# Development Project Block 15/06 East Hub, Soyo, Zaire Province

# Environmental Social and Health Impact Study

**Report Prepared for:**

**Eni Angola**

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# Environmental Social and Health Impact Study


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# Non-Technical Summary

## 1. INTRODUCTION

Eni Angola S.p.A., a subsidiary of Italian multinational oil and gas company Eni, proposes to develop two oil fields, Cabaça North and Cabaça South-East, in the northeastern part of offshore concession Block 15/06 off the coast of northern Angola (see **Figure 1**). The development is referred to as the East Hub project and will take place in waters that are 450 m to 550 m deep. Oil production from the East Hub project is due to start in 2016, and it is projected that approximately 225 million barrels of oil will be produced over 15 years.

Angolan law requires that Eni must apply for an Environmental License for the proposed development, and as part of this must do a study to identify and evaluate the potential impacts of the project on the natural environment and on people. The results of the study will be taken into consideration by the Angolan authorities when making a decision on whether to grant the Environmental License for the project.

To comply with the Angolan legislation and Eni's corporate requirements, Eni appointed Angola Resources Consultants Lda (ARC) to undertake an Environmental Social and Health Impact Assessment (ESHIA) study. ARC used a team with expertise in impact assessment, the marine environment and socio-economic issues to conduct the ESHIA. This document is a Non-Technical Summary of the ESHIA report that presents the results of the study.

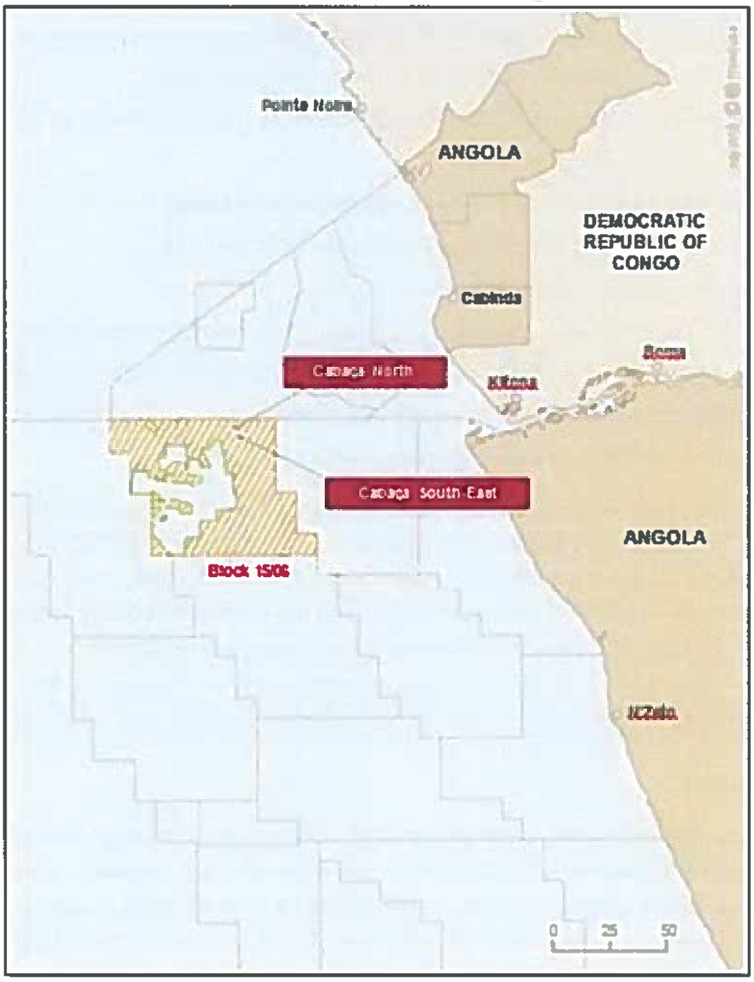


**Figure 1: Location of Block 15/06 and the East Hub oil fields.**

## 2. LEGAL FRAMEWORK

Oil and gas industry activities in Angola are regulated by the Ministry of Petroleum (MinPet). Also, the Ministry of Environment (MinAmb) is required to review environmental impact assessment reports and advise MinPet on whether planned oil and gas development activities are acceptable. The most important legislation with regard to the ESHIA process and oil and gas industry activities are:

- The General Environmental Law No. 5 of 1998 (GEL, *Lei de Bases do Ambiente*): Article 16 states that an environmental impact assessment and consultation with the public is required for all planned activities that can affect the natural and social and environment;
- The Decree on Environmental Protection for the Petroleum Industry No. 39 of 2000 (PIEPD) deals more specifically with oil and gas industry activities; and
- The Decree on Environmental Impact Assessment No. 51 of 2004 was established under the GEL and sets out the steps that must be taken when an environmental impact assessment is done.

Other Angolan laws that are relevant to the project include:

- Decree No. 59 of 2007 on Environmental Licensing;
- Executive Decree No. 140/13 on Environmental Licensing Fees;
- Executive Decree No. 87/12 on Public Consultation for Projects Subject to Environmental Impact Assessment;
- Executive Decree No. 92/12 on the Terms of Reference for Environmental Impact Studies;
- Executive Decree No. 11 of 2005 on Notification of Occurrence of Spills;
- Executive Decree No. 8 of 2005 on the Management, Disposal and Deposition of Waste;
- Petroleum Activities Law No. 10 of 2004;
- Presidential Decree No. 194/11 on Liability on Environmental Damage;
- Executive Decree No. 224/12 on Operational Discharges Management;
- Law No. 6-A/04 on Biological Aquatic Resources;
- Law No. 14/2010 on Territorial Sea, Contiguous Zone and Exclusive Economic Zone Act;
- Presidential Decree No. 141/12 on Prevention and Pollution Control in National Waters;
- Resolution No. 42/06 on the National Biodiversity Strategy and Action Plan (NBSAP) (26/07/2006); and
- Presidential Decree No. 190/12 on Waste Management (24/08/2012.

International conventions which Angola has signed include the International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL), the Convention for the Safety of Life at Sea, 1974 (SOLAS), the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS), the United Nations Convention on Law of the Sea 1982 (UNCLOS) and the Convention on Biological Diversity 1992 and the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

## 3. PROJECT DESCRIPTION

### 3.1 Project Motivation

Angola has one of the fastest-growing economies in the world, which is almost entirely dependent on oil production – oil exports contribute about 90% to the Angolan government's income. Various programmes are being implemented that aim to spread the financial benefits of oil exports to the country's population. Projects such as the proposed East Hub development will contribute to the success of these programmes.

## 3.2 Project Components and Activities

Eni plans to drill 23 subsea wells to obtain oil from the Cabaça North and Cabaça South-East oil fields, using at least two mobile offshore drilling units (drill rigs or drillships) working at the same time. Twelve of the wells will produce oil, while the remaining 11 will be used to inject water and/or gas into the subsurface oil reservoirs to help the production wells flow more easily.

In order to drill a well, a drill bit is lowered through a drill pipe from the drill rig or drillship to the seafloor (see **Figure 2**). The drill bit crushes rock into "drill cuttings" (small pieces of rock) while it is driven deeper into the ground until the desired depth of the well is reached.

Drill cuttings are removed from the bottom of the hole by using drilling fluid or "mud", which consists mainly of water (water-based mud or WBM) or synthetic oil (low-toxicity oil-based mud or LTOBM) with various additives such as clays, chemicals, etc. The drilling mud is inserted down the drill pipe and emerges from the hole, carrying the drill cuttings from the bottom up and out of the hole.

A special set of valves, known as a Blow-Out Preventer (BOP), is installed on top of each well to prevent a well blow-out, which could otherwise result in oil flowing out of the well and spilling into the sea.

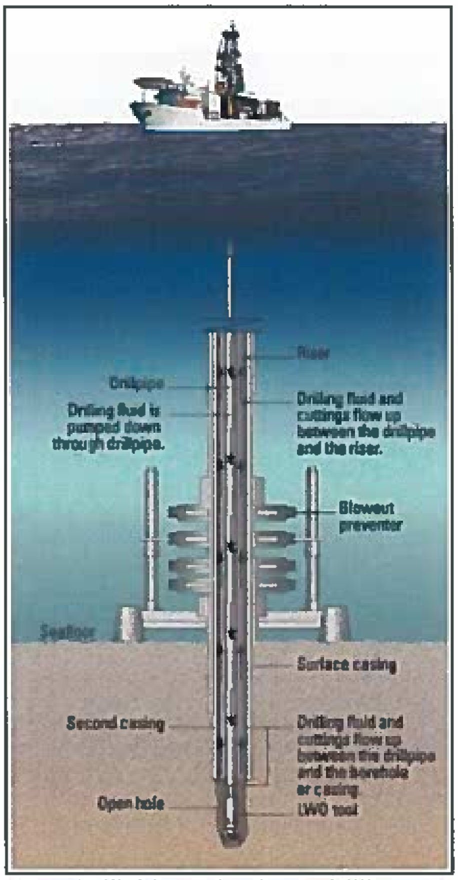


**Figure 2: Drillship and subsea drilling equipment.**

Once the wells have been completed, a number of specialised offshore construction vessels will install a network of pipelines (called flowlines, risers and umbilicals) and other infrastructure on the seafloor (refer to **Figure 4**). This subsea production and control system will link the wellheads with the production platform, which for this project will be a Floating Production Storage and Offloading (FPSO) vessel. An example of an FPSO is shown in **Figure 3**. The FPSO will be moored (anchored) in water approximately 500 m deep.

**Figure 3: Example of an FPSO.**

Once the FPSO is moored in location, it will be connected to the subsea production and control system (pipelines) and production can commence. **Figure 4** shows a layout of a simplified FPSO and subsea system.

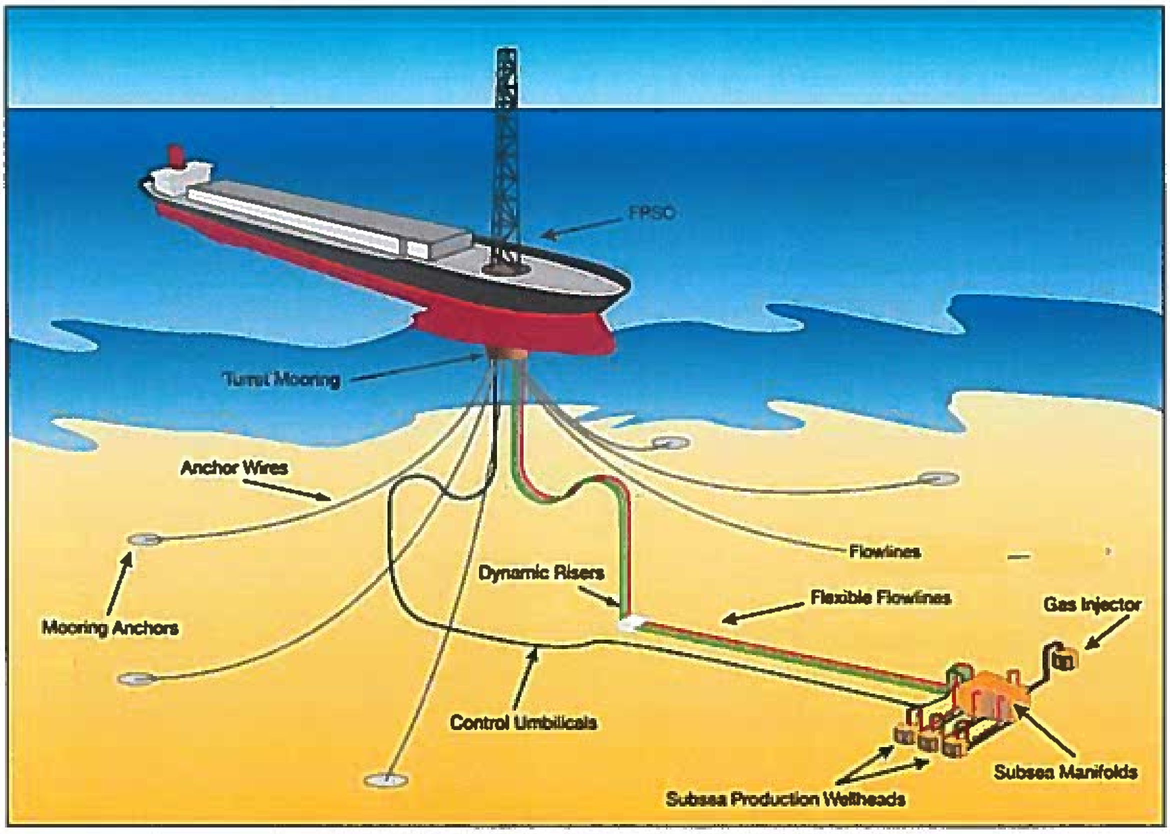


**Figure 4: A simplified FPSO and subsea systems layout.**

Fluids brought up from the wells via the subsea pipelines will be treated on board the FPSO. This treatment will include separating the fluids into crude oil, gas and water. The crude oil will be treated and stored on board, and regularly offloaded to a shuttle tanker for export. Gas and water will be treated on board the FPSO and used in various processes, e.g. gas and water are injected into the reservoirs via injector wells to assist with production (of oil), gas is used to power the FPSO and excess water is disposed of into the sea.

Throughout the drilling of the wells, installation of the subsea systems and FPSO, and production, a number of supply vessels will carry equipment and supplies between the East Hub area and the Kwanda onshore support base at Soyo, Zaire Province. Helicopters will also be used to transport people (crew) to and from the offshore facilities.

**Figure 5: Example of the Platform Supply Vessels that will travel between the oil field and the Kwanda Base during the East Hub development projects.**

It is projected that the East Hub oil fields will be in production for about 15 years. Afterwards, the field will be decommissioned and abandoned. The FPSO will leave the area after all of the wells have been plugged and the subsea equipment cleaned. Most of the cleaned subsea equipment (pipelines, anchors, etc.) will be abandoned on the seafloor and all relevant regulations will be complied with.

## 3.3 Project schedule

The anticipated overall project schedule is shown in Table 1 below. Drilling activities will take place for approximately 26 months, with the work of the two drilling units overlapping. Production will start as soon as the FPSO is moored in place and connected in early 2016. Well drilling and installation of subsea systems will continue in other parts of the East Hub Development Area and be tied back to the FPSO.

**Table 1: East Hub project schedule.**

| Activities | 2014 | | | 2015 | | | | 2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apr – Jun | Jul – Sept | Oct – Dec | Jan-March | Apr – Jun | Jul – Sept | Oct – Dec | Jan-March | Apr – Jun | Jul – Sept | Oct – Dec |
| Drilling unit 1 | | | | | | | | | | | |
| Drilling unit 2 | | | | | | | | | | | |
| Subsea installation | | | | | | | | | | | |
| FPSO installation | | | | | | | | | | | |
| Production | | | | | | | | | | | |

## 3.4 Emissions, discharges and waste

Several types of emissions, discharges and waste will be generated during the East Hub development, including:

- Emissions to air, which will mainly be exhaust gases from the main engines and other devices, but also from flaring, as well as fugitive and incinerator emissions;
- Noise emissions, in particular underwater noise generated by drilling equipment;
- Routine discharges to sea, mainly drilling discharges (drill cuttings and mud) and produced water generation during oil production; and
- Solid and liquid waste disposal on land.

# 4. AFFECTED ENVIRONMENT

## 4.1 Marine environment

The study area for the East Hub development ESHIA is defined as the marine environment (continental shelf and slope) and the coastline between Cap Lopez (Gabon) in the north and Luanda in the south. For potential socio-economic and health impacts on the local communities, the Commune of Soyo in Zaire Province is defined as the study area, as this is where the only land-based activities associated with the East Hub development will take place.

Northern Angola has a warm and moist tropical climate with mostly southerly and south-westerly winds. Most rain falls in the hottest period from February to April, while rainfall in the cooler months of June to September is much less. The seafloor in the East Hub development area consists of very fine, soft sediments (sandy or coarse silt). A survey to analyse the sediments in the East Hub development area found that the sediments are of good quality with no contamination. The Congo River flows into the ocean in the vicinity of the project area and forms a plume of freshwater that extends far into the sea and deposits sediments and organic matter from inland onto the seafloor. This plume is also thought to contribute to the higher numbers of plant-like plankton that is found off northern Angola at certain times of the year compared to other parts of the Angolan offshore area.

Benthic fauna – tiny animals that live on the seafloor – on soft sediments in the East Hub area appear to be similar to those found in other parts of the tropical West African coast and are not considered unique. Coral reefs and other hard bottom areas such as tar mounds are known to occur in deep water off northern Angola and are home to different types of benthic fauna. Although the benthic fauna occur elsewhere in the world, these hard bottom areas are important biodiversity features.

**Figure 6: Sandy seafloor (left) and tar mounds (right), with benthic fauna.**

The important types of fish that occur in the area are those that support the commercial and artisanal fisheries, and include sardinella, horse mackerel and tuna (pelagic species) as well as seabreams and hakes (demersal species). Important crustaceans are also targeted by fisheries and include prawns, shrimps and crabs (also demersal). Many seabird species occur in the region and include large species that live on the open oceans (e.g. albatrosses) as well as those that feed on the open ocean (e.g. gannets) and many smaller species known to frequent the coastline. All species of seabirds likely to occur offshore Angola have wide distributions in the southeastern Atlantic and western Indian Oceans.

Fishing takes place off the coast of Angola. The East Hub development area is located in water deeper than areas targeted by fishermen, with the exception of areas targeted for catching crustaceans (see **Figure 7**). Large pelagic species like tunas are caught in waters 500 to 1 000 m deep, which also overlaps with the East Hub area, but these species are caught all along the coast and the East Hub area is very small compared to the total tuna fishing area.

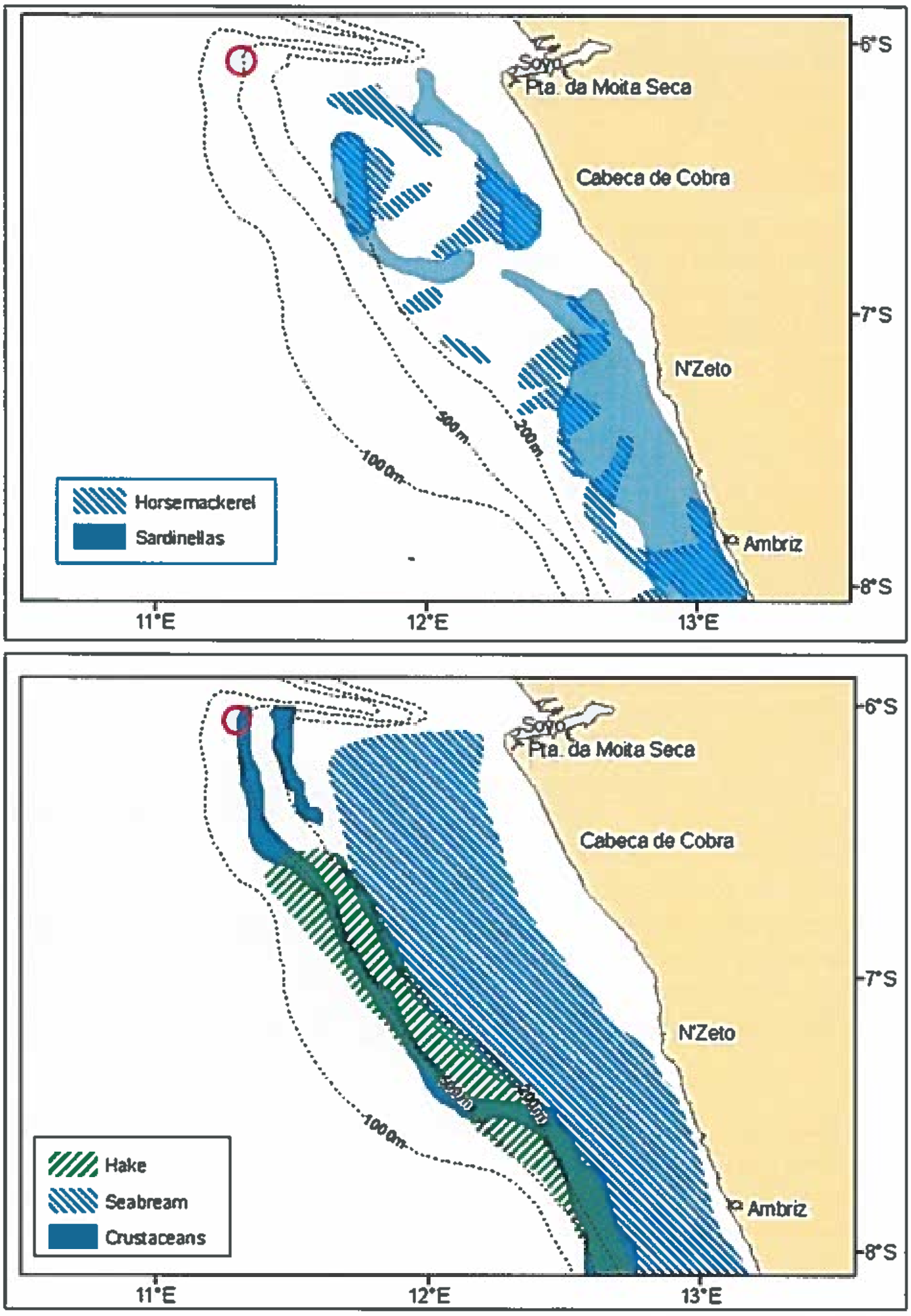


**Figure 7:** **Maps of northern Angola showing the East Hub development area (red circle) and areas where fishing takes place for small pelagic species (top) and demersal species (bottom).**

Whales and dolphins are abundant in the region with 11 dolphin species and 14 whale species confirmed in the region. Most live in deep water but some also come close to shore. Humpback whales are common in Angolan waters and are often accompanied by calves. Some species such as the Sperm whale and the Humpback dolphin are considered to be threatened, meaning that there is a risk that these species may become endangered. The African manatee occurs in the rivers and lakes of West Africa between Senegal and the Kwanza River in Angola. Five endangered turtle species have been recorded in Angolan coastal waters and some of these (Green, Olive ridley and Leatherback turtles) are known to nest on beaches on the coastline of northern Angola. Nesting takes place from October to March, and many hatchlings can be found in the ocean during this time.

The northern Angolan coastline consists mostly of a narrow sandy beach backed by low red sandstone cliffs. There are several lagoons and estuaries. Mangrove forests are important ecosystems that occur at the mouths of the Congo and Nzombo Rivers. There are a number of formal conservation areas to the north of the Congo River and to the south of Luanda.

### Socio-economic environment of Soyo

As mentioned above, the development of the East Hub will be supported from the Kwanda base located in Soyo. The Commune of Soyo is located in Zaire Province and comprises approximately 20 communities of which five are located within the city of Soyo and are considered urban. The remaining communities comprise several located on the coastline or on the banks of the Congo River, which rely largely on fishing for their livelihood, while those located inland rely more on agriculture, although most communities take part in both activities.

The Commune's population is young with 65% younger than 30 years and the average household comprises four members. About 83% of the population has some schooling, but only about 1% has tertiary education. Lack of schooling facilities and lack of household income are the main reasons for pupils dropping out of school in Soyo. About 11% of the population of Soyo considers themselves to be farmers or fishermen. Portuguese and Kissolongo are the main languages spoken.

Approximately 40% of the population owns land for cultivation, and nearly 70% of these landowners grow crops for subsistence (family consumption) only, with another 27% growing both commercial and subsistence crops. Very few people practise only commercial agriculture. Only about 14% of the population fish (in the sea or on rivers), and just over half of these fishermen fish for subsistence as well as to trade. Purely commercial fishermen comprise only about 6% of the local population. More than half of these fishermen do not own their own boat. Of those that do own their own boat, only about 25% have engines.

**Figure 8: Boats used by local fishermen.**

In Soyo there is a high rate of maternal mortality (death of women while pregnant or soon thereafter) and a high death rate among children under five, the majority of which is caused by preventable and treatable conditions such as pneumonia, diarrhoea and malaria. HIV/Aids rates are lower in Angola than in other countries, but the life expectancy (at 50 years) is lower. There is only one municipal hospital and six smaller health centres or clinics


**Figure 9: The municipal hospital in Soyo.**

The biggest socio-economic and health concerns identified in the Soyo communities are:

- Lack of access to basic services (water, electricity, sewerage systems and waste management), especially in rural communities;
- Lack of equipment and adequate infrastructure for artisanal fishing and subsistence agriculture activities;
- Lack of employment and training opportunities in Soyo area;
- Lack of health facilities, equipment and health service providers, especially in rural communities;

## 5. STAKEHOLDER CONSULTATION

Ten discussion group meetings were held with the local communities in Soyo to gather socio-economic baseline data and discuss the East Hub project. Separate meetings were held with the local *sobas*, and members of the predominantly agricultural communities, the fishing communities and urban communities. A meeting was also held with young people in urban communities. In addition, 22 in-depth interviews were held with various people from the local authorities, education and health institutions, and community-based organisations, etc. The public inquiry process required by Angolan legislation was held in Soyo between 23 and 31 January 2013 and in Luanda between 1 and 22 February.

Concerns raised by local communities in discussions about the East Hub development focused on:

- Employment opportunities for local people and the likely short duration of such opportunities;
- Potential impact of pollution caused by the project on agriculture and fishing, and people's way of life; and
- Adequate and fair compensation for any loss of income suffered by local communities as a result.

Regardless of these concerns, the local communities welcome the project and see it as an opportunity for local growth and development.

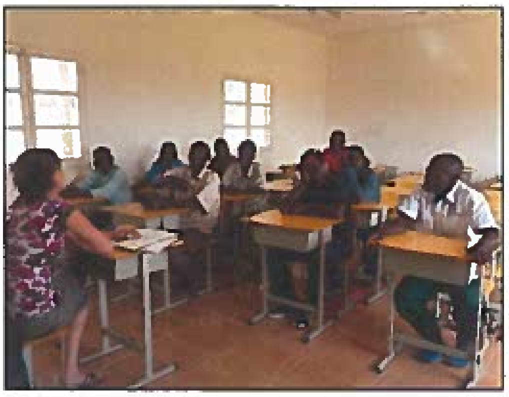

**Figure 10: Discussion group meetings held in Soyo.**

## 6. IMPACT ASSESSMENT

An environmental impact is any change (positive or negative) in the natural or socio-economic environment caused by a project. To identify the potential impacts of the proposed East Hub project, the project activities described in Section 3 above are carefully investigated to identify how activities may change the environment described in Section 4 above.

The potential changes (impacts) are then assessed using a set of criteria, namely how long the impact would last (duration), the area it will affect (spatial extent), how strong the effect would be (magnitude) and how many individuals or what proportion of the population will be affected, as well as the likelihood that the impact will occur. These criteria are used to determine the significance of each potential impact – impacts can be negligible or of very low, low, medium, high or very high significance. Potential negative impacts with a higher significance are undesirable, while impacts with lower significance are considered to be tolerable consequences of a project. Mitigation measures are recommended to avoid and/or reduce the significance of negative impacts and ensure that all of the potential impacts of the proposed project are acceptable.

The potential impacts of offshore oil field developments are well understood and the oil and gas industry uses many methods to avoid or minimise these impacts. The assessment of the potential impacts of the East Hub development assumes that Eni will implement these measures during the East Hub development, and that all Angolan and international regulations will be followed during the project.

During normal operations (no accidents or emergencies), the potential impacts of the East Hub development are assessed as follows:

- The potential *impact of vessel operations* is assessed to be of *low significance*. This includes the impact of vessel movements, noise and lighting and the general increase in the number of vessels in the area on marine fauna and other vessels. Only a small number of animals and vessels would be affected;
- The potential *impact of pollution at sea* because of waste and wastewater disposed of into the sea is assessed to be of *low significance*. This includes changes in seawater quality, harmful effects on marine organisms and impacts on biodiversity. Any pollution would rapidly dilute in the large ocean and will not be concentrated enough to cause harm;
- The potential *impact to the benthic environment* (habitat and organisms on the seafloor) is assessed to be of *medium significance*. This includes smothering of benthic organisms and changes in what the seafloor consist of because of discharged drill cuttings. Equipment on the seafloor (e.g. pipeline) would also impact on the benthic environment;
- The potential *impact on the socio-economic environment and health* of Angolan communities (particularly in Soyo) is assessed to be of *low significance*. This includes social tensions caused by in-migration of people wanting to work on the project, increased community health risks and reduced access to resources for local communities. Communities in Soyo are used to large offshore oilfield development projects and are able to cope with the consequences;
- The potential *impact of decommissioning on marine life* is assessed to be of *medium significance*, mainly because of the long-term effects of the abandoned equipment on marine life;
- The *socio-economic impact of the disruptions to other users of the sea (e.g. fishermen)* is assessed to be of *medium significance*, mainly because coastal communities rely on fishing as an important source of protein and income; and
- The *potential economic benefit* of the proposed East Hub project includes the creation of more employment in Angola and increased government income, and is assessed to be of *medium significance*.

Table 2 below summarises the significance of the impacts as discussed above.

**Table 2: Summary of significance of potential impacts of the planned East Hub project during normal operations.**

Note that negative impacts are indicated with –ve, while positive impacts are indicated with +ve.

| Potential Impact | Significance |
|---|---|
| **Potential impacts on marine environment** | |
| Impact of increased number of vessels on navigation | Low –ve |
| Blocking of access to fishing areas | Low –ve |
| Impact of vessel and helicopter movements, noise and lighting on seabirds, fish and squid. | Low –ve |
| Impact of vessel movements and noise on cetaceans. | Low –ve |
| Impact of noise and lighting on turtles | Low –ve |
| Modifications to benthos and benthic habitat by disposal of drilling cuttings and muds. | Medium –ve |
| Toxicity effects on benthos from disposal of drilling cuttings and fluids. | Low –ve |
| Impact of pollution at sea due to routine vessel operational discharges, emissions and solid waste disposal to sea. | Low –ve |
| Impact of intermittent releases of hydrocarbons from subsea equipment. | Low –ve |
| Impact of hydrotest water discharges on water quality and biodiversity. | Low –ve |
| Impact of produced water discharges on water quality and biodiversity | Low –ve |
| Impact of structures on the sea bed changing reef habitats | Medium –ve |
| Impact of decommissioning on marine life | Medium –ve |
| **Potential socio-economic and health impacts (with a focus on Soyo)** | |
| Increased local (Angolan) employment | Medium +ve |
| Increased social conflicts due to an influx of employees and work seekers into the Soyo region | Low –ve |
| Disruption of fishing activities and offshore navigation | Medium –ve |
| Increased community health risks | Low –ve |
| Reduced access to resources for local communities | Low –ve |
| Increased government revenue | Medium +ve |

Accidents or emergencies are unlikely to occur, but some of them can result in an oil spill if they do happen. These include:

- A pipeline that separates during refuelling of vessels at sea, which can result in a spill of marine diesel at the sea surface; or
- A pipeline cracks that gets separated during offloading of crude oil into a tanker, or a well blowout when control is lost over a subsea well, which can result in a spill of crude oil at the sea surface or at the sea floor.

Oil spill modelling can predict the areas that an oil spill may affect and how likely it is that specific areas (such as the coastline) would be affected if an oil spill occurs. The potential impacts **in the unlikely event of an oil spill** during the East Hub development project are assessed as follows:

- The *potential impact of a marine diesel spill* would be of *low significance*, because diesel degrades quickly and will not be in the water for long enough to have a significant impact;

- The *potential impact of a large crude oil spill on seabirds, whales, dolphins, sandy or rocky shorelines, fishing activity, tourism and recreation* is assessed to be of *low significance*. Reasons vary and include the sparse distribution and extensive natural ranges of seabirds, the ability of whales and dolphins to avoid crude oil spills, the fact that sandy or rocky shorelines are quick to recover after oiling, and the relatively low number of individuals affected in the case of fishing activity and tourism/recreation;
- The *potential impact of a large crude oil spill on turtle populations* is assessed to be of *medium significance* because turtles are sensitive to oil spills (they are not very quick and cannot avoid oil spills) and the fact that all turtles in Angola are endangered species;
- The *potential impact of a large crude oil spill on estuaries and lagoons* is assessed to be of *medium significance* because these are important ecosystems and mangrove and salt marshes are sensitive to oil and will take a long time to recover;
- Similarly, the *potential impact of a large crude oil spill on coastal conservation areas* is assessed to be of *medium significance*. Oil spill modelling results show that several coastal conservation areas from Gabon to the DRC would be at risk of an oil spill in the East Hub area and these areas contain sensitive coastal habitats (e.g. mangroves).

It must again be noted that it is highly unlikely that an oil spill will occur during the East Hub development, and many procedures and plans will be in place to prevent a spill and to contain a spill if it does occur. These include:

- Oil Spill Emergency Response Plan approved by MinPet;
- Shipboard Oil Pollution Emergency Plan; and
- Spill Prevention Plan.

**Table 3: Summary of significance of potential impacts in the unlikely event of an oil spill during the East Hub project.**

| **Potential Impact** | | **Significance** |
|---|---|---|
| Potential impact of a marine diesel or crude oil spill on: | Seabird populations | Low –ve |
| | Fishing activity | Low –ve |
| | Tourism and recreation | Low –ve |
| Potential impact of a marine diesel spill on: | Turtle populations | Low –ve |
| | Cetaceans | Low –ve |
| | Open coastal habitats | Low –ve |
| | Estuaries and lagoons | Low –ve |
| | Conservation areas | Low –ve |
| Potential impact of a crude oil spill on: | Turtle populations | Medium –ve |
| | Cetaceans | Low –ve |
| | Open coastal habitats | Low –ve |
| | Estuaries and lagoons | Medium –ve |
| | Conservation areas | Medium –ve |

The East Hub area is located in a region where there are many other oil field operations. All of these projects together also impact on the environment in the ways described above to create a cumulative impact. The East Hub project, as one of many such projects, will contribute a little to this cumulative impact in the offshore environment. Waste that is not handled and disposed of correctly on land will also contribute to the cumulative pollution impact that inadequate waste collection and management in Angola has on the environment.

## 7. ENVIRONMENTAL MANAGEMENT, MONITORING AND AUDITING

Environmental management (including monitoring and auditing) during a project is necessary in order to ensure that all of the mitigation measures identified in the ESHIA are implemented to avoid and/or reduce the significance of the project's impacts on the environment. This will be achieved by:

- Compliance with all relevant international and local (Angolan) regulations, as well as Eni's Health, Safety and Environmental (HSE) policies;
- Integrating environmental and socio-economic issues fully into the approach used for planning and operations;
- Ensuring that all workers are aware of the requirement and procedures for environmental management;
- Ensuring that all activities are undertaken in an sustainable way; and
- Continuously consulting with relevant authorities, community leaders, community-based organisations and other interested or affected parties throughout the entire project.

Eni has an existing set of plans and guidelines that address environmental management for different phases or components of the proposed project. These include:

- A management structure that sets out environmental management roles and responsibilities for the different people in the management team;
- Guidelines for environmental awareness training of workers;
- Guidelines for communicating environmental management issues;
- Plans for environmental control, monitoring the changes in the environment and auditing compliance with the environmental management objectives;
- Waste and wastewater management plans;
- Oil spill contingency plans;
- Guidelines for safety during the project; and
- Guidelines for decommissioning and abandonment.

## 8. CONCLUSION

The ESHIA has identified and assessed the potential impacts of the proposed East Hub development on the marine environment, as well as on the Angolan socio-economic environment, focusing on the Commune of Soyo. The ESHIA has found that, with responsible management of activities, including compliance with the relevant international and Angolan regulations, as well as Eni's corporate standards and procedures, the planned East Hub development and associated activities pose minimal threat of serious or permanent damage to the environment. While certain negative impacts are unavoidable, they are mostly not very significant, mainly because the project is located in deep offshore waters and the marine environment is able to cope with the potential impact.

