, 2015; RPS Energy, 2014b; Tulp and Leopold, 2004; Burton, 2003; Centre de Recherches Océanographiques de Dakar-Thiarroye, 2002; Camphuysen, 2000). From historical surveys, numbers of marine mammal species and their relative abundances were observed in much greater numbers within areas of high productivity (i.e., areas of upwelling and ocean current convergence), generally in waters along the continental shelf edge and beyond. This area of upwelling extends along the coasts from Portugal to Guinea (ranging from latitude 42° to 10°N), driven by winds rotating around the subtropical anticyclonic systems (Section 4.4.4).

Recent studies have shown that there are at least two distinct regional upwellings. The most productive area in the region is around Cape Blanc, Mauritania. The upwelling season south of Cape Blanc is shorter in duration. It is likely that oceanographic conditions (i.e., conditions initiating and maintaining upwelling in the region) must generate spatially and temporally dynamic foraging conditions for these species. Consequently, observations of marine mammal (and other resource) species presence, distribution, and abundances from survey programs referenced in this section do not fully capture both spatial and temporal and spatial shifts in local or regional foraging conditions (Camphuysen, 2000).

4.5.6.2 Mauritania Marine Mammals

Table 4-23 identifies marine mammal species of Mauritania, their IUCN designation, and their potential presence within the core and extended study areas. A total of 22 species are known to (or likely to) occur in these waters, with an additional seven species whose presence is considered possible due to species-specific broad scale habitat preferences, range limits, or seasonal migratory patterns. Three species are considered unlikely or very unlikely to be present. Appendix G provides habitat and range summaries, as detailed in IUCN (2017), and protected status for multiple listing organizations.

Seven marine mammal species listed in Table 4-23 are currently classified within the IUCN Red List of Threatened Species as Endangered or Vulnerable (IUCN, 2017). As defined by the IUCN (2017), a species is Endangered when the best available evidence indicates that it is considered to be facing a *very high risk* of extinction in the wild; and Vulnerable when the best available evidence indicates that it is considered to be facing a *high risk* of extinction in the wild.

Table 4-23. Marine Mammals of Mauritania, including their IUCN Red List Designation and their Potential Presence in the Core and Extended Study Areas.

Common and scientific names of some species reflect recent taxonomic revisions as proposed by the Committee on Taxonomy (2016). Species categorized as Endangered by the IUCN are identified in red.

Common Name	Scientific Name	IUCN Category[1]	Presence in the Core and Extended Study Areas[2]
Order: Cetacea			
Suborder: Mysticeti (baleen whales)			
Family: Balaenopteridae			
North Atlantic minke whale	*Balaenoptera a. acutorostrata*	LC	Unlikely
Northern sei whale	*Balaenoptera b. borealis*	EN (A1ad)	Very unlikely
Bryde's whale	*Balaenoptera edeni brydei*	DD	Likely; seasonal
Northern blue whale	*Balaenoptera m. musculus*	EN (A1abd)	Likely; seasonal
Northern fin whale	*Balaenoptera p. physalus*	EN (A1d)	Possible
North Atlantic humpback whale	*Megaptera n. novaeangliae*	LC	Possible; seasonal
Suborder: Odontoceti (toothed whales, dolphins, and porpoises)			
Family: Phocoenidae			
Harbor porpoise	*Phocoena phocoena*	LC	Likely
Family: Physeteridae			
Sperm whale	*Physeter macrocephalus*	VU (A1d)	Likely
Family: Kogiidae			
Pygmy sperm whale	*Kogia breviceps*	DD	Possible
Dwarf sperm whale	*Kogia sima*	DD	Possible
Family: Ziphidae			
Blainville's beaked whale	*Mesoplodon densirostris*	DD	Very unlikely
Gervais' beaked whale	*Mesoplodon europaeus*	DD	Likely
Cuvier's beaked whale	*Ziphius cavirostris*	LC	Likely
Family: Delphinidae			
Killer whale	*Orcinus orca*	DD	Likely
Pygmy killer whale	*Feresa attenuata*	DD	Likely
False killer whale	*Pseudorca crassidens*	DD	Likely
Common dolphin	*Delphinus d. delphis*	LC	Likely
Fraser's dolphin	*Lagenodelphis hosei*	LC	Likely
Atlantic humpback dolphin	*Sousa teuszii*	VU (C2a[i])	Likely
Pantropical spotted dolphin	*Stenella attenuata graffmani*	LC	Likely
Clymene dolphin	*Stenella clymene*	DD	Likely
Striped dolphin	*Stenella coeruleoalba*	LC	Likely
Atlantic spotted dolphin	*Stenella frontalis*	DD	Likely
Gray's spinner dolphin	*Stenella l. longirostris*	DD	Likely
Rough-toothed dolphin	*Steno bredanensis*	LC	Likely
Common bottlenose dolphin	*Tursiops t. truncatus*	LC	Likely
Short-finned pilot whale	*Globicephala macrorhynchus*	DD	Likely
Long-finned pilot whale[3]	*Globicephala melas*	DD	Possible
Risso's dolphin	*Grampus griseus*	LC	Possible
Melon-headed whale	*Peponocephala electra*	LC	Likely
Order: Sirenia			
Family: Trichechidae			
African manatee	*Trichechus senegalensis*	VU (A3cd)	Possible
Order: Carnivora			
Family: Phocidae			
Mediterranean monk seal	*Monachus monachus*	EN (C2a[i])	Likely

[1] IUCN Category: EN = endangered; VU = vulnerable; LC = least concern (where a taxon has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened status; widespread and abundant taxa are included in this category); DD = data deficient (when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status). Under the criteria for Endangered, and Vulnerable, there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the category. Alphabetic or alphanumeric entries associated species classified as Endangered (EN) and Vulnerable (VU) in the table follow current IUCN (2017) designations and descriptions (http://www.iucnredlist.org/static/categories_criteria_3_1).
[2] Presence in the Core and Extended Study Areas: “Likely” - documented as native or migrant in Mauritania waters; “Possible” - documented in Mauritania waters, but may occur only seasonally; “Unlikely”, not documented in Mauritania waters; “Very Unlikely” - not documented in Mauritania waters, with range restrictions.
[3] Presence of long-finned pilot whales (*G. melas*) off Mauritania was reported by Camphuysen (2000), based on some physical characteristics. Positive identification (i.e., separation from the short-finned pilot whale, *G. macrorhynchus*) was not verified.

(From: IUCN, 2017; Jefferson et al., 2015)

Historic marine mammal surveys conducted offshore Mauritania provide valuable information on species presence and relative abundances, as well as their spatial and temporal distributions. Summaries of pertinent examples are provided below.

Ship-based seabird and marine mammal surveys were conducted during September 2015 as part of the research project financed via the Programme “Biodiversity Gas and Oil”, and performed by IMROP, in cooperation with Dutch researchers and sponsored by Kosmos Energy (Camphuysen et al., 2015). This survey included areas of the Mauritanian Continental shelf (neritic zone) and slope (shelf break) between Nouadhibou (Mauritania) and Saint-Louis (Senegal). Transects were designed to cross the shelf break preferably at a 90° angle and followed a zigzag pattern with two to three shelf-slope crosses each day (surveying from dawn to dusk). Thirteen species of cetaceans were recorded during the survey, including two mysticete whales (blue whale and humpback whale), and 11 odontocete whales and dolphins (sperm whale, Gervais' beaked whale, killer whale, false killer whale, short-finned pilot whale, Risso's dolphin, bottlenose dolphin, pantropical spotted dolphin, Clymene dolphin, Atlantic spotted dolphin, and common dolphin). The shelf-break was the area of greatest species abundance for cetaceans (and seabirds [Section 4.5.5]). Several species (and the overall biodiversity) peaked in the northern part of the survey area (off northern Mauritania), where cool water reached the surface. *Stenella* dolphins and common dolphins were abundant during the survey.

Seismic surveys were conducted between June and November 2013 within and adjacent to the Offshore Area. Observations of marine mammals were recorded throughout the survey. Mysticete whales observed during these surveys included blue whales (three individuals), Bryde’s whales (three individuals), humpback whale (one individual), and fin whale (one individual). Toothed whales were dominated by short-finned pilot whales and sperm whales, with fewer observations of Clymene dolphins, common bottlenose dolphins, Fraser’s dolphins, pantropical spotted dolphins, and Risso’s dolphins (RPS Energy, 2014b).

Surveys conducted by Camphuysen et al. (2013) during 2012 sighted at least 11 cetacean species, including four mysticete whales (blue, fin, Bryde’s and humpback whales), two odontocete whales (sperm whale and unidentified beaked whales), four dolphins (common, Atlantic spotted, Risso’s and bottlenose dolphins) and one porpoise (harbor porpoise). One sighting of a solitary Mediterranean monk seal was made off transect near Cape Blanc on 28 November 2012. Areas of higher cetacean densities included the deep slope (close to deep oceanic waters) on Leg C (around 20° N). Whales (including all sperm whales) and large groups of dolphins were observed seaward of an oceanic front separating shelf water and oceanic water. Large humpback whales and balaenopterid mysticete whales were most numerous on the southernmost legs. The mysticete whales seemed to utilize the slope rather than the upper shelf, with some individuals in deeper (oceanic) waters.

Results of earlier survey efforts documenting the presence of marine mammals offshore Mauritania (e.g., Tulp and Leopold, 2004; Burton, 2003) are presented in Appendix G.

GIZ, in conjunction with IMROP, coordinated a systematic survey of Mauritanian shelf and slope waters during 1 to 12 November 2016, following the survey design and protocols used by Camphuysen et al. (2015, 2013). Data collected during this survey and previous surveys will be compiled to prepare an atlas of selected species (i.e., marine mammals, marine birds, and sea turtles) in the pelagic environment offshore Mauritania. As of March 2017, the 2016 survey summary report was unavailable.

However, Abdallahi (2016) presented preliminary survey findings at an IMROP workshop in December 2016. Survey transects crossed shelf and slope waters along a series of 185 km long transects generally oriented east-west between Cape Blanc in the north to near N'Diago in the south. Major observations of marine mammal distributions included 2,618 individuals representing 15 cetacean species.

4.5.6.3 Senegal Marine Mammals

Table 4-24 identifies the marine mammal species of Senegal, their IUCN designation, and their potential presence in the core and extended study areas. A total of 20 species are likely to be present, with an additional seven species whose presence is considered possible due to habitat preference, range limits, or seasonal migratory patterns. A single marine mammal species is considered unlikely to be present, and three species are considered very unlikely to be present. Appendix G provides detailed habitat and range summaries for the marine mammals of Senegal, as outlined by IUCN (2017), and protected status for multiple listing organizations.

Endangered species include three baleen whale species – sei whale (presence very unlikely); blue whale (presence possible, during winter); and fin whale (presence very unlikely), and a single phocid – the Mediterranean monk seal (likely presence; see Appendix F-2). Vulnerable species include sperm whale (presence likely), Atlantic humpback dolphin (presence likely), and African manatee (presence possible).

Protected species observers aboard seismic survey vessels operating in the Saint-Louis Offshore Deep and Cayar Offshore Deep blocks between March and October 2014 observed several marine mammal species. The most abundant dolphin species observed were short-finned pilot whales (i.e., 87 sightings, 1,340 individuals). Other dolphin species observed included Atlantic spotted dolphin (11 sightings), spinner dolphin (10 sightings), common bottlenose dolphin (8 sightings), rough-toothed dolphin (4 sightings), short-beaked common dolphin (4 sightings), long-beaked common dolphin (2 sightings), pantropical spotted dolphin (3 sightings), melon-headed whale (1 sighting), and killer whale (1 sighting).

Among the whales, the most frequent species observed were sperm whales (i.e., 7 sightings, 30 individuals). Other whale species included Bryde's whale (4 sightings), minke whale (3 sightings), and pygmy blue whale (1 sighting; GeoGuide Consultants Limited, 2015).

Table 4-24. Marine Mammals of Senegal, including their IUCN Red List Designation and their Potential Presence in the Core and Extended Study Areas.

Common and scientific names of some species reflect recent taxonomic revisions as proposed by the Committee on Taxonomy (2016). Species categorized as Endangered by the IUCN are identified in red.

Taxonomic Placement/ Common Name	Scientific Name	IUCN Category[1]	Presence in the Core and Extended Study Areas[2]
Order: Cetacea			
Suborder: Mysticeti (baleen whales)			
Family: Balaenopteridae			
North Atlantic minke whale	*Balaenoptera a. acutorostrata*	LC	Unlikely
Northern Sei whale	*Balaenoptera b. borealis*	EN (A1ad)	Very unlikely
Bryde's whale	*Balaenoptera edeni brydei*	DD	Possible; seasonal
Northern Blue whale	*Balaenoptera m. musculus*	EN (A1abd)	Possible; seasonal
Northern Fin whale	*Balaenoptera p. physalus*	EN (A1d)	Very unlikely
North Atlantic Humpback whale	*Megaptera n. novaeangliae*	LC	Possible; seasonal
Suborder: Odontoceti (toothed whales, dolphins, and porpoises)			
Family: Phocoenidae			
Harbor porpoise	*Phocoena phocoena*	LC	Likely
Family: Physeteridae			
Sperm whale	*Physeter macrocephalus*	VU (A1d)	Likely
Family: Kogiidae			
Pygmy sperm whale	*Kogia breviceps*	DD	Possible
Dwarf sperm whale	*Kogia sima*	DD	Possible
Family: Ziphidae			
Blainville's beaked whale	*Mesoplodon densirostris*	DD	Very unlikely
Gervais' beaked whale	*Mesoplodon europaeus*	DD	Likely
Cuvier's beaked whale	*Ziphius cavirostris*	LC	Likely
Family: Delphinidae			
Killer whale	*Orcinus orca*	DD	Likely
Pygmy killer whale	*Feresa attenuata*	DD	Likely
False killer whale	*Pseudorca crassidens*	DD	Likely
Common dolphin	*Delphinus delphis*	LC	Likely
Fraser's dolphin	*Lagenodelphis hosei*	LC	Likely
Atlantic humpback dolphin	*Sousa teuszii*	VU (C2a(i))	Likely
Pantropical spotted dolphin	*Stenella attenuata*	LC	Likely
Clymene dolphin	*Stenella clymene*	DD	Likely
Striped dolphin	*Stenella coeruleoalba*	LC	Likely
Atlantic spotted dolphin	*Stenella frontalis*	DD	Likely
Spinner dolphin	*Stenella longirostris*	DD	Likely
Rough-toothed dolphin	*Steno bredanensis*	LC	Likely
Common bottlenose dolphin	*Tursiops truncatus*	LC	Likely
Short-finned pilot whale	*Globicephala macrorhynchus*	DD	Likely
Risso's dolphin	*Grampus griseus*	LC	Possible
Melon-headed whale	*Peponocephala electra*	LC	Likely
Order: Sirenia			
Family: Trichechidae			
African manatee	*Trichechus senegalensis*	VU (A3cd)	Possible
Order: Carnivora			
Family: Phocidae			
Mediterranean monk seal	*Monachus monachus*	EN (C2a(i))	Likely[3]

[1] IUCN Category: EN = endangered; VU = vulnerable; LC = least concern (where a taxon has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened status; widespread and abundant

taxa are included in this category); DD = data deficient (when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status). Under the criteria for Critically Endangered, Endangered, and Vulnerable, there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the category. Alphabetic or alphanumeric entries associated with EN and VU entries per IUCN (2017) descriptions.
[2] Presence in the Core and Extended Study Areas: Likely, documented as native or migrant in Senegal waters; Possible, documented in Senegal waters, but may occur only seasonally; Unlikely, not documented in Senegal waters; Very unlikely, not documented in Senegal waters, with range restrictions.
[3] Since 2005, Mediterranean monk seal (*Monachus monachus*) have frequented the waters of the Langue-de-Barbarie National Park (see Appendix F-2)

(From: IUCN, 2017)

4.5.7 Sea Turtles

4.5.7.1 Regional Patterns

Six species of marine turtles are known to occur within the CCLME. These include the loggerhead turtle (*Caretta caretta*), leatherback turtle (*Dermochelys coriacea*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), and Kemp's ridley (*Lepidochelys kempii*).

Living sea turtles include constituents of the reptile families Cheloniidae and Dermochelyidae. The family Dermochelyidae includes the leatherback turtle. The other five species are members of the family Cheloniidae (Márquez, 1990). All six sea turtle species are currently listed within the IUCN Red List of Threatened Species as Critically Endangered, Endangered or Vulnerable (IUCN, 2017). A summary of information on each of these species, including their habitat, current IUCN designation status, and likelihood of presence in the core and extended study areas is provided in Table 4-25. Summary information on species presence is provided below. Additional information on each species is provided in Appendix G.

The loggerhead turtle (*Caretta caretta*) is the most common species in the region. Adults feed on a wide variety of benthic fauna such as mollusks, crabs, sea urchins, sponges, and fish. Hatchling turtles feed on jellyfish, *Sargassum*, gastropods, and crustaceans (Márquez, 1990). The migration path of loggerhead turtles within west Africa is not well understood. Satellite tracking studies found that adult loggerhead females, and possibly also males (Cejudo et al., 2008), may travel close to the west African coast between Mauritania and Sierra Leone between nesting seasons (Hawkes et al., 2006). Loggerhead turtles nest during the months of July to October, mainly on continental coastlines.

The leatherback turtle (*Dermochelys coriacea*) is the largest sea turtle and one of the largest reptiles. The leatherback turtle is a cosmopolitan species that is found in the Mediterranean Sea and Indian, Pacific, and Atlantic Oceans. It is a highly pelagic species that approaches coastal waters during the breeding periods, although individuals have been reported in coastal waters in search of prey items. Leatherback turtles feed mainly on jellyfish, tunicates, and other epipelagic soft-bodied invertebrates. Little is known about the route that leatherback turtles follow during their migration, but it is known that this species moves erratically in search of food. Some nesting of leatherback turtles was reported in Mauritania and Senegal (Maigret, 1978, 1983; Dupuy, 1986), but whether nesting is regular in these countries remains to be confirmed (Fretey et al., 2007).

The green turtle (*Chelonia mydas*) is a circumglobal species found in the Mediterranean Sea and the Pacific, Indian, and Atlantic Oceans between 30° N and 30° S latitude, and, to a lesser extent, in temperate waters (Márquez, 1990). Satellite tagging data indicate that, similar to other sea turtles, green turtles display highly migratory behavior, making vast seasonal coastal and annual transoceanic migrations (Godley et al., 2003, 2008, 2010). Adult and juvenile green turtles occur along most of the west African coastline between Morocco and Namibia, including substantial nesting and feeding populations in Mauritania, Guinea Bissau, Equatorial Guinea, Sao Tome, and Gabon. The significant areas of seagrass beds within the Banc d'Arguin National Park is considered to have the most important feeding grounds for green turtles in west Africa (Formia and Bruford, 2008). Nesting occurs from January to March and July to October.

The hawksbill turtle (*Eretmochelys imbricata*) is a circumglobal species found in the Pacific, Indian, and Atlantic Oceans between latitudes 30° N and 30° S (Márquez, 1990). Hawksbill turtles display highly migratory behavior, with satellite tagging data demonstrating that these turtles undergo short and long migrations from nesting to foraging grounds (Blumenthal et al., 2009).

The olive ridley turtle (*Lepidochelys olivacea*) is a pantropical species that lives mainly in the northern hemisphere. It usually migrates along continental shelves and feeds in shallow waters of the inner shelf and within embayments (Márquez, 1990). This species is sometimes seen in the region but its visits there are believed to be rare.

The Kemp's ridley (*Lepidochelys kempii*) has a relatively restricted range, including the Gulf of Mexico and western North Atlantic (Márquez, 1990). Stranded individuals of this species have been recorded along the shores of Mauritania; however, its presence in the region is considered extralimital or accidental.

Fossette et al. (2014) recently addressed the issue of the long-term susceptibility of leatherback turtle to bycatch in longline fisheries, identifying areas where high-fishing-pressure areas overlapped with leatherback habitat use in the Atlantic Ocean. High susceptibility areas included those where there was both high fishing pressure and high turtle use. Nine main high-susceptibility areas were identified in the north and south Atlantic, including both international waters and the EEZs of 12 countries. High susceptibility areas included the EEZs of Cape Verde Islands, The Gambia, Guinea Bissau, Mauritania, and Senegal.

Table 4-25. Sea Turtle Species of Mauritania and Senegal, including Habitat and Diet, Nesting Season and Location (where known), Current International Union for Conservation of Nature (IUCN) Designation Status, and Likelihood of Presence in the Core and Extended Study Areas.

Species categorized as Critically Endangered and Endangered by the IUCN are identified in red.

Common Name		Scientific Name	Habitat and Diet	Nesting Season	IUCN Status[1]	Presence in the Core and Extended Study Areas[2]
English	French					
Loggerhead turtle	Tortue caouanne	*Caretta caretta*	Occupies three different habitats – oceanic, neritic, and terrestrial (nesting only), depending upon life stage; omnivorous	July-October; Found nesting in Tanit Bay (50 km north of Nouakchott)	VU (A2b)	Transient; Likely
Leatherback turtle	Tortue luth	*Dermochelys coriacea*	Pelagic, lives in the open ocean and occasionally enters shallower water (bays, estuaries); omnivorous	June-September	VU (A2bd)	Transient; Possible
Green turtle	Tortue verte	*Chelonia mydas*	Aquatic, but known to bask on shore; juvenile distribution unknown; omnivorous	January-March and May-October (peak July-August); nesting has been reported on the beaches of the Banc d'Arguin	EN (A2bd)	Transient; Possible
Hawksbill turtle	Tortue imbriquée	*Eretmochelys imbricata*	Pelagic; feeding changes from pelagic surface feeding to benthic, reef-associated feeding mode; opportunistic diet	Sporadic nesting in area – no established season	CR (A2bd)	Transient; Possible
Olive ridley turtle	Tortue olivâtre	*Lepidochelys olivacea*	Primarily pelagic, but may inhabit coastal areas, including bays and estuaries; most breed annually, with annual migration (pelagic foraging, to coastal breeding/nesting grounds, back to pelagic foraging); omnivorous, benthic feeder	Sporadic nesting in Senegal (none in Mauretania) – no established season	VU (A2bd)	Transient; Possible
Kemp's ridley turtle	Tortue de Kemp	*Lepidochelys kempii*	Extralimital – only few stranded individuals have been recorded on the Mauritanian coast	No records of nesting in area	CR (A1ab)	Transient; Unlikely

[1] IUCN status: CR = critically endangered; EN = endangered; VU = vulnerable. Under the criteria for Endangered, and Vulnerable, there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the category. Alphabetic or alphanumeric entries associated with CR, EN, and VU entries per IUCN (2016) descriptions (http://www.iucnredlist.org/static/categories_criteria_3_1).
[2] Presence in the Core and Extended Study Areas: Likely, documented as native or migrant in Mauritania or Senegal waters; Possible, documented in Mauritania or Senegal waters, but may occur only seasonally; Unlikely, not documented in Mauritania or Senegal waters; Very unlikely, not documented in Mauritania or Senegal waters, with range restrictions (from Hawkes et al., 2006).

(From: IUCN, 2017)

4.5.7.2 Mauritania Sea Turtles

The distribution of sea turtle species and their relative densities in offshore waters of Mauritania have been described in a number of investigations. Ship-based surveys focusing on seabird and marine mammal distributions and relative abundances were conducted along the Mauritanian continental shelf (neritic zone) and slope (shelf break) between Nouadhibou (Mauritania) and Saint-Louis (Senegal) during September 2015 (Camphuysen et al., 2015). Transects were designed to cross the shelf break (preferably at a 90° angle) and followed a zigzag pattern with two or three shelf-slope crosses each day (surveying from dawn to dusk). A total of 28 individual transects (east-west orientation) were completed. Five sea turtles were observed during the September 2015 surveys, including two loggerhead turtles and three unidentified cheloniid (hardshell) turtles. All turtles were seen in the north part of the survey area (19° N to 20° N), with two sighted within the neritic zone (water depth between 62 and 66 m), and three in the oceanic zone (water depth between 854 and 1,355 m). All sightings were made in a narrow range of sea surface temperatures (26.5 ± 0.4°C, range 26.1°C to 27.1°C, n=5).

Observations made during seismic survey efforts conducted offshore of the Senegalese-Mauritanian border within Mauritania Blocks C8 and C12 (east and north of the Offshore Area, respectively) during June to November 2013 recorded multiple sightings of hawksbill, loggerhead, and olive ridley turtles (RPS Energy, 2014a).

Camphuysen et al. (2013) conducted a survey offshore Mauritania between 27 November and 8 December 2012. The survey design was similar to that performed in 2015 (covering five legs [A, B, C, D, and E], labelled from north to south). Sea turtles were observed on Legs B to E (Cape Nord to just south of Cape Timiris). Seven turtles (four loggerhead, one hawksbill, and two unidentified cheloniids) were observed on Leg B. Loggerhead turtles were also observed on Legs C (three individuals), D (one individual), and E (one individual).

Offshore surveys conducted during January 2000 extended north to south along much of the Mauritanian shelf and shelf break, from Cape Blanc and south (Camphuysen et al., 2003). A single loggerhead turtle and one unidentified cheloniid turtle was sighted during the January on Leg B, between Cape Blanc and Cape Timiris (Camphuysen et al., 2003).

As previously mentioned, survey efforts have been conducted by GIZ and IMROP over the Mauritanian shelf and slope during November 2016. Up to March 2017, the summary report of this 2016 survey was not yet available. Abdallahi (2016) presented preliminary survey findings at an IMROP workshop in December 2016. Sea turtles observations included 47 individuals representing three species, including green turtles (23 individuals), loggerhead turtles (17 individuals); other individuals (7) could not be identified to the species level. Based on the frequency of observations, highest faunal densities were typically evident in the northern portion of the survey area, near Banc d'Arguin. Several survey lines completed in southern offshore Mauritanian waters were approximately 25 to 30 km east (inshore) of the Offshore Area.

Historically, sea turtle nesting areas within Mauritania include the Baie du Lévrier, north of the Banc d'Arguin (leatherback turtles) (Fretey, 2001), Banc d'Arguin National Park (green turtles) (Godley et al., 2003), and along the coast to Tanit Bay (north of Nouakchott) (loggerhead turtles) (Fretey, 2001). The main breeding season for turtles in the Banc d'Arguin National Park area is from January to March, and May to October, with a peak in July-August (Fretey, 2001). The northernmost nesting area for loggerhead turtles has been found further south, in Tanit Bay, approximately 50 km north of Nouakchott, where four nests were discovered in July 1994.

Regional nesting information, as summarized by State of the World's Turtles (2017), indicates that small numbers of turtles nest along the coast of Mauritania, including an aggregation of green turtles, south of Nouakchott. Mauritania's Banc d'Arguin National Park is an important foraging area for green turtles from the Bijagós Archipelago. Nesting locations are discussed in Section 4.5.11 and shown in Figure 4-25.

Reports of nesting leatherbacks in Mauritania and Senegal are rare, even though the area may be an important foraging zone for leatherbacks from the Americas. Coastal waters off Senegal are well known as a migratory corridor for sea turtle species, and four species (green, loggerhead, olive ridley, and leatherback) are known to nest there infrequently. Hawksbills appear to be very rare. Green turtles also nest on the coast of The Gambia between Bakau and Kartung, and numbers of immature green turtles live in The Gambia's nearshore waters. The frequency of olive ridley and hawksbill turtles in this region is poorly known, although both species are known to nest in the Bijagós Archipelago (Guinea-Bissau) and on Katrack Island (Guinea).

4.5.7.3 Senegal Sea Turtles

Satellite tracking studies of adult turtles along the west African coast suggest that five sea turtles species (loggerhead, green, hawksbill, olive ridley, and leatherback) may be seasonally present in offshore waters of Senegal (Hawkes et al., 2006). Juveniles and subadult green turtles, loggerhead turtles, and leatherback turtles are considered common in the offshore waters along the Senegal coast.

Loggerhead turtles are the most common species in the region. Satellite tracking studies found that adult loggerhead females, and possibly also males (Cejudo et al., 2008), appear to travel close to the west African coast between Mauritania and Sierra Leone between nesting seasons (Hawkes et al., 2006). These studies also found that adult female loggerhead turtles migrate southward to benthic feeding grounds along the coast of Sierra Leone, whereas small-sized females (sub-adults) migrate to oceanic waters off Mauritania, The Gambia, and Senegal (Hawkes et al., 2006). Green and hawksbill turtle juveniles are often found feeding in neritic waters of the Cape Verde Islands. Olive ridley and leatherback turtles migrate through the waters of the Cape Verde Islands and are difficult to observe.

No comprehensive nationwide turtle observation or nesting survey has been undertaken in Senegal. Observations and nesting sites noted in the available literature include 1) Langue-de-Barbarie National Park – turtles frequent the site; 2) Îles de la Madeleine National Park – marine turtle egg-laying/nesting site; 3) Saloum Delta National Park and Biosphere Reserve – highly significant egg-laying site for four species of marine turtles; and 4) Pointe de Kalissaye Bird Sanctuary – established to protect marine turtle breeding sites (and nesting seabird colonies).

RPS Energy (2014a) during June to November 2013 in and near the Offshore Area recorded multiple sightings of hawksbill, loggerhead, and olive ridley turtles. During a recent seismic survey in the Saint-Louis Offshore Deep and Cayar Offshore Deep blocks, the use of protected species observers provided sightings data for marine mammals and sea turtles present within the blocks of interest. During the course of the survey, only two sea turtle species were identified. Loggerhead and hawksbill sea turtles were each sighted on three occasions. Unidentified sea turtles accounted for seven sightings (GeoGuide Consultants Limited, 2015).

4.5.8 Threatened Species

Discussion of threatened species is based on current IUCN Red List listings (IUCN, 2017a), with a focus on the identification of Critically Endangered and Endangered species.

There are a total of 10 Critically Endangered species identified on the IUCN Red List (IUCN, 2017a) which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas (Table 4-26). Critically Endangered species include two marine and coastal bird species, two sea turtle species, and six demersal soft bottom and hard bottom fish species. No Critically Endangered marine mammals occur in the core or extended study areas. The presence of one Critically Endangered species (Atlantic Goliath Grouper) within the core or extended study areas is considered likely, whereas the presence of several other Critically Endangered species (three fish species, one bird species, and one turtle species in the core or extended study areas is considered possible.

Table 4-26. Summary of Critically Endangered (CR) Species Potentially Present in the Core and Extended Study Areas.

Resource Area/Species	Scientific Name	Section	Presence
Fishes (demersal, hard bottom)			
Atlantic Goliath Grouper	*Epinephelus itajara*	4.5.4	Likely
Fishes (demersal, soft bottom)			
Common Skate	*Dipturus batis*	4.5.4	Unlikely
Smalltooth Sawfish	*Pristis pectinata*	4.5.4	Possible
Largetooth Sawfish	*Pristis pristis*	4.5.4	Unlikely
Sawback Angel Shark	*Squatina aculeata*	4.5.4	Possible
Smoothback Angel Shark	*Squatina oculata*	4.5.4	Possible
Marine and Coastal Birds			
Balearctic Shearwater	*Puffinus mauretanicus*	4.5.5	Possible
Northern Bald Ibis	*Geronticus eremita*	4.5.5	Very unlikely
Marine Mammals			
None	--	--	--
Sea Turtles			
Hawksbill sea turtle	*Eretmochelys imbricata*	4.5.7	Possible
Kemp's ridley sea turtle	*Lepidochelys kempii*	4.5.7	Unlikely

Likely presence from IUCN, 2017a.

There are 18 Endangered species identified on the IUCN Red List (IUCN, 2017a) which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas (Table 4-27). Endangered species include four marine mammal species, one sea turtle species, nine demersal soft and hard bottom fish species, and four pelagic fish species. No endangered marine and coastal bird species are present in the core or extended study areas. Five endangered demersal fish, three pelagic fish species and one marine mammal species are considered likely to occur in the core or extended study areas.

The status, distribution, habitat, and potential presence of each of these Critically Endangered and Endangered species in the core and extended study areas are summarized separately in respective resource-specific discussions, as noted. Additional details on fish and other fishery resources for Mauritania and Senegal are also provided in Appendix E-1 and E-2, respectively.

Table 4-27. Summary of Endangered (EN) Species Potentially Present in the Core and Extended Study Areas.

Common Name	Scientific Name	Section	Presence
Fishes (demersal, hard bottom)			
Dusky Grouper	*Epinephelus marginatus*	4.5.4	Likely
Fishes (demersal, soft bottom)			
Daisy stingray	*Fontitrygon margarita*	4.5.4	Unlikely
Blackchin Guitarfish	*Glaucostegus cemiculus*	4.5.4	Likely
Senegalese Hake	*Merluccius senegalensis*	4.5.4	Likely
Cassava Croaker	*Pseudotolithus senegalensis*	4.5.4	Likely
Undulate Skate	*Raja undulata*	4.5.4	Unlikely
Common Guitarfish	*Rhinobatos rhinobatos*	4.5.4	Likely
African Wedgefish	*Rhynchobatus luebberti*	4.5.4	Possible
White Skate	*Rostroraja alba*	4.5.4	Unlikely
Fishes (pelagic)			
Whale Shark	*Rhincodon typus*	4.5.4	Likely
Scalloped Hammerhead	*Sphyrna lewini*	4.5.4	Likely
Great Hammerhead	*Sphyrna mokarran*	4.5.4	Likely
Atlantic Bluefin Tuna	*Thunnus thynnus*	4.5.4	Possible
Marine and Coastal Birds			
None	--	--	--
Marine Mammals			
Northern sei whale	*Balaenoptera b. borealis*	4.5.6	Very unlikely
Northern blue whale	*Balaenoptera m. musculus*	4.5.6	Possible; seasonal
Northern fin whale	*Balaenoptera p. physalus*	4.5.6	Possible in Mauritania; Very unlikely in Senegal
Mediterranean monk seal	*Monachus monachus*	4.5.6	Likely
Sea Turtles			
Green sea turtle	*Chelonia mydas*	4.5.7	Transient, Possible

(From: IUCN, 2017a)

4.5.9 Protected Areas

There are seven protected areas that are either within or adjacent to the core or extended study areas (two protected areas in Mauritania and five protected areas in Senegal). Additionally, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Senegal River Delta Transboundary Biosphere Reserve includes areas in both Mauritania and Senegal and is discussed separately in Section 4.5.9.3.

Three of the protected areas are also IBAs. IBAs are discussed in Biological Areas (Birds) Section 4.5.5. Some protected areas are also classified as “Ramsar Wetlands of International Importance” (or “Ramsar Sites”), which are selected based on qualifying criteria based on representative, rare or unique wetland types, important biological communities, and a wide range of wetland dependent species (Ramsar, 2018). In Mauritania, there are four Ramsar sites, including three coastal sites (Chatt Tboul, Diawling National Park, and Banc d’Arguin) and one inland site (Lac Gabou et le réseau hydrographique du Plateau du Tagant) (Ramsar, 2017a). In Senegal, there are five Ramsar sites, including three coastal sites (Parc national du Delta du Saloum, Réserve Spéciale de Faune de Guembeul, and Parc National des Oiseaux du Djoudj) and two inland sites (Réserve du Ndiael and Réserve Naturelle Communautaire de Tocc Tocc) (Ramsar, 2017b). Detailed reports presenting information on selected protected areas in Mauritania and Senegal were prepared by in-country experts (Ecodev, 2017c; Tropica, 2017c) and are presented in Appendices F-1 and F-2, respectively; summaries derived from these expert reports are presented below.

4.5.9.1 Protected Areas of Mauritania

Three coastal protected areas in Mauritania are summarized in Table 4-28 and presented in Figure 4-20. A description of each area and a brief summary of its flora and/or fauna of importance are presented in the following subsections.

Table 4-28. Coastal Protected Areas of Mauritania and Relative Proximity to the Core and Extended Study Areas.

Area Name	Designation	Distance[1] from Core and Extended Study Areas (km)	
		Core	Extended
Banc d'Arguin National Park	IBA; IUCN Category II and VI Protected Area; Ramsar site; National Park	~18	~12
Chatt Tboul Reserve	Natural Reserve (by Mauritanian Navy); IBA; IUCN Category VI Protected Area; Ramsar Site; included in UNESCO Cross Border Biosphere Reserve (Senegal River Delta Transboundary Biosphere Reserve)	0	0
Diawling National Park	IBA; IUCN Category II and VI Protected Area; Ramsar Site; included in UNESCO Cross Border Biosphere Reserve (Senegal River Delta Transboundary Biosphere Reserve); National Park	0	0

[1] Distance calculated using the shortest distance from Study Area to the boundary of the Protected Area; distances do not indicate location of project facilities.
IBA = Important Bird and Biodiversity Area; IUCN = International Union for the Conservation of Nature; Ramsar = Ramsar Convention, or The Convention on Wetlands of International Importance (www.ramsar.org); UNESCO = United Nations Educational, Scientific and Cultural Organization.

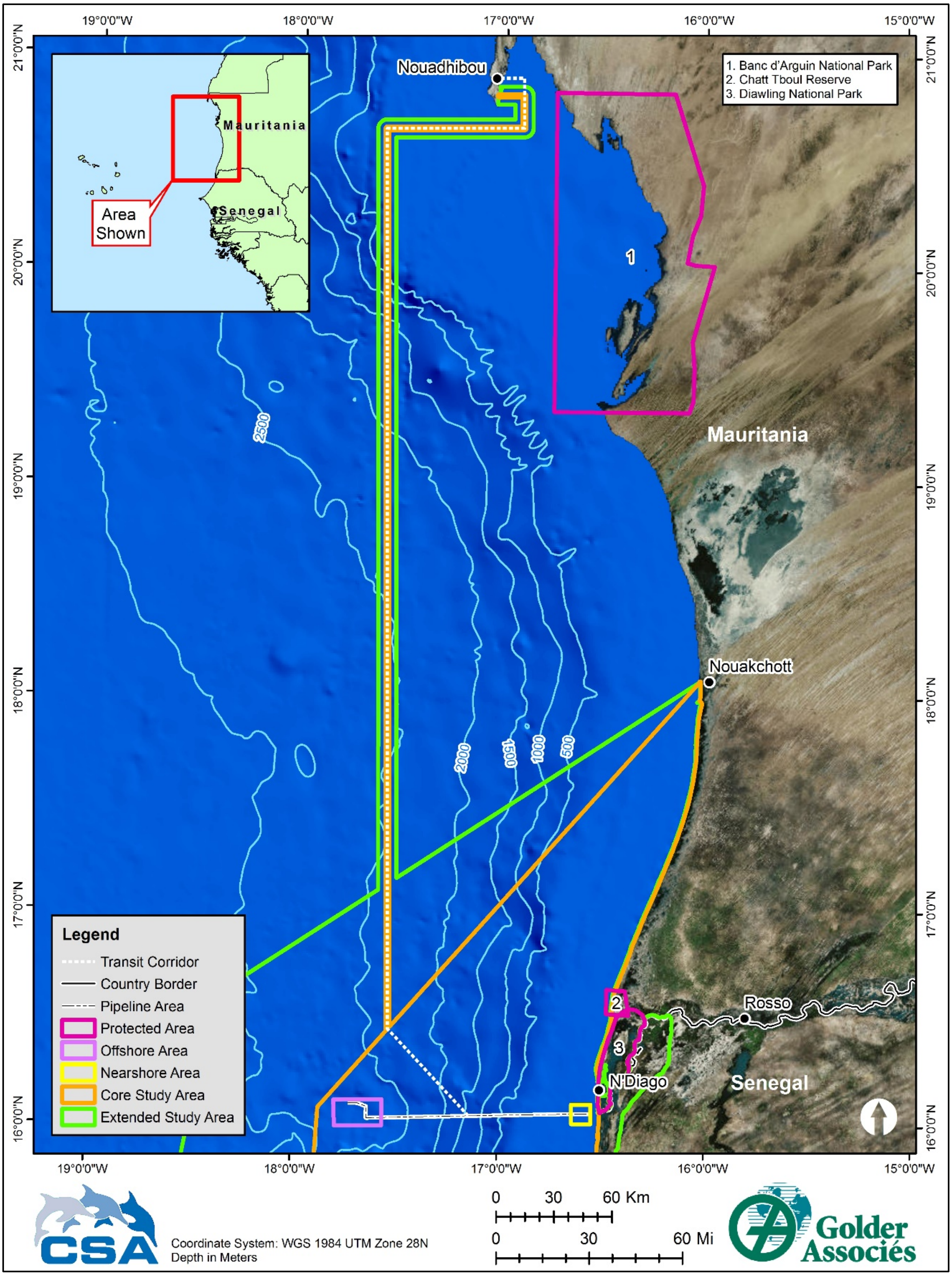


Figure 4-20. Coastal Protected Areas in Mauritania in Relation to the Core and Extended Study Areas.

Banc d'Arguin National Park

The Banc d'Arguin National Park is the largest coastal park in Africa, comprising an area of 12,000 km^2. The park is half marine, half terrestrial, with the marine portion extending up to 50 km from shore. Banc d'Arguin is designated as an IBA, an IUCN Category II and IV Protected Area, and a Ramsar Site. The park is located approximately 18 to 12 km east of a portion of the core and extended study areas (Table 4-28), respectively (i.e., east of the construction/installation transit lane from Nouadhibou). The National Park contains a variety of physiographic features, including sand dunes, coastal swamps, small islands, and extensive shallow coastal waters providing important feeding and breeding habitat for a multitude of flora and fauna.

The shallow marine zone of the Banc d'Arguin covers between 60,000 and 80,000 hectares. This shallow water environment contains vast expanses of seagrass, including eelgrass (*Zostera noltii*) in the intertidal zone and slender seagrass (*Cymodocea nodosa*) and shoal grass (*Halodule wrightii*) in the subtidal zone. Seagrass beds support algal epiphytes and a diverse and abundant invertebrate fauna (e.g., molluscs, crustaceans).

The marine portion of the Banc d'Arguin National Park is a major fish spawning and nursery ground. Three primary categories of fish are noted by UNEP (2011), including 1) shallow water fish found within the seagrass beds (e.g., mudskippers [*Periophthalmus* spp.], gobies [Gobiidae], seahorses [Syngnathidae] and rays [Batoidea]); 2) juveniles using the seagrass beds as nursery sites (e.g., sea perch [*Lutjanus* spp.], croakers [*Argyrosomus* spp.] and sea bass [*Centropristus* and *Dicentrachis* spp.]); and 3) traditional fishing target species (e.g., striped mullet [*Mugil cephalus*], white mullet [*Mugil curema*], groupers [*Epinephalus* spp.] and sea bream [*Sparus* spp.]). Migrant pelagic fish include tunnies (*Thunnus* spp.), smalltooth sawfish (*Pristis pectinata*), guitarfish (*Rhinobatos* spp.), and smooth hammerhead shark (*Sphyrna zygaena*).

The Banc d'Arguin National Park is an important breeding site for marine and coastal birds found along the west African coast, exhibiting one of the largest winter concentration of wading birds in the world. According to UNEP (2011), there are more than 2 million wintering shorebirds present in the park, including hundreds of thousands of dunlin (*Calidris alpina*), bartailed godwit (*Limosa lapponica*), knot (*Calidris canutus*), and curlew sandpiper (*C. ferruginea*), and tens of thousands of greater flamingo (*Phoenocopterus roseus*), ringed plover (*Charadrius hiaticula*), redshank (*Tringa tetanus*), Eurasian curlew (*Numenius arquata*), whimbrel (*N. phaeopus*) and black-bellied plover (*Pluvialis squatarola*). The 40,000 pairs of breeding birds include white pelican (*Pelecanus onocrotalus*), three subspecies of reed cormorant (*Phalacrocorax africanus*), European spoonbill (*Platalea leucorodia leucorodia*) and a variety of tern species.

Two endangered species of turtle breed in the Banc d'Arguin, including hawksbills (*Eretmochelys imbricata*) and green (*Chelonia mydas*). UNEP (2011) note that three other species have been sighted in the Park, including loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*).

A small population (i.e., 130 to 150 individuals) of the endangered monk seal (*Monachus monachus*) lives on the Côte des Phoques at Cap Blanc; this population is one of only two populations found outside of the Mediterranean. Other marine mammals regularly seen in the water of Banc d'Arguin are Atlantic hump-backed dolphin (*Sousa teuszii*), common dolphin (*Delphinus delphis*), rough-toothed dolphin (*Steno bredanensis*), bottlenosed dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*) and killer whale (*Orcinus orca*), with occasional sightings of fin whale (*Balaenoptera physalus*) and common porpoise (*Phocoena phocoena*).

Chatt Tboul Reserve

The Chatt Tboul Reserve is an approximately 155 km^2 protected area designated as a natural reserve by the Mauritanian Navy. It is also designated as an IBA, an IUCN Category IV Protected Area, and a Ramsar Site. The Chatt Tboul Reserve comprises a portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve (see Section 4.5.9.3) (Ecodev, 2017c). The Chatt Tboul Reserve is located approximately 124 km from the Offshore Area and 48 km from the Nearshore Area. The Reserve is located within the core and extended study areas (Table 4-28).

The Chatt Tboul Reserve is a below-sea-level depression that is a former mouth of the Senegal River. The Reserve contains a lagoon that is separated from the ocean by a narrow dune ridge. The lagoon is connected to the Senegal River by two channels which help prevent waters in the lagoon from becoming hypersaline, though the lagoon is routinely flooded with seawater during spring tides (Ecodev, 2017c).

The Reserve is an important area for migratory birds, partially due to the permanent presence of water in an area with an extended dry season. A January 2017 survey in the Chatt Tboul Reserve identified 69 unique species of birds. Abundant species (> 100 individuals) included Garganey (*Spatula* [*Anas*] *querquedula*), White-faced Whistling duck (*Dendrocygna viduata*), Great White Pelican (*Pelecanus onocrotalus*), Northern Shoveler (*Spatula* [*Anas*] *clypeata*), Greater Flamingo (*Phoenicopterus roseus*), Little Stint (*Calidris minuta*), Northern Pintail (*Anas acuta*), Caspian Tern (*Hydroprogne caspia*), Ruff (*Calidris* [*Philomachus*] *pugnax*), and Great Cormorant (*Phalacrocorax carbo*) (DNP, 2017). Other notable species that are known to use the Chatt Tboul Reserve include the Lesser Flamingo (*Phoeniconaias minor*); categorized as Near-Threatened by the IUCN) and the Black-crowned Crane (*Balearica pavonina*; categorized as Vulnerable by the IUCN). A national action plan for the Lesser Flamingo and the Crowned Crane has recently been prepared by Diagana and Diawara (2015).

A survey of aquatic fauna in Chatt Tboul Reserve was conducted in 2005 by the Mauritanian Institute of Oceanographic Research and Fisheries (IMROP, 2005). This survey identified 84 species of fauna associated with freshwater, brackish water, and marine water including species from families such as Clupeidae (shad), Cichlidae (tilapia), Mugilidae (mullet), and Penaeidae (shrimp) (IMROP, 2005).

Diawling National Park

Diawling National Park was created in 1991 by the Mauritanian Ministry of Rural Development. It is designated as an IBA, an IUCN Category II and VI Protected Area; and a Ramsar Site. Diawling National Park comprises a portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve (see Section 4.5.9.3) (Ecodev, 2017c). Diawling National Park is located approximately 112 km from the Offshore Area and 4 km from the Nearshore Area. Portions of Diawling National Park are located within the core and extended study areas (Table 4-28).

The main portion of Diawling National Park is approximately 160 km^2 in size and is located in the southern portion of Mauritania on the west bank of the Senegal River. An adjacent 560 km^2 peripheral zone is considered part of the park although it has no legal designation by the Mauritanian government.

Diawling National Park and its periphery are comprised of a complex hydrological system that is now controlled by a network of structures located along the river which allow for the regulation of freshwater levels in the Park and help prevent saltwater intrusion (Ecodev, 2017c). A detailed description of the seven hydrological units of the Diawling National Park and its periphery is provided in Appendix F-1.

Diawling National Park has a Sahelian climate with low annual rainfall. A wet season from July to October results in nearly all of the annual precipitation. Consequently, the vegetation and fauna of the Diawling National Park are dependent on location relative to water sources. While the coastal side of the Diawling National Park has sparse vegetation, the areas between the dunes have abundant vegetation. Species in the floodplain have changed in recent decades due to overgrazing and other factors (e.g., changes in environmental conditions, dam effects, salt water intrusion, etc.), with opportunistic species such as *Typha* sp. replacing species such as *Sporobolus robustus, Acacia nilotica,* and *Anogeissues leiocarpus (*Ecodev, 2017c). In the estuarine portions of the park, vegetation includes the mangroves *Rhizophora racemosa* and *Avicennia germinans*, although their extent is far less than in the past due to overutilization for construction and firewood. A restoration program planted approximately 40,000 mangrove plants in 0.2 km^2 of Diawling National Park (Dia, 2012).

Like Chatt Tboul Reserve, Diawling National Park is an important area for birds. Surveys conducted by the Diawling National Park in 2016 and 2017 focused on waterfowl, flamingos, shorebirds, herons, and Charadriiformes (migratory terns and shorebirds) (Diawling National Park, 2013). Overall, more than 250 species of birds were observed in the Diawling National Park including two species listed by the IUCN as Vulnerable (Aquatic Warbler [*Acrocephalus paludicola*] and Black-crowned Crane, and six species listed by the IUCN as Near-Threatened (Martial Eagle [*Polemaetus bellicosus*], Black-tailed Godwit [*Limosa limosa*], African Skimmer [*Rynchops flavirostris*], Lesser Flamingo, Ferruginous Duck

[*Aythya nyroca*], and Audouin's Gull [*Larus audouinii*]) (Ecodev, 2017c). A bird census in the Diawling National Park in January 2017 recorded 107 species and approximately 248,846 individuals, including the rare species Tufted Duck (*Aythya fuligula*), African Skimmer, Ruddy Shelduck (*Tadorna ferruginea*) and Eurasian Dotterel *(Charadrius morinellus*) (DNP, 2017). A summary listing of 314 bird species identified in the Diawling National Park is provided in Appendix G.

Other species of note that are known to inhabit Diawling National Park include a variety of large mammals including jackals, warthogs, and patas monkeys (Diawling National Park, 2013). A total of 33 reptile species and 4 species of amphibians have been identified in the park (Sow and Brito, 2016), while Diawling National Park (2013) identified 28 species of marine fish, 41 species of brackish water fish, and 67 species of freshwater fish. Various invertebrates including decapod crabs and penaeid shrimp have also been observed. IMROP (2005) concluded that the Diawling National Park serves as an important nursey area for many aquatic species. A summary listing of the 76 fish species and 4 invertebrate species identified in Diawling National Park is provided in Appendix G.

Diawling National Park and its periphery include a human population of approximately 11,000 people (2002 data) scattered over approximately 37 villages (Ecodev, 2017c). Consequently, various anthropogenic activities including fishing, livestock keeping, agriculture, and resource gathering occur in the Park. Further details on socioeconomic activities that occur in Diawling National Park can be found in Appendix F-1.