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# List of Acronyms and Abbreviations

| | |
|---|---|
| ALARP | As Low As Reasonably Practical |
| API | American Petroleum Institute |
| ARC | Angola Resources Consultants Lda |
| bbl | Barrel |
| BOP | Blow-out Preventer |
| CAPEX | Capital Expenditure |
| $CH_4$ | Methane |
| CN | Cabaça North |
| CO | Carbon oxide |
| $CO_2$ | Carbon dioxide |
| CSE | Cabaça South-East |
| DRC | Democratic Republic of Congo |
| ED | Executive Decree |
| EIA | Environmental Impact Assessment |
| EPC | Engineering, Procurement and Construction |
| ESD | Emergency Shutdown |
| ESHIA | Environmental Social and Health Impact Assessment |
| FGS | Fire and Gas System |
| FPSO | Floating Production, Storage and Offloading |
| GDP | Gross Domestic Product |
| HAZOP | Hazard and Operability |
| HLV | Heavy Lift Vessel |
| HP | High-Pressure |
| HSE | Health, Safety and Environment |
| HSE | Health Safety and Environment |
| ICSS | Integrated Control and Safety System |
| IMO | International Maritime Organisation |
| IPA | Institute for Artisanal Fishing |
| ISO | International Organisation for Standardisation |
| LM | Lower Miocene |
| LNG | Liquefied Natural Gas |
| LP | Low-Pressure |
| LTOBM | Low Toxicity Oil Based Mud |
| MARPOL | International Convention for the Prevention of Pollution From Ships, 1973 |
| MGO | Marine Gas Oil |
| MMSCFD | Million standard cubic feet per day |
| MODU | Mobile Offshore Drilling Unit |

| | |
|---|---|
| N | North |
| NORM | Naturally Occurring Radioactive Material |
| $O_3$ | Ozone |
| ODMP | Operational Discharges Management Plan |
| OPEX | Operational Expenditure |
| PCS | Process Control System |
| PIP | Pipe-In-Pipe |
| PLET | Pipeline End Termination |
| PLET | Pipeline End Termination |
| PPE | Personal Protective Equipment |
| PSV | Platform Supply Vessel |
| ROV | Remotely Operated Vehicle |
| SE | South-East |
| SMBS | Subsea Multiphase Boosting Station |
| $SO_2$ | Sulphur dioxide |
| SOPEP | Shipboard Oil Pollution Emergency Plan |
| SRK | SRK Consulting (South Africa) (Pty) Ltd |
| STI | Sexually Transmitted Infection |
| SURF | Subsea Umbilicals Risers and Flowlines |
| TEG | Tri-Ethylene Glycol |
| UM | Upper Miocene |
| US | United States |
| WAG | Water Alternating Gas |
| WMDDP | Waste Management Disposal and Deposit Plan |

# 1 Introduction

## 1.1 Background and Project Overview

Eni Angola S.p.A., a subsidiary of Italian multinational oil and gas company Eni, proposes to develop several oil fields in the northeastern corner of offshore concession Block 15/06, off the coast of northern Angola near its border with the Democratic Republic of Congo (DRC) (see Figure 1-1). The project is known as the East Hub development, and will entail the development of several Upper Miocene reservoirs and one Lower Miocene reservoir in two oil fields, known as Cabaça North and Cabaça South-East.

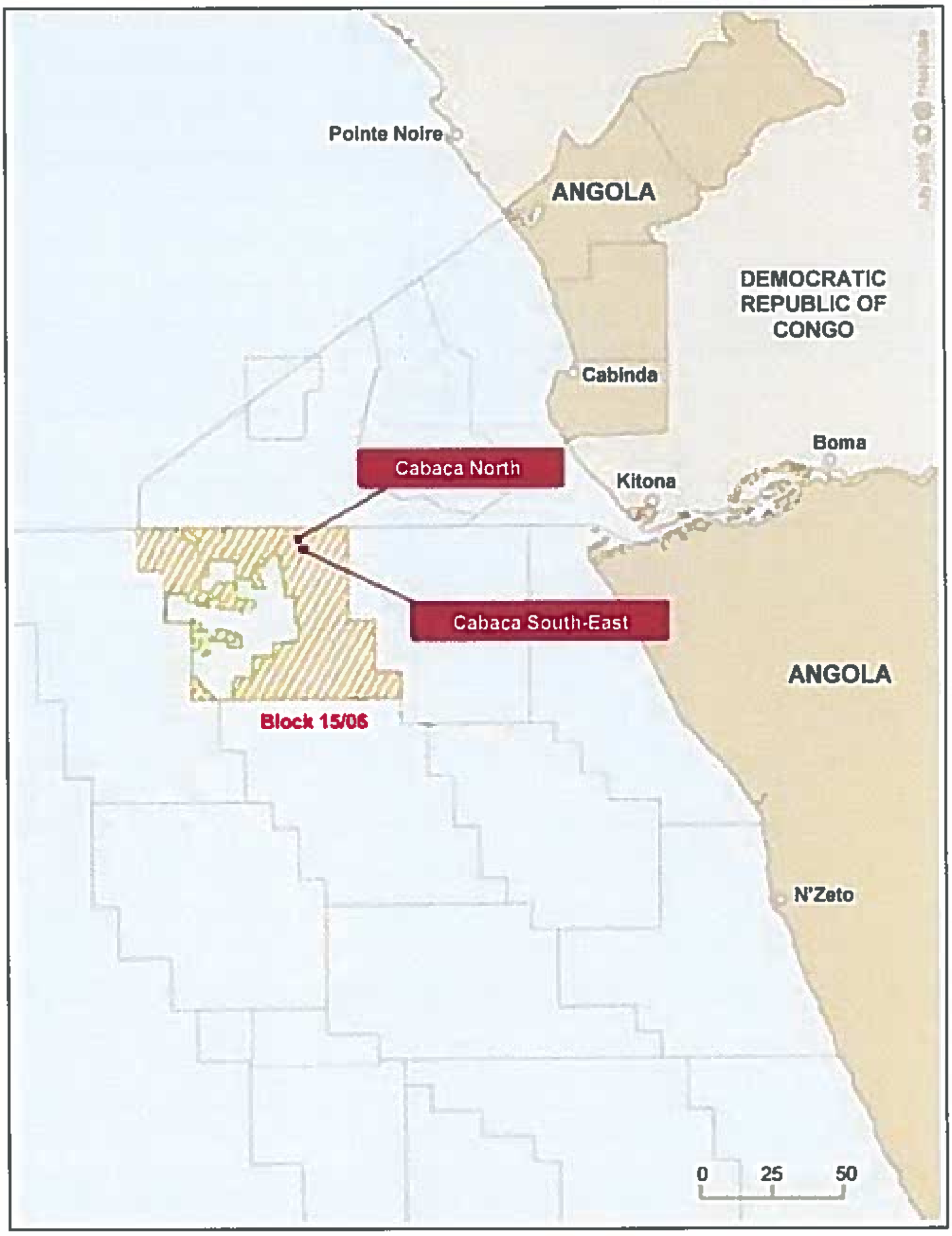


**Figure 1-1: Location of Block 15/06 and the East Hub oil fields.**
Source: adapted from www.enerzine.com

First oil from the East Hub development is scheduled for early 2016 and it is anticipated that approximately 225 million barrels (bbl)[1] of oil will be produced over the projected 15-year production lifespan of the project. The development is expected to entail 23 subsea wells tied back to a turret-moored Floating Production Storage and Offloading (FPSO) vessel.

An environmental impact assessment process is required in terms of Angolan legislation and Eni's corporate governance requirements, to evaluate the potential environmental (biophysical and socio-economic) impacts of the planned activities and to recommend measures to avoid and/or mitigate potential negative impacts and enhance any benefits. The results of the study will be taken into consideration by the Angolan authorities when making a decision on whether to allow the proposed project to go ahead.

Angola Resources Consultants Lda (ARC), in collaboration with SRK Consulting (South Africa) Pty Ltd (SRK), has been appointed by Eni Angola S.p.A. to undertake the EIA process for the proposed East Hub development project. This Environmental Social and Health Impact Assessment (ESHIA) reports on the result of the EIA process undertaken for the proposed development.

## 1.2 Details of the Proponent, Consultant and ESHIA Team

Details of the proponent and environmental consultants are provided below.

### 1.2.1 Proponent

| | |
|---|---|
| **Name:** | Eni Angola S.p.A |
| **Address:** | Edifício AAA, Avenida Lenine n.º58 |
| **Telephone:** | +244 222 391844 (Ext. 2334) |
| **Contact Person:** | |
| Name: | Raúl Muachiteca |
| Position: | HSE Regulatory & Compliance Coordinator |
| Telephone: | +244 924 069 050 |
| E-mail: | raul.muachiteca@eni.com |

### 1.2.2 Lead Consultant

| | |
|---|---|
| **Name:** | Angola Resources Consultants Lda |
| **MinAmb Registration Number:** | 047 - Livro No. A-1 |
| **Address:** | Rua Che Guevara, n.º45 – 2ºandar, Maculusso - LUANDA |
| **Telephone:** | +244 927 005 244 |
| **Contact Person:** | |
| Name: | Ana Paula Ramos |
| Position: | Head of Department |
| Telephone: | +244 927 005 244 |
| E-mail: | ana@arc-angola.com |

[1] One barrel (bbl) of oil is equivalent to approximately 159 litres.

### 1.2.3 ESHIA Team

The multi-disciplinary team involved in compilation of this ESHIA document comprised personnel from the following consultancies, each with specific roles:

- Angola Resource Consultants LDA – Lead consultant:
  - Ana Ramos – Project Manager;
- SRK Consulting (South Africa) Pty Ltd – Report compilation and technical review:
  - Chris Dalgliesh – Principal Environmental Consultant; and
  - Danélle Fourie – Principal Environmental Consultant;
- Lwandle Technologies Pty – Environmental baseline survey:
  - Dr Robin Carter – Marine specialist;
- Sue Lane and Associates – Marine baseline and impact assessment:
  - Sue Lane – Marine specialist; and
- SINFIC – Socio-economic and health baseline and stakeholders consultation:
  - Rute Saraiva - Project Management;
  - Suse Emiliano - Project Coordination;
  - Sara Vieira - Qualitative Researcher;
  - Cristina Rodrigues - Qualitative Researcher;
  - Jeremias Ntyamba - Programming Questionnaires and Field Supervision;
  - Jorge Hillinawa - Field Supervision;
  - Rita Viveiros - Geographic Information System (GIS);
  - Edgar Solano - Monitoring data quality;
  - Helena Lopes - Monitoring data quality; and
  - 17 Interviewers.
- RPS/ASA – Applied Science Associates:
  - Eric Comerma - Project Management;
  - Emily Chaite – Scientist;
  - Zach Singer-Leavitt – Scientist; and
  - Tatsu Isaji – Senior Scientist.

## 1.3 Purpose of this Report

The main purposes of this report are to:

- Provide a brief description of the proposed project and associated activities;
- Describe the potentially affected (baseline) biophysical and socio-economic environment in the project area and/or its area of influence;
- Provide a summary of the stakeholder consultation process conducted to date;

- Identify and assess the significance of the potential biophysical and socio-economic (including health) impacts of the proposed activities;
- Recommend mitigation measures to avoid and/or minimise potential negative impacts (and enhance any benefits);
- Set out the proposed environmental management, monitoring and auditing measures to manage the potential environmental impacts of the development; and
- Inform the decision by the authorities on whether to issue an Environmental License for the proposed activities.

## 1.4 Assumptions and Limitations

As is standard practice, the findings of this report are based on a number of assumptions and are subject to certain limitations, which should be borne in mind when considering the information presented in this report. However, these assumptions and limitations do not compromise the integrity of the ESHIA. Relevant limitations and assumptions are listed below:

- It is assumed that the project information provided by Eni and used in this assessment was correct at the time of writing of this report. In the event that project information changes significantly from that presented in this report, further assessment may be warranted;
- It is assumed that Eni has in place (or will have) approved management plans as required by Angolan legislation, e.g. an Oil Spill Emergency Response Plan, a Waste Management Disposal and Deposit Plan (WMDDP) and an Operational Discharges Management Plan (ODMP). This ESHIA was compiled without access to these documents; and
- The documented scientific knowledge base available in Angola is limited, and various data gaps were identified during the baseline investigation and impact assessment presented in this report (see below). However, the data gaps are unlikely to have a significant bearing on the results of the assessment as presented in this report, and the environmental management and monitoring measures presented take account of the potential risks associated with these data gaps.

## 1.5 Structure of the Report

This report consists of eight chapters, as set out in Table 1-1 below.

**Table 1-1: Chapters in this report.**

| Chapter | | Overview of content |
|---|---|---|
| 1. | Introduction | Provides background to the ESHIA and sets out the details of the proponent, purpose of the report, assumptions and limitations in the study, ESHIA team and structure of the report. |
| 2. | Governance Framework | Provides a brief summary and interpretation of national legislation, international regulations and corporate requirements relevant to the ESHIA and proposed development. |
| 3. | Project Description | Provides background to the project and history of exploration activities in the East Hub oil fields, a description of the proposed project components and activities, and a discussion of the anticipated operational waste streams which will be generated by the project. |

| Chapter | | Overview of content |
|---|---|---|
| 4. | Affected Marine Environment | Provides a description of the current (baseline) marine environment that may be affected by the proposed project, focussing on the biophysical characteristics of the offshore region and adjacent coastline. |
| 5. | Affected Social Environment | Provides a description of the current (baseline) social environment that may be affected by the proposed project, focussing on the socio-economic and health characteristics of the Soyo region. |
| 6. | Stakeholder Engagement | Provides an overview of the stakeholder engagement conducted as part of the ESIA to date. |
| 7. | Marine Impact Assessment | Identifies and assesses the potential impacts of the proposed development on the marine environment. |
| 8. | Social Impact Assessment | Identifies and assesses the potential socio-economic and health impacts of the proposed development. |
| 9. | Environmental Management, Monitoring and Auditing | Describes the general environmental management, monitoring and auditing measures that Eni intends to implement during all phases of the East Hub development. Outlines Eni's waste, wastewater and oil spill contingency plans, safety philosophy and decommissioning and abandonment guidelines. |
| 10. | Conclusions | Summarises the key findings of the report. |

# 2 Legal Framework

## 2.1 Introduction

The Republic of Angola is a unitary state based on the Constitution of 1975 (as amended, most recently in 2010), which provides the framework for the national administrative and organisational structure. Article 16 of the Constitution states that all natural resources existing in the soil and subsoil, in the territorial waters, in the economic exclusive zone and on the continental shelf, shall be the property of the state, which shall determine the conditions for its concession, prospect and exploration, under the terms of the Constitution, law and International Laws. Article 39 of the Constitution provides for the fundamental right of individuals to live in a healthy and non-polluted environment and establishes an obligation on the State to take the necessary actions to protect the environment and maintain the ecological balance.

Angolan law is enacted at the national level through different legislative instruments. The most important of these are laws and decrees as described below:

- **Laws:** the primary legislation passed by the National Assembly. They tend to cover broad issues and provide the enabling framework for the competent authorities to issue more detailed implementing legislation, e.g. decrees. Laws issued at national level apply throughout Angola, with implementation, monitoring, and enforcement carried out at both the national and provincial levels.
- **Decree-laws and Decrees:** legislation passed by the Council of Ministries, while Regulations (Executive Decrees) and Dispatches and are normally issued by a ministry. They provide a subordinate form of primary legislation and tend to cover more specific issues (and are analogous to regulations adopted in many other countries).

This ESHIA has been undertaken within the context of Angolan laws and regulations. Several pieces of national law refer to pollution of the environment, environmental impact assessment and the protection of the environment in general. In addition, guidelines exist that aim to address potential environmental damage associated with the petroleum industry in particular. Many of these laws and guidelines apply to the current project. With respect to regulations it should be noted that Angolan regulations tend to be fairly broadly framed and – as a rule – do not provide detailed standards (e.g. air quality, noise levels etc.) against which compliance can be measured. In the absence of such standards the default is to international standards (e.g. World Bank) and, sometimes, to regional standards (e.g. South African, European Directives). A synopsis of the relevant legislative and administrative framework is provided further below.

In addition to Angola's national regulatory requirements, other international standards and requirements may be relevant. These include international treaties and conventions to which Angola is a signatory. Furthermore, ENI Angola is also obliged to comply with their HSE policy.

Note that other legislative, regulatory and administrative requirements may pertain to the proposed operations, but identification and interpretation of these is beyond the brief of this study. As such, the summary provided below is not intended to be definitive or exhaustive, and serves to highlight key environmental legislation and obligations only.

## 2.2 Regulatory Framework

### 2.2.1 Ministry of Petroleum

Oil and gas industry activities in Angola are regulated by the Ministry of Petroleum (MinPet). MinPet's responsibilities include the administration of *Decree 39/00 on Environmental Protection for the Petroleum Industry* (see section 2.3.1.2 below) in the development of petroleum activities.

### 2.2.2 Ministry of Environment

The Ministry of Environment (MinAmb) is responsible for the development and coordination of the country's environmental policy and the National Programme of Environmental Management. The National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) from MinAmb, is required to review EIAs and advise MinPet on the acceptability of proposed development activities. MinAmb has responsibility to approve EIAs under *Decree No. 51/04 on Environmental Impact Assessment* and issue environmental licenses in terms of *Decree No. 59/07 on Environmental Licensing*. For oil and gas projects, licenses are issued in consultation with MinPet.

## 2.3 Legislative Framework

The main component of Angolan legislation is the requirement to carry out a comprehensive EIA (i.e. an EIS, incorporating environmental management plans, followed by a comprehensive review by the authorities) for the project. Five items of legislation, which regulate the way in which EIAs are undertaken and environmental licensing, are currently in force and are discussed below. They are:

- The General Environmental Law No. 5/98 (19/06/1998);
- Decree No. 39/00 on Environmental Protection for the Petroleum Industry (10/10/2000);
- Decree No. 51/04 on Environmental Impact Assessment (23/07/2004);
- Decree No. 59/07 on Environmental Licensing (13/07/2007);
- Executive Decree No. 87/12 on Public Consultation for Projects Subject to Environmental Impact Assessment (24/2/2012); and
- Executive Decree No. 92/12 on the Terms of Reference for Environmental Impact Studies (1/3/2012); and
- Joint Executive Decree No. 140/13, approves the base Calculation of Fees Applicable to Environmental Projects of the Oil Industry (3/05/2013).

Additional legislation with relevance to the proposed development operations includes:

- Executive Decree No. 8/05 on the Management, Disposal and Deposition of Waste (05/01/2005);
- Petroleum Activities Law No. 10/04 (12/11/2004);
- Decree No. 1/09 on Petroleum Operations (27/01/2009);
- Decree No. 38/09 on Safety, Hygiene and Health at Petroleum Operations (14/08/2009);
- Executive Decree No. 11/05 on Notification of Occurrence of Spills (12/01/2005);
- Presidential Decree No. 194/11 on Liability on Environmental Damage (07/07/2011);
- Executive Decree No. 224/12 on Operational Discharges Management (16/07/2012);
- Law No. 6-A/04, on Biological Aquatic Resources (08/10/2004);

- Law No. 14/2010, on Territorial Sea, Contiguous Zone and Exclusive Economic Zone Act (14/07/2010);
- Presidential Decree No. 141/12 on Prevention and Pollution Control in National Waters (21/06/2012);
- Resolution No. 42/06 on the National Biodiversity Strategy and Action Plan (NBSAP) (26/07/2006); and
- Presidential decree No. 190/12, on Waste Management (24/08/2012).

These are all briefly discussed below.

## 2.3.1 EIA Legislation

### 2.3.1.1 General Environmental Law No. 5 of 1998

The General Environmental Law No. 5 of 1998 (GEL, *Lei de Bases do Ambiente*) was promulgated in accordance with the Constitutional Law of the Republic of Angola (paragraphs 1, 2 and 3 of Article 24 and paragraph 2 of Article 12). The purpose of the law is to "*define the basic concepts and principles for the protection, preservation and conservation of the Environment, promotion of the Quality of Life and the rational use of Natural Resources*" (Article 1). The GEL incorporates international declarations which Angola has ratified (e.g. Agenda 21) and defines citizens' rights and responsibilities. Further, the GEL introduces the concept of legal penalties for illegal activities that have caused damage to the environment.

Article 4 includes a number of principles guiding GEL, including a principle in respect of liability: "all persons or organisations which through their actions cause harm to the environment, or the degradation, destruction or depletion of national resources, shall be held liable for the same, and shall be required to repair such damage and/or pay compensation for the damage caused".

Article 16 of GEL requires that an EIA, including public consultation (Article 10 and 32), be mandatory for all undertakings which have an impact on the balance and wellbeing of the environment and society. Clause 2 of this Article states that more specific legislation on EIAs will be developed by the government. An excellent example is Decree No. 51/04 on Environmental Impact Assessment.

An Environmental License is issued on the basis of the EIA and this license is required before any other license required by law will be granted (Article 17(2)). According to the GEL, MinAmb is responsible for issuing Environmental Licenses, except for activities related to the petroleum industry, which are licensed by MinPet. Subsequent legislation overrides this and delegates responsibility back to MinAmb, who issue environmental licences in consultation with MinPet for activities related to the Oil and Gas sector.

***Legal requirements for this project***

In terms of the GEL, Eni is required to apply for an Environmental Licence for the proposed activities, and has a responsibility to minimise (and repair) any damage to the environment caused through operational activities.

### 2.3.1.2 Decree No. 39 of 2000 on Environmental Protection for the Petroleum Industry

Whereas the General Environmental Law No. 5/98 deals with any activity which has an impact on the balance and wellbeing of the environment and society, the Decree on Environmental Protection for the Petroleum Industry No. 39/00 (PIEPD) deals more specifically with activities related to the Petroleum Industry and their operations. The purpose of the Decree (article 2) is to provide for the protection of the environment (including health, water, land and sub-land, air, flora, fauna, ecosystems, landscape, atmosphere and the cultural, archaeological and aesthetic values) in the course of petroleum-related activities. Article 3, states that this Decree regulates the system of protection of the Environment, either onshore or offshore, to which the Petroleum Activities shall be subject. The preamble to PIEPD requires that the petroleum companies must give highest priority to reduction, recycling, disposal and adequate deposit of wastes.

This decree also refers that the Concessionaire and the Associates, through the Operator, should take the necessary precautions to prevent the negative impact of pollution and to limit to the extent possible the consequences if such impact has already occurred. The Concessionaire and the Associates, through the Operator should also ensure that the personnel who carry out the petroleum operations comply with this Decree.

The Decree requires that companies and others involved in the petroleum industry (both offshore and onshore) prepare and apply "Environmental Management Instruments" (actions and practical measures) in order to avoid undue harm to the environment. These instruments cover a range of plans and studies including an EIA.

Decree No. 51/04 on EIA, promulgated subsequent to PIEPD, lists petroleum-related activities requiring EIA. The purpose of the EIA is to identify likely environmental impacts and determine appropriate mitigation measures to reduce negative impacts. For petroleum-related activities in Angola the environmental licensing authority is MinAmb in consultation with the MinPet (Article 6). The Decree states that *"if the opinion is favourable, the Ministry of Urbanism and Environment* (now MinAmb) *will issue an Environmental License"*.

Article 15 states that all spills that may cause damage to the environment must be reported to MinPet, in accordance with Executive Decree No. 11/05 on Notification of Occurrence of Spills.

According to Article 16, the operator of the facility which caused the spill must take immediate, appropriate and effective steps to control, clean and respond to the spill. This may include requesting the assistance of other petroleum companies operating in Angolan offshore waters.

According to the PIEPD the following plans must be submitted to the MinPet for proposed petroleum-related projects: Spill Prevention Plan, Spill Response Plan, Waste Management, Disposal and Deposit Plan (WMDDP) and Operational Discharges Management Plan (ODMP).

***Legal requirements for this project***

Decree No. 39/00 applies to Eni application for environmental licensing of the proposed project. In terms of the PIEPD, Eni Angola must conduct an EIA and must implement measures to reduce the environmental impacts that are likely to be associated with the proposed project. Eni is also required to compile and submit to MinPet a Spill Prevention Plan, Spill Response Plan, WMDDP and an Operational Discharges Management Plan.

#### 2.3.1.3 Decree No. 51 of 2004 on Environmental Impact Assessment

Decree No. 51/04 on Environmental Impact Assessment was established under the GEL to ensure better environmental protection from human activities likely to have an impact on the environment. It establishes a set of procedures to be followed when carrying out an EIA and compiling an EIS.

According to this decree, an EIS should achieve the following objectives:

- Provide a description of the project;
- Report on the environmental impact study; and
- Take into account all technological alternatives and the location of the project, bearing in mind the probability of non-execution of the project.

Article 4 refers to a list of activities, annexed to the Decree, that require an EIA. Activities listed in this annex must acquire an Environmental License before commencement. Other (unlisted) projects that may cause significant damage to the environment (as identified by MinAmb) may also be required to undergo an EIA and licensing process.

Article 7 prescribes technical measures required for the actual EIA, including a description of the ecological, biological and social environment, the identification of impacts, the 'definition of mitigation measures' and the requirement to draw up an observation and monitoring programme.

Article 10 of the decree also provides for public consultation to be organised by the licensing authority, but, other than specifying the release of a non-technical summary, does not specify the form of consultation.

According to the Decree, the EIA licensing process is the responsibility of the "*Minister responsible for the environment*" (assumed to be the MinAmb), exercised jointly with the Minister responsible for the relevant sector of the project (Article 11), (assumed to be MinPet in this instance). Subsequent legislation delegates the licensing responsibility to MinAmb who issues environmental licenses in consultation with MinPet for projects in the oil and gas sector.

Ultimately the project must be licensed or approved by the entity authorised to license or approve the project, assumed to be MinAmb in this instance. The decision taken by MinAmb can be appealed in accordance with the general terms of administrative procedures and litigation.

***Legal requirements for this project***

In terms of the Decree No. 51/04, Eni must undertake an EIA for their proposed activities to inform the decision on environmental licensing to be taken by MinAmb.

#### 2.3.1.4 Decree No. 59 of 2007 on Environmental Licensing

Decree No. 59 of 2007 on Environmental Licensing adopts provisions concerning requirements, criteria and administrative procedures related to environmental licenses.

In terms of Section II Article 10, any activity requiring an EIA must acquire an Environmental License. Environmental licenses are "*issued by the entity responsible for environmental policy*" (assumed to be MinAmb).

Two types of environmental licences are required for listed activities: an environmental licence is acquired first and is needed for the establishment or undertaking of a listed activity, while an operation environmental licence is issued once compliance with all the requirements of the EIA has been demonstrated.

In order to obtain an environmental license, an application must be submitted to the administrative offices of the entity responsible for the environmental policy. According to Article 6 of the decree, an Environmental Impact Assessment Report must be summarised in the application and the entire report attached to the application. The decision on the application is announced within 90 days of receipt of the application (Article 8).

***Legal requirements for this project***

In terms of the Decree No. 59/07, Eni must undertake an EIA for their proposed activities and submit it to MinAmb in order to inform their decision on environmental licensing, which is to be taken in consultation with MinPet.

#### 2.3.1.5 Executive Decree No. 87/12 on Public Consultation for Projects Subject to Environmental Impact Assessment

Executive Decree No. 87/12 defines and sets out the purpose of public consultation for projects that require EIA. While the need for public consultation following submission of the EIS to the relevant Ministry, before approval and issuing of an Environmental License, is prescribed in legislation prior to the promulgation of Executive Decree No. 87/12, this Decree provides a more detailed and extensive explanation of the objectives of and requirements for public consultation.

The new regulations include a list of definitions related to public consultation (Article 1), the objectives and purpose of public consultation (Article 2 and 3), as well as the composition of the committee to preside over public consultation and their roles (Article 4 to 7). In Article 8, the requirements for information disclosure at public consultations are explained, including the role of the Non-Technical Summary. Administrative details such as the timeframe within which consultation must take place (5 – 10 days), compilation of a public consultation report and the fact that all costs associated with public consultation must be born by the developer, are also set out in the regulations.

***Legal requirements for this project***

In terms of Executive Decree No. 87/12, Eni will be required to carry the cost of any public consultations required by the authorities and to ensure that the information presented at such public consultations comply with the requirements of Executive Decree No. 87/12.

#### 2.3.1.6 Executive Decree No. 92/12 on the Terms of Reference for Environmental Impact Studies

Decree No. 92/12 sets out the terms of reference for the EIS and specifies its general content. This Decree establishes that the EIS must be compiled in terms of the legislation on EIA and should follow the guidelines contained in any relevant sector-specific standard terms of reference for EIS (currently being developed by MinAmb) once promulgated.

The Decree includes three annexes providing guidance for the information to be presented to the Ministry. Annex I is an application form for the project proponent to indicate which Environmental License is being applied for and Annex II provides a form for the provision of simplified preliminary project information. Annex III outlines the required content and structure for the EIS, but does not provide details on the required content of each section. It is understood that such details are currently being developed by the Ministry of Environment, but this has not been made available at the time of writing this report.

***Legal requirements for this project***

In terms of Executive Decree No. 92/12, Eni should complete and submit the required forms in Annexes I and II and must ensure that the EIS complies with the content requirements set out in Annex III and follows the guidelines set out in the terms of reference for EISs for production activities developed by MinAmb.

#### 2.3.1.7 Joint Executive Decree No. 140/13, approves the Calculation Method for Environmental Fees Applicable to the Oil Industry

This Decree includes four annexes that provide guidance regarding the calculation method for environmental fees produced in terms of the Total Environmental Impact. Annex I defines the Scope of Environmental Impact. Annex II and III define the Severity and Duration of Environmental Impact respectively. Annex IV provides the calculation method for the environmental fees taking into account the prior attachments. Although it is not specified in the decree, it is expected that this calculation will be done by MinAmb or a designated commission.

***Legal requirements for this project***

Eni will have to pay a fee to acquire an Environmental License for the proposed activities, calculated in terms of this decree.

## 2.3.2 Other Relevant Legislation

### 2.3.2.1 Executive Decree No. 8 of 2005 on the Management, Disposal and Deposition of Waste

Article 1 of this Decree prescribes the preparation of rules and procedures for the management, disposal and deposition of waste to be implemented by the operator and other companies, with a view to ensuring the prevention or minimization of damage to the health of persons and to the environment. This applies to all waste generated in the course of oil-related activities, provided for in Article 1, paragraph (a) of Decree No. 39/00, namely all the activities related to the prospecting, exploration, appraisal, development, production, transportation, refining, processing, storage, distribution and sale of oil and its by-products, as well as the use and storage of chemical products for the performance of petroleum activities.

Thus, within the scope of the present decree (Article 3, Section 1), operators and other oil companies must develop and keep an updated Plan for the Management, Disposal and Deposition of Waste which (in addition to what is referred to in Decree No. 39/00) also includes:

- Classification of waste, in terms of the danger level of the determined waste, for health and the environment;
- Identification of the main activities that generate significant amounts of waste, with reference to the procedures to be implemented with regard to handling, storage, transport, treatment (justification of the treatment option adopted) and disposal;
- Control of waste with regard to systematic record-keeping;
- Maintenance programs for equipment used in any operation;
- Environmental monitoring program for any of the continuous operations of the waste management activity.

In the management of waste, preference must be given to the following guidelines:

- Reduction at source (implementation of methods which minimise the generated quantity of waste or which reduce the presence of noxious substances in the waste, through more efficient practices);
- Reuse and recycling of materials and/or products;
- Use of waste as a raw material for other sectors of activity; and
- Return of waste/recycled waste to suppliers.

***Legal requirements for this project***

In terms of Executive Decree No. 8/05, Eni must draft and maintain a WMDDP for the proposed activities.

### 2.3.2.2 Petroleum Activities Law No. 10 of 2004

The Petroleum Activities Law No. 10/04 sets out the fundamental principles that regulate the exploitation of Angola's petroleum potential.

This law addresses in particular the aspects concerning ownership of natural resources and operating licences (Chapter IV). The law prohibits offshore flaring of gas flaring except for very short periods or during tests (Chapter VI, Section II, Article 73). Impacts should be assessed in a plan explaining measures to be taken by the operator to prevent damages to the environment. HSE responsibilities are detailed in Article 25 (Section II). Requirements for environmental protection and the evaluation of environmental impacts in oil and gas operations are presented in Article 24 (Section II).

***Legal requirements for this project***

Law No. 10/04 requires that Eni must undertake an EIA of the proposed operations and must submit to MinPet plans specifying the management measures to be implemented in order to prevent harm to the environment.

#### 2.3.2.3 Decree No. 1/09 on Petroleum Operations

This Decree approves the regulations applicable to oil-related operations, defining and establishing the conditions and methods to observe in operations carried out on and offshore, under the terms of Law No. 10/04.

According to article 17(1), item g) (on Section I: Prospection, Research and Evaluation), the annual work plan to be elaborated by National Concessionaire and associates should include seismic surveys and well drilling and include the environmental impact study, in accordance with the current legislation. In Section II, concerning Development and Production Activities (articles 22 and 27), an environmental and socioeconomic impact study is also required, with particular emphasis on technical solutions to prevent, minimize and fight pollution.

***Legal requirements for this project***

In terms of Decree No. 1/09, Eni must undertake an environmental impact study of the proposed development project.

#### 2.3.2.4 Decree No. 38/09 on Safety, Hygiene and Health at Petroleum Operations

This regulation aims to define rules and procedures to ensure oil-related activities are carried out in accordance with health, hygiene and safety standards set out in current legislation and with internationally accepted standards in the oil industry. This Decree is applicable to the facilities and the entire life cycle of oil-related operations both on and offshore. According to article 4, the operator must ensure that all the staff involved in oil-related activities is adequately trained to execute their tasks in full compliance with all relevant legislation on health, hygiene and safety issues. Article 14 states that the operator must adopt protection measures to ensure workers are not routinely exposed to noise levels liable to cause damage to human beings, as defined in applicable national or international standards.

***Legal requirements for this project***

Eni must ensure full compliance of this Decree for the proposed Project and monitor its implementation. The operator must ensure that workers are not exposed to high noise levels capable of causing hearing damage.

#### 2.3.2.5 Executive Decree No. 11 of 2005 on Notification of Occurrence of Spills

This Decree defines and standardises the procedures for notifying the MinPet of the occurrence of spills. According to Article 2, all spills in quantities exceeding one barrel (bbl)[2] or spills for which environmental impacts are considered significant, must be reported within a period of eight hours, measured from the moment members of the emergency response group of the operator and other oil companies observe the spill.

In the case of a major spill, all companies in Angola with the equipment, personnel, supplies and other means to control, respond and clean up the spill, are obligated to co-operate. A National Oil Spill Contingency Plan has been developed by the MinPet and the oil industry in Angola.

***Legal requirements for this project***

In terms of Executive Decree No. 11/05, Eni is required to notify MinPet of any spills of potential contaminants exceeding one bbl during the proposed operations.

#### 2.3.2.6 Presidential Decree No. 194 of 2011 on Liability on Environmental Damage

These Regulations aim to establish strict liability for the degradation of the environment, based on the "polluter-pays" principle, with a view to preventing and repairing environmental damages.

According to item 1 of Article 3, these regulations are applicable to all activities capable of causing environmental damages. These Regulations are applicable to all activities capable of causing environmental damages.

In Article 5, item 1 states that anyone who, acting with wilful misconduct or negligence, has caused environmental damages shall be required to repair the damages and/or compensate the State and private entities or individuals for losses and damages arising therefrom, by way of compensation for damages and environmental recovery measures.

Whenever environmental damages occur, according to Article 11, the operator shall promptly advise the competent authority of all relevant aspects of the situation and take the following measures:

(a) The proper steps to immediately control, contain, eliminate or otherwise manage the relevant pollutant elements and any other hazardous factors in order to limit or prevent additional environmental damages and adverse effects on human health or further deterioration of services;

(b) The necessary repair measures.

***Legal requirements for this project***

In case environmental damage could occur, where an imminent threat thereof exists, Eni shall promptly adopt the necessary preventive measures. Eni shall bear all costs related to the prevention and repair of damages it causes.

#### 2.3.2.7 Executive Decree No. 224/12 on Operational Discharges Management

Executive Decree No. 224/12 (which revokes Executive Decree No. 12/05) sets out the rules and procedures regarding management of operational discharges by oil companies operating onshore and offshore in Angola.

According with item 3 of Article 4, discharges of the following effluents resulting from operations in the maritime zone are prohibited and these must be treated as hazardous waste:

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[2] A barrel (bbl) is the standard unit of volume measurement in the petroleum industry and is equivalent to 42 US gallons or approximately 0.159 $m^3$ (159 litres).

- Drill cuttings contaminated with non-water based drilling muds;
- non-water based drilling fluids; and
- Produced sands.

According to Article 5, the operator must compile an Operational Discharges Management Plan (ODMP) that specifies the main wastes produced, the discharge points for all operational discharges, chemical products used and the Material Safety Data Sheet (MSDS), environmental monitoring plan according with Articles 16, 17 and 19, and procedures and equipment to adopt for the monitoring and mitigation of air emissions. Article 17 states that environmental monitoring activities should be in place before the beginning of the operations to establish a baseline for the EIS; regularly during the life time of the project and whenever an incident occurs.

***Legal requirements for this project***

In terms of Executive Decree No. 224/12, Eni is required to compile and maintain an ODMP during the proposed activities. According with Article 4, item 2, Eni must implement measures to protect soils, surface water and groundwater from and monitor contamination by operational discharges. The compilation of the ODMP is outside the scope of this EIA.

#### 2.3.2.8 Law No. 6-A of 2004 on Biological Aquatic Resources

This law establishes standards to ensure the conservation and sustainable use of biological resources existing in the waters under the sovereignty of the Angolan State, as well as the general basis of the activities related thereto, especially fishing and aquaculture.

According to Article 92, in the exclusive economic zone, territorial sea, continental waters, coastal waters and riverside waters, the following activities are forbidden:

a) The introduction of prohibited substances into the marine environment and / or beyond the limits of the respective international conventions to which Angola is a party, including MARPOL 73/78 and its annexes, subject to the effluent discharges and other substances permitted under the law on prevention and control of pollution from petroleum activities;

b) The introduction into the aquatic environment, including coastal and freshwater, any other substances from any source which causes damage to the environment or biological resources, on terms to be set by decree and without subject to the law on environmental and natural resources applicable;

c) Engaging in activities that involve or may involve danger of pollution or degradation of the aquatic environment, except in case of joint authorization, under the conditions prescribed by regulation, the competent Minister who oversees environmental policy and, in the case of the continental waters, the Minister of Energy and Water and subject to the legislation on other natural resources, environmental protection and transport equipment.

Article 93 (on the polluter pays principle) states that all natural or legal persons (e.g. companies, individuals, etc.) whose activities cause pollution of the aquatic environment are required to apply at their own expense measures to prevent and minimize pollution that may be defined by regulation.

***Legal requirements for this project***

Eni is required to put in place instruments to prevent damage to the aquatic environment. In case of an accident, measures to remediate the incident should be implemented.

#### 2.3.2.9 Law No. 14 of 2010 on Territorial Sea, Contiguous Zone and Exclusive Economic Zone

This law defines the limits of maritime zones under national jurisdiction, applying to all areas of maritime extension of the national territory and beyond the sea, under the UN Convention on the Law of the Sea. The provisions of this Law shall not affect the powers exercised by the Angolan state in the maritime states of others or in specific maritime spaces, as defined in international law.

Maritime zones under national jurisdiction are: inland waters, territorial sea, contiguous zone, Exclusive Economic Zone (EEZ) and continental shelf.

According to Article 9, the outer limit of the EEZ is the line whose points are located 200 nautical miles from the nearest point of the baselines.

***Legal requirements for this project***

The Angolan State is responsible for adopting preventive measures to reduce the emission of toxic substances, and measures to prevent, reduce and control pollution related with discharges/deposition (e.g. wastes, equipments, materials, etc.) to the sea. Therefore, Eni is responsible to put into practice all instruments required by Angolan law to protect the marine environment.

#### 2.3.2.10 Presidential Decree No. 141/12 on Prevention and Pollution Control in National Waters

This regulation has the objective of establishing a framework for the prevention, inspection and control of pollution of national waters by vessels, rigs and industrial facilities. According to Article 8 of this decree, vessels and oil rigs are obliged to have up to date certificates on contamination prevention. Article 9 sets the requirement for a MARPOL-compliant Emergency Plan for each vessel or oil rig detailing how they would combat water pollution. Article 11 states the need to inform the environmental authority and maritime authorities on any discharges or spills that are not permitted under MARPOL. Any hydrocarbon discharge is forbidden in national waters, with the exception of specific discharges covered by this law, as well as discharges permitted under the operational discharges management regulations and all conventions where Angola is a signatory.

***Legal requirements for this project***

In terms of Presidential Decree No. 141/12, any spills of potential contaminants during the proposed activities must be reported to the regulators. Eni has to comply with all requirements under this law.

#### 2.3.2.11 Resolution No. 42/06 on the National Biodiversity Strategy and Action Plan

To implement the recommendations from the United Nations Convention on Biological Diversity (UNCBD, ratified by the Resolution No. 23/97) the Government approved through Resolution No. 42/06 of July 26th the National Biodiversity Strategy and Action Plan (NBSAP). This strategy aims to incorporate measures for the conservation and sustainable use of biological diversity, and the fair and equitable distribution of biological resources in favour of all Angolans, into policies and development programmes.

The NBSAP has eight Strategic Areas that were defined through a process of public consultation that involved representatives of government institutions, local and traditional authorities, environmental protection institutions, the education sector, the private sector and the press. These areas include:

- Strategic Area A: Research and Information Dissemination;
- Strategic Area B: Education for Sustainable Development;
- Strategic Area C: Biodiversity Management in Environmental Protected Areas;

- Strategic Area D: Sustainable Use of Biodiversity Components;
- Strategic Area E: The Role of Communities in Biodiversity Management;
- Strategic Area F: Institutional Strengthening;
- Strategic Area G: Legislation and its Implementation; and
- Strategic Area H: Management, Coordination and Monitoring.

This strategy recommends a number of activities which include the identification and adoption of practices that will contribute to the conservation and sustainable of use of biodiversity.

#### 2.3.2.12 Presidential Decree No. 190/12 on Waste Management

Presidential Decree n. 190/12 fills an existing gap in national legislation and will come into force 90 days after it was published (i.e. on 24 November 2012). This Decree establishes the rules concerning waste generation and disposal; discharges to water and the atmosphere; collection, storage and transport of any wastes, with the exception of radioactive wastes or any other subject to specific regulations. These rules aim to prevent or minimize the negative impacts on people's health and the environment, without prejudice to the establishment or rules aiming to reduce, reuse, recycle, recover and dispose of waste. According to Article 2, this regulation applies to all activities that might generate wastes or are involved in waste management. Article 5 identified different categories of non-hazardous wastes and refers to Annex IV where the different categories of hazardous wastes are identified.

Paragraph 1 of Article 7 establishes that all private or public entities producing wastes should develop a Waste Management Plan. This plan is valid for four (4) years and should be submitted to MinAmb 90 days before the expiry date and every time there are substantial changes to the submitted plan.

Paragraph 3 of Article 18 states that hazardous wastes should be packaged or treated according to technical rules to be established through specific instructions on hazardous waste treatment, and labelled according to the sign codes contained in Annex V.

The producer of hazardous wastes must fill in a manifest (in quadruplicate), mentioning quantities, quality and destination of the collected wastes. One of the copies must be submitted to MinAmb. Within the producer's facilities, hazardous wastes should be transported through the use of adequate equipment.

***Legal requirements for this project***

In accordance to this decree, Eni must compile a Waste Management Plan for the proposed operations and must guarantee that contractors that will deal with the waste management should follow this Decree.

## 2.4 International Conventions

Angola has ratified important international conventions with relevance to the management of impacts on the marine environment, in particular pollution. The key conventions are briefly discussed below and include:

- International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL);
- Convention for the Safety of Life at Sea, 1974 (SOLAS);
- Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS);
- United Nations Convention on Law of the Sea 1982 (UNCLOS);
- Convention on Biological Diversity 1992; and

- United Nations Framework Convention on Climate Change and the Kyoto Protocol.

### 2.4.1 International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL)

The MARPOL Convention is the main international convention and aims to prevent pollution of the marine environment by ships from operational causes and to minimise accidental discharge of such substances. It is currently ratified by 136 nations, including Angola, and contains six annexes that address the prevention of different forms of pollution from ships, namely (from www.imo.org):

- *Annex I: Oil*, which lists the conditions under which vessels are allowed to discharge oil into the sea, including the following conditions:
  - The total quantity of oil which a tanker may discharge in any ballast voyage whilst under way must not exceed 1/15 000 of the total cargo carrying capacity of the vessel;
  - The rate at which oil may be discharged must not exceed 60 litres per mile travelled by the ship; and
  - No discharge of any oil whatsoever must be made from the cargo spaces of a tanker within 50 miles of the nearest land.
- *Annex II: Noxious Liquid Substances*, which details the discharge criteria and measures for the control of pollution of 250 identified noxious liquid substances carried in bulk (no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land);
- *Annex III: Harmful Substances Carried in Packaged Form*, which contains general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances;
- *Annex IV: Sewage*, which requires vessels to be equipped with either a sewage treatment plant, a sewage comminuting (reduce to small pieces or particles by pounding or abrading) and disinfecting system or a sewage holding tank;
- *Annex V: Garbage*, which specifies distances from land and the manner in which different types of garbage may be disposed of and imposes a complete ban on the dumping of all forms of plastic into the sea; and
- *Annex VI: Air Pollution*, which sets limits on sulphur oxide and nitrogen oxide emissions from vessel exhausts and prohibits deliberate emissions of ozone depleting substances.

Angola has ratified all of these annexes except the last (Annex VI). Further detail about specific MARPOL requirements are discussed where relevant in the Project Description section and on the Impact Assessment section of this EIS.

### 2.4.2 Convention for the Safety of Life at Sea, 1974 (SOLAS)

The SOLAS Convention is generally regarded as the most important international maritime safety treaty. Originally passed in 1914 in response to the sinking of the Titanic, it has been amended and updated several times over the years. Angola acceded to the 1974 version in 1992.

The SOLAS Convention specifies minimum standards for the construction, equipment and operation of ships to ensure their safety. An Annex containing 12 chapters sets requirements for specific operational aspects such as fire protection, life-saving equipment and procedures, radio communications and safety of navigation.

Flag States are responsible for ensuring that ships under their flag comply with its requirements in terms of the SOLAS Convention.

### 2.4.3 Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS)

The COLREGS sets out the rules of conduct to be followed by ships and other vessels when at sea and covers steering and sailing, conduct of vessels when in sight of one another, conduct of vessels in restricted visibility, navigational lights to be used at night, as well as manoeuvring and warning sound and light signals. Annexes contain technical requirements for lights, shapes and additional signals for fishing vessels in close proximity. The COLREGS also covers the rules of conduct with regard to a 'vessel restricted in her ability to manoeuvre', the definition of which includes 'a vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course'.

### 2.4.4 United Nations Convention on Law of the Sea 1982 (UNCLOS)

The UNCLOS or Law of the Sea Convention has been signed by 155 parties and defines the rights and responsibilities of nations in their use of the oceans. The Convention replaced four previous treaties, namely:

- The Convention on the Territorial Sea and Contiguous Zone;
- The Convention on the Continental Shelf;
- The Convention on the High Seas; and
- The Convention on Fishing and Conservation of Living Resources of the High Seas.

The Law of the Sea Convention defines the rights and responsibilities of nations in their use of the oceans and establishes guidelines for businesses, the environment and the management of marine natural resources.

### 2.4.5 Convention on Biological Diversity 1992

In addition to the marine conventions mentioned above, Angola is also party to the Convention on Biological Diversity of 1992. The objectives of this convention are:

- The conservation of biological diversity;
- The sustainable use of its components; and
- The fair and equitable sharing of benefits arising from genetic resources.

Member states are required to develop national strategies for the conservation and sustainable use of biological diversity and Angola has compiled a National Biodiversity Strategy and Action Plan in its fulfilment of its obligations under the Convention.

### 2.4.6 United Nations Framework Convention on Climate Change and the Kyoto Protocol

Angola ratified the Convention in 2000 and the Kyoto Protocol in 2007, and therefore has to comply with the provisions in these two international legal instruments. The objective of the convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The convention itself sets no mandatory limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. The treaty provides for updates (called "protocols") that would set mandatory emission limits. The main update is the Kyoto Protocol.

Member states are required to develop national strategies and respective plans for climate change, and Angola has compiled a National Strategy in fulfillment of its obligations under the Convention and Kyoto Protocol.

## 2.5 Eni's HSE Policy

Eni Angola Exploration BV and Eni Angola Production BV are committed to protecting:

- The Health and Safety of all employees and associated personnel; and
- The Environment in our business activities, through eliminating the adverse impacts of our operations.

To meet our commitment, we:

- Implement an HSE Integrated Management System (IMS) in all our activities, which meets the requirements of health, safety and environmental standards;
- Ensure that all our activities fully comply with Angolan and International legislative requirements;
- Implement controls to protect all personnel involved in ENI Angola activities;
- Actively promote awareness of HSE issues;
- Foster a culture where accidents, incidents and near misses are reported and investigated and lessons learned are shared throughout the organisation;
- Seek to implement best industry practice and endeavour to set new standard of care in our operations;
- Encourage everyone involved in our operations to bring forward proposal for improving HSE performance;
- Provide HSE training to all our employees and work with contractors to ensure they meet the same standards of care;
- Ensure that a high priority is placed on planning for emergencies and other unforeseen events;
- Continually monitor our performance and conduct regular audits of our operations to ensure the effectiveness of established controls and that our goals are being achieved;
- Consult with and respond to the concerns of other stakeholders on HSE issues; and
- Drive continuous improvement of HSE performance targets.

We believe that excellence in HSE performance is essential for good business and it contributes to improved business performance.

Responsibility for compliance with the HSE policies of ENI Angola Production B.V. lies with all managers and their staff.

## 2.6 Eni's Approach to Sustainability

Eni´s company sustainability goals include protection of the environment and contribution to the quality of life and socioeconomic development of the local communities where its projects take place. Conducting research and producing analyses of the local context in their projects´ areas ensures the management of relevant local and societal issues, to the mutual benefit of stakeholders and society in general. By engaging in this process, Eni reinforces its position as an active corporate citizen.

In the following corporate documents, Eni´s core values and principles are summarized:

- Code of Ethics;
- Annual Report (section on "Commitment to Sustainable Development");
- Eni Guidelines on the Protection and Promotion of Human Rights; and
- The Sustainability Report.

ENI´s sustainability efforts include its commitment to operate within the framework of the United Nations Universal Declaration of Human Rights, the Fundamental Conventions of the International Labour Organization (ILO), and the OECD Guidelines on Multinational Enterprises. Additionally, Eni has subscribed to several international agreements including:

- The UN Global Compact Initiative;
- The Agreement on Transnational Industrial Relations signed with ICEM;
- The Extractive Industry Transparency Initiative (EITI).

For the sustainable development of local communities, Eni´s approach includes identifying priority areas of intervention in line with international best practices. The main tools used in this process include: analysis of the context, organized dialogue with local stakeholders, Social Impact Assessment (SIA), Health Impact Assessment (HIA), and the development of initiatives and partnerships with local communities.

# 3 Project Description

An abridged description of the proposed Block 15/60 East Hub development project is provided in this chapter. The description is not intended to be technically comprehensive, but aims rather to provide a general understanding of what is proposed and to describe those project aspects that could potentially result in environmental impacts.

Information on the background to the project and history of exploration activities in the East Hub oil fields is provided, followed by a description of the proposed project components and activities, and a discussion of the anticipated operational waste streams which will be generated by the project.

## 3.1 Introduction and Background

Eni's planned East Hub development project comprises the development of a number of Miocene hydrocarbon reservoirs in two distinct oil fields, namely Cabaça South-East (Cabaça SE) and Cabaça North (Cabaça N), in the north-eastern corner of offshore concession Block 15/06 (see Figure 3-1). Water depths in the East Hub area of Block 15/06 range between 450 m and 550 m.

Eni has been exploring for oil in Block 15/06 for several years and in 2008 drilled the first successful well in the Sangos field (Sangos-1) in the West Hub area in the north-western corner of the concession area (see Figure 3-1). Plans to develop the West Hub oil fields (Sangos, Ngoma and Cinguvu) are well underway: drilling of 16 planned wells commenced in 2012 and first oil from the West Hub development is expected in 2014.

In the East Hub area, the first successful well, Cabaça N-1, was drilled in October 2009. This was followed by the drilling of Cabaça SE-ST1 and Cabaça SE-2 in May and August 2010, respectively, and Cabaça SE-3 in October 2011. Shortly thereafter Eni released a declaration of commercial discovery for the Cabaça N and Cabaça SE fields as one Development Area.

## 3.2 Project Motivation

Angola's economy – one of the fastest-growing in the world and the third-largest in Africa – is almost entirely dependent on oil production, with oil exports accounting for more than 90% of government revenue in recent years (EIA, 2013). Efforts to improve the equitable distribution of the country's profits from the export of crude oil among the country's population have increased over the last decade through the establishment of the country's Oil Investment Fund and a policy of "Angolanisation", with the establishment of a sovereign wealth fund announced at the end of 2012 (EIA, 2013).

With the country's current (2012) crude oil production levels estimated at just over 1.8 million barrels (bbl)[3] per day, and the Angolan government's 2014 target of 2 million barrels per day (EIA, 2013), projects such as Eni's proposed development of the East Hub oil fields are essential to the success of the above-mentioned programs, as well as Angola's general economic welfare.

[3] One barrel (bbl) is equivalent to approximately 159 litres of crude oil.

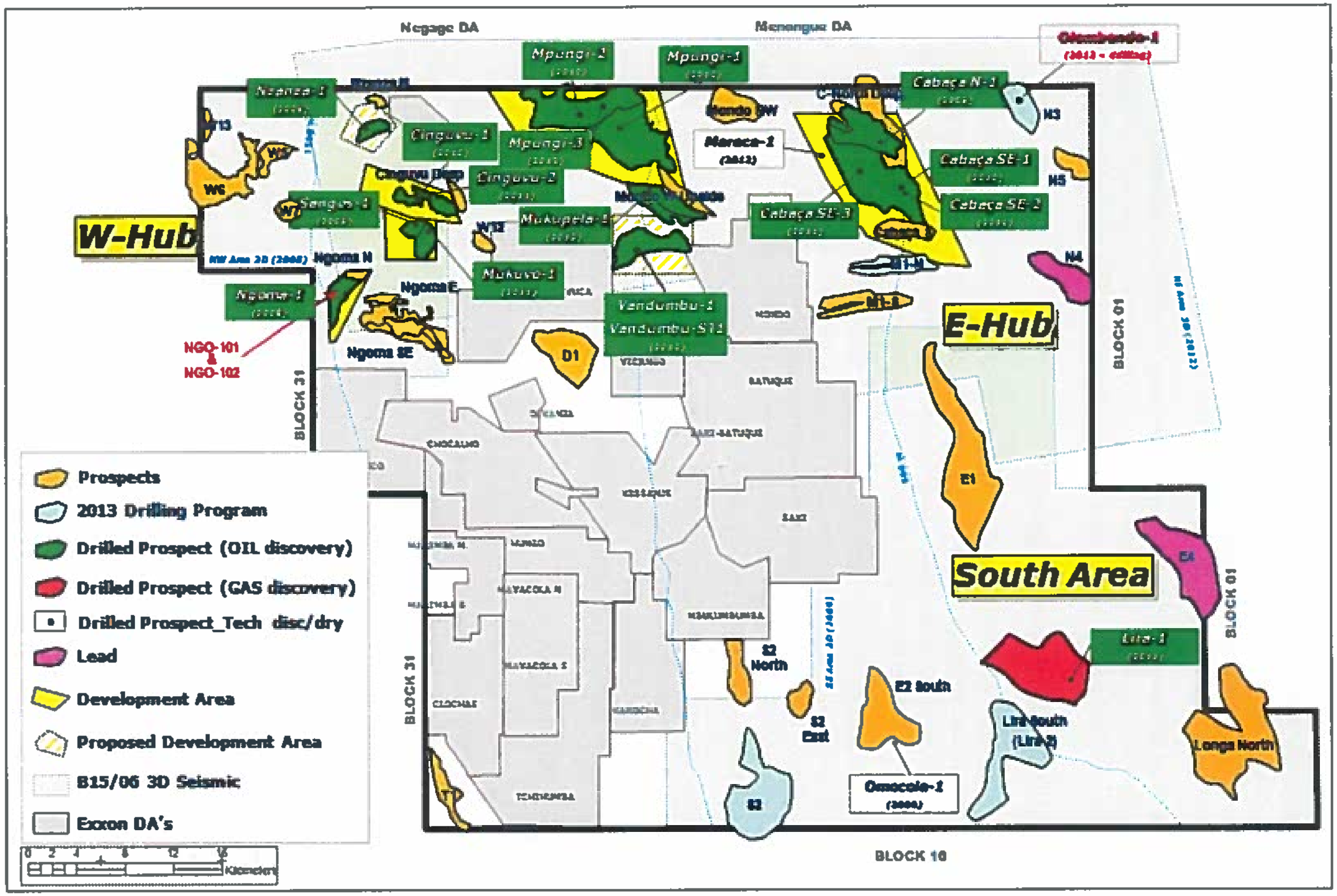



Figure 3-1: Map of Block 15/06 showing historical exploration activities, prospects and planned development areas, including the East Hub (E-Hub).

## 3.3 Project Overview

The proposed development of the East Hub oil fields will entail the drilling of 23 subsea wells (12 production and 11 injection wells) in a number of Upper Miocene (UM) reservoirs within the Cabaça N and Cabaça SE fields, and one Lower Miocene (LM) reservoir in the Cabaça SE field. Drilling (and well completion) will be undertaken by at least two mobile offshore drilling units (MODUs) over a period of approximately 26 months. Development of the reservoirs will require water injection to maintain reservoir pressure and facilitate production, and water injection wells will therefore be required for all of the reservoirs. Development of the Cabaça SE LM reservoir will also require downhole gas lift (artificial lift) to stimulate well production due to insufficient reservoir pressure, and water-alternating-gas (WAG) injection wells will therefore be drilled in this reservoir.

The subsea wells will be tied back to a single Floating Production, Storage and Offloading (FPSO) vessel via a subsea production system consisting of production trees, manifolds, flowlines, umbilicals and risers. The FPSO will be moored in water depths of approximately 500 m. Reservoir fluids will be processed on the FPSO to the required crude oil specification and the produced oil will be stored on board before transfer to conventional ocean-going oil tankers for export. Produced water will be treated to the required specification and re-injected into the reservoirs. Excess produced water may be discharged overboard. Produced gas will be used as fuel gas on board the FPSO, with excess gas injected into the reservoirs.

First oil from the East Hub development is planned for early 2016, and the lifespan of the development is expected to be 15 years (i.e. to 2031). The East Hub reservoirs are estimated to contain total recoverable reserves of approximately 225.5 million bbl (at an estimated recovery rate of 28%), as set out in Table 3-1 below. The oil found in the UM reservoirs is typically a heavy oil (20 – 22°API)[4], while oil in the LM reservoir in Cabaça SE is light (34°API).

**Table 3-1: East Hub estimated oil in place and recoverable oil reserves.**

| Field | Reservoir | Oil in place MMstb* | Oil reserves MMstb* |
|---|---|---|---|
| Cabaça N | UM 6 | 71 | 16.8 |
| | UM 8 | 142 | 36.5 |
| **Subtotal Cabaça N** | | **213** | **53.3** |
| Cabaça SE | UM 4/5 | 100 | 34.2 |
| | LM 22 | 491 | 138.0 |
| **Subtotal Cabaça SE** | | **591** | **172.2** |
| **TOTAL East Hub** | | **804** | **225.5** |

* million stock tank barrel

Production is anticipated to peak at about 86 000 bbl per day (bbl/d) six to eight months after the start of production, after which production rates will drop off to less than 15 000 bbl/d by 2030. The anticipated production profile for the East Hub project is provided in Figure 3-2 below.

The anticipated capital expenditure (CAPEX) for the East Hub development is estimated at US$ 4.493 million, while the average annual operational expenditure (OPEX) is estimated at US$ 296

[4] API = American Petroleum Institute. API gravity is expressed in "degrees" and is a measure of how heavy or light petroleum liquid is compared to water. The higher the petroleum liquid's °API, the lighter the liquid.

million. The anticipated decommissioning and abandonment cost is estimated at approximately US$ 302 million (current).

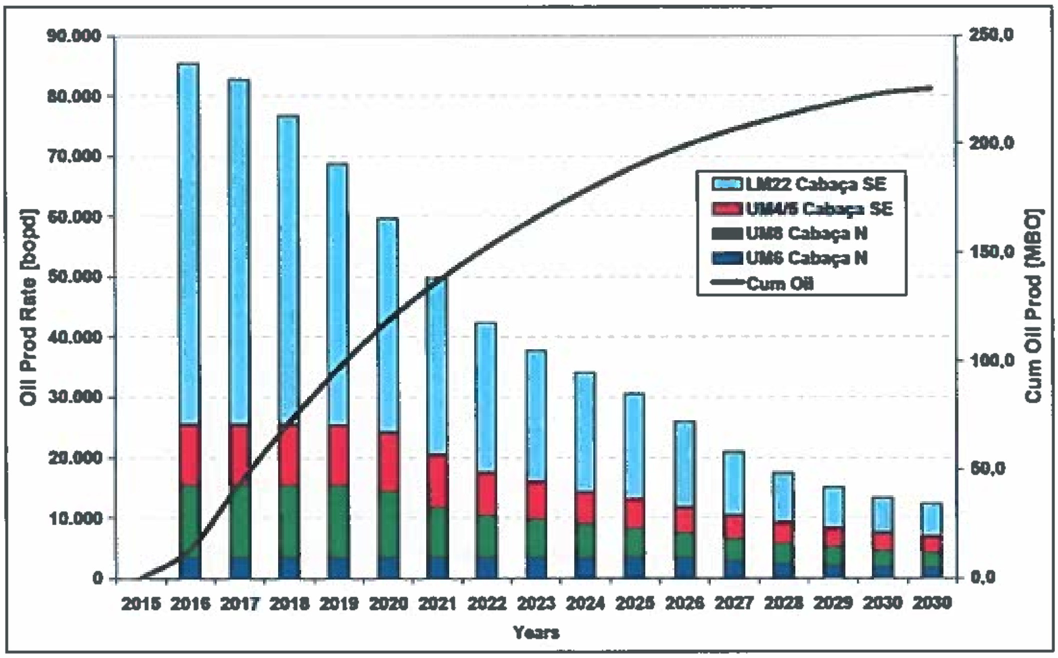



**Figure 3-2: East Hub production profile.**

## 3.4 Development Wells

### 3.4.1 Well Locations

As noted in Section 3.3, the 23 subsea wells planned for the East Hub development include 12 production wells and 11 injection wells, the latter consisting of eight water injection and three WAG wells. Nine wells (five production and four water injection) will be drilled in the UM reservoirs comprising the Cabaça N field and 14 wells (seven production, four water injection and all three WAG wells) are planned for the UM and LM reservoirs in the Cabaça SE field, as indicated in Table 3-2 below.

**Table 3-2: East Hub planned subsea well types and numbers.**

| Field | Reservoir | Wells per Type | | | Total Wells |
|---|---|---|---|---|---|
| | | Oil production | Water Injection | WAG | |
| Cabaça N | UM 6 | 2 | 2 | / | 4 |
| | UM 8 | 3 | 2 | / | 5 |
| Subtotal Cabaça N | | 5 | 4 | / | 9 |
| Cabaça SE | UM 4/5 | 2 | 2 | / | 4 |
| | LM 22 | 5 | 2 | 3 | 10 |
| Subtotal Cabaça SE | | 7 | 4 | 3 | 14 |
| TOTAL East Hub | | 12 | 8 | 3 | 23 |

The 23 development wells will be drilled from eight drill centres. Drill centre and well location coordinates are provided in Table 3-3 below. Diagrams showing the drill centres and well layouts for the Cabaça N and Cabaça SE fields are provided in Figure 3-3. To reach the reservoir targets, many of the wells will be drilled at high angles with well displacement up to 2 km from the drill centres.

**Table 3-3: Drill centre and well location coordinates.**

| Field | Drill Centre | Drill Centre Location | | Reservoir | Wells | Well Type | Well Location | |
|---|---|---|---|---|---|---|---|---|
| | | X (m) | Y (m) | | | | X (m) | Y (m) |
| Cabaça N | CN-1 | 482 463.30 | 9 329 619.80 | UM8 | CN1 | Production | 482 463.30 | 9 329 619.80 |
| | | | | UM6 | OP2 | Production | 482 687.00 | 9 329 652.00 |
| | CN-2 | 482 162.58 | 9 328 969.39 | UM6 | OP1 | Production | 482 003.00 | 9 328 878.00 |
| | CN-3 | 481 185.50 | 9 329 751.36 | UM8 | OP5 | Production | 481 495.67 | 9 330 043.01 |
| | | | | | OP6 | Production | 481 009.13 | 9 329 769.54 |
| | CN-4 | 480 003.31 | 9 329 924.32 | UM6 | WI1 | Water injection | 480 081.50 | 9 329 610.70 |
| | | | | | WI2 | Water injection | 480 262.00 | 9 330 079.40 |
| | | | | UM8 | WI5 | Water injection | 479 821.62 | 9 330 216.70 |
| | | | | | WI6 | Water injection | 480 007.00 | 9 329 725.26 |
| Cabaça SE | CSE-1 | 483 760.25 | 9 324 855.50 | UM 4-5 | UM-OP1 | Production | 483 987.00 | 9 324 574.00 |
| | | | | | UM-OP2 | Production | 483 533.50 | 9 325 137.00 |
| | CSE-2WAG | 480 507.32 | 9 327 209.42 | LM 22 | LM-WAG3 | WAG | 480 425.00 | 9 325 504.00 |
| | | | | | LM-WAG4 | WAG | 479 512.00 | 9 327 727.00 |
| | | | | | LM-WAG5 | WAG | 480 587.00 | 9 328 860.00 |
| | CSE-2OP | 484 030.96 | 9 327 461.35 | LM 22 | LM-OP2 | Production | 482 660.00 | 9 326 470.00 |
| | CSE-3 | 481 943.36 | 9 324 681.43 | UM 4-5 | UM-WI1 | Water injection | 481 886.71 | 9 324 821.86 |
| | | | | | UM-WI2 | Water injection | 482 000.00 | 9 324 541.00 |
| | CSE-4 | 484 807.06 | 9 324 062.61 | LM 22 | LM-OP1 | Production | 484 630.00 | 9 325 350.00 |
| | | | | | LM-OP3 | Production | 483 763.00 | 9 325 175.00 |
| | | | | | LM-OP4 | Production | 484 998.00 | 9 323 845.00 |
| | | | | | LM-OP5 | Production | 485 475.00 | 9 324 593.00 |
| | | | | | LM-WI1 | Water injection | 486 371.00 | 9 322 705.00 |
| | | | | | LM-WI2 | Water injection | 483 161.00 | 9 323 423.00 |

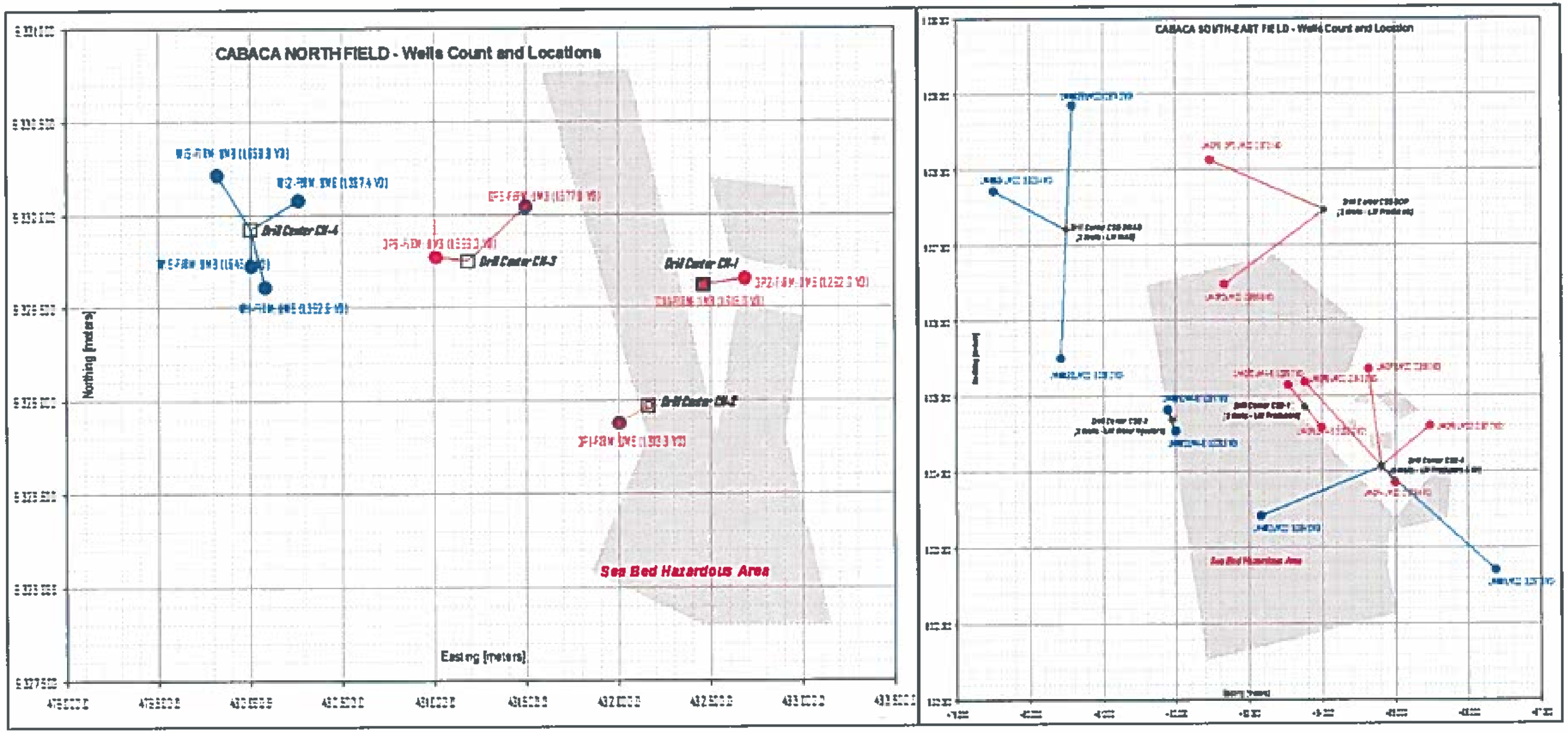



Figure 3-3: Proposed well layout and drill centre locations for Cabaça N (left) and Cabaça SE (right).

### 3.4.2 Well Drilling Equipment and Method

Eni plans to contract two drilling units to drill the planned development wells over an ~18 month period. Various types of drilling units are used worldwide, with the type of unit typically dependent on water depths in which it needs to operate. While the type of drilling unit(s) to be used in the development of the East Hub has not been determined, it is anticipated that semi-submersible drilling units or drillships will be used (see Figure 3-4).

Semi-submersible drilling units ("semi-subs") are floating rigs supported by large pontoon-like structures and steel columns that can be filled with seawater to partially submerge and stabilise the rig on location. Some semi-subs can sail using their own propulsion systems but most are moved or towed by tugs. Most semi-subs are anchored to the seafloor with a number of anchors tethered by chains and wire cables, but some are equipped with dynamic positioning[5]. Drillships are typically modified maritime vessels that have been equipped with drilling equipment. Drillships can sail independently (by their own propulsion systems) and can typically operate in very deep waters. While drillships can be moored to the seafloor with anchors, dynamic positioning systems are typically used in very deep waters to keep the vessels in place.