4.5.9.2 Protected Areas of Senegal

Coastal protected areas in Senegal that are within the core or extended study areas are summarized in Table 4-29 and presented in Figure 4-21. The Saint-Louis Marine Protected Area and Langue-de-Barbarie National Park are located within the core study area whereas the other four protected areas are located within the extended study area. A detailed report prepared by in-country experts with details on each protected area is presented in Appendix F-2; summaries are presented below.

Table 4-29. Coastal Protected Areas of Senegal and Relative Proximity to the Core and Extended Study Areas.

Area Name	Designation	Distance[1] from Core and Extended Study Areas (km)	
		Core	Extended
Langue-de-Barbarie National Park	National Park	0	0
Djoudj National Bird Sanctuary	Ramsar Site, UNESCO World Heritage Site, IBA	15.1	0
Parc National des Iles de la Madeleine	UNESCO World Heritage Tentative Site, IBA	0	0
Saint-Louis Marine Protected Area	MPA	0	0
Guembeul Natural Reserve	Ramsar Site	3.8	0
Cayar Marine Protected Area	MPA	0	0

[1] Distance calculated using the shortest distance from Study Area to the boundary of the Protected Area; distances do not indicate location of project facilities

Ramsar = Ramsar Convention, or The Convention on Wetlands of International Importance (http://www.ramsar.org); UNESCO = United Nations Educational, Scientific and Cultural Organization; IBA = Important Bird and Biodiversity Area; MPA = Marine Protected Area.

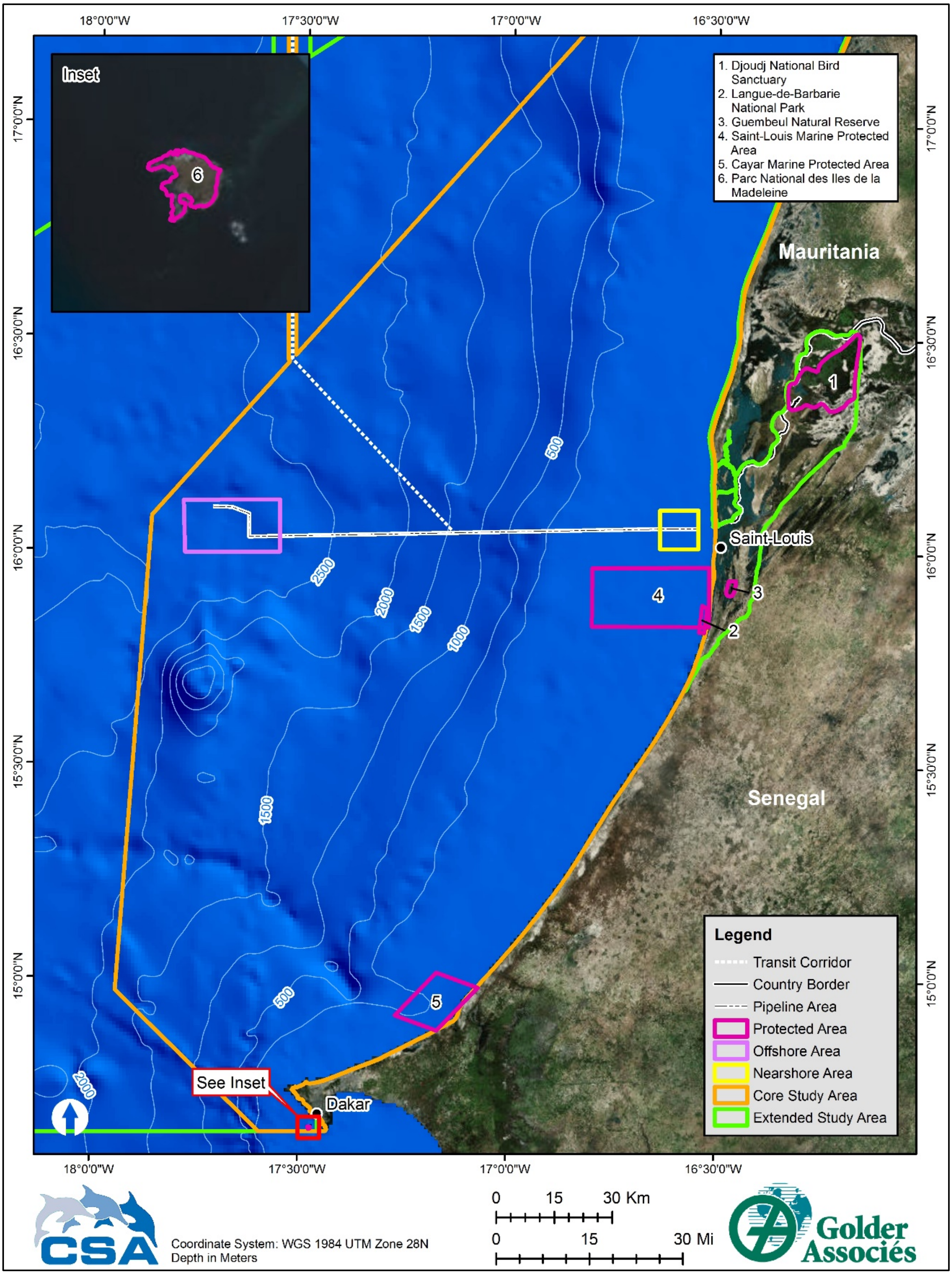


Figure 4-21. Costal Protected Areas in Senegal in Relation to the Core and Extended Study Areas.

Langue-de-Barbarie National Park

The Langue-de-Barbarie National Park is located on the western shore of Senegal on a sandy peninsula that separates the Atlantic Ocean from the Senegal River, approximately 110 km from the Offshore Area and 15 km from the Nearshore Area. The Park is located within the core and extended study areas (Table 4-29). Langue-de-Barbarie National Park comprises a portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve (see Section 4.5.9.3) (Tropica, 2017c).

The park consists of two islands comprising a total area of approximately 20 km^2 (Au-Senegal, 2010). Prominent habitat types include sandy beach, a 500-m wide maritime portion, and marshes and lagoons associated with the Senegal River. The park serves as a protected area and nesting habitat for sea turtles, and breeding grounds for numerous species of waterbirds. The Park is an important area for nesting for several species of gulls, terns, herons, and egrets, including Gray-headed gull (*Larus cirrocephalus*), Slender-billed Gull (*Larus genei*), Royal Tern (*Thalasseus maximus* [*Sterna maxima*]), Caspian Tern (*Hydroprogne caspia)*, Little Tern (*Sterna albifrons*), Western Reef Heron (*Egretta gularis*), and Gull-billed Tern (*Gelochelidon* [*Sterna*] *nilotica*) (Tropica, 2017c).

In 2003, a 5-m wide flood relief channel was purposely cut in the peninsula to help reduce flooding impacts in nearby Saint-Louis. While the channel successfully reduced peak tide levels in Saint-Louis, the channel quickly widened (to 5 km as of late 2015) and now serves as the primary mouth of the Senegal River. Due to the altered water flow, some areas such as Gandiole, no longer receive substantial freshwater flow from the Senegal River (Tropica, 2017c). Due to the dynamic nature of the channel, tides, and currents in the region, some coastal areas such as the fishing village Goxxu Mbacc have been subject to increased erosion and tidal flooding (GMA Network, 2015).

Djoudj National Bird Sanctuary

Djoudj National Bird Sanctuary is a 160 km^2 protected area which is designated as a Ramsar Site, UNESCO world heritage site, and IBA. The Sanctuary is located approximately 134 km from the Offshore Area, 35 km from the Nearshore Area, 15.1 km from the core study area at its closest point, and is located within the extended study area (Table 4-29). Djoudj National Bird Sanctuary comprises a portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve (see Section 4.5.9.3) (Tropica, 2017c).

Historically, the Djoudj National Bird Sanctuary was subjected to wet-season freshwater flooding from the Senegal River followed by dry-season saltwater intrusion from the Atlantic Ocean. However, construction of the Diama dam altered the natural hydrological flow in the area which prevents much of the wet season flooding and all of the dry season saltwater flooding (African World Heritage, 2017). Consequently, several aquatic invasive plant species including *Pistia stratoites*, *Lavinia molesta*, and *Typha australis* are now established in the Sanctuary (UNESCO, 2017).

Habitats in the Djoudj National Bird Sanctuary include lakes, streams, ponds, and other wetlands (UNESCO, 2017). The Sanctuary is known to contain more than 365 species of birds, which includes approximately 120 species of Palearctic migrant birds. The habitat within the Sanctuary provides important nesting areas for numerous species including the White Pelican, the Purple Heron (*Ardea purpurea*), the African Spoonbill (*Platalea alba*), the Great Egret (*Casmerodius albus*), the Night Heron (*Nycticorax nycticorax*) and the Great Cormorant (UNESCO, 2017), as well as an important habitat for the Aquatic Warbler which is listed by the IUCN Red List as Vulnerable. The Sanctuary is also home to a rich ichthyofauna population including approximately 92 species of fish, multiple terrestrial mammal species including gazelles, warthogs, jackals, the caracal (*Caracal caracal*), African wildcat (*Felis silvestris*), genets, civets, Egyptian mongoose (*Herpestes ichneumon*), and porcupines, as well as the African manatee (*Trichechus senegalensis*) (Tropica, 2017c).

Saint-Louis Marine Protected Area

The Saint-Louis Marine Protected Area is a 496 km^2 marine reserve established in 2004 to protect marine and coastal habitat, biodiversity, and fish stocks. The Marine Protected Area (MPA) is located approximately 80 km from the Offshore Area, 5 km from the Nearshore Area, and is located within the core and extended study areas (Table 4-29).

The seafloor in the MPA is primarily mud flats with seagrass beds (*Zostera noltii* and *Cymodocea* sp.). Upwelling of cold, nutrient rich waters as a result of winds drive a complex ecosystem that support diverse benthic fish, invertebrate, and marine mammal populations. Ecologically and commercially important fish populations found within the MPA include drums (Sciaenidae) and porgies (Sparidae).

Upwelling provides food for a variety of cetacean species, including whales and delphinids (e.g., common bottlenose dolphin, *Tursiops truncatus*). The Saint-Louis Marine Protected Area is also part of the bird migration corridors that are utilized by numerous species of birds that are going to and from the Langue-de-Barbarie National Park and Djoudj National Bird Sanctuary. Sea turtles may also be present in the Saint-Louis Marine Protected Area, with the green sea turtle observed most commonly (Tropica, 2017c).

Guembeul Natural Reserve

The Guembeul Natural Reserve is located approximately 10 km south of Saint-Louis and approximately 116 km from the Offshore Area and 11 km from the Nearshore Area. At its closest point, the Reserve is located approximately 4 km from the core study area and is located within the extended study area (Table 4-29).

The Guembeul Natural Reserve is comprised of a 7.2 km^2 fenced-off area that is designated as a Ramsar Site and is part of the UNESCO Senegal River Delta Transboundary Biosphere Reserve (see Section 4.5.9.3). The fenced off area of Guembeul Natural Reserve includes a 3.4 km^2 depression that is an important nesting and feeding site for numerous species of birds, including the Pink-backed Pelican (*Pelecanus rufescens*), White Pelican, Greater and Lesser Flamingos, and the Pied Avocet (*Recurvirostra avocetta*). When flooded, the Guembeul Natural Reserve is also an important roosting site for the Eurasian Spoonbill (*Platalea leucorodia*).

Effects from installation of the Diama dam have resulted in lower amounts of freshwater flowing to the Reserve and thus making the waters occasionally salty or brackish. Complete inundation by saltwater is common, resulting in mangrove mortality. Fauna present in the Reserve includes the desert warthog (*Phacochoerus aethiopicus*), patas monkey (*Erythrocebus patas*), African spurred tortoise (*Geochelone sulcata*), mongoose, and other mammals (Ramsar, 2014). Several mammal species have been reintroduced to the area, including the dama gazelle (*Gazella dama mhorr*), Dorcas gazelle, Addax (*Addax nasomaculatus*), and the scimitar oryx (*Oryx algazelle*) (Tropica, 2017c).

Fishing is allowed in the Guembeul Natural Reserve in areas away from sensitive bird nesting habitat. Commercially important fish species that are caught include several species of tilapia, mullet, and catfish, among others. Some species with historical observations in the area, including the Senegal bichir (*Polypterus senegalus*), oysters, and cockles are no longer found, likely due to changing salinity conditions due to dam installation (Tropica, 2017c).

Cayar Marine Protected Area

The Cayar MPA lies within the core study area, along the Grande Côte coast just north of Dakar. This MPA was established in 2004 by presidential decree. Encompassing 171 km^2, it was established to protect sites of special interest for maintaining and renewing fishery stocks in and around the conservation area. The Cayar MPA extends approximately 12 km offshore. The Cayar MPA is recognized for its distinct canyon feature offshore (Cayar Canyon), as a spawning and nursery area for a variety of invertebrate and fish species, and as a possible turtle nesting site.

Parc National des Iles de la Madeleine

The Parc National des Iles de la Madeleine was created in 1976. With an area of 45 ha, it is the smallest national park in the world. It consists of three rocky, volcanic islands lying about 4 km west of the Senegal coast, off the southern end of the Cap Vert peninsula on which Dakar lies, and the areas of sea between the islands (Rampao, 2018). The park is also an IBA and a UNESCO World Heritage Tentative List site. One bird species, the Red-billed Tropicbird (*Phaethon aethereus*), triggers IBA criteria at this Marine IBA which includes key near-colony areas for this species (approximately 180 individuals) (BirdLife International, 2018). This Marine IBA is identified using seaward extensions around the colonies. It originates from the Senegal Exclusive Economic Zone (EEZ) and falls within the

Atlantic, Eastern Central FAO ocean region. The site covers an area of 4 km2 and borders the coastline. The depth ranges from 15 to 19 m (BirdLife International, 2018).

4.5.9.3 UNESCO Senegal River Delta Transboundary Biosphere Reserve

The Senegal River Delta Transboundary Biosphere Reserve was created in 2005 as a result of cooperation between the Mauritania and Senegal governments. The Reserve encompasses approximately 6,420 km^2 of land and water centered on the Senegal River (Figure 4-22). The core area of the Biosphere Reserve includes Mauritania's Diawling National Park and Chatt Tboul Reserve and Senegal's Djoudj National Bird Sanctuary, Langue-de-Barbarie National Park, Guembeul Natural Reserve and Ndiael Reserve. A buffer area includes an additional 13 protected areas including one MPA, six forests, three islands, one forest-pastoral reserve, and one Community Natural Reserve (Vasilijević et al., 2015).

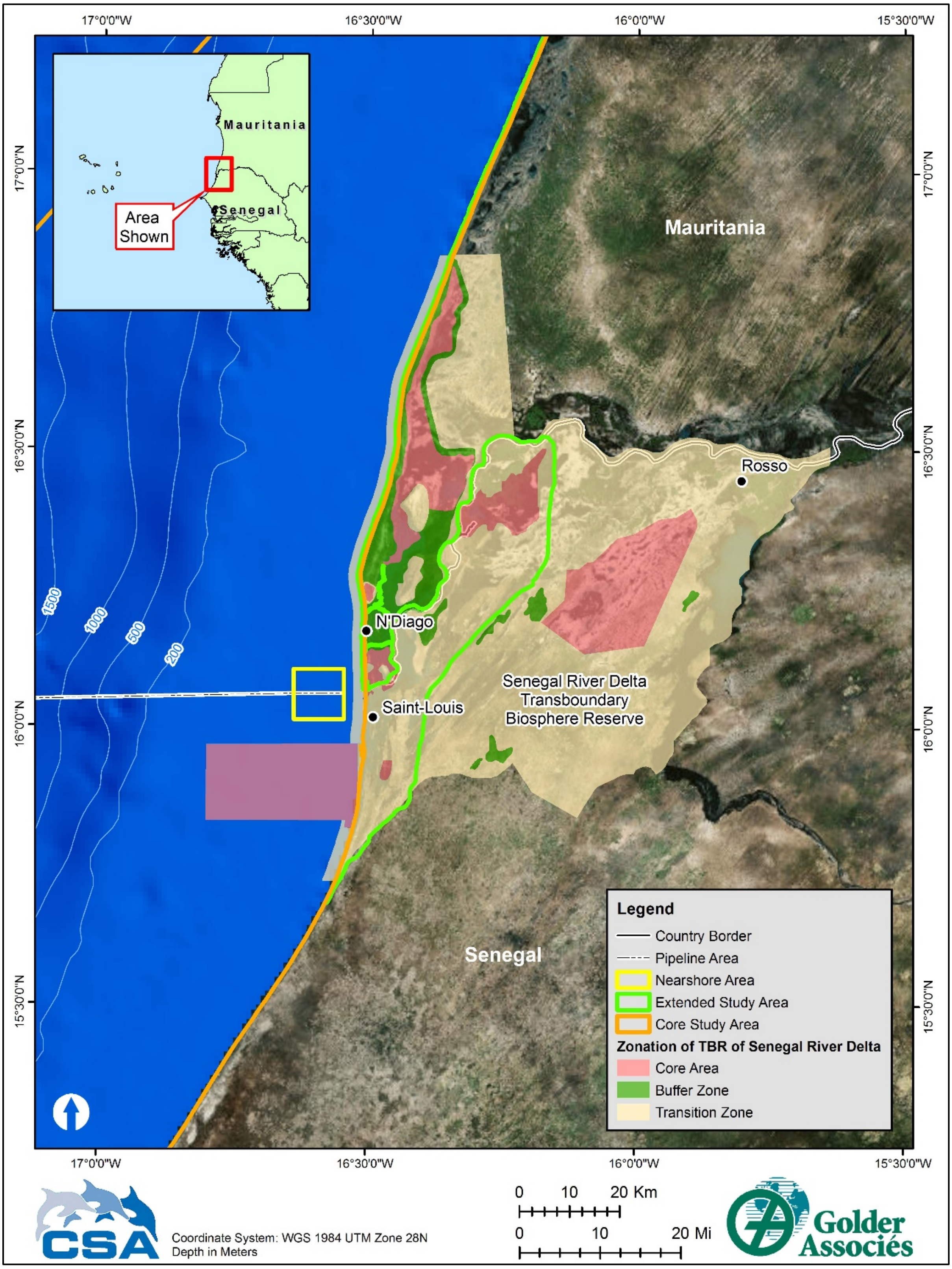


Figure 4-22. The Senegal River Delta Transboundary Biosphere Reserve in Relation to Mauritania, Senegal, and the Core and Extended Study Areas.

Biodiversity in the Senegal River delta region is largely due to complex hydrographic basins that vary seasonally due to river flooding, tidal flooding, and rainfall (UNESCO, 2007). The only topographic relief is from both continental and coastal dunes. The reserve includes both marine and coastal areas incorporating numerous habitat types such as wetlands, grasslands, savannahs, lakes, coastal and inland dunes, and mangrove habitats (Vasilijević et al., 2015; Tropica, 2017c). More than 350 species of birds have been observed within the Reserve. It is estimated that approximately 3 million individual birds visit the region during the wintering period from November to May (Vasilijević et al., 2015). Mangrove areas provide ideal habitat for other species, including crocodiles, snakes, sea turtles, the African manatee, and gazelles. Details regarding each of the individual protected areas within the Biosphere Reserve are located within their specific section (Section 4.5.9.1 for protected areas in Mauritania or Section 4.5.9.2 for protected areas in Senegal).

Much of the Senegal River delta is under agricultural cultivation, including rice and sugar cane. Livestock raising, fishing, and gathering are also practiced by the approximately 375,000 people living within the boundaries of the biosphere reserve (UNESCO, 2007). As a result of hydrodynamic changes due to dams and anthropogenic uses, invasive aquatic plants (such as *Pistia stratoites, Lavinia molesta*, and *Typha australis*) are established within the Reserve. Other conservation concerns include increased soil salinity downstream of the Diama dam, reduced fishing productivity as a result of hydrodynamic changes, and reduced vegetation cover (Tropica, 2017c).

4.5.9.4 Other Areas of Conservation Interest

4.5.9.4.1 Important Bird and Biodiversity Areas

Important Bird and Biodiversity Areas (IBAs) have been identified previously in association with Marine and Coastal Birds (Section 4.5.5) and detailed above (Section 4.5.9). IBAs are not strictly protected areas; rather, they are areas that have been identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations, Specific IBA thresholds are set by regional and national governing organizations (BirdLife International, 2017c). Protected areas can include or also be classified as IBAs, as is the case with Chatt Tboul Reserve in Mauritania and Djoudj National Bird Sanctuary in Senegal. Descriptions of those IBAs that are contained within existing protected areas were presented within Section 4.5.9 and are not repeated below (e.g., Banc d'Arguin National Park, Chatt Tboul Reserve; Diawling National Park).

There are several IBAs in the vicinity of the project area, as previously shown in Figures 4-18 and 4-19. Additional detailed information on IBAs is provided in Appendix G.

Mauritania

Cap Blanc IBA

The Cap Blanc Peninsula IBA is a 3,100 km^2 area that covers the Mauritanian portion of the Cap Blanc Peninsula and the bay between the peninsula and mainland Mauritania. The IBA is adjacent to the Banc d'Arguin National Park to the southeast and contains the Cap Blanc Satellite Reserve within its boundaries. The coastlines within the IBA range from steep and rocky to sandy. The area is an important winter habitat for numerous species of waterbirds, the Ruddy Turnstone (*Arenaria interpres*), the Slender-billed Gull (*Larus genei*), the Lesser Black-backed Gull (*Larus fuscus*), the Caspian Tern (*Hydroprogne caspia*), and the Sandwich Tern (*Thalasseus sandivicensis*) (BirdLife International, 2017a).

Canary Current Shelf-Break South IBA

This IBA is approximately 489,746 ha in size and encompasses offshore waters 50 m to 1000 m deep in the productive waters of the Canary Current. The area is used as a foraging area as several bird species including Cory's shearwater (*Calonectris borealis*) (which also breeds locally), Northern Gannet (*Morus bassanus*), Pomarine Jaeger (*Stercorarius pomarinus*), and the European storm-petrel (*Hydrobates pelagicus*), among others (BirdLife International, 2018).

Aftout Es Sahli IBA

Aftout Es Sahli is a 1,200 km^2 coastal lagoon that is designated as an IBA that extends from Nouakchott south to approximately 60 km north of Saint-Louis. Aftout Es Sahli is located approximately 137 km from the Offshore Area and 59 km from the Nearshore Area. At its closest point, the IBA is located approximately 0.9 km from the core and extended study areas. The salinity in the lagoon varies depending on freshwater input from the Senegal River and rainfall, as well as occasional connection to the sea through channelization through the dunes. The lagoon can dry out in years when there is no rainfall and when it received no water input from the ocean (BirdLife International, 2017b).

The diversity of waterbirds in the IBA varies annually depending on rainfall. Under favorable conditions, the IUCN listed Near-Threatened Lesser Flamingo utilizes the area in large numbers, with Aftout Es Sahli the only known nesting site in West Africa for this species; more than 2,000 were recorded during a survey in 2000 (BirdLife International, 2017b) and more than 3,000 were recorded by the Working Group International Waterbird and Wetland Research (Hagemeijer et al., 2004). Other IUCN bird species that are listed as Near Threatened that are known to utilize the IBA include Arabian Bustard (*Ardeotis arabs*) and Black-tailed Godwit (*Limosa limosa*).

Senegal

Guembeul Avifaunal Reserve and Saint-Louis Lagoons

Characteristics of the Guembeul Avifaunal Reserve were described previously in Section 4.5.9.2. The Saint-Louis lagoons, included as part of this IBA, are comprised of a series of brackish lagoons present near Saint-Louis. The Saint-Louis lagoons vary in size, depending upon the water level of the Senegal River and the amount of rainfall. Vegetation surrounding these highly productive lagoons is Sahelian thorn-bush savanna dominated by *Acacia* spp. (BirdLife International, 2018).

Niayes IBA

The Niayes IBA extends from approximately 60 km south of Saint-Louis to Dakar in the south. The IBA, measuring approximately 150 km in length, is comprised of a series of permanent freshwater lakes and seasonal wet depressions (niayes). The IBA and its lake and niayes features are located behind the coastal sand dunes of the Grande Côte. The lakes are replenished by seasonal rainfall and from a shallow water table. Wetlands range in size from 40 to >200 km^2, depending upon rainfall and the depth of the water table.

Cap Vert IBA

The Cap Vert IBA consists of the coastline of the Cap Vert peninsula running from Les Mammelles and Pointe des Almadies north to Cambérène (c.19 km in length), together with the offshore islands and reefs and the narrow strip of sea between the islands and the mainland (up to about 2 km offshore). The coast and islands consist of rocky outcrops and some sandy beaches, and there is a string of reefs off the Pointe des Almadies, known as the “Chaussée des Almadies”. The reefs and islands form a degree of natural protection from the Atlantic Ocean for the narrow sea channel (less than 1 km) between them and the mainland. The site is of considerable importance for marine birds, particularly as a migration route along which move very large numbers of spring- (northward) and autumn- (southward) passage shearwaters, petrels, skuas, gulls and terns. IBA trigger species include the Audoin’s Gull (*Larus audoinii*), Black Tern (*Chlidonias niger*), and Sandwich Tern (*Thalasseus sandvicensis*).

Northern Senegal Shelf Break IBA

The Northern Senegal Shelf Break Marine IBA was established in 2016 as an area to delineate habitat for the Cape Verde Shearwater (*Calonectris edwardsii*). The 7,788 km^2 area is located within the Core Study Area and is located entirely offshore, extending from just offshore of Saint-Louis in the north to just south of Dakar (BirdLife International, 2017c). The Northern Senegal Shelf Break IBA is a broad offshore swath extending from 15º 20' 23" North (15.34º) offshore of St. Louis to 17º 6' 35" West

(-17.11º) south of Cap Vert. The IBA trigger species is the Cape Verde Shearwater which is currently listed as Near Threatened by the IUCN (IUCN, 2017).

4.5.9.4.2 Ecologically or Biologically Significant Areas

Five areas in the vicinity of the Core and Extended Study Areas have been identified as Ecologically or Biologically Significant Areas (EBSAs) by the Convention on Biological Diversity (Figure 4-23). Brief descriptions of each of these EBSAs is presented below.

Coastal Habitats of the Neritic Zone of Mauritania and the Extreme North of Senegal

This wide-reaching area includes the entire nearshore coastal zone of Mauritania and the northern portion of the coastal region of Senegal. The area is generally characterized by high productivity and serves as a nursery area for numerous fish species which form much of the basis for the fishing economy of Mauritania. The coastal area is also home to monk seals, numerous species of marine mammals, and sea turtles (Convention on Biological Diversity, 2016a). This coastal area either includes or is adjacent to several officially designated protected areas, including Guembeul Natural Reserve and Saint Louis MPA (Senegal) and Chatt Tboul Reserve and Diawling National Park (Mauritania).

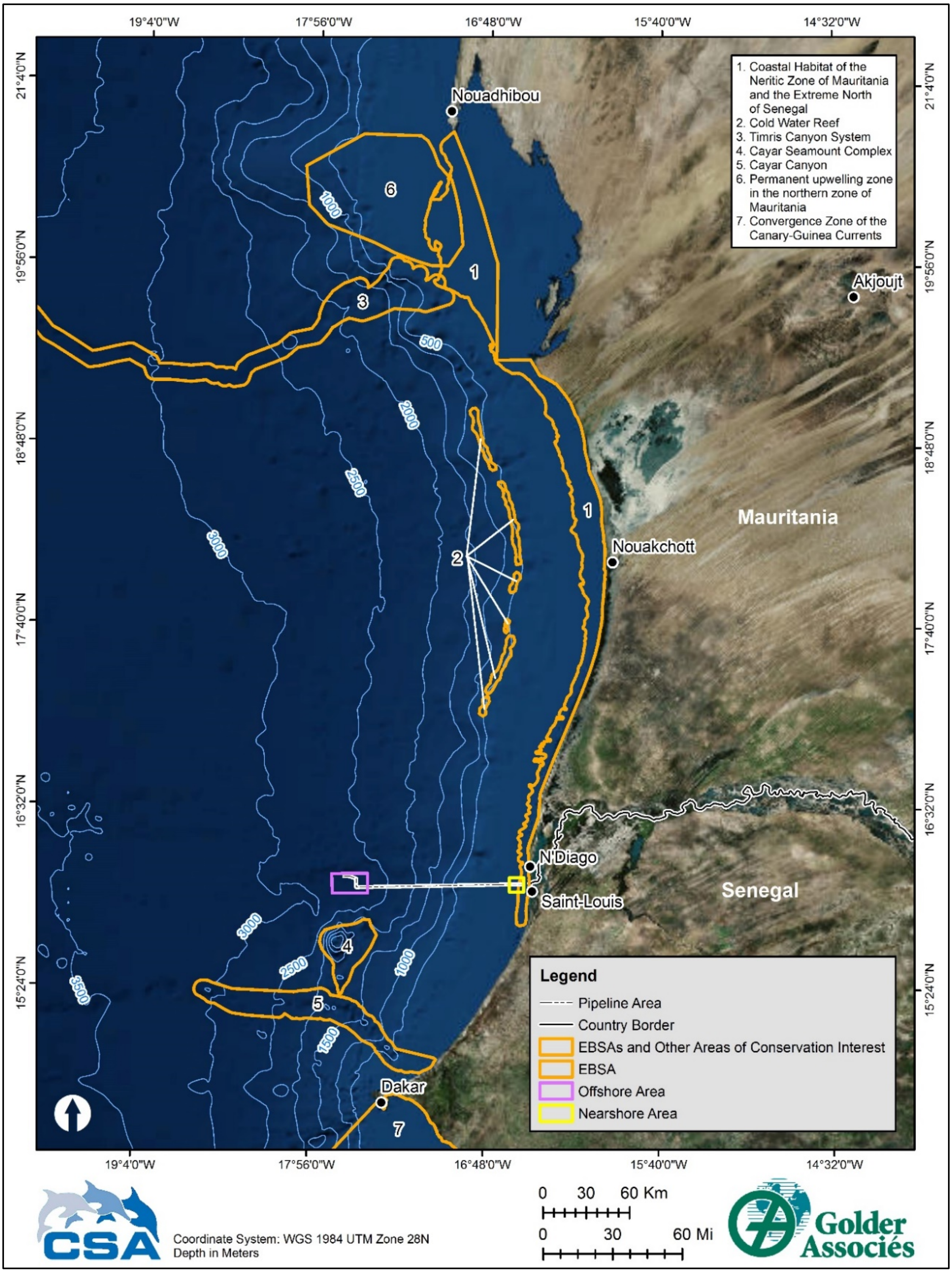
Timiris Canyon System

The Cap Timiris Canyon is a submerged ancient river system shaped by the Tamanrasset River located at 19°15' N, 18°56' W and comprises an approximately 270-m deep and 2.5-km wide feature. The upper part of Cap Timiris Canyon is composed of a series of gullies up to 150 m deep that cut back to the outer shelf. Eight main tributaries gradually merge downslope into one main canyon at approximately 2,000 m water depth at 55 km from the shelf break. Beyond this point, the average canyon depth is 250 to 300 m, with typical widths of 2 to 3 km, although the canyon widens to 7.5 km at two locations (Krastel et al., 2004; Antobreh and Krastel, 2006).

Within the Timiris Canyon System, The Canyon acts as a connector for nutrients, sediment, and fauna between the deepwater areas to the west and the neritic and coastal areas of Mauritania. The rocky canyon walls are known to contain corals (*Lophelia pertusa* and *Madrepora oculata*), crustaceans, and bivalves, but detailed information on fauna within the Canyon remains unknown (Convention on Biological Diversity, 2016b).

Cold Water Coral Reefs off Nouakchott

A series of cold water reefs approximately 400 km long are found offshore Mauritania at the base of the continental slope in a water depth of approximately 600 m. Much of the area is comprised of a fossil reef, and though live corals were sampled by Westphal et al (2013) in 2010, the extent of living corals remains unknown. Upwelling at the edge of the continental slope provides nutrient rich water that results in high productivity where cold water corals can survive. Known coral species from the area include *Lophelia pertusa* and *Madrepora oculata*. The associated biological community is known to contain crustaceans, bivalves (including *Lima excavate* and the long lived giant oyster *Neopycnodote zibrowii*), cetaceans, sea turtles and numerous species of fish (Convention on Biological Diversity, 2016c).



(Adapted from: Convention on Biological Diversity, 2016a,b,c,d,e)

Figure 4-23. Location of Ecologically or Biologically Significant Areas in the vicinity of the Core and Extended Study Areas.

Cayar Seamount Complex

The Cayar Seamount Complex is located within the Core Study Area, off the coast of Cayar. The Cayar Seamount is situated 100 km north-northwest of the Cap-Vert peninsula and Dakar, between 17.864223° W and 17.496424° W longitude and 15.832420° N and 15.368942° N latitude. The seamount is located between 200 and 500-m water depths. This complex comprises three mounts: Cayar mount, Petit Cayar mount, and Medina mount. The Cayar Seamount is one of the rare seamounts off the coast of Senegal characterized by high biodiversity and strong hydrodynamics. The hydrodynamics are results in productive, nutrient rich waters and rich biodiversity, including many species of pelagic fauna not found in surrounding areas. Numerous large pelagic biota, such as tunas, sharks, sea turtles, dolphins, and whales are commonly found in the vicinity of the Seamount Complex. Due to the rich fish fauna, the area is used by commercial trawlers as well as artisanal fishermen (Convention on Biological Diversity, 2016d).

Cayar Canyon

The Cayar Canyon is located off the coast of Senegal, originating near the shoreline (10 to 20 m deep) on the upcurrent side of the Cap-Vert peninsula and extends downslope to the oceanic basin. The canyon trends in a northwest direction from shore. Its channel remains a prominent feature at 3,294 m; its maximum width is 9 km (Dietz et al., 1968). The canyon is characterized by high biodiversity, including seabirds, turtles, and demersal and pelagic fish species. Several species of fish (e.g. *Sardinella maderensis* and *Sardinella aurita*) use the canyon as a breeding area and sea turtles use the areas for foraging (Convention on Biological Diversity, 2016e).

4.5.10 Other Areas of Interest

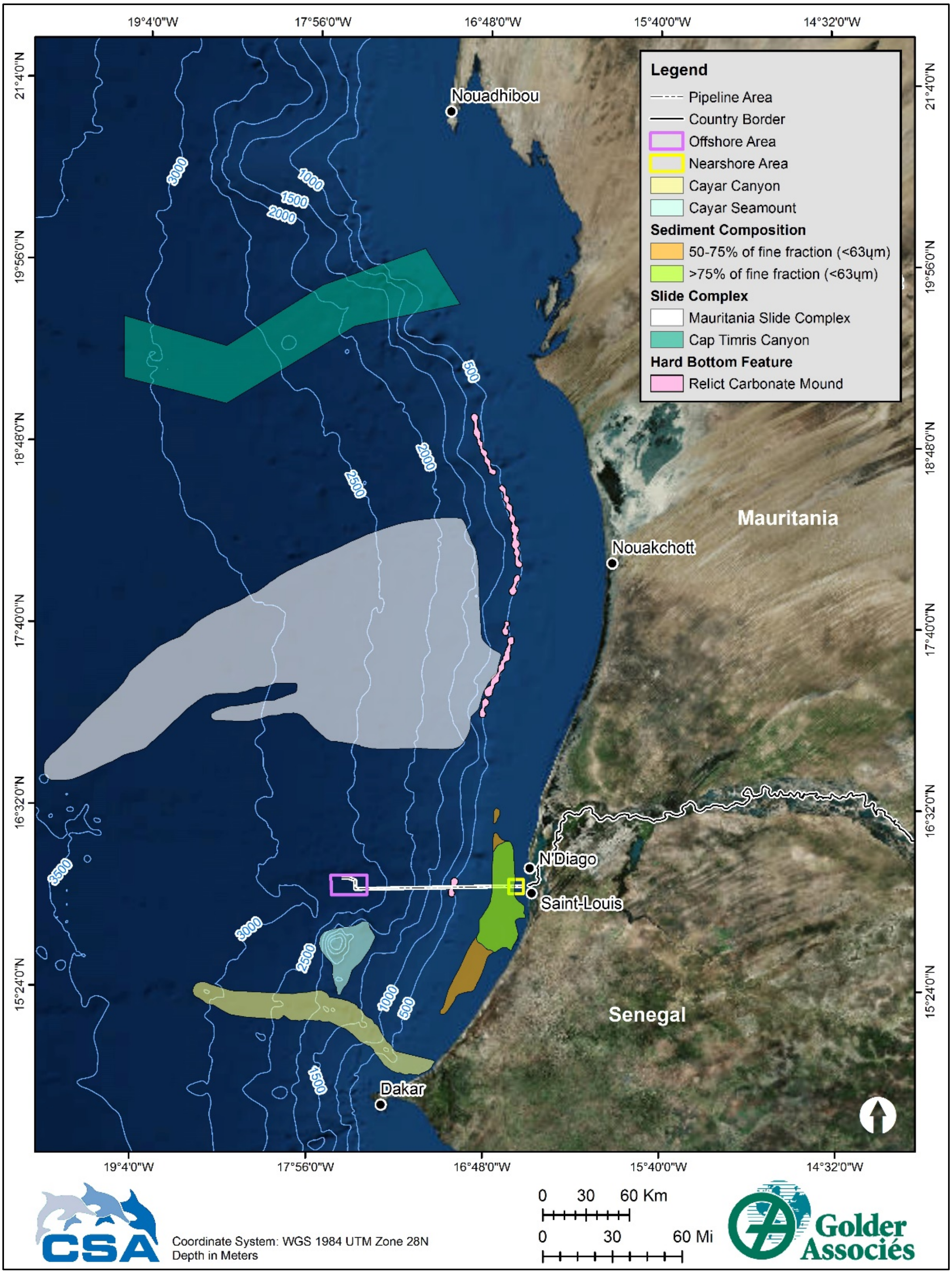
Significant features found offshore or along the coastal margin of southern Mauritania and northern Senegal, within the core or extended study areas, include 1) regional hard bottom features; 2) the marine environment around the Senegal River mouth; 3) the Cayar Seamount and Cayar Canyon; and 4) Cap Timiris Canyon and the Mauritania Slide Complex.

4.5.10.1 Regional Hard Bottom Features

Regional hard bottom features, including relict carbonate mounds and discontinuous emergent hard or live bottom, have been documented offshore Mauritania in water depths of 400 to 550 m (Figure 4-24), with indications that the feature may extend further south into Senegal waters. This offshore relic carbonate reef structure was described by Colman et al. (2005), and has been identified within and adjacent to the Pipeline Area in a discontinuous form (see Section 4.5.3). These hard bottom features represent a discontinuous, offshore relict carbonate reef structure (i.e., relict cold-water coral reefs) which is more prevalent to the north, toward Nouakchott and Banc d’Arguin.

4.5.10.2 Marine Environment at the Senegal River Mouth

The marine environment at the mouth of the Senegal River and north and south of the river opening along the continental shelf has been characterized as a mud belt. Under the influence of riverine discharge, fine grained sediments are deposited in nearshore waters under the influence of seasonally changing oceanographic processes (Nizou et al., 2010).



(Adapted from: Colman et al., 2005; Nizou et al., 2010; Hansen et al., 2008; Krastel et al., 2006; Gardline and Oceaneering, unpublished data)

Figure 4-24. Location of Relict Carbonate Mounds, Senegal River Mouth Mud Belt, Cayar Seamount and Cayar Canyon, Cap Timiris Canyon, and Mauritania Slide Complex.

To the north of the Cap-Vert peninsula, the continental shelf off Senegal is quite variable. Between Cayar and M'Boro, the shelf is approximately 20 km wide, with a slope ranging from 1.8% to 0.3%. Two canyon features are present in this area – Cayar Canyon off Cayar and Djoloff Canyon off M'Boro. These canyon features bisect the shelf at their origin. Between M'Boro and the Senegal River mouth, the shelf broadens to approximately 40 km, and the slope decreases to 0.2%. One canyon feature is present in this area – Peul Canyon, off Lompoul. North of the Senegal River mouth, the shelf narrows again (Pinson-Mouillot, 1980), with the shelf break located at approximately 100 m water depth.

Major parts of this shelf are dominated by bioclastic sands. However, Domain (1977) and Seibold and Fütterer (1982) have defined a muddy area along the middle shelf that is characterized by more than 75% of fine-grained (<63 µm) sediments. Off the Senegalese shelf, terrigenous input is dominated by fine-grained, Fe-rich fluvial material. These determinations have been supported by acoustic profiles, as summarized by Nizou et al. (2010).

4.5.10.3 Cayar Seamount and Cayar Canyon

Brief descriptions and locations of the Cayar Seamount and the Cayar Canyon are presented in previous Section 4.5.9.3.2 *Ecologically or Biologically Significant Areas*.

As previously mentioned, the Cayar Seamount Complex is one of the rare seamounts off the coast of Senegal characterized by high biodiversity and strong hydrodynamics. The hydrodynamics results in productive, nutrient rich waters and rich biodiversity (UNEP, 2014a). The detailed morphology of the Cayar Seamount Complex is presented in Hansen et al. (2008). The canyon is characterized by high biodiversity, including seabirds, turtles, and demersal and pelagic fish species. Several species of fish (e.g. *Sardinella maderensis* and *Sardinella aurita*) use the canyon as a breeding area and sea turtles use the areas for foraging (Convention on Biological Diversity, 2016e)

Several other significant seafloor features are present in the region, including the Dakar Canyon and Dakar Slide. The Dakar Canyon is a relatively straight, deeply incised (up 1,000 m) canyon running from Dakar and the Cap-Vert peninsula offshore in a southeast direction. At 3,900-m water depth, the southeastern canyon flank was destroyed by the Dakar Slide and associated mass transport deposits that occurred 1.2 million years ago. At approximately 4,100 m, the entire canyon disappears under hummocky (i.e., undulating, wavy) slide topography (Meyer et al., 2012). The Dakar Slide is located between 12°40’ N and 13°35’ N offshore central Senegal and The Gambia, well south of the core and extended study areas. To the northwest, the slide is confined by the bordering Dakar Canyon and to the south by the Diola Canyon.

4.5.10.4 Cap Timiris Canyon and Mauritania Slide Complex

The Cap Timiris Canyon is a submerged ancient river system shaped by the Tamanrasset River.

The Mauritania Slide Complex is located beyond the shelf break offshore southern Mauritania. Covering an area of approximately 34,000 km^2, the complex is located at water depths between 600 and >3,500 m. The slide complex is ovate-shaped and displays a long run-out distance >300 km. Slide formation was prompted by uninterrupted deposition of upwelling-induced organic-rich sediment in an open slope environment that gave rise to rapid accumulation of poorly consolidated bedded sediment interspersed with thin weak layers (Henrich et al., 2008; Krastel et al., 2006).

4.5.11 Biodiversity

Myers et al. (2000) first proposed the concept of “biodiversity hotspots” to identify areas with exceptional concentrations of endemic species that are also highly threatened. Key biodiversity characteristics of marine ecosystems historically have included two metrics – species richness and species endemism – to be considered when assessing biodiversity, or establishing biodiversity hotspots (Willis et al., 2007). Marine ecosystems with high species richness are thought to possess greater resilience to environmental impacts (Folke et al., 2004), while endemic species, or those with a restricted geographic range, are more prone to extinction from widespread environmental change (Myers et al., 2000). There is increasing evidence from marine and terrestrial environments, however, that indicate that biodiversity hotspots that exhibit high species richness may not reflect high species endemism or threat. Marine biodiversity assessment, therefore, should be made within the context of ecosystem function rather than simply species richness (Belley and Snelgrove, 2016). For example, areas where threatened species or local endemics are concentrated that may be considered as biodiversity hotspots could exhibit lower species richness (Marchese, 2015).

There is also increasing interest in determining the characteristics of areas of lower biodiversity, or coldspots (Kareiva and Marvier, 2003). Biodiversity coldspots may not necessarily indicate degraded or impacted habitat, particularly in pelagic communities; therefore, conservation efforts should not be too focused on biodiversity hotspots to the detriment of ecosystem functionality and other measures of ecological importance.

Mauritania

The high level of biodiversity present in the Mauritania coastal environment and marine waters has been summarized in various publications (e.g., Biodiversity, Gas, and Petroleum Program [BGP], 2013), most of which have been further detailed and referenced in this assessment. In addition to the BGP (2013) summary, other biodiversity sources are acknowledged, including a summary of the CCLME (Valdes and Denis-Gonzalez, 2015) and benthic biodiversity analyses (Ramos et al., 2017a).

The CCLME project has conducted, on the basis of a bibliographical study, a summarization on the state of marine biodiversity between Morocco and Guinea (CCLME, 2014). Results indicated that more than 12,500 species have been reported in the seven countries considered. In Mauritania, a total of 2,649 species distributed between the different phyla were reported. The phylum Chordata (including fish) was the most reported, represented by 1,111 species.

In 2014, Mauritania published its second report on national strategy and biodiversity for the 2011 to 2020 period (Ministère de l’Environnement et du Développement Durable [MEDD], 2014a) and its fifth national report (MEDD, 2014b). The second national strategy report updated the scope and direction of previous plan and identified seven strategic directives for identification of national biodiversity objectives. While a primary focus lies with the problem of desertification, Mauritania also recognizes the need to support sustainable development, promote renewable energy, and implement good management practices in compliance with Agenda 21. MEDD (2014a) does not identify specific biodiversity hotspots, but does discuss protected areas and, in broad terms, the terrestrial and marine biodiversity of Mauritania. MEDD (2014b) provides greater detail regarding coastal ecosystems, species, and genetic resources, with emphasis on Banc d’Arguin National Park, the Senegal River estuary, Diawling National Park, the Cap Blanc Reserve, Baie de l'Étoile (Bay of the Star, Nouadhibou), Aftout Es Sahli, and the Chatt Tboul Reserve.

The priority for Mauritania, in terms of biodiversity, is to: 1) preserve those components of the environment that are threatened with extinction; 2) maintain balance and/or developing natural resources with little or no threat; and 3) ensuring that biodiversity can contribute to the socio-economic development of the country (MEDD, 2014b). A summary of protected areas and associated biodiversity in Mauritania is provided in Appendix F-1. Diversity in fisheries and fishery resources in Mauritania has been summarized in Appendix E-1.

Senegal

The high level of biodiversity present in the Senegal coastal environment and marine waters has been acknowledged in the CCLME summary analysis (Valdes and Denis-Gonzalez, 2015) on a regional basis. In addition, high biodiversity in the marine environment has been summarized in group-specific analyses (e.g., Le Loeuff and von Cosel, 1998; benthic fauna) and within supporting documentation for management of Senegal’s marine-related protected areas (e.g., Direction des Parcs Nationaux, 2010a, 2010b; Ndong et al., 2014).

Until 2016, Senegal had not undertaken an exhaustive assessment of national biological resources. Implementation of the Senegalese National Information System on Biodiversity (SENBIO-INFOS) project in June 2016 established a system for biodiversity data identification and access. SENBIO was implemented as a coordination point (i.e., data node) where the National Biodiversity Committee can provide counsel and facilitate scientific and technical collaboration on Senegal biodiversity, contributing to the implementation of national biodiversity strategy and action plans (Global Biodiversity Information Facility, 2017).

CCLME (2014) reported on the presence of approximately 1,900 marine species distributed between the main phyla in Senegal. The phylum Chordata (including fish) was the most represented with 866 species.

A summary of protected areas and associated biodiversity in Senegal is provided in Appendix F-2. Diversity in fisheries and fishery resources in Senegal has been summarized in Appendix E-2.

Regional Considerations

Mauritania and Senegal both fall within the CCLME. On a global scale, to provide a basis for comparison, Selig et al. (2014) identified the CC region as one of several with particular high levels of species richness (i.e., within the top 5%). One important caveat noted by Selig et al. (2014) in their global biodiversity analysis was a deficiency in available information for many benthic and demersal species beyond the continental shelf (i.e., deepwater environments). The Mauritanian southern coast and Senegalese northern coast, as well as their respective offshore areas (including the EEZ), were not identified as priority areas for marine biodiversity conservation by Selig et al. (2014) or Marchese (2015).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO, 2013) has assembled data and mapped available information regarding potential designation of Ecologically or Biologically Significant Marine Areas (EBSAs) in the southeast Atlantic Ocean, including off the coast of west Africa; specifically, they have identified coastal habitats of the neritic zone of Mauritania and the extreme north of Senegal, within coordinates 17.238° W and 16.024° W; 20.773° N and 15.802° N, as warranting further characterization and possible designation.

CSIRO (2013) was developed to inform the South-Eastern Atlantic Regional Workshop to Facilitate the Description of EBSAs. No formal EBSA designations have been made off the Mauritanian or Senegal coasts, although a series of reports (Lehlou, 2013a,b,c) have identified the ecological and biological importance of the Mauritanian and northern Senegal coasts and nearshore coastal waters in support of EBSA designation. These summaries have cited upwelling features, the presence of unique carbonate reefs and the abundance of marine mammals, turtles, and fish in these waters, noting the high productivity of the area and the designation of protected areas (e.g., Banc d'Arguin National Park; Diawling National Park; Chatt Tboul Reserve; Langue-de-Barbarie National Park); these attributes have been noted in the current analysis.

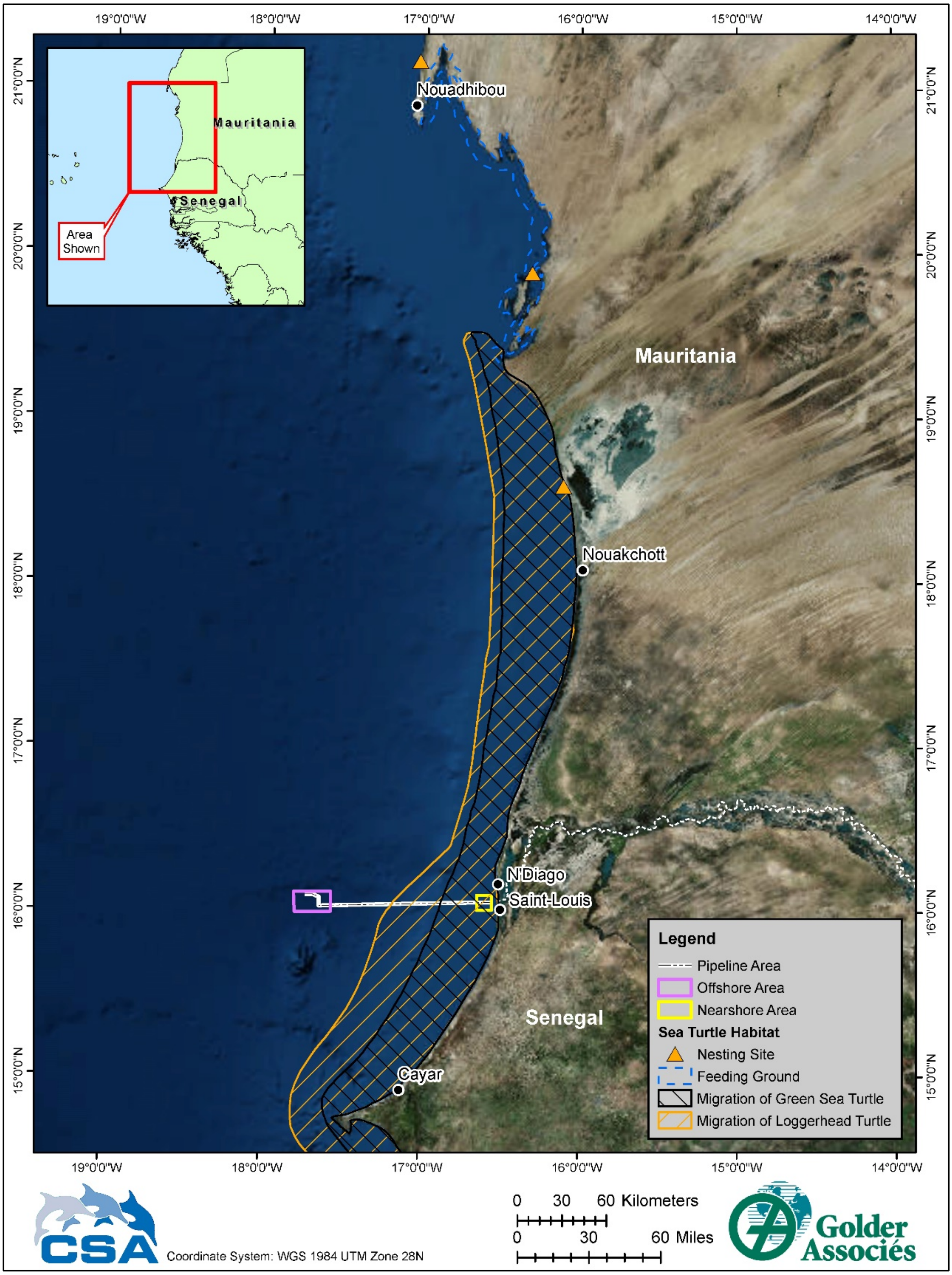
When considering biodiversity within the marine environment, biodiversity experts have argued for separate pelagic and benthic biodiversity analyses due to their different contributions and diverse characteristics, although the lack of comprehensive benthic sampling, particularly in the deep sea, makes benthic biodiversity determinations problematic. In general, biodiversity hotspots in the epipelagic or pelagic zone have been described in areas where physical conditions promote high primary productivity and, consequently, elevated concentrations of primary and secondary consumers (Marchese, 2015). In such areas, upwelling, mesoscale eddies, and fronts result in elevated primary production (Wingfield et al., 2011). In the benthic realm, the presence of seamounts, canyons, and cold and warm water coral reefs are recognized as biodiversity hotspots (Ramirez-Llodra et al., 2010). Other researchers have focused on specific species groups to characterize areas of high biodiversity (e.g., groundfish off the western U.S.; Piacenza et al., 2015). Clark et al. (2014) have proposed that seamounts be nominated as candidates for designation as EBSAs.

While the biophysical characterization presented in this ESIA has been structured on a resource-specific basis, several different levels relevant to biodiversity have also been addressed. The relevant levels of biodiversity, and their corresponding level of characterization in this section, include the following:

- Bioregional Level: regional characterization (e.g., oceanography; regional distribution of marine mammals, sea turtles, marine and coastal birds, and fish);
- Ecosystem Level: food web dynamics, particularly associated with areas of high productivity, upwelling, and biodiversity hotspots;

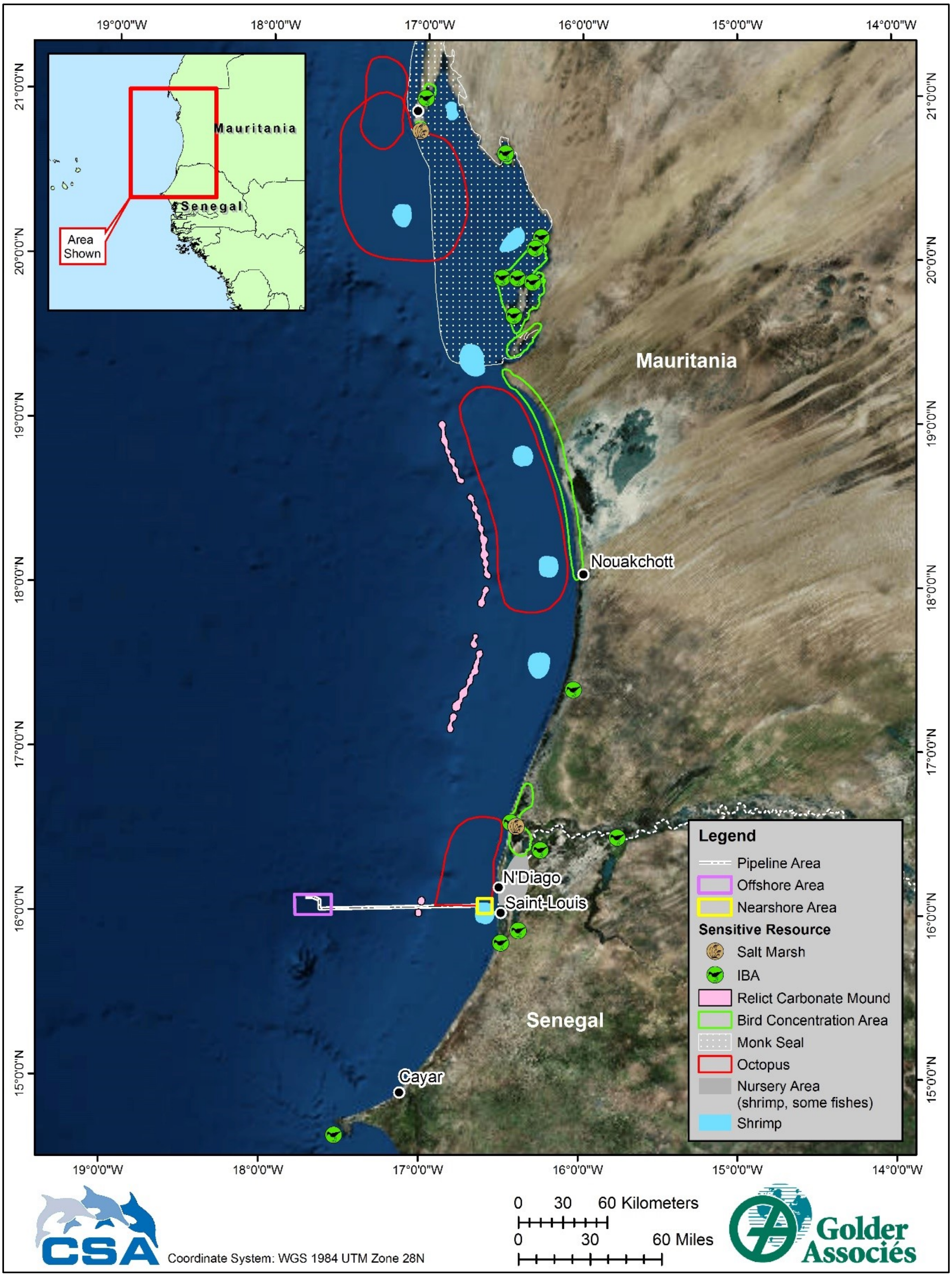
- Habitat Level: preferred habitat for key species across multiple resources, including protected and/or threatened species;
- Community Level: characterization of community dynamics and interactions, as available;
- Species and Population Level: species status, population trends, and spatial and temporal characteristics of populations, with an emphasis on protected and/or threatened species; and
- Individual Level: limited characterization of individual attributes.

Key components of biodiversity have been presented in Figures 4-25 and 4-26. Important components depicted include sea turtle habitat, turtle feeding grounds, and migratory routes (green and loggerhead turtles), sensitive resources (i.e., relict carbonate structures, salt marshes, seagrass beds, IBAs), distribution for important species (molluscs, Monk seal, octopus, shrimp, sea turtles), and bird congregation areas. The importance of the Senegal River estuary as a nursery area and migratory pathway for shrimp and various fish species is also noted.



(Adapted from: BGP, 2013 and Appendices F-1 and F-2)

Figure 4-25. Key Components of Biodiversity (Sea Turtle Nesting, Feeding, Migration) near the Core and Extended Study Areas.



(Adapted from: BGP, 2013 and Appendices F-1 and F-2)

Figure 4-26. Key Components of Biodiversity near the Core and Extended Study Areas.

Summary of Important Biodiversity Features in Mauritania and Senegal

Important biodiversity features in Mauritania and Senegal include IBAs, sensitive hard bottom, and biodiversity hotspots. IBAs are defined as sites needed to ensure the survival of viable populations of bird species. IBAs also hold a large and representative proportion of other biodiversity.

There are six IBAs located nearshore or along the coast in Mauritania, including (from north to south) Cap Blanc, Banc d'Arguin National Park, Canary Current Shelf-Break South, Aftout Es Sahli, Chatt Tboul Reserve and Diawling National Park (BirdLife International, 2016a). Only four of Mauritania's IBAs are located in the core study area.

Six IBAs are noted for Senegal, including the Northern Senegal Shelf Break, Langue-de-Barbarie National Park, Niayes, Cap Vert, Guembeul Natural Reserve, and Madeleine Islands National Park; the Djoudj National Bird Sanctuary lies inland along the Senegal River. Among these IBAs, only the Senegal Shelf Break, Langue-de-Barbarie National Park, and Madeleine Islands National Park lie within the core study area, while all six are located within (or immediately adjacent to) the extended study area.

The Saint-Louis Marine Protected Area is also located within the core and extended study areas; while not recognized as an IBA, the protected area provides refuge for a variety of marine species.

Threatened marine-associated species include fish, marine and coastal birds, sea turtles, and marine mammals. In Mauritania, there are two critically endangered and one vulnerable marine and coastal bird species; four endangered and three vulnerable marine mammal species; two critically endangered, one endangered, and three vulnerable sea turtle species; and six critically endangered and 13 endangered fish species. In Senegal, there are no critically endangered, endangered or vulnerable marine or coastal bird species; four endangered and three vulnerable marine mammal species; two critically endangered, one endangered, and three vulnerable sea turtle species; and six critically endangered and 13 endangered fish species. Species presence for these IUCN-listed species is variable, ranging from likely to very unlikely.

The only identified sensitive hard bottom areas known to be present within the core and extended study areas are the discontinuous relict carbonate mounds found intermittently within the Pipeline Area between 400 and 550 m water depths, along the Mauritania-Senegal maritime boundary (see Figure 4-26). These live bottom features are discussed in detail in Section 4.5.3.

Biodiversity hotspots in Mauritania have been identified and extensively characterized by BGP (2013); there is no comparable summary for Senegal, although the geographic location of the northern Senegal study area to Mauritania indicates that these two countries share significant biodiversity resources. In addition, in-country experts have detailed the characteristics of protected areas within both Mauritania and Senegal; these reports are provided in Appendices F-1 and F-2.

Biodiversity hotspots include areas of upwelling (both permanent and seasonal), relict carbonate mound communities, seagrass beds, mangrove swamps, seamounts, environmentally vulnerable areas (e.g., IBAs), the Senegal River Delta Transboundary Biosphere Reserve (inclusive of both Mauritanian and Senegalese protected areas), and prominent geographic features. Biodiversity hotspots within or adjacent to the core and extended study areas have been characterized under their respective resource topics in the current report, and are summarized in Table 4-30.

Table 4-30. Summary of Biodiversity Features in or near the Core and Extended Study Areas.

Biodiversity Feature	Country	Summary of Biodiversity Sensitivities
IBAs	Mauritania	Cap Blanc (5 key species), Banc d'Arguin National Park (39 key species), Canary Current Shelf-Break South (7 key species), Aftout Es Sahli (6 key species), Chatt Tboul Reserve (2 key species), and Diawling National Park (3 key species); extensive migrant populations at Banc d'Arguin NP and Diawling NP
	Senegal	Northern Senegal Shelf Break (1 key species), Langue-de-Barbarie National Park (6 key species, Niayes (5 key species), Cap Vert (3 key species), Guembeul Natural Reserve (5 key species), and Madeleine Islands National Park (1 key species); Djoudj National Bird Sanctuary lies inland along the Senegal River
Protected Areas	Mauritania	3 protected areas: Banc d'Arguin National Park, Chatt Tboul Reserve, Diawling National Park
	Senegal	6 protected areas: Langue-de-Barbarie National Park, Djoudj National Bird Sanctuary, Parc National des Iles de la Madeleine, Saint-Louis Marine Protected Area, Guembeul Natural Reserve, Cayar Marine Protected Area
Biosphere Reserve	Mauritania	Senegal River Delta Transboundary Biosphere Reserve, encompassing both core, buffer, and transition zones within southern Mauritania and northern Senegal, around the Senegal River
	Senegal	
EBSA	Mauritania	3 EBSAs: Coastal Habitats of the Neritic Zone of Mauritania and the extreme north of Senegal, Timiris Canyon System, Cold Water Coral Reefs off Nouakchott
	Senegal	2 EBSAs: Cayar Seamount Complex, Cayar Canyon
Seagrass habitat	Mauritania	Extensive seagrass beds in the shallow waters of Banc d'Arguin NP
	Senegal	Limited to estuarine waters of the Senegal River near Langue de Barbarie NP
Carbonate mounds	Mauritania	Discontinuous relict carbonate mounds found intermittently between 400 and 550 m water depths; more prevalent in Mauritania than in Senegal
	Senegal	
Threatened species	Mauritania	2 CR and 1 VU bird species; 4 EN and 3 VU marine mammal species; 2 CR, 1 EN, and 3 VU turtle species; 6 CR and 13 EN fish species present in Mauritania and Senegal
	Senegal	No CR, EN or VU bird species; 4 EN and 3 VU marine mammal species; 2 CR, 1 EN, and 3 VU turtle species; 6 CR and 13 EN fish species present in Mauritania and Senegal
Sea turtle nesting	Mauritania	Limited sea turtle nesting sites north of Nouakchott, within Banc d'Arguin NP
	Senegal	One of the objectives in creating the Langue de Barbarie NP was to ensure the protection of egg-laying sites for sea turtles (Tropica, 2017c)
Other areas of interest	Mauritania	Marine environment at the Senegal River mouth; Cap Timiris Canyon and Mauritania Slide Complex; important areas for invertebrate species of commercial interest (octopus, shrimp)
	Senegal	Marine environment at the Senegal River mouth; Cayar Seamount and Cayar Canyon; important areas for invertebrate species (shrimp); nursery area for shrimp, some fishes in the lower Senegal River estuary
Upwelling	Mauritania and Senegal	Seasonally upwelling between 15° N and 21° N, with strongest intensity and expansion between January and May; upwelling is persistent throughout the year north of 21° N

4.6 Social Environment of Mauritania

This section provides socio-economic information on the Mauritanian portion of the study area.

As defined in Section 4.3, the Mauritanian portion of the ESIA's core study area includes a coastal strip bound by the city of Nouakchott to the north and by the Mauritania-Senegal border to the south. It also comprises a maritime corridor linking the Nouadhibou ore port infrastructure area from which materials might be transported during the construction phase. Given the peripheral location of Nouadhibou with respect to the project, socio-economic information on this city is presented under the extended study area. The Mauritanian portion of the extended study area includes Diawling National Park and its vicinity, an area more generally referred to as the Mauritanian lower delta of the Senegal River.

A detailed portrait of the communities of the core study area is provided in this section, as is higher-level information for communities in the extended study area. This information is sourced from a review of literature as well as secondary data collected in the field between March and April 2017 by three Mauritanian researchers. The results of their work are provided in three separate reports provided in Appendix E-1 for Mauritanian fishery resources and fisheries, Appendix E-3 for Mauritania fishing communities and Appendix F-1 for Mauritania’s protected areas. These three reports provide in-depth data on the topics addressed and complete the data presented herein. Lastly, additional socio-economic data are provided in Appendix H. In the current report, « fishermen community » is used as a generic name. It includes all members of the community, male and female.

In the context of the project proposed activities and location, key sensitivities in the social environment include:

- the fisheries (particularly artisanal fisheries);
- the economic conditions, employment and means of subsistence; and
- the maritime navigation (particularly artisanal fishermen safety).

Other components of the social environment that were not raised during public consultations or that are less sensitive, but that are important to understand the host environment of the project or that could potentially be impacted by the project are also described, such as the administrative framework, the land use and human settlements, the population, other maritime and coastal activities, etc. The key sensitivities are the same for the social environments of Mauritania and of Senegal.

4.6.1 Administrative Framework

4.6.1.1 Administrative Organization of Mauritania

The Mauritanian administration is partially decentralized and is based on hierarchical principles. The country has three main administrative levels or *circonscriptions*: *wilayas* (regions), *moughataas* (departments) and *markez idariya* (districts).

- The country contains 15 *wilayas*: Adrar, Assaba, Brakna, Dakhlet-Nouadhibou, Gorgol, Guidimakha, Hodh Ech Chargui, Hodh El Gharbi, Inchiri, Nouakchott-Nord, Nouakchott-Ouest, Nouakchott-Sud, Tagant, Tiris Zemmour, and Trarza. Each *wilaya* is placed under the authority of a *Wali* (Governor), which represents the central power.
- The *wilayas* are in turn divided into 55 *moughataas* (departments) administrated by *Hakems* (Prefects).
- *Moughataas* are sub-divided into districts (*markez idariya*) directed by District chiefs (*Raïs markez idari*). Districts cover only part of the country; there are 33 of them in Mauritania.

Moreover, each district encompasses one or more urban or rural *communes*. There are 218 *communes*, which are administered by Mayors. The *communes* include a number of localities.

The *wilayas, moughataas,* and *markez idariya* are *déconcentrés* (devolved) levels of the administration, while the *commune* is a decentralized level (MIDEC-AECID-IEJI, 2009).

Although its autonomy and its exercise of power are limited, the *commune* is the only territorial administration outside the State to have a legal character as well as administrative and financial autonomy. The main function of the *commune*, which notably serves as a bridge between the central administration and local populations, is to ensure local public services, including the following:

- Urban transport and local roadways;
- Construction, maintenance and equipping of basic educational and health buildings (schools, dispensaries and maternal and children's centres); and
- Sanitation and hygiene services, water supply and public lighting.

4.6.1.2 Administrative Organization of the Study Area

Core Study Area

The core study area overlaps four *wilayas*: Nouakchott-Nord, Nouakchott-Ouest, Nouakchott-Sud, and Trarza.

Nouakchott enjoys a unique status, being a city composed of three *wilayas* that are administered by *Walis*, and divided into nine *moughataas* that are administered by *Hakems*. These *moughataas* also have the status of *communes*, which are administered by elected Mayors. These nine *communes* make up the Nouakchott Urban Community (*Communauté Urbaine de Nouakchott* [CUN]). The CUN has a president and is managed by an urban council.

In other words, the same territorial space is managed on one hand by devolved authorities nominated by the State (*Walis, Hakems and Raïs markez idari*) for administrative matters, and on the other hand by decentralized authorities elected during municipal elections (CUN President, Mayors) for service-related issues. All these entities fall under the authority of the Minister of the Interior and Decentralization (*Ministère de l'Intérieur et de la Décentralisation*).

The unique status of Nouakchott was recently defined by Decree Nº 2014-182 of November 25, 2014, which created three *wilayas* from the previously existing one:

- Nouakchott-Nord (*moughataas* of Dar-Nain, Toujounine and Teyarett);
- Nouakchott-Ouest (*moughataas* of Tevragh-Zeina, Ksar and Sabkha); and
- Nouakchott-Sud (*moughataas* of Arafat, El Mina and Riadh).

South of Nouakchott, human settlements belong to the *wilaya* of Trarza, which extends as far as the border with Senegal. This *wilaya* is composed of six *moughataas* (Boutilimit, Keur Macene, Mederdra, Ouad Naga, R'Kiz, and Rosso), three of which have a seaboard: Keur Macene, Mederdra and Ouad Naga.

The coast of the *wilaya* of Trarza comprises 8 human settlements, including 3 fishing villages, 4 fishing camps and 1 non-fishing village. The list of these settlements and their administrative affiliation is presented in Table 4-31.

Table 4-31. Coastal Human Settlements South of Nouakchott.

	Name	Type of Human Settlement	Commune	*Moughataa*
1	PK 28 (sometimes called Vernana)	Fishing camp	El Arye	Ouad Naga
2	PK 65	Fishing camp	Tiguent	Mederdra
3	Legweichich (sometimes called PK 93)	Fishing village	Tiguent	Mederdra
4	PK 144	Fishing camp	M'Balal	Keur Macene
5	Mouly	Fishing camp	Keur Macene	Keur Macene
6	N'Diago	Fishing village	N'Diago	Keur Macene
7	Mboyo 2	Fishing village	N'Diago	Keur Macene
8	Lorma	Non-fishing village	N'Diago	Keur Macene

Source: Ecodev, 2017b

As indicated in Table 4-31, the three fishing villages in the core study area are Legweichich, N'Diago and Mboyo 2. The village of N'Diago is the largest of the three; it belongs to the N'Diago *commune* and the *moughataa* of Keur Macene. The N'Diago *commune* has 33 localities: the village of N'Diago is the largest locality in the *commune*. The village of Mboyo 2 also lies within N'Diago *commune*. The village of Legweichich belongs to the Tiguent *commune*.

The four fishing camps in the area are PK 28, PK 65, PK 144 and Mouly. It is noted that the fishing villages of N'Diago and Legweichich also host seasonal fishing camps for up to six months a year.

Lastly, the only other coastal settlement in the area, Lorma, is not inhabited by fishermen. Lorma is located south of Mboyo 2; the village lies within the N'Diago *commune*.

Extended Study Area

Diawling National Park and the surrounding area comprise approximately thirty villages (DNP, 2016). These villages belong to the *communes* of Keur Macene, M'Balal and N'Diago, all located within the *moughataa* of Keur Macene (*wilaya* of Trarza). Appendix H provides a list of villages within the Diawling National Park and its vicinity. The largest village in the Diawling National Park is Keur Macene, which belongs to the *commune* of Keur Macene and the *moughataa* of the same name. It is noted that the villages of N'Diago, Mboyo 2 and Lorma are included in this list, as they are found in Diawling National Park's periphery.

The extended study area also includes Nouadhibou. The town belongs to the *wilaya* of Dakhlet-Nouadhibou. This *wilaya* is located along the Atlantic Ocean in northwestern Mauritania. It has just one *moughataa*, which is Nouadhibou. The latter is composed of one urban *commune* (Nouadhibou) and four rural *communes*. These rural *communes* are located outside the extended study area.

4.6.2 Land Use and Human Settlements

4.6.2.1 Core Study Area

On the Mauritanian side, the core study area contains a single large urban metropolis, i.e., the city of Nouakchott. In fact, land use in the core study area is characterized by a strong contrast in density between Nouakchott and a sparsely populated coast containing just four villages and four fishing camps. The locations of these human settlements are illustrated in Figure 4-27.

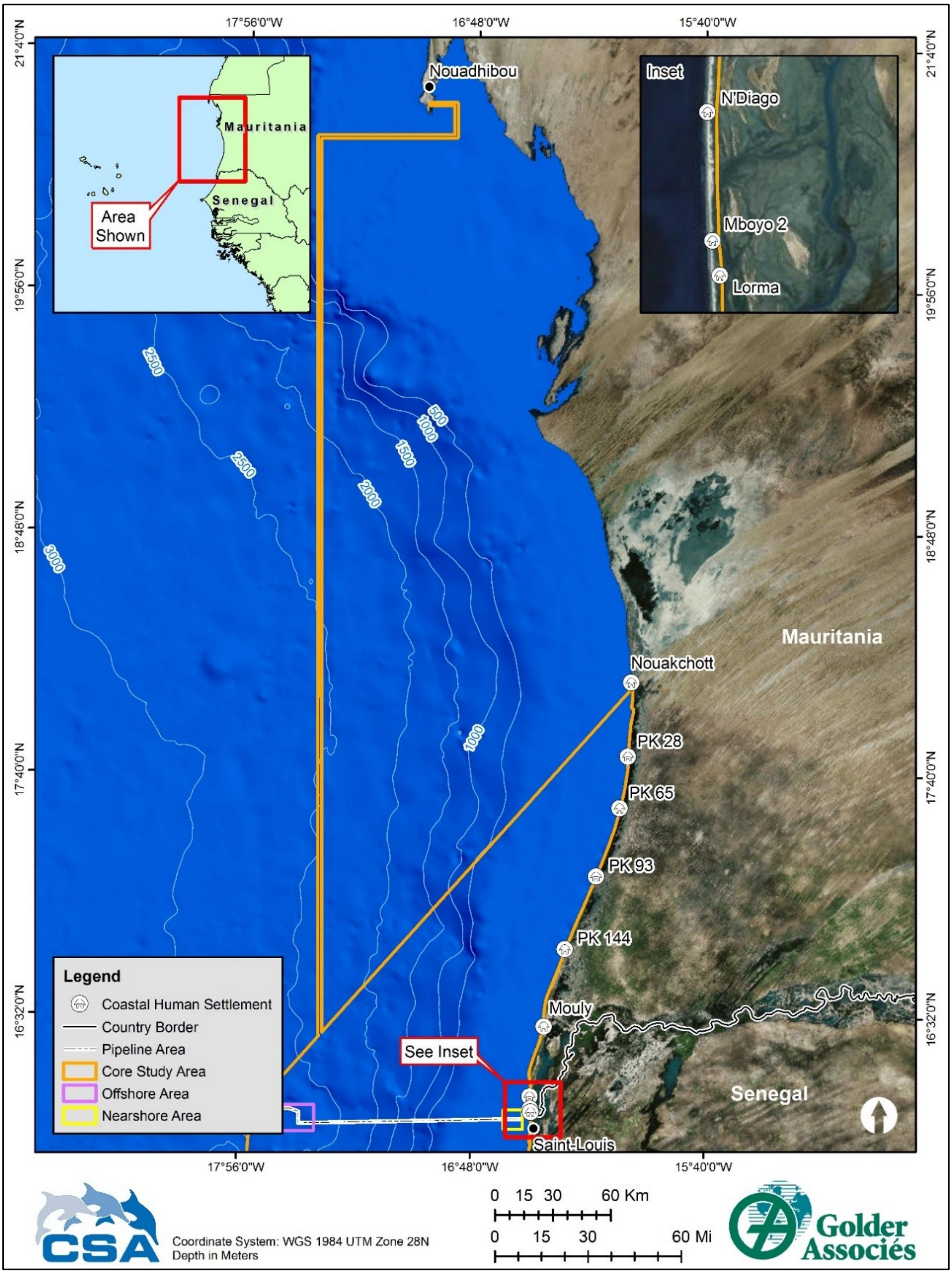


Figure 4-27. **Main Coastal Human Settlements in the Core Study Area – Mauritania Portion.**

Nouakchott

The city of Nouakchott is the capital of Mauritania. It is the most populous city in the country, with an estimated population of 958,399 and a surface area of approximately 1,000 km^2. This represents a density of 958 inhabitants per km^2, which is very high compared to the national average of 3.4 inhabitants per km^2. The geographic coordinates of the city centre are 18°04'47' N latitude and 15°58'30' W longitude (STP, 2016).

Nouakchott is expanding (Photo 4-23) and has evolved considerably since it was founded over 50 years ago. It is the main administrative and political centre of the country and possesses all the infrastructure required of a modern capital. Compared to the country's economic hub of Nouadhibou, which lies in a free trade zone, the economic weight of Nouakchott is growing very rapidly. This phenomenon is especially explained by the number of international corporations and organizations that have established their head offices there, as well as the opening of the Trans-Sahara Highway. In fact, the capital is a central hub where transport infrastructures converge (new international airport, port, major highways) and connect the city to national and international networks (Chopin, 2009). The city's formal economy is essentially characterized by service and commercial activities, while the continued proliferation of a multitude of informal economic activities represents the basis of the means of existence and subsistence for many of the city's inhabitants.

Photo 4-23. View of Nouakchott.

N'Diago

The coastal village of N'Diago lies 300 km south of Nouakchott, very close to the Senegalese border. N'Diago is the capital of the *commune* of the same name and the largest human settlement and fishing village on the coast south of Nouakchott.

According to local sources, the creation of N'Diago goes back over 150 years and is credited to a migrant farmer by the name of Abou Fall, whose origins are unknown.

The village is located on the right bank of the Senegal River, on the northern extension of the Langue de Barbarie, less than 10 km from Goxxu Mbacc, a neighborhood of Saint-Louis, Senegal. The village's location between the river and the sea provides it with a particularly favorable geographic position for fishing (Photo 4-24). Moreover, this geographic position also explains the simplicity and importance of river and ground traffic of N'Diago residents commuting to and from the Senegalese city of Saint-Louis.

(© Kosmos 2016)

Photo 4-24. Aerial View of the Village of N'Diago.

N'Diago is accessible from Mauritania's interior by land via 50 km of paved national highway to Keur Macene, then by an unpaved road running along the coastal dunes of Ghahra.

The village is divided into five neighborhoods that shape the main socio-economic functions of fishing, trade and places of worship. These neighborhoods are named as follows: Dekeube, Garaw, Takkegue, Galou, and Yallayama.

N'Diago is often referred to as the village closest to the Mauritania-Senegal border. However, in reality, the villages of Mboyo 2 and Lorma are closer to the border. These two villages, located on the outskirts of the village of N'Diago, are part of N'Diago *commune*. The eponymy of the *commune* and the village of N'Diago can explain the commonly accepted designation of the village of N'Diago as being the southernmost human settlement on Mauritania's border.

Other Villages in Core Study Area

The main characteristics of the three other villages in the area in terms of land use are the following (Ecodev, 2017b in Appendix E-3):

- **Legweichich** (Photo 4-25), is located at PK 93, between Nouakchott and N'Diago. This fishing village was officially created in 2003 after the MPEMa and Spanish Cooperation developed an artisanal fishing service complex, including accommodations for fishermen and fish marketing halls. Legweichich currently forms a fishing village with 65 dwellings, a primary school (one classroom for multiple grades), a mosque and four shops. A maritime surveillance unit is also based at this site, as are fishing camps (of which there are currently five). The site is accessible by road (17 km of unpaved road from Tiguent on the national highway).

Photo 4-25. View of the Village of Legweichich.

- **Mboyo 2** is an extremely old fishing village. It is located on the Langue de Barbarie, 7 km south of N'Diago. In addition to being accessible by river, Mboyo 2 can be reached by land via an unpaved road connecting N'Diago to Senegal. Mauritania's border post is located at the southern edge of Mboyo 2. Like N'Diago, the geographic location of Mboyo 2 on the Langue de Barbarie provides it with a particularly suitable position for fishing activities and river transport (Photo 4-26).

Photo 4-26. Aerial View of Mboyo 2.

- **Lorma** is a small village, sometimes also called Mboyo Peulh, whose inhabitants are mainly engaged in animal farming (Photo 4-27). It is located 1 km south of Mboyo 2, after the border post of the Gendarmerie and the police. In addition to being accessible by river, the village can also be reached by land from Mboyo 2. This long-established (100 years) village is occupied year round, though some residents regularly leave to graze their livestock up to more than 50 km from the village.

Photo 4-27. Village of Lorma.

Fishing Camps in the Core Study Area

The core study area contains four fishing camps: PK 28, PK 65, PK 144, and Mouly. The term "camp" covers both localities – e.g. the four camps in the core study area – and the smaller units established at these sites, or at N'Diago and Legweichich, which host a number of temporarily settled fishermen.

The main characteristics of the four fishing camps (localities) in terms of land use are the following (Ecodev, 2017b in Appendix E-3):

- Located at Kilometer no. 28, PK 28, sometimes called Vernana, has existed since 1989, year of the events between Mauritania and Senegal that resulted in a massive and reciprocal return of migrants from each of the two neighboring countries to the other country. At the time, authorities decided to make PK 28 the headquarters of an integration program for young returnees who wanted to take up artisanal fishing. The site's organization revolves around an artisanal fishing training centre, which is part of the Qualification and Training Centre for Fishing Trades (*Centre de Qualification et de Formation sur les Métiers de la Pêche* [CQFMP]). This training centre represents the only administrative presence in the locality. Residents are mainly fishermen, fishmongers, processors and shopkeepers. There are also 10 small fish meal and fish oil production units[28] (Photo 4-28**).** The site is accessible by land (12 km of unpaved road from the national highway).

Photo 4-28. Fish Meal Production Units at PK 28.

- Located at Kilometer Point 65, PK 65 is an official landing site for artisanal fishing created in 1990. A Coast Guard unit is present. The site traditionally hosted camps of Senegalese fishermen, but it is currently nearly deserted. PK 65 is accessible by land (6 km of unpaved road from the national highway).

[28] These units have a fishery product processing capacity of 100-150 tonnes/day/unit. During the field work in April 2017, these units could not be visited. According to the individuals consulted, activity here has declined. No information is available as to the size of these companies, their production or their workforce, nor where the latter is from or where it resides.

- Located at Kilometer no. 144, PK 144 is also a site that was designed by MPEMa in 1994 for the settlement of fishermen and their socio-economic advancement. The infrastructures built are now used for the offices and staff accommodations of an artisanal fishing training centre (CQFMP) as well as for a Coast Guard base. While this camp had 571 fishermen in 2016 (Wagne and Braham, 2016), the PK 144 site is now hardly inhabited at all, with just a few fishermen tallied in April 2017. The land along the unpaved road that runs from PK 144 to the national highway (27 km away) is occupied by more or less rudimentary structures (shanties) that are used to accommodate families who arrive from Nouakchott to vacation during the rainy season.

- Mouly is a small camp between PK 144 and N'Diago, and is accessible via 35 of unpaved road from the national highway. It consists of four scattered wooden shanties of variable size. These structures are used as accommodation for fishermen and other camp employees. Currently, activity here has dropped off considerably.

Other Human Uses of the Coast

In 2016, construction of a multi-purpose port was initiated 31 km north of N'Diago. Since the first stone was laid in December 2016, the project seems to be at a standstill. Very little information is available with regard to this project.

Photo 4-29 illustrates the work progress as of December 2016. In May 2017, no progress in the project could be observed at the site.

(© Kosmos 2016)

Photo 4-29. Multi-Purpose Port Project North of N'Diago.

4.6.2.2 Extended Study Area

In addition to the localities of the core study area, the extended area encompasses the Diawling National Park and its outlying areas located in the Mauritanian lower delta of the Senegal River. The territory is characterized by a series of permanent and temporary watercourses, a large number of islands, the Diama dam, a series of dikes and hydraulic structures, pools, conservation zones, coastal and inland dunes as well as villages (Photo 4-30).

(© Kosmos 2016)

Photo 4-30. View of Diawling National Park.

The activities of the Diawling National Park residents are largely based on the use of natural resources (see Appendix H). In terms of natural resource uses in and around the park's water bodies, grazing and fishing are two important activities. Appendix F-1 presents a map of the Mauritanian lower delta as well as additional information on land use in the Diawling National Park.

The extended study area also includes Nouadhibou. Port city with a long, narrow layout, Nouadhibou is located on the peninsula of Cape Blanc on the northernmost stretch of Mauritania's coast. The city does not occupy the entire peninsula. The latter is shared along its length between Mauritania and Western Sahara.

Four major types of land occupation are prevalent in the city: the urban environment, port facilities, industrial zones, and natural areas. The industrial zones are located inland of or in proximity to the port facilities. One of these zones is located at the southern edge of the city. It encompasses important infrastructures of the SNIM, whose railway terminus is located here. This area adjoins the ore port and the oil port, both of which are located in Lévrier Bay (see Appendix H).

4.6.3 Population

4.6.3.1 Demography

Mauritania conducted its fourth general population and housing census (RGPH) in April 2013 (ONS, 2015). Carried out by the National Statistics Office (*Office National de la Statistique* [ONS]), this census is one of the most recent sources of official population data. These data represent a rich source of information on important localities such as Nouakchott as well as the urban and rural communities of the country. However, the RGPH provides little disaggregated information specific to the small villages and camps within the core study area. To complete the RGPH population data, other sources were used such as the results of the field work conducted in April 2017 (Ecodev, 2017b in Appendix E-3).

With approximately 958,399 inhabitants, Nouakchott is by far the largest metropolis in Mauritania and its residents represent 27% of the national population, which is estimated at 3,537,368 inhabitants. In terms of gender and age, Nouakchott's population is broken down as follows:

- 494,885 men and 463,514 women, i.e., 106 men for every 100 women; and
- 38.5% of the population is 14 and under, 57% is aged between 15 and 59 (inclusive) and 4.4% is 60 and over.

There are a total of 160,842 households in Nouakchott, with an average of 6.0 people/household, while the national average is 6.2 (ONS Mauritania, 2014).

The villages and camps of the core study area are very sparsely populated. The *wilaya* of Trarza, which includes the core study area's human settlements south of Nouakchott, has only 272,773 inhabitants (Ecodev, 2017b), or 7.4% of the national population (ONS, 2015). The three *moughataas* bordering the sea have a total of 81,898 inhabitants, broken down as follows: 30,440 inhabitants in the *moughataa* of Mederdra, 27,760 inhabitants in the *moughataa* of Keur Macene and 23,698 inhabitants in the *moughataa* of Ouad-Naga (Ecodev, 2017b). However, the vast majority of residents of these *moughataas* live in inland areas.

The total population of the villages and camps located on the coast south of Nouakchott is estimated at 2,910 persons. The average household size in the *wilaya* of Trarza being 5.5, the total number of households in these villages and camps is estimated at 529. However, the number of residents, notably in the camps, can increase during the peak fishing season. At certain times of the year, the total number of inhabitants on the coast can therefore exceed 2,910.

Table 4-32 provides detailed information on the estimated number of residents in each of the coastal villages and camps. In 2013, the largest village, N'Diago, had 1,240 residents (6,137 in the *commune* as a whole), i.e., approximately 225 households. The smallest village, Lorma, has just 100 inhabitants, i.e. fewer than 20 households. Available data indicate that the number of inhabitants in the fishing camps varies between 40 and 600.

In terms of age and gender structures, available ONS data do not provide figures broken down by village or camp. However, it is observed that the fishing camps are mostly occupied by men (Ecodev, 2017b in Appendix E-3). Moreover, part of N'Diago's male population resides in Nouadhibou and Nouakchott, which are concentration points for artisanal fishing.

In the extended study area, the villages of the Diawling National Park and its vicinity had a total estimated population of 13,200 inhabitants in 2014 (DNP, 2016). This represents 2,400 households. Keur Macene, the largest of these villages, had 2,049 inhabitants in 2013 while the *commune*, which comprises 13 localities, had a total of 4,751 inhabitants (ONS Mauritania, 2014).

The population of the Diawling National Park villages varies with the seasons. The market gardening activities practiced on islands in the river delta (e.g. island of Mboyo) and lands of the coastal dune (e.g. N'Diago) are partially dependent on seasonal migrant farm laborers, mainly from Senegal. These workers are locally referred to as "sourga".

Besides the Diawling National Park, the extended study area also encompasses Nouadhibou. In terms of demographics, Nouadhibou is the second most important city in Mauritania after Nouakchott. Its population was 121,122 in 2013 (ONS, 2015).

The data presented in Table 4-32 provide an estimate of the population in the core (961,309 inhabitants) and extended (1,093,861 inhabitants) study areas. Notably, it is also observed that more than 87.6% of the population of the extended study area and 99.7% of that of the core study area is concentrated in Nouakchott.

Table 4-32. Population Estimates in Core and Extended Study Areas – Mauritania Portion.

City, Village, Camp	Population
Core study area	
Nouakchott	958,399
Villages and camps south of Nouakchott	
PK 28	400
PK 65	40
Legweichich	600
PK 144	100
Mouly	30
N'Diago	1,240
Mboyo 2	400
Lorma	100
Sub-total – villages and camps	2,910
SUB-TOTAL – Core study area	961,309
Extended study area	
Villages of the Diawling National Park and vicinity (details in Appendix H)*	11,460
Nouadhibou	121,122
TOTAL – Extended study area	1,093,891

*The Diawling National Park has 13,200 inhabitants including those of N'Diago, Mboyo 2 and Lorma, whose numbers have been subtracted here to avoid double counting.

Sources: ONS, 2014, DNP, 2016 and Ecodev, 2017b

4.6.3.2 Migration

In-country migratory movements are common in Mauritania. The ONS defines a migrant as any sedentary person who changed residence during the census reference period. The general census indicates that 20.2% of Mauritania's sedentary population has a migrant status.

Nouakchott, being the capital city, is a significant migration destination due to its political and economic status and its geostrategic position. Rural exodus was a massive phenomenon in the late 60s, 70s and 80s, mostly due to drought, desertification and food crises. Nowadays, the inland migration toward the coastal cities, notably Nouakchott, is generally a consequence of high unemployment and lack of job opportunities in rural areas. During the 2013 General Census, 46.9% of Nouakchott's residents were classified as migrants, born outside of the city (ONS, 2015).

Apart from the in-country migration, part of the migration movements includes people from West African countries, especially Senegal and Mali, immigrating to Mauritania, looking for temporary or permanent economic opportunities.

In the coastal villages and fishing camps south of Nouakchott, migration consisted until early 2017 mostly of Senegalese fishermen that settled temporarily during the high fishing season. However, the situation is different now. Mauritania is enforcing a national law preventing non-Mauritanians from artisanal fisheries in Mauritanian waters. Therefore, migrant foreign fishermen are now absent from the fishing encampments. The whole demography of these encampments is currently undergoing important changes.

4.6.4 Education

4.6.4.1 Literacy

Data from RGPH 2013 show that Mauritania's illiteracy rate is currently 36.3%[29]. This is a significant improvement over the rates of 1988 and 2000, which were 61.4% and 46.9%, respectively.

RGPH 2013 figures also show that the illiteracy rate varies by place of residence and gender. In urban areas, only one person in five is illiterate (21.2%), while in rural-sedentary regions, over half the population is illiterate (51.6%). Irrespective of place of residence, women are most affected by illiteracy. In fact, 41.0% of Mauritanian women are illiterate, compared to 31.3% of men.

RGPH 2013 also shows that the national average illiteracy rate masks disparities from one *wilaya* to another. In the study area, the *wilaya* of Nouakchott shows an illiteracy rate of 17.1% (20.7% for women and 13.8% for men) while the *wilaya* of Trarza has a rate of 24.6% (27.0% for women and 21.8% for men). By inference, the literacy rate in Nouakchott can be established at 82.9% (79.3% for women and 86.2% for men) and the literacy rate in the *wilaya* of Trarza at 75.4% (73.0% for women and 78.2% for men).

Based on the rate of the *wilaya* of Trarza, it can be estimated that the villages and camps of the core study area comprise 716 illiterate individuals out of a total population of 2,910, while the extended study area would have 269,097 illiterate individuals out of a total population of 1,093,891.

In the *wilaya* of Dakhlet-Nouadhibou, the illiteracy rate is 13.0% (ONS, 2015), i.e., the literacy rate is 87.0%.

4.6.4.2 School Enrolment and Education Level

Although progress was made between 2000 and 2013, notably thanks to the adoption of Law N° 054-2001, which made "fundamental" education[30] compulsory for all Mauritanian children between the ages of 6 and 14, Mauritania is still far from achieving universal schooling for its population. RGPH 2013 data reveal that 31.1% of the population aged 6 and over declared having no schooling. Of those that did have an education, 64.7% reached primary school, a mere 7.7% reached middle school, and 5.2% high school. Technical/vocational education and graduate education show very low figures: 2.5% and 0.3%, respectively[31].

In terms of school enrolment, differences are observed in terms of gender (in favor of men), place of residence and *wilaya*. Disparities in education levels between *wilayas* concern all levels of schooling. RGPH 2013 shows that the *wilayas* of Nouakchott and Trarza have gross enrolment ratios of 96.7% and 79.7%, respectively, which are above the national average (72.4%).

In the villages of the core study area, there are three primary schools: one in N'Diago, one in Legweichich and one in Mboyo 2. However, only the N'Diago school offers a complete course of primary education with 6 grades. With regard to secondary education, there is a middle school in N'Diago, which is attended by students of that locality and from throughout the *commune*.

[29] Persons aged 10 and over who lack the ability to read and write in at least one language.
[30] "Fundamental" education corresponds to primary school.
[31] The rest of the educated population (about 20%) has only benefited from a Koranic instruction.

4.6.4.3 Educational Infrastructure

Nouakchott has an educational infrastructure and services of all levels, from elementary to university.

The coastal settlements and fishing camps south of Nouakchott have limited educational infrastructure. Legweichich, N'Diago and Mboyo 2 each have one elementary school. Additionally, N'Diago has a middle school. More details on these schools are provided in Appendix E-3.

In the fishing camps, existing education is vocational only and is offered to aspiring artisanal fishermen. Two fishing training centres exist in the camps at PK 28 and PK 144.

4.6.5 Economic Conditions, Employment and Means of Subsistence

4.6.5.1 Labor Force and Employment

In Mauritania, only 13.6% of jobs are in the formal sector, compared to 86.4% in the informal sector. The distribution of jobs by sector of activity indicates that 37.3% of jobs are in the agriculture, animal breeding and fishing sector, while 38.9% are in trade. The remaining jobs are split among different sectors including telecommunications and services (13.8%), education, health care and administration (7.2%) and, lastly, the extractive industry (2.8%) (MEFPNT, 2014).

While at the national level, there are about 1,913,368 people of working age (14 to 64 years old), in Nouakchott, 60.7% of the population, i.e. 582,689 people, is of working age (ONS, 2015). The Nouakchott population in this working age class is young, with over 63% of people aged between 14 and 34. The labor force participation rate in Nouakchott is 51.4%. This rate refers to the proportion of people within the working-age population who are available to work. Nouakchott's unemployment rate is 24.9%. The unemployment rate refers to the proportion of individuals of working age who are available to work but are not employed (ONS, 2015). The informal economy occupies approximately 80% of the city's workforce (MEFPNT, 2014).

There are no official employment data in the fishing villages and camps in the core study area or the extended study area. However, the field work conducted in April 2017 revealed that existing jobs are especially in the fishing sector. Unemployment affects a very significant portion of the labor force, which drives younger generations to migrate to urban centres (Ecodev, 2017b).

4.6.5.2 Primary Economic Activities and Means of Subsistence of Communities

Nouakchott

The economy of Nouakchott is diverse. The city is home to a number of governmental buildings, services and activities. A high concentration of economic activities (service, public sector, transport, finance) is found in the older central districts of Ksar, Sebkha, El Mina, and Capitale (Ecodev, 2017b).

The city has one port: the Port Autonome de Nouakchott, also called Port de l'Amitié (PANPA) Photo 4-31). In 2013, PANPA handled 70% of the country's exports and 40% of its imports (Ateliers, 2014). Within the port, there are a number of companies and services (insurance, banks, security/transit/consignment services, etc.). There are 30 such public, parapublic and private enterprises, approximately 10 of which are active. PANPA directly employs 300 people. Furthermore, it is estimated that port activities generate an additional 4,500 jobs (essentially dockers). In addition to the aforementioned jobs, there is a wide array of small informal trades (food retailers, shops, eateries [*gargotes*], etc.) that employ a very significant number of Mauritanians who have come from various parts of the country to settle in Nouakchott.

Photo 4-31. View of the Port of Nouakchott.

Fishing boats are not permitted in PANPA. Industrial fishing boats operating in proximity to Nouakchott use the port of Nouadhibou, whereas artisanal fishing boats land on the beach in Nouakchott (PANPA, 2016). Artisanal fishing, which plays an important role in the local, national and cross-border economies, represents a significant source of revenues (see Section 4.6.6.4).

The Nouakchott economy is also based on trading that takes place mainly in the markets. There are 57 markets, of which 11 operate at a national scale and approximately 40 at a local scale (OSPUN, 2013).

The service sector is also important for the Nouakchott economy, particularly telecommunications and to a lesser extent, banking. Although Nouakchott is not an industrial city, it does have a few industries that generate economic activity, especially in two fields: agribusiness and the construction / public work sector.

While the majority of Mauritania's agricultural production is along the Senegal River, market gardening is practiced in Nouakchott. In 2014, there were seven market gardens in the city (Ateliers, 2014).

Lastly, the majority of Nouakchott residents make their living in the informal economy, which covers a number of activities such as the food and clothing trade, garages, domestic work, etc. Most businesses in the informal sector are family owned, often small in size, highly labor-intensive and use a rudimentary or intermediate technology. The female workforce is concentrated in agricultural activities, handicrafts, trade and dyeing (Ecodev, 2017b).

Costal Fishing Communities South of Nouakchott

In the coastal villages and camps south of Nouakchott, the economy is almost exclusively linked to the sea. A few other activities are also practiced such as small-scale trade, animal farming and market gardening. This latter activity is mainly practiced by women in the framework of cooperatives, but is faced with structural issues such as water availability.

The economic activities of residents in the village of N'Diago are mainly related to artisanal fishing. Some men practice the latter in N'Diago (Photo 4-32), but the majority operate off the coast of Nouadhibou or Nouakchott where the fishery resources are much more plentiful. In N'Diago, several dozen women are involved in the fresh fish trade and sell their products in the border city of Saint-Louis, whereas other women are engaged in fish processing. This artisanal processing uses very rudimentary infrastructures (see Photo 4-33). Fostered by the availability of water in the village, market gardening represents another emerging activity in N'Diago.

Photo 4-32. Fishermen in N'Diago.

Photo 4-33. Fish Processing Facility in N'Diago.

Extended Study Area

In the extended study area, the economy of the Diawling National Park's inland villages is partially based on fishing in branches of the river and other water bodies within the park. In addition to river-based fishing, residents of inland villages are engaged in trade, animal farming (small ruminants and camels, as well as a few cattle) and market gardening. Along the coastal dune from N'Diago to Dar es Salam, women practice mat making, for which they collect Sporobolus grasses. The gathering sites are essentially located in the Bell and Diawling-Tichilitt Basins. They sometimes travel great distances to collect the material needed for their activity. Moreover, residents of some villages harvest shrimp in N'Ter Lake; this is an irregular but highly lucrative activity. This practice mainly concerns six villages: Ziré Taghrédient, Ziré Sbeikha, Sbeikha Bariel/Ziré Angor, Dar-es-Salam/Meimakh, Birette, and Bouhajra.

In Nouadhibou, the main sectors of activity are mines, fishing (industrial, coastal and artisanal), trade and services. In the *wilaya* of Dakhlet-Nouadhibou, major disparities in employment rates are observed between men and women (61.01% for men versus 11.47% for women).

4.6.6 Fisheries

This section provides socio-economic information on fishing that summarizes and completes the information presented in Section 4.5.4.2 and in Appendices E-1 and E-3. In this section, reference to fish generally needs to be understood in the broader sense of fishery resources, including for instance crustacean and cephalopod species.

4.6.6.1 Overview of Fishery Sector

The EEZ of Mauritania stretches along approximately 720 km of coastline and occupies a surface area of 234,000 km^2.

Fishing is one of the pillars of the national economy. Fishery resources are harvested by an industrial fleet (mainly foreign) as well as an artisanal and coastal fleet (mainly domestic). Fishing provides 29% of the country's budgetary revenues (Ateliers, 2014) and, according to various sources, the sector employs between 20,166 (ONS, 2015a) and 55,000 people (MPEMa, 2015). It is estimated that within the fishing sector, artisanal fishing represents 90% of jobs and 10% of catches, whereas industrial fishing (also called *hauturière*) generates 90% of catches while providing just 10% of the jobs[32] (IMROP, 2013; Ecodev, 2017a).