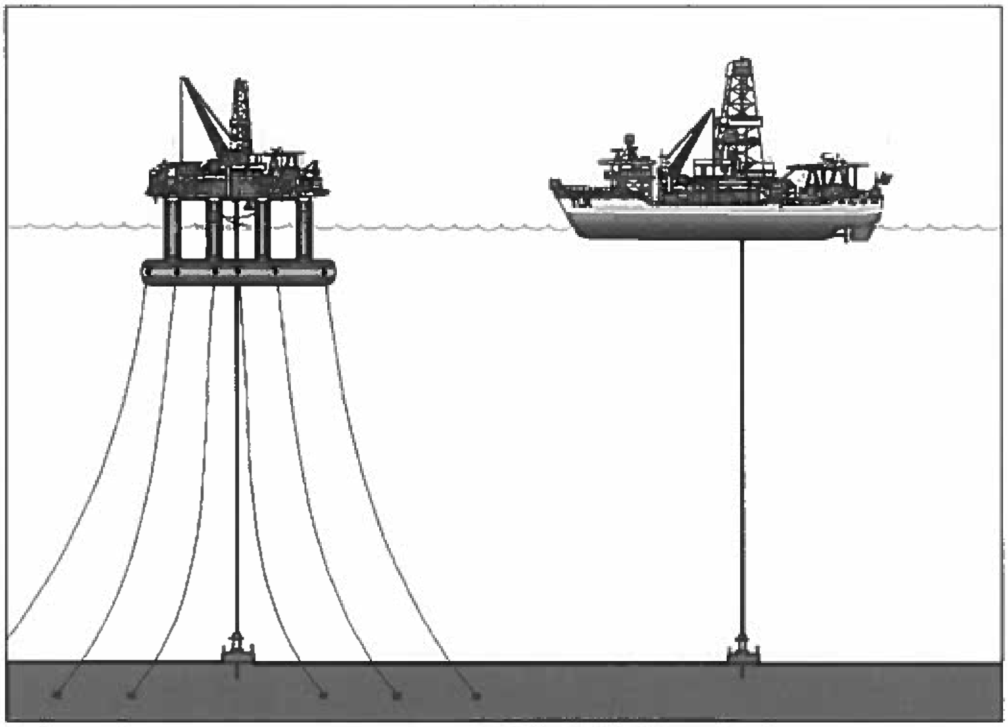


**Figure 3-4: Drawing of a moored semi-submersible drilling rig (left) and a dynamically positioned drill ship (right) while drilling.**

All drilling units comprise a number of basic components, including the drilling equipment, living quarters and helicopter landing pads. Drilling equipment includes the derrick or mast (the pyramidal structure that supports the drill string), draw works that reel the drill string in and out, the rotary table or topdrive that rotates the drill string, mud handling equipment, power generators (engines), cementing and testing equipment and the drill string itself. The drill string consists of the drill pipe, the

[5] Dynamic positioning refers to the stationing of a vessel using computer-controlled propulsion units or thrusters.

bottomhole assembly (including the drill bit and drill collar), as well as the equipment used to rotate the drill bit and connect the drill bit to the platform.

Drilling is undertaken by lowering the drill string to the sea floor. During rotary drilling, the entire drill string is rotated and causes the drill bit to crush or break up the rock at the bottom of the hole. The bottom hole assembly (consisting of the drill bit, drill collar and other equipment) weighs down on the bit and provides the pressure for the rotating bit to crush the rock at the bottom of the well bore. Drilling is regularly interrupted so that new sections of pipe can be added to the drill string or to replace the drill bit.

Casings (large-diameter pipes) that encompass the drill string are lowered into drilled holed sections and cemented in place by pumping specially formulated cement slurry into the annular space between the casing and the borehole wall. Casings are designed to withstand pressure as well as (corrosive) chemicals and are used to isolate (and protect) subsurface formations from the drilling pipe and the annular space where drilling and cuttings are contained. Drilling takes place in well sections that become progressively narrower until the total depth of the well is reached. The preliminary casing profile for each well includes a 30-inch conductor pipe, 20-inch surface casing, 13⅜-inch intermediate casing and 9⅝-inch production casing (refer to diagrams in Figure 3-7 to Figure 3-11). The top sections of each well are anticipated to be drilled vertically, while the lower sections will be drilled at an angle.

Batch drilling operations are planned for each of the drill centres in the East Hub oilfield development. Batch drilling involves the drilling in succession of the same hole section for each well drilled from a single drill centre, rather than consecutively drilling and completing each well before moving on to the next. Batch drilling enables the drilling unit to use the same mud system, drilling equipment (e.g. drill bit sizes) and casing sizes for all wells drilled from that drill centre before moving on to the next well section for which these systems and equipment may need to be changed. This allows for improved drilling efficiency and logistics, resulting in time and cost savings.

### 3.4.3 Drilling Fluids

Drill cuttings (broken up pieces of rock) are removed from the bottom of the hole by pumping drilling fluids ("mud") from the mud tanks on the rig down the hollow drillstring and through nozzles in the drill bit. The mud circulates through the bit and carries the cuttings up to the seabed / platform in the annular space between the drill pipe and the casings. In addition to carrying the drill cuttings to the surface, drilling fluids or muds have many uses, including to:

- Cool, lubricate and clean the drill bit and drillstring;
- Keep the borehole clean to prevent clogging; and
- Balance subsurface hydraulic pressures in the borehole.

The mud circulating system on board a drilling rig typically consists of mud pits (holding tanks), shale shakers (vibrating sieves used to remove solids from the returned drilling mud – see Figure 3-5) and various other mud treatment equipment such as de-gassers, de-sanders, de-silters and centrifuges.

**Figure 3-5: Example of an operating shale shaker, with cuttings pile in the foreground.**
Source: www.glossary.oilfield.slb.com

Drilling fluids can consist of a number of components, including water (or other medium), clays, polymers, emulsifiers and other additives. Many different types of drilling fluids are used, and different types of fluids are used within a single well to drill different sections of the well.

It is anticipated that the initial (upper) sections of the planned wells will be drilled using seawater and high viscosity pills as required. High-viscosity pills are small quantities (typically less than 200 bbl) of a special blend of drilling fluid that are used to help remove cuttings out of a vertical wellbore. The lower sections of each well will be drilled with Low Toxicity Oil Based Mud (LTOBM), a non-aqueous (non-water based) mud with a base fluid comprising of synthetic oil.

It is estimated that approximately 1 390 $m^3$ of LTOBM will be used in the drilling each of the 23 wells (i.e. a total of 31 970 $m^3$). No information about the composition of the LTOBM likely to be used in the drilling of the East Hub development wells was available at the time of writing this report.

### 3.4.4 Blow-Out Prevention

One of the key concerns during well drilling operations, particularly during development well drilling, is the prospect of an uncontrolled release of reservoir fluids into the wellbore and potentially to the surface, known as a blow-out. Blow-outs result in a loss of control over the well, which can lead to environmental pollution and present a danger to the drilling rig and crew. Blow-out Preventers (BOPs) are used to prevent the occurrence of blow-outs. A BOP is a large set of valves installed at the top of a well that can be closed to contain any natural pressure from the well bore if the drilling crew loses control of the well fluids. BOPs are usually remotely-operated hydraulic valves, but include a variety of sizes, styles and pressure ratings.

A typical BOP stack consists of at least two types of BOPs. A "ram-type BOP" is usually installed at the bottom of the BOP stack. A ram BOP usually consists of two halves of a cover that can be used to quickly close and seal a well. Two or more ram-type BOPs can be used in a BOP stack, usually with at least one annular BOP installed at the top. Annular BOPs contain sealing elements resembling large rubber rings that can be used to seal a variety of pipe sizes. Figure 3-6 shows diagrams of a typical BOP stack as well as an annular and several types of ram-type BOPs. The kill and choke lines that are connected to the BOP are high-pressure lines that direct well fluid and mud from the well bore.

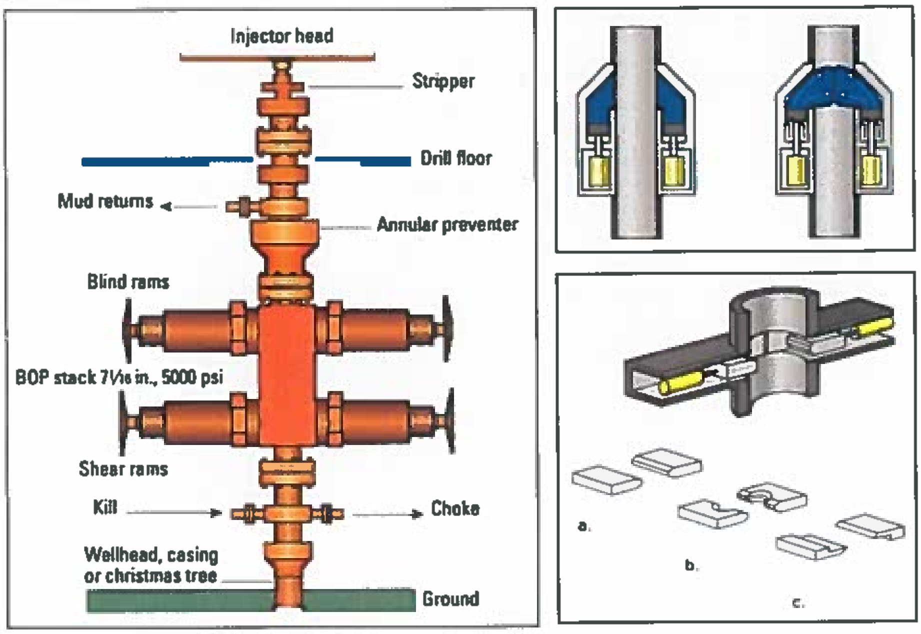



**Figure 3-6: Diagrams of a typical BOP stack (left), annular BOP (top right) and ram BOP (bottom right) showing a blind ram (a), pipe ram (b) and shear ram (c).**

Source: http://www.glossary.oilfield.slb.com and http://en.wikipedia.org/wiki/Blowout_preventer

### 3.4.5 Formation Evaluation

Evaluation of the rock and well fluid properties will be undertaken periodically during the drilling process. Drilling mud and cuttings brought to the surface are analysed (termed "mud logging") to determine the type and porosity of the rock and monitor changing downhole conditions. This information is used in controlling well fluids and downhole pressures. Downhole formation evaluation methods such as wireline logging and measurement while drilling are also typically employed. Wireline logging requires that the drillstring is removed from the well whereafter an electrical cable is used to lower the wireline logging tools into the borehole. Radioactive sources may be used in data acquisition to determine the physical properties of the rock as well as for calibration of wireline tools.

### 3.4.6 Well Completion

Well completion refers to the actions taken to prepare the wellbore, in particular the bottom of the hole, for safe and efficient production, as well as the downhole equipment required to do so. All of the planned production wells in the East Hub development will also require the application of sand control techniques to prevent reservoir sand (fines) from entering the wellbore. Different types of sand control techniques are planned for the different well types, depending on the reservoir characteristics and downhole requirements. Sand control techniques typically involve the installation of a type of screen to filter out sand (fines) from reservoir fluid before it enters the wellbore and can include open hole gravel pack, cased hole frac pack and stand alone screen techniques. It is expected that downhole pressure gauges will be installed in all proposed wells for reservoir monitoring purposes. The proposed completion techniques for each of the planned well types in the East Hub development are illustrated in Figure 3-7 to Figure 3-11.

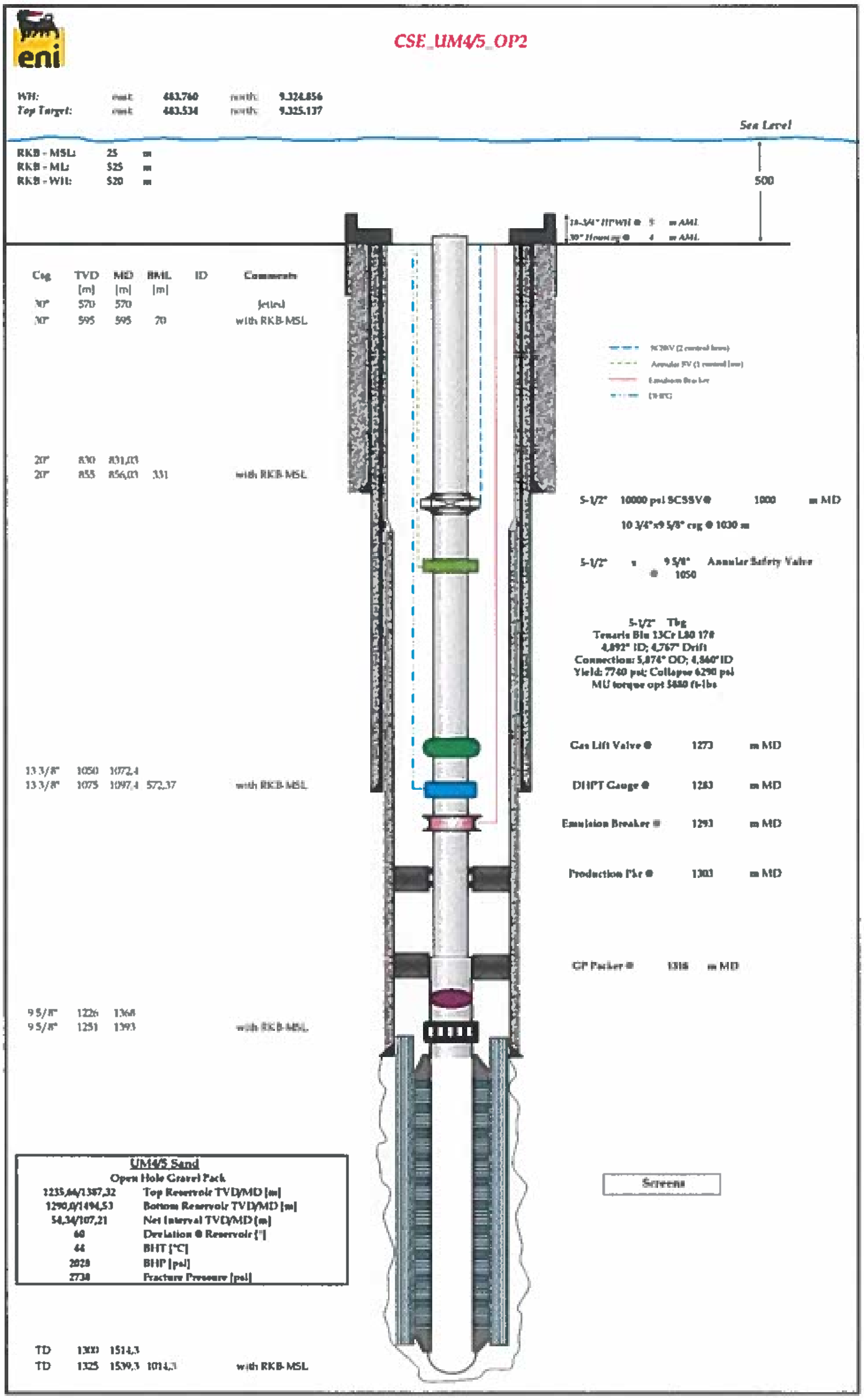



**Figure 3-7: Well completion– UM production well with open hole gravel pack.**

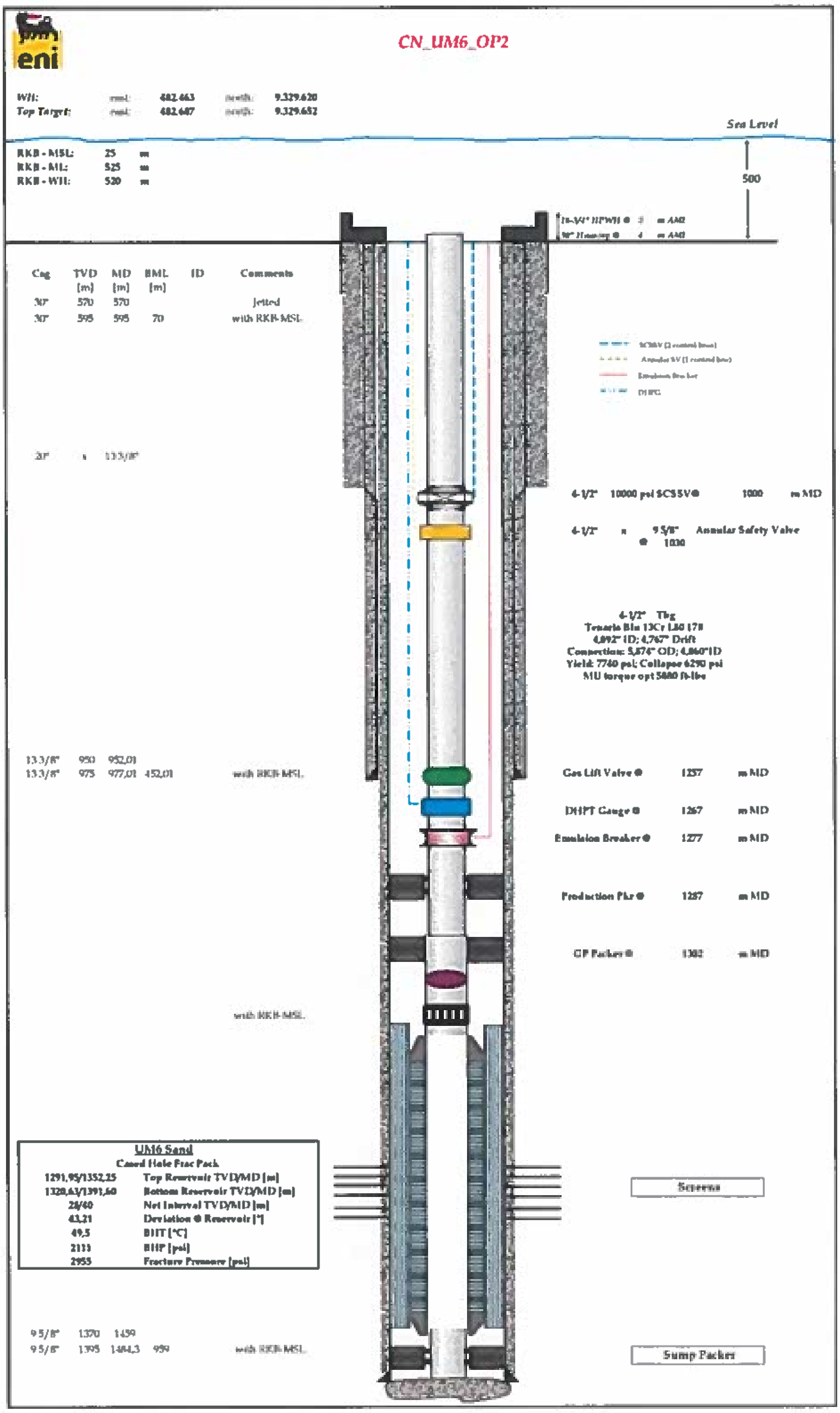


**Figure 3-8: Well completion– UM production well with cased hole frac pack.**

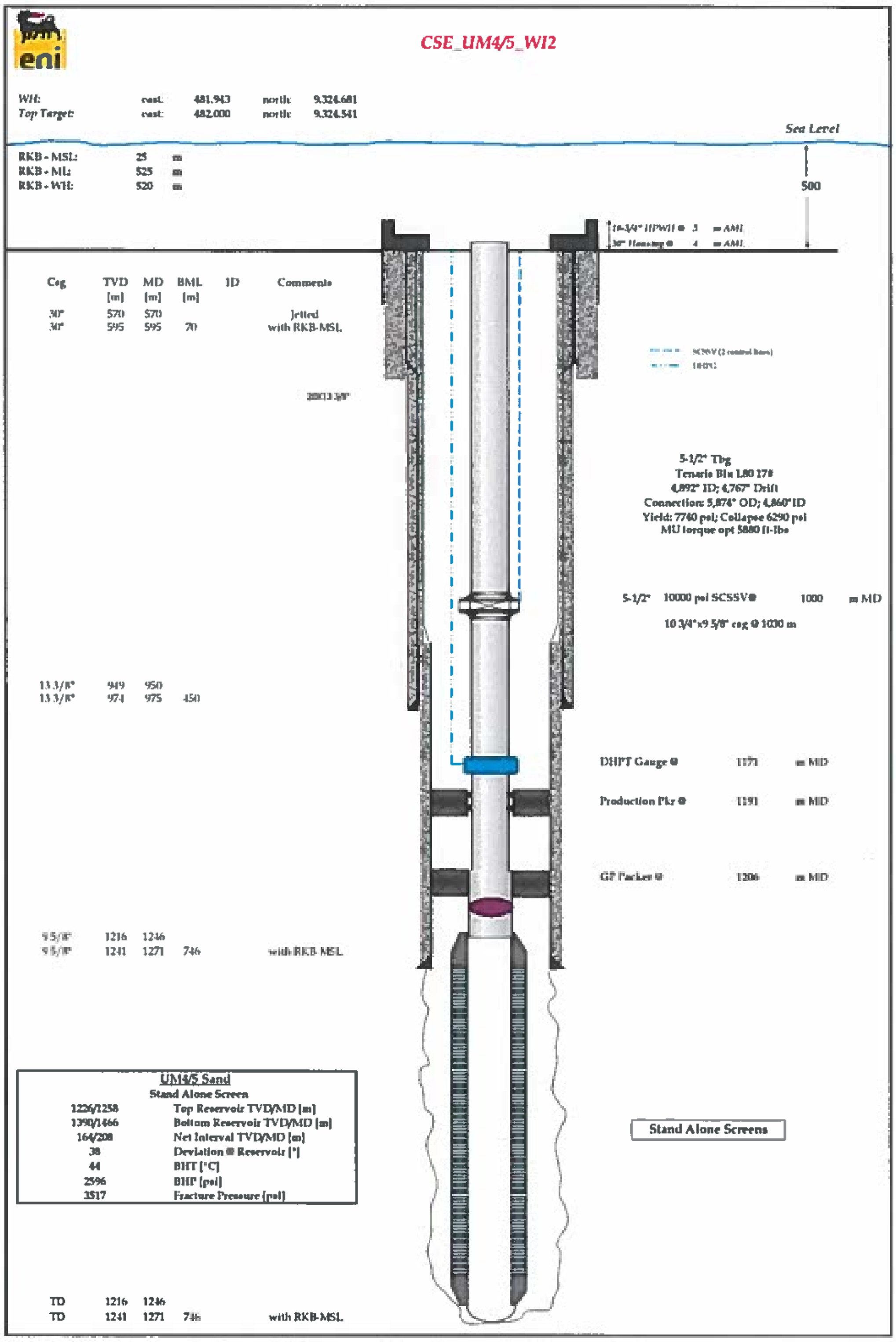



**Figure 3-9: Well completion– UM water injection well with stand alone screen in open hole.**

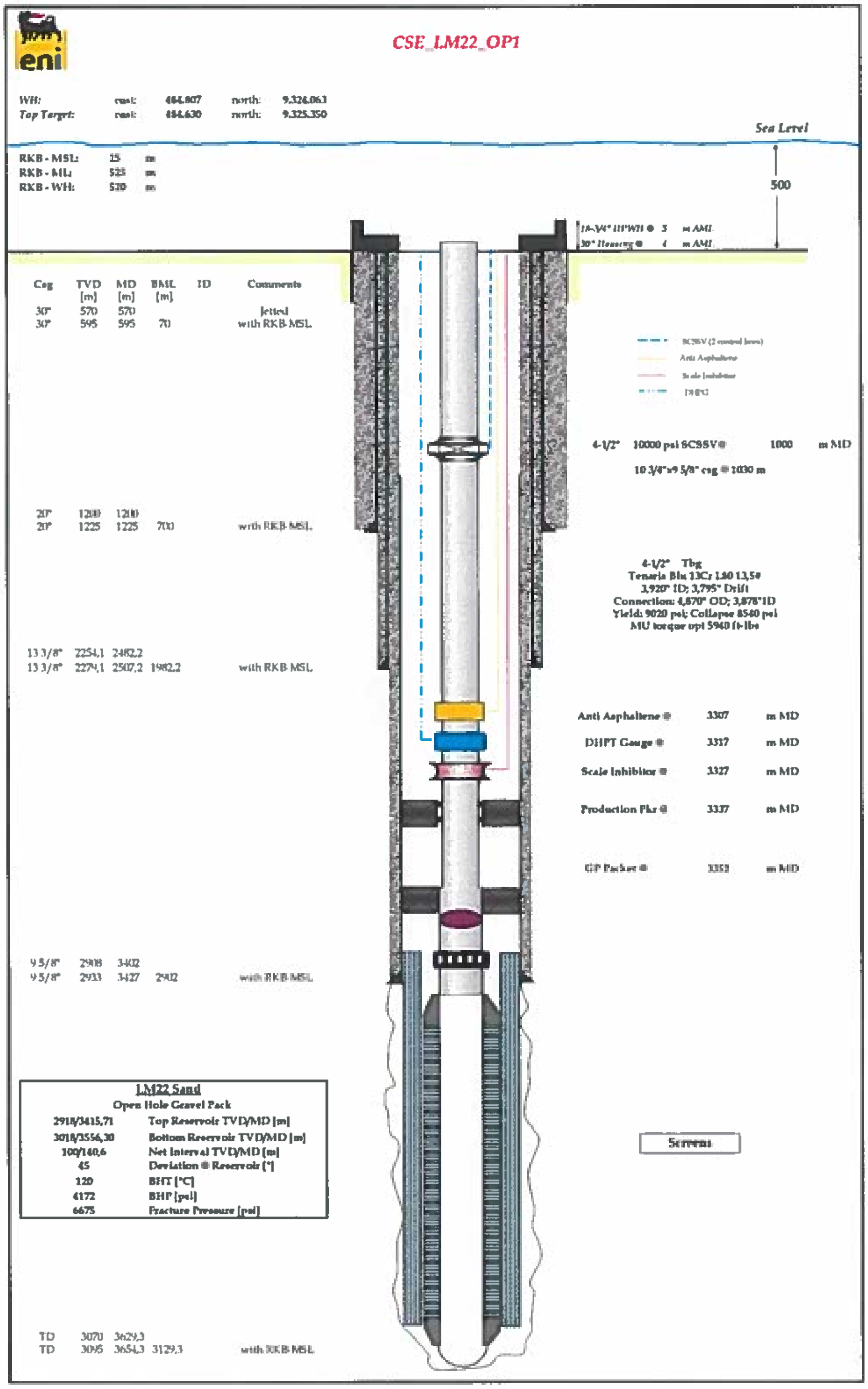



**Figure 3-10: Well completion– LM production well with open hole gravel pack.**

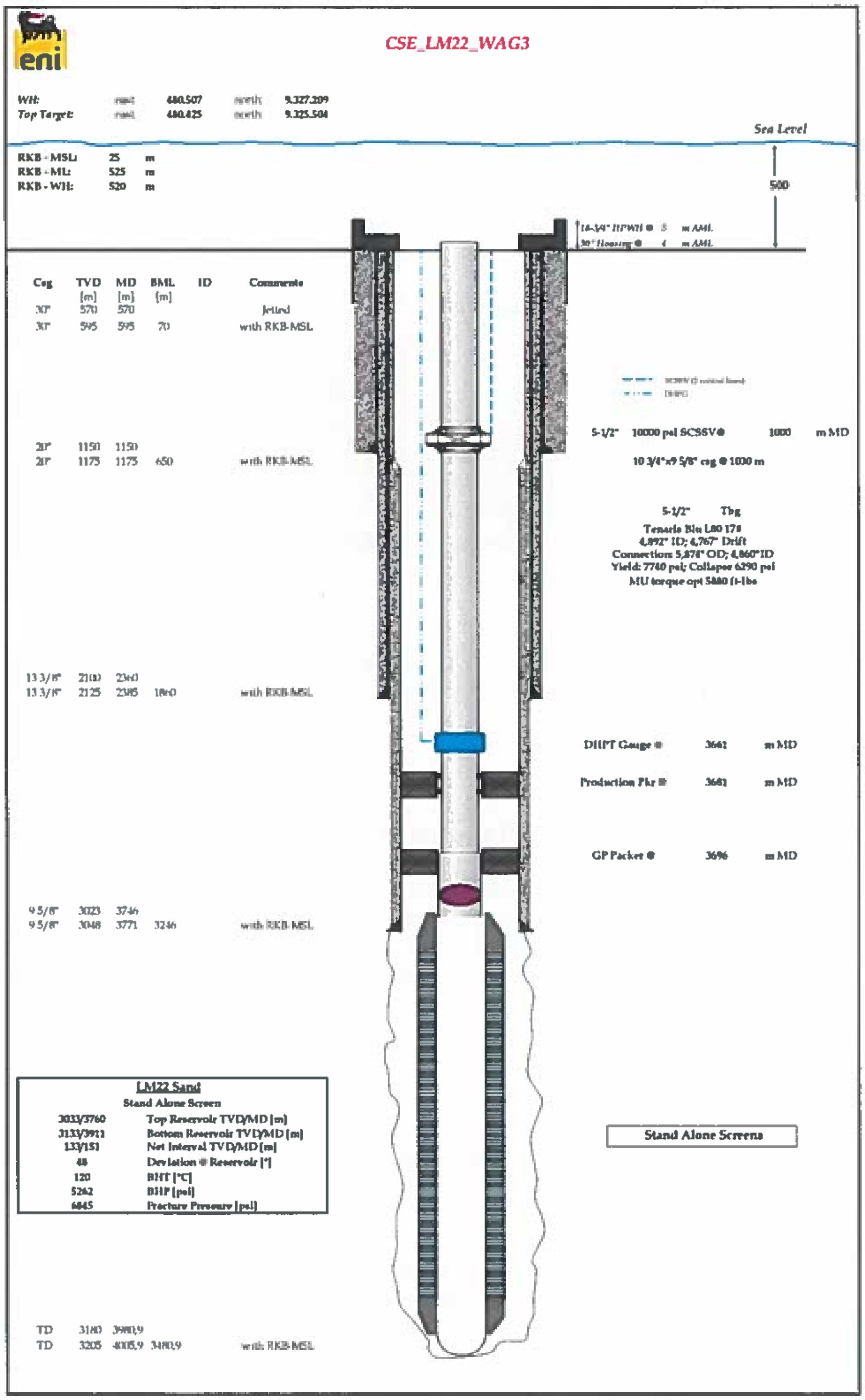



**Figure 3-11: Well completion– LM water injection or WAG well with stand alone screen in open hole.**

### 3.4.7 Supplies and Servicing

For the duration of the drilling operation, the drilling units will be supported by a number of platform supply vessels (PSVs), which are general purpose vessels designed to carry a variety of equipment and cargo. These vessels will supply the drilling units with fuel for weekly offshore refuelling, drilling muds, cement and miscellaneous equipment such as casing, drill pipe and tubing. They will also remove waste and cuttings that must be appropriately disposed of on land. A typical PSV is shown in Figure 3-12.

**Figure 3-12: Typical Platform Supply Vessel.**
Source: www.tdw.com

Helicopters will be used to transport people during routine crew changes and other visits to the drilling units and will be on standby in case of emergencies.

The Kwanda Base in Soyo will be used as the onshore logistics and support base for the proposed prospect well drilling operations.

## 3.5 Subsea Production and Control Systems

After completion of development well drilling, the subsea production and control systems will be installed. The subsea production and control systems comprise the production and injection systems (production trees and manifolds) and the various pipelines (risers and flowlines) and cables (umbilicals) that connect the wells with the FPSO.

### 3.5.1 Subsea Production System

Horizontal production trees or "Christmas trees" – the assembly of valves that controls the flow to and from a well – will be installed on top of each well. Christmas trees come in a variety of sizes and configurations, depending on the production requirements and characteristics of the well, and are installed using Remotely Operated Vehicles (ROVs).

The Christmas trees are designed to enable injection of chemicals such as hydrate inhibitor, wax inhibitor, emulsion breaker, asphaltene inhibitor and scale inhibitor (refer Section 3.5.5). All of the Christmas trees in the East Hub development will be designed to allow for conversion between injection and production, and multiphase flowmeters will be installed on each Christmas tree to measure fluid flow rates.

Ten subsea production (including water injection and WAG) manifolds will be installed in the East Hub development area. Production manifolds are gathering points for production fluids from the wells as well as distribution points for injection fluid from the FPSO to the wells.

The Christmas trees and production manifolds will be tied back to the FPSO via the pipelines and umbilicals comprising the SURF system (see below).

**Figure 3-13: Drawing showing examples of a production tree (right) and manifold (left).**
Source: http://www.fmctechnologies.com

## 3.5.2 Subsea Umbilicals Risers and Flowlines (SURF)

The SURF system will comprise approximately 62 km of pipeline, consisting of 51 km of rigid and 11 km of flexible pipe (flowlines and risers), as well as approximately 27 km of umbilicals.

### 3.5.2.1 Flowlines and Risers

Flexible pipes will used for dynamic applications (i.e. risers), while rigid pipes of different types will be used for all static applications (i.e. flowlines, including spools and jumpers[6]). Flowlines for the UM reservoirs will need to meet certain thermal insulation requirements and a "pipe-in-pipe" design type is planned, while conventional "wet insulated" pipelines are proposed for the LM reservoirs.

The East Hub subsea flowlines and risers will be manufactured from stainless or carbon steel and designed to operate at 600 m water depth, and will comprise:

- Eight km of pipe-in-pipe technology pipelines;
- 10 km of wet insulated pipelines;
- 35 km of non-insulated pipelines; as well as
- 11 km of flexible riser pipelines.

Pipeline diameters will range from 4 inches for gas lift pipelines (flowlines and risers), 6 inches for gas injection pipelines, 8 inches for UM production pipelines and 10 inches for water injection and LM production pipelines. A detailed breakdown of the planned East Hub riser and flowline lengths and applications is provided in Table 3-4 below.

**Table 3-4: Proposed East Hub riser and flowline lengths and applications.**

| Field | Description | Pipe Type | Material | Diameter (inches) | Length (m) |
|---|---|---|---|---|---|
| Cabaça N | UM Production riser | Flexible | Duplex stainless steel | 8 | 1 000 |
| | UM Water injection riser | Flexible | Duplex stainless steel | 10 | 1 000 |
| | UM Gas lift riser | Flexible | Duplex stainless steel | 4 | 1 000 |
| | UM Production flowline | Rigid (PIP) | Duplex stainless steel | 8 | 1 710 |
| | UM Production flowline | | | | 670 |

[6] Short sections of either flexible or rigid (straight or bent) pipelines used to connect larger pipelines to subsea structures and/or other pipelines.

| Field | Description | Pipe Type | Material | Diameter (inches) | Length (m) |
|---|---|---|---|---|---|
| | UM Production flowline | | | | 1 200 |
| | UM Water injection flowline | Rigid | Carbon steel | 10 | 5 100 |
| | UM Gas lift flowline | Rigid | Carbon steel | 4 | 1 750 |
| | UM Gas lift flowline | | | | 670 |
| | UM Gas lift flowline | | | | 1 200 |
| Cabaça SE | UM Production riser | Flexible | Duplex stainless steel | 8 | 1 000 |
| | UM Service line riser | Flexible | Duplex stainless steel | 8 | 1 000 |
| | LM Production riser | Flexible | Duplex stainless steel | 10 | 1 000 |
| | LM Production riser | | | | 1 000 |
| | LM Water injection riser (WAG) | Flexible | Duplex stainless steel | 10 | 1 000 |
| | LM Water injection riser | Flexible | Duplex stainless steel | 10 | 1 000 |
| | LM Gas injection riser | Flexible | Duplex stainless steel | 6 | 1 000 |
| | UM Gas lift riser | Flexible | Duplex stainless steel | 4 | 1 000 |
| | UM Production flowline | Rigid (PIP) | Duplex stainless steel | 8 | 4 250 |
| | UM Service flowline | Rigid | Carbon steel | 8 | 4 100 |
| | LM Production flowline | Rigid | Carbon steel | 10 | 1 300 |
| | LM Production flowline | | | | 1 320 |
| | LM Production flowline | | | | 3 470 |
| | LM Production flowline | | | | 3 470 |
| | LM Water injection flowline | Rigid | Carbon steel | 10 | 4 550 |
| | LM Water injection flowline | | | | 2 900 |
| | LM Water injection flowline | Rigid | Carbon steel | 10 | 4 860 |
| | LM Gas injection flowline | Rigid | Duplex stainless steel | 6 | 4 560 |
| | UM Gas lift flowline | Rigid | Caron steel | 4 | 4 100 |

Numerous pipeline end termination (PLET) structures will be installed on the seafloor to provide the interface between the different pipeline sections (flowlines, risers, spools and jumpers).

#### 3.5.2.2 Umbilicals

Subsea umbilicals convey electric power, hydraulic power, chemical injection and data communication services from the FPSO to the subsea production system, via a number of subsea distribution units (SDUs) that distribute these signals to the various subsea components, including the Christmas trees, manifolds, etc. Approximately 27 km of umbilicals, consisting of three main and seven infield umbilicals are envisaged for the East Hub development. In the Cabaça N field, a single umbilical will serve both the production and water injection well clusters, with a total of four SDUs placed close to each manifold. Two umbilicals are required for the Cabaça SE field, one to serve the UM and LM WAG manifolds, and another for the LM production and water injection manifolds. A total of seven SDUs will be required for the Cabaça SE field.

A single subsea multi-phase boosting station (SMBS) with a dedicated power and control umbilical will be used to improve oil recovery and enhance field operations by boosting the flow of unprocessed heavy oil from the East Hub UM fields. The SMBS will be located at the base of the risers, approximately 2 km from the FPSO in water depths of ~460 m.