The status of the artisanal and coastal fleet is distinguished from that of the industrial fleet by the Decree on the general regulation implementing Law n°17-2015 of July 29, 2015 on the Fishing Code. This decree stipulates the following (Ecodev, 2017a in Appendix E-1):

- Maritime artisanal fishing is considered to be any fishing practiced on foot or using craft with a length overall (LOA) of less than or equal to 14 m, is non-motorized or has a motor rated less than or equal to 40 hp, and operates with passive fishing gear with the exception of purse seines.
- Maritime coastal fishing is considered to be any fishing practiced with a craft (i) less than or equal to 26 m long for demersal fish species and (ii) strictly less than 60 m long for pelagic species. They operate with passive fishing gear or non-passive gear except for bottom trawling and dredging.
- Maritime industrial fishing is considered to be any commercial fishing practiced with ships having characteristics other than those defined above.

[32] Certain sources provide different data and indicate that nearly one-third of catches are landed by artisanal fishing (Ecodev, 2017a).

An exclusive coastal zone is reserved for artisanal fishing. This exclusive zone, based notably on bathymetry, extends less than 6 nautical miles from the coast in the southern portion of the EEZ of Mauritania and less than 9 nautical miles elsewhere on the coast (see map in Appendix E-1).[33]

In scientific campaigns and for the purposes of IMROP statistics, the EEZ of Mauritania is divided into three sectors: North Zone, Central Zone and South Zone. For artisanal fishing statistics, IMROP distinguishes five sectors: North Zone, Banc d'Arguin National Park (PNBA) Zone, Central Zone, Nouakchott Zone and South Zone. In both these partitions, the South Zone begins approximately 25 km south of Nouakchott (near the camp at PK 28) and extends to Mauritania's border with Senegal. The Central Zone lies north of Nouakchott. The infrastructures planned as part of the GTA project are located in the South Zone. The artisanal fishing statistics relevant for characterizing the project's core study area are essentially those of the Nouakchott Zone and the South Zone.

In terms of spatial distribution, fisheries are found throughout the country's offshore waters, though they are heavily concentrated in the North Zone. This is notably attributable to:

- The high productivity of this area (width of continental shelf, permanent upwelling);
- The existence of receiving infrastructures with the presence of the only true fishing ports – both artisanal (including coastal) and industrial – in Nouadhibou;
- The relative proximity of Europe and the Canary Islands in particular; and
- The relatively benign maritime conditions in this zone compared to the South Zone, where the presence of a dangerous “bar” and large waves represents a constraint for artisanal fishing.

More than 2/3 of Mauritania's total production volume is harvested in EEZ of Mauritania's North Zone. The importance of the North Zone is particularly pronounced with regard to artisanal fishing. On average, from 2012 to 2015, the North Zone generated 76% of artisanal fishing catches in the country (Ecodev, 2017a).

4.6.6.2 Industrial Fishing

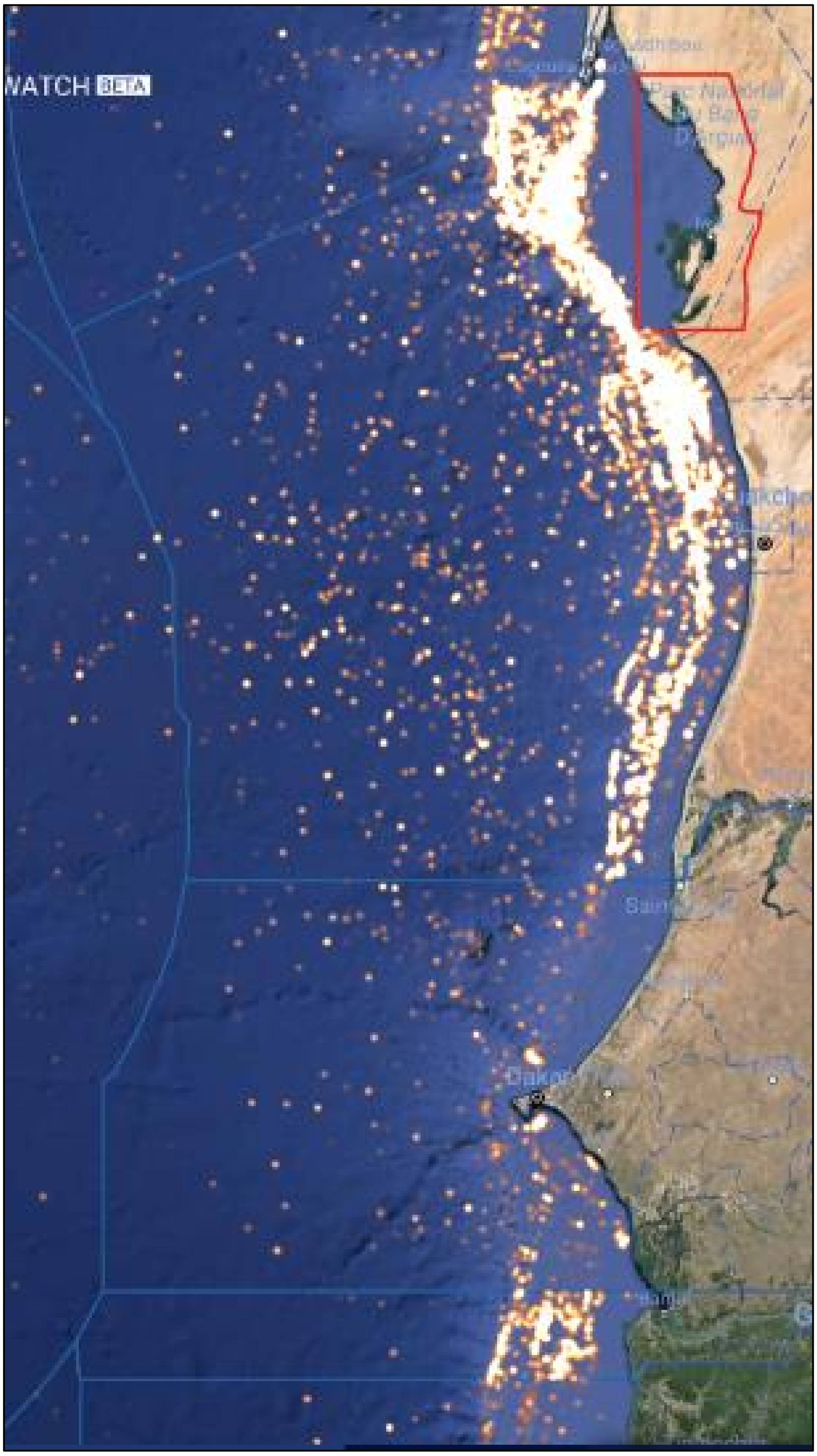
Industrial fishing, also referred to as *hauturière* fishing, comprises the demersal fishery (which targets bottom-dwelling species) and the pelagic fishery (which targets species inhabiting the water column).

It is dominated by foreign boats, which represent approximately 2/3 of the roughly 300 industrial fishing units[34]. International fleets are entitled access to Mauritanian resources under diverse fishing agreements, notably with the EU, Russia (small pelagics), Japan (tuna) and Senegal (tuna and small pelagics). The memorandum of understanding with the EU (the most important of the fishing agreements) was implemented in 2015 for a four-year period and allows the EU fleet to harvest a total of up to 281,500 tonnes a year of shrimp, demersal fish, tuna and small pelagic fish in Mauritanian waters.

Despite the fact that the industrial fleet covers the entire EEZ, industrial fishing is practiced more in the country's North Zone. It is also important in the Central Zone and diminishes in the southern part of the country. Observations by Global Fishing Watch provide indications of the spatial distribution of industrial fishing fleets (Figure 4-28) in Mauritania as well as south of the country's border. The importance of Mauritania's North Zone at the regional level can be clearly seen.

[33] Permits issued for artisanal, coastal or industrial fishing are not associated with specific geographical locations, except for the coastal zone reserved for artisanal fishing.

[34] The number of industrial fishing units varies according to the fishing agreements. The number of domestic units has remained largely stable at around 100 units, whereas for instance that of foreign units went from approximately 200 to 75 during negotiations with the EU between 2012 and 2015.



(Source: Global Fishing Watch, cited by Ecodev, 2017a)

Figure 4-28. Concentrations of Industrial Fishing Boats in the Mauritania/Senegal Region, 2012-2017.

4.6.6.3 Coastal Fishing

Coastal fishing is found exclusively in Nouadhibou; it is not practiced in the GTA project infrastructure area. This is explained notably by the absence of port infrastructures anywhere except for Nouadhibou where coastal fishing boats can dock. The coastal fleet is marginal. In the mid-2000s, the latter numbered close to 100 boats; currently, there are approximately 150 boats. Due to its dilapidated state, this fleet is characterized by frequent downtime and permanent decommissionings (see Ecodev 2017a in Appendix E-1).

4.6.6.4 Artisanal Fishing

Artisanal fishing is practiced using boats called pirogues, which are mainly made of wood, but also fiber glass (also referred to as plastic) or aluminum. Pirogues are equipped with outboard motors generally rated 15 hp[35] (IMROP, 2013).

The Mauritanian pirogue fleet rose from 530 units in 1982 to 6,244 units in 2016. This increase in the number of pirogues is coupled with an increase in their harvest capacities, notably thanks to enhanced motorization and navigation techniques.

Despite being more concentrated off the coasts of Nouadhibou and Nouakchott, pirogues operate along the entire Mauritanian coast and, outside of Banc d'Arguin, no spatial constraints have been imposed on artisanal fishing.

In the Mauritanian portion of the ESIA study area, Mauritanian artisanal fishermen can fish wherever they want, regardless of the village or the city they live in. There are no community-based customary claims to stretches of shoreline or areas immediately adjacent to coastal villages. There are no traditional systems that define ownership, access to and use of fishing resources or fishing grounds in the maritime waters. Georeferenced data on artisanal fishing grounds in Mauritania do not exist. During the field work conducted in April 2017, N'Diago fishermen indicated that they generally fish approximately 3 km – and at most 7 to 9 km – from the coast (Ecodev, 2017b). The distance that fishing is practiced with respect to the coast is a function of bathymetry. In fact, artisanal fishing techniques mean that it is practiced at water depths generally varying between less than 20 m and 200 m at the most. Moreover, few fishermen operate in proximity to the Senegalese border. Indeed, the waters there are less rich than they are farther north. Furthermore, crossing the bar is dangerous. In April 2017, fishermen in N'Diago indicated that they travel upwards of 35 km, and even sometimes up to 45-60 km, north of N'Diago to practice their activity. While several fishermen originally from N'Diago live in Nouadhibou and Nouakchott and operate from there, those living in N'Diago perform daily sea trips and they do not fish very far away from where they live. The landings are made where the fishermen live and have their pirogues. Therefore, it is possible to link the landings in a locality to its pirogues, and to estimate the tonnage or monetary value of catches per pirogue.

Annual catches generated by artisanal fishing and landed in Mauritania between 2012 and 2015 average approximately 300,000 tonnes, and the South Zone's contribution to this tonnage, i.e., 6,161 tonnes, represents just 2.1% of catches (Ecodev, 2017a). Artisanal fishing yield in the South Zone (16 tonnes/pirogue/year) is well below that of the Nouakchott Zone (46 tonnes/pirogue/year) and much less than that of the North Zone (65 tonnes/pirogue/year). Additionally, with 393 units, the pirogue fleet in the South Zone represents a mere 6.3% of the national pirogue fleet (Estimate by Golder using IMROP data cited by Ecodev, 2017a).

Table 4-33 provides production data for localities in the core study area for the period 2012-2015[36]. It can be seen that in this zone, Nouakchott receives 89.7% of artisanal fishing landings, N'Diago receives 4.0%, while other camps and villages make only a very marginal contribution to production. With an average production estimated at 2,391 tonnes/year for the period 2012-2015, the village of N'Diago contributes just 0.8% of the country's total artisanal production.

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[35] Some pirogues can have motors rated up to a maximum of 40 hp. Nearly all pirogues in Mauritania are motorized, except those in Banc d'Arguin National Park (PNBA), where motorized boats are prohibited.

[36] These data do not include Mouly (the smallest camp in the zone) or Mboyo 2 and Lorma, which are potentially included in the data of N'Diago due to their geographic proximity.

Table 4-33. Average Annual Fisheries Production in the Core Study Area for the Period 2012-2015 – Mauritania Portion.

Landing site	Production (tonnes)	Percentage of Tonnage
Nouakchott	53,861	89.7%
PK 28	1,481	2.5%
PK 65	515	0.9%
PK 93	1,429	2.4%
PK 144	345	0.6%
N'Diago	2,391	4.0%
Total	60,022	100.0%

Source: IMROP, cited by Ecodev, 2017a in Table 13 of Appendix E-1

Table 4-34 presents artisanal fishing production data for each of the fishing zones in the EEZ of Mauritania. Based on these data, the following observations can be made:

- The volume of fishery products harvested is 121 kg per trip to sea in the South Zone, compared to 323 kg in the Nouakchott Zone and 474 kg in the North Zone.
- The value of catches and/or the prices paid to fishermen are two-and-a-half times greater in the North Zone (768 ouguiya (MRO) per kg) than in the South Zone (299 MRO/kg).

Table 4-34. Productivity Indicators for Artisanal Fishing per Zone – Mauritania Portion[37].

	North	PNBA*	Centre	Nouakchott	South
Production/trip (kg)	474	163	71	323	121
Percentage of pirogue fleet at national level	49	16	4	24	6
Percentage of catches at national level	69	2	3	23	2
Price paid at 1st sale (MRO/kg)	768	136	401	536	299

* PNBA: Parc National du Banc d'Arguin

Source: IMROP, cited by Ecodev, 2017a in Table 15 of Appendix E-1

These data can be used to estimate the average monetary value of the annual production per zone and per pirogue for the period 2012-2015 (Table 4-35). It can be observed that:

- The average monetary value of annual production for all pirogues in the South Zone is MRO 1,842,139,000 (i.e. US$ 5,130,572[38]).
- The average monetary value of annual production per pirogue in the South Zone is MRO 4,687,377 (i.e., US$13,055).

[37] It is important to note that these data on landing prices constitute a global estimate that gives a general idea. However they do not reflect the ranges and variations of prices related to various factors such as the type of fish resources (for instance demersal species or octopus landings can be 25 times more expensive than sardinella landings), the fishing area, and the period of time (high season and low season). The Mauritanian Government and IMROP are continuously trying to solve this issue of obtaining precise data on landing prices. To this end, an Economic Observatory has recently been created by the MPEMa with financial support from the World Bank (Ecodev, 2017d).

[38] As of July 16, 2017, US$ 1 = MRO 359.05

- There is a very large variation in the average monetary value of the annual production per pirogue in the different zones. In this regard, the monetary value of the annual production per pirogue is over 50 million MRO/pirogue/year in the North Zone, while it is less than 5 million MRO/pirogue/year in the South Zone. These variations are notably attributable to the significant differences in the annual yield per pirogue in the different zones and to the significant variations in the value of catches and/or the prices paid to fishermen per kg in the different zones.

Table 4-35. Estimated Value of Average Annual Fisheries Production per Zone and per Pirogue for the Period 2012-2015 – Mauritania Portion.

Zone	Average Annual Production (tonnes)	Price per Tonne (MRO)	Monetary Value of Zone's Annual Production (MRO)	Number of Pirogues	Average Monetary Value of Annual Production per Pirogue (MRO)*
North	229,125	768,000	175,968,000,000	3,517	50,033,551
PNBA	3,233	136,000	439,688,000	221	1,989,538
Centre	7,454	401,000	2,989,054,000	951	3,143,064
Nouakchott	53,861	536,000	28,869,496,000	1,162	24,844,661
South	6,161	299,000	1,842,139,000	393	4,687,377
Total	299,834		210,108,377,000	6,244	33,649,644

* The monetary value changes over time. This column provides a mean over the 2012-2015 period. Unpublished data of April 2017 show lower values: 32 792 000 MRO for the North zone, 330 000 MRO for PNBA, 1 300 000 MRO for the Centre Zone, 13 430 000 MRO for Nouakchott, 1 300 000 MRO for the South Zone, for a total of 49 152 000 MRO. (Ecodev, 2017d)

(Source: Estimate by Golder using IMROP data cited by Ecodev in Tables 11 and 15 of Appendix E-1.)

The IMROP data can also be used to estimate the average value of production of the villages and camps in the core study area. In the absence of annual yield data per pirogue broken down for each locality, the estimate is made from the yield in the South Zone (Table 4-36). According to this estimate, the average annual value of catches in the core study area between 2012 and 2015 was more than MRO 30,711,635,000 (i.e. US$ 85,535,817). Nouakchott accounted for 94% of this monetary value. As indicated above, the total average annual value of catches in the villages and camps of the South Zone was MRO 1,842,139,000 (i.e. US$ 5,130,572).

Table 4-36. Estimated Value of Catches for Localities in Core Study Area for Period 2012-2015 – Mauritania Portion.

Locality	Average Annual Production (tonnes)	Price (MRO/tonne)	Estimated Average Price of Annual Production (MRO)	Percentage of Total Monetary Value
Nouakchott	53,861	536,000	28,869,496,000	94.0%
PK 28	1,481	299,000	442,819,000	1.4%
PK 65	515	299,000	153,985,000	0.5%
PK 93	1,429	299,000	427,271,000	1.4%
PK 144	345	299,000	103,155,000	0.3%
N'Diago	2,391	299,000	714,909,000	2.3%
Total	60,022		30,711,635,000	100.0%

Source: Estimate by Golder using IMROP data cited by Ecodev in Tables 12 and 13 of Appendix E-1.

Until 2017, Senegalese fishermen constituted an important part of the Mauritanian artisanal workforce. In April 2016, the South Zone had 393 pirogues and 1,358 fishermen, 67% of whom were Senegalese (IMROP, 2016, cited by Ecodev, 2017b. This situation recently changed markedly, however. Based on the field work conducted in April 2017, it is estimated that, between 2016 and 2017, the number of pirogues declined from 393 to 272 and the number of fishermen fell from 1,358 to 637 (Table 4-37). Given this decline in pirogues and fishermen, it is likely that the results of artisanal fishing will decrease in 2017.

Table 4-37. Number of Pirogues and Fishermen per Site as of April 2017 – Mauritania Portion.

Zone	Number of Pirogues	Number of Fishermen
PK 28	13	60
PK 65	2	10
Legweichich	200*	340
PK 144	12	65
Mouly	5	26
N'Diago	40	136
Total	272	637

*At least half of these units are inactive (in part due to lack of means to maintain them).

Source: Ecodev, 2017b

The decline in the number of fishermen in the communities of the core study area is notably explained by a significant amendment made to a fishing agreement between Mauritania and Senegal and the recent application of a regulation reserving artisanal fishing for Mauritanian nationals. Up until early 2017, artisanal fishing in Mauritania was practiced by numerous fishermen from other countries of the sub-region such as Ghana, Guinea-Bissau, Mali, and Senegal. Among these foreign fishermen, some used to come and temporarily settle in the country during the peak fishing season and work for Mauritanian operators (plant owners or fishmongers), while others – the Senegalese – fished in Mauritanian waters and landed directly in Saint-Louis, Senegal, under the convention between Senegal and Mauritania (SRFC-Mauritania, 2016). However, this convention was not renewed in 2017. Furthermore, artisanal fishing is now reserved for Mauritanians.

In terms of infrastructure for artisanal fishing in the core study area, only Nouakchott is equipped with significant infrastructure, namely the fish market (also called the fishermen beach). This market notably contains: two central halls for fish vendors, wholesale stores with storage facilities, administrative offices, a Coast Guard station, premises for professional organizations, a fuel station, an ice-making facility, sanitary facilities, supply stores, shipbuilding sites, mechanical repair workshops, etc. (Ecodev, 2017b). However, landings are offloaded from the pirogues directly onto the beach, as Nouakchott has no fish landing dock. In the other localities of the core study area, the only existing infrastructures are an ice-making facility in N'Diago and hangars for fishmongers in N'Diago and the other localities (Ecodev, 2017b).

In the core study area, Mauritanian fishermen generally make 1- or 2-day trips out to sea known as *marées*. A boat generally takes 5 individuals, including a captain who is responsible for the trip. The fishing grounds and the times of departure and return to shore are determined on a daily basis by the captain.

The main artisanal fishing techniques used in the localities of the core study area and the artisanal fishing calendar are provided in Appendix E-3. With the significant decline in the number of pirogues and artisanal fishermen in Mauritania since early 2017, a slowdown in artisanal fishing activity can already be felt and was deplored by the numerous local stakeholders who were spoken to in April 2017 (Ecodev, 2017b).

4.6.6.5 Fishing-Related Economic Activities

There are many land-based jobs associated with fishing; these are mainly associated with the marketing and processing of artisanal fishery products (Ecodev, 2017b in Appendix E-3).

One of the important links in the sector is the fishmongers, who are the intermediaries that oversee the sale of the fishermen's production. Some fishmongers also help to finance the *marées*, notably in the camps. Fishmongers can be collectors, distributors, and exporters.

Retail vendors, notably those in the markets of Nouakchott, are mostly women. They work in residential neighborhoods and in the markets.

Processors, who are more often than not women, use traditional fish processing methods (salting, smoking or drying) and market their products in Nouakchott, the country's interior and even abroad, particularly in Ghana, Mali and Senegal. A large portion of the stakeholders in the sector are West African nationals, especially Ghanaians, Malians and Nigerians. They are generally buyers who work for merchants in their home country.

In Nouakchott, a number of other artisanal fishing-related jobs are visible in the fish market: ice porters, vendors of various provisions, fish porters, scalers, etc.

Lastly, a number of individuals are also employed in transporting fish to the country's interior and to Senegal, as well as exporting it to other countries.

Available data do not provide indications as to the number of persons concerned by these various activities nation-wide or within the core study area.

4.6.7 Other Maritime and Coastal Activities

In addition to fishing, other maritime and coastal activities are practiced in the core study area. At sea, these activities are notably navigation and shipping, oil and gas activities, as well as activities related to the presence of submarine telecommunication cables, and shipwrecks on the ocean floor. On land, coastal socio-economic activities are very limited, and essentially concern recreational activities on the beaches of Nouakchott.

4.6.7.1 Maritime Navigation and Shipping

Navigation and shipping offshore from Mauritanian coast is intensive and comprises ships sailing within and beyond the country's borders, as well as ships transiting through its waters. Maritime traffic in the Port of Nouakchott consists of approximately 400 vessels per year, mostly container ships, tankers, tugs, flyboats, and ro-ro ships (PANPA, 2016). Two workshops, with the participation of IMO experts, are planned from the month of September 2017 to move the maritime navigation corridors further offshore to protect the Banc d'Arguin.

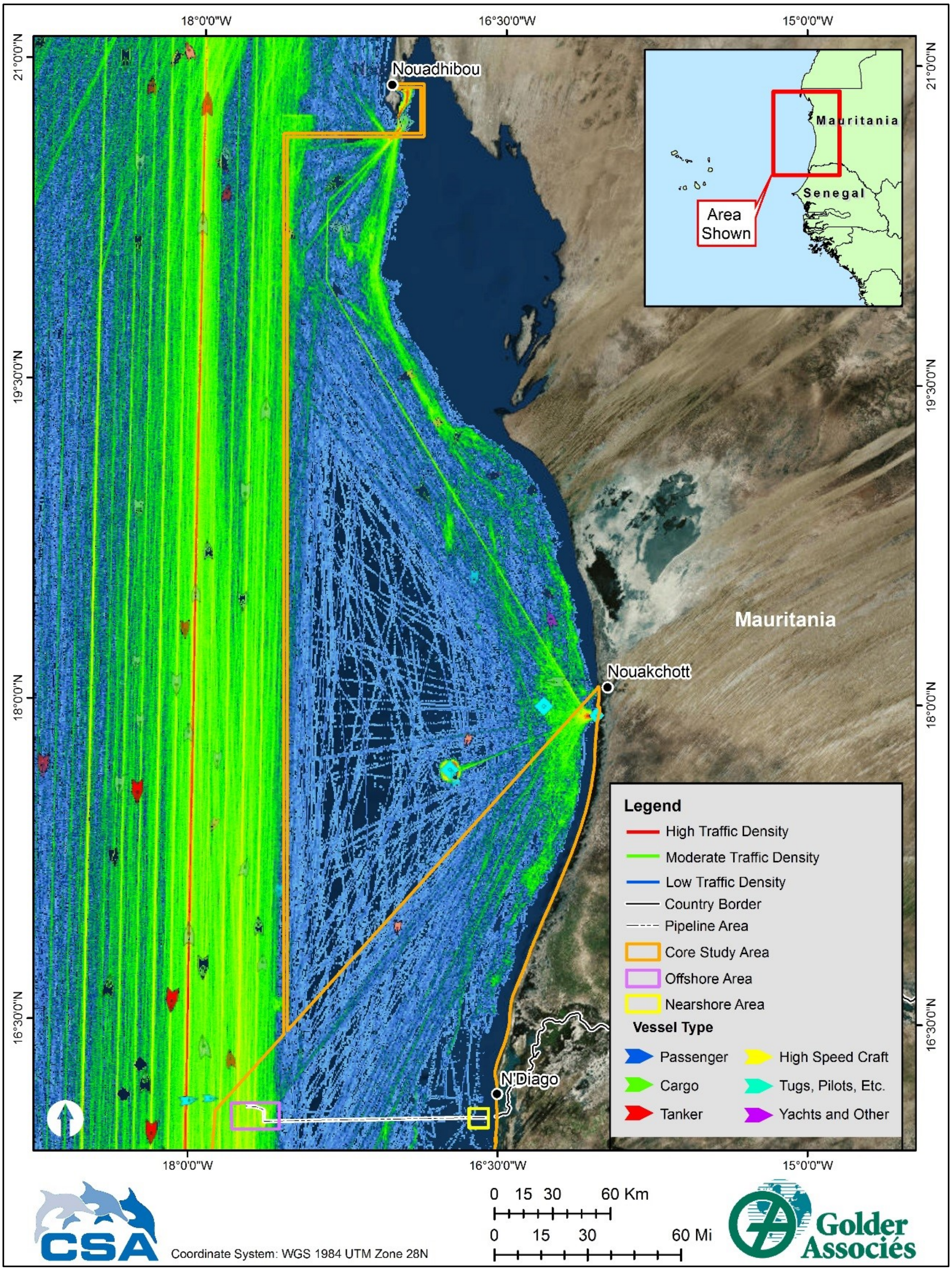
As shown in Figure 4-29[39], a shipping channel with moderate traffic density traverses the western portion of the core study area on a north-south axis. In the project infrastructure area near the coast and the pipeline area, traffic is generally light. In the offshore area, it is of moderate intensity.

Maritime traffic includes a large number of tankers. IMROP estimates that 400-500 million tonnes of petroleum products are transported annually off the Mauritanian coast from oil-producing countries (Angola, Congo, Equatorial Guinea, Nigeria, etc.) to consumer countries (Europe, North America) (IMROP, 2013).

[39] Figure 4-29 and Figure 4-37 in Section 4.7 have been built using the MarineTraffic data base which provides their imagery with a qualitative determination of marine traffic density as follows: “The colour coding is based on a rather compound algorithm. An approximate estimation on the numeric values of the corresponding colours follows - the numbers refer to distinct vessels on a daily basis and count positions per square km : Blue=less than 30, Green=30 to 70, Yellow=70 to 140 and, Red= more than 140” (https://help.marinetraffic.com/hc/en-us/articles/204802167-Display-Density-Maps). The density maps reflect annual (2016) traffic levels.

In the vicinity of Nouakchott, maritime traffic is of moderate intensity and is related to the activities of the Port Autonome de Nouakchott, which is used for commercial purposes. Maritime traffic in the vicinity of Nouadhibou is of moderate intensity. Nouadhibou has four ports:

- The Port Autonome de Nouadhibou, a commercial port whose main purpose is to export fishery products;
- An artisanal port, called Établissement Portuaire de la Baie du Repos (EPBR);
- The ore port, which is used exclusively by SNIM; and
- The oil port, which is located near the ore port.



Source: MarineTraffic. 2017

Figure 4-29. Maritime Traffic in the Core Study Area – Mauritania Portion.

4.6.7.2 Tourism and Recreation

Mauritania has tourism assets, both at the cultural/historical level and at the natural/landscape level. At the historic and cultural level, four ancient *ksour* (citadels) are listed as World Heritage of Humanity sites, namely Chinguetti, Oualâta, Ouadâne, and Tichit. These are located in the country's interior and very far from the project study areas.

At the natural and landscape level, two sites located within the extended study area have tourism potential, namely the Diawling National Park and the hundreds of kilometers of beach along the coast. However, few tourists visit these sites.

Generally speaking, the tourism sector is underdeveloped in the study area. In the Diawling National Park and the surrounding area, three operators have been identified:

- The Sodetour tourism complex established in 2012 in proximity to the head office of the Diawling National Park Conservation Service; it has 16 beds and is dedicated to the discovery of the Diawling National Park's rich heritage;
- The MKT hunting camp installed in the hunting reserve near Keur Macene; the camp has 64 beds and is dedicated to warthog and waterfowl hunting; and
- The Maure Bleu camp, established since 2011 in El Ghahra along the coastal dune.

Hotel capacity in Nouakchott stands at 637 rooms. In the coastal villages of the core study area, there are just two hotels, both of which are closed (Ecodev, 2017e).

4.6.7.3 Submarine Telecommunication Cables and Shipwrecks

Submarine telecommunication cables and shipwrecks are present on the ocean floor off Mauritania.

Offshore the country's coast, there are submarine telecommunication cables that link other countries with each other or with Mauritania. The cables connected to Mauritania are locally operated by MAURITEL. Two large fiber optic systems currently have connection points with Mauritania: Africa Coast to Europe (ACE) and Globacom-1 (GLO-1). The location of the known submarine telecommunication cables is presented on Figure 4-30.

Shipwrecks are also present on the seafloor. Officially recorded shipwrecks are illustrated on Figure 4-31. In the core study area of the project, the majority of the known wrecks are around Nouadhibou, while there are only four known wrecks around Nouakchott and one wreck towards N'Diago. None of the known wrecks is close to the project's infrastructure. Section 4.6.13 gives more details on Mauritania's marine archaeological heritage.

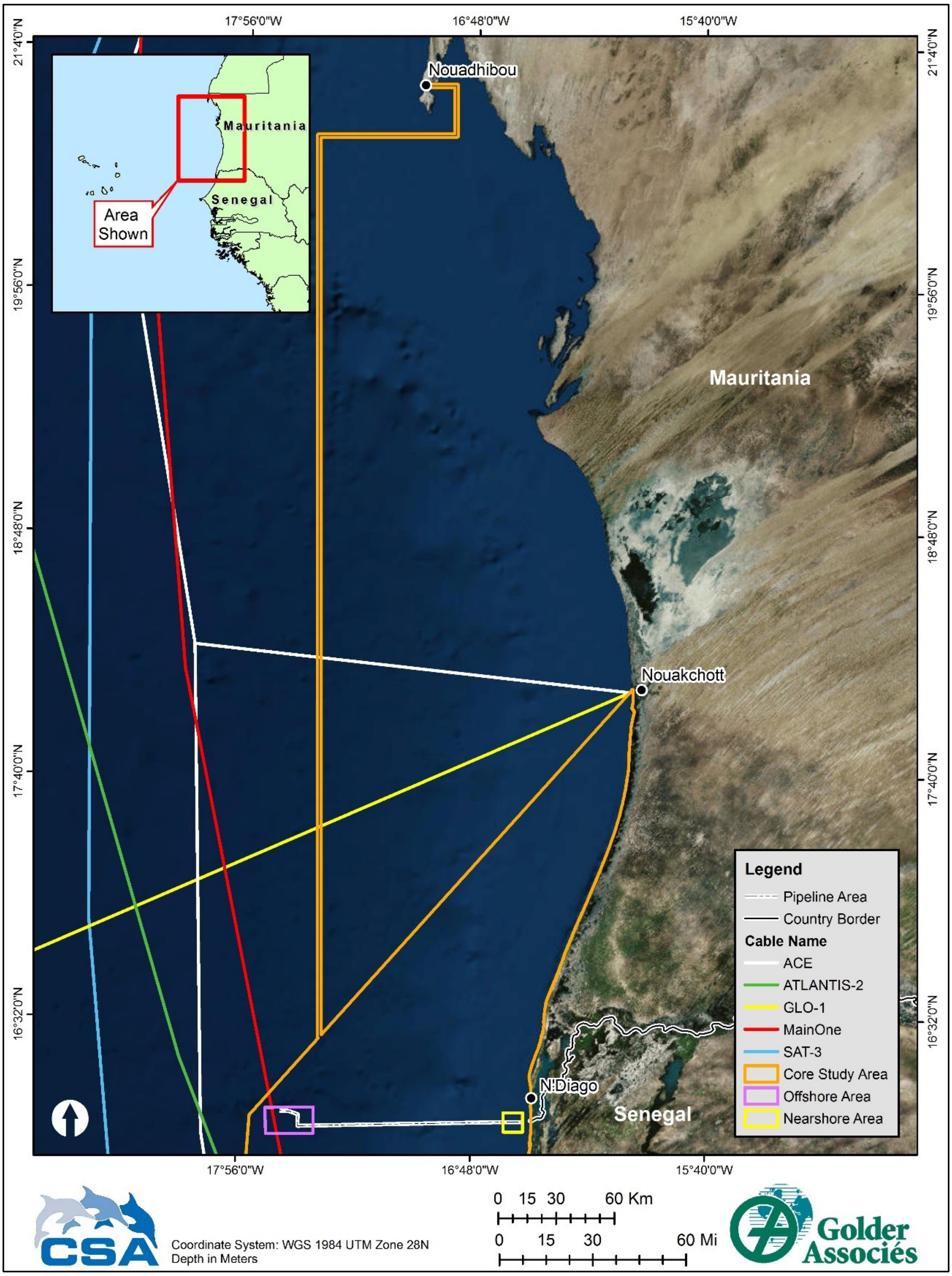
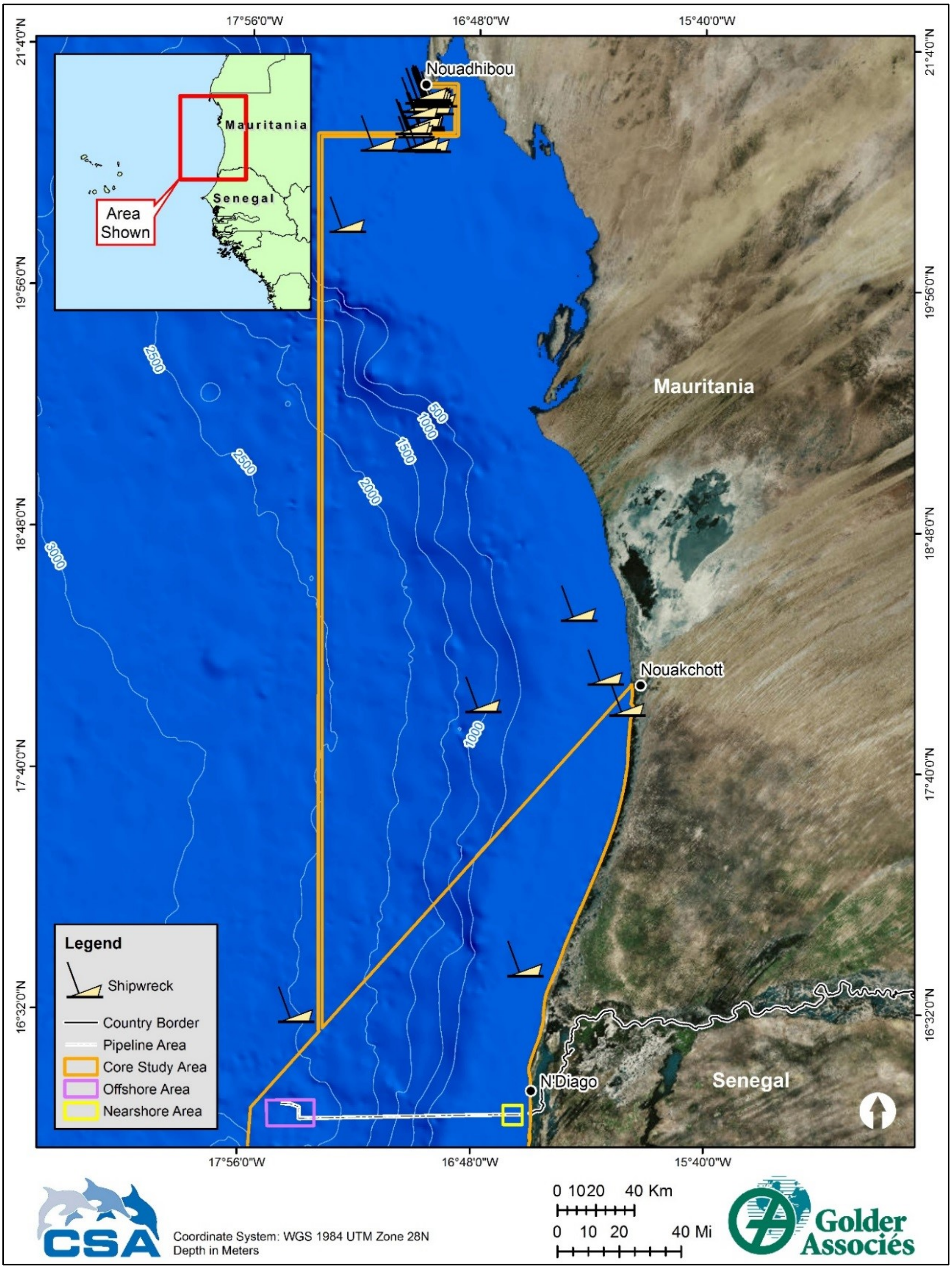


Figure 4-30. Submarine Telecommunication Cables in the Core Study Area – Mauritania Portion.



Source: Global Maritime Wrecks Database. 2017

Figure 4-31. Known Shipwrecks in the Seabed of the Core Study Area – Mauritania Portion.

4.6.7.4 Oil and Gas Exploration and Production Activities

Since the 2001 discovery of the Chinguetti offshore oil field and the beginning of its exploitation in 2006, Mauritania has become an oil and gas exploration and production country.

Appendix H provides a map of licensed blocks off the Mauritanian coast. As indicated in the map, in addition to the partnership between Kosmos and BP, there are currently three offshore oil and gas operators: Petronas, Total and Tullow.

In addition to these operators' exploration and production activities, hydrocarbon bunkering is another activity practiced offshore Mauritania. The activity consists of refueling fishing boats or industrial transport vessels from a tanker. Since 2011, Mauritania has regulated offshore bunkering activities via MPEMi, which issues the bunkering licenses. Currently, only one company holds a license, namely SK&T (MPEMi, 2016a). IMROP has estimated that the quantity of hydrocarbons transshipped at sea via bunkering is greater than the quantity of hydrocarbons sold at gas stations throughout the country (IMROP, 2013).

4.6.8 Social Organization of Communities

The social organization of communities differs greatly depending on whether they are in a rural or an urban environment (Ecodev, 2017b in Appendix E-3).

In urban environments, there are professional organizations, associations and cooperatives, some of which are linked to political, religious and ideological undercurrents. These groups form the civil society, which attempts to play an intermediate role between the population and institutional stakeholders. The proliferation of these organizations, the representation and credibility of which are variable, is currently driving these stakeholders to greater specialization in their trade as well as to federated groups in the form of forums.

In villages, the traditional system of authority is important, even if it is somewhat altered according to the context. In N'Diago, the village chief still performs representational duties with the authorities, but also allows an increasingly greater role to be played by other more modern forms of social functioning such as cooperatives and associations. In 2012, fishermen in N'Diago created an association called LEKRAIM, which comprises 80 fishermen. Women fish processors also have an association, as do women engaged in market gardening.

Social organization in camps is different. In localities referred to as camps, there is actually a series of small camps. The latter are temporary groups organized around fishing. They are generally initiated by and placed under the responsibility of a fishmonger. An informal contractual relationship binds the fishmonger and the fishermen. Here, fishmongers are businessmen. They are in charge of supplying provisions to "their" camp, organizing trips to sea, transporting catches to Nouakchott and selling these catches. A fishmonger can have under his authority 30 to 40 individuals or more. This relationship does not exclude that the fishermen can belong to fishermen's associations in Nouakchott or elsewhere. This camp system is widespread both south and north of Nouakchott.

At the national level, the main organization for artisanal fishermen is the Free Federation of Artisanal Fishing (*Fédération Libre de la Pêche Artisanale* [FLPA]). This federation is made up of local associations. As of 2017, the president of the FLPA is a native of N'Diago.

4.6.9 Public Health and Safety

4.6.9.1 Public Health Situation

According to available data, the main public health issue in Mauritania is geographic and financial accessibility to health care services, particularly to maternal and childcare services (Minister of Health, 2016a).

In Mauritania, life expectancy is less than 60 years (WHO, 2013). The Mauritanian Ministry of Health indicates that there are major challenges, with 1/3 of the population living below the poverty line and barely 10% of the population having health insurance. Additionally, the share of Mauritania's national revenue allocated to health (3.8%) is lower than that of any of the countries that it borders.

Infant and child mortality rates (65‰ and 84‰, respectively) are high, despite the progress that has been observed. The maternal mortality rate of 582 deaths for every 100,000 births is one of the highest in the sub-region. The epidemiological profile – marked by the prevalence of infectious and parasitic diseases (respiratory infections, malaria, diarrhea, tuberculosis, etc.) as well as non-communicable diseases, in particular cardiovascular diseases and diabetes – has become a concerning public health issue, thus creating a double burden of morbidity and mortality. The prevalence of overall chronic malnutrition observed across the country is 15.9% (Minister of Health, 2016a).

In the core study area, it is reported in N'Diago that the most frequently encountered illnesses are respiratory ailments, high blood pressure and rheumatism. During the rainy season, malaria represents the top reason for consultations. Patients requiring care are referred to Nouakchott while in severe cases, patients in need of rapid treatment are evacuated to Saint-Louis in Senegal (Ecodev, 2017b).

HIV/AIDS Situation

According to the National AIDS Committee (CNLCS, 2014), the prevalence of HIV/AIDS in the general population is estimated at 0.4%. This figure varies by region as well as by population group. For example, the rate of prevalence is 0.5% in Nouakchott, compared to 1.7% in Nouadhibou. As for prevalence by population group, two population groups in particular must be considered, namely the high-risk group and the vulnerable group. The high-risk group in Mauritania is composed of female sex workers and their patrons, those with sexually transmitted infections (STIs), prison inmates, truck drivers, fishermen and seamen. The vulnerable group includes youth, women and migrants. Studies conducted in these groups in 2007 show a prevalence of 7.6% in women working in the sex trade, 9% in people with STIs and 3.9% in inmates. These figures are much higher than that of the general population. The vulnerability of these groups is further magnified by the reported prevalence of STIs, which is 13.0% for truck drivers, 15.3% for seamen and 13.8% for fishermen. Truck drivers are most likely not to take any measures to avoid infecting their partner (40.0%), followed by seamen (22.4%) and fishermen (15.5%) (CNLCS, 2014).

No data are available on the prevalence of HIV in the villages and camps of the core study area.

Health Care Services and Establishments

The Mauritanian health care system is pyramidal with three levels: central, regional (*wilaya*) and departmental (*moughataa*).

- At the central level, there are public hospitals and private clinics;
- The regional level includes public health centres and private medical practices; and
- At the departmental level, there are public health posts and private health practices.

In the project's core study area, there are major disparities in health care services and establishments between Nouakchott and the coastal villages. Most of the country's health resources, including health care staff, are concentrated in Nouakchott. The city has 11 hospitals and clinics in addition to 16 health centres and 21 health outposts (Ecodev, 2017e). In the fishing villages, health service provisions are very limited. N'Diago has one health outpost, which does not have any doctors. Medical services are overseen by an advanced technician supported by three assistants/midwives. The other villages do not have any health care establishments.

Generally speaking, the residents of N'Diago, Mboyo 2, Lorma and the villages of the Diawling National Park regularly use the health infrastructures of Saint-Louis due to the proximity of this city and its easy access by river (via pirogue) or overland routes.

4.6.9.2 Maritime Safety

For the period 2015-2016, the Service of navigation and maritime safety at the MPEMa provides the following statistics with regard to maritime safety incidents at the national level (Ecodev, 2017e).

- Number of accidents: 74
- Number rescued: 75
- Number injured: 5
- Number of fatalities: 14
- Number missing: 25

The statistics are recorded by the national service in charge of search and rescue, based on incidents for which their services have been requested. Therefore, it is possible that the number of accidents, rescued people, injured/fatalities/missing is underreported. No data are available on maritime safety incidents for the villages and camps in the core study area.

4.6.10 Infrastructure and Services

4.6.10.1 Housing

The National Statistics Office (ONS, 2014) classifies the main housing types occupied by households into three categories:

- Precarious housing: corresponds to tents, huts and shanties. Overall, these represent 35.9% of households.
- Ordinary sedentary housing: consists of "ordinary houses" and "private rooms". This type of housing is dominant, representing 62.1% of the housing occupied by households, and is generally characterized by a built surface of 100 m^2, with rooms (2-3 on average) built of cement and roofs made of concrete or zinc.
- High-quality housing: occupied by 6.6% of households, this housing consists of villas, apartments and multi-storey residential buildings.

Analysis of housing structures by place of residence reveals a high concentration of high-quality housing in urban areas, whereas precarious housing is most concentrated in rural areas. This situation is more nuanced in the core study area.

Besides the camps, which are temporary in nature and whose housing is precarious (tents and shanties), in the other localities and in N'Diago in particular, dwellings are often of ordinary sedentary housing (Photo 4-34).

(Source: Ecodev, 2017b)

Photo 4-34. Housing in N'Diago.

4.6.10.2 Energy, Water and Sanitary Facilities

In 2012, the rate of access to drinking water in Mauritania was 48% in rural areas and 52% in urban areas, while the rate of access to sanitation was 9% in rural areas and 51% in urban areas (pS-Eau, 2015). The rate of electrification is 73% in urban areas and 5% in rural areas (MPEMi, 2016b).

Nouakchott

Nouakchott relies on two main sources for its water supply: the system from Idini (water volume unknown) and the system from the Aftout Es Sahli project (volume of 80,000 m^3 per year). Consumption of drinking water of Nouakchott households has increased considerably since the commissioning of the Aftout Es Sahli project, both for households that are directly connected to the system and those that are not (supplied from water access points). In 2015 this consumption was estimated at (GIZ, 2015):

- 30 liters per capita per day for households not connected to the networks; and
- 65 liters per capita per day on average for households connected to the networks (including 140 for high-quality homes and 30 for precarious homes).

In terms of sanitation, the capacity of Nouakchott is relatively low. Current infrastructures, built between 1960 and 1980, are composed of a sewer system and a wastewater treatment plant, both of low capacity. The sewer system measures 69 km, of which the functional portion only serves approximately 20 km in the central neighborhoods with only 1,700 clients benefiting from this service, while the wastewater treatment plant only handles approximately 2,000 m^3 per day. The vast majority of households thus use autonomous, low-performance sanitation systems. Household waste management is transported to technical landfill sites, as well as to unauthorized dumps (CUN, 2011)

With regard to energy access, 39% of Nouakchott's population had electricity as of 2010 (RIM, 2010).

Coastal Settlements South of Nouakchott

None of the localities in the core study area has access to the public electric grid. However, N'Diago has a hybrid power station (thermal and solar). With the exception of N'Diago, which receives its drinking water from the Biret treatment plant, the other villages and camps in the core study area obtain their water supply by tanker trucks or vehicles chartered by the fishmongers. None of the villages or camps has sanitation infrastructures or household waste collection.

4.6.10.3 Transport and Communications

Transport

Nouakchott has modern transport infrastructure including a port and an airport that meet international standards.

The Port Autonome de Nouakchott was built in 1987. Since 2008, it is compliant with the ISPS Code (International Ship and Port Facility Code) adopted in 2002 by IMO (International Maritime Organization), of which Mauritania is a member. It is one of the pillars of the national economy and its traffic has experienced exponential growth ever since it was commissioned, rising from less than 400,000 tonnes in 1987 to 3,851,434 tonnes in 2015, growing at an average rate of +9.5% a year. Container traffic has gone from 56,448 TEU (twenty-foot equivalent unit) in 1988 to about 116,828 TEU in 2015, i.e., an average annual progression of +12.5%.

With regard to air traffic, since June 27, 2016, Nouakchott has had a new airport (Nouakchott Oum Tounsy) located 20 km northwest of the capital. This new infrastructure has a capacity of two million passengers per year and can accommodate large aircraft such as the Airbus 380 and the Boeing 780. (Ecodev, 2017e)

In the villages and camps of the core study area, ground transportation infrastructure is rudimentary. These villages and camps are only connected to the national network by unpaved roads, which are not easily drivable during the rainy season.

In Nouadhibou, the Port Autonome de Nouadhibou receives on a monthly basis 8 container ships, 7 cargo ships, 1 or 2 tankers (1 oil tanker and 1 ship transporting fish oil) and 450 trawlers that use the port's services either for refueling or landing purposes. The SNIM also has a new ore port that was built between 2009 and 2012. This port can accommodate ships with a deadweight tonnage of 250,000 and has a loading rate of 10,000 tonnes per hour (Ecodev, 2017b).

Communications

Nouakchott is a completely equipped and operational area in terms of communications. The city has phone centres, radio stations, a Global System for Mobile (GSM) network, post offices, satellite TV systems, and Internet services.

The main means of telecommunication in Mauritania's rural regions are the mobile satellite phone network and the radio. These are the only means of communication in the fishing villages and camps in the core study area (Ecodev, 2017e).

4.6.10.4 Security

In Mauritania, the administrative authorities are responsible for the security of the communities. The *Wali* of Trarza is responsible for the safety of the coastal communities south of Nouakchott since the *wilaya* of Trarza covers the entire coast line South of Nouakchott and a large hinterland. At a more local level, the *Hakem* of the *moughataa* of Keur Macene is responsible for the security of the coastal communities of PK 144, Mouly, N'Diago, Mboyo 2, Lorma and the communities inside Diawling National Park. According to the geographical limits of the *moughataa*s, the *Hakem* of the *moughataa* of Mederdra is responsible for the security of PK 65 and Legweichich, while the *Hakem* of the *moughataa* of Ouad Naga is responsible for the security of PK 28.

On the ground, law enforcement and security are ensured by policemen in the towns and by gendarmes in the areas where there are no police stations. In the core study area, there are policemen in Nouakchott and N'Diago. N'Diago has its own police station which reports to the *Hakem* of Keur Macene.

Offshore, coast guards patrol the maritime waters. They are responsible for monitoring and protecting the Mauritanian waters and for search and rescue operations. As such, their responsibilities include ensuring that no illegal fishing activities are conducted in Mauritanian waters. While the coast guards are armed, they operate with a small number of vessels. They have limited means with regards to the length of the coast under their responsibility.

4.6.11 Women and Vulnerable Groups

In the core study area, the following groups can be identified as vulnerable[40]: women, youth, the disabled, HIV positive people/households, descendants of former slaves, and refugees who returned from Senegal in 1989.

Women may be doubly victimized by discrimination due to belonging to vulnerable groups and their female gender (UNDP, 2009). Women are generally absent from the fishing camps and there are no data on the number of women in the four villages of the core study area. Based on the sex ratio of Trarza, which is 91.5 men for every 100 women (ONS, 2015), it can be estimated that the female population of the villages of the core study area is approximately 1,222. For the Diawling National Park as a whole, the number of women is estimated at 6,893 while the number of women in the core study area and the extended study area is estimated at 501,989 and 571,222, respectively.

Another vulnerable group is youth with little or no education. In rural areas, youth is affected by difficulties in gaining access to education. In urban areas, they are the first victims of unemployment. Adolescents and young adults are also vulnerable to HIV/AIDS and other sexually transmitted diseases.

Based on the proportion of young people under 15 years of age in Trarza, which is 42.6% (ONS, 2015), it can be estimated that the population of young people under the age of 15 in the villages of the core study area is approximately 997. For the Diawling National Park as a whole, the number of young people under the age of 15 is estimated at 5,623, while this segment of the population in the core study area and the extended study area is estimated at 409,518 and 465,998, respectively.

The disabled are also vulnerable, and RGPH 2013 indicates that 0.96% (33,920 inhabitants) of Mauritania's total population live with a disability. Nouakchott is home to a significant proportion of these people, notably due to the presence in the capital of a number of health care services. These individuals are at risk of social exclusion and unemployment (ONS, 2015). Based on the percentage of people with disabilities nation-wide, it can be estimated that the population of the core study area would have 9,229 disabled individuals: 9,201 in Nouakchott and 28 in the other localities. No health care system is available in the villages for these individuals and access to employment is very rare. The families usually take care of the disabled.

As indicated previously, the prevalence of HIV/AIDS in the general population of Mauritania is estimated at 0.4%. No data are available on the prevalence of HIV in the core study area. Based on the percentage of people with HIV/AIDS nationwide, it can be estimated that the population of the core study area would have 3,845 individuals living with HIV/AIDS: 3,843 in Nouakchott and 12 spread-out in the other localities. Out of Nouakchott, no health care is available for people living with HIV/AIDS.

According to a UNDP report (UNDP, 2009), former slaves and their descendants constitute a vulnerable group that is found throughout the country. The major problem faced by individuals of this group is integrating themselves into the economy, as they are victims of the combined effects of poverty and illiteracy, and to a large extent remain marginalized in terms of development.

[40] According to the World Bank, a vulnerable group is a population having a certain specific characteristic that makes it at higher risk of falling into poverty than others living in areas targeted by a project. Vulnerable groups include the elderly, the mentally and physically disabled, at-risk children and youth, HIV/AIDS-affected individuals and households, ethnic and religious minorities and, in some societies, women.

As for refugees and deportees of the events of 1989, their situation is still believed to be precarious. In 2007, the Government of Mauritania, the Government of Senegal and the Office of the United Nations High Commissioner for Refugees (UNHCR) signed an agreement on the return of refugees and the repatriation of 24,000 people that had been deported to Mali and Senegal. According to the most recent data on the topic, this process is encountering certain implementation difficulties, in particular with regard to property restitution (UNDP, 2009).

4.6.12 Quality of Life

The quality of life in communities in the core and extended study areas varies depending on whether one is talking about Nouakchott, Nouadhibou or rural communities. The previous sections, notably Section 4.6.4 (Education), 4.6.5 (Economic Conditions, Employment and Means of Subsistence), 4.6.6.4 (Artisanal Fishing), 4.6.9 (Public Health and Safety) and 4.6.10 (Infrastructure and Services), provide information on the quality of life in the core and extended study area. The current section provides additional information on this subject.

The quality of life in the villages and camps of the core study area is limited due to the lack of access to basic social infrastructure (Table 4-38). In the villages of the Diawling National Park, access to basic social infrastructure is also deficient; drinking water access in particular is problematic.

Table 4-38. Basic Social Infrastructure in Coastal Settlements – Mauritania Portion.

Locality	Drinking Water	Electricity	Primary School	Middle School	Health Outpost	Cellular Coverage
PK 28	No	No	No	No	No	Yes
PK 65	No	No	No	No	No	Yes
Legweichich	No	No	Yes	No	No	Yes
PK 144	No	No	No	No	No	Yes
N'Diago	Yes	Yes (thermal/solar hybrid plant)	Yes	Yes	Yes	Yes
Mboyo 2	No	No	Yes	No	No	Yes
Lorma	No	No	No	No	No	Yes

Source: Ecodev, 2017e

One of the main trends in the coastal settlements is the lack of basic social infrastructure. Except for N'Diago which is a little better off, these settlements have no drinking water infrastructure, no electricity, no medical services, and no maternity services.

In case of medical emergencies including in N'Diago, sick or badly injured people and laboring women are taken by family members to the Saint-Louis hospital in Senegal. Ambulance transportation is inexistent. People requiring urgent medical attention are transported to Saint-Louis by pirogues on the Senegal River or by cars using the dirt road that links N'Diago to Saint-Louis.

This lack of basic social infrastructure is a major issue for the communities and this is reflected in the results of the public consultation for the current project (see Chapter 6). Most of the stakeholders' comments during the consultation were actually requests for basic social infrastructure and services. However, this trend is not specific to the coastal settlements. The lack of basic social infrastructure is a common trend in rural areas of Mauritania.

More information on the basic social infrastructure in the coastal settlements, notably in N'Diago, is provided in Appendix E-3.

Another important trend in the coastal villages, highlighted during the public consultation, but for which no data is available is youth unemployment. Again, this is a common trend in Mauritania.

Very few data exist on the coastal communities' revenues, household incomes, savings or indebtness which could provide indicators as to the standard of living of these communities. This lack of data is not specific to this area. Nationwide, very little data exist for these economic indicators.

While basic social infrastructure lacks in the fishing camps of the core study area (PK 28, PK 65, PK 144 and Mouly), these settlements do not share the social trends of the coastal villages. As indicated in Section 4.6.2, the fishing camps have been created by the Mauritanian authorities in the last 30 years to serve as artisanal fishing training centres and/or official landing sites. The fishing camps have never been inhabited by families. Moreover, the fishing activities in the fishing camps drastically dropped in 2017. As indicated in Appendix E-3, Senegalese fishermen used to be the main inhabitants of the settlements. They left with the termination of the fishing agreement between Mauritania and Senegal. Since January 2017, the termination of the agreement is enforced by the authorities. Currently, the four fishing camps are nearly deserted.

4.6.13 Cultural and Archaeological Heritage

In 2011, the surface archeological survey (Moreno Lete, 2011, cited by Ecodev, 2017e) conducted in the context of the AECID-PARCE/DNP project concluded that the Mauritanian delta was not inhabited in ancient times, as geomorphological conditions were not conducive to populations settling here during the Neolithic period. The Senegal River delta is a recent geomorphological construction. Indeed, during the Nouakchott era (6000-10,000 before present, the entire region was a gulf hundreds of kilometers wide. (Ecodev, 2017e). The lower delta area was a crossroads of influence throughout the Neolithic Era, as it was a contact area between Saharan Neolithic populations and the first Sahelian peasant societies (Vernet 1993, in A. André and N. Chenaval, 2007, cited by Ecodev, 2017e). There is also a deposit of fossil oysters in Chatt Tboul, shell heaps of anthropogenic origin and archeological sites (pottery, bones, metal) both in the Diawling National Park (near Mirador in the Diawling-Tichilitt Basin) and on the coastal dune (north of Lekser), on the dune of Ziré, in Bouhajra, and on the dune of Birette (Ecodev, 2017e).

There are no known underwater archeological activities in Mauritania. However, the extreme southern Mauritanian coast, near the city of Saint-Louis in Senegal, has been a high maritime traffic area since the beginning of European explorations in the precolonial era. During trans-Atlantic trade (including the slave trade) and later colonization, sites like that of Saint-Louis (and the island of Gorée in Senegal) were maritime crossroads with intense traffic. The history of the extreme southern Mauritanian coast suggests that the latter might contain shipwrecks that are witnesses of this history. However, no underwater archeological research has been conducted to conform this hypothesis. Near N'Diago, for generations a shipwreck known as Lekraim has existed and represented a powerful symbolic reference in the sea, but at the present time nobody in the locality knows its exact history (Ecodev, 2017e).

4.6.14 Landscape

The secondary data collected in the field between March and April 2017 helped identify the major landscape features in the core study area (Ecodev, 2017e). The coastal area south of Nouakchott is characterized by a sandy and rectilinear coastline where several coastal dunes form the interface between the sea and other physical environments (*sabkhas*, *marigots* (pools), islands, etc.). Such is the case of the coastal dune separating the sea from the Aftout Es Sahli area.

On the barrier beach, vegetation is nearly absent on the dune summits, though in interdunal areas, vegetative cover is relatively significant.

The fishing camps on this barrier beach are the main markers of human presence, and are characterized in the landscape notably by the shanties and hangars used by fishing stakeholders for housing and storage.

N'Diago is located on the barrier beach. Fishing boats, fishmongers' cars, and carts are strong symbols of the landscape of this fishing village, which represents a hub of activities for the other villages of the entire coastal dune.

With regard to the seascape, the only noteworthy element is a shipwreck (whose date of sinking is unknown) known as Lekraim; it serves as a visual reference for residents.

4.6.15 Political and Social Climate

The field work of March-April 2017 provided an overview of the political and social climate in the coastal villages as well as in the Diawling National Park.

In the most recent legislative and *commune* elections of November 2013, a polarization of local political life seemed to be perceptible against the backdrop of economic crisis. This polarization brought to light local rivalries: coastal N'Diago versus the islands, Diawling National Park villages versus N'Diago, traditional authority versus new political players aspiring to communal responsibilities, etc.

Today, with the revitalization of N'Diago as an economic hub on one hand, and the development projects undertaken by the Diawling National Park authorities on the other hand, the climate seems to be calmer.

In N'Diago, a number of socio-economic organizations (fishermen, processors, etc.) bring together members of diverse social sensitivities, which is testimony to the calmness of the social climate.

In the villages of the Diawling National Park, formal consultation on the rules of natural resource use seems to be contributing in calming the social climate (Ecodev, 2017e).

With regard to the perceptions of offshore oil and gas activities, residents are hopeful to be able to take advantage of the situation in terms of opportunities for employment and for financing their economic activities. However, fishermen show greater distrust, fearing that fish stocks will decline. In fact, some members of this group believe that fishing and oil and gas activities are incompatible.

4.6.16 Ongoing or Planned Projects

As of October 2017, available data indicate that only one major infrastructure project is currently planned in N'Diago and its surroundings.

As indicated in Section 4.6.2, the construction of a multipurpose port was initiated 31 km north of N'Diago in December 2016.

According to publicly available data (AMI, 2016), the port will notably include:

- A military port and a navy base;
- A fishing port with seven landing wharfs;
- A shipyard with a 70 boats/year capacity;
- A commercial wharf for boats up to 180 m long; and,
- A landing point for artisanal fisheries.

An ESIA has not been made publicly available for this project. As of October 2017, the project seems to be at a standstill. The project is managed at the Presidency's level and very little information is made public.

4.7 Social Environment of Senegal

This section provides socio-economic information on the Senegalese portion of the study area.

A detailed portrait of the communities of the core study area is provided in this section, as is higher-level information for communities in the extended study area. This information is sourced from a review of literature as well as secondary data collected in the field between March and April 2017 by three Senegalese researchers. The results of their work are provided in three separate reports provided in Appendix E-2 for Senegalese fishery resources and fisheries), Appendix E-4 for Senegalese fishing communities and Appendix F-2 for Senegal's protected areas. These three reports provide in-depth data on the topics addressed and complete the data presented herein. Lastly, additional socio-economic data are provided in Appendix H. In the current report, « fishermen community » is used as a generic name. It includes all members of the community, male and female.

In the context of the project proposed activities and location, key sensitivities in the social environment include:

- the fisheries (particularly artisanal fisheries);
- the economic conditions, employment and means of subsistence; and
- the maritime navigation (particularly artisanal fishermen safety).

Other components of the social environment that were not raised during public consultations or that are less sensitive, but that are important to understand the host environment of the project or that could potentially be impacted by the project are also described, such as the administrative framework, the land use and human settlements, the population, other maritime and coastal activities, etc. The key sensitivities are the same for the social environments of Mauritania and of Senegal.

4.7.1 Administrative Framework

4.7.1.1 Administrative Organization of Senegal

Administrative and territorial organization in Senegal is defined by the Decree N° 2008-1025 of September 10, 2008, which establishes the territorial jurisdiction and the capitals of the regions, departments and districts, and Law N° 2013-10 of December 28, 2013 implementing the General Code of Local Government Structures. The country thus comprises:

- administrative divisions (14 regions, 45 departments and 117 districts); and
- local government structures (45 departments and 557 *communes*).

The 14 administrative regions of Senegal are: Dakar, Diourbel, Fatick, Kaffrine, Kaolack, Kédougou, Kolda, Louga, Matam, Saint-Louis, Sédhiou, Tambacounda, Thiès, and Ziguinchor. Regions represent the highest level of administrative division and, within their jurisdictions, have a degree of authority granted by the State as part of a decentralization process. Regions have a regional capital and are administered by a Governor.

As local government structures, *communes* and departments are administered by a municipal council (headed by a Mayor) and a departmental council (headed by a president), respectively. These local government structures are transferred a number of jurisdictions, some of which concern the environment and natural resources (Senegalese Code of Local Government Structures, 2013, cited by Tropica, 2017d).

4.7.1.2 Administrative Organization of the Study Area

Core Study Area

As described in Section 4.3, the Senegalese portion of the ESIA's core study area includes the coastal strip that stretches between the cities of Saint-Louis and Dakar. This core study area is located on the portion of the Senegalese coast called the Grande Côte and encompasses four administrative regions: Dakar, Thiès, Louga, and Saint-Louis.

The region of Dakar is adjacent to the region of Thiès to the east, and borders the Atlantic Ocean to the north, west and south (Dircod, 2015). Dakar is both a region and the capital of the country. The region of Dakar is divided into 4 departments (Dakar, Rufisque, Pikine, and Guédiawaye) and 10 districts. All the departments of Dakar are part of the core study area.

The region of Thiès borders the region of Louga to the north, the region of Fatick to the south, the regions of Diourbel and Fatick to the east, and the region of Dakar and the Atlantic Ocean to the west. The region of Thiès is divided into 3 departments (Thiès, Mbour and Tivaouane) and 10 districts (Dircod, 2015). Only the departments of Thiès and Tivaouane are part of the core study area.

The region of Louga is bound by the region of Saint-Louis to the north, the regions of Kaolack and Diourbel to the south, the region of Matam to the east, and the region of Thiès and the Atlantic Ocean to the west. Administratively, this region is divided into 3 departments (Louga, Linguère and Kébémer) and 11 districts (Dircod, 2015). Only the departments of Louga and Kébémer are part of the core study area.

The region of Saint-Louis borders Mauritania to the north, the region of Louga to the south, the region of Matam to the east and the Atlantic Ocean to the west. Administratively, the region is divided into 3 departments (Podor, Dagana and Saint-Louis) and 7 districts (Dircod, 2015). Only the department of Saint-Louis is part of the core study area.

Extended Study Area

Besides the localities of the core study area, the extended study area encompasses the Senegal River delta, from the mouth of the river[41] to the boundaries of Djoudj National Bird Sanctuary. Administratively, these lands are part of the department of Saint-Louis and the rural *communes* of Gandon, Ndiébène Gandiole, and Diama.

Downstream of Saint-Louis, the rural *commune* of Ndiébène Gandiole contains 35 villages, 9 of which are located along the mouth of the river: Mouit, Darou Mboubaye, Pilote Bare, Tassinère, Mbou Baye, Deggou Niey, Lakhrar, Gneling Mbao, and Taré Banda. These 9 villages are included in the extended study area.

The rural *commune* of Gandon surrounds the city of Saint-Louis. It officially comprises 56 villages, some of which are located along branches of the Senegal River while others are situated inland. In the absence of disaggregated data, the entire *commune* is taken into consideration in the extended study area.

The rural *commune* of Diama officially comprises 67 villages, some of which are located in the Senegal River delta while others are situated inland. Djoudj National Bird Sanctuary is also located within this *commune*. In the absence of disaggregated data, the entire *commune* is taken into consideration in the extended study area.

4.7.2 Land Use and Human Settlements

4.7.2.1 Core Study Area

Grande Côte

Land occupancy on the Grande Côte is characterized by a marked contrast in density between two important urban centres on one hand and a relatively sparsely populated coastline on the other hand. At the southern and northern extents of the Grande Côte are the cities of Dakar and Saint-Louis. The main human settlements of the Grande Côte are presented on Figure 4-32.

[41] Since the breach opened in October 2003, the mouth of the river has been shifting and altering the habitat of the area. Consequently, the list of localities adjacent to the mouth of the river is constantly evolving. For example, the village of Doune Baba Dièye is currently under water.

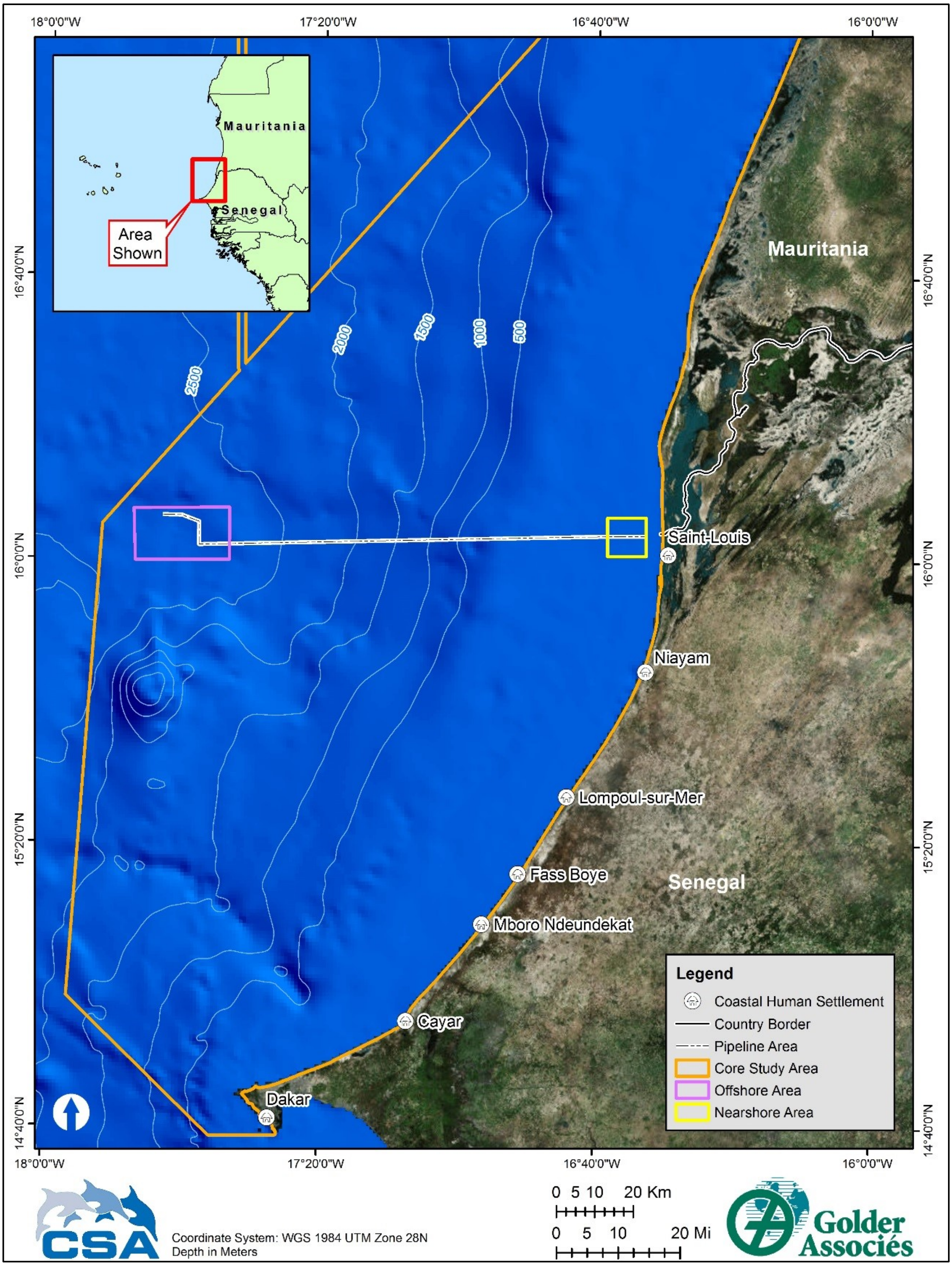


Figure 4-32. Main Coastal Settlements in Core Study Area – Senegal Portion.

Dakar

Located in the centre of the Cap-Vert Peninsula, the geographic coordinates of city Dakar are 14°40'N latitude and 17°26'W longitude. This city is the capital of Senegal and, together with its suburbs, makes up the region of Dakar. Dakar is both the most populated city and the smallest region in the country in terms of surface area. It covers 550 km², i.e. 0.28% of the country. Within the city of Dakar, there are two main communities of fishermen who reside in the neighborhoods of Yoff and Hann-Plage. Initially, these two neighborhoods were fishing villages. They were absorbed into the city by Dakar's urbanization, and have now expanded beyond the boundaries of the former villages. Besides Yoff and Hann-Plage, there are other fishing communities (which were also formerly villages) in Dakar: Ngor, Ouakam, Soumbédioune, Terrou Baye Sogui, and Anse Bernard.

Saint-Louis

The city of Saint-Louis, located 264 km north of the capital and near the Mauritanian border, is situated on the Atlantic Ocean coast, 24 km north of the mouth of the Senegal River (Photo 4-35). The geographic coordinates of its centre are 16°02'N latitude and 16°30'W longitude and its surface area is 45.8 km².

Photo 4-35. Aerial View of the Mouth of Senegal River.

The city of Saint-Louis encompasses four sectors: Saint-Louis Island, the Langue de Barbarie, Sor, and the *commune* outskirts. A map illustrating these sectors and their respective neighborhoods is provided in Appendix E-4.

- **Saint-Louis Island**, which constitutes the historic heart of the city, lies in the Senegal River. It borders Sor to the east and the Langue de Barbarie to the west. The island measures approximately 0.68 km². It is connected to Sor by the Faidherbe Bridge and to the Langue de Barbarie by the Ousmane Masseck Ndiaye and Moustapha Malick Gaye bridges. Land use on the island of Saint-Louis is primarily residential, administrative and commercial. Most of the buildings date from the colonial era. Founded on the island in 1659, Saint-Louis was the capital of French West Africa until 1902 and the capital of Senegal and Mauritania until 1957.

- The **Langue de Barbarie** (Figure 4-33) is a narrow spit of land bound by the Atlantic Ocean to the west and the Senegal River to the east. The northern extent of the Langue de Barbarie is the border with Mauritania, while to the south, the spit ends at the mouth of the Senegal River. There is no physical barrier on the Langue de Barbarie to indicate the land border with Mauritania. According to popular folklore, a few palm trees mark this border in an uninhabited area called Sal Sal (Photo 4-36).

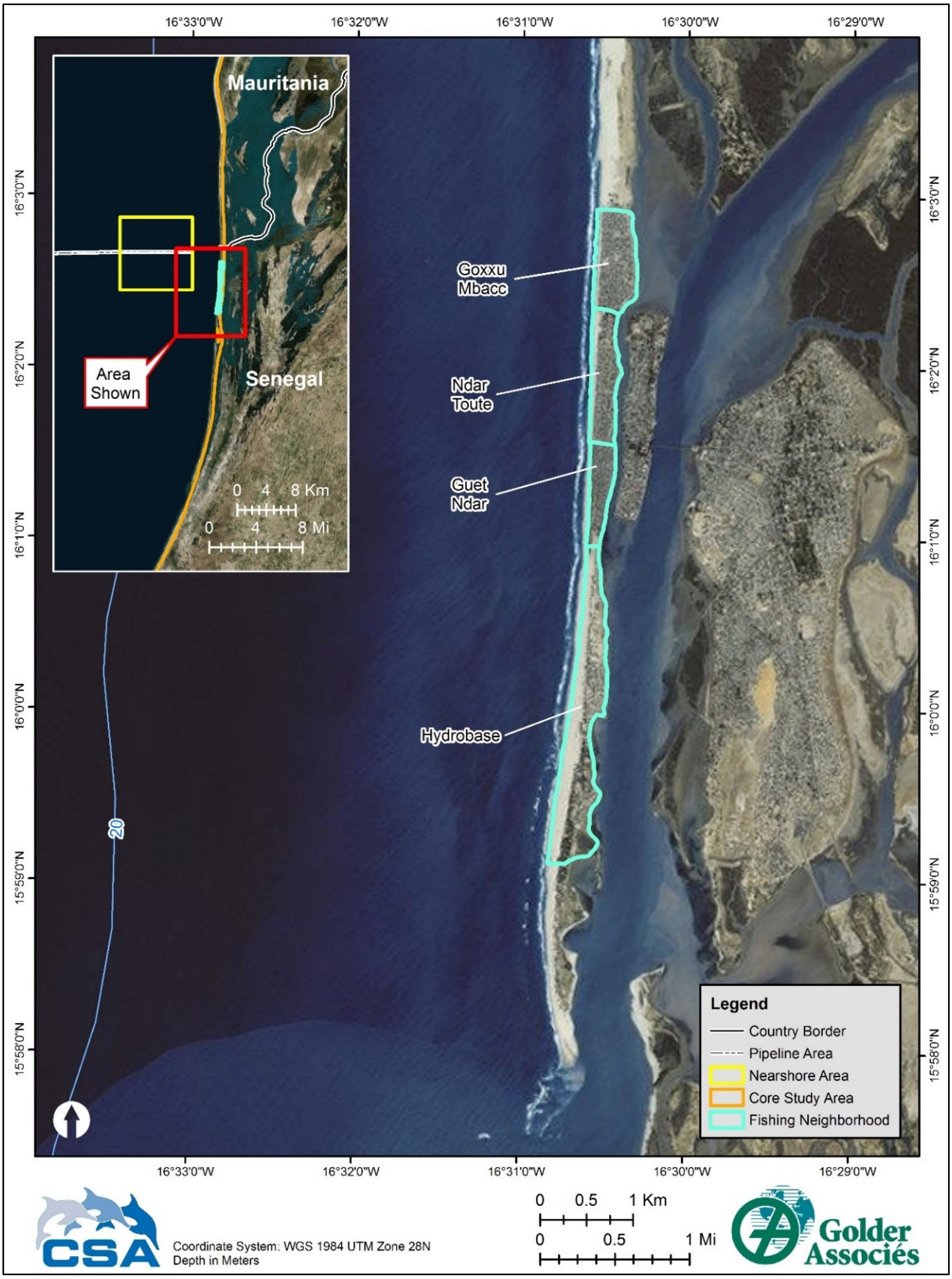


Figure 4-33. Location of Fishing Neighborhoods of Langue de Barbarie.

Photo 4-36. Aerial View of Sal Sal.

- Saint-Louis' four fishing neighborhoods are found on the Langue de Barbarie: Goxxu Mbacc, Ndar Toute, Guet Ndar, and Hydrobase. The neighborhood of Guet Ndar, originating from a traditional fishing village established on the Langue de Barbarie since the mid-16th century (Tropica, 2017b), is the most important of these neighborhoods historically and demographically speaking. Together, the four fishing neighborhoods occupy a narrow spit of land averaging 250 m wide and 9 km long for a surface area of less than 3 km2. This strip of land includes a cemetery located between Guet Ndar and Hydrobase.
- To the south of the fishing villages are the Saint-Louis port infrastructures, the village of Fass Dièye[42], the Hydrobase beach as well as accommodations (hotels and campgrounds). The Hydrobase beach is used for recreational purposes by the population of Saint-Louis on a seasonal basis (approximately June to September).
- The **Sor Sector** came into being as a result of the urban sprawl on Saint-Louis Island in the 1970s. Sor comprises ten neighborhoods, including Pikine, which is the largest and most populous of the city of Saint-Louis. Land use in Sor is mainly residential and commercial.
- The ***Commune* Outskirts** emerged with the continual expansion of Sor. These outskirts include three traditional villages that have become urbanized with the expansion of the city: the village of Khor, the village of Bango in which the Saint-Louis airport and a military camp are located, as well as the village of Ngalèle which is home to Gaston Berger University, which opened in 1990. These three traditional villages are now neighborhoods of the city. Land is use is mainly residential, though agricultural activities are also carried out.

Other Villages in the Core Study Area

Along the coast between Saint-Louis and Dakar, there are just a few human settlements (see Figure 4-32). Five of these coastal villages and small coastal towns are known for being highly involved in fishing activities. Lompoul-sur-Mer, Fass Boye, Mboro Ndeundekat, Cayar (also spelled Kayar), and Niayam (sometimes referred to as Potou, the name of another nearby village located inland). Inhabitants of neighboring villages in the hinterland earn their livings in animal husbandry and agriculture, notably market gardening.

[42] Administratively, Fass Dièye is part of the *commune* of Gandon.

4.7.2.2 Extended Study Area

In addition to the localities of the core study area, the extended area encompasses part of the Senegal River delta.

Downstream of Saint-Louis, one finds notably:

- Nine villages of the *commune* of Ndiébène Gandiole established along the mouth of the Senegal River. This region is commonly called Gandiole or Le Gandiolais.
- Langue-de-Barbarie National Park and Guembeul Natural Reserve.

Upstream of Saint-Louis, one finds notably:

- Islands, including Bopp Thior (*commune* of Gandon), which is less than 2 km from the city of Saint-Louis and located opposite Sal Sal;
- The anti-salt Diama dam, which is part of the infrastructures placed under the responsibility of the Organization for the Development of the Senegal River (OMVS) and which is located in the *commune* of Diama;
- Numerous villages belonging to the rural *communes* of Gandon and Diama;
- Important farmland including irrigated crops, notably the agricultural irrigation areas developed by the National Society for the Development and Exploitation of the Lands of the Senegal River Delta and the Senegal and Falémé Valleys (S.A.E.D.); and
- Djoudj National Bird Sanctuary, which is located 60 km north of Saint-Louis and is the third-largest bird sanctuary in the world. No villages are found within this sanctuary.

Information on Langue-de-Barbarie National Park, Guembeul Natural Reserve and Djoudj National Bird Sanctuary are provided in Section 4.5.9.2 and in Appendix F-2.

4.7.3 Population

4.7.3.1 Demography

In 2013, the National Agency of Statistics and Demography (ANSD) completed the fourth general census of Senegal. This census, the results of which were published between 2014 and 2017[43], offers the most recent and most complete official population data available and, in certain cases, presents projections for the years 2015 and 2017.[44] However, public census data are not disaggregated any further than the *commune* level. In this regard, estimates of the number of inhabitants per neighborhood or village were made by combining general census data with other data for Senegal's rural regions. Moreover, the secondary data collected in the field in March and April 2017 helped complete the population estimates.

In 2013, the total population of Senegal was 13,207,873 inhabitants and the average household size was 8 persons; averaging 7 in urban areas and 10 in rural areas (ANSD/RGPHAE, 2014). According to ANSD's projections, the country's population in 2017 would be 15,256,346, which corresponds to a density of 78 inhabitants per km^2.

For Dakar Region, the 2013 census indicates a population of 3,137,196[45], i.e. nearly one-fourth of the Senegalese population and a density of 5,074 people per km^2. This average density masks large disparities; for example, the department of Guédiawaye has a population density of 18,539 people per km^2. Further, Dakar accounts for over 60% of the country's urban population. The number of households is estimated at 522,866 (6 persons per household). Dakar is composed of 50.3% men and 49.7%

[43] In 2017, ANSD published regional reports of the 2013 RGPHAE.
[44] hen such projections for 2015 and 2017 are available, they are indicated in this report.
[45] For the year 2017, the population projection for Dakar is 3,529,300.

women. The population of Dakar Region is very young, with 7 out of 10 residents of the region under the age of 35 (SES Dakar, 2013, cited by Tropica, 2017b).

For the *commune* of Saint-Louis, the 2013 census indicates a population of 218,926 composed of 51.0% men and 49.0% women. For 2015, the estimated population is 230,801 (ANSD/RGPHAE, 2014), which would indicate a density of 5,039 people per km^2. Considering that the average household in Saint-Louis had 8 persons, Saint-Louis would have comprised approximately 28,850 households in 2015.

The neighborhoods of the Langue de Barbarie comprise a total estimated population of 74,415 inhabitants, i.e., more than one-third of the population of the *commune* and a density of 24,805 people per km^2. Guet Ndar, the oldest of these neighborhoods, has approximately 26,000 inhabitants, including 12,246 men and 13,754 women, living on a small expanse of land measuring 20 ha (Guet Ndar Neighborhood Council census, 2014, cited in Tropica, 2017b). With a population density in the order of 130,000 people per km^2, this neighborhood is known for being the most densely populated area of Senegal. Guet Ndar is the oldest and most important fishing community in the country. As of 2015, the neighborhood was still inhabited nearly exclusively by fishermen and their families, who have lived there for generations.

Ndar Toute, Goxxu Mbacc and Hydrobase are also mainly inhabited by fishermen and their families who settled in the area more recently. The number of residents in each of these three neighborhoods is estimated at 11,644, 23,288 and 14,000, respectively (Medical Region of Saint-Louis, 2016, Hydrobase Neighborhood Council, 2016, cited in Tropica, 2017b).

Based on the size of households in Saint-Louis, it can be estimated that Langue de Barbarie comprises 8,817 households, 3,250 of which are in Guet Ndar.

Outside of Dakar and Saint-Louis, the total population of the coastal fishing communities lying within the core study area is estimated at 54,810:

- Niayam has an estimated population of 1,500 (Kosmos, 2015);
- Lompoul-sur-Mer has an estimated population of 10,000 (Kosmos, 2015);
- Mboro Ndeundekat is part of the *commune* of Mboro and has a total estimated population of 2,000 (Kosmos, 2015);
- Fass Boye has an estimated population of 15 000 (Tropica, 2017b); and
- Cayar, the largest of these communities, is a small town of 16 km^2 (Tropica, 2017b) with the status of a *commune*. Its total population is estimated at 29,810 inhabitants (ANSD/RGPHAE, 2014), which translates into a density of approximately 1,858 people per km^2.

In the localities of the Senegal River delta lying within the extended study area, the total number of inhabitants is estimated at 82,626.

Despite being from a variety of sources and years, the data in Table 4-39 can be used to estimate the population of the core study area at 3,481,117 (including 3,137,196 in Dakar) and that of the extended study area at 3,563,743.

Table 4-39. Population Estimates in Core and Extended Study Areas – Senegal Portion.

Towns and Villages	Population	Source and Year
Core Study Area		
Saint-Louis	230,801	Estimate for 2015 (ANSD/RGPHAE, 2014)
Saint-Louis Island	Not available	
Langue de Barbarie	*70,532*	SRSD Saint-Louis, 2012, cited by Tropica, 2017b
Guet Ndar	*26,000*	Neighborhood development committee of Guet Ndar, cited by Tropica, 2017b
Ndar Toute	*11,644*	Medical Region of Saint-Louis, cited by Tropica, 2017b
Goxxu Mbacc	*23,288*	Medical Region of Saint-Louis, cited by Tropica, 2017b
Hydrobase	*14,000*	Neighborhood development committee of Hydrobase, cited by Tropica, 2017b
Sor	Not available	
Commune outskirts	*10,234*	2010 census (SRSD Saint-Louis), cited by Tropica, 2017b
Main coastal fishing villages between Saint-Louis and Dakar	*54,810*	
Niayam (Potou)	*1,500*	2015 (Kosmos, 2015)
Lompoul-sur-Mer	*10,000*	Regional Fisheries Service of Louga, cited by Tropica, 2017b
Fass Boye	*15,000*	Village chief of Fass Boye, cited by Tropica, 2017b
Mboro Ndeundekat	*2,000*	2015 (Kosmos, 2015)
Cayar	*29,810*	Administration of Cayar, cited by Tropica, 2017b
Dakar	3,137,196	ANSD/RGPHAE, 2014
Sub-total, core study area	3,481,117	
Extended study area		
Villages of Le Gandiolais along the mouth of the Senegal River*	6,038	Estimate from community data and other sources, cited by Tropica, 2017b
Rural *commune* of Gandon**	40,673	2013 RGPH (census) cited by the commune de Gandon, 2015
Rural commune of Diama	35,915	Communauté Rurale de Diama, 2010
Total, extended study area	3,563,743	

* Estimate by default, as data are missing for 1 of the 9 villages. See details for number of inhabitants per village in Appendix H.
** Available figures indicate that in 2011, the island of Bopp Thior had 184 inhabitants and the village of Fass Dieye had 192 inhabitants (Semis, 2011, cited by Tropica, 2017b).

4.7.3.2 Migration

The Senegalese migrate, whether within the country or abroad, essentially for four reasons: search for employment (73.4%), education (12.2%), family reasons (6.9%), and marriage (3.3%) (ANSD/RGPHAE, 2014).

Dakar is the main hub of domestic migration due to the concentration of the majority of the country's public services, infrastructures, employment and economic activities. In Dakar, there are also migrants from other countries of the subregion. Their presence is mainly attributable to the search for work.

In Saint-Louis, the main migration phenomenon involves the movement of fishermen to practice their activities abroad, notably in Mauritania, Guinea, Guinea-Bissau, and The Gambia, but also much more distant countries such as Angola and Gabon. Until recently, Senegalese fishermen benefited from the

Convention on Fisheries and Aquaculture, which was signed on February 25, 2001 between the Republic of Senegal and the Islamic Republic of Mauritania. Up until this agreement was suspended in early 2017, the migratory flows of fishermen from Saint-Louis to Mauritania, notably Nouadhibou and Nouakchott, were very significant. This migration of fishermen from Saint-Louis to Mauritania has come to an end. The few fishermen who have illegally attempted to enter Mauritanian territorial waters have for the most part been intercepted by the Mauritanian Coast Guard and their fishing gear confiscated. In the view of leaders within the Union of Artisanal Fishing Professionals, the termination of the fishing agreement between the two countries has had a profound effect on Saint-Louis fishermen (Tropica, 2017b).

Besides international migrations, Guet Ndar fishermen are known for their temporary or permanent migrations within the country. In Senegal, one of their main destinations is Cayar. Founded circa 1871, Cayar has become a favorite destination for residents of Guet Ndar ever since its sea canyon and rich fishing grounds were discovered around 1935. In fact, generations of Guet Ndarians have settled in Cayar. This permanent settlement of Guet Ndarians is also observed in other coastal villages.

The movements of fishermen are not limited to those of Guet Ndar. The numerous movements of Senegalese fishermen all along the country's coasts are driven by the search for good fishing grounds.

4.7.4 Education

4.7.4.1 Literacy

The illiteracy rate[46] in Senegal is estimated at 54.6% (62.3% for women versus 46.3% for men) (ANSD/ RGPHAE, 2014).

There are great variations between urban areas and rural areas. Dakar shows the highest literacy rate in Senegal: 69.0% for men and 54.8% for women (RGPHAE 2014, cited by Tropica, 2017d). Saint-Louis ranks eighth with a literacy rate in the order of 47.2%, i.e. slightly less than half the population (ANSD, 2013, cited by Tropica, 2017d).

In the fishing neighborhoods of Saint-Louis and the other fishing communities on the Grande Côte, literacy rates are not known.

4.7.4.2 School Enrolment and Education Level

In Senegal, school enrolment of the population aged 3 and over is estimated at 58.7% (i.e. 41.3% of the population has never attended school). In rural areas, the proportion of the population that has never attended school is 52.2%, compared to 28.3% in urban areas. Data concerning educational levels show gender-based variations depending on the level. In primary school, there is an equal distribution or even an advantage for girls (51.7% for girls versus 48.3% for boys). From secondary school to higher education, the trend is reversed. At the university level, women make up just 21.1% of the student body, versus 78.9% for men. This situation is mainly caused by the social and family obligations that fall on women such as domestic tasks, early marriages and pregnancy (ANSD/RGPHAE, 2014).

A study of Senegalese fishing communities (ANSD, 2008[47]) indicates that the most educated people in the fishing villages are often the heads of the fishing units. They, too, have low levels of schooling, however. In this government study conducted among 340 fishermen, 20.6% of the fishermen had no education, 31.2% had reached primary school, 9.1% had reached secondary school, 1.2% had a level of schooling higher than secondary, 34.4% had attended a Quranic school, and 3.5% were literate in one of the national languages (other than French, the country's official language) (ANSD, 2008).

4.7.4.3 Educational Infrastructure

Dakar and Saint-Louis have educational infrastructures and services of all levels, from primary to university.

[46] Persons aged 10 and over who lack the ability to read and write in at least one language.
[47] The ANSD has not published a more recent study on the fishing communities.

The fishing neighborhoods of Saint-Louis have five primary schools, one French-Arabic school and one middle school. The enrolment at these establishments, the number of classrooms and the number of teachers are provided in Appendix H.

4.7.5 Economic Conditions, Employment and Means of Subsistence

4.7.5.1 Labor Force and Employment

Senegal's working-age population, i.e. persons aged 15 and over, is estimated at 7,728,868 (58.2% of the country's total population) (ANSD/RGPHAE, 2014). People of working age can be divided into the economically active and economically inactive populations. The economically active population corresponds to persons who work and those who are unemployed but seeking work, while the economically inactive population includes, for instance, students, housewives, retirees, etc. The unemployment rate in Senegal is estimated at 25.7% (ANSD/RGPHAE, 2014). This rate masks disparities based on place of residence and gender. At the national level, unemployment affects women more than men, regardless of place of residence. In urban areas, the unemployment rate is 17.7% (12.0% for men and 28.1% for women). In rural areas, this figure is estimated at 33.4% (23.6% for men versus 53.0% for women). Overall, the unemployment rate across the country is 18.0% for men versus 40.4% for women (ANSD/RGPHAE, 2014, cited by Tropica, 2017d).

In urban areas, workers are often employees, while in rural areas, they are mostly independent workers (farmers, fishermen, etc.). Temporary jobs are common in urban areas, especially in the informal sector (ANSD/RGPHAE, 2014, cited by Tropica, 2017d).

In the core study area, it is noted the region of Dakar has the most people of working age, i.e., 2,094,523 individuals, and it also has the lowest unemployment rate, i.e., 14.9% (9.7% for men, 24.1% for women). The unemployment rate is 24.9% in the region of Saint-Louis (17.4% for men and 43.3% for women), 24.6% in the region of Thiès (18.0% for men and 39.3% for women), and 30.8% in the region of Louga (21.3% for men and 50.2% for women) (ANSD/RGPHAE, 2014, cited by Tropica, 2017d).

There are no statistics on unemployment in the fishing communities. However, the municipal and customary authorities met with in the context of collecting secondary data in March-April 2017 indicate that unemployment in these communities is low, considering that the majority of the population is engaged in fishing-related activities. For example, on the Langue de Barbarie, men (minors and adults) are engaged in fishing, in situ landings and transport, small-scale wholesaling, etc. Women are responsible for supplying the town markets with fishery products and processing such products. Older residents and children perform minor repairs of fishing material (Tropica, 2017b). In other localities such as Cayar, the unemployment rate is also believed to be rather low. In the case of Cayar, for example, notwithstanding young graduates who have been unable to find work, all young people in the locality are engaged either in fishing or in market gardening (Tropica, 2017e).

4.7.5.2 Primary Economic Activities and Means of Subsistence of Communities

Economic conditions in the core study area vary considerably, as the area encompasses fishing communities and two urban centres, including the national capital.

Dakar

Dakar contains 80% of Senegal's transportation infrastructure (SRSD Dakar, 2015), and it is estimated that between 70% and 80% of the country's economic and administrative activity takes place in the city. Its economy is diversified, and the city hosts most of the country's industries, headquarters of governmental institutions, NGO offices as well as trade and service enterprises. The accommodation establishments in the capital also make the latter an important destination and transit centre for business tourism. The informal sector is very important, and is particularly developed in the areas of trade and services (Photo 4-37).

Photo 4-37. View of Downtown Dakar.

Saint-Louis

Former capital of Senegal, Saint-Louis is an administrative city that is home to numerous governmental structures. Its economy is heavily based on artisanal fishing and tourism.

The former employs a significant portion of the city's population, primarily that of the Langue de Barbarie, where the fishing neighborhoods are established. Saint-Louis is home to the largest number of fishermen in Senegal and the greatest concentration of pirogues (Photo 4-38). In 2016, artisanal fishing provided approximately 22,000 direct jobs (fishermen), i.e. nearly 30% of the Langue de Barbarie population (Regional Fisheries Service of Saint-Louis, 2016, cited by Tropica, 2017b). Further details on artisanal fishing and associated activities are presented in Section 4.7.6.

Photo 4-38. Pirogues Docked on the Small Branch of the Senegal River in Guet Ndar, with Saint-Louis Island in the Background.

Tourism revolves around the city's historic and cultural heritage. The island of Saint-Louis has been designated a UNESCO world heritage site since 2000. The city's location on an island in the Senegal River and its colonial architecture dating back to the 17th century lend it a unique character (Photos 4-39 and 4-40). Given that the city enjoys a unique marine ecosystem (mouth of the Senegal River converging with the Atlantic Ocean), beach tourism is also developed here. Hotels are located on the seafront on the southern part of the Langue de Barbarie. Tourism provides numerous jobs in the city (hotel staff, tour guides, antique dealers, shopkeepers, small entrepreneurs, etc.) (SRSD Saint-Louis, 2015).

Photo 4-39. Road on Saint-Louis Island.

Photo 4-40. Governance of the Region of Saint-Louis.

Coastal Fishing Communities between Saint-Louis and Dakar

The coastal fishing communities lying between Saint-Louis and Dakar present similar characteristics. The main economic activity and source of revenue for these communities is fishing and related activities (see Photos 4-41 to 4-44).

With the exception of market gardening, other economic activities in the villages are marginal. Indeed, these communities are located in the Niayes area, which provides nearly 75% of the country's market gardening production. Market gardening is the second most important source of income for these communities (Municipal Development Agency, cited in Kosmos, 2015).

Additionally, Lompoul-sur-Mer offers tourist activities. The desert of Lompoul located adjacent to the village represents a tourist attraction that is being promoted, namely through an annual festival called the "Festival of the Sahel". A few campgrounds provide accommodation for tourists.

Lastly, a small number of residents of the coastal villages are employed in the mining sector, e.g., the Taïba phosphate mine in Mboro and the extraction of mineral sands in Diogo, near Fass Boye.

Photo 4-41. Fishermen in Niayam.

Photo 4-42. Fish Dock in Lompoul-sur-Mer.

Photo 4-43. Fish Processing in Fass Boye.

Photo 4-44. Transport of Fishery Products in Fass Boye.

Extended Study Area

In the extended study area, the communities in the villages of Senegal River Delta live mainly off irrigated agriculture and, to a lesser extent, river fishing in the Senegal River or its distributaries.

4.7.6 Fisheries

This section provides socio-economic information on fishing that summarizes and completes the information presented in Section 4.5.4.2 and in Appendices E-2 and E-4. In this section, reference to fish generally needs to be understood in the broader sense of fishery resources, including for instance crustacean and cephalopod species.

4.7.6.1 Overview of Fishery Sector

Senegal has a long tradition of fishing, the social and economic importance of which has been continually growing in recent decades. Fishing is organized into two sub-sectors: artisanal fishing, which is conducted using pirogues, and industrial fishing, which is carried out from larger boats (domestic and foreign trawlers)[48]. The artisanal sub-sector produces approximately 80% of national production, i.e., 350,000 tonnes (CSRP-SÉNÉGAL, 2017). The exclusive zone dedicated to artisanal fishing under Senegalese legislation is located between 0 and 7 nautical miles (12.96 km) from shore along the entire

[48] Permits issued for artisanal or industrial fishing are not associated with specific geographical locations, except for the coastal zone reserved for artisanal fishing.

coastline (SRFC, 2017). Industrial fishing boats are prohibited from fishing in this exclusive zone. However, artisanal fishermen are not obligated to stay within this area.

The fishery employs approximately 63,000 Senegalese fishermen, 94% of whom are artisanal fishermen. Auxiliary or secondary fishing activities (processing, sales, etc.) employ more than 600,000 people, which represents approximately 15% of Senegal's labor force (CSRP-SÉNÉGAL, 2017). In 2014, fishing generated approximately 278 billion FCFA (approximately US$ 488 million[49]).

In addition to being important for the economy, fishing is also important for the health of the communities. It is estimated that fishing satisfies approximately 75% of the national population's animal protein requirements (CSRP-SÉNÉGAL, 2017) and, with an annual consumption of 24.5 kg per person (USAID, 2015), Senegal is one of the largest consumers of fish per capita in Africa.

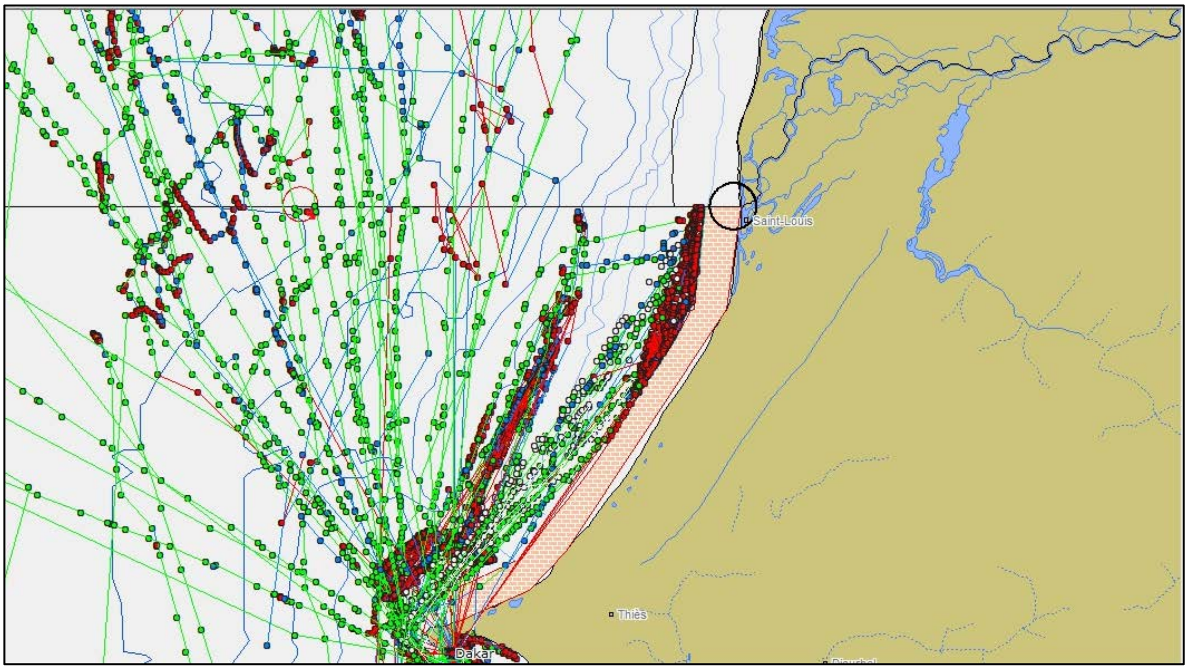
In Senegal, monitoring of fisheries is conducted by two departments of the Ministry of Fishery and Maritime Economy: the Department of Maritime Fisheries (*Direction des Pêches Maritimes*) and the Department for Protection and Surveillance of Fisheries (*Direction de la Protection et de la Surveillance des Pêches*). Additionally, scientific monitoring of maritime fishing activities and oceanographic research are conducted by the Dakar-Thiaroye Centre for Oceanographic Research (*Centre de Recherches Océanographiques de Dakar-Thiaroye* [CRODT]).