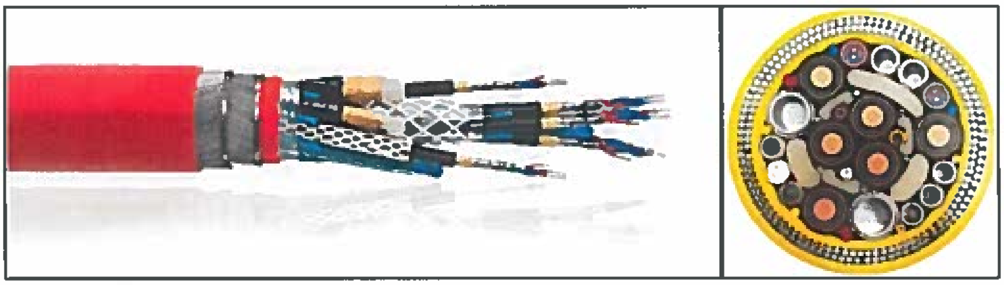


**Figure 3-14: Typical umbilical composition (left) and cross-section (right).**

Source: http://www.rigzone.com and http://www.oilfieldwiki.com

### 3.5.3 Subsea Layout

The 23 subsea wells will be arranged in typical manifold-cluster configurations, where one or more wells are connected to a central production manifold by means of jumpers (flexible pipe sections), while spools (straight or bent pipe sections) connect each manifold to the flowlines.

In the Cabaça N field, production wells will be clustered around a total of three piggable production manifolds. Water injection wells will be arranged around one central water injection manifold. In the Cabaça SE field, the LM production wells will be arranged around two production manifold clusters, while a single WAG manifold and a single water injection manifold are foreseen. Water and gas injection flexibility will be provided by separate water injection and gas injections lines from the FPSO to the WAG manifold. Two manifolds – one production and one water injection – will serve the Cabaça SE UM wells. A dedicated gas lift line will provide artificial gas lift capability to the Cabaça SE UM wells.

Schematics of the Cabaça N and Cabaça SE subsea field layouts are provided in Figure 3-15 and Figure 3-16, respectively.

### 3.5.4 Construction and Installation

Construction and installation of the subsea production and control system will be undertaken by contractors using a range of specialised vessels, including Heavy Lift Vessels (HLVs), pipelay vessels and cargo liners. These vessels will be equipped to undertake all subsea construction and installation activities. The subsea infrastructure will be lowered to and installed on the seafloor using dynamic positioning systems and specialised equipment to ensure that each structure is accurately positioned and correctly installed. Construction vessels will be supplied with fuel and other supplies by dedicated supply vessels and cargo liners and helicopters will be used for crew changes, etc. Crew accommodation will be provided the vessels.

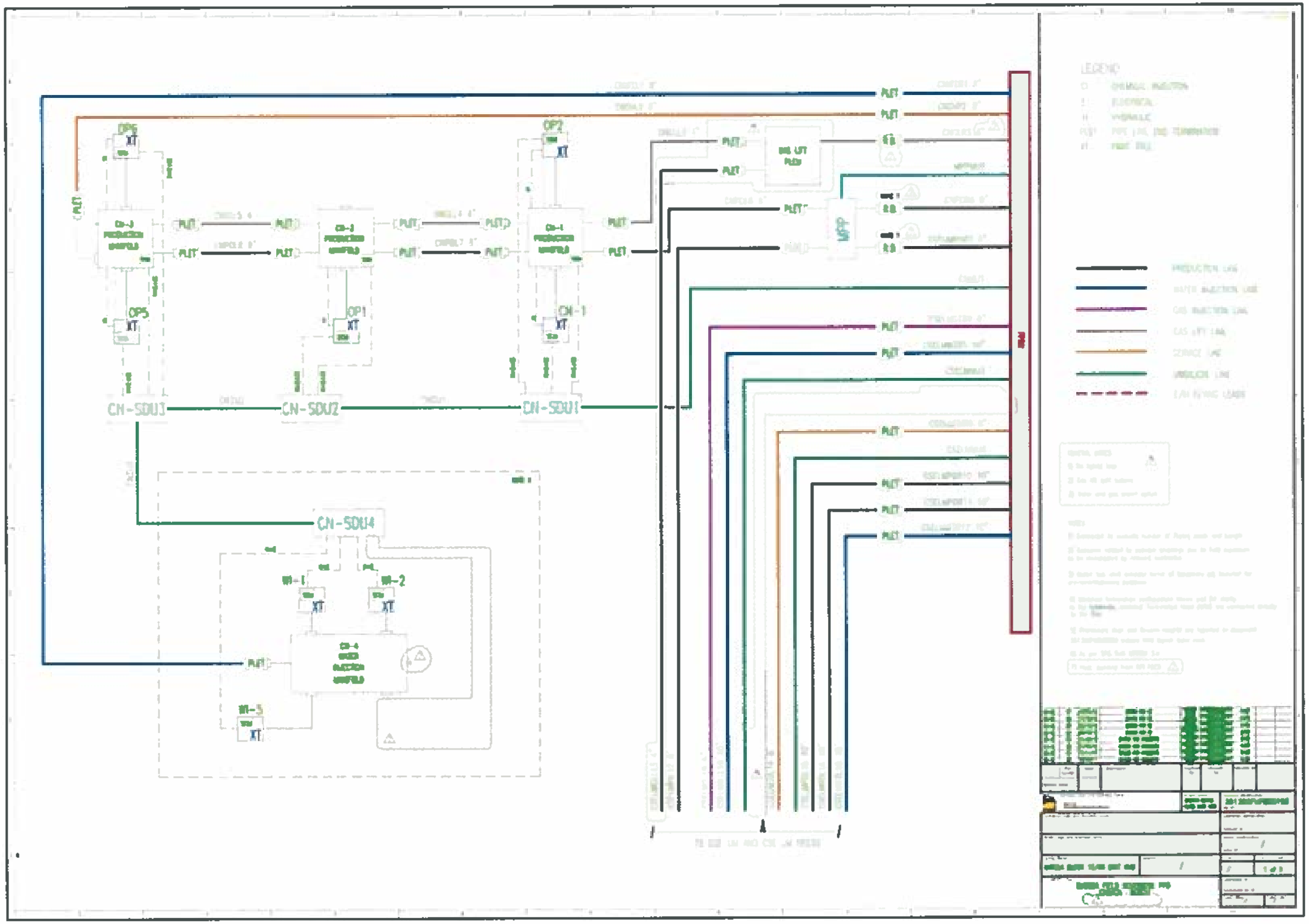



Figure 3-15: Cabaca N subsea field schematic.

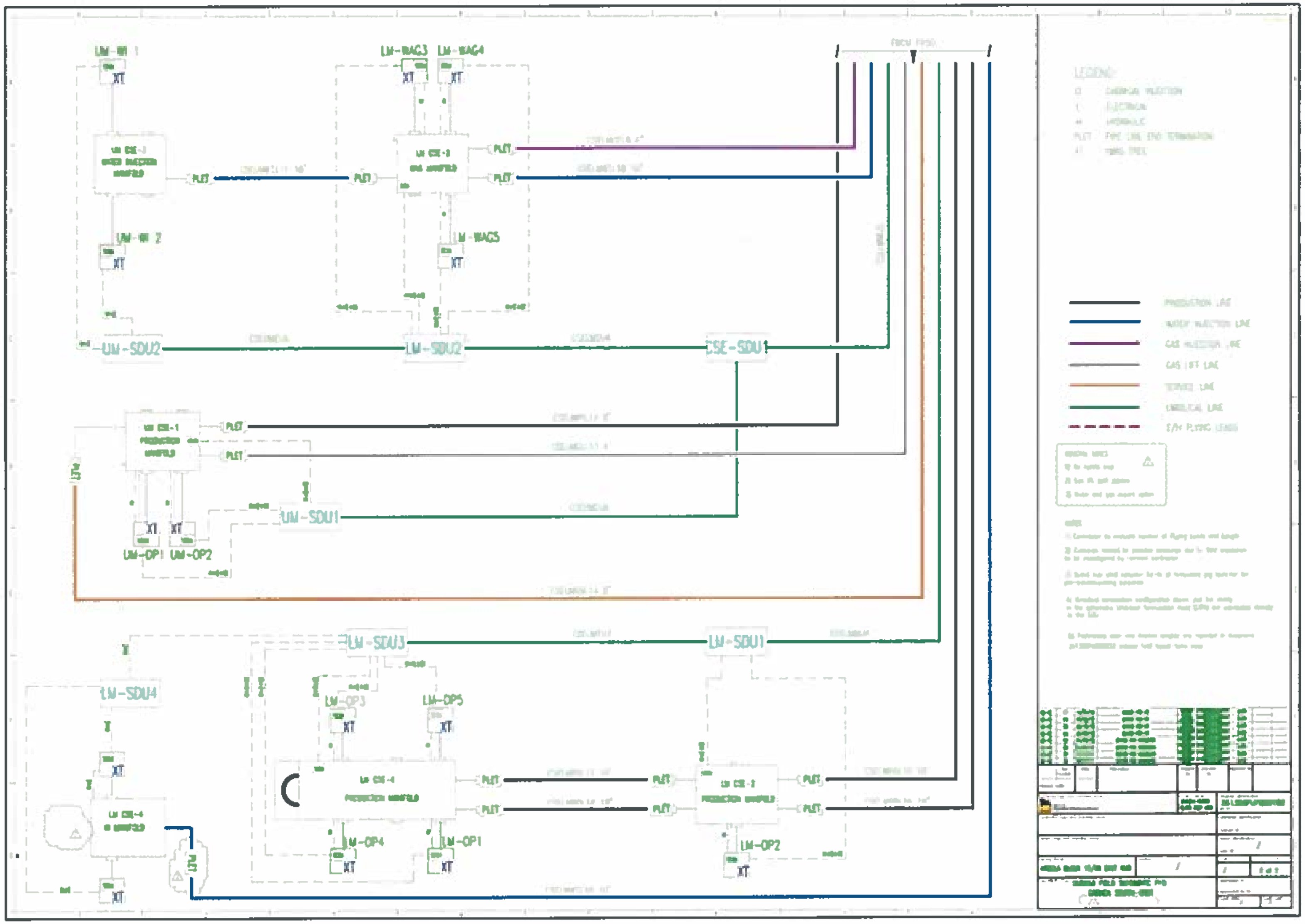



Figure 3-16: Cabaca SE subsea field schematic.

### 3.5.5 Control and Safeguarding

The subsea production and SURF systems will operate in accordance with Eni's corporate safety rules which focus on safety, accident prevention and the reduction of risks to as low as practicable. In addition, hazard and operability (HAZOP) studies will be carried out on the final designs and drawings for the subsea systems in order to verify safety systems and the integrity of pipelines. Safety barriers, referring to any element or group of elements designed to prevent or limit the impact of an accidental event, will be included in the design. The general safety philosophy shall be based on the "double barrier" concept, which entails the application of two independent barriers in series, so that only failure of both barriers would fail to prevent a potential accident. One barrier will be controlled with manual activation and the other with automatic activation.

The subsea system design shall make provision for various maintenance and control functions, including the following:

- *Corrosion protection:* Corrosion protection will be achieved through good design (material selection), continuous monitoring and the use of chemical inhibition (injection of corrosion inhibitor) in the production systems. Corrosion in the water injection system will be controlled by treating the injection water to reduce oxygen concentration to acceptable levels. Cathodic protection with sacrificial anodes and ground beds will also be implemented to minimise the rate of corrosion;
- *Scale management:* Scale formation will be managed using scale inhibitor in the subsea production system and by treatment (sulphate reduction) of the water for use in the water injection system. A sulphate removal unit is required along with continuous injection of scale inhibitor;
- *Wax management*: In general, paraffin (wax) deposition in the production flowlines and risers will be managed by maintaining temperatures in the LM pipelines. No significant deposition is expected for the UM pipelines. The production flowlines will also be "round trip" piggable to facilitate the removal of any residual wax. Provision will be made for the use of paraffin inhibitors in the production flowlines and risers;
- *Asphaltene management:* Asphaltene deposition in the subsea production system or the oil offloading system will be monitored during production. The subsea system will have the capability to circulate an asphaltene solvent down the risers through the flowlines, and manifold headers; and
- *Hydrate management*: Hydrates will be managed using a combination of inhibitor, thermal insulation and operating practices. Hydrate inhibitor will be used during system start-up and shutdown. During normal operations, hydrates will be managed by maintaining temperatures outside the hydrate region.

## 3.6 Floating Production Storage and Offloading

Once the subsea production and SURF systems have been installed on the seafloor, the FPSO will be brought to location for mooring and installation. There are generally two options for mooring, depending on the vessel's built-in mooring system, namely turret mooring or spread mooring. Turret mooring is a single point mooring system that allows the FPSO to weathervane around the mooring system in response to environmental conditions (wind, currents, etc.), while spread mooring entails mooring of the vessel from the bow and the stern to maintain the vessel in a fixed orientation. Both methods involve the use of a number of anchors connected to mooring lines (anchor wires).

Once the FPSO is securely in place, the risers and umbilicals will be picked up from the seafloor and connected to the FPSO turret. The East Hub FPSO will have the capacity to accommodate up to 18 slots for risers and umbilicals, although only 15 slots will be required for the East Hub development (the additional slots will be reserved to accommodate possible future expansions). A schematic of a simplified (turret-moored) FPSO and subsea development layout is shown in Figure 3-17 below.

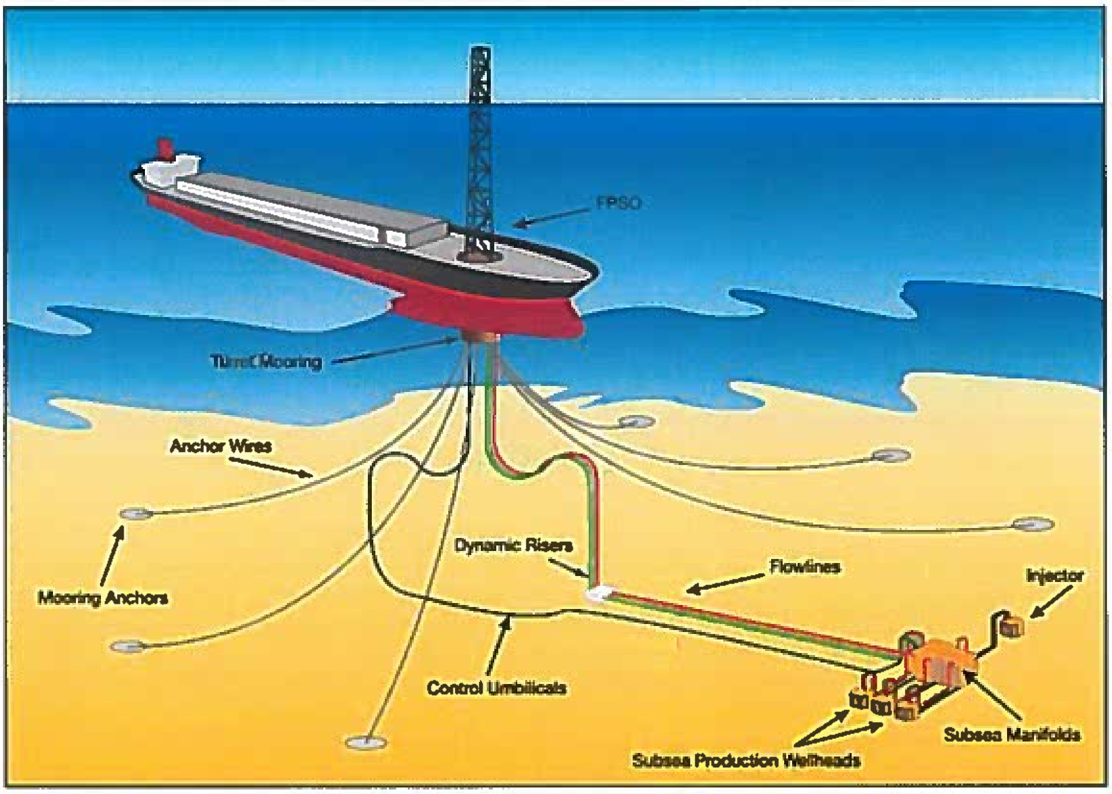



**Figure 3-17: Example schematic of a simplified FPSO and subsea systems layout.**
Source: adapted from http://www.redden.com.au/mining_map_illustration.html

### 3.6.1 FPSO Vessel

The FPSO that will be used in the East Hub development has not yet been selected, but FPSOs are typically converted tankers or custom-built ship-shaped vessels. Figure 3-18 shows the Xikomba FPSO, a converted tanker which is currently being refurbished for use in Eni's Block 15/06 West Hub development.

Processing of the reservoir fluids takes place primarily in the FPSO topsides facilities, which are located on the FPSO deck. The topsides facilities comprise a number of components or modules each with a specific function, including crude separation, gas compression, gas treatment, water treatment, utilities, power generation, etc. (see Figure 3-19).

**Figure 3-18: The Xikomba FPSO, prior to refurbishment for use in Eni's West Hub development.**
Source: http://www.photoship.co.uk/

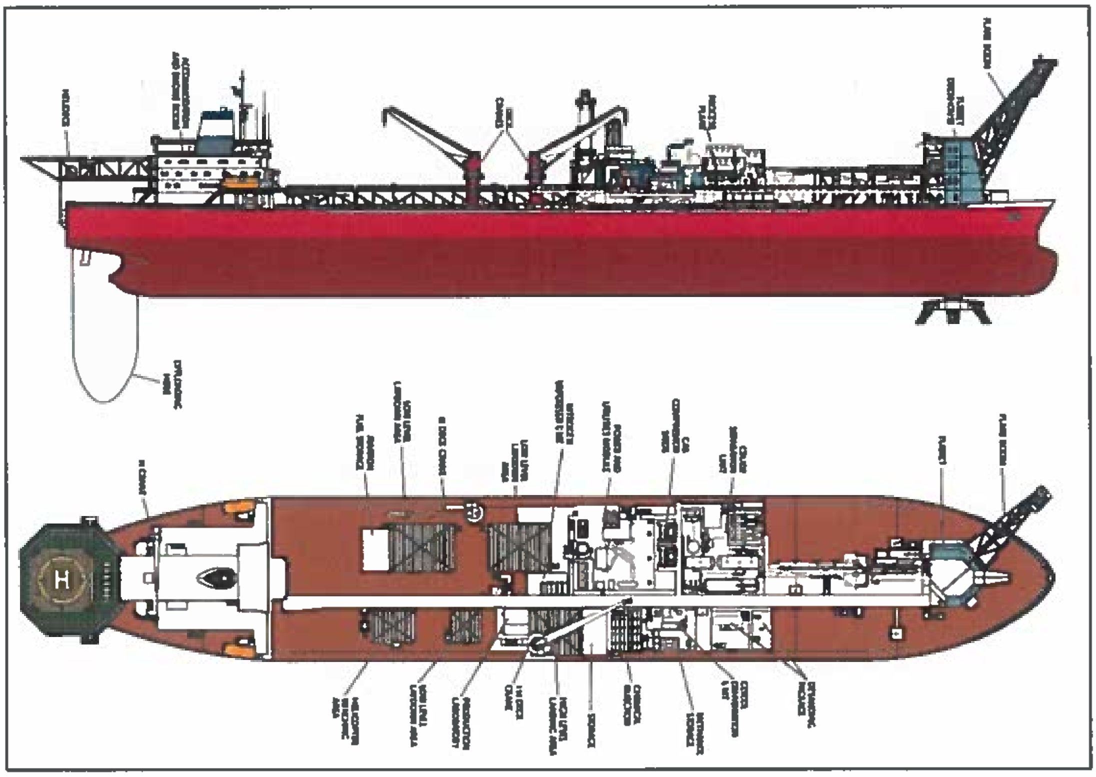


**Figure 3-19: Example diagram of FPSO topsides facilities and layout.**
Source: http://www.marineinsight.com/marine/types-of-ships-marine/what-is-fpso-floating-production-storage-and-offloading-system/

The FPSO to be used in the East Hub development will be designed for a minimum of 20 years of continuous operation and will have the following processing/handling capacities:

- Produced crude oil: 100 000 bbl/d;
- Produced water: 100 000 bbl/d;

- Produced gas: 100 million standard cubic feet per day (MMSCFD) (excluding gas lift);
- Gas lift system: 50 MMSCFD;
- Water injection system: 145 000 bbl/d; and
- Seawater system: 145 000 bbl/d.

After processing (see Section 3.6.2 below), crude oil is stored in the storage tanks that are typically located below the topsides in the hull of the FPSO. The FPSO to be utilised in the East Hub development is expected to be a converted tanker of double hull design with a minimum net oil storage capacity of 1.7 million bbl.

In summary, the main functions of the FPSO during the development of the East Hub oil fields include:

- Controlling the subsea wells during production;
- Providing chemical injection facilities;
- Providing water injection, gas injection as well as gas lift facilities;
- Receiving fluids from the subsea wells;
- Processing of the incoming fluids for separation into crude oil, water and gas;
- Power generation for the processing facilities, offloading and utilities;
- Storage of the stabilised crude oil and maintaining it at the required temperature;
- Offloading of crude into tandem moored shuttle tankers;
- Treatment of effluent for discharge to the sea;
- Providing accommodation for operating and maintenance personnel; and
- Providing facilities (helideck) for helicopter operations.

### 3.6.2 Production Processing

Once all offshore infrastructure and equipment are in place, production can commence. Reservoir fluids will flow continuously from the subsea Christmas trees through the subsea manifolds, flowlines and risers to the process facilities on the FPSO. Production processing of the reservoir fluids will take place on the FPSO and will entail the separation, treatment and storage/use of crude oil, produced water and produced gas. A simplified diagram of the typical production process on an FPSO is presented in **Figure 3-20**.

#### 3.6.2.1 Crude Oil

Reservoir fluids brought up to the FPSO will be tested and pressure controlled and then processed in a three-phase flash separation system to separate the crude oil from the associated water and gas, resulting in stabilised crude oil (to the required specifications).

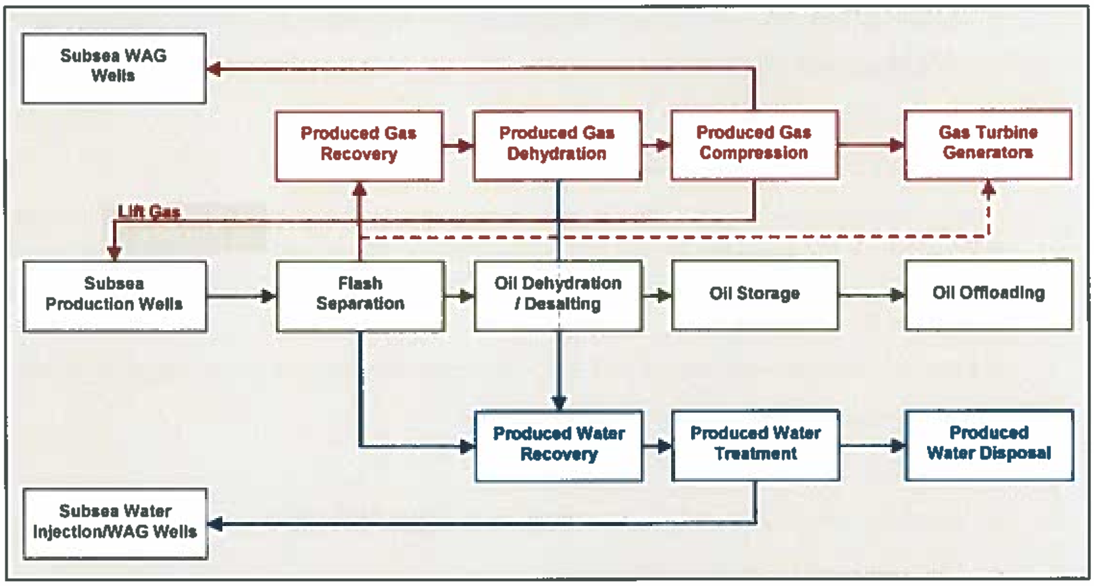



**Figure 3-20: Simplified flowchart of the production (reservoir fluids separation and treating) process on a typical FPSO.**

After separation the crude oil is treated in an electrostatic dehydrator / desalter to remove remaining water and salt. Electric charges are applied to enhance the separation of oil and water. Crude from the dehydrator / desalter is cooled and sent to the cargo tanks for storage. The stored crude oil is periodically offloaded to shuttle tankers tandem moored to the FPSO using a hawser and a loading hose (see Figure 3-21).

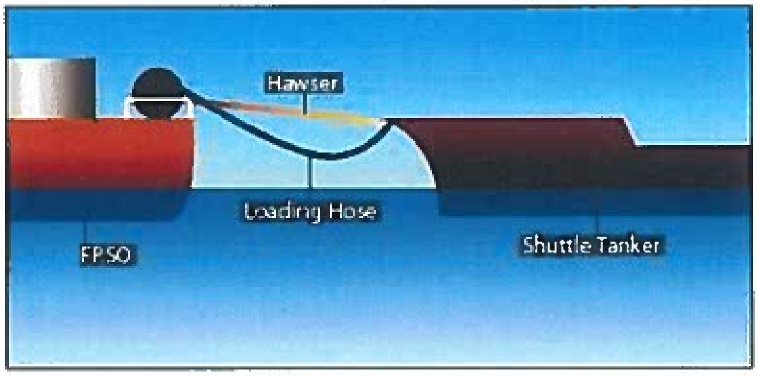



**Figure 3-21: Diagram of a tandem moored offloading system.**

Source: adapted from http://www.oilspillsolutions.org/offshore.htm

### 3.6.2.2 Produced Gas

Produced gas must be processed to meet gas quality specifications so that the gas can be used for gas lift, as fuel gas (to power the FPSO facilities) or for gas injection into the Cabaça SE LM reservoirs via the WAG wells. Treatment for use as injection gas will include the use of a conventional tri-ethylene glycol (TEG) absorption dehydration system. This is to prevent hydrate formation in the gas lift and gas injection systems, where the high pressure gas will cool down to seabed temperatures. This would minimise the potential for corrosion of the subsea pipelines and other potential hydrate issues. The TEG used in dehydration will be recycled through a TEG regeneration system where water and other impurities will be removed and the purified TEG circulated back to the gas dehydration unit. Compression is required to ensure and maintain suitable pressures.

#### 3.6.2.3 Produced Water

Produced water will be generated during all stages of the oil separation process. The bulk of produced water generated will be used as injection water, with excess produced water disposed of overboard. Produced water will be mixed with seawater, which is supplied to the water injection system by seawater lift pumps in sufficient volumes to meet the demand for injection as well as for cooling. Excess produced water will be treated to ensure that the oil-in-water content is below the required level prior to discharge overboard. The treatment process will involve degassing, cooling, two-stage oil/water separation and further de-oiling in the slops tanks.

### 3.6.3 Utilities

Various utilities are required to facilitate the functioning of the FPSO topsides oil, water and gas processing equipment. The main utilities discussed below include:

- Power generation;
- Chemical injection system;
- Seawater system;
- Flare system;
- Inert gas and tank venting system;
- Heating and cooling system; and
- Storage tanks.

#### 3.6.3.1 Power Generation

Electrical power for the FPSO facilities is provided by gas turbine generators. Produced gas will be conditioned to remove rich heavy hydrocarbons so that it can be used as fuel gas in the gas turbine generators. Under normal conditions, fuel gas will be taken from the gas compression system, but gas can also be drawn directly from the oil separation system. The fuel gas system is subdivided into high-pressure (HP) and low-pressure (LP) fuel gas systems to provide gas to the various facilities at suitable pressures and temperatures. A stand-by (diesel) generator will be available to generate power during start-up, and will automatically start and supply power ifone of main power generators fails.

#### 3.6.3.2 Chemical Injection System

The chemical injection system will make provision for the storage and supply of various chemicals for the topsides production facilities and subsea systems. Chemicals for the topsides facilities will include biocides, corrosion inhibitor, oxygen scavenger, demulsifier, foam inhibitor, scale inhibitor and methanol (hydrate inhibitor) for the topsides facilities. Chemicals for the subsea system will include corrosion inhibitor, scale inhibitor, methanol (hydrate inhibitor), low dosage hydrate inhibitor, wax inhibitor, etc. The chemicals will all be compatible with each other in case of common injection points, and injection will be done at suitable pressures to ensure that the chemicals are supplied where it is required.

#### 3.6.3.3 Seawater System

Seawater is supplied to the topsides facilities by seawater lift pumps, and is used for cooling, fresh and potable water generation, as firewater and to supply seawater to the water injection system. The treatment of seawater will involve filtration to remove suspended solids, sulphate removal and de-aeration to remove oxygen.

#### 3.6.3.4 Flare System

A general "no flaring" policy will be adopted on the FPSO, which means that there will be no continuous flaring during normal operations. Intermittent flaring may however be required during emergency conditions, maintenance operations as well as during start-up.

#### 3.6.3.5 Inert Gas and Tank Venting System

The inert gas and tank venting system facilitates the intermittent relieving of pressure that builds up in the FPSO's cargo and slop tanks through manual and/or automatic venting. Inert gas is also used to maintain pressure in the cargo tanks by filling the space created when cargo tanks are emptied with an inert gas, which also requires venting when the cargo tanks are filled up again.

#### 3.6.3.6 Heating and Cooling System

Heating is required at several stages during the production process, e.g. to meet the crude oil product specifications, to heat fuel gas, to pre-heat wash water, etc. Heating is done with hot (fresh) water or with steam. Cooling is required to remove heat generated in the compression systems and various other areas in the production process. Cold (fresh) water will be continuously circulated in a closed circuit between these areas and the seawater coolers, which are supplied with seawater by the seawater lift pumps.

#### 3.6.3.7 Storage Tanks

The FPSO's cargo tanks will make provision for receiving, distributing and storing crude from the processing facilities, but will also receive off-specification crude oil in a dedicated off-spec cargo tank (before recirculation back to the processing facilities by means of the cargo pumps). The cargo system is also used as a ballast system and will make provision for emergency ballasting with seawater if required. Slop tanks are used to receive and store oily water from the washing of tanks, from cargo tank stripping as well as off-spec produced water and drains from the processing facilities.

The cargo tanks will be regularly washed with crude oil to remove deposits and bottom sediment from the tanks, which will be discharged with the cargo into the export tankers. This is normally done during export operations, but could be done at any time providing sufficient crude oil is available on board.

Water washing of cargo tanks will be conducted for tank inspection or maintenance and will normally be done immediately after offloading when the FPSO is nearly empty. Hot water washing of tanks will use water from the slop tanks, heated by the slop tanks heating coils. The wash water will be returned to the slop tanks after use.

### 3.6.4 Control and Safeguarding

The control and safeguarding system to be implemented on the FPSO will comprise a Process Control System (PCS) that monitors process conditions and the application of corrective actions when necessary, an Emergency Shutdown (ESD) system to safeguard equipment against abnormal conditions, a Fire and Gas System (FGS) to prevent hazardous fire and gas situations, as well as the communications system to alert personnel to potentially hazardous situations.

Evacuation, escape and rescue operations will be facilitated by ensuring that sufficient escape routes are provided on the FPSO and that these are adequately marked and sized to accommodate personnel wearing full firefighting gear and/or transporting injured persons on stretchers. Facilities will be provided to rescue persons from the water and life rafts, buoys, lifejackets and other safety equipment such as portable fire extinguishers will be readily available.

## 3.7 Decommissioning and Abandonment

At the end of the operational life of the East Hub development, Eni will implement a decommissioning and abandonment plan in compliance with the relevant Angolan regulatory requirements, international codes and standards as well as Eni's internal (corporate) standards.

At this (early) stage of the process to develop the East Hub oil fields, the following is assumed with regard to decommissioning of the East Hub facilities:

- Risers and main umbilicals will be disconnected from the FPSO, flushed, cleaned and filled with seawater, before being plugged, secured and abandoned on the seafloor;
- Mooring lines will be disconnected from the FPSO and abandoned (along with the anchors) on the seafloor;
- Flowlines and static umbilical sections will be left in place on the seafloor. Flowlines will be flushed and cleaned, filled with seawater, plugged, secured and abandoned on the seafloor;
- The FPSO will be cleaned, including removal and disposal of naturally occurring radioactive material (NORM) and returned to the owners;
- The subsea wells will be abandoned and permanently plugged to isolate hydrocarbon-bearing zones and prevent migration of formation fluids within the well bore or to the seafloor; and
- All casings, wellhead equipment and pilings will be abandoned on the seafloor.

## 3.8 Project Schedule

Drilling of the development wells is planned to commence by the end of the 2nd quarter of 2014 (~June 2014) with one drilling unit. The second drilling unit will commence drilling operations in the development area at the end of 2014 (~December 2014). The first drilling unit is expected to leave the East Hub development area after 24 months, while the second drilling unit will remain for a further two months. The total drilling operation is therefore expected to take approximately 26 months and will be a continuous (24 hours a day) operation.

Installation of the subsea production and SURF system is expected to start in mid-2015, with FPSO installation planned for the end of that year. Offshore drilling and installation activities will therefore take place over approximately 18 months before the FPSO is installed and production commences, with drilling and installation continuing in other parts of the East Hub area for several months in parallel with production.

First oil, from the Cabaca SE LM reservoir, is expected in early 2016. The production plateau is expected to be reached shortly thereafter (mid-2016) and the development's anticipated lifespan is expected to be reached by 2031 (i.e. 15 years).

## 3.9 Project Execution Approach and Personnel

The project will be executed mainly through Eni entering into Engineering, Procurement and Construction (EPC) contracts with suitably experienced Contractors, meaning much of the detailed design of project components will be finalised by the appointed Contractors. The EPC contracts for the lease and operation of the FPSO, SURF installation and supply of the SMBS will be awarded on a design competition basis, while the bulk of the contracts will be based on technical specifications developed by Eni. Eni's project management team will be based in Italy and in Angola and will provide overall project management for all phases of the work.

Approximately 150 full time personnel will be employed on the project during the execution phase (after the main contracts have been awarded but before commencement of offshore construction / installation activities), working in various locations depending on the location of the relevant Contractor(s). As the project progresses into the final stages of execution (prior to and during commencement of offshore construction / installation activities), the various site teams will be based in Angola.

## 3.10 Key Operational Waste Streams

An overview of the key waste streams generated during normal operations, including air and noise emissions, discharges to sea, as well as waste streams for disposal on land, during all phases of the proposed development of the East Hub oil fields is provided in this section.

### 3.10.1 Emissions to Air

Air emissions will be generated by a number of sources during all phases of the project. The main sources of emissions to air will comprise:

- Exhaust gases;
- Flaring; and
- Fugitive emissions / venting.

Each of these is discussed in more detail below:

#### 3.10.1.1 Exhaust Gases

The most significant contribution to air emissions from the East Hub development project will be in the form of exhaust emissions from the main engines, electricity generators, boilers, turbines, compressors, pumps, etc. on the various vessels involved in the project, namely the drilling units, the various construction vessels, the FPSO, as well as the supply and support vessels to be used during all phases of the project.

Various fuel types will be used during the East Hub development: diesel fuel is expected to be used on most vessels (including the drilling units) to power ship engines, power generators, etc., while many of the construction vessels use in the installation of the subsea production and SURF systems are expected to run on Marine Gas Oil (MGO). Diesel, MGO and produced gas will be used on the FPSO in the power generation unit and other facilities.

Exhaust emissions generally comprise a number of potential pollutants, including carbon dioxide ($CO_2$), nitrogen oxides ($NO_X$), sulphur dioxide ($SO_2$) and methane ($CH_4$), and smaller volumes of carbon monoxide (CO), ozone ($O_3$), particulate matter (mostly soot) and unburned hydrocarbons from incomplete combustion, depending on the type and composition of the fuel used.

It is estimated that the two drilling units will each consume approximately 17.4 $m^3$ of diesel fuel per day while in operation. The drilling units to be used to drill the planned wells in the East Hub oil fields are anticipated to be in operation for approximately 740 and 602 days, respectively. The total fuel consumption by the drilling units during drilling of the planned development wells is therefore estimated at 23 350.8 $m^3$. During drilling, exhaust emissions from the drilling units will release approximately 63 kilotonnes of $CO_2$ and small volumes of the other pollutants listed above. Similar data on the anticipated fuel consumption by the construction, supply and support vessels as well as the FPSO was not available at the time of writing this report.

It should be noted that the emissions sources discussed above will staggered over time in various locations (within the development area as well as between the development area and the onshore support base), meaning that the emissions at any one location will be significantly less than the total emissions for the operation.

#### 3.10.1.2 Flaring

Continuous flaring off the coast of Angola is not permitted, but small pilot flares will be required on the drilling units during well drilling and on the FPSO during production. In addition, intermittent flaring will take place as follows:

- During well testing it may necessary to flare off any produced hydrocarbons (gas or oil);
- During production (operation of the FPSO), intermittent routine flaring will occur during maintenance operations and excess gas (produced gas not used as fuel gas on board or injected into the reservoirs via the WAG injection wells) from the oil separation and stabilisation unit, the produced water treatment unit, etc. will be flared; and
- Flaring of hydrocarbons on the FPSO will also be required during production start-up, as well as during any unforeseen emergency conditions.

Likely emission volumes are not known.

#### 3.10.1.3 Fugitive Emissions / Venting

Additional atmospheric emissions generated by the proposed development of the East Hub oil fields will include fugitive emissions from leaking pipes, valves, flanges, pumps, tanks, etc. on the drilling units, supply and construction vessels and the FPSO.

During drilling, ventilation of the mud circulation system (pits and shakers), refuelling operations and well testing will also release fugitive emissions. In addition, any gas influx that may occur in the well bore during drilling will be cold vented into the atmosphere from a stack at the same elevation as the top of the drilling rig.

During production (operation of the FPSO), purging of the fuel gas flare, venting of the TEG regeneration package and plant compressor sealing system and operation of the inert gas and cargo tank venting system will result in the release of fugitive emissions into the atmosphere.

It is not possible to predict the volumes of pollutants (mostly hydrocarbons) that may be released as a result of fugitive emissions and venting.

#### 3.10.1.4 Incinerator Emissions

Small volumes of combustible waste, including used lubricating oil, etc., may also be incinerated on board the vessels. This will be done in accordance with MARPOL Annex VI and volumes involved will be small.

### 3.10.2 Noise Emissions

Low frequency noise will be generated on the drilling units by equipment such as the diesel engines, rotary tables, winches, pumps and cementing units. Noise levels on the drilling units themselves will be highest near the engines and cementing units (typically around 105 dBA equivalent continuous sound level or $L_{eq}$), with lower levels on the derrick floors (typically around 94 dBA $L_{eq}$) and in the pump zones (typically around 86 dBA $L_{eq}$).

In addition, during all phases of the proposed East Hub development, noise will be generated by propellers and thrusters (shipping noise) and machinery noise from power generators, compressors, pumps, etc. Helicopters will also generate noise. Eni will set a maximum (onboard) sound pressure level of 85 dBA for external work areas in contracts with contractors, with lower values set for offices, control rooms, living quarters, etc.

Underwater noise will be generated by the above activities, as well as by the underwater installation and operation of the subsea production and SURF system equipment, such as flowlines and choke valves, etc. Underwater noise generated by project activities will generally be of a low frequency with strongest tones at around 100 kHz as indicated in Table 3-5 below.

**Table 3-5: Indicative sound emission levels from project activities.**

| Project Activity (Sound Source) | Approximate Highest Sound Levels (dB re 1 µPa @ 1 m)* | Peak Frequency Band – Indicative Ranges (Hz)** |
|---|---|---|
| Tug | 170 dB | 50 – 1 000 |
| Pipelay vessel | 180 dB | 1 000 – 100 000 |
| Supply vessel | 180 dB | 10 – 1 000 |
| Export tanker | 190 dB | 10 – 100 |
| Subsea choke valve | 120 dB | 1 000 – 100 000 |
| FPSO | 160 dB | 1 000 – 100 000 |
| MODU | 174 to 185 dB | 10 – 10 000 |

* Sound pressure is expressed on a decibel scale (dB) and reference to 1 micro Pascal at 1 m from the source (dB re 1 µPa @ 1 m).

** Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level.

Source: ERM, 2009

## 3.10.3 Routine Discharges to Sea

Routine discharges to sea will take place during normal operations on all vessels involved in the East Hub development and during all phases of the project. The key discharges to sea during offshore oilfield development projects (in terms of volume and potential environmental impacts) are drilling fluid and cuttings (from the drilling units during development drilling) and produced water (from the FPSO during production). These key discharge streams are discussed in more detail in Sections 3.10.3.1 and 3.10.3.2 below.

Miscellaneous smaller discharges to sea during normal operations could include ballast water, deck drainage and bilge water, sewage and grey water, galley (food) wastes, desalination brine, cooling water, hydraulic fluid and cement. The relevant regulations governing the release of these smaller discharges are summarised in Table 3-6 below.

### 3.10.3.1 Drilling Fluid and Cuttings

The disposal of drill cuttings (and associated drilling fluid) into the sea is one of the key discharges during offshore well drilling operations. Cuttings consist of crushed rock and can range from clay to coarse gravel, depending on the types of sedimentary rock that are penetrated and crushing specifications of the drill bit. Cuttings are usually relatively inert, but may contain small amounts of trace metals, hydrocarbons and drilling mud components, which may be released into the environment.

During the initial stages of drilling of each well, cuttings will be carried out of the borehole and disposed of on the seabed where it will create a cuttings pile around each hole. These initial sections are typically drilled using seawater and high-viscosity pills as drilling fluid, which will be discharged in association with the cuttings. The likely volume of untreated cuttings to be disposed of on the seabed was not known at the time of writing this report.

Subsequent well sections will be drilled using LTOBM and with a riser installed, which will ensure that all cuttings are carried up to the drilling unit. As of January 2014, the disposal at sea of drill cuttings generated during drilling with non-water based mud will be prohibited in terms of Angolan legislation (Executive Decree 224/12), and all such cuttings will be required to be stored on board and taken to shore for treatment and disposal at suitable cuttings treatment facilities.

### 3.10.3.2 Produced Water

During production (operation of the FPSO), produced water will be generated in the oil separation and stabilisation unit (where reservoir fluids will be separated into formation water, crude oil and produced gas). Although produced water will be re-injected into the reservoirs, excess produced water and produced water generated during any upset conditions, may be discharged to sea.

Produced water is typically very saline and contains particulates as well as oil. As described in Section 3.6.2.3 above, produced water will be treated in the produced water treatment system on board the FPSO prior to discharge to the sea. Angolan regulations (Executive Decree 224/12) requires the monthly average oil-in-water content of discharged produced water to not exceed 30 parts per million (ppm), while daily peaks of up to 45 ppm are permitted. MinPet must be notified of any exceedance of the daily peak.

Produced water discharge volumes can be extremely variable over the lifetime of the project: initially they are generally small and reach a maximum when maximum oil production rate is reached, followed by a steady decline until the end of the oil field's life. The anticipated total volume (or likely discharge rate) of treated produced water to be discharged from the FPSO was not known at the time of writing this report.

While the anticipated volume of treated produced water to be discharged from the FPSO is not known, the (unmodified) Xikomba FPSO has the capacity to discharge approximately 100 000 bbl of treated produced water a day (666 $m^3/hr$). The *maximum* volume of produced water that could be discharged over the 15-year lifespan of the West Hub project is therefore anticipated to be about 550 million bbl, but the actual volume will be much lower.

**Table 3-6: Miscellaneous discharges to sea during routine operations and relevant regulations.**

| Discharges | Regulations |
|---|---|
| **Ballast water** | The International Maritime Organisation (IMO) Ballast Water Management convention sets out requirements for ballast water management that aim to minimise the potential impacts of ballast water discharges.<br>Angolan ED 224/12 regulations on ballast water management requires vessel entering Angolan waters to change ballast water at least 200 nm from the Angolan coast in water depths of at least 200 m. |
| **Deck drainage and bilge water** | MARPOL Annex I (Prevention of pollution by oil) stipulates that the oil content of discharges originating from machinery space drainage of vessels must not exceed 15 ppm without dilution. No vessels may discharge oily wastes above these concentrations at sea and oily water must be processed in a suitable separation and treatment system before discharge.<br>Angolan ED 224/12 requires that the discharge of deck drainage may not result in the formation of oil sheen on the surrounding waters. Non-complying oily wastes must be stored on board and properly disposed of on shore. |

| Discharges | Regulations |
|---|---|
| **Sewage and grey water** | MARPOL Annex IV (Prevention of pollution by sewage from ships) requires that sewage discharged from vessels be treated or comminuted (pulverised) and disinfected before discharge at a distance of more than 3 nautical miles from the shore.<br>Angolan ED 224/12 requires observation for and recording of any floating solid particles during discharge. |
| **Galley (food) waste** | According to MARPOL Annex V (Prevention of pollution by garbage from ships), biodegradable food waste should be macerated to less than 25 mm in size and disposed of into the sea at a distance of greater than 3 nautical miles (nm) from the shore.<br>Angolan ED 224/12 permits the discharge of similarly treated food and domestic waste only at a distance of more than 12 nm from the coast. |
| **Hydraulic fluid** (released during BOP testing and can leak from ROVs, etc.) | Angolan ED224/12 prohibits the direct discharge of any chemical products, and provides minimum specifications for all chemical products (toxicity / biodegradability and/or bioaccumulation factor). |
| **Desalination brine** (from on board freshwater supply systems based on seawater desalination) | None |
| **Cooling water** (seawater taken up for use as cooling water and returned to sea with temperatures ranging from 35 to 50 °C) | |
| **Cement** (used in cementing of casings during drilling and released when cement lines are flushed) | |
| **Flare drop-out** (oil drop-out from flaring could result in the formation of visible oil sheen) | |

## 3.10.4 Solid and Liquid Waste Disposal on Land

Several types of solid and liquid wastes generated on board the drilling unit may not be discharged to sea, and will be transported to shore for treatment and/or disposal at suitable facilities, using an appropriate Waste Contractor. In terms of Angolan legislation, Eni is required to compile and implement a WMDDP approved by MinPet.

A summary of the different types of wastes, sources and typical management/disposal methods is provided in Table 3-7 below.

**Table 3-7: Types of wastes and management methods for land-based disposal.**

| Waste type | Management / disposal methods | Sources |
|---|---|---|
| Deck drainage: rainwater potentially contaminated with lubricants, grease, oil and detergents. | Most modern vessels are equipped with 'curbing' to isolate clean runoff from areas where runoff may contact these contaminants. Contaminated deck drainage is collected for storage on vessels, and is periodically pumped into tanks on the supply vessels and taken to shore for treatment and disposal. | Drilling units, FPSO |

| Waste type | Management / disposal methods | Sources |
|---|---|---|
| Vessel machinery space drainage: generally contains oils, grease and other potential contaminants. | Machinery spaces (machine room, pump zone and engine areas located below the main deck) are also fitted with curbing and the drainage is collected and sent to the on board oil-water separation system. The water that is separated out is sent to the deck drainage collection tank described above, while the oil is stored in special drums on board the vessel until such time is can be taken to land for treatment and disposal. | Drilling units, FPSO |
| Used drilling fluid (LTOBM) | Stored in a dedicated tank on the drilling rig and transported to shore for treatment (with a thermal desorption method) by the relevant Waste Contractor. | Drilling units |
| General domestic waste: garbage such as waste paper, plastics, wood, glass, etc. | Collected on board, transported to shore and disposed of at a suitably licensed landfill facility. | All vessels |
| Scrap metal | Reused where possible, otherwise transported to shore and disposed of at a suitably licensed landfill facility. | All vessels |
| Empty drums and containers, which may contain contaminating residues. | Transported to shore and recycled where possible (steel containers), otherwise disposed of at a suitably licensed landfill facility, after rinsing and crushing/shredding.<br>If rinsed on board, rinse water must be disposed of according to MARPOL or transported to shore and disposed of as per the WMDDP. | All vessels |
| Used oil such as lubricating oil, gear oil, solvents, petroleum-based detergents, machine oil, etc. | Transported to shore in secured containers and recycled where possible (as fuel oil), otherwise incinerated, or solidified, stabilised and disposed of at a suitably licensed disposal facility. | All vessels |
| Hazardous and chemical wastes such as radioactive materials, toner cartridges, etc. | Disposal on a case-by-case basis and according to relevant legislation and/or appropriate regulatory authorities. | All vessels |
| Medical waste such as used bandages and needles and infectious wastes such as food wastes from persons with infectious diseases. | Transported to shore and disposed of at suitably licensed disposal facility. | All vessels |
| Filters and filter media: oily residue and media in oil filters may contain metal fragments | Transported to shore and disposed of at suitably licensed disposal facility. | All vessels |

# 4 Affected Marine Environment

This chapter describes the abiotic and biotic features of the marine and coastal environments of northern Angola and adjacent areas that may influence or be affected by activities associated with the proposed development and operation of Eni's East Hub in Block 15/06. The description of the affected marine environment was compiled by Sue Lane and Associates based on:

- Secondary data, including available scientific literature, research reports and semi-formal publications for the region, data provided by the Ministry of Fisheries (Ministerio das Pescas), especially the INIP (2013) survey report, and information from other marine and environmental scientists working in the region. These are referenced throughout the report; and
- Primary field data from a baseline environmental survey undertaken by Lwandle Technologies for this project in conjunction with a geophysical survey from 23 December 2012 to 18 January 2013, from the drilling ship Bavenit. The data and information acquired include oceanographic and water quality measurements in the water column as well as information on sea bed sediment properties, sediment quality and benthos distributions. The locations of field sampling stations are shown in Figure 4-1. The full survey report is attached as Appendix A.

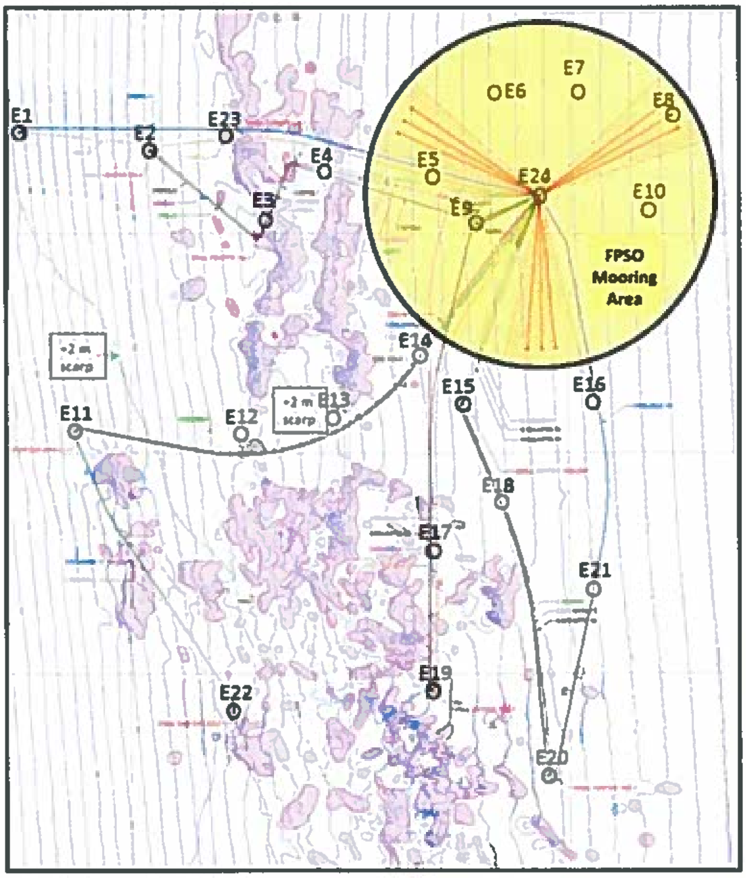



**Figure 4-1: Location of Lwandle's sampling sites (numbered circles) on the Subsea Field Layout Base Case**

Ref: 361302FUDGS0233_CDFE02_SH1of6. 5 m contour interval.

## 4.1 Methodology

The following steps were taken to predict impacts of Eni's proposed East Hub oil fields development:

- Activities that could directly, indirectly or cumulatively interact in a harmful way with the marine environment and its beneficial users were identified.
- The components of the natural and social marine environment that could be adversely affected by these activities were described using the available information.
- Simulation modelling was employed to predict the behaviour of accidental oil spills and to identify the environmental components that may be at risk.
- Based on the project's area of influence, the study area is clearly defined for the baseline description.
- Potential impacts to the marine environment were assessed and evaluated using Eni's impact assessment methodology and criteria.
- Suggestions were made about mitigation and monitoring that can be included in Environmental Management Plans that Eni/ARC will compile. The use of these plans will enable Eni to demonstrate compliance with the recommended mitigation measures and to verify predictions made in this specialist report and the EIA.

## 4.2 Project Location and Area of Influence

The affected environment is defined by the area/s that could be impacted by the project (the Project's Area of Influence). This area can vary from a local, to a regional, to a national or to a global scale, depending on the relative importance and value of the particular environmental component being discussed.

The study area which this baseline describes includes the outer continental shelf and slope offshore of the northern coast of Angola and countries to the north, and encompasses their coastlines and maritime areas, and the High Seas where relevant (Figure 4-2).

Figure 4-2 illustrates the descriptors of the geographic scales used in the baseline section, which are:

- **Region/ Study area** – Defined as the continental shelf and slope out to an approximate depth of 4 000 m, and the coastline between Cap Lopez in the north (just south of the equator in Gabon) to Luanda in the south (about $9^0$ south in Angola); This area of influence, in this instance, is partly defined by the maximum spatial extent of surface oiling probabilities; and
- **Project area** – Defined as the water body and seabed within the confines of the East Hub development area, as proposed by Eni.


**Figure 4-2: Area of influence.**

The respective locations of the proposed Block 15/06 East Hub Project Area (in blue square) and the sea and coastline of the wider study area (in red ellipse) focused upon in this environmental baseline description.

Base map Google Earth 2013.

## 4.3 Climate and Meteorology

Northern Angola has a warm and moist tropical climate with average maximum air temperatures varying between 24 °C (July to August) and 32 °C (February to April). Annual rainfall is 35 mm to 600 mm and strongly seasonal (Figure 4-3).

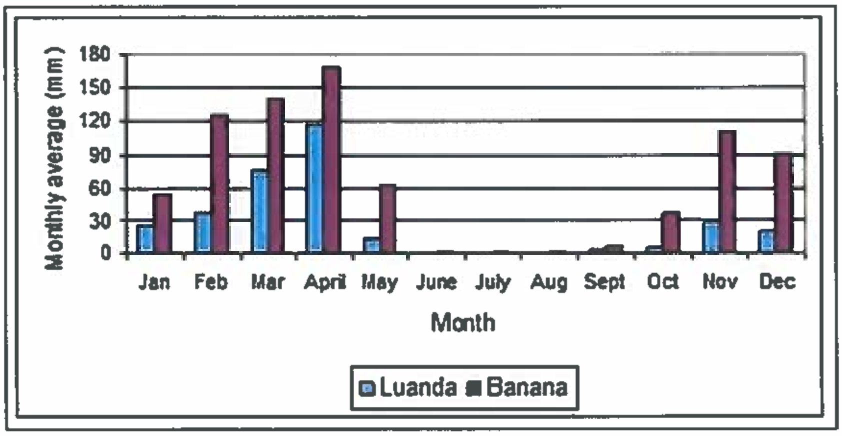



**Figure 4-3: Average monthly rainfall at Luanda and Banana (DRC).**
Source: Africa Pilot 1979

Most rain falls between February and April, correlating with the hottest months. Rainfall in the cooler months of June to September is markedly reduced.

Figure 4-4 shows the monthly variability in wind patterns at 10 m above sea level for the proposed East Hub development area in Block 15/06. The wind regime is dominated by southerly and south-westerly winds which are generally low to moderate in strength, with monthly average velocities <5 m/sec (<10 knots). Monthly maximum velocities range from 10-13 m/sec (18-26 knots). There is no marked seasonality in the wind pattern other than slightly lower mean and maximum velocities in August and September and reduced south-easterlies in August to November.

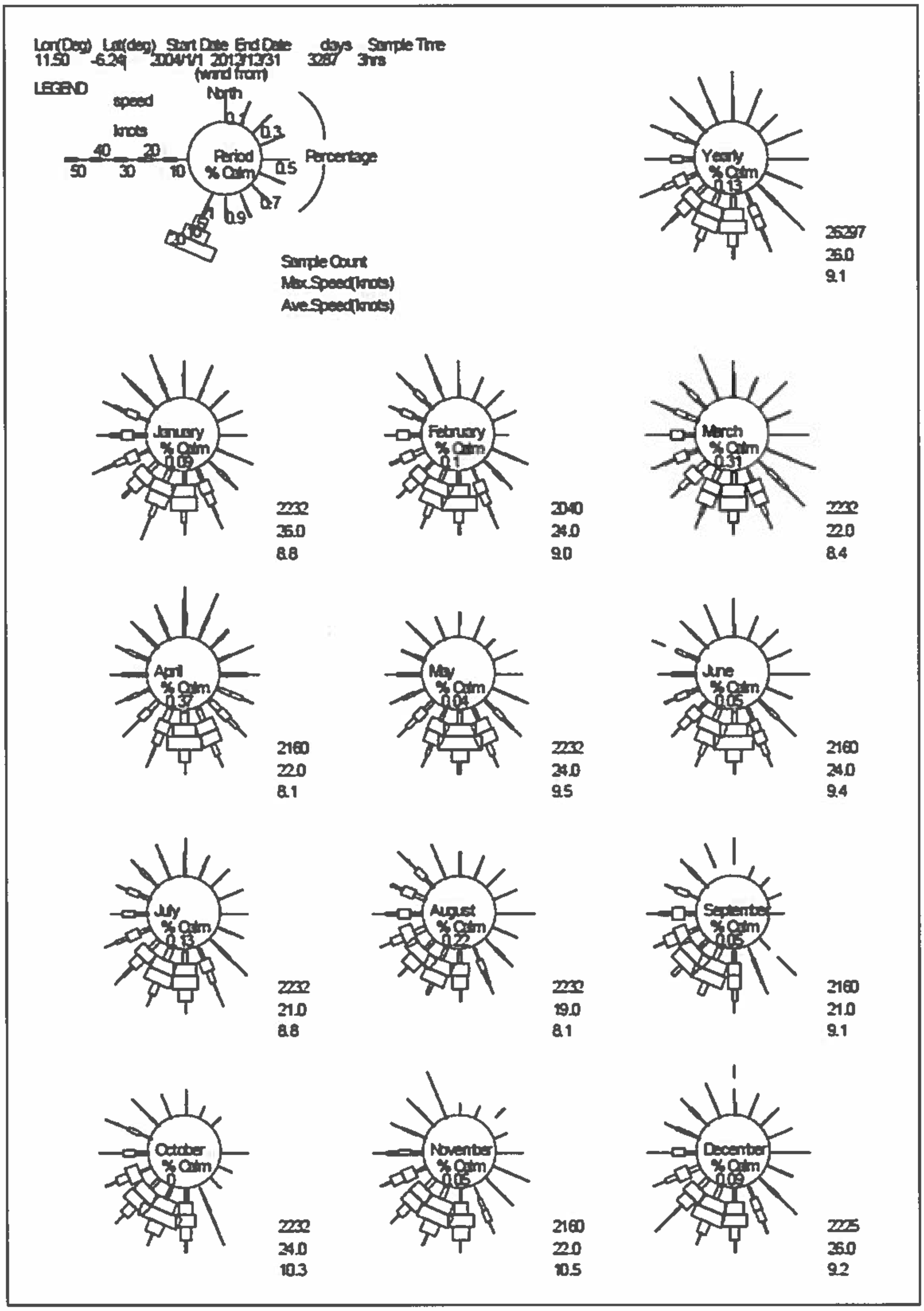



**Figure 4-4: Monthly wind roses for a NOGAPS site 6.24° S, 11.50° E just south of the East Hub.**

Speeds in knots, using meteorological convention, i.e. direction wind is coming from.

Source: RPS-ASA 2013

# 4.4 Physical Oceanography

## 4.4.1 Topography and Sediments

The continental shelf slope is mainly regular and slopes at ~35 m/km in the 200 m-500 m depth range and then flattens out to a slope of ~15 m/km in the 500 m-2 000 m depth range (Figure 4-5).

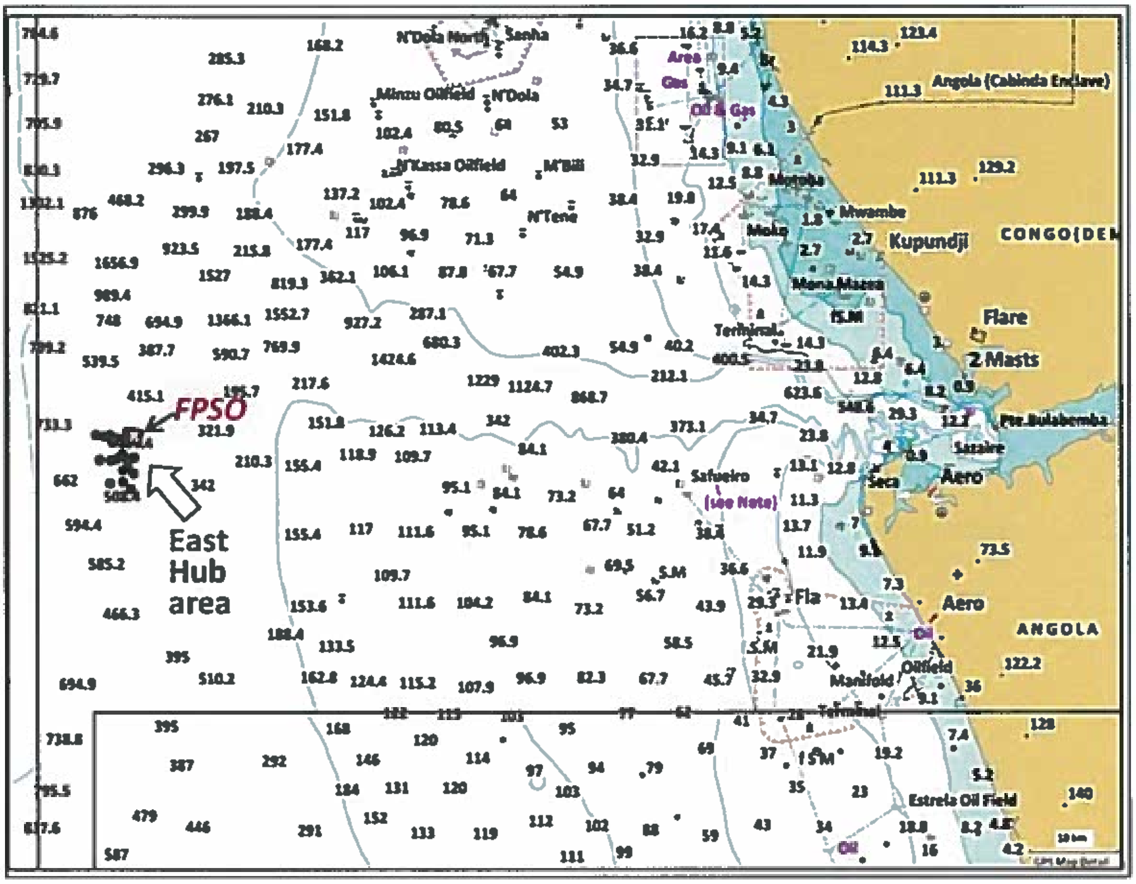



**Figure 4-5: Broad scale bathymetry (m) and coastline in relation to the East Hub development area.**

Source: BlueChart Atlantic v7.5

Van Iperen et al. (1987) classifies the seafloor sediments in the area as 'upper slope deposits' with most of the material being terrigenous in origin, having been transported there by the Congo River.

Lwandle (2013a) reports that surficial sediments in the East Hub area are brown in colour and become grey and more cohesive with depth. They determined that sediment textures ranged from very fine sandy fine silt to very fine sandy coarse silt, gravel sized sediments being entirely absent from the sediment samples (Figure 4-6).

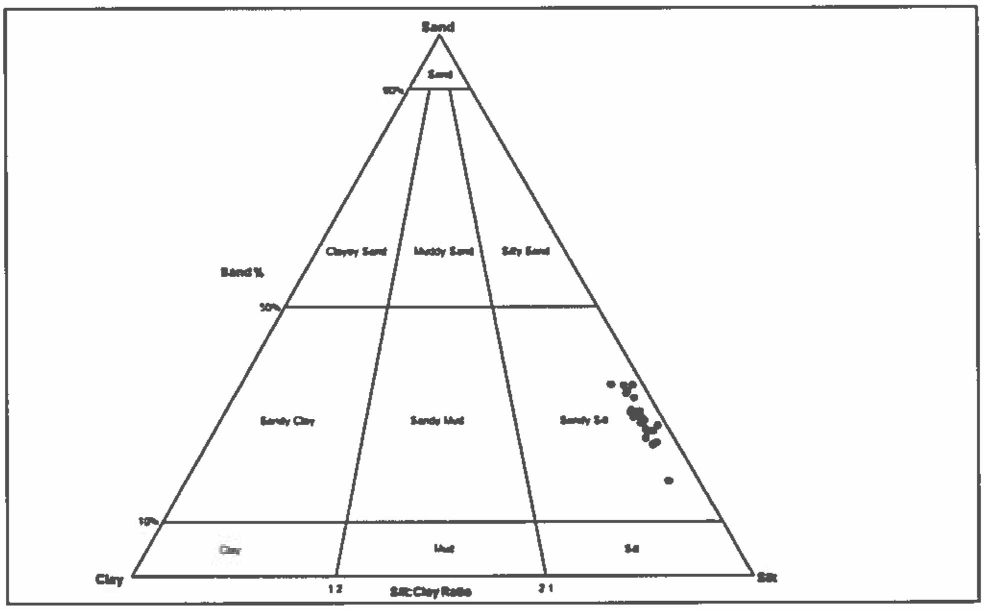



**Figure 4-6: Ternary diagram showing sediment texture in the survey area.**
Source: Lwandle, 2013a

Sediment particle size distributions were polymodal and poorly sorted (Figure 4-7) implying admixtures of sediments from different sources. The distribution of mud (grouped as all sediments < 63 µm equivalent spherical diameter) across the survey area is shown in Figure 4-8. As gravel sized sediments were entirely absent the distribution of sand (grouped as all sediments > 63 µm) would be a mirror image of Figure 2-8.

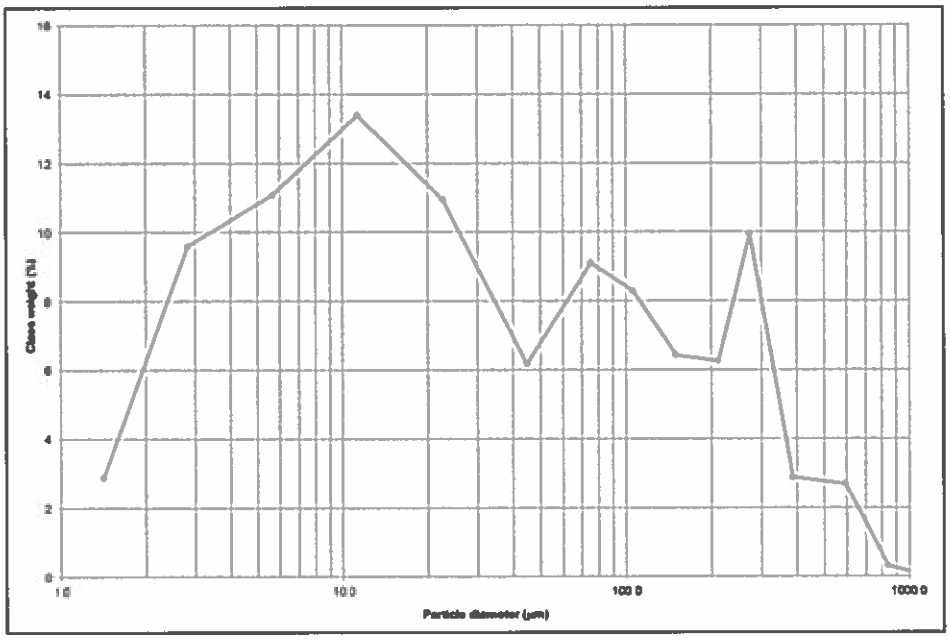



**Figure 4-7: Mean sediment particle size distributions.**
Source: Lwandle, 2013a

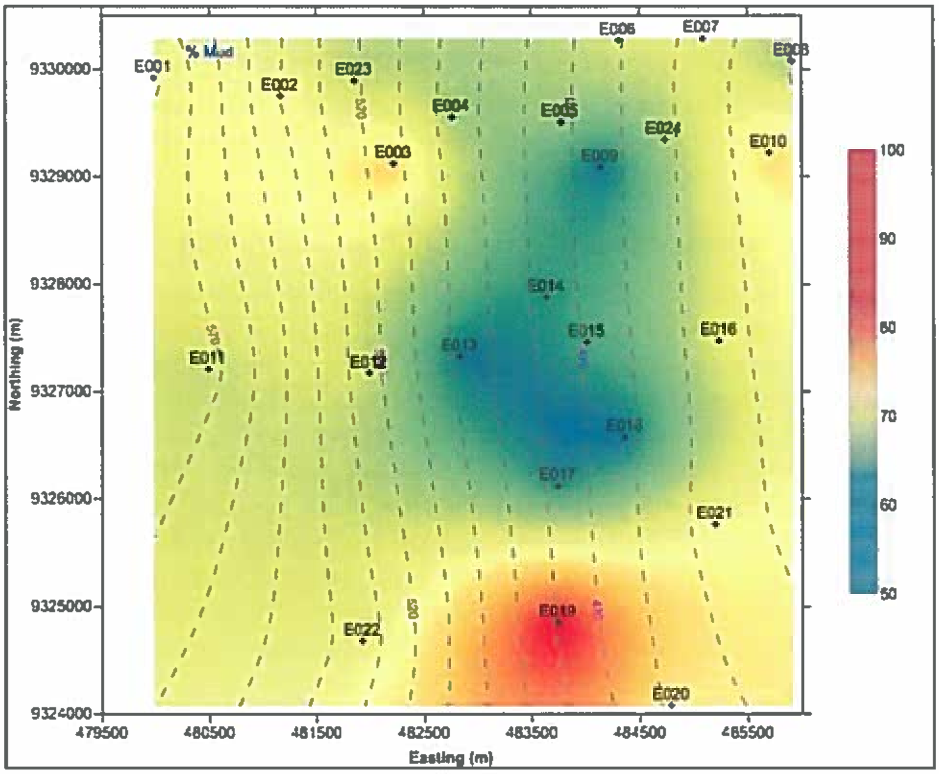



**Figure 4-8: Distribution of % mud in the survey area.**

The crosses show field sample positions and the dashed lines 10 m interval isobaths

Source: Lwandle, 2013a

The sediments were found to have high organic carbon loads (4-5%) and, surficially at least, are oxic, in agreement with Pimenov et al. (1993). Inshore of the East Hub location continental shelf surficial sediments are coarser (Bianchi 1992), oxic and moderately enriched with organic carbon (2.1% - 2.9%; Pimenov et al. 1993) and may be interrupted by beds of stones, rocks and corals (Bianchi 1992). Corals have also been recorded on carbonate mounds on the Angola margin at 400 m depth (Le Guilloux et al. 2009) with the cold water coral *Lophelia petusa* being well represented and having associated diverse fish assemblages. Le Guilloux et al. (2009) did not identify any coral mound communities deeper than 400 m in a survey area that extended to 1 400 m depth. The organic material depositing on the outer continental shelf and slope south of the Congo River exhibits a C/N ratio of ~8 and is considered to be derived from marine sources (Rabouille et al. 2009). This contrasts with higher sedimentary organic material C/N ratios (10-14) within the confines of the Congo River canyon with a primarily vascular plant origin (Eisma and Kalf, 1984, Rabouille et al. 2009). The measured East Hub C/N ratios are high (Lwandle, 2013a) implying a terrestrial origin for most of the organic material that was present during the survey period (December 2012-January 2013), as opposed to it being derived mainly from sedimenting marine phytoplankton.

More detailed bathymetry of Block 15/06 in the East Hub development area is illustrated in Figure 4-1 above. Neither this figure nor admiralty charts provide information on sediment texture distributions for the East Hub project area. Further south, at similar depth horizons in Blocks 15 and 18, the seafloor surficial sediments were mainly fine (brown) silt overlying compacted clay (Lwandle data and ERM 2005). Notable features of the seafloor were numerous pockmarks (possible methane seeps) with isolated salt diapirs. Coarser sediments (sands) were found to be associated with diapirs.

In accordance with the above and as evident in Figure 4-1 the proposed East Hub development area has a diverse seafloor with surface and buried faults and subsurface fluid or gas saturation.

There are no obstructions marked on the admiralty chart for the East Hub development area but there are oil field operations on all four sides of the block. None of these marked features should influence the planned East Hub development programme.