4.7.6.2 Industrial Fishing

Industrial fishing is practiced in waters lying outside the exclusive zone reserved for artisanal fishing. The industrial fishing fleet in Senegal operates under Decree n° 2016-1804 implementing Maritime Fishing Code Law n° 2015-18 of July 13, 2015, which authorizes four types of licenses: 1) coastal pelagic fishing; 2) *hauturière* pelagic fishing; 3) coastal demersal fishing; and 4) deep-water demersal fishing. In 2015, the industrial fishing fleet comprised a total of 140 boats (including 105 domestic boats) with total landings of 85,095 tonnes (out of which 56% came from domestic boats) (Tropica, 2017a).

Industrial fishing landings are concentrated in Dakar, though industrial fishing takes place off the entire Senegalese coastline (Figure 4-34). It should be noted that, only tuna boats operate in the waters close to the GTA project's offshore area, with bottom trawlers stopping at 600 meter-deep waters. (Tropica, 2017f).

[49] As of July 16, 2017, US$ 1 = 568.812 FCFA



Source: Direction de la Protection et de la Surveillance des Pêches (DPSP) (as provided by P.S.Diouf in July 2017)

Legend:
Dots: industrial fishing vessels (National and Foreigners) with a fishing license to operate in Senegal
Blue dots: vessels conducting fishing activities and therefore moving at a low speed; Red dots: vessels moving at a medium speed in search of fish banks and fishing areas; Green dots: vessels moving at a greater speed, in transit from one fishing area to another.

Figure 4-34. Industrial Fishing Boat Activity off Grande Côte between July 1 and 25, 2017.

Due to industrial fishing's low contribution to landings, frozen fish plants and processing factories are increasingly turning to artisanal fishing operators for their provisions (PAS, 2015).

The main industrial fishing associations are the Senegalese Association of Ship Owners and Industrial Fisheries (GAIPES) and the National Union of Fishmonger EIGs of Senegal (UPAMES).

In addition to industrial fishing ships operating under license, industrial fishing boats are also known to operate illegally in Senegalese maritime waters. In 2017, this illegal fishing was widely denounced internationally[50]. Consequently, it is highly probable that illegal industrial fishing is practiced in the core study area. The DPSP keeps records of offences committed when illegal vessels are arrested and has some information on illegal fishing. However, existing data does not allow to fully characterize illegal fishing. Fishing ships operating without a fishing license represents an offence with regard to the law.

4.7.6.3 Artisanal Fishing

Artisanal fishing is practiced by a number of coastal communities in Senegal and in the core study area in particular. This is an activity practiced with craft called pirogues, which are made of wood[51], measure between 4 and 25 m long and are motor-driven with engines rated 15 hp, 40 hp or 60 hp (Tropica, 2017a).

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50 Notably, New York Times published an article on this issue on April 30, 2017 (New York Times, 2017). According to the article, numerous industrial ships from foreign countries (notably China) fish illegally off the Senegalese coast, often at night or on the fringes of Senegal's 200 nautical mile-wide EEZ, well out of reach for the country's navy.

51 There are also a few pirogues built of fiber glass, though for the most part the fleet is composed of wooden pirogues that are made locally.

The Senegalese pirogue fleet is by far the largest in West Africa. The most recent national census conducted in 2015 indicates 19,009 artisanal fishing units, 90% of which were motorized (CSRP-SÉNÉGAL, 2017).

There is no consensus as to how far from the coast artisanal fishermen practice their activity. This question was examined in 2015 at the time of the ESIA performed for the exploratory drilling project in the Saint-Louis Offshore Deep and Cayar Offshore Deep blocks. According to the Regional Department of Maritime Fishing of Saint-Louis, no fishing activity is carried out in the deep waters off the coast of Saint-Louis: 90% of Saint-Louis fishermen fish near the coast and in waters less than 200 m deep, while 10% fish in the waters of neighboring countries (Kosmos, 2015). According to the Regional Department of Maritime Fishing of Thiès, which is responsible for the Cayar region, artisanal fishing is practiced up to 50 or 60 km from the coast (Kosmos, 2015). Fishermen sometimes venture into the high seas when they are in transit to other fishing grounds in Senegal or other countries of the sub-region. However, fish are generally caught in waters near the coast. Indeed, artisanal fishing techniques do not lend themselves well to fishing in water depths exceeding 200 m.[52]

In Senegal, artisanal fishermen can fish wherever they want, regardless of the village or the city they live in. There are no community-based customary claims to stretches of shoreline or areas immediately adjacent to coastal villages. There are no traditional systems that define ownership, access to and use of fishing resources or fishing grounds in the maritime waters.

The most accurate information on the main fishing grounds comes from scientific data provided by CRODT. CRODT compiles data on the main artisanal fishing grounds of the fishing communities, notably between Dakar and Saint-Louis. Data are reported for the following areas: Oukam (Dakar), Cayar, Fass Boye/Mboro, Potou, and Saint-Louis.

The data provided by CRODT, including the Wolof name used by local fishermen to designate each fishing area, are indicated in the map on Figure 4-35[53].

[52] The only exception is longline fishing, which is occasionally practiced in deeper waters, but even in these cases, it rarely takes place in water depths of more than 200 m (Tropica, 2017e).

[53] The database used for this figure provides main locations without details on type of fishing conducted or gear used at these locations.

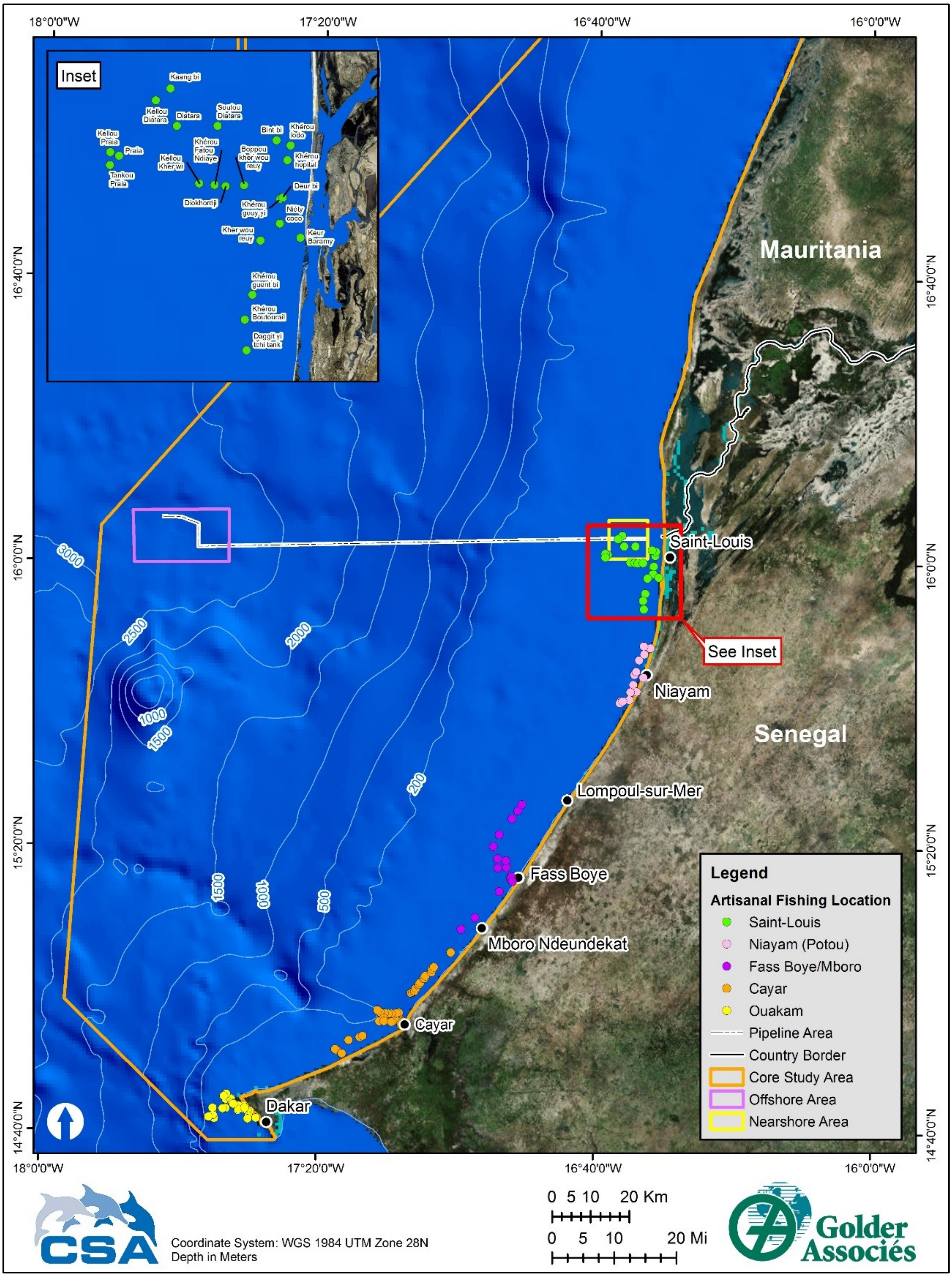


Figure 4-35. Location of Artisanal Fishing in the Core Study Area – Senegal Portion.

Evidently, fishing grounds shift as a function of the movements (seasonal movements in particular) of fishery resources. Consequently, the locations of the main fishing grounds must not be considered to be static data. These data must be interpreted in a holistic manner. The general portrait that emerges is that artisanal fishing takes place near the coast. The approximate distances between the points illustrated in the figure and the coast are provided in Table 4-40. For the area off the coast of Saint-Louis, this distance varies between 400 m and 14.7 km.

Table 4-40. Approximate Distance of Artisanal Fishing Grounds from Coast – Senegal Portion.

Artisanal Fishing Ground	Distance from Coast (m)				
Cayar	200				
	7,000				
Fass Boye / Mboro		800			
		10,200			
Ouakam			60		
			8,100		
Potou				80	
				2,100	
Saint-Louis					400
					14,700

Calculations based on the coordinate system: WGS 1984 UTM Zone 28N

Minimum distance

Maximum distance

In Saint-Louis, maritime artisanal fishing is practiced by fishermen from the four neighborhoods of the Langue de Barbarie. As of 2016, the Langue de Barbarie had 3,411 registered pirogues, approximately 22,000 fishermen, 1,000 women processors and 150 fishmongers. In terms of fishing infrastructure, there are 2 fish docks, 3 fish processing sites, 8 ice plants, and 19 pirogue fueling stations (Regional Fisheries Service of Saint-Louis, 2016, cited by Tropica, 2017b).

In 2016, landings on the Langue de Barbarie were evaluated at more than 63 731 tonnes with a market value of 15,450,000,000 FCFA[54] (SRPS, 2016, cited by Tropica, 2017g), this corresponding to US$ 27,161,874[55]. In 2016, more than 87% of the landings on the Langue de Barbarie are intended for wholesale; the area supplies fish to all of Senegal's regions and even other countries of the subregion such as Mali and The Gambia. Of all landings, only 4.4% is destined for the population of Saint-Louis's consumption and the remaining landings are used for artisanal processing (Tropica, 2017a).

Based on the detailed data provided in Appendix E-4, it can be estimated that in Saint-Louis:

- There is an average of 6.4 fishermen per pirogue;
- The average monetary value of one tonne of landed product in Saint-Louis is 242,435 FCFA (US$ 426); and
- Each woman processor produces approximately 25 tonnes of fish a year.

[54] Data on landing volumes and values are not always identical from one consulted reference to the next; those used in this report are from the Regional Fisheries Services indicated in Appendix E-4.

[55] As of July 16, 2017, 1 US $ = 568,812 FCFA

It is not possible to estimate the average monetary value of annual production per pirogue in Saint-Louis or in another community in the Grande Côte. Indeed, fishermen of this region, and particularly those of Saint-Louis, often migrate and for instance pirogues registered in Saint-Louis can land their catches in other localities.

Fishermen from the Langue de Barbarie are active day and night, but night fishing is more important than day fishing. Day fishing consists of launching in the morning (between 06:00 and 08:00) and returning in the late afternoon (approx. 17:00-18:00). Night fishing entails launching around 16:00 and returning the following morning around 08:00 to 09:00.

The extremely high number of pirogues operating in coastal waters near Saint-Louis was observed in April 2017 during the gathering of scientific data at sea by the Sea Surveyor (Figure 4-36). The ship was positioned less than 10 km off the coast of Saint-Louis. In this radar image, the mass on the right is the Saint-Louis coastline while the yellow points on the left are pirogues.

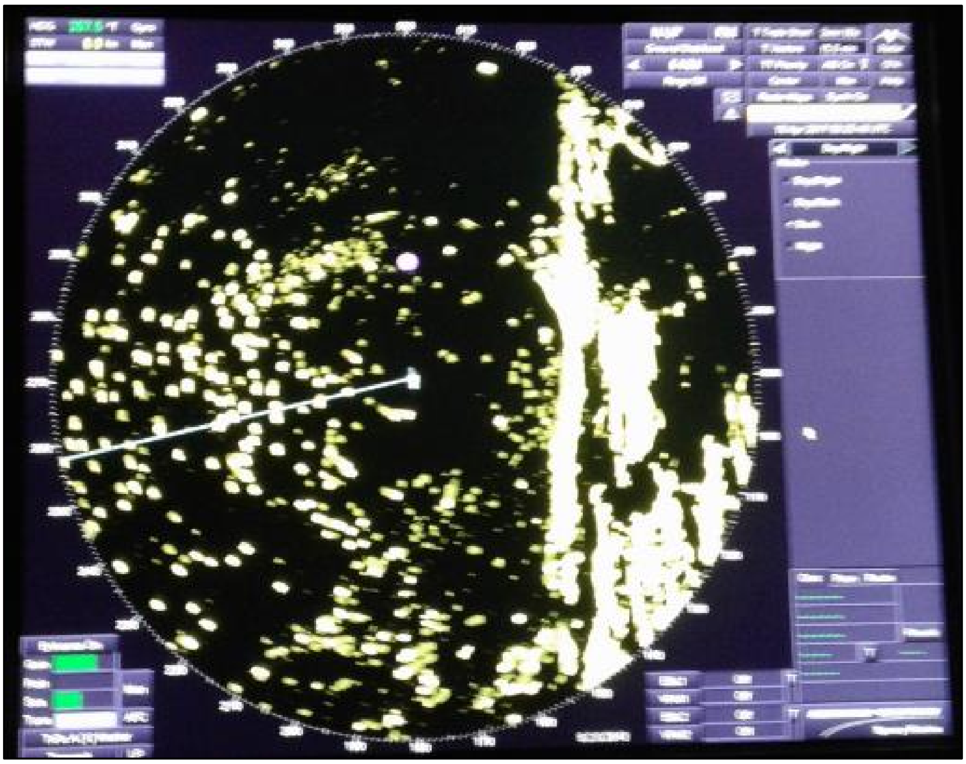


Figure 4-36. Radar Image of Sea Surveyor – April 13, 2017 at 05:00.

Additional details on fishing in the communities of the Langue de Barbarie are available in Appendices E-2 and E-4.

Besides the fishermen of Saint-Louis, the Grande Côte includes other fishing communities, the most important of which are: Cayar, Mboro Ndeundekat, Fass Boye, Lompoul-sur-Mer, and Niayam (Potou). Artisanal fishing practices vary by locality, notably as a function of marine zones, the seasons, and the socio-economic conditions of the fishing communities.

In Cayar, the fishery production landed in 2016 amounted to 34,643 tonnes for an estimated market value of 16,421,136,000 FCFA, which corresponds to US$ 28,869,180[56] (Tropica, 2017g). The number of fishermen in Cayar varies depending on the fishing season. In the low season (July to October),

[56] In Saint-Louis, small pelagics are abundant in catches and are of low commercial value, while in Cayar there are many species of high commercial value, which in part explains why the commercial value of catches in Cayar is relatively higher than in Saint-Louis (Tropica, 2017g).

when activities are at their lowest level, fishermen number approximately 3,000. During the high season (November to June) their number can increase to 6,000. There are an estimated 15 women processors, 329 fishmongers, and 1,032 registered pirogues. Cayar has 4 ice plants, 10 fueling stations, 3 fish docks and 1 fish processing site (Cayar Departmental Fisheries Service, 2016, cited by Tropica, 2017b). Appendix E-4 presents further details on the various fishing stakeholders and infrastructures in Cayar.

In Mboro Ndeundekat, data on the volume and value of landings are not available. In this locality, fishing involves 229 registered pirogues, 985 fishermen, 57 fishmongers, and 47 women processors (Mboro Fisheries Service, cited by Tropica, 2017b). Fishing takes place year round, with the peak season extending from March to July. Appendix E-4 presents further details on the labor force of various fishing stakeholders in Mboro Ndeundekat.

In Fass Boye, landings in 2016 reached 21,592 tonnes for an estimated market value of 8,322,735,500 FCFA, i.e. US$ 14,631,786. The pirogue fleet is estimated at 513 registered pirogues; additionally, there are approximately 3,500 fishermen, 110 fishmongers, and 700 women processors. There are in Fass Boye: 1 fish dock and 1 fish processing site (Fishery Control Post of Fass Boye, 2016, cited by Tropica, 2017b). Appendix E-4 presents further details on the various fishing stakeholders and infrastructures in Fass Boye.

In the village of Niayam (Potou), landings in 2016 amounted to 588 tonnes for an estimated market value of 418,415,000 FCFA, which corresponds to US$ 735,595. The village comprises 41 registered pirogues, 230 fishermen, 25 fishmongers, and 119 women processors. In terms of fishing infrastructure, Niayam has a fish dock (which includes a fish processing site) that was inaugurated in March 2017, and 2 fueling stations (Regional Fisheries Service of Louga, 2016, cited by Tropica, 2017b). Appendix E-4 presents further details on the various fishing stakeholders and infrastructures in Niayam.

In 2016 in the village of Lompoul-sur-Mer, landings reached 1,929 tonnes for an estimated market value of 759,121,000 FCFA, which translates into US$ 1,334,573. This village comprises 149 registered pirogues, 420 fishermen, 40 fishmongers, and 300 women processors (Regional Fisheries Service of Louga, 2016, cited by Tropica, 2017b). The village's fishing infrastructure are 1 fish dock, 1 fish processing site, 1 ice plant, and 3 fueling stations. Appendix E-4 presents further details on the various fishing stakeholders and infrastructures in Lompoul-sur-Mer.

The following Table 4-41 summarizes the main available data on fishing stakeholders and the quantities of fishery products landed and their value in Saint-Louis and the other fishing communities of the Grande Côte in 2016. It can be seen in this table that:

- The Grande Côte accounts for 33,135 fishermen and 5,375 pirogues. Approximately 2/3 of the total pirogue fleet (63.5%) and total number of fishermen (66.4%) are concentrated in Saint-Louis. Cayar is the second-largest locality in terms of the number of pirogues and fishermen. However, it is far behind Saint-Louis since it only comprises 19.2% of the pirogue fleet and 18.1% of the total number of fishermen.
- The Grande Côte accounts for 2,449 women processors and Saint-Louis comprises 40.8% of them. The second place of concentration of women processors is Fass Boye with 28.6% of the total number. Despite the size of the fishing population in Cayar, this locality has a smaller number of women processors than Saint-Louis and Fass Boye. In fact, only 6.1% of the women processors of the Grande Côte are in Cayar.
- It appears that there are 711 fishmongers in the Grande Côte, with a high concentration in Cayar (46.3%), while Saint-Louis has only 21.1% of the total number. These figures should be considered with caution because the term fishmonger covers a broad set of categories of intermediaries and it is possible that they are not recorded uniformly in each of the localities. As a result, the number of fishmongers in Saint-Louis may be higher than 150. However, Cayar may also have a high concentration of fishmongers because of the high commercial value of products landed there and the proximity of Dakar, where a large part of the national consumption takes place and where the export takes place for the international market.
- In 2016, fishermen on the Grande Côte landed 122,484 tonnes of fish products for a total value of about 41.3 billion FCFA, or about US$ 72.7 million.

- Saint-Louis is by far the main locality in terms of quantities of fish products landed, with 63,731 tonnes, or 52.0% of the catches of the Grande Côte. Cayar is far behind with 34,643 tonnes, or 28.3% of the total catches. However, the commercial value of catches landed at Saint-Louis (15.4 billion FCFA) is lower than in Cayar (16.4 billion FCFA). The commercial value of the products landed in Cayar represents 39.7% of the total value of the catches of the Grande Côte. Saint-Louis contributes to only 37.3% of this total value despite the fact that more than half of the catches are landed there.

Table 4-41 provides useful information on quantities of fish products landed in the localities of the Grande Côte and their monetary value. However, we cannot link the fish landings in Saint-Louis to the pirogues registered in that locality to estimate the tonnage or the monetary value of catches/pirogue of the Saint-Louis fishermen. Fishermen do not limit themselves to waters close to the locality where they live. Senegalese fishermen, notably those from Saint-Louis, are known to travel and fish all along the coast and in neighboring countries. The fish landings occur wherever it is more convenient. The important geographical mobility of the Senegalese fishermen makes the analysis of their revenues yet more complex.

Table 4-41. Summary Table of Fishing by Site in 2016 – Senegal Portion.

Zone	Number of Pirogues	Propor-tion of Total	Number of Fisher-men	Proportion of Total	Number of Women Proces-sors	Proportion of Total	Number of Fish-mongers	Proportion of Total	Quantity of Fishery Products Landed (kg)	Value of Landed Products (FCFA)	Value of Landed Products ($US)
Saint-Louis	3,411	63.5%	22,000	66.4%	1,000	40.8%	150	21.1%	63,731,000	15,450,000,000	27,161,874
Cayar	1,032	19.2%	6,000	18.1%	150	6.1%	329	46.3%	34,643,340	16,421,136,000	28,869,180
Mboro Ndeundekat	229	4.3%	985	3.0%	180	7.3%	57	8.0%	n/a	n/a	n/a
Fass Boye	513	9.5%	3,500	10.6%	700	28.6%	110	15.5%	21,592,339	8,322,735,500	14,631,786
Niayam (Potou)	41	0.8%	230	0.7%	119	4.9%	25	3.5%	587,790	418,415,000	735,595
Lompoul-sur-Mer	149	2.8%	420	1.3%	300	12.2%	40	5.6%	1,929,500	759,121,000	1,334,573
Total	5,375	100.0%	33,135	100.0%	2,449	100.0%	711	100.0%	122,483,969	41,371,407,500	72,733,008

n/a: not available

4.7.6.4 Fishing-Related Economic Activities

A number of economic activities related to fishing are carried out in the communities of the study area, notably on the Langue de Barbarie: wholesaling, artisanal processing, transport, and commercialization of fishery products.

Fishmongers are a category of professionals who perform a number of functions: procuring fish on the beaches, handling and transporting fish to buyers within the country or abroad, and sometimes even financing of artisanal fishing[57]. Depending on the target market and their area of specialization, several types of fishmongers can be distinguished (small-scale fishmongers for local markets, national fishmongers for national market, etc.). Guet Ndar is a very important centre for domestic fishmongers (Photo 4-45) and this is evidenced by the number of trucks waiting to be loaded with fish. During a five-day field visit in March 2015, between Guet Ndar and Hydrobase, there were consistently over 130 trucks lined up along the shoreline waiting for pirogues to arrive. These trucks were in addition to those in the Guet Ndar parking lot built for this purpose and those parked at the same time in Ndar Toute and Goxxu Mbacc. Some trucks had come from as far away as Mali.

(Tropica, 2017b)

Photo 4-45. Fishmongers in Guet Ndar.

A fraction of artisanal fishing catches, usually the portion rejected by the fishmongers, is sold directly on the premises or processed artisanally in the communities for local consumption and commercialization. Part of the processed fish is also sold for export in neighboring countries. Artisanal processors are mostly women (Photo 4-46). Fishermen sell them certain species that are of less interest or catches that are not as fresh for processing. Processing operations have an important social function and are often the only source of revenue for women in the fishing villages. Fishery product processing covers a variety of practices, including braising, salting, fermenting and drying. Additionally, processed products are part of the typical Senegalese diet.

[57] Some pirogue owners, when lacking the means to fund a campaign at sea, may turn to fishmongers for support.

(Source: SIPA, 2016)

Photo 4-46. Processing Site in Cayar.

Other fishing-related trades that are found in the studied communities (ice porters, fish porters, carpenters, transporters, etc.) are presented in detail in Appendix E-4.

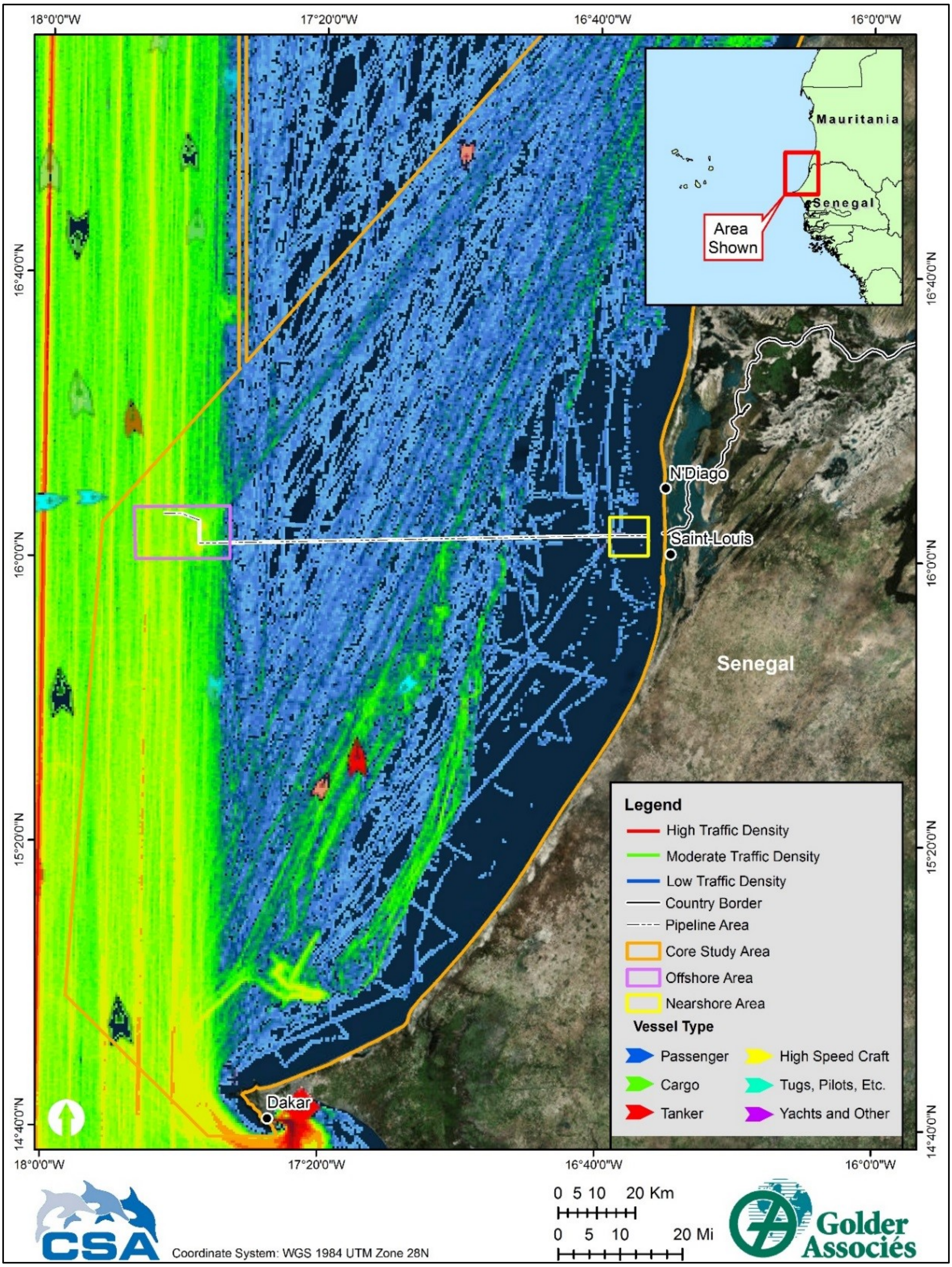
4.7.7 Other Maritime and Coastal Activities

In addition to fishing, a number of maritime and coastal activities are carried out in the study area: navigation and shipping, oil and gas exploration, telecommunication activities related to the presence of submarine cables on the ocean floor, and recreational and tourism activities. It is to be noted that there are also on the seabed some shipwrecks.

4.7.7.1 Maritime Navigation and Shipping

Senegal has four ports: Dakar, Kaolack, Ziguinchor, and Saint-Louis. The ports of Saint-Louis and Dakar are located within the core study area. The Port of Saint-Louis is in disrepair and is not heavily used. The Port of Dakar is a commercial port and is extremely important. It is Senegal's most important port, handling over 90% of the country's foreign trade (APIX, 2015). In 2015, the Port of Dakar registered 2,705 port calls and total traffic of 15,187,937 tonnes (Port of Dakar, 2017).

Maritime traffic transiting through the Port of Dakar is dense and the main shipping channel lies outside the core study area, as illustrated in Figure 4-37. This figure shows that the majority of maritime traffic in the study area takes place at the Port of Dakar. It is noted that the remainder of the core study area notably experiences moderate traffic in the offshore area and light traffic near the coasts. It is also observed that oil tankers contribute to this traffic.



Source: MarineTraffic. 2017

Figure 4-37. Maritime Traffic in Core Study Area – Senegal Portion.

4.7.7.2 Tourism and Recreation

There are four main types of tourism in Senegal: seaside tourism, business tourism, cultural tourism, and nature-based tourism. Seaside tourism dominates. For coastal communities, tourism can be both a source of earnings and a source of conflicts stemming from certain social phenomena (increased prostitution and drug trafficking) and land grabs made by building and hotel owners. The potential for seaside tourism is high along the entire Grande Côte due to access to the ocean, the quality of the beaches and the landscapes. In the core study area, this potential is harnessed essentially in Dakar and Saint-Louis (APIX, 2015a).

In Dakar, where most of the country's infrastructure and hotel establishments are found, tourism is generally associated with business activities. The local beaches are primarily frequented by residents of the city. However, tourists nevertheless take advantage of the seaboard since a number of hotels are established there. Additionally, one of the country's main tourist attractions is Gorée Island near Dakar (APIX, 2015b).

Saint-Louis offers seaside tourism, cultural tourism and nature-based tourism: attractions include the Atlantic Ocean, dune landscapes, rich biodiversity, the cultural and historical heritage of Saint-Louis Island, national parks, etc. (APIX, 2015b). Coastal resorts are concentrated in the southern part of the Langue de Barbarie, which comprises 20 tourist establishments including 7 hotels, 4 inns, 3 campgrounds, and 6 straw huts corresponding to a total of 632 beds spread across 279 rooms. Significant recreational activities are also practiced by local residents on the Hydrobase beach between July and October.

In Saint-Louis and on the Grande Côte in general, deep-sea sport fishing is not practiced except out of Dakar, where the activity remains very limited.

On the coast between Saint-Louis and Dakar, tourism is underdeveloped despite the presence of a sandy beach extending 200 km between Saint-Louis and Lake Retba (a.k.a. Lac Rose, Thiès Region). However, there are a few small campgrounds for tourists near the village of Lompoul-sur-Mer. The latter cater to tourists visiting the Lompoul desert.

In the extended study area, the main tourist destination is the Djoudj National Bird Sanctuary, which is the third-largest bird sanctuary in the world. Moreover, Guembeul Natural Reserve and Langue-de-Barbarie National Park are also featured in tourism packages, notably those organized by the Syndicat d'Initiatives de Saint-Louis. For the year 2014, these three sites registered 11,312 visitors (Regional Tourism Service, cited by Fall, 2015). Lastly, Le Gandiolais offers tourist attractions related notably to the presence of the Senegal River and the natural environment (dune landscapes, water bodies, water birds, etc.). No fewer than five tourist campgrounds are found along the river banks.

4.7.7.3 Submarine Telecommunication Cables and Shipwrecks

There are a number of submarine telecommunication cables on the ocean floor off the coast of Senegal that link to other countries or directly to Senegal. The cables that connect to Senegal are locally operated by the Société Nationale des Télécommunications (Sonatel). However, more submarine cables offshore the Senegalese EEZ may be present but these may not connect to Senegal.

- The three important fiber optic systems presently connected to Senegal are: ACE, Atlantis II and SAT-3/WASC (South Atlantic Telephone / West African Submarine Cable). The ACE fiber optic underwater communication system is a network of cables that runs along Africa's west coast. It provides a fiber optic link between France and South Africa and is managed by a consortium of 17 operators and administrations.
- Atlantis-II (or Atlantis-2) is a Trans-Atlantic fiber optic telecommunications cable that connects Argentina, Brazil, Cabo Verde, the Canary Islands, Portugal, and Senegal.
- As for the SAT-3/WASC system, it is an underwater fiber optic cable that runs 14,350 km along the west coast and southern part of the African continent.

The location of the known submarine telecommunication cables with respect to the project area is presented in Figure 4-38**.**

The seabed also contains shipwrecks. The Senegalese coast has been a place with an important maritime traffic since the beginning of European explorations of the precolonial era. During the transatlantic trade and then during the colonization, sites like those of Saint-Louis and Gorée were maritime crossroads with intense traffic. This resulted in a legacy of archaeological artefacts on the coast, as demonstrated by research on underwater archeology around the island of Gorée. This search for archives, limited to Gorée, suggests that the entire coast of Senegal might have a large number of wrecks (Archeo Navale, 2015). However, due to absence of sufficient effort, no other significant research has since been carried out. Beyond this possible marine archaeological heritage, there are also some modern shipwrecks, mainly of fishing boats. As illustrated on Figure 4-39, known wrecks are mostly around Dakar, those in the core study area are all within 20 nautical miles of the coast, and there are no known wrecks in the vicinity of the GTA project areas.

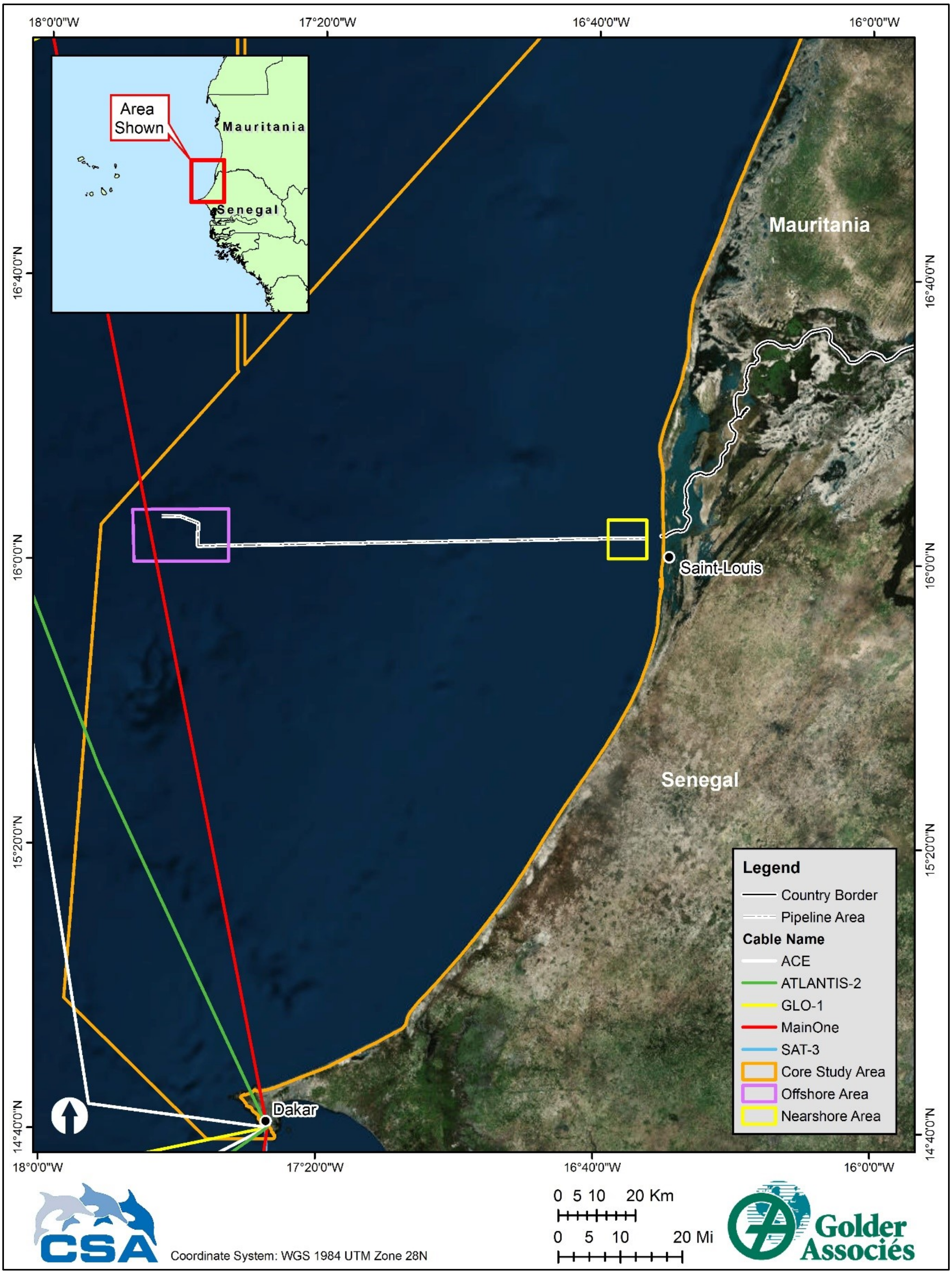
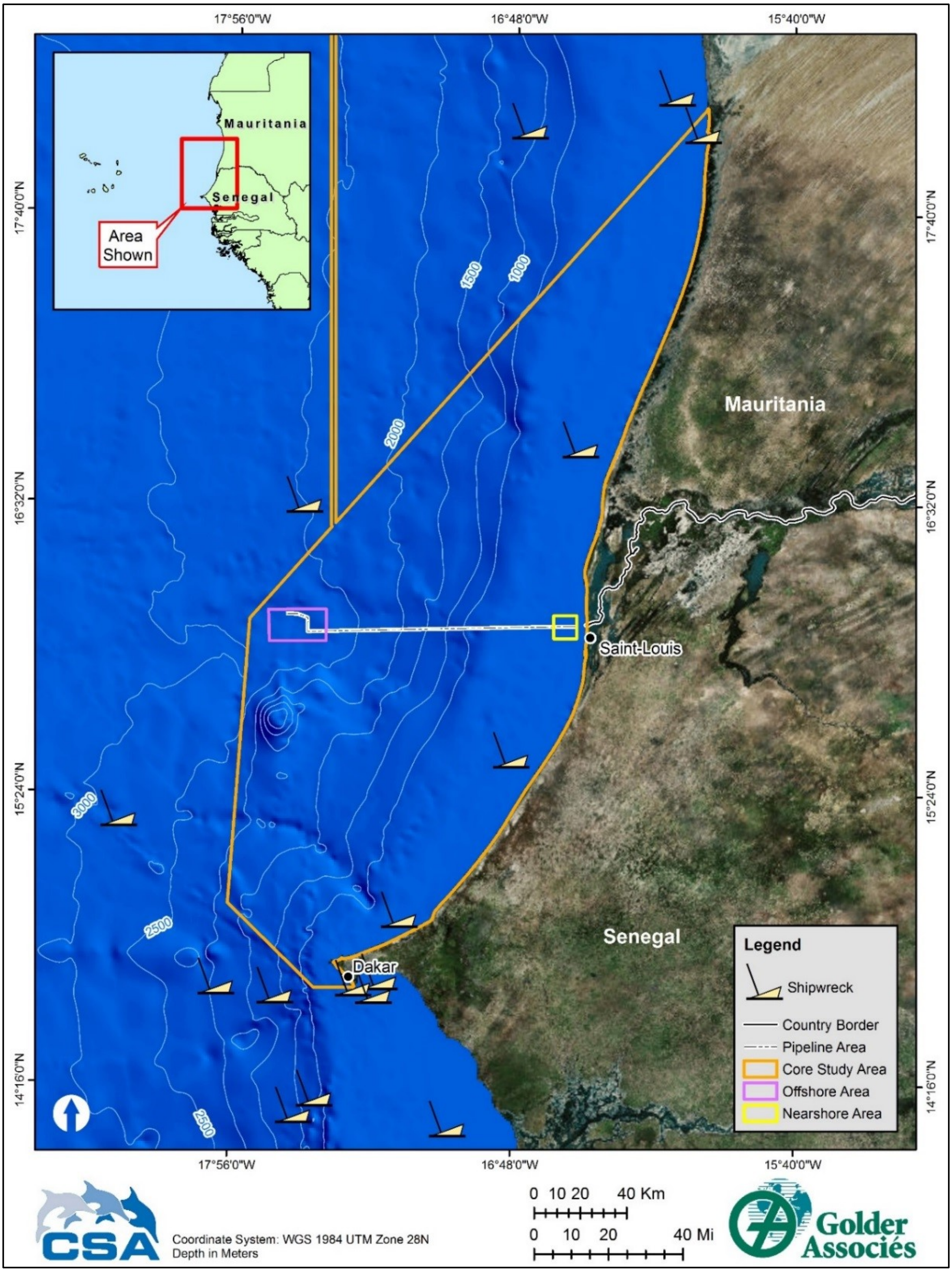


Figure 4-38. Submarine Telecommunication Cables in Core Study Area – Senegal Portion.



Source: Global Maritime Wrecks Database. 2017

Figure 4-39. Known Shipwrecks in the Seabed of the Core Study Area – Senegal Portion.

4.7.7.4 Oil and Gas Exploration and Production Activities

In Senegal, offshore exploration and drilling for hydrocarbons are recent activities and the first discovery of an offshore field was made in 2014 pursuant to prospecting carried out by Cairn Energy, its Senegalese subsidiary Capricorn Sénégal and the latter's joint venture partners. These developments notably took place south of Dakar, off the Petite Côte, in the Rufisque and Sangomar Deep Offshore blocks. In 2015, Kosmos conducted offshore exploration activities along the Grande Côte in the Cayar Offshore Deep and Saint-Louis Offshore Deep blocks. It was in these blocks that gas discoveries were announced by Kosmos in 2016 and in this context that BP partnered with Kosmos for the GTA project.

Appendix H provides a map of licensed blocks off the Senegalese coast. As indicated in the map, in addition to the partnership between Kosmos and BP, there are currently five offshore oil and gas operators: African Petroleum Corp., Capricorn Senegal Ltd/ First Australian Resources/ Woodside Energy Senegal, Total Sa, Oranto Petroleum Ltd., and Trace Atlantic.

4.7.8 Social Organization of Communities

In Dakar and Saint-Louis, the social organization of communities is generally modern. The city authority is the Mayor and the representatives of the central government are the Governor at the regional level and the Prefect at the departmental level.

In rural areas and in fishing communities, organization is more traditional. Each village/neighborhood comprises a certain number of families. Village or neighborhood leaders such as the village/neighborhood chief and the religious leader are chosen from among the heads of households.

Social organization in the fishing communities shows a number of particularities unique to these communities. Work is organized based on the family unit; the crew of a given pirogue is generally composed of members of the same family. For example, in the communities of Saint-Louis, learning and organization of the trade traditionally take place through the family. Boys as young as 9 or 10 years of age begin learning the profession by accompanying their fathers at sea. The captain of the pirogue is often the owner's eldest son, while the other sons are crew members. If the owner has several wives and several pirogues, boys will team up with their brothers from the same mother to form a crew. If the size of the pirogue or the type of fishing requires more people than the total number of sons (e.g. purse seining requires two pirogues), temporary workers may be hired (the latter are paid after each day of fishing). Daily work organization is related to the tides and weather conditions; departure and return times vary as a function of both. Women family members are generally involved in the processing and retail sale of the fishery products. Their daily schedules are also therefore punctuated by the departure and return times of the pirogues. Women's domestic chores and family meal times are also linked to the times the pirogues head out to sea and return. The interplay of family units and artisanal fishing largely explains the necessity for members of the same family to live together or in proximity to one another, hence the very high demographic density of the neighborhoods of the Langue de Barbarie. It should be noted that the formation of crews on the basis of kinship can have dramatic consequences. In fact, when accidents at sea occur, oftentimes all of the siblings perish, thus decimating the entire family.

In terms of associations, all of the fishing trades (purse seiners, longline fishermen, processors, fishmongers, transporters, etc.) have their own local associations, some of which bring together stakeholders from different sub-sectors, as in the case of the Union of Fishing Professionals of Saint-Louis. These associations are dynamic and make the fishing sector an organized and vocal sector whose lobbying capacity is non-negligible. Thus, it is common for representatives of the fishermen to meet with the authorities to defend their interests. For example, in May 2017, Saint-Louis fishermen, through their associations, engaged in discussions with the Governor of the region to present a number of suggestions, including the creation of a fund to help integrate fishermen who had been deported from Mauritania, providing financing for fishermen interested in switching to aquaculture, protecting residents from coastal erosion, establishing a credit line, and canceling the cooperation agreement with the European Union. Due to their demographic and economic weight, these communities have a certain negotiating power with the authorities.

Additionally, fishermen are sometimes affiliated with national fishing organizations. The three existing organizations are the National Federation of Economic Interest Groups of Fishermen (FENAGIE), the National Inter-professional Council of Artisanal Fishing in Senegal (CONIPAS) and the National Collective of Artisanal Fishermen of Senegal (CNPS). These national organizations allow the different communities to network and collaborate to defend their interests.

In addition to the professional fishing organizations mentioned above, certain fishermen are members of local artisanal fishing councils (CLPA), introduced by a ministerial order, whose purpose is to create and state the composition, the attributions and the mode of operation of these structures. Ministerial Order nº 9077 of October 8, 2010 created five CLPAs including those of Lompoul and of Saint-Louis; the latter covers Guet Ndar, Goxu Mbathie, Santhiaba et Hydrobase sites. CLPAs were set up to serve as bridges between local artisanal fishing stakeholders and public agencies. They are frameworks of cooperation that help manage conflicts, ensure the surveillance and monitoring of fisheries, and promote the co-management of resources.

Each CLPA is made up of representatives of colleges (wise or notable, local elected representatives, local administration, actors of the artisanal maritime fisheries such as fishermen, fish mongers, processors and related professions). Appointed by order of the head of the relevant administrative division (Prefect), the members of the council are 40 persons at most and at least three quarters are chosen from the fishing communities.

The CLPA is chaired by the head of the relevant administrative division; the secretariat is provided by the representative of the administration college who is an officer of the fisheries department of the locality where the council is established. The operational resources of the CLPA come from the contributions of the Ministry in charge of Fisheries, contributions from development partners, part of the annual fees for licenses for professions related to artisanal maritime fisheries or any other contributions. The council draw up and forward to the competent departments of the Ministry in charge of Fisheries an annual budget showing the needs and the sources of financing.In addition to these associations, communities also have other structures of social organization. For example, in all the neighborhoods of Saint-Louis, municipal authorities have established neighborhood councils. The latter are considered to be the interlocutors and the voice of the local populations on administrative matters. Neighborhood councils are composed of several members, including a president. As of June 2017, the president of the neighborhood council of Goxxu Mbacc is a woman, while the presidents of the three other neighborhoods of the Langue de Barbarie are men. Besides the presidents of the neighborhood councils, each neighborhood is represented by a neighborhood delegate (formerly called "neighborhood chief"). A neighborhood delegate is a community leader recognized or nominated by the devolved administration. He or she serves as a bridge between the said administration and residents. The neighborhood delegate also has administrative functions such as issuing residence certificates. The communities are also home to women's associations as well as youth and senior associations. Guet Ndar, for example, has an association of young fishermen and a council of elders. The latter, also called the *Conseil des vieux de la baraque* (loosely translated: council of the old-timers from the shacks), is a traditional advisory and conflict management body that has considerable influence on the population of the neighborhood.

The organizational models of the communities and their associations are detailed in Appendix E-4.

4.7.9 Public Health and Safety

4.7.9.1 Public Health Situation

According to available data, the main public health issue in Senegal is the prevalence of malaria, which is the No. 1 disease affecting the Senegalese population, followed by severe respiratory infections, skin diseases, diarrhea and anemia. In the absence of data at the level of the fishing communities between Dakar and Saint-Louis, it can be assumed that the national health profile is a good indicator of the local situation.

The region of Saint-Louis is particularly noteworthy in terms of the prevalence of malaria, as it is the region where this disease is the least present. For example, in Q1 of 2016, only 148 cases were recorded in the region of Saint-Louis, compared to 4,470 cases in Dakar and 2,185 cases in Thiès

(Ministry of Health, 2016c)[58]. In the fishing communities of the Langue de Barbarie, the most noteworthy pathologies are, in order of importance, colds, diarrhea, wounds, high blood pressure, STIs and epigastralgia. Moreover, Goxxu Mbacc, Guet Ndar and Pikine are the Saint-Louis neighborhoods in which tuberculosis is most widespread (Saint-Louis Health Neighborhood, 2015, cited by Tropica, 2017b).

HIV/AIDS Situation

In Senegal, the prevalence of HIV/AIDS in the general population between the ages of 15 and 49 is 0.7% (ANSD, 2013). The prevalence of HIV/AIDS among women aged 15 to 49 (0.8%) is higher than in men of the same age group (0.5%). Additionally, analysis of the epidemiological situation in 2012 (updated in 2014) as well as the HIV Strategic Plan 2014-2017 indicate that certain population groups are much more exposed to a higher prevalence of HIV than the national average (Conseil National de Lutte contre le Sida, 2015).

The most vulnerable population groups include:

- Sex workers (HIV/AIDS prevalence of 18.5% in 2010);
- Men engaging in sexual relations with other men (HIV/AIDS prevalence of 18.5% in 2013); and
- Intravenous drug users (HIV/AIDS prevalence of 10.2% in 2011).

There are other population groups that are vulnerable due to their mobility. The situation is characterized by a significant interior and cross-border migration and occupational mobility (law enforcement officers, truck drivers, fishermen, individuals participating in weekly markets, etc.). Factors that place these mobile populations at risk are related to mobility itself, geographic celibacy and other socio-cultural factors (e.g., marital status, education, poor access to preventive care and treatment) (Conseil National de Lutte contre le Sida, 2015).

It should be noted that recent disaggregated data on the HIV/AIDS situation were not obtained for the *commune* of Saint-Louis and its fishing neighborhoods, or for other fishing communities established along the coasts (between Dakar and Saint-Louis). However, the prevalence of HIV/AIDS among fishermen, mainly in Thiès, Louga, Saint-Louis, and Dakar, was studied in 2006 and 2010. Although there was a decline in the prevalence of HIV/AIDS between 2006 (1.0%) and 2010 (0.8%), fishermen exhibit a prevalence that exceeds the national average for men (0.5%). Respondents between the ages of 25 and 29 are the most infected (1.5%) (Conseil National de Lutte contre le Sida, 2015).

Health Care Services and Establishments

There are large disparities in health care coverage within the core study area. The urban regions of Dakar and Saint-Louis benefit from a number of services and establishments, while communities such as the fishing villages between Dakar and Saint-Louis are poorly covered.

With 432 health establishments, 243 of which are private (56.3% of the total), the region of Dakar is the best equipped in the country in terms of health care. Of the 359 Senegalese doctors employed in public establishments, 266 work in Dakar (approximately three-quarters). However, practices in the region of Dakar do not meet WHO standards (SRSD Dakar, cited in Kosmos 2015).

The department of Saint-Louis has 1 hospital, 2 health centres, 18 health outposts, and 36 rural dispensaries and maternities. Access to health care establishments is 100% in the city of Saint-Louis and 52% in the rural parts of the region (SES Saint-Louis, 2013, cited by Tropica, 2017b). There are five health structures on the Langue de Barbarie: the health outposts of Goxxu Mbacc, Ndar Toute, and Guet Ndar; a dispensary at Hydrobase and a dispensary at Ndar Toute specializing in child care (nutritional recovery, vaccination).

[58] The regions of southeastern Senegal are the most heavily affected; for example, for the same period, the region of Kolda had 15,264 cases.

With regard to the coastal fishing communities between Saint-Louis and Dakar, health care establishments are summarized as follows:

- Niayam has one health outpost;
- A health outpost is under construction at Lompoul-sur-Mer;
- Fass Boye has one health outpost;
- Mboro Ndeundekat has one dispensary; and
- Cayar has a health outpost, a maternity facility, a dispensary and a private clinic.

4.7.9.2 Maritime Safety

An important maritime safety issue in the core study area is the occurrence of accidents at sea. The uptick in such accidents, especially in the peak swell period (December-April) presents difficulties for people using the sea. This mainly concerns artisanal fishermen.

Table 4-42 presents an indication of the official data on incidents at sea in Senegal. Disaggregated information on the core study area could not be obtained from the authorities responsible for maritime safety.

Table 4-42. Statistics for Incidents at Sea, 2013-2016 – Senegal Portion.

Year	Offshore Rescue Operations	Individuals Rescued	Individuals Missing
2013	81	301	61
2014	67	145	66
2015	73	77	86
2016	66	175	50

Source: HASSMAR and National Navy, 2016, cited par Tropica, 2017b

Maritime accidents in the Saint-Louis area are often linked to the strong swell on the northern coast during the cold season. During this period, the winds can exceed the speed of 40 kilometers per hour and generate swells of more than 2.5 meters in height. Combined with the topography of the area, swells create a set of waves close to the shore that make navigating and fishing difficult and dangerous. This set of waves is locally called “the bar” (Tropica, 2017a). To address this situation, the MPEM developed an awareness-raising program to encourage artisanal fishermen to wear life vests. In addition to these measures, and in partnership with the National Agency of Civil and Maritime Navigation (*Agence Nationale de la Navigation Civile et Maritime* [ANACIM]), a mechanism for announcing offshore weather alerts has been put into place by the MPEM. Accordingly, fishermen receive daily weather messages through the devolved services of the State and the fishing authorities. Mobile phones have been distributed to different officials to enhance the delivery of weather messages. In the event of a hazardous weather warning (special advisory), craft are forbidden from heading out to sea.

4.7.10 Infrastructure and Services

4.7.10.1 Housing

The types of housing in Senegal partially reflect the living standards of the population. Across the country, 21.9% of the population lives in huts, 2.3% in shanties, 57.2% in single-storey houses, 15.9% in multistorey houses, and 2% in apartment blocks (ANSD/RGPHAE, 2014).

In Senegalese homes, the average number of individuals per room is 2.5. Nearly 3 households in 10 (29.3%) have an average of "three or more" individuals per room, and this number is higher in rural areas (30.9% versus 27.8% in urban areas) (ANSD/RGPHAE, 2014).

The region of Dakar has a particular situation with 48.8% of households residing in single-storey houses, 41.7% in multistorey houses, and 5.7% in apartment blocks. Moreover, 85.6% of Senegalese households living in apartment blocks and 81% of those living in multistorey houses reside in Dakar (ANSD/RGPHAE, 2014).

No housing data are available for the city of Saint-Louis. The data available are those for the region of Saint-Louis, where 69.5% of homes are single-storey houses, 20.9% are huts, 6.1% are multistorey houses, and the rest are shanties (SRSD Saint-Louis, 2015). However, field visits performed during the consultations conducted in March-April 2017 revealed a large percentage multistorey houses in the city of Saint-Louis, notably on the island of Saint-Louis.

By and large, housing on the Langue de Barbarie is characterized by a mix of singe-storey and multistorey houses (Photo 4-47). A significant percentage is in good condition, while houses in disrepair are generally found in Guet Ndar, which is the oldest of the neighborhoods (Tropica, 2017b). One of the important characteristics of the housing in these four fishing neighborhoods is that the homes are located in close proximity to the infrastructure, equipment and material used for artisanal fishing: ice-making facilities, fuel stations, pirogue building and repair shops, pirogues on the river banks, fishing nets, etc.

In 2017, one of the main housing issues in the neighborhoods of the Langue de Barbarie is the exposure of the homes to the effects of coastal erosion. This is particularly important in the neighborhoods of Guet Ndar and Goxxu Mbacc (Photo 4-48). This problem represents an important concern for the population and the public authorities, and is widely reported by the local and national press.

(Tropica, 2017b)

Photo 4-47. Housing in Hydrobase.

Photo 4-48. House Destroyed by Erosion in Guet Ndar.

No housing data are available in the fishing towns and villages except for Cayar. The particularity of housing in Cayar is the concentration of nearly three-quarters of the homes in the coastal parts of the town due to the appeal of the shore for fishermen (Municipal Development Agency, cited in Kosmos, 2015). The dominant type of housing in Cayar is the single-story house. Other types of housing include huts and the occasional shanty, which are especially present among seasonal residents such as those from Guet Ndar (Tropica 2017b).

Field visits in the other villages revealed very modest living conditions, and in certain villages such as Fass Boye and Mboro Ndeundekat, there are significant numbers of huts and shanties, with a few single-storey houses made of concrete.

4.7.10.2 Energy, Water and Sanitary Facilities

In Senegal, the public management of sanitary facilities, electricity supply and drinking water supply is overseen by three public utilities, namely the Office National d'Assainissement (sanitation, ONAS), Société National d'Électricité du Sénégal (electricity company, Senelec) and Sénégalaise Des Eaux (water company, SDE). Within the core study area, there are significant disparities in the coverage of these public utilities between the cities of Dakar and Saint-Louis and other coastal communities.

Dakar

As of 2013, 98.0% of households in the region of Dakar had access to drinking water. The water provided by SDE is consumed by households (72.6%), public establishments (9.0%) as well as large users (18.4%). However, interruptions in the water supply in Dakar are frequent (SRSD Dakar, 2015).

In 2013, the region of Dakar was responsible for 56.9% of the country's total electricity consumption, accounting for 1,369,709,333 kWh out of a total of approximately 2,406,469,814 kWh. Statistics indicate that Senelec has 463,102 subscribers in the region of Dakar, with domestic subscribers representing 77.1%, i.e., 352,406 subscribers (SRSD Dakar, 2015). Dakar's energy sector faces a number of challenges such as increasing demand, recurrent power outages and households connected illegally to the grid.

The wastewater network of the region of Dakar is 863 km long and has 45 pumping stations and 4 water treatment plants with a total capacity of 24,100 m^3 a day. The system is in disrepair and its treatment capacity is very low. Approximately 300 km of the system (34.8%) requires renovation in light of its condition and state of disrepair. Pipe breakages are frequent, with approximately 400 failures a year. Despite the existence of four water treatment plants, the wastewater treatment rate in the region of Dakar is only 40%, with the remaining water being discharged directly into the ocean without undergoing any treatment (SRSD Dakar, cited in Kosmos, 2015).

Dakar's solid waste management is variably efficient depending on the neighborhood, and generally speaking, faces a number of challenges. At the institutional level, there are frequent changes in roles and responsibilities between *communes* and ministries; at the technical level, waste management is limited to collection and disposal at temporary dumps, with no waste recovery infrastructure or mechanisms; at the financial level, there is a lack of continuity in the subsidy scheme for small and medium-sized businesses responsible for collecting refuse.

Saint-Louis

In the department of Saint-Louis, drinking water access in 2013 was 88.3%. In this period, SDE had 24,077 subscribers and annual consumption stood at 4,646,000 m^3. Representing 55% of SDE's total billings, the administration appears to be the said utility's top client in the department, while households rank second with 40%, and large consumers pay approximately 5% of the total amount billed by SDE (SRSD Saint-Louis, 2015).

In the region of Saint-Louis, 86.7% of urban households use electricity as an energy source (SRSD Saint-Louis, 2015). Other sources of energy include wood, rechargeable and oil lamps, etc. In Saint-Louis' fishing neighborhoods, all families generally have an electrical connection (Tropica, 2017b).

As of 2013, ONAS had 6,959 households connected to the public sewer system in the *commune* of Saint-Louis (SRSD Saint-Louis, 2015). The city's sanitation infrastructure is plagued by a number of deficiencies that are particularly visible in the fishing neighborhoods. The sewer system does not extend beyond the city of Saint-Louis and there is no water treatment system; additionally, the wastewater of the city (and of the fishing neighborhoods) is discharged into the Senegal River. With regard to solid waste, collection is delegated by the public authorities to small entrepreneurial groups called Economic Interest Groups (EIG) for the Collection, Disposal and Processing of Household Waste (CETOM)[59]. These CETOM EIGs transport waste to containers, which are then sent to the city's technical landfill site. However, this system has its shortcomings, as the landfill has nearly reached its capacity, the CETOM EIGs are unable to meet the needs of the city, and there is an increasing number of

59 CETOM EIGs collect garbage using carts and trucks.

unauthorized dumps in the city (NGO "Le Partenariat", 2017). Another sanitation-related problem in the fishing neighborhoods concerns the pumping of septic tanks, which is also done into the sea or river.

Coastal Fishing Communities between Dakar and Saint-Louis

In the fishing communities of the Grande Côte, the situation with regard to electricity supply is variable. In Cayar, electricity is provided by Senelec. In Niayam, a certain number of households have access to the Senelec grid. Lompoul-sur-Mer, Fass Boye and Mboro Ndeundekat are not electrified, however.

Drinking water supply varies from one community to another. In Cayar, drinking water is provided by a rural water engineering mechanism that supplies water to individual connections and community fountains. Other communities get their drinking water especially from traditional wells, and in certain cases from boreholes (Tropica, 2017b). Drinking water supply issues are very common. Moreover, in the communities of the region of Niayes such as Lompoul-sur-Mer, Fass Boye, Mboro Ndeundekat, and Cayar, water supply challenges have an impact on market gardening activities.

With a few exceptions, there is no sanitation infrastructure in the coastal communities. Only a few homes have private latrines with septic tanks (ANSD/RGPHAE, 2014).

Furthermore, there is no solid waste collection in these communities.

4.7.10.3 Transport and Communications

Transport

In terms of transport infrastructure, the community with the best coverage in the core study area is the capital. Dakar possesses a port and an airport, both of which meet international standards.

Located at the westernmost point of mainland Africa (14°40'60.00"N 17°25'60.00"W), the Port of Dakar lies at the crossroads of a number of shipping channels between Africa, Europe, Latin America, and North America. The port is built over 160 ha of water varying in depth between 10 and 13 m. It has an access channel that is marked with buoys and regularly dredged. The port offers an extensive area to operate, making certain maneuvers possible without the need for towing. It also offers modern facilities that make it one of the most important infrastructures in West Africa (Port of Dakar, 2015). However, use of the port's land-based infrastructures is very high (Figure 4-40). The congestion of these infrastructures limits the port's ability to accommodate additional operators.

(Source: Port of Dakar, 2017)

Figure 4-40. Aerial View of the Port of Dakar.

A new international airport has been serving Dakar since December 2017. It is the Blaise Diagne International Airport (AIBD) which is located approximately 40 km from Dakar and is connected to the city by a highway. Its capacity will be around 3 million passengers per year (Blaise Diagne Dakar Airport, 2018).

Saint-Louis has an international airport, which was built in 1930 and was recently renovated, but its contribution to the economic development of the region is minor. Data from 2013 indicate that, as of this date, the airport handled predominantly small private flights, which represented at least 46.0% of traffic. The latter were followed by flying clubs flights and commercial flights at rates of 29.0% and 18.0%, respectively, the remaining flights being military flights or else (SRSD Saint-Louis, 2015). As of 2017, available information indicates that there are currently no commercial flights at this airport (Saint-Louis Airport, 2017, cited by Tropica, 2017b).

The Port of Saint-Louis was built in 1978 with support from the Polish government. It is a river port. It has a T-shaped dock measuring 140 m long and 20 m wide. It was designed for boats with drafts of between 3.8 and 5.0 m. Generally speaking, the port is antiquated, its infrastructures are in disrepair and it is rarely used. In 2017, the dock was used only by artisanal fishermen. However, the dock is not suited for pirogues and is not fully functional.

In terms of roadways, Saint-Louis is connected to the rest of the country via National Highway 2; the main roads are paved while some of the minor streets are not.

The road network on the Langue de Barbarie is characterized by the presence of a single paved lane running on a north-south axis, with the exception of Guet Ndar, which has a second paved lane parallel to the first. The cross streets, of which there are many, are not paved. Means of transport consist essentially of Tata buses, taxis, carriages, and minibuses (Photo 4-49).

Photo 4-49. Means of Transport on Langue de Barbarie.

The fishing towns and villages have only rudimentary transportation infrastructure. For instance, Cayar, the largest of these communities, only has a few stretches of paved road to facilitate access to the landing docks and the main highways of the region. Cayar, Mboro Ndeundekat, and Fass Boye are connected to one another and to the urban centres by the Niayes Highway and indirectly by National Highway 2.

Communications

In Senegal, the Société Nationale des Télécommunications (Sonatel), a member of the international group Orange, has historically been the most important telecommunications operator in the country and provides fixed telephone services. However, mobile telephone services increasingly dominate the market and are offered by a number of companies.

The urban communities of the core study area are well covered in terms of telecommunication. In Dakar (SRSD Dakar, 2015) and Saint-Louis (SRSD Saint-Louis, 2015), there is a fixed-line phone network, a GSM network, call centres, radio stations, post offices, satellite TV systems and Internet services.

The main means of telecommunication in Senegal's rural regions are the mobile satellite phone network and radio. These devices are generally the only means of communication in the fishing communities of the core study area, with the exception of Cayar, which is covered by Sonatel.

The most recent National Survey on Information and Communication Technologies indicated that radio is "the most common device" in households, especially in rural regions with 160 radios per 100 households, compared to 140 radios per 100 households in urban regions (APS, 2010). Radio plays an important role in the fishing communities. In Saint-Louis, two radio stations (Radio RTS and Téranga) have programs specifically dedicated to fishermen. These programs have a wide audience among fishermen and represent important sources of information for them, notably with regard to weather conditions.

Other than Dakar and Saint-Louis, telephone coverage is variable in the communities of the study area. In Fass Boye, Lompoul-sur-Mer and Niayam (Potou), satellite coverage for mobile phones is poor. On the other hand, it is good in Cayar and Mboro Ndeundekat.

Mobile phones play a very important role for artisanal fishing. Certain fishermen emphasize the importance of mobile phones for their activities as well as the importance of GPS, which a number of pirogues are equipped with. The mobile phone plays an even greater role for fishmongers, as it represents their main working tool.

4.7.10.4 Security

In Senegal, the administrative authorities are responsible for the security of the communities. The Governor of Saint-Louis is responsible for the security of the cities and villages located inside the region of Saint-Louis. The Governors of Louga, Thiès and Dakar are responsible for the security of the communities inside their own regions. At a more local level, the *Préfet* of Saint-Louis is responsible for the security of the communities within the Department of Saint-Louis in which is located the city of Saint-Louis.

On the ground, law enforcement and security are ensured by policemen in the towns while the gendarmes generally operate outside the towns. While the policemen have the prime responsibility in the towns, gendarmes can also operate in towns for specific occasions. In some cases, both the policemen and the gendarmes are called in for the security of a town, for instance in case of a large public event. In Saint-Louis, policemen are responsible for law enforcement and security of the communities including the fishing communities on the Langue de Barbarie. Saint-Louis has more than one police station. The main one is located on the Island of Saint-Louis.

Offshore, coast guards patrol the maritime waters. They are responsible for monitoring and protecting the Senegalese waters, and for search and rescue operations. As such, their responsibilities include ensuring that no illegal fishing activities are conducted in Senegalese waters. While the coast guards are armed, they operate with a small number of vessels. They have limited means with regards to the length of the coast under their responsibility.

4.7.11 Women and Vulnerable Groups

According to the World Bank, a vulnerable group is a population having a certain specific characteristic that makes it at higher risk of falling into poverty than others living in areas targeted by a project. Vulnerable groups include the elderly, the mentally and physically disabled, at-risk children and youth, HIV/AIDS-affected individuals and households, ethnic and religious minorities and, in some societies, women.

Within the core study area, women may be identified as a vulnerable group, particularly those in the fishing villages. Indeed, women in Senegal's rural regions are affected by illiteracy and a lack of easy access to land and services; their access to credit is often limited to *tontines* that offer them only very small loans (ANSD, 2008). There are no data on the number of women in the fishing communities, with the exception of Guet Ndar, which comprises approximately 13,754 women (Tropica, 2017b). Based on the country's sex ratio, which is 99.6 men for every 100 women (ANSD/RGPHAE, 2014), it can be estimated that the female population of Saint-Louis' fishing neighborhoods is 37,282. For the core study area and extended study area, the number of women is estimated at 1,609,736 and 1,651,132, respectively.

Another vulnerable group is youth with little or no education. In rural areas, young people are affected by difficulties in accessing all levels of education; in urban areas, they are the first victims of unemployment. Adolescents and young adults are also vulnerable to HIV/AIDS and other sexually transmitted diseases. Nationwide, 54% of the population is under the age of 20 and if one extrapolates this figure to the communities under study, it can be observed that this population would be 40,184 in the fishing neighborhoods of Saint-Louis, 1,735,038 in the core study area and 1,779,656 in the extended study area.

Further, the number of disabled persons can be estimated based on the prevalence rate of handicaps for the Senegalese population nationwide. The 2013 census indicates this figure as being 5.9%, which would correspond to 4,390 persons in the fishing neighborhoods of Saint-Louis, 205,386 in the core study area and 210,261 in the extended study area. Nationwide, the services for disabled people are very limited and access to employment is very rare. Their families usually take care of them. However, some services do exist in the cities. In Saint-Louis, the hospital and a few international and national

NGOs provide some support to people with disabilities. Services are provided at the hospital and in some social centers. However, they operate with very limited means. During the public consultation conducted for the current ESIA, one disabled stakeholder did raise this issue and he asked for specific social investments for disabled people in the fishing communities.

Lastly, the entire population living in the neighborhoods of the Langue de Barbarie is at risk of becoming vulnerable due to the erosion process that threatens the physical integrity of this narrow spit of land.

Since 2016, some households have lost their homes after they were destroyed by coastal erosion. A number of other households might also lose their dwellings. Additionally, certain basic social infrastructures or amenities on the Langue de Barbarie are also threatened, including the Cheikh Touré primary school in Guet Ndar and the landing dock in Goxxu Mbacc. Some residents of the Langue de Barbarie have already been relocated by the public authorities and several others are at risk of being relocated.[60]

4.7.12 Quality of Life

The above Sections 4.7.4 (Education), 4.7.5 (Economic Conditions, Employment and Means of Subsistence), 4.7.6.3 (Artisanal Fishing), 4.7.9 (Public Health and Safety) and 4.7.10 (Infrastructure and Services) provide information on the quality of life in the core study area. The current section provides additional information on this subject.

Within the study area, the quality of life varies from one sector to another. Dakar is the capital of Senegal and concentrates the majority of the country's infrastructures and socio-economic facilities.

Saint-Louis, the quality of life varies depending on the part of the city. On the island of Saint-Louis, the roads are paved, several heritage buildings are present, there is a concentration of public services and amenities, garbage is collected relatively regularly and the population density is relatively low.

On the Langue de Barbarie, the situation is different. The populations live in notoriously crowded and insalubrious conditions, notably in Guet Ndar: the population density is very high, public services and amenities are lacking, household waste is not collected regularly, refuse and wastewater are dumped or discharged onto the beach or river banks (Photo 4-50). Lastly, coastal erosion is also altering the quality of life and threatens the homes of the residents of the Langue de Barbarie.

[60] On May 30, 2017, the Senegalese Press Agency relayed an announcement from the Mayor of Saint-Louis whereby fishing families affected by coastal erosion, as well as those expelled from Mauritania, would be resettled in the *commune* of Gandon and in the Ngalèle mixed development zone in the Saint-Louis suburbs (APS, 2017). Relocating fishermen and their families may also result in vulnerability if they are moved to places where they are unable to practice their means of subsistence, i.e., far from the sea.

(Tropica, 2017b)

Photo 4-50. Unauthorized Dump on River Bank in the Neighborhood of Goxxu Mbacc.

The absence of adequate solid waste collection and wastewater management is not unique to the Langue de Barbarie. Other neighborhoods of the *commune* face similar situations. The difference lies mainly in the demographic density, which exacerbates the problem on the Langue de Barbarie and makes it one of the main trends in the fishing communities. The other main current trends in these communities are the termination of the fishing agreement between Mauritania and Senegal, the unresolved problems of the breach on the Langue de Barbarie and the coastal erosion. These social trends are detailed in Section 4.7.15.

Very few data exist on Saint-Louis fishing community revenues, household incomes, savings or indebtness which could provide indicators as to the standard of living of these communities. This lack of data is not specific to this area. Nationwide, very little data exist for these economic indicators.

In the fishing communities between Dakar and Saint-Louis, the quality of life varies from one locality to another. Overall, public services and amenities are more developed in Cayar than they are in the other localities.

Additional information on the public services and amenities in the communities of the core study area and the extended study area is provided in Appendix H.

4.7.13 Cultural and Archaeological Heritage

The island of Saint-Louis has been designated a UNESCO world heritage site since 2000. The list of Senegalese historic monuments and registered sites established by the ministry responsible for culture includes the following monuments and sites in Saint-Louis:

- Island of Saint-Louis;
- Faidherbe Bridge;
- Former floatplane base and monument to Jean Mermoz;
- Fishermen's cemetery, Langue de Barbarie;
- Church and grotto of Notre-Dame-de-Lourdes, Sor neighborhood;
- Remains of first brickyard in Africa, island of Bopp Thior;

- Keur Cluny: former orphanage of Sisters of Saint-Joseph de Cluny, Ndar Toute;
- Veterans' monument, Place Pointe à Pitre, Guet Ndar;
- Marmyale Catholic cemetery, Sor neighborhood;
- École des fils de Chefs et des Interprètes, Khayar Mbengue School, Sor neighborhood;
- Railway station, Sor neighborhood; and
- Former Protestant temple and slave refuge, Pont-de-Khor.

Saint-Louis also boasts an important intangible heritage. Examples include *Fanal* (festival), *Signares* (historical figures), regattas (pirogue races) and *Simb* (artistic and spiritual ceremony) (SES Saint-Louis, 2013, cited by Tropica, 2017b).

One important aspect of Saint-Louis' intangible heritage is the protective goddess named "Mame Coumba Bang". This guardian goddess of the city of Saint-Louis is depicted in the guise of a mermaid. Her abode is believed to lie near the mouth of the Senegal River. Mame Coumba Bang is revered by fishermen. Likewise, whenever waves violently pound the shore or when the waters become rough or depleted of fish, fishermen are eager to make offerings to Mame Coumba Bang in the river (Tropica, 2017b). Just as for the river, intangible cultural heritage includes traditional beliefs and rituals linked to the sea. The beach of Sal Sal (north of Goxxu Mbacc), which is located where project infrastructures are planned near the coastline, is one of the important places where these sea-related rituals are carried out. In fact, as part of supposedly mystical practices, some inhabitants of Saint-Louis and especially of the fishing neighborhoods occasionally go to Sal Sal in the middle of the night to perform rituals such as offerings (animal sacrifices). One of the reasons why these individuals go specifically to Sal Sal and at night is that this area is uninhabited and generally rarely visited, and these types of rituals must be performed in secret.

4.7.14 Landscape

The coastal landscape in the core study area consists of alternating uninhabited coastline and populated areas. Even in the uninhabited areas, the coast is often strewn with garbage, which takes away from the esthetics of the natural environment.

This situation is particularly visible in the fishing neighborhoods of the Langue de Barbarie. Both on the river and ocean sides, the beaches of the Langue de Barbarie are littered with refuse, which greatly detracts from the esthetic beauty of the area.

At Sal Sal, the seascape is mostly devoid of human activities (Photo 4-51). The pirogues that regularly ply the coastal waters are the only human presence visible at sea. The occasional cargo ship can be spotted in the distant offshore waters. Generally speaking, the natural environment dominates the seascape.

Photo 4-51. Landscape at Sal Sal.

4.7.15 Political and Social Climate

The political climate in Senegal is generally calm. It is founded on principles such as democracy, which implies a multiparty system, respect for rights and freedoms, etc. In Dakar, where political parties are the most present, the political climate is at times fraught with tension. In Saint-Louis, the situation is rather calm.

In the fishing communities, the social climate can occasionally be tense. Generally speaking, relationships between the different fishing communities in Senegal are good, but tensions do sometimes arise between fishermen, especially when fishery resources are scarce. Competition for these resources can lead to clashes between fishermen. The most remarkable conflict in recent years is the one between the fishermen of Guet Ndar and those of Cayar. Although Cayar is home to a sizable community of fishermen from Guet Ndar, cohabitation has led to numerous conflicts that have resulted in violent fighting, fires and the destruction of homes, which has prompted law enforcement authorities to intervene and detain a number of individuals.

Since the beginning of 2017, the social climate in the fishing communities of the Langue de Barbarie has been particularly tense.[61] The administrative and political authorities have been and continue to be called upon by the communities. This tension and the response of the public authorities have been widely covered by the local and national media. Three factors contribute to this tension:

- The termination of the fishing agreement between Mauritania and Senegal and the loss of access to fishery resources and associated revenues from fishing in Mauritanian waters;
- The unresolved problem of the breach in the Langue de Barbarie and associated marine safety issues; and
- The unresolved problem of coastal erosion on the Langue de Barbarie and the associated hazards and risks that homes might be lost.

Under a fishing agreement signed between Mauritania and Senegal in 2015, Mauritania granted artisanal fishing licenses to Senegalese fishermen. This agreement was not renewed in 2016, though the Mauritanian authorities waited until January 2017 to apply the regulation in force. Additionally, in January 2017, Mauritania began enforcing a 2012 law whereby artisanal fishing was reserved for Mauritanians. Since January 2017, no fishing license has been granted to Senegalese fishermen,

[61] The present analysis of social tensions on the Langue de Barbarie is based on a press review conducted by Golder.

artisanal fishing catches made in Mauritanian waters must be landed in Mauritania, and the crews on board artisanal fishing craft must be of Mauritanian nationality.

The fishing communities of the Langue de Barbarie have openly expressed their discontent to the Senegalese authorities, notably through their professional associations. Additionally, members of these communities have created a committee to discuss the issue. In May 2017, this committee held a workshop in Saint-Louis advocating reinforced coordination between Senegal and Mauritania so that Senegalese fishermen might once again be authorized to operate in Mauritanian waters under new fishing agreements.

The second important concern of fishermen is the opening of the breach in 2003 and its uncontrolled enlargement, which has made it dangerous for pirogues to cross the mouth of the river. Numerous wrecks have occurred. Marine safety issues seem to be on the rise since early 2017. In April 2017 alone, more than 20 pirogues capsized in the mouth of the river.

On the Langue de Barbarie, wrecks and drownings of fishermen are not a recent phenomenon. Crossing “the bar” of the coastal waters has always represented a danger. However, crossing the breach adds a level of risk to an already dangerous situation. Since the opening of the breach, a number of Langue de Barbarie fishermen have lost their lives in the mouth of the river. Pirogue crews generally being composed of members of a single family, accidents thus translate into the loss of multiple lives within the same family. These family dramas have a tremendous impact on the fishing communities of the Langue de Barbarie.

To address this maritime safety issue, public authorities have implemented appropriate measures, including weather advisories. Additionally, in February 2017, the Senegalese Navy, in coordination with the Department of Fisheries Protection and Surveillance (DPSP), was dispatched to prevent pirogues from crossing the breach in the event of rough seas. However, the breach issue remains and the public authorities are seeking to address this problem.

Lastly, the third important concern of the Langue de Barbarie fishing communities is the coastal erosion that is physically threatening the area. This coastal erosion is not a recent phenomenon, nor is it unique to the Langue de Barbarie. In fact, coastal erosion affects all of Senegal as well as adjacent countries. However, on the Langue de Barbarie, the problem seems to have grown worse since the beginning of 2017. Several houses have been engulfed by the sea and a number of others are threatened. The State has already announced its intention to curb coastal erosion along the entire seaboard and on the Langue de Barbarie in particular.

Since early 2017, the fishing communities of the Langue de Barbarie have suffered considerably. The absence of satisfactory solutions to the three major problems affecting these communities contributes to social discontent and, in certain cases, a certain degree of despair. The latter is openly expressed to the administrative and political authorities. It was also widely voiced during the public consultations of June 2017 dedicated to the project described in this ESIA.

As of July 2017, the communities of the Langue de Barbarie have expressed their social dissatisfaction in a non-violent manner. However, the severity of the problems affecting these communities raises the prospect of a volatile social climate.

4.7.16 Ongoing or Planned Projects

As of October 2017, available data indicate that there are a three major infrastructure projects currently planned in Saint-Louis and its surroundings, and which are of special interest for the current project:

- Structure for Protecting the Langue de Barbarie; and
- Two River Port Projects in Saint-Louis.

Publicly available data on these three projects are limited. Those available are presented below. No information is available on the provisional calendars of these projects,

In addition to these projects, there is a political will of the President and the Government of Senegal to manage the coastal erosion problem of the country (which is not specific to Saint-Louis) and to solve the issues of the breach of the Langue de Barbarie. This has been reported in medias on a regular basis. However, as of October 2017, there doesn't seem to be yet any specific projects to address these issues on the ground.

Structure for Protecting the Neighborhoods of the Langue de Barbarie

An emergency project to protect the neighborhoods of the Langue de Barbarie from swell and coastal erosion is currently under study. The project is conducted under the responsibility of a public agency: the Agency for Promotion of the National Hydrographic Network (*Agence pour la Promotion du Réseau Hydrographique National*) (APRHN). This agency is under the responsibility of the Ministry of Hydraulics and Sanitation (*Ministère de l'Hydraulique et de l'Assanissement*).

The current project consists in engineering studies to build a 3,5 km structure in the sea, from Goxxu Mbacc to Guet Ndar, at a distance of about 5 meters from the houses built on the shoreline. The type of infrastructure is not fully determined yet but it would serve as a protection dike.

In 2017, this emergency project was announced publicly by the Mayor of Saint-Louis, who is also the Minister of Hydraulics and Sanitation. The ESIA for this project is currently being finalized (Cabinet Prestige, 2017).

Information on the provisional calendar for this project, its cost and its funding are not available.

River Ports in Saint-Louis

Available data indicate that two different river port projects are planned on the Senegal River in Saint-Louis and its surroundings. Both of them include a refurbishing of the existing infrastructure on the river side of Hydrobase, at the "Poles"[62] port.

The first project is planned by the Organization for the Development of the Senegal River (*Organisation pour la Mise en Valeur du fleuve Sénégal*) (OMVS). Within OMVS, the Corporation for Management and Operation of Navigation (*Société de Gestion et d'Exploitation de la Navigation)* (SOGENAV) is in charge of planning a project for river navigation all along the Senegal River, over more than 900 km, from Amdibébi in Mali to Saint-Louis in Senegal. This project, called "*Système Intégré de Transport Multimodal*" (SITRAM), includes several types of infrastructure for navigation of the river. It includes a commercial and fishing river port in Saint-Louis, on the left-hand side of the estuary. This port would involve moving the artisanal fishing landings and commercial chain from the Langue de Barbarie to the other bank of the river. Therefore, the numerous trucks involved in road transportation of fishing catches from Saint-Louis would no longer have to cross the Island of Saint-Louis and the Langue de Barbarie.

This project also involves refurbishing the current river port at Hydrobase, located on the right-hand side of the estuary, and transforming it into a yacht harbor. This harbor would be able to accommodate up to 48 yachts.

The project includes several other types of infrastructure in Mali, Mauritania and Senegal and its total cost is estimated at US $200 million. According to existing information, the feasibility study and the ESIA of the project are currently being conducted (OMVS, 2013 and SOGREAH, 2006).

While the OMVS project is planning a yacht harbor at "Poles Port", it seems that the National Agency on Maritime Affairs (*Agence Nationale des Affaires Maritimes*) (ANAM) of Senegal is currently planning a new artisanal fishing port at the same location.

[62] The existing river port infrastructure on the river side of Hydrobase were built in the 1970s by the Polish. Since then, it has been referred to as Poles Port (*Port des Polonais*).

ANAM is a public agency under the responsibility of the Ministry of Fisheries and Maritime Economy. ANAM has several projects to improve port infrastructure in Senegal. One of them is the refurbishment and development of the Saint-Louis River port to upgrade the artisanal fishing facilities. The planned project will notably include the following infrastructure:

- A landing wharf for artisanal fishing boats with three distinct areas;
- Three storage areas for fresh fish;
- A parking lot for refrigerated trucks;
- An industrial area for fish processing; and,
- Ancillary buildings.

The cost of the project is estimated at $15 billion FCFA, i.e., about US $25 million. According to existing information, the feasibility study for this project is completed and the ESIA is currently being conducted. (ANAM, 2017).

4.8 Ecosystem Services

The baseline environment chapter presented previously has been based on a resource-specific approach, relying on the characterization of potentially affected biophysical and social resources at a commensurate level with perceived, *a priori* impacts. Similarly, biodiversity has been addressed following this resource-centric approach.

Ecosystem goods and services, or abbreviated simply as ecosystem services, are defined as the direct and indirect benefits people obtain from the environment, including ***provisioning services*** (e.g., food, water, timber, and fiber); ***regulating services*** that moderate or control (e.g., climate, flooding, disease, and water quality); ***cultural services*** that provide recreational, aesthetic, and spiritual benefits; and ***supporting services*** (e.g., soil formation, photosynthesis, and nutrient cycling). Consequently, ecosystem services consider both the biophysical and social environments. According to the Millennium Ecosystem Assessment (2005), each service is defined as follows:

- Provisioning services: services that can be extracted from ecosystems to support human needs, and are more or less synonymous with a prior definition of ecosystem “goods” including assets such as freshwater, food (crops, fish, etc.), fiber and fuel;
- Regulatory services: processes that regulate the natural environment such as the natural regulation of air quality, climate, water flows, erosion and pests;
- Cultural services: diverse aspects of aesthetic, spiritual, recreational and other cultural values; and
- Supporting services: processes essential for the maintenance of the integrity, resilience and functioning of ecosystems (such as soil formation, photosynthesis and water recycling), and so the delivery of all other services; supporting services do not necessarily have direct economic worth.

This ESIA has characterized the biophysical and social environment of the core and extended study areas as a basis for impact assessment and identification of mitigation measures. Ecosystem services have also been developed from integration of important biophysical and social environment attributes to ensure that the ESIA properly considers not only the resources to be affected by the project but the services and goods that these resources provide (Table 4-43). A preliminary listing of the dominant ecosystem features for key ecosystem services is also provided. A modified approach has been adopted in the description of ecosystem services based on the Millennium Ecosystem Assessment (2005) and other sources (e.g., World Resources Institute, 2013; Everard and Waters, 2013; IPIECA, 2016; Interim Framework for Effective Coastal and Marine Spatial Planning, 2009).

Table 4-43. Summary of Ecosystem Services for the GTA Project Core Study Area.

Service Category	Subcategory	Key Ecosystem Services Present in the Core Study Area	Dominant Ecosystem Feature Providing the Service
Provisioning Services	Crop and livestock	-	-
	Capture fisheries and aquaculture	✓	Fisheries productivity
	Non-oil mineral resource	-	-
	Pharmaceutical resources	-	-
	Genetic resources	-	-
Regulating Services	Climate regulation	✓	Senegal River estuary
	Freshwater timing and flow regulation	✓	Senegal River estuary
	Freshwater purification and treatment	✓	Sand dunes and coastal wetlands
	Erosion control	✓	Coastal morphology
	Waste assimilation and breakdown	-	-
	Natural hazard protection	✓	Sand dunes, coastal wetlands and coastal morphology
Cultural Services	Navigation/Transportation	✓	Senegal River estuary
	Angling	-	-
	Boating	-	-
	Scuba/Snorkel/Wildlife viewing	✓	Protected areas and other areas of interest
	Immersion sports/Beach use	✓	Protected areas and other coastal areas of interest
	Traditional/Archaeological	✓	Spiritual values associated with the sea/nature
	Education/Research	-	-
	Non-use/protected values for habitats and species	✓	Senegal River estuary and nearshore marine ecosystem (cold water corals)
Supporting Services	Habitat & species support (food, refuge, nursery areas)	✓	Nearshore currents; upwelling areas; Senegal River estuary
	Primary production (photosynthesis/chemosynthesis)	✓	Upwelling areas
	Nutrient cycling	-	-

Key provisioning services considered in this ESIA include capture fisheries, where fishing activities play an important role in the local, national and cross-border economies of the area, and represent a significant source of revenue for local economies. Fishery resources are harvested by an artisanal and coastal fleet (mainly domestic) and a predominantly foreign industrial fleet (see Sections 4.6.5 and 4.6.6), with the local labor market heavily influenced by fishing operations and processing.

Key regulating services associated with beach loss and erosional issues include erosion control and natural hazard protection. Coastal erosion is a significant issue along the west Africa coast, and has adverse effects on both the biophysical environment and local infrastructure as discussed in Sections 4.4.3, 4.7.8, and 4.7.10.

Key cultural services include wildlife viewing associated with the areas of conservation interest (Section 4.5.9), beach use (see Section 4.7.7.2) and traditional activities, captured in discussions associated with artisanal fishing (as outlined in Section 4.7.6.3 but discussed throughout the social environment sections). Key supporting services include habitat and species support (e.g., areas of conservation interest, Sections 4.5.9) and primary production, primarily as it relates to upwelling and enhanced fishery-related production (see Sections 4.5.1 and 4.5.4).

CHAPTER 5: ANALYSIS OF ALTERNATIVES AND DESCRIPTION OF THE CHOSEN PROJECT

5.0 ANALYSIS OF ALTERNATIVES AND DESCRIPTION OF THE CHOSEN PROJECT

The initial design of the project was a general conceptual design based on the limited (at the time) understanding of the project area and target hydrocarbon reservoirs. As additional surveys, studies, and tests were completed, BP developed a better understanding of both the availability of design options and the environmental and social sensitivities of the project area. During this process, various alternatives to the initial project design were identified and considered. This chapter describes the major project alternatives that were considered and briefly describes the chosen option for each alternative that make up the current proposed project.

5.1 No Project Alternative

Under this alternative, the proposed Greater Tortue/Ahmeyim Phase 1 project would be cancelled and no further drilling or gas development/production in the GTA field would occur. The potential environmental impacts and economic and other benefits specifically associated with the proposed Greater Tortue/Ahmeyim Phase 1 project would not occur.

5.2 Project Variants

5.2.1 Pipeline Route Avoiding Carbonate Mounds

As described in Section 4.5.3.2, relict carbonate mounds have been documented offshore Mauritania in the Pipeline Area. These hard bottom features are primarily composed of fossilized and dead coral fragments with occasional live coral species. Exposed rock and lithoherms have been documented via remote sensing and photographed via drop camera imagery. Two pipeline route options were considered. The initial pipeline route between the Offshore Area and the location of the FLNG vessel in the Nearshore Hub/Terminal Area intersects these relict carbonate mounds (Figure 5-1).

Following additional studies and surveys of the pipeline corridor, an alternate route pipeline route was identified to avoid the area of the relict carbonate mounds, corals, rocky outcrops, and other features as identified with subsea mapping. The alternate route would serve to eliminate or reduce direct impacts (e.g. increased turbidity resulting in smothering or direct disturbance during pipelaying) on the seafloor features from the pipeline installation. The alternate route has been specifically routed to 1) avoid slide debris by at least 1,000 m; 2) avoid subsea gully run-outs to the maximum extent possible; 3) cross seafloor gullies in the lowest slope area possible; 4) cross an identified headwall scarp at a perpendicular angle; 5) avoid coral exclusion zones by at least 600 m; 6) avoid the confluence of gullies; and 7) avoid crossing gullies and rocky outcrops where possible (Figure 5-2).

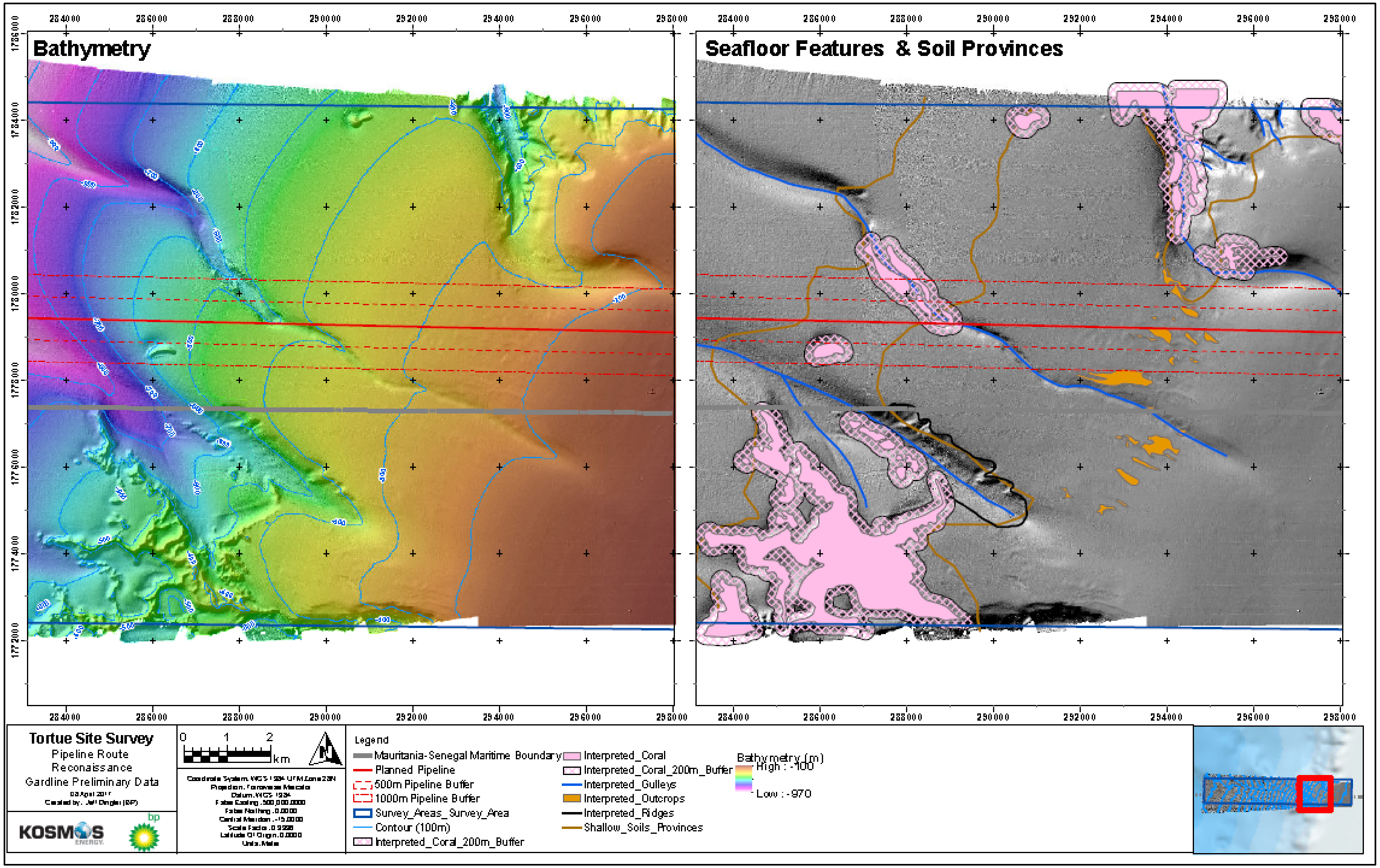


Figure 5-1. Initial Pipeline Route through the Relict Carbonate Mound Features Offshore Mauritania in the Pipeline Area.

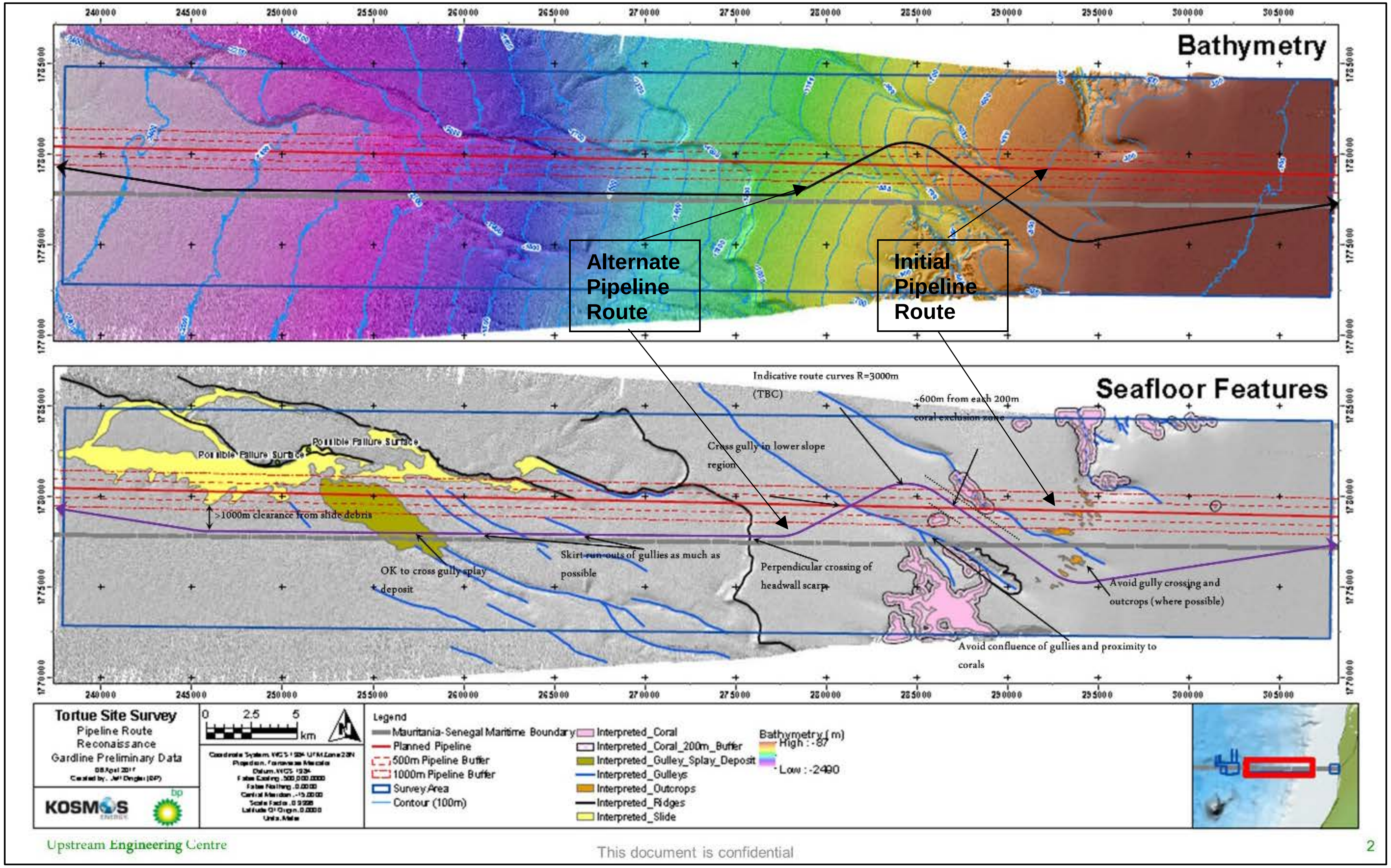


Figure 5-2. **Alternate Pipeline Route (black line on top, purple line on bottom) as Compared with the Initial Pipeline Route (red line) through the Area of Relict Carbonate Mounds Offshore Mauritania.**

5.2.2 FPSO Location

Multiple locations for the moored FPSO were considered in developing the proposed project, taking in account potential environmental impacts, operational logistics, financial considerations, and other potential benefits or disadvantages. Potential alternatives for the FPSO location included 1) a location in the Offshore Area in deep water; 2) at a mid-water location in approximately 120 m water depth and 40 km from shore, or 3) at a location in shallow water at the Nearshore Hub/Terminal Area.

Additionally, a nearshore Steel Piled Jacket (SPJ) platform at the Nearshore Hub/Terminal Area was also considered instead of an FPSO, but due to the increased design complexity, higher cost, and remaining need for storage of condensate in floating storage unit at the nearshore location the use of an FPSO was considered preferable.

5.2.2.1 Deepwater FPSO in Offshore Area

Under this option, the FPSO would be located in the GTA gas field in approximately 2,250 m water depth. Challenges associated with this location include the ultra-deep water depth, which would stretch industry experience and require complex and modified mooring and riser systems to accommodate the water depth. Additionally, it was determined that the placement of the FPSO in the Tortue field could potentially interfere with future well drilling or subsea infrastructure installation and that the distance from shore would increase shipping time for all supplies and would potentially require the use of larger ships to transfer chemicals. Helicopters would also need to be used to transfer crew to and from the FPSO.

Conversely, the in-field location would likely reduce flow-assurance and wax concerns, thereby reducing the volume of tanks required for MEG storage. An in-field location would also place the gas processing closer to the wellsites, thereby reducing back pressure, which would serve to maximize recovery from the field. However, gas compression would be required to export the gas for LNG and domestic use, thereby consuming some produced gas while also generating emissions. Condensate spill modelling based on a deepwater FPSO location showed that while some offshore oiling would occur in the event of a worse-case spill, no shoreline oiling would be expected.

5.2.2.2 Mid-water FPSO

A mid-water FPSO would be located in approximately 120 m of water at the shelf break, located approximately 40 km from the shoreline. The relatively shallow water depth would allow for flexible risers, which reduce complexity and cost. The 40 km distance from the shoreline is out of sight of land (resulting in less visual nuisance) and beyond the extent of the nearshore artisanal fishing activities. The mid-water location also allows for standard offloading and results in lower back pressure on the wells as compared with a location in the Nearshore Hub/Terminal Area. There is no need for compression as the gas will flow naturally the remaining distance to the LNG facilities.