### 4.4.2 Heavy Metals, Hydrocarbons, PCBs (Potential Pollutants)

Heavy metal concentrations in the East Hub area of Block 15/06 were found by Lwandle (2013a) to be relatively low, which compares favourably with their results reported for the West Hub. Barium concentrations of >600 mg/kg would be indicative of previous drilling activities (e.g. ERM 2005) and the observed concentrations imply that drilling has not been conducted in the survey area, or that any barium released has been diluted back to background levels. Further, the results of analysis imply that the readily bioavailable heavy metals in the East Hub area of Block 15/06 do not represent any toxicity risk to benthos or other organisms in the area. This is the same as was found in Lwandle's West Hub survey (Lwandle 2011). All of the distributions showed relatively narrow concentration ranges, which is to be expected from the limited spatial scales of the survey area within the larger outer continental shelf and slope setting, as well as the mostly uniform distribution of mud across the survey area (Figure 4-8). All of the measured heavy metal concentrations fell well within sediment quality guidelines for Angola (BCLME 2006).

All but one of the total petroleum hydrocarbon measurements (one of 32 mg/kg) were below detection limits for the analytical methods used, as were all PAH compounds, and PCBs. This accords with the mostly low total hydrocarbon concentrations recorded in the Block 15/06 West Hub survey (Lwandle 2011). The set sediment quality guideline concentrations (TEL and PEL, BCLME 2006) all exceeded 1 mg/kg, which is generally an order of magnitude greater than the detection limits. Therefore pollution effects and pollution risks to marine ecology and resources from hydrocarbons and PCB compounds in the survey area appear unlikely. The single high value of 32 mg/kg total petroleum hydrocarbon concentration measured lies at the lower end of a range of no observed effects concentrations (NOEC) measured by Verbruggen (2004) in acute and chronic effect toxicity tests on seven benthic organisms. The reported range is 25-710 mg/kg. Hence, deleterious environmental effects from hydrocarbons at the site where the relatively high level was measured also appear to be unlikely.

### 4.4.3 Water Masses and Temperature/Salinity Relationships

Continental shelf waters off Angola consist of Tropical Surface Water overlying thermocline water which is a mixture of South Atlantic and Indian Ocean Central Water (Shannon and O'Toole, 1998). The surface water salinity is ~36.4 ppt and the temperature is generally greater than 24°C (Lass et al. 2000). Figure 4-9 and Figure 4-10 show the temperature/salinity (T/S) relationship for the region which encompasses the development area as well as T/S measurements obtained at the East Hub site in December 2012-January 2013. Note the occurrence of low salinity water at high temperatures which is indicative of the penetration of the Congo River water into the area (e.g. Vangriesheim et al. 2009). Temperatures vary seasonally with lower temperatures occurring in southern Angola in winter and spring (20°C – 26°C) compared with further north in summer/autumn when the temperature range is generally 27°C – 30°C (Lass et al., 2000). The temperature and salinity of the thermocline water is typically less than 16°C and 35.4 ppt respectively (Figure 4-10 Shannon and O'Toole, 1998).

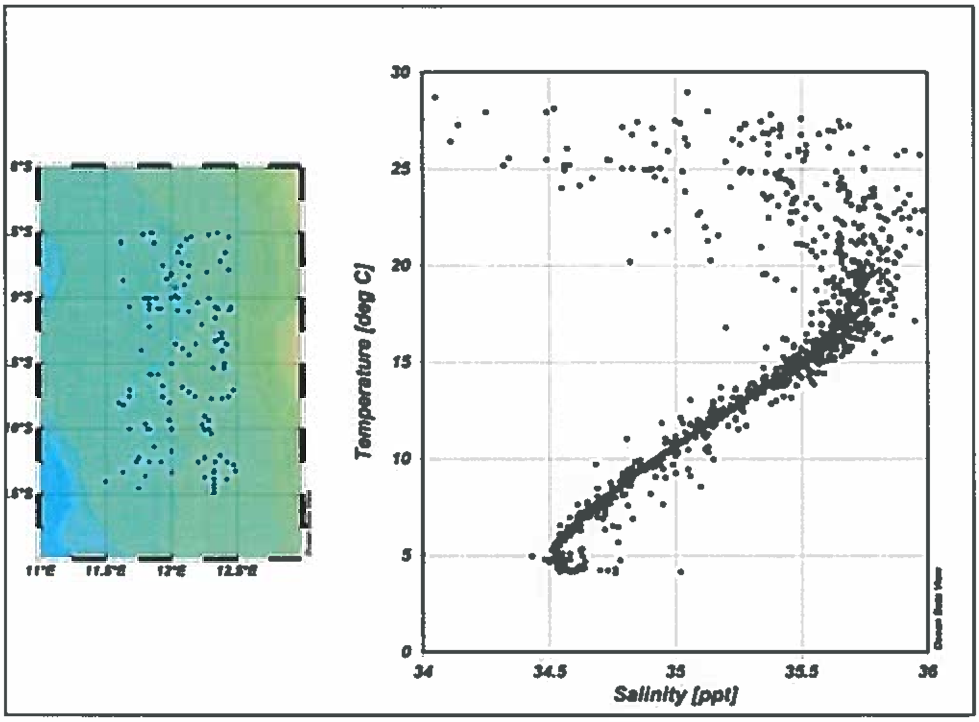



**Figure 4-9: Temperature/salinity relationship for the water masses for the region encompassing the development area.**
Source: SADCO

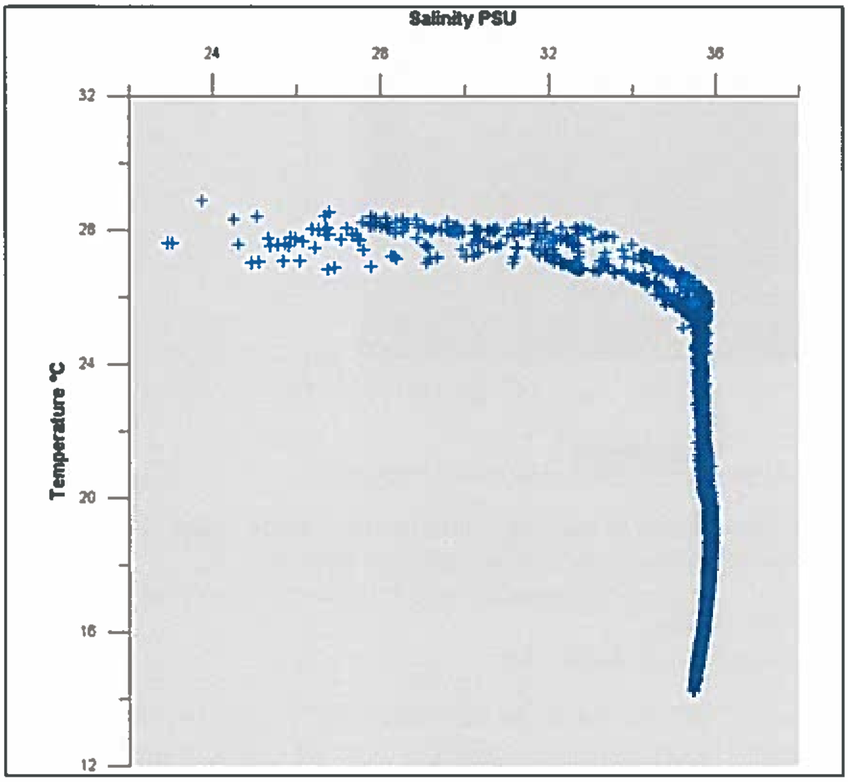



**Figure 4-10: Temperature /salinity relationship in the East Hub area**
Source: Lwandle, 2013a

Figure 4-11 shows a composite of surface salinity distributions from a number of surveys in the area. The axis of the low salinity plume in the immediate vicinity of the Congo River mouth is NNW but east of 11° E the plume can flow SSW and penetrate to 10° S. Offshore of 11° E the flow is seasonally variable; in February/March the direction of flow is SW or SSW, from April to August W or WSW and in October/November NW. The NW flow is linked with the establishment of the summer low pressure cell over southern Africa and the generation of SW monsoon winds (Eisma and van Bennekom, 1978). The SSW flow of the plume is attributed to a reversal of generally accepted northwards flow of the surface waters. Piton (1982 in Van Bennekom and Berger 1984) observed persistent southward flow for a 10 day period off the Gabon coast and Wacongne and Piton (1992) report almost bimodal flow on the NW/SE axis at both 10 m and 35 m on the continental shelf at ~ 5° S. The position of the plume is thus variable.

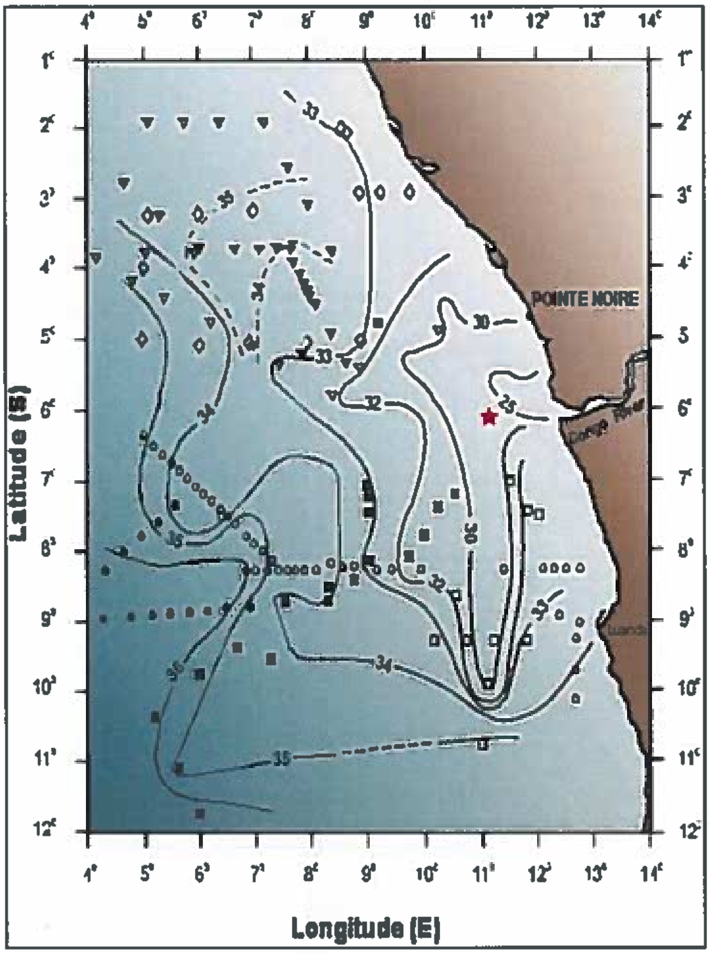



**Figure 4-11: Composite diagram of the maximum extension of the Congo River plume.**

From surface salinity observations conducted by a number of authors

Dashed line ( - - - -) indicates the north-western limits of the river plume in November 1976 The East Hub area is indicated by a red star.

Source: van Bennekom and Berger, (1984).

Due to density differences with the continental shelf waters the Congo River plume is essentially a surface feature (evident in Figure 4-11 and the vertical sections in Figure 4-12 and Figure 4-13), being mostly limited to the upper 50 m of the water column . Here it can contribute to marked stratification as shown in the vertical temperature sections in Figure 4-14 and Figure 4-15.

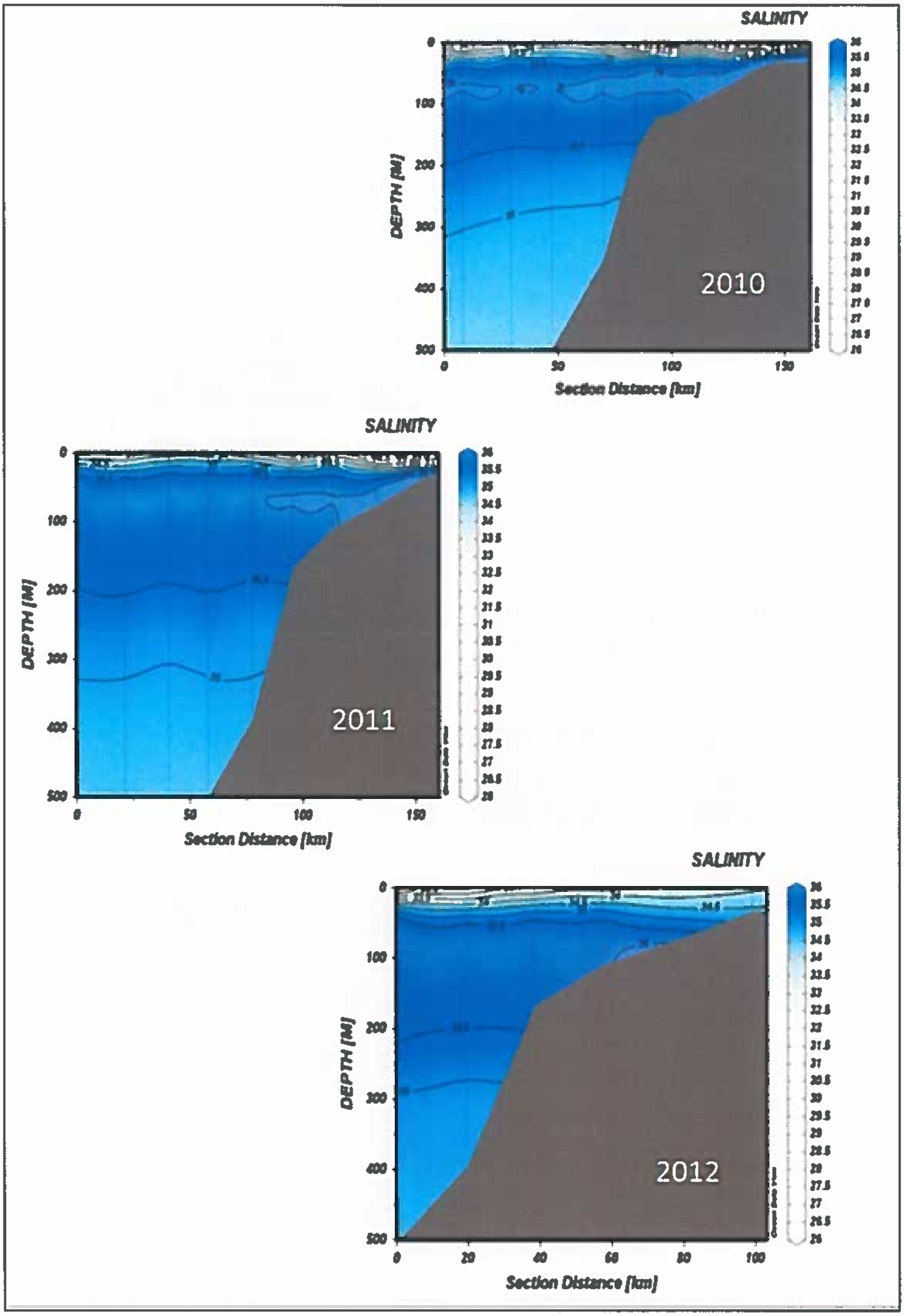



**Figure 4-12: Vertical sections showing salinity distributions with depths and distance offshore in Block 15 in the wet season.**

Source: INIP 2013a

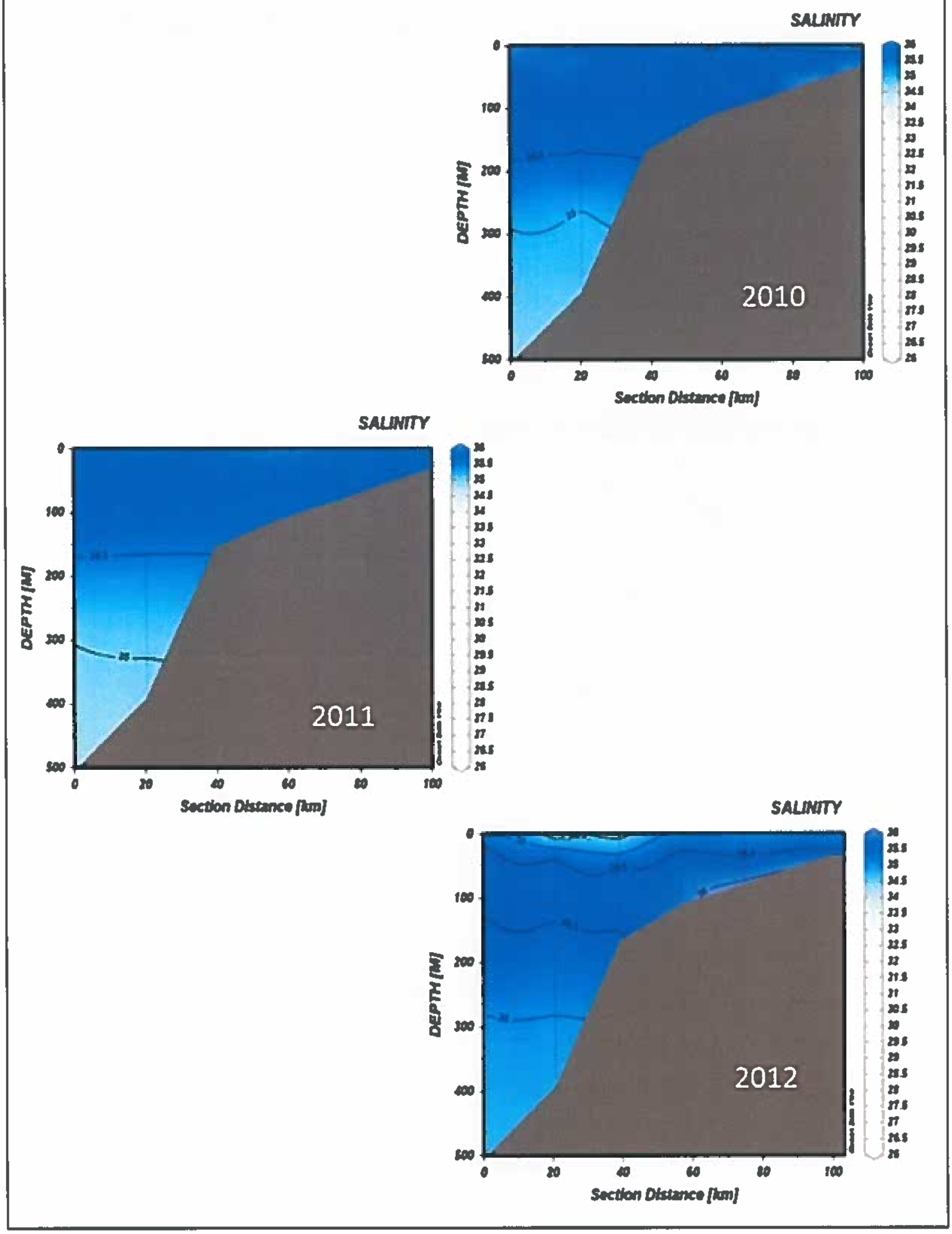



**Figure 4-13: Vertical sections showing salinity distributions with depths and distance offshore in Block 15 in the dry season.**

Source: INIP 2013a

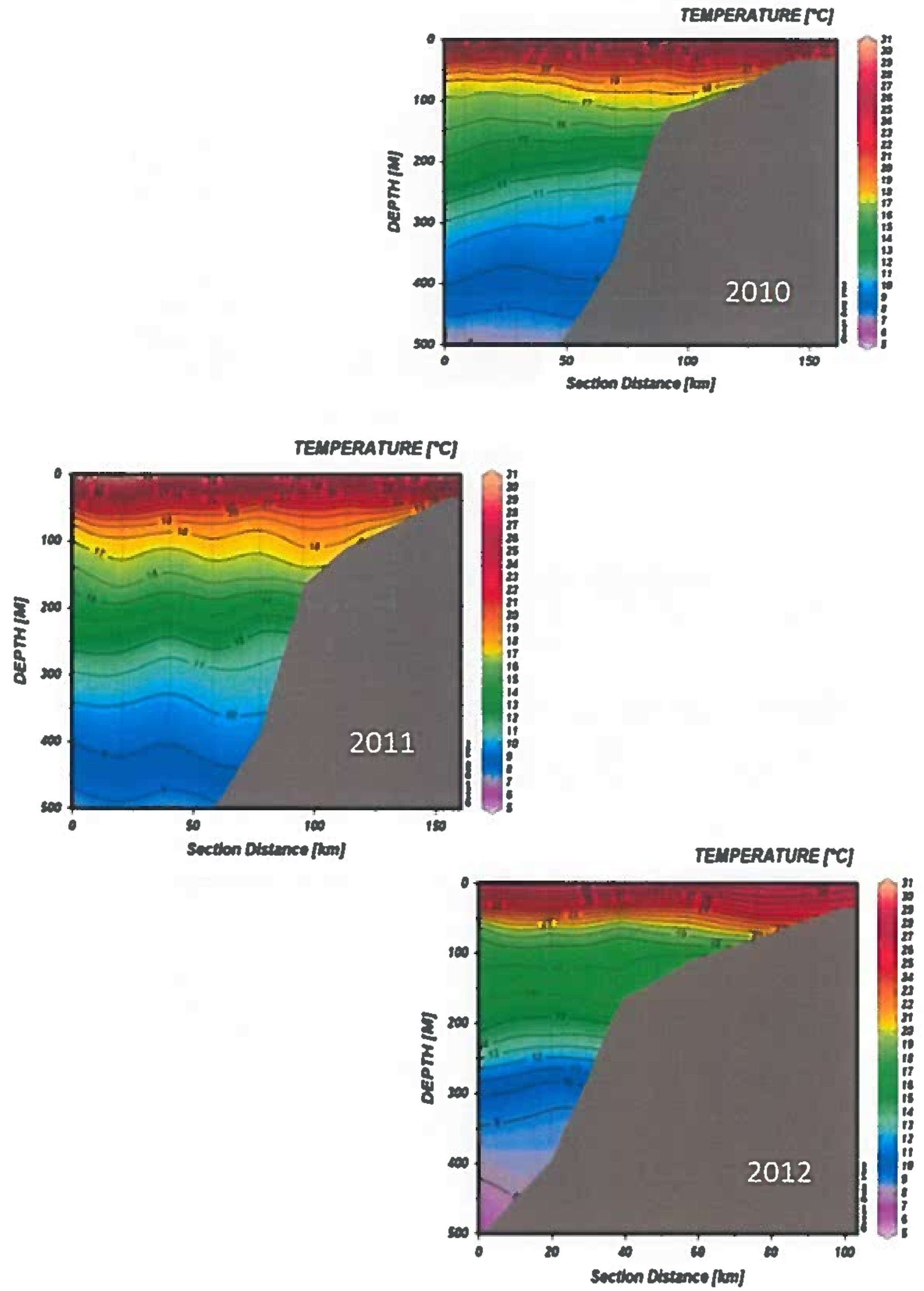



**Figure 4-14: Vertical sections showing temperature distributions with depths and distance offshore in Block 15 in the wet season.**

Source: INIP 2013a

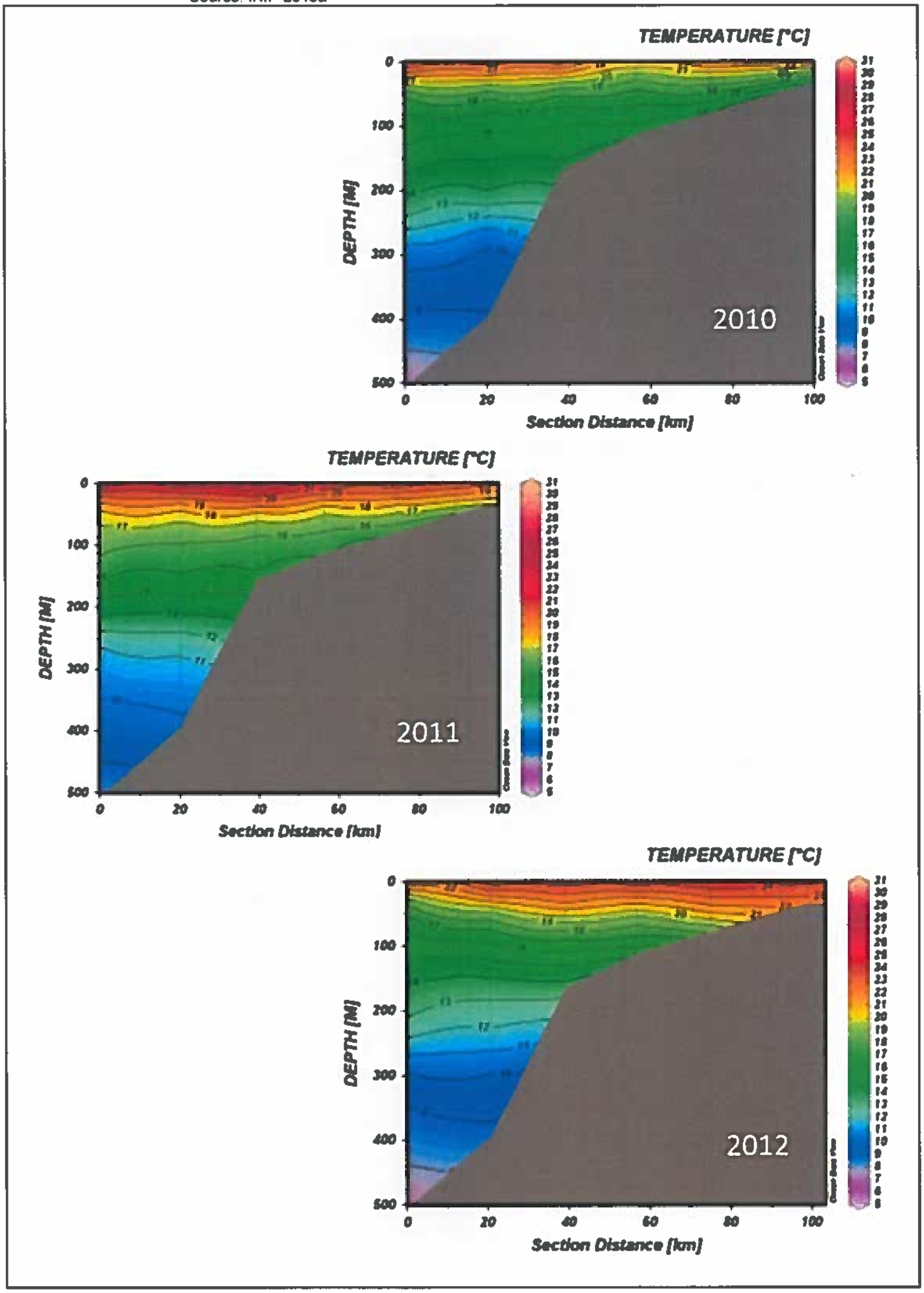



**Figure 4-15: Vertical sections showing temperature distributions with depths and distance offshore in Block 15 in the dry season.**

Source: INIP 2013a

### 4.4.4 Water Circulation and Currents

The dominant circulation features of the Angolan continental shelf south of the Congo River mouth is the warm southward flowing Angola Current (Moroshkin et al., 1970, Meeuwis and Lutjeharms, 1990, Shannon and O'Toole, 1998, Lass et al. 2000). This current is generally best developed to the south and inshore of the proposed East Hub development area (9° S at Ponta das Palmeirinhas to 16° S at Tombua, where it meets the cool, northward flowing Benguela Current). The current is fast flowing and stable and penetrates to 250 m 300 m depth, covering both the continental shelf and slope. Current velocities are typically 50 cm/s but may attain 70 cm/s or higher (Moroshkin et al., 1970, Sætersdal et al., 1999). The origin of the current, at least at the surface, is the southeast branch of the South Equatorial Counter Current.

Figure 4-16 shows a schematic view of the main circulation features.

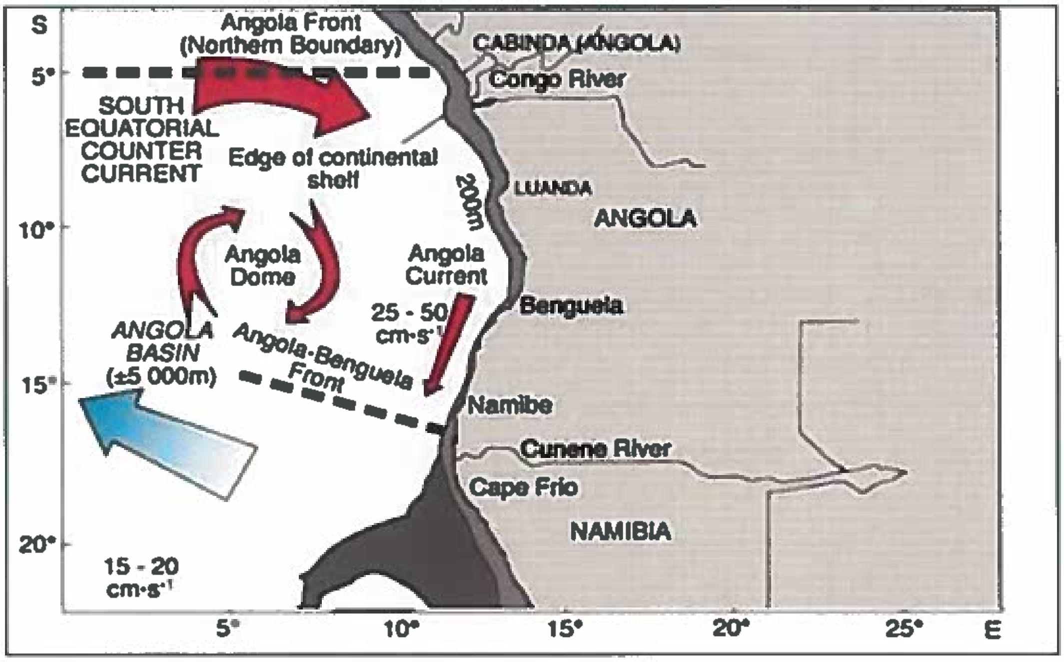



**Figure 4-16: The main hydrographic features of the Angolan Current system.**
Source: modified from N Sweijd, BCLME

Central Angolan continental shelf currents are probably more complex than implied in Figure 4-16. NOAA AOML satellite tracked surface drifting buoy trajectories show south, north, and westward flow (http://oceancurrents.rsmas.miami.edu). Drift velocities along the buoy tracks are variable but are generally low off the central Angola coast (10-15 cm/s). Data for the East Hub area are sparse, however, and the drift trajectory variability should be considered as indicative as opposed to being definitive.

RPS-ASA (2013) present simulated surface currents for the proposed East Hub oil fields development area in Block 15/06. Current velocities average 25 cm/s but maximum flows may exceed 80 cm/s (Figure 4-17). Monthly averages show a predominance of westward flow with seasonality in velocity as opposed to direction with lowest current speeds occurring in September to December (Figure 4-18).

Direct current measurements show that maximum current velocities are generally highest at the surface, where they can be appreciable, but decline with depth to speeds of 20 cm/s and lower (Shannon and O'Toole, 1998, Vangriesheim et al. 2005).

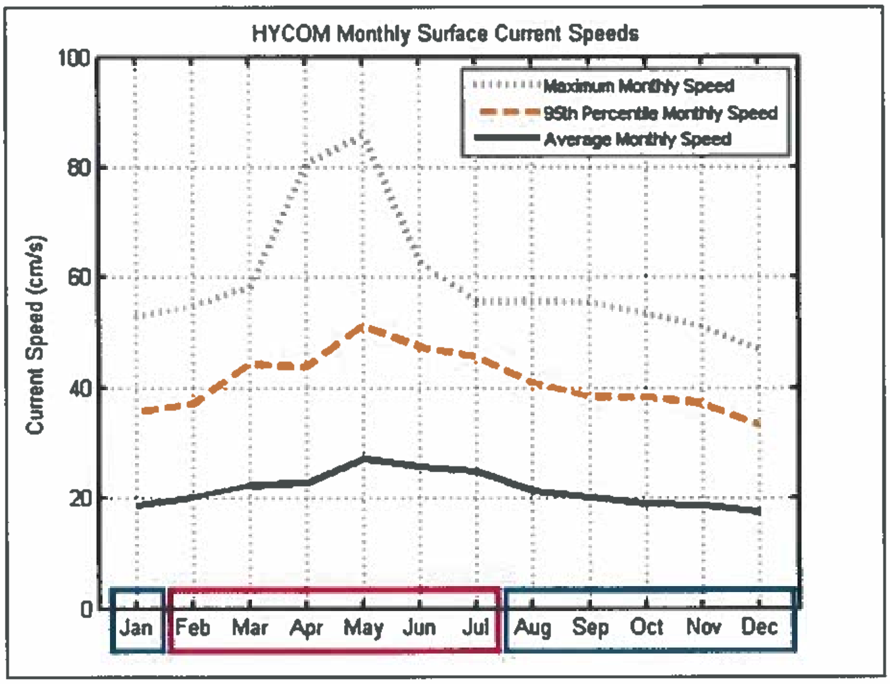



**Figure 4-17: Modelled monthly current surface speed statistics near the FPSO location.**

Monthly average (grey), 95th percentile (dashed orange) and maximum (dashed grey) current speed

Source: RPS-ASA 2013

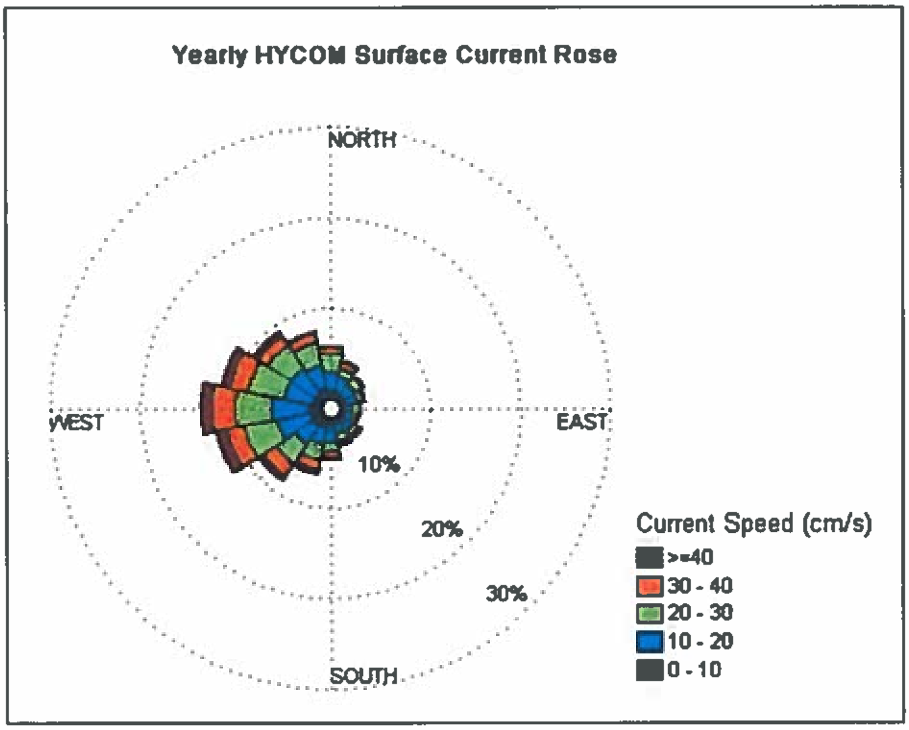



**Figure 4-18: Modelled surface current roses near the FPSO location**

Averaged yearly (top) and during the months of January (bottom left) and July (bottom right), sample period 2003-2012

Source: RPS-ASA 2013

### 4.4.5 Water Column Stratification (Thermoclines)

Thermoclines are well developed on the central Angolan continental shelf with upper mixed layer depths of 10 m to 20 m (van Bennekom and Berger 1984). Temperature gradients in such thermoclines can attain 0.32° C/m in the 25 m-50 m depth range with correspondingly tight gradients in salinity (e.g. Lass et al. 2000). Examples of thermoclines that can occur in Block 15 are shown in Figure 4-14 and Figure 4-15 above.

In the regional context the most conspicuous thermocline feature is the Angola Dome, formed by an apparently semi-permanent eddy centred at about 10° S, 9° E (Shannon et al. 1987). This eddy flows clockwise and appears to be part of the mechanism, or a result, of entraining South Equatorial Counter Current water into the southward flowing Angola Current (Wacogne and Piton 1992). The Angola Dome and the other thermoclines that develop off Angola are all considered to be important in the biological productivity of the region.