Condensate spill modeling based on the mid-water FPSO location showed that in the event of a worst-case spill (without spill response activities or mitigation measures), first shoreline oiling would be estimated to occur on Day 8 post-spill. Moderate to light oiling of the coastline along the shoreline northeast of Dakar could be expected by Day 9 post-spill, moderate oiling occurring along approximately 48 km by Day 13 post-spill, and the maximum amount of shoreline oiling occurring after 17 days with an estimated 51 km of shoreline affected.

5.2.2.3 Shallow Water FPSO in Nearshore Hub/Terminal Area

Under this option, the FPSO would be located in the Nearshore Hub/Terminal Area. Concerns with this location included the shallow (20 m) water depth which would require modifications to the typical FPSO hull design, and development of novel mooring and riser systems. The distance from the FPSO to the gas field (120 km) also introduced concerns over well back pressure issues which would likely result in significantly reduced recovery volumes from the field. Furthermore, the addition of an FPSO at the Nearshore Hub/Terminal would increase the potential for social impacts, as the location is within the area used by local artisanal fishermen.

Condensate spill modelling based on the FPSO located at the Nearshore Hub/Terminal location in shallow water showed in the event of a worst-case spill (without spill response activities or mitigation measures) that the first shoreline oiling would occur approximately 39 hours post-spill. By Day 9 post-spill, significant shoreline oiling could be expected along the nearshore sediments between Dakar and N'Diago/Saint-Louis. On Day 13 post-spill, heavy oiling could impact up to 234 km of shoreline. Maximum shoreline oiling is estimated to occur on Day 17 post-spill, when an estimated 247 km of shoreline could be impacted.

5.2.3 Presence of a Breakwater

Under this alternative, it was explored whether a breakwater located at the FLNG vessel location in the Nearshore Hub/Terminal Area was necessary. As an alternative to a breakwater, side-by-side loading in both deep and shallow water was considered, as was a turret/spread moored FLNG with innovative loading. The latter option was dismissed due to the lack of readily available technology.

With side by side loading in deep water, LNG would be loaded year-round in approximately 2,700 m water depth. Based on a metocean analysis, the significant wave heights in the offshore location would result in no availability windows where the operating efficiency could remain above 90%. With side by side loading in shallow water (approximately 20 m water depth), significant wave heights were assessed and it was determined that missed cargoes would be likely between December and May. This option was not deemed practical due to the likelihood of a full-field shutdown as a result of missed cargoes and the associated need for flaring during shutdown and start-up conditions.

Other considerations included 1) the difficulty of expandability in open water in the absence of a breakwater, , and 2) the exposure of non-working crew on board the FLNG vessel to the hydrocarbon risks of the FLNG plant without access to alternative accommodation, 3) the risk of vessel collision between LNG carrier and the FLNG without a loading facility, and 4) the need for a small tug harbor to be constructed in the N'Diago and/or Saint-Louis region to accommodate the required tugs for the nearshore unloading operation.

5.2.4 Breakwater Location

Modeling was completed to predict the impact of the breakwater on the coastline. Multiple breakwater locations were evaluated during modeling to provide information regarding differing potential impacts based on the distance of the breakwater from shore and potential effects on coastal erosion. The breakwater was modeled at three locations: approximately 4 km, 7 km, and 10 km offshore, as well as an extended breakwater at the 4 km location. Appendix I-2 presents a detailed discussion on these modelings.

Figure 5-3 below presents the results of the modelling conducted as part of the breakwater location selection study for the 3 breakwater locations including the extended breakwater design after 10 years relative to the case without breakwater. The red dotted line represents the breakwater location at 4 km from the shore, the green line at 7 km from the shore, the pink line at 10 km from the shore and the grey line represents an extended breakwater design at 4 km from the shore. The black axis line represents the case without breakwater.

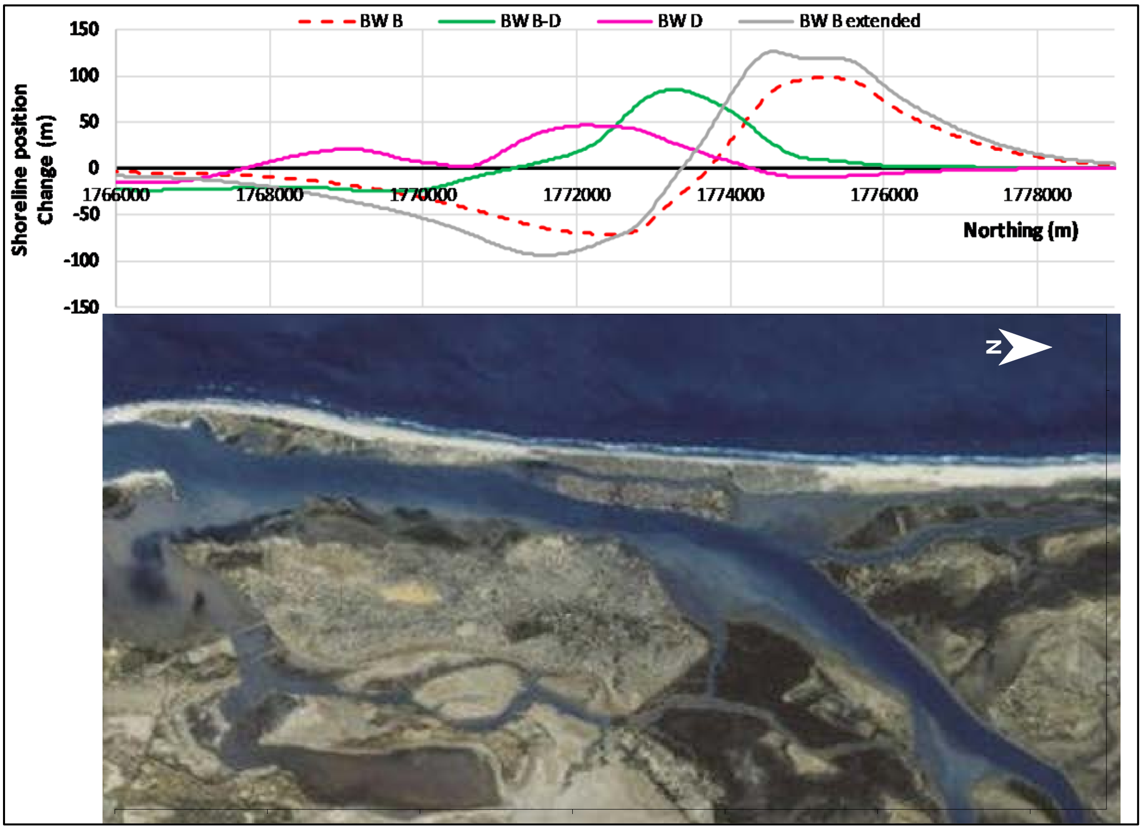


Figure 5-3. Modelled Coastline Changes for 3 Breakwater Locations (including an extended breakwater design) after 10 Years Relative to the Case without Breakwater.

Results suggested that for all breakwaters modeled, accretion or reduction in erosion occurred in the shadow zone and some erosion occurred south of the shadow zone. As the modeled breakwater was moved inshore, potential impacts from erosion tended to increase. For the 10 km breakwater location, the maximum modeled change in erosion as compared with natural erosion rates was 15 m over 10 years, a rate that is small compared to the highly variable natural erosion rates that can reach 5 m/year[63]. Maximum increased erosion (over 10 years) at other breakwater locations ranged from 25 m at the 7 km location to 93 m for the extended breakwater at the 4 km location.

5.2.5 FPSO Greenhouse Gas Emission Reduction

Under this alternative, various measures were considered to reduce greenhouse gas (GHG) emissions from the FPSO over the life of the project. These measures included reductions in power consumption and increased power and heat efficiencies. They included raised inlet pressure and process design to eliminate compression, inclusion of turbo expander instead of Joule Thomson valve (JT valve) to improve energy efficiency, deletion of MOL sieves and associated regeneration gas usage. Additionally, waste heat recovery, flare gas recovery and vapor recovery were implemented to reduce emissions and improve efficiency. The reduced power demand allows for smaller power generation units with greater flexibility to be used as well as a high degree of electrication of the FPSO processing equipment.

[63] It should be noted that additional modeling of coastal erosion processes was carried out subsequently using more accurate data and the results of this study show a maximum erosion change of 6 m over a period of 10 years, compared to natural erosion rates for the 10 km offshore breakwater location (see Appendix I-3).

5.2.6 LNG Processing Location

Various options for the LNG processing location were considered, including onshore LNG, in-field open water FLNG, and an alternative nearshore FLNG with an alternative refrigeration cycle, or a nearshore FLNG with a converted LNG carrier which will be moored to a nearshore breakwater. Key considerations for the selection of the LNG processing location included maturity of concept, future flexibility, standardization of design, environmental impacts, safety, and minimizing early capital exposure.

The onshore LNG facility allowed good separation between personnel and LNG facility, and the high operability due to the ability for BP to leverage engineering know-how from global LNG operations. However, the onshore LNG presented problems due to the lack of available space to place the LNG facility in the cross-national border, potentially significant environmental issues due to construction of an LNG harbor and continuous dredging of the harbor to enable LNG export, the extended time required to build an onshore LNG facility, and the relatively high costs of onshore LNG facilities. The potential footprint was projected to be considerable.

The in-field open water FLNG would be located far from sensitive coastal environmental communities and have high operability due to the ability for BP to leverage engineering know-how from previous global LNG operations. However, open water FLNG vessels have typically taken extended time periods (over 50 months) to become operational, and have high costs. They are unable to be expanded which would restrict the scale of development and the associated operational and environmental efficiencies.

An alternative nearshore FLNG process utilizing an alternative refrigeration cycle using non-hydrocarbon refrigerants, which can offer some reduction in process safety risk, was also considered and would allow for BP to leverage engineering know-how from global LNG operations However, the concept is not proven in industry and significant development would be required therefore not meeting at the planned 36 month timescale to deliver first gas by the required date.

5.3 Chosen Project

Based on the alternatives and options presented previously, a proposed chosen project has been selected that is the best combination of safety, risk reduction, and minimization of environmental and social impacts while bearing in mind operational flexibility and reliability and certain financial considerations as outlined above. The options chosen for each alternative are described below.

5.3.1 Pipeline Route Avoiding Carbonate Mounds

The alternate pipeline route was chosen to re-route the pipeline to avoid all relict carbonate mounds, avoid slide debris by at least 1,000 m, avoid subsea gully run-outs to the maximum extent possible, cross seafloor gullies in the lowest slope area possible, cross an identified headwall scarp at a perpendicular angle, avoid coral exclusion zones by at least 600 m, avoid the confluence of gullies and avoid crossing gullies and rocky outcrops where possible.

5.3.2 FPSO Location

The preferred alternative for the FPSO location is the mid-water location approximately 40 km from shore. The relatively shallow water depth would allow for flexible risers, which reduce complexity and cost. The 40 km distance from the shoreline is out of sight of land and beyond the extent of the nearshore artisanal fishing activities. The mid-water location also allows for standard offloading and results in lower back pressure on the wells as compared with a location in the Nearshore Hub/Terminal Area. Additionally, in consideration of potential accidents and hydrocarbon release, the location of the FPSO in the mid-water location reduces the risk of significant shoreline oiling as compared to the FPSO located at the Nearshore Hub/Terminal option.

5.3.3 Presence of a Breakwater

The necessity of a breakwater was confirmed based on wave height modeling. Results of the modeling suggested that significant wave heights would preclude LNG offloading for significant durations of time, introducing the possibility for missed cargoes and the likelihood of a full field shutdown as a result. It was determined that the most feasible, cost effective, and environmentally friendly option was to construct a breakwater which eliminates the berth availability issues due to wave heights. A breakwater is an established worldwide solution and has no technology readiness concerns and eliminates the need for a tug harbor construction in N'Diago and/or Saint-Louis. However, potential environmental issues with the construction of the breakwater include the possibility of enhanced shoreline erosion or accretion as a result of both natural and anthropogenic processes. See Section 7.2.3 for a discussion of potential impacts on shoreline erosion due to events occurring in the Construction phase, including construction of a breakwater.

5.3.4 Breakwater Location

Based on shoreline erosion and accretion modeling presented in Figure 5-3 and Appendix I-2, it was determined that the breakwater at approximately 10 km from shore location was the preferred option from an environmental and social perspective, with this location producing the least amount of increased erosion over the natural erosion rate. BP and its partners validated the significantly higher financial investment associated with that option compared to the other shallower options. For the approximately 10 km breakwater location, the maximum modeled change in erosion as compared with natural erosion rates was 15 m over 10 years[64], a rate that is small compared to the highly variable natural erosion rates that can reach 5 m/year. Maximum increased erosion (over a 10-year period) at other breakwater locations ranged from 25 m at the 7 km location to 93 m for the extended breakwater at the 4 km location.

5.3.5 FPSO Greenhouse Gas Emissions Reduction

Based on the results of greenhouse gases emissions estimates calculation for the initial concept for project facilities, BP will implement various mitigation measures to reduce GHG emissions.

These measures include reductions in power consumption and increased power and heat efficiencies. They include raised inlet pressure and process design to eliminate compression, inclusion of turbo expander instead of JT valve to improve energy efficiency, deletion of MOL sieves and associated regeneration gas usage. Additionally, waste heat recovery, flare gas recovery and vapor recovery are implemented to reduce emissions and improve efficiency. The reduced power demand allows for smaller power generation units with greater flexibility to be used as well as a high degree of electrication of the FPSO processing equipment.

5.3.6 LNG Processing Location

The nearshore FLNG option was chosen as the preferred alternative. Under this option, risks include the high equipment density due to the limited space on the FLNG vessel, and the use of hydrocarbon based refrigerants. However, several benefits exist with this option as described in Section 5.2.6, including less environmental/social impacts as compared with the onshore LNG option, reduced costs as compared to onshore or deepwater LNG options, and the promised timeframe of delivery of an FLNG vessel in 36 months which would allow the first facilities to be operational on location end of 2021.

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64 See previous footnote.

CHAPTER 6: PUBLIC CONSULTATION

6.0 PUBLIC CONSULTATION

This chapter presents the stakeholder engagement and public consultation framework and plan, the methodology used to carry it out, as well as the results of the consultation. It also presents how these results have been considered in the ESIA report.

6.1 Consultation Framework and Plan

The environmental regulations of Mauritania and Senegal set up the frameworks and the plans for the consultations that were conducted for the GTA project ESIA. Additionally, IFC's PS1 requirements with regards to stakeholder engagement and public consultation were also considered.

6.1.1 Mauritania

In Mauritania, the public consultation process for ESIAs is conducted by the DCE, in collaboration with local authorities. The number/location of the public consultation meetings to be conducted during an ESIA are determined by the DCE. The DCE is also responsible for inviting the targeted stakeholders. However, public consultation meetings are publicized and they are open to all. Additionally, registers are open at the *Hakem*'s office in each location where meetings are held; stakeholders can provide written comments on the project or the ESIA in addition to those expressed during the meetings. The registers are then kept at the DCE for their records.

The ESIA consultant[65] is responsible for the presentation of the project and of the ESIA during the consultation meetings. The consultant is also responsible for the logistics of the meetings. Finally, the consultant needs to take into account the stakeholders' comments in the ESIA report.

For the current project, the DCE decided on the consultation plan. The DCE listed 25 local communities to be included in the consultation process. These included coastal communities and non-coastal communities from the Diawling National Park. The DCE also decided that representatives of these stakeholders could be met together during public consultation meetings in three locations: N'Diago, Bouhajra (location of the Diawling National Park headquarters) and Nouakchott, where national institutional stakeholders, mainly environmental Non-Governmental Organizations (NGOs), would be invited. Therefore, the plan included three consultation meetings in Mauritania.

In Mauritania, the regulatory process includes one round of consultations during the course of the ESIA. After submittal of the draft ESIA report to the DCE, a public enquiry process is initiated by the Ministry of Environment and Sustainable Development. The public enquiry process is publicized in newspapers. Copies of the draft ESIA report are made available at designated *Hakem* offices. The public can consult the document and provide written comments in a register at the *Hakem* office. No public consultation meetings are included in the public enquiry process[66].

6.1.2 Senegal

In Senegal, the ESIA consultant is responsible for conducting public consultations during the course of the ESIA preparation. The consultant also needs to demonstrate that consultations have been conducted and that stakeholders' comments have been considered in the ESIA report. It is up to the consultant to determine the number/location of the public consultation meetings. The DEEC is not involved in this process.

For the current project, the ESIA consultant listed the local communities and institutional stakeholders to be targeted by the consultation process. The list included: 1) the potentially affected communities of Saint-Louis with a focus on fishing communities as they are the main sea users of the area where the nearshore facilities of the project are planned; and 2) representatives of other coastal fishing

[65] As explained in Section 1.4, the ESIA consultant for the current ESIA is Golder in partnership with CSA, Ecodev and Tropica.
[66] The public enquiry of the GTA Phase 1 project in Mauritania has been conducted during the fourth quarter of 2018. The summary of the Public Enquiry Report dated November 2018 as well as a tracking table of responses to the comments noted in this document are included in Appendix X.

communities south of Saint-Louis, institutional stakeholders and NGOs that might feel concerned by the project or indirectly affected by it[67].

The consultant initially planned on holding four public assemblies in the city of Saint-Louis: one for the general public and three for the fishing communities of Goxxu Mbacc, Ndar Toute and Guet Ndar/Hydrobase. The consultant also planned on holding institutional stakeholder meetings in each of the four administrative regions included in the ESIA extended study area: Saint-Louis, Louga, Thiès, and Dakar. These meetings were to be organized during dedicated Regional Development Committee (*Comité régional de développement [CRD]*) meetings, to be held under the chairmanship of the Governor of each region. The CRD meetings were also to include representatives from coastal fishing communities and NGOs. Therefore, the consultation plan included a total of eight meetings: four public assemblies and four CRDs. While this consultation plan did not require the approval of the DEEC, the consultant shared it with the DEEC which indicated that it met their expectations and provided support for the organization of the CRDs. Adjustments to this plan were made during the consultation process to take into account the realities on the ground, notably requests made by the municipal authority of Saint-Louis and requests from the Hydrobase fishermen to have their own meeting instead of joining the one in Guet Ndar. In the end, a total of 14 consultation meetings were held in Senegal; 7 of them were public assemblies in Saint-Louis.

In Senegal, the regulatory process includes a second round of consultation conducted by the DEEC with the local authorities[68]. This second round, conducted after the pre-approval of the draft ESIA report by the Technical Committee is called “public hearings”. The objective of the public hearings is to present the results of the ESIA and to collect local stakeholders’ concerns and comments. The number/location of the public hearings are determined by the Technical Committee. The ESIA consultant is responsible for the presentation of the draft ESIA results and for the logistics of the meetings. After the public hearings, the consultant needs to take into account the stakeholders’ comments in a revised version of the ESIA report if requested[69].

6.1.3 IFC Requirements

PS1 (IFC, 2012) states the importance of effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them. Where projects involve specifically identified physical elements, aspects and/or facilities that are likely to generate environmental and social impacts, the project proponent needs to identify the affected communities and meet a set of requirements with regard to stakeholder analysis and engagement planning. This includes informing and consulting the potentially affected communities during the ESIA process.

For the current project, the identification of the potentially affected communities was based on the identification of the communities who live in the vicinity of the planned nearshore project infrastructure/operations and are sea users that will potentially be directly affected by the project. As a result of this assessment, the consultation plan included the communities of N’Diago and Saint-Louis.

Additionally, the consultation process was broadened to cover a larger geographical area in recognition of the fact that some communities living further from the planned project infrastructure/operations might feel concerned by the project’s potential environmental and social impacts. In Mauritania, the consultation process included representatives from the few coastal communities located between N’Diago and Nouakchott and from non-coastal communities from the Diawling National Park. In Senegal, the consultation process included representatives from the numerous fishing communities located between Saint-Louis and Dakar.

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67 Representatives of the tourism sector were also included in recognition of the beach tourism existing on the Langue de Barbarie.

68 Senegal's regulatory process also includes conducting a public enquiry as part of the Classified Establishments request for authorization. This was carried out in Saint-Louis in accordance with the Order Nº 336/GRSL/AD/MS dated October 07, 2016 on the public enquiry opening for a period of 15 days, from October 13 to October 27, 2016.

69 For the GTA Phase 1 project, the Technical Committee has asked that a public hearing be held in Saint-Louis. This public hearing was conducted on November 13, 2018. The proceedings of this meeting and a tracking table of the responses to the participants’ observations are included in Appendix W of this report.

Additionally, the consultation process included institutional stakeholders and NGOs[70] on a regional and a national level.

While stakeholder engagement and consultation is an ongoing process, standard practice generally requires at least two rounds of public consultation during an ESIA process. The first round, conducted early in the ESIA process, provides preliminary project information to help stakeholders understand the project and to determine their concerns that need to be addressed by the ESIA. The second round, conducted before the ESIA is finalized, provides information on the project, the potential impacts on the communities and mitigation measures, the envisaged stakeholder engagement process and the grievance mechanism. Affected communities need to be informed about how their concerns have been considered.

6.2 Methodology

The first round of consultations for the ESIA took place in May 2017 in Mauritania and in June 2017 in Senegal[71].

Before the consultations were held, important preparation work was conducted in the field to secure the meetings: informing concerned authorities and obtaining their authorization and support to conduct the consultation meetings, engaging with local elected representatives, involving community leaders in the meeting organization and logistics, selecting and preparing appropriate meeting venues, agreeing on a meeting calendar, informing stakeholders to ensure extensive participation in the meetings, ensuring attendance of specific stakeholders (fishermen, women involved in artisanal fish processing and fishmongers), organizing attendees' transportation if required, etc.

Significant information activities were conducted at a neighborhood or village level before the public assemblies to maximize participation, including:

- A series of courtesy visits several weeks before the public assemblies and follow-up visits to local elected officials, notables, traditional leaders, imams, and other key stakeholders who are established communication relays in their community;
- Banners displayed in several visible public locations with the dates, location and hour of the public assemblies;
- Series of radio advertising of the meetings;
- Recall of the meeting location and hour at the mosques during prayers as is customary; and
- Town criers recalling the location and hour of the meeting.

During this preparatory work, engagement with local elected representatives led to the addition of public consultation meetings in Saint-Louis to meet their requirements.

Preparatory work also included a PowerPoint presentation, its verbal translation into Hassanya and Wolof, and several dry-runs in each country.

[70] The consultation plan targeted environmental NGOs. It did not target "social NGOs" as this is a denomination which covers a very wide range of heterogeneous organizations whose actions have no direct link with the potential impacts of the Ahmeyim/Guembeul project. However, social concerns were well represented by community leaders, local elected officials, fishermen representatives, women representatives, and youth representatives. The results of the consultation clearly show that social concerns were widely expressed during the public consultation process.

[71] In Senegal, the last two meetings were held during the first week of July 2017 due to a public holiday at the end of June.

The consultation sessions consisted in:

- Giving a presentation on the project[72], including information regarding project proponents; location, purpose, nature and scale of the project, duration of proposed project activities, potential project impacts, potential mitigation measures[73], and the ongoing ESIA;
- Providing answers to questions raised by the participants; and
- Gathering questions, concerns and recommendations from the participants that needed to be addressed within the current ESIA[74].

Information was presented to session participants using a French PowerPoint presentation. The same presentation was used for both countries. In Mauritania, simultaneous translations into Hassanya and Wolof (in N'Diago) were conducted. Questions and answers were also provided in these languages. In Senegal, presentations were conducted in Wolof except for a few meetings that were held in French at the attendees' request. Questions and answers were also in Wolof or in French.

While the sequence of the consultation meetings was always the same, the format of the meetings changed according to the targeted stakeholders. Most of the assemblies were held outdoors and anybody could attend them. Meetings with institutional stakeholders and NGOs were attended by invitation only. They were held in formal meeting rooms in public buildings or local hotels.

In each country, the consultation team included about 15 people involving three scribes writing down all comments, questions and answers brought up during the meetings.

Detailed public consultation reports are provided in Appendix Q-1 for Mauritania and Q-2 for Senegal. These reports include the PowerPoint presentation, meeting records, lists of attendees, pictures taken during the meetings and, for Mauritania, copies of the comments noted in the registers opened by the *Hakems*.

6.3 Consultation Process and Consulted Stakeholders

In Mauritania and Senegal, the consultation meetings started with an official opening by a local or regional authority, official speeches, introductions and presentation of the meeting agenda. In several cases, a short prayer was also recited as is customary in these proceedings.

Afterwards, the PowerPoint presentation was given. At the end of the presentation, a locally designated person in charge of moderating the meeting gathered the names of the people wishing to ask questions or offer comments. After all questions/comments were put forth, answers were provided. Answers were provided by various members of the ESIA consultant team, the KEM and KES External Affairs and Corporate Social Responsibility managers, Kosmos' Vice-President for Environment, Health and Safety or BP's Regulatory Compliance-Environment-Social Manager for the current project, depending on the subject at hand.

A total of 17 consultation meetings were held and meetings were generally scheduled in the morning[75]. The meetings with the institutional stakeholders generally started on time and lasted about three hours. The public assemblies all started with one to two-hour delays, which made them last about five hours.

[72] The PowerPoint was based on the project description as defined by Kosmos/BP in May 2017. At the time, the nearshore hub/terminal was to be located 3-5 km from the shore and it included two FLNGs. The project also included a platform in addition to the FPSO. However, the presentation indicated that the project planning was in progress and that the components' design would be detailed and optimized in the coming months. The current project description, presented in Chapter 2, is actually reduced compared to the layout presented during the consultation. Basically, the project operator did not add anything, but took out elements or moved to locations that have less potential impacts.

[73] Attendees were informed that the project planning and the ESIA were still in their early stages, and that high level potential impacts and mitigation measures were presented.

[74] As indicated to participants at the beginning of each meeting, all contributions during the meetings were noted by scribes to be reported in detailed meeting records to serve as registers of their questions, concerns and recommendations (see Appendices Q-1 and Q-2). To avoid inhibiting participation, no meetings were recorded by audiovisual means except when recorded by stakeholders themselves which was the case on a few occasions in Senegal.

[75] The time of the meeting was chosen by the local authorities and key stakeholders that were involved in the public assemblies preparation. It was chosen to maximize potential attendance of both men and women.

More than 2,600 people attended the public consultation meetings. The attendees included a wide variety of stakeholders. The public assemblies in local communities included notably fishermen, fishermen association representatives, fishmongers, women working as artisanal fish processors, women association representatives, youths and youth association representatives, neighborhood councils or other elected representatives, local dignitaries, teachers and professors, local association representatives, retirees and other ordinary citizens. The institutional stakeholder meetings included governors, prefects, subprefects, mayors, technical department government representatives, municipal and regional elected or appointed officials, scholars, civil society associations, environmental NGOs, fishermen associations, media representatives, etc.

Table 6-1 provides details on locations, type of meeting and number of attendees. The largest meetings were the public assemblies in the fishing communities: N'Diago for Mauritania and Guet Ndar, Goxxu Mbacc, Hydrobase and Ndar Toute in Senegal.

Table 6-1. Public Consultation: Location, Type of Meeting and Attendees.

	Location	Type of Meeting	Male	Female	Total Attendees
1	N'Diago	Public assembly at N'Diago	81	23	104
2	Bouhajra	Public assembly at Bouhajra	35	8	43
3	Nouakchott	Institutional stakeholder and NGO meeting in Nouakchott	20	4	24
4	Dakar	Saint-Louis Oil and Gas Management Committee[76]	2	0	2
5	Saint-Louis	Regional Development Committee of Saint-Louis	48	6	54
6	Saint-Louis	Municipal Council of Saint-Louis	38	21	59
7	Saint-Louis	Public assembly on the Island of Saint-Louis	124	26	150
8	Saint-Louis	Public assembly at Guet Ndar	232	105	337
9	Saint-Louis	Public assembly at Goxxu Mbacc	200	253	453
10	Saint-Louis	Public assembly at Pikine Bas Sénégal	32	49	81
11	Saint-Louis	Public assembly at Sor	84	25	109
12	Saint-Louis	Public assembly at Hydrobase	150	114	264
13	Saint-Louis	Public assembly at Ndar Toute	186	547	733
14	Louga	Regional Development Committee of Louga	37	5	42
15	Thiès	Regional Development Committee of Thiès	30	14	44
16	Dakar	Regional Development Committee of Dakar	74	23	97
17	Saint-Louis	Supplementary meeting with the neighborhood council of Guet Ndar[77]	8	4	12
TOTAL			1381	1227	2608

The consultation process was very well received by the stakeholders. In all meetings, a large number of stakeholders praised the information and consultation process conducted for the project. Some indicated that several rumors circulated regarding the project and they were pleased to have the opportunity of obtaining the information at the source. They also indicated that they were glad to have a chance to express their concerns and expectations.

During the meetings, attendees fully participated in the discussions. Both men and women seemed very comfortable making themselves heard. Even where there was a strong statement of concern, stakeholders were always courteous. The details of the main concerns raised during the meetings show that genuine discussions were held during the consultation process.

6.4 Key Results and their Consideration in the ESIA Report

One of the key results of the consultation process is the presence of large audiences during the meetings, especially in the fishing communities. This is an indicator of the interest and/or the concern of stakeholders for the project.

It should be noted that at the beginning of each meeting, the chairman usually asked the attendees to avoid repeating a question or a concern already raised to prevent lengthy meetings. Therefore, the fact

[76] This Committee was set up by the Mayor of Saint-Louis. The members are prominent Senegalese natives of Saint-Louis appointed by the Mayor.

[77] A supplemental meeting with the neighborhood council of Guet Ndar was conducted to show them images from the PowerPoint presentation, as technical problems occurring during the public assembly limited the visibility of the slides.

that a concern was only raised once during a meeting does not mean that is not a frequent or shared concern.

However, some questions, concerns and requests/expectations recurred in several meetings. The frequent ones are summarized here with indications of the country in which they were raised and extracts of the comments are presented. The sections of the current report in which the comments were addressed is also indicated in the summary tables.

While the summary tables are useful to highlight the main results, the detailed meeting records in Appendices Q-1 and Q-2 provide comprehensive data with the wording of the stakeholders.

6.4.1 Questions Concerning the Gas Production Project

Stakeholders raised a series of high-level questions regarding the project itself. The frequent ones are summarized in Table 6-2. Chapter 2 of the current report provides a project description that addresses most of the questions identified in the table. However, some of the questions raised by stakeholders refer to State responsibilities and they are out of the ESIA scope.

While there were some technical questions, the most recurrent one was centered on the name of the project. The stakeholders wanted to know what the name meant and how it was chosen. Several indicated that the name "Ahmeyim/Guembeul" was meaningless and they wished that a name they could relate to had been chosen.

In Senegal, several stakeholders of the Langue de Barbarie asked whether the project would entail the physical resettlement of the inhabitants even though the presentation was clear that none was required. In recent years, several major projects in Senegal have entailed broad resettlement plans. Therefore, it might be difficult to conceive that a major project located near the shore will not require any temporary or permanent land acquisition and resettlement.

Table 6-2. Frequent Questions on the Gas Production Project.

	Frequent Questions	Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	What does Ahmeyim/Guembeul mean and how was that name chosen?	Yes	Yes	Section 1
2	How much gas will be produced by the project?	Yes	Yes	Section 2.1.2
3	How will solid wastes, wastewater and other discharge be managed?	Yes	Yes	Sections 2.10 and 2.11
4	Will there be any project facilities on shore?	Yes	Yes	Section 2.2.4
5	What will happen with the project infrastructure at the end of the project and what decommissioning operations will be conducted?	Yes	Yes	Section 2.3.4
6	Where will the rocks for the construction of the breakwater come from and how will they be transported to the nearshore location?	Yes		Section 2.7 (partly addressed, with details to come in later stages of the project planning)
7	How will the project revenues be split between Mauritania and Senegal and who will decide on this?	Yes	Yes	Out of ESIA scope
8	Will the project provide local taxation at a municipality level?	Yes	Yes	Out of ESIA scope
9	Will the project entail the resettlement of the inhabitants of the Langue de Barbarie?		Yes	Section 2.1.3

6.4.2 Concerns over Project Potential Environmental Impacts

In all consultation meetings, stakeholders raised important concerns regarding the project's potential impacts. The frequent ones are summarized in Table 6-3. Chapter 7 of the current report addresses the questions identified in the Table.

The majority of the stakeholders shared concerns regarding the risk of negative project impacts on the marine environment, fisheries and fishing communities.

Stakeholders from diverse backgrounds stressed the importance of fisheries for the economy of both countries and the local communities of N'Diago and Saint-Louis.

In Saint-Louis, a few experienced fishermen indicated that artisanal fisheries can live together with oil and gas activities. They gave examples based on their fishing experience in oil producing countries such as Congo, Gabon and Ghana.

However, most of the stakeholders were convinced that the project facilities and operations would have negative impacts on fisheries: destruction of marine habitats, disturbance of fishery resources migration path, depletion of fishery resources, reduction of fishing grounds, etc. They indicated that this would entail loss of revenues for fishermen but also for the whole artisanal fisheries production and commercialization chain, which extends beyond the fishermen.

> *"Fishermen, traders, women processors, truck drivers, everybody is concerned. The project is planning facilities offshore which will certainly reduce our fishing grounds. Won't that impoverish fishermen? If we add all the years of the project, from construction phase to decommissioning, this adds up to 34 years. And during all those years, the project will impact the fisheries. Considering this damage, what do the project proponents plan in terms of compensation for people in the fishing sector?"*

In Mauritania and Senegal, stakeholders' concerns included the risk that the breakwater could contribute to the very active erosion process of the Langue de Barbarie. This issue was raised repeatedly during the consultation meetings:

> *"Our main concern is the coastal erosion and the breach. The breach, where marine currents are extremely strong, kills a lot of people. The coastal erosion has reached our houses and the places where we used to conduct our activities. Several houses have been swallowed up by the sea. Won't the breakwater increase the coastal erosion and make these issues worse?"*

Concerns were also raised around maritime safety for artisanal fishermen due to density of project-related ship traffic, and the dangers associated with project operations notably the risk of explosion/fire and air emissions for coastal communities.

In Mauritania, local communities were particularly concerned that the project might have negative social impacts. They highlighted that they are still negatively impacted by the Diama dam which was constructed a long time ago:

> *"We are afraid. Yesterday it was the Diama dam that caused us tremendous harm and today it is Kosmos' breakwater. This dam in Diama has had nothing but negative impacts on us: no more farming, no more drinking water. It has destroyed our lands. Now it is our ocean that is threatened at a time when it is all that we have left."*

Finally, some stakeholders in Senegal highlighted the risk of conflicts between project proponents and artisanal fishermen, especially those wanting to enter the buffer areas around the project infrastructure because the latter could attract fish.

Table 6-3. Frequent Concerns regarding Project Potential Environmental Impacts.

	Concerns	Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	General concerns regarding environmental and social impacts of the project, notably for neighboring communities, and planned mitigation measures	Yes	Yes	Sections 7.2 to 7.6 and 9.2
2	Concerns regarding risks of destruction of marine habitats, disturbance of the migration of certain species and depletion of fishery resources	Yes	Yes	Sections 7.2.5, to 7.2.7, 7.3.5 to 7.3.7, 7.4.5 to 7.4.7 and 7.5.5. to 7.5.7
3	Concerns regarding reduction of fishing grounds due to planned project facilities and their buffer zones	Yes	Yes	Sections 7.2.15, 7.2.16, 7.3.15, 7.3.16, 7.4.15, and 7.4.16
4	Concerns regarding loss of revenues for fishermen and for other people involved in fisheries	Yes	Yes	Sections 7.2.16, 7.2.26, 7.3.16, 7.3.26, 7.4.16 and 7.4.26
5	Concerns regarding maritime safety for other sea users, notably the artisanal fishermen, due to density of project-related ship traffic	Yes	Yes	Sections 7.2.14, 7.3.14 and 7.4.14
6	Concerns regarding risk of ocean pollution due to the project vessels and accidental events, and impacts of such pollution on the fishery resources	Yes	Yes	Sections 7.5.1 and 7.5.6
7	Need for an in-depth assessment of the dangers associated with the project operations	Yes	Yes	Chapter 8
8	Concerns regarding project impacts on greenhouse gas emissions and climate changes	Yes	Yes	Sections 7.2.1, 7.3.1 and 7.4.1
9	Need for consideration of the very active coastal erosion process in the area and the breach situation and for measures to prevent such issues from increasing	Yes	Yes	Sections 7.2.3, 7.3.3, 7.4.3, 7.6 and 9.2
10	Concerns regarding project impacts on air quality and water quality	Yes		Sections 7. 2.1, 7.2.2, 7.3.1, 7.3.2, 7.4.1 and 7.4.2
11	Concerns regarding the risks of negative social impacts of the project on local communities as was the case with the Diama dam project	Yes		Sections 7.2.13 to 7.2.26, 7.3.13 to 7.3.26, 7.4.13 to 7.4.26 and 7.6
12	Risk of conflicts between project proponents and artisanal fishermen, especially those wanting to enter the buffer areas around the project infrastructure		Yes	Sections 7.2.21, 7.3.21 and 7.4.21

6.4.3 Statements on Project Benefits and Benefit Sharing

While stakeholders had concerns regarding the project’s potential negative impacts, there was a general trend that the gas discoveries in Mauritania and Senegal were God-given gifts. Some stakeholders indicated that the project could bring wealth to Mauritania and Senegal and it could raise the citizens’ standard of living as it has in oil-producing countries.

> *"We need to thank God. He has fulfilled our wishes, granting us resources such as oil and gas. Oil has allowed some Arabic countries to emerge: Saudi Arabia, Kuwait, Iraq, Iran, and others. Saudi Arabia is what it is thanks to oil; therefore, the same could happen to us."*

The stakeholders indicated the need for benefit sharing and for local benefits at a community level. Those comments were made mainly in the fishing community public consultations. Outside of fishing communities there were also a lot of comments stating that benefits/investment projects should not just target fishing communities. Additionally, statements were made regarding the need for local taxation and/or royalties. In Senegal, some stakeholders referred to the country's new constitution that states that natural resources are to be managed at a local level for the benefit of local communities.

Finally, there was a general trend in Saint-Louis that any project onshore support activities would have positive effects on employment. Several stakeholders were adamant that support operations for Senegal should be based in Saint-Louis instead of all port and airport support operations based in Dakar.

The frequent observations and requests regarding project benefits and benefit sharing are listed in Table 6-4. Most of the requests regarding project benefits and benefit sharing are State responsibilities. Therefore, those requests are out of the scope of the current ESIA.

Table 6-4. Frequent Observations and Requests regarding Project Benefits and Benefit Sharing.

Observations and Requests		Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	The gas production project can provide economic development and important financial benefits for the country and local communities (example of Saudi Arabia, Kuwait and other countries where citizens are very well off)	Yes	Yes	Section 2.1.1
2	Need for positive benefits for local communities of N'Diago and Saint-Louis	Yes	Yes	Out of ESIA scope
3	Need for positive benefits in terms of financial revenue at a local level, including through local taxation and/or local royalties (municipalities of N'Diago and Saint-Louis)	Yes	Yes	Out of ESIA scope
4	Need for a local committee to follow up on local benefits and benefit sharing	Yes	Yes	Out of ESIA scope
5	According to the new Constitution of Senegal (decentralization of natural resources management), local resources are to be managed at a local level for the benefit of local communities		Yes	Out of ESIA scope
6	Since the project is located in Saint-Louis, it should use the airport of Saint-Louis and refurbish its port instead of using the ports and airports of Dakar and Nouakchott		Yes	Section 2.2.4

6.4.4 Specific Requests from Fishermen

As indicated previously, a large part of the stakeholders' concerns related to fishery resources and artisanal fisheries. Additionally, several stakeholders, notably in fishing communities, made firm statements or requests for mitigation measures dedicated to fishing communities. The frequent ones are identified in Table 6-5. Most of them are addressed in the ESMP in Chapter 9 of the current report.

A large number of stakeholders stated that the 30-year project will compromise or severely impact artisanal fishing activities. Most of the requests focused on ensuring that the fishermen will maintain their current fishing revenues or that the project proponents will compensate for any loss. Suggestions were made such as, including professional retraining of fishermen if fishing is compromised, creation of artificial reefs to increase fishery resources in the area, development of pisciculture, etc.

In Senegal, fishing community members asked that the project proponents help in renewing the fisheries country agreement between Mauritania and Senegal to allow them fishing licenses in Mauritanian waters thus maintaining their fishing activities and revenues.

> *"When I heard that both countries had agreed to develop one single gas production project, I told myself that they could use this opportunity to find an agreement for the renewal of the artisanal fishing licenses. I ask the project proponents to work towards this goal."*

There were also some requests to ensure fishermen's safety at sea due to the additional accident risks they might encounter due to project-related ship traffic.

While requests for mitigation measures for fishermen were made in Mauritania and Senegal, the fishermen of Senegal were much more vocal. They made clear statements that they will require firm commitments from the project proponents. On a few occasions, they added that they would fight for their rights.

> *"We, fishermen, need to gather, and look for lawyers that will defend our interests and make sure that we will receive fair compensation to repair to damage that this project will cause."*

Table 6-5. Frequent Requests from Fishermen.

Requests		Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Need for fair and equitable compensation of fishermen who are the main users of the sea and who will be affected by the project	Yes	Yes	Sections 7.2.16, 7.2.26, 7.3.16, 7.3.26, 7.4.16, 7.4.26, 7.6 and 9.2
2	Request for training to support fishermen transitioning to other activities (due to project impacts on fisheries)	Yes	Yes	Sections 7.2.16, 7.2.26, 7.3.16, 7.3.26, 7.4.16, 7.4.26, 7.6 and 9.2
3	Request that the project help renew relations between Mauritania and Senegal over fishing agreements to enable Senegalese fishermen to fish in Mauritanian waters		Yes	Out of ESIA scope
4	Request for implementation of projects to recover fishery resources such as development of artificial reefs and pisciculture		Yes	Sections 7.2.16, 7.2.26, 7.3.16, 7.3.26, 7.4.16, 7.4.26, 7.6 and 9.2
5	Request that fishermen be provided with safety equipment such as GPS devices containing the geographic coordinates of all project installations and buffer zones, as well as life vests		Yes	Sections 7.2.14, 7.3.14, 7.4.14, 7.6 and 9.2
6	Need for project proponent commitments to fishermen		Yes	Sections 7.6 and 9.2
7	Fishing communities will organize themselves to defend their rights. They are ready to fight to protect their interests		Yes	Out of ESIA scope

6.4.5 Requests for Training and Local Employment Opportunities

During the consultation meetings, several requests were made around training opportunities and local employment. Stakeholders' expectations regarding "Local employment" refer to job opportunities at a community level, for instance N'Diago and Saint-Louis. Job opportunities for Mauritanian or Senegalese, at a national level, were not considered as local employment opportunities by the population consulted.

In Mauritania, stakeholders were concerned that they might not be able to compete with Senegalese workers as they think that these workers are often more skilled. They requested specific training opportunities for Mauritanians to ensure a fair distribution of employment between the two countries. A similar concern was raised for women and young people to allow a fair distribution of employment between men and women, and experienced and younger workers.

Stakeholders have expectations regarding training and employment opportunities for their children, especially since the project will last 30 years. Their frequent requests are summarized in Table 6-6. The requests were noted by the ESIA consultant and transmitted to BP for potential social investments as part of the company's Corporate Social Responsibility (CSR). High level information on the project operator's local employment policies are provided in Section 2.13.3 of the current report. However, some of the stakeholders' requests refer to State responsibilities. Therefore, those requests are out of the scope of the current ESIA.

Table 6-6. Frequent Requests regarding Training and Local Employment Opportunities.

Requests		Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Need to give priority to local employment versus national employment	Yes	Yes	Section 7.2.18, 7.2.26, 7.3.18,7.3.26, 7.4.18 and 7.4.26
2	Need to train local youth in oil & gas industry professions	Yes	Yes	Out of ESIA scope
3	Need to provide prior training to local young people and to women to ensure that they will have access to local employment	Yes	Yes	Section 7.2.18, 7.2.26, 7.3.18,7.3.26, 7.4.18 and 7.4.26
4	Saint-Louis workers have more skills than those of N'Diago. The latter will require specific training to ensure fair employment opportunities	Yes		Out of ESIA scope
5	Request for the list of profiles potentially being sought by the project/positions to be filled and for the number of jobs anticipated for local residents		Yes	Out of ESIA scope
6	Need for the creation of a training institute in Saint-Louis for oil and gas professions		Yes	Out of ESIA scope

6.4.6 Request for Information, Consultation and Involvement of Stakeholders in the Project

Several stakeholders had requests regarding information and consultation on the project. Additionally, some made clear requests regarding their involvement in the project. These requests are listed in Table 6-7. Most of them are addressed in the ESMP or the Surveillance and Monitoring Plan of the current report.

The different requests show that while receiving information and being consulted on the project is important, some local and regional stakeholders, as well as scholars and civil society representatives, expect an active role in the project monitoring.

Table 6-7. Frequent Requests regarding Information, Consultation and Involvement of Stakeholders.

	Request	Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Need to create a permanent consultation framework with all stakeholders in order to anticipate potential conflicts between the project and sea users	Yes	Yes	Sections 7.2.26. 7.3.26, 7.4.26, and 7.6 (see measures M19 and M28)
2	Need to implement a project Monitoring Committee which will be presided by the *Wali* of Trarza and the Governor of Saint-Louis. The Mayors of N'Diago and Saint-Louis would be part of it.	Yes		Section 7.6 (see mitigation measures M19 and M28)
3	Need to make the municipal authorities the main point of contact for the project.		Yes	Out of ESIA scope
4	Need to establish a sound communication plan		Yes	Section 7.6 (see mitigation measures M09, M13, M15, M18, M28)
5	Need to have a local project Monitoring Committee at the fishing community level to defend local interests and ensure fair project compensations		Yes	Section 7.6 (see mitigation measure M19)
6	Request that academic researchers be involved in all phases of the project implementation process, including ESIA		Yes	Out of ESIA scope
7	Request that civil society representatives be part of a permanent project monitoring committee	Yes		Section 7.6 (see mitigation measure M19)

6.4.7 Requests for Investments in Public Infrastructure and Services

One of the general trends in the public consultation meetings was the many significant requests for investments in public infrastructure and services by the project proponents. While stakeholders from Mauritania and Senegal shared requests for investments in health and education facilities, most of the requests were country specific. The frequent ones are listed in Table 6-8. The requests were noted by the ESIA consultant and transmitted to BP for potential social investments as part of the company's Corporate Social Responsibility (CSR). High level information on the operator's CSR policy is provided in Section 3.8.2 of the current report. In addition, the social investments planned by the GTA Phase 1 project are discussed in Section 2.14. However, several of the stakeholders' requests refer to State responsibilities. Both the operator's social investments and the States' investments are out of the scope of the ESIA.

Table 6-8. Frequent Requests regarding Investments in Public Infrastructure and Services.

Request		Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Request for investments in school construction and equipment for local communities	Yes	Yes	Out of ESIA scope
2	Request to upgrade the technical capabilities of existing health care facilities in the area	Yes	Yes	Out of ESIA scope
3	Request for the construction and equipment of agriculture and cattle-raising facilities	Yes		Out of ESIA scope
4	Request for investments in access to drinking water for local communities	Yes		Out of ESIA scope
5	Request for road construction to link remote villages to the main roads	Yes		Out of ESIA scope
6	Request for support to local tourism development	Yes		Out of ESIA scope
7	Request for electrification of villages	Yes		Out of ESIA scope
8	Request that the project help solve the erosion problem on the Langue de Barbarie		Yes	Out of ESIA scope
9	Request that the project help stabilize the breach which is the cause of regular fatal accidents		Yes	Out of ESIA scope
10	Request that the project contribute to the rehabilitation of the Saint-Louis port and airport infrastructure and that a heliport be built in Saint-Louis to accommodate the logistical bases of the project		Yes	Out of ESIA scope
11	Request for the health care facilities to ensure that there are sufficient capacities and capabilities to handle a project emergency scenario		Yes	Section 8.3.6

6.4.8 Requests regarding Other Social Investments and Capacity Building

In addition to requests for public infrastructure and services, stakeholders stated that they expect the project proponents to implement a sound CSR program with extensive social investments in the local communities. In both countries, local authorities indicated that they need to lead the identification of local needs and priorities on which the program will be based.

Finally, some institutional stakeholders in Senegal made requests for capacity building support.

The frequent requests are listed in Table 6-9. The requests were noted by the ESIA consultant and transmitted to BP for their departments in charge of CSR.

Table 6-9. Frequent Requests regarding Other Social Investments and Capacity Building.

	Request	Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Need to develop and implement a comprehensive social investment program	Yes	Yes	Out of ESIA scope
2	Need to extend social investments in N'Diago and Saint-Louis to other communities of the Keur Macene *moughataa* and the Saint-Louis Department	Yes	Yes	Out of ESIA scope
3	Request for the support of women for the development of income-generating activities	Yes	Yes	Out of ESIA scope
4	Request for investments for local economic development	Yes		Out of ESIA scope
5	Importance of assessing the capacity of technical services to monitor the project and support for reinforcing such capacity	Yes	Yes	Section 9.5
6	Need to provide capacity building to technical services which might be called in to provide services during the course of the project, for instance the fire fighters		Yes	Section 9.5

6.4.9 Concerns regarding Security and Peace

In several meetings, stakeholders raised concerns around the "oil curse". In Mauritania and Senegal, some stakeholders highlighted that oil development projects have led to conflicts and wars in other countries. In Saint-Louis, several stakeholders indicated that they were afraid that the project could lead to a conflict between Mauritania and Senegal over sharing gas revenues.

> *"If fishery resources have caused the current dispute between Senegal and Mauritania, what about the gas that has been discovered on the border of the two countries?"*

Concerns regarding security and peace were also raised in relation to outsiders coming into N'Diago and Saint-Louis. Finally, the fear of sea piracy or terrorism was also raised a couple of times.

The frequent concerns regarding security and peace are listed on Table 6-10. The concerns were noted by the ESIA consultant and transmitted to BP. However, they are also addressed at a high level in Sections 7 and 9 of the current ESIA report.

Table 6-10. Frequent Concerns regarding Security and Peace.

	Request	Raised in Mauritania	Raised in Senegal	Section of the ESIA Report where the Issues are Addressed
1	Concerns regarding oil and gas project developments which have led to insecurity in other countries (with examples of war-torn countries)	Yes	Yes	Sections 7.3.21, 7.4.21 and 7.6
2	Concerns regarding outsiders coming into the area which could entail local and regional security issues	Yes	Yes	Sections 7.2.19, 7.3.19 and 7.4.19,
3	Concerns regarding potential acts of sea piracy or terrorism in the project area	Yes	Yes	Sections 7.3.21, 7.4.21 and 7.6
4	Concerns regarding risks of conflict between Mauritania and Senegal over sharing gas revenues, especially since the two countries cannot even agree on sharing fishery resources		Yes	Out of ESIA scope

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