### 4.4.6 Upwelling

The major upwelling feature in the study area is that associated with the Congo River outflow itself. The velocity of the outflow is high (Malela, 100 - 240 cm/s, Eisma and van Bennekom, 1978) which leads to entrainment of subsurface (~ 30 m) marine water in the plume (van Bennekom and Berger, 1984). The major feature of the upwelling process is the very shallow thermoclines that occur in the area of the river plume. Although this effect does not break the surface the extent of the thermocline uplift is large and thus the impact of the river-induced upwelling is extensive here (van Bennekom and Berger, 1984), due to the occurrence of strong nutriclines in the vicinity of the Congo River mouth. Seasonal upwelling along the coast both north and south of the Congo River mouth also has a major influence on the nutrient availability in the near-surface waters (van Bennekom et al. 1978) and also the oceanic/shelf waters entering the Congo River canyon below the shallow freshwater surface outflows. The seasonality of the upwelling on the southern African west coast to the latitude of 34°S is shown in Figure 4-19.

There is a clear seasonal signal of cooler water on the continental shelf in the area between the Congo River mouth and Luanda in the period June to September (Figure 4-19, panel 'a'). There are corresponding increased negative gradients in temperature compared to offshore waters at this time (panel 'b') as well as sea level gradients (negative values imply offshore flow = upwelling, panel 'c'). It is notable that, despite the similarity in gradients between areas immediately north and south of Luanda, upwelling in the former area does not appear to reach the same level of development as in the latter area (e.g. Figure 4-20). Nevertheless the process is important for transporting nutrients into the surface layers of the continental shelf waters (below).

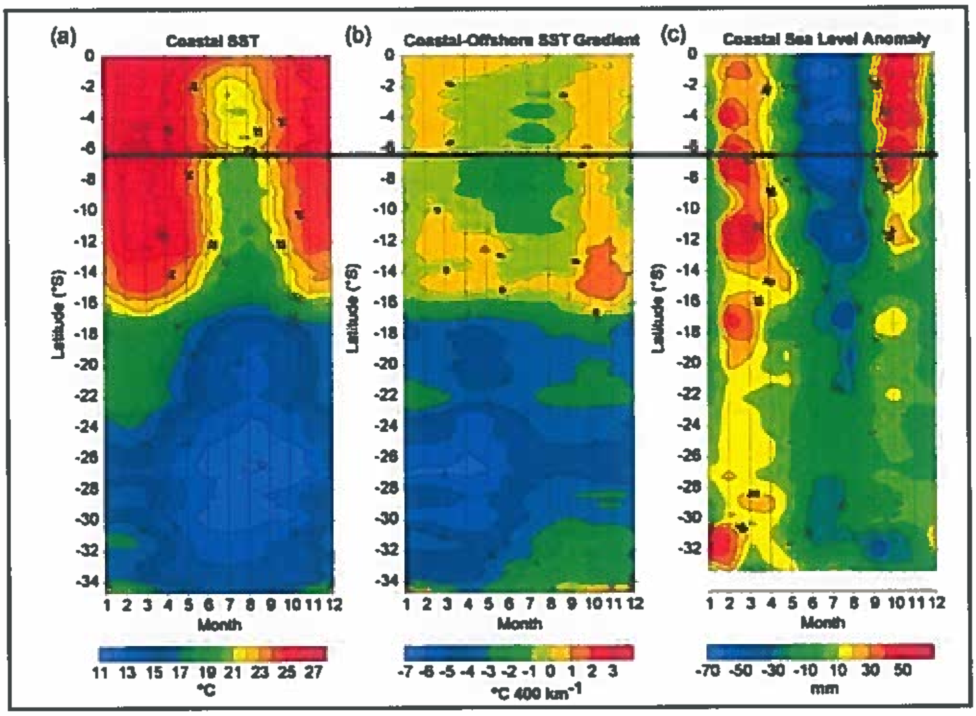



**Figure 4-19: Latitude by month plots.**

For (a) coastal sea surface temperature (°C); (b) coastal–offshore sea surface temperature gradient (°C 400 km-1); (c) coastal sea level differences (mm).

In (b), coastal–offshore sea surface temperature gradient is calculated as the SST difference between a 20 km strip at the coast and a 20 km strip situated 400 km offshore. The horizontal line indicates the latitude of the proposed East Hub development area.

Source: Modified from Hardman-Mountford et al. (2003)

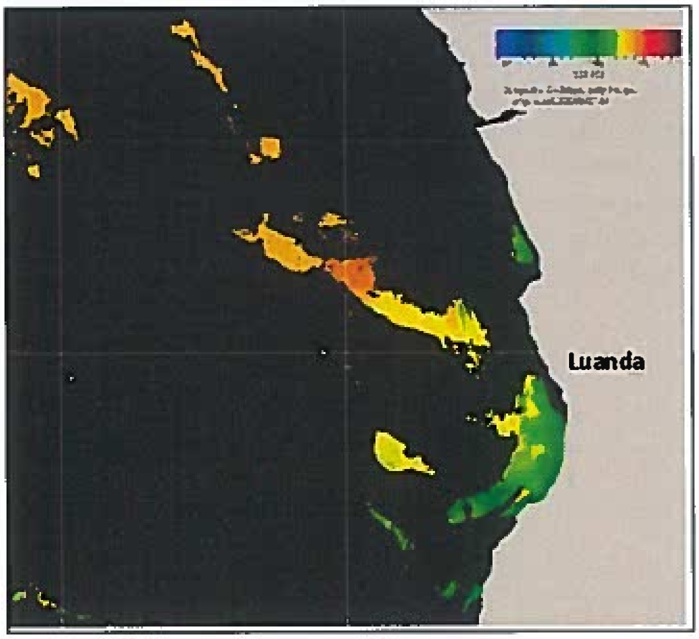



**Figure 4-20: Sea surface temperatures off the Angolan coast on 21/07/2006.**

Note the contrast between the extent of the cooler water south and north of Luanda

Source: http://www.rsmarinesa.org.za

### 4.4.7 Nutrient and Dissolved Oxygen Distributions

Surface water inorganic nutrient concentrations in Angolan continental shelf waters are low with nitrate-nitrogen and orthophosphate concentrations ranging between 0.2 and 0.5 µM/l (Van Bennekom et al. 1978, Lwandle, 2013a). Sub-thermocline waters support higher nutrient concentrations as the ultimate source waters (south Atlantic and Indian Ocean Central Water) contain nitrate, phosphate and silicate concentrations of 10-18µM/l, 0.8-1.5µM/l and 6-15µM/l respectively (Jones 1971, cited in Chapman and Shannon 1985). These concentrations may be modified by both removal and addition processes on the continental shelf (Chapman and Shannon 1985) but would remain enriched compared to the generally oligotrophic surface waters. Therefore, due to strong and relatively shallow thermoclines with high nutrient concentrations in sub-thermocline waters, any coastal or river induced upwelling can lead to large increases in nutrients in the surface (van Bennekom et al. 1978). The Congo River itself is a contributor of nutrients to the marine system, being especially high in silicate concentrations (Table 4-1).

As pointed out above, the Congo River plume induces upwelling by entrainment of subsurface water. This process effectively brings nitrates in the concentration band 10 - 15 µM/l, phosphates 1-1.2 µM/l and silicates 5 - 7 µM/l to the surface layers. From this and the data in Table 4-1 it can be seen that upwelling is important for nitrates but is less so for silicates as the river outflow itself is the major provider (van Bennekom et al. 1978, Vangriesheim et al 2009). Water samples taken just outside the Congo River mouth and up to 5 km south of the mouth suggest that ammonium of up to 5 - 10 µM/l would become available under upwelling conditions (CSIR, 2003b; Hinrichsen and Simpson, 2004a,b).

**Table 4-1: Average concentrations of dissolved nutrients (µM/l) in the Congo River in 1976 and 1978.**

| Year | $PO_4$-P | $NO_3$-N | $NO_2$-N | $NH_4^+$-N | $H_4SiO_4$ |
|---|---|---|---|---|---|
| 1976 | 0,72 | 7,3 | 0,28 | 0,4 | 161 |
| 1978 | 0,89 | 5,9 | 0,10 | 0,5 | 171 |

Source: van Bennekom et al. 1978

The actual distribution of the plant nutrients in the Congo River plume appears to be controlled more by physical mixing process than by take-up by phytoplankton (van Bennekom et al. 1978; Cadee, 1978, Vangriesheim et al. 2009). Thus in the mixing process, in the initial stages in any case, the plant nutrients appear to behave as conservative variables; e.g. silicate is linearly diluted up to 25 - 30 psu (approximately equivalent to ppt), and nitrate can behave linearly up to 30 psu but may, on occasion, have a maximum at 25 psu. This accords with mixing with subsurface seawater (van Bennekom et al. 1978). Phosphates generally follow the same trend but may deviate due to the incorporation of 'extra' phosphate from suspended material in the river plume and the maintenance of solubility equilibria (van Bennekom et al. 1978).

Offshore of the 25 psu contour, nitrate and phosphorus concentrations decline with increasing salinity. This is due to take-up by the developing phytoplankton in the plume (Cadeé, 1978); i.e. these variables assume their general non-conservative behaviour patterns in seawater at this point and nitrates, specifically, become limiting for phytoplankton growth. The distribution and behaviour of oxygen parallels that of the nutrients. Oxygen saturation levels in the Congo River are 115 - 147% which is attributed to physical processes (van Bennekom et al. 1978). Oxygen concentrations at subsurface depths are low and the combination with the river water leads to variable concentrations in the surface. Oxygen in the canyon is negligible, due to remineralisation processes (van Bennekom et al. 1978), and reducing conditions occur there.

In the open ocean dissolved oxygen decreases with depth from values near saturation at the surface to relatively low values at an oxygen minimum, which lies at an intermediate depth (300 – 600 m). In coastal upwelling systems such as the Benguela Current the oxygen minimum rises towards the coast. Bubnov (1972) showed three distinct classes of vertical oxygen distribution off Angola and in the northern Benguela region:

- The continental shelf where the oxygen content decreases with depth to a minimum in the bottom layer;
- The open ocean where a single oxygen minimum (typically 1 mg/litre) exists at intermediate depth (300 – 600 m); and
- A dual minimum situation where a second (subsurface) minimum (1 – 2 mg/litre) exists at 100 – 200 m depth overlying the main minimum.

The conditions in Block 15/06 would appear to be those described under the second bullet as evident in the dissolved oxygen sections shown in Figure 4-21 and Figure 4-22. Oxygen concentrations can be variable over a range of time scales with Figure 4-23 providing an example of this measured at the East Hub site. The survey period was three weeks showing that there can be marked variations extending throughout the upper water column.

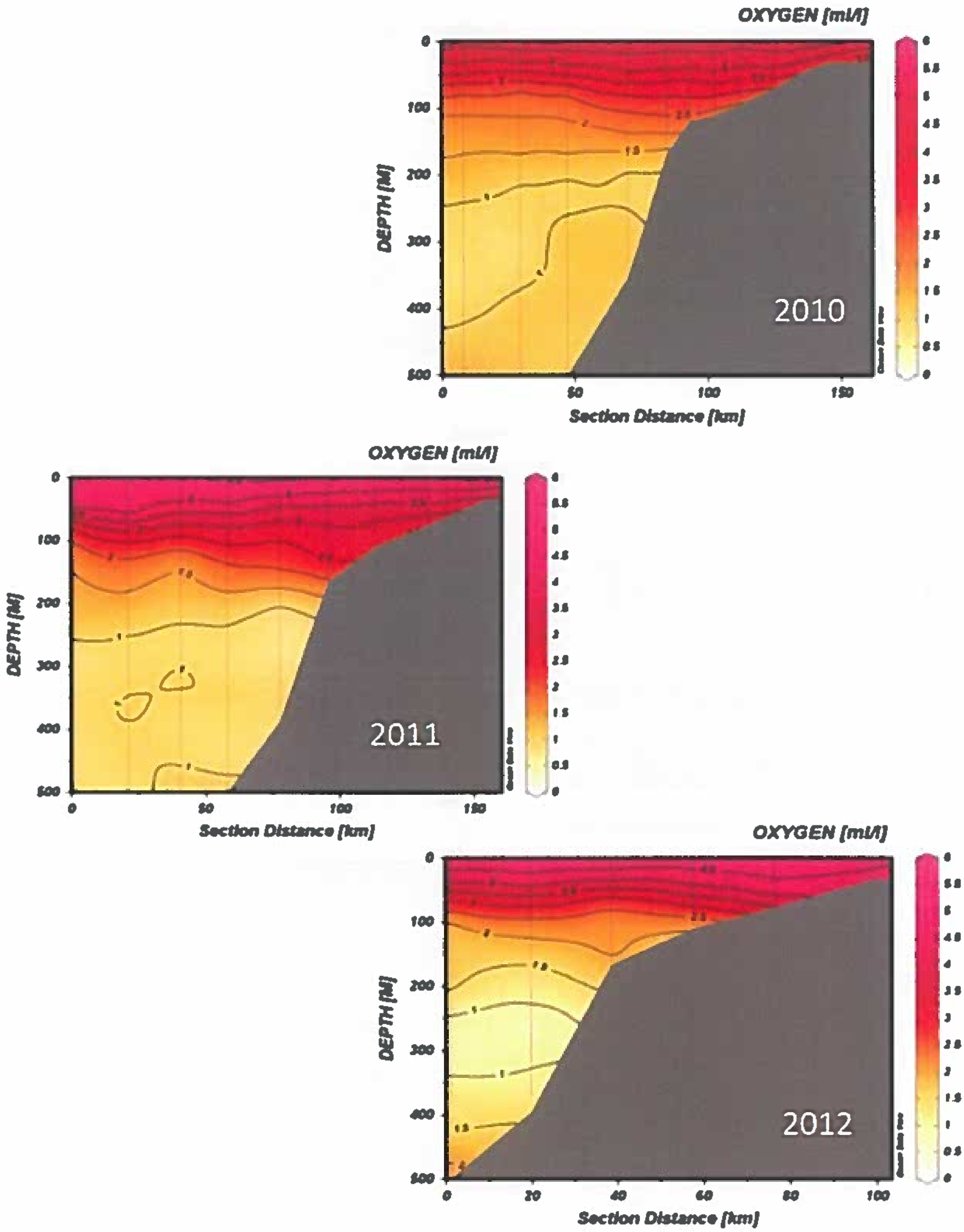



**Figure 4-21: Vertical sections showing dissolved oxygen distributions with depths and distance offshore in Block 15 in the wet season.**

Source: INIP, 2013a

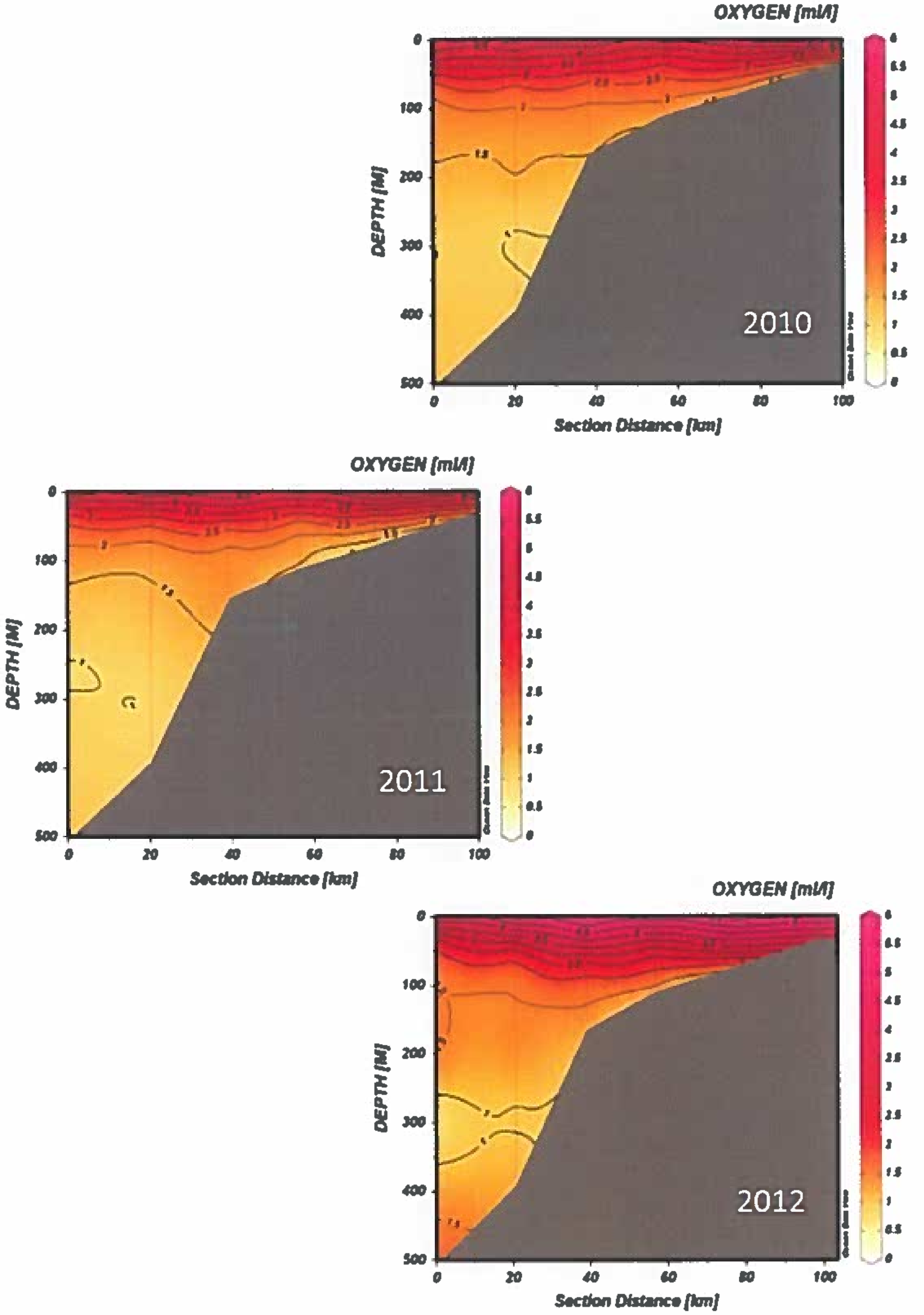



**Figure 4-22: Vertical sections showing dissolved oxygen distributions with depths and distance offshore in Block 15 in the dry seasons.**

Source: INIP, 2013a

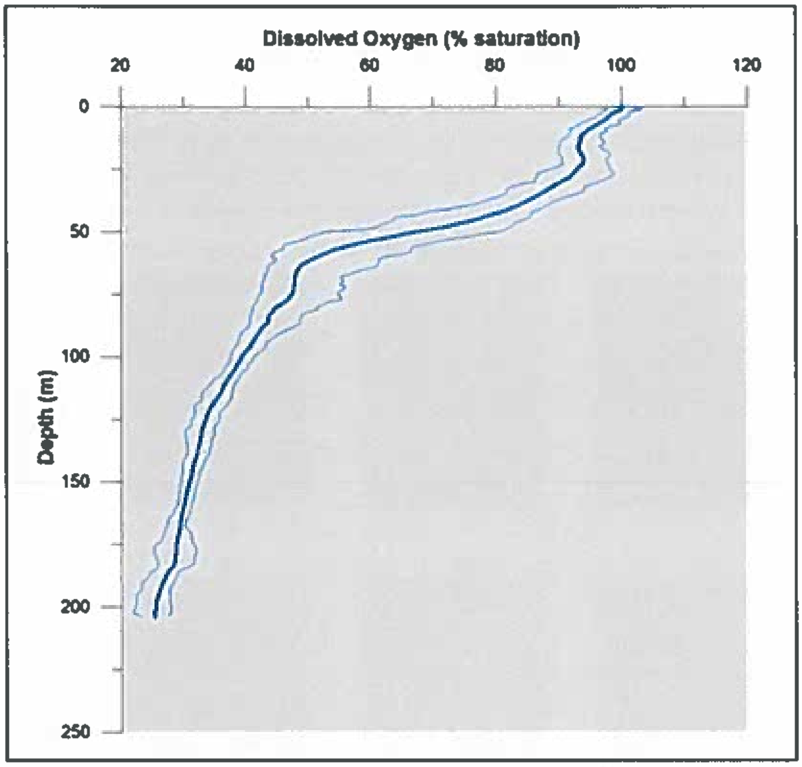



**Figure 4-23: Dissolved oxygen distributions in the upper water column in the East Hub are measured in December 2012 and January 2013.**

The thick blue line shows the mean profile and the thin lines the 5th and 95th percentiles of the measurements.

Source: Lwandle, 2013a

Dissolved oxygen measurements in Block 15 reported by INIP (2013a) show ranges between 1.0 and 5.5 ml/l (approximately equivalent to _14-77% saturation), lower than that evident for the surface layers of the water column in Figure 4-23.

Existing data do not allow a determination of whether the low oxygen water (dissolved oxygen concentrations in the range 2.0ml/l – 0.1ml/l, 2.8 mg/l-0.14 mg/l) that is a perennial feature of the southern Angola and northern Namibia continental shelf sub-thermocline water (Chapman and Shannon 1985) penetrates to the northern Angola continental shelf.

## 4.5 Biological Oceanography

Life in the ocean is discussed primarily because the behaviour and health of elements of biological systems could be affected by physical and chemical changes produced by the proposed development and operation of the East Hub oil fields.

### 4.5.1 Plankton

Plankton research in the study area has focused on the major hydrographic features. The Block 15/06 East Hub project area falls within areas investigated by INIP as part of its national oceanographic and fisheries surveys and INIP (2013a) summarises the distributions of the main biological communities here. Cadee (1978) investigated phytoplankton distribution and Drits et al. (1992) that of *Pyrosoma* in the Congo River plume. More recently attention has been paid to the Angola-Benguela Front region with a series of publications on zoo- and ichthyoplankton dynamics in this zone (Richardson et al. 2001, Verheye et al. 2005, Auel et al. 2005 and Ekau and Verheye 2005). This focused research is augmented by broader scale remotely sensed phytoplankton biomass distributions available from http://www.rsmarinesa.org.za, and investigations into zooplankton distributions off Angola (and Namibia), specifically Postel et al. (2007).

In general **Phytoplankton** distribution off the Angolan coast is variable and mainly associated with the discontinuous upwelling processes. Examples of phytoplankton biomass (as chlorophyll a) distributions for the west coast of southern Africa are shown in Figure 4-24.

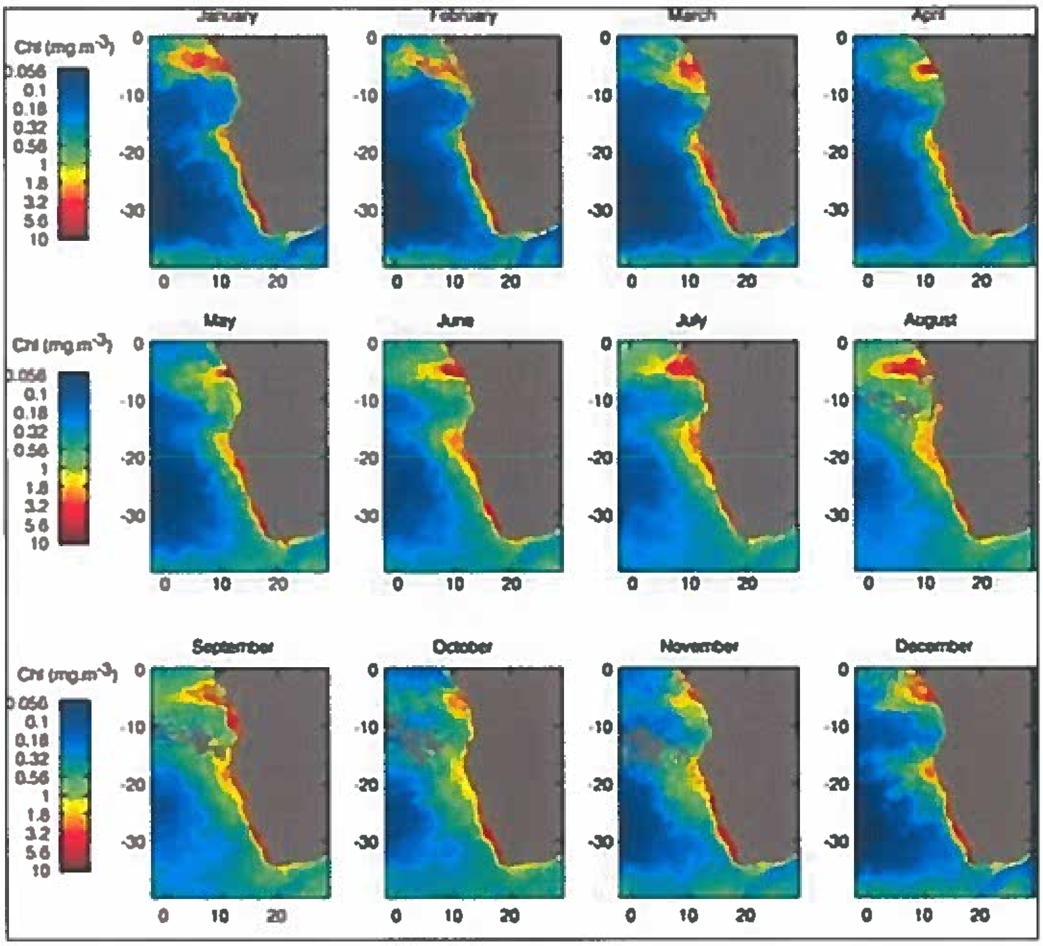



**Figure 4-24: Satellite images of monthly mean phytoplankton biomass in surface waters off Angola.**

Source: http://www.rsmarinesa.org.za

The figure shows that relatively high levels of phytoplankton occur adjacent to the Angolan coast in all seasons, though somewhat reduced during the austral summer. It is notable that phytoplankton blooms are best developed off northern Angola, which is probably linked to dynamic upwelling associated with the Congo River outflow (e.g. Wolanski 1992).

Phytoplankton distributions in Block 15 are shown in Figure 4-25 and Figure 4-26.

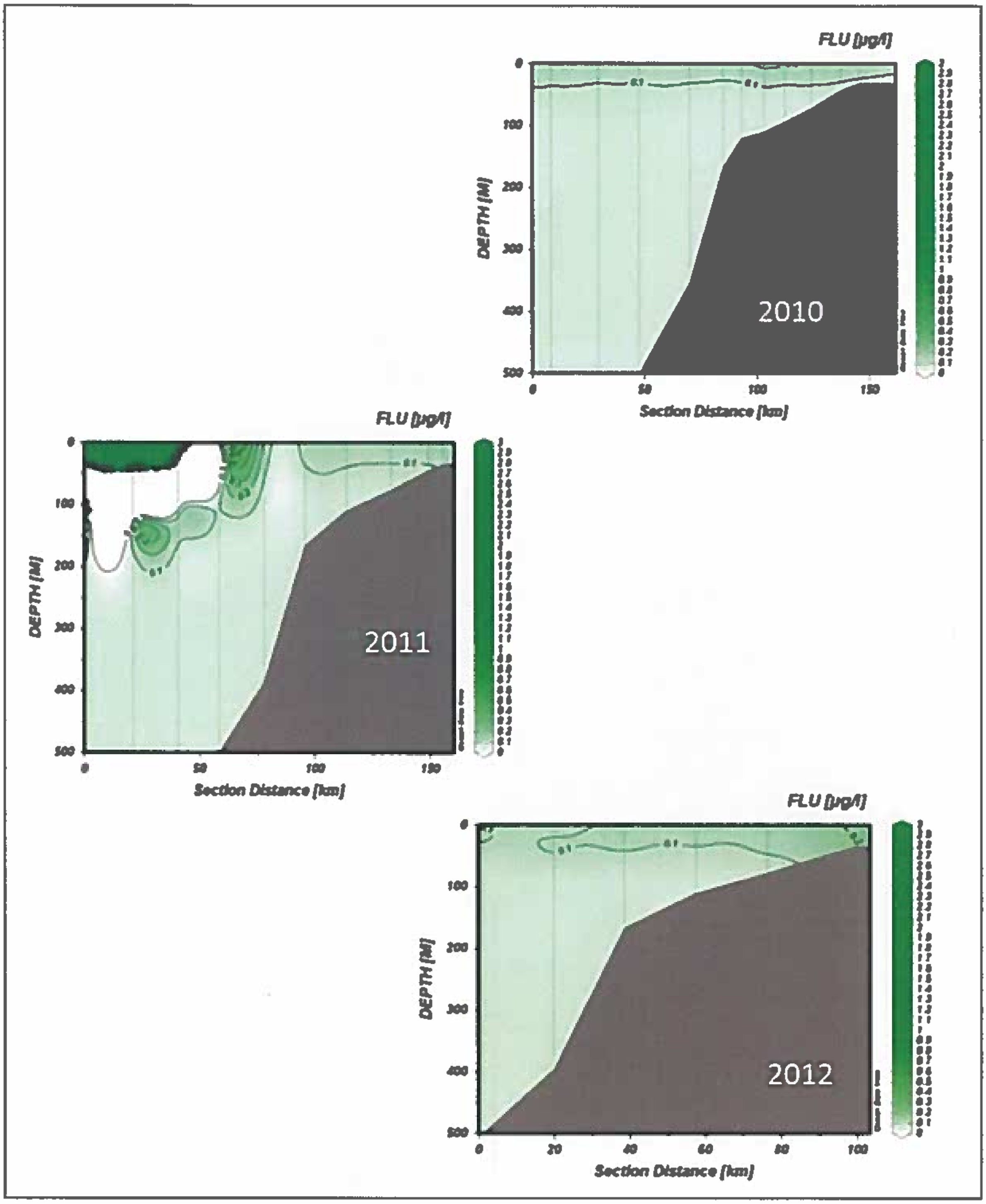



**Figure 4-25: Vertical sections showing chlorophyll fluorescence (= Chla) distributions with depths and distance offshore in Block 15 in the wet season.**

Source: INIP, 2013a

Concentrations in the upper water column can be high in either season. In the section measured in the 2011 wet season highest phytoplankton biomasses were observed offshore. The dry season sections (Figure 4-26) show biomass peaks close to the coastal margin which is considered to be indicative of coastal upwelling.

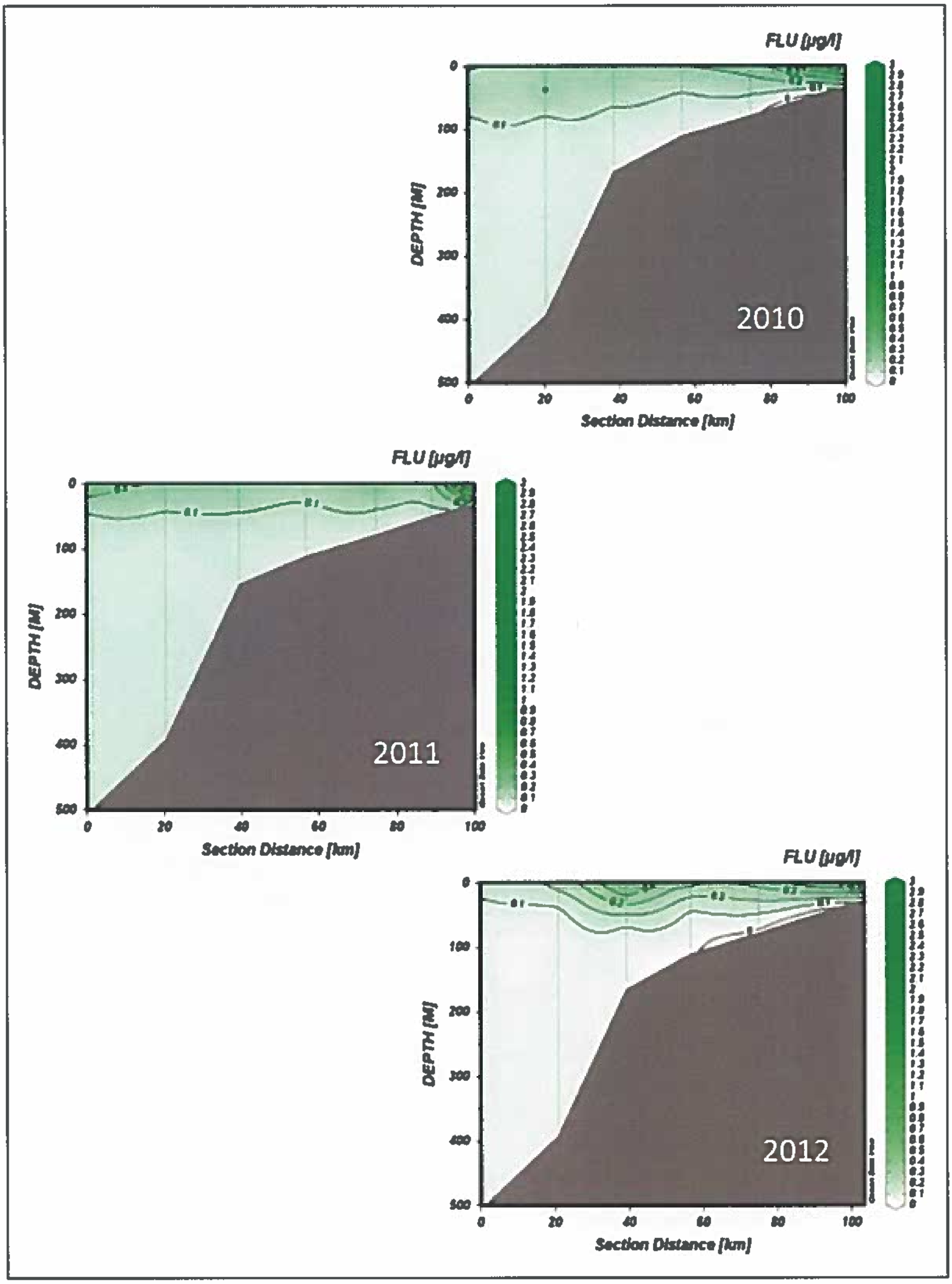



**Figure 4-26: Vertical sections showing chlorophyll fluorescence (= Chla) distributions with depths and distance offshore in Block 15 in the dry season.**

Source: INIP, 2013a

Figure 4-27 shows upper water column phytoplankton cell counts recorded by INIP (2013a) in Block 15. The biomass peak was located above 20 m with a secondary maximum at 30-50 m depth. This distribution is approximately in agreement with phytoplankton cell count data of Silva et al. (2006) who showed that, in the region, phytoplankton cell counts were highest at 10-20 m depths compared to depth strata above this (0-10 m) and below (20-30, 30-50 and 50-75 m).

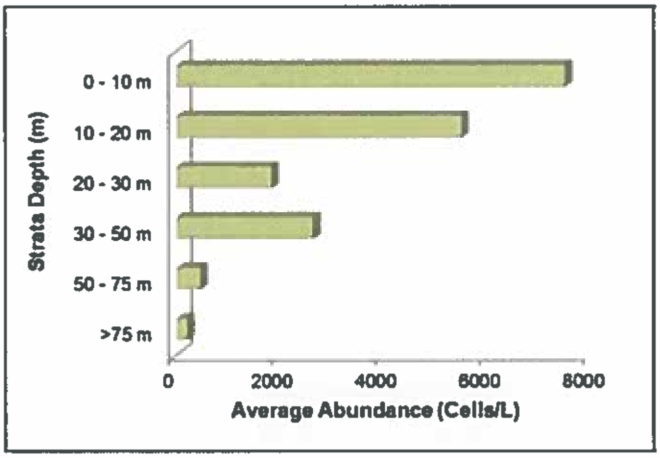



**Figure 4-27: Vertical distribution of phytoplankton biomass in the upper water column in Block 15.**

Source: INIP, 2013a

There are few taxonomic studies on phytoplankton but Silva (1955, cited in Shannon and Pillar, 1986) and Silva et al. (2006) recorded mostly diatom species in the study area with few dinoflaggelates. The broad taxonomic numerical splits recorded for Angolan waters by the latter were diatoms comprising 53%, dinoflagellates 23%, flagellates 17% and cyanophyceae (blue-green algae) 7%. In this the flora was similar to neritic waters south of the Angola-Benguela Front.

Recent data for the Block 15 project area show that, dissimilar to the above, blue-green algae (Cyanophycaea) and diatoms formed co-dominants with dinoflagellates and flagellates comprising low proportions in the phytoplankton community (Figure 4-28). However, the phytoplankton community in the project area can be expected to be variable in community composition. Survey data for Block 19 to the south of Block 15 show that, during 2004, 2008, 2009 and 2010 the phytoplankton was dominated by diatoms and dinoflagellates but that dinoflaggelates and blue-greens were dominant over diatoms in 2011 and that blue-greens absolutely dominated the phytoplankton assemblage in 2012 (INIP 2013b).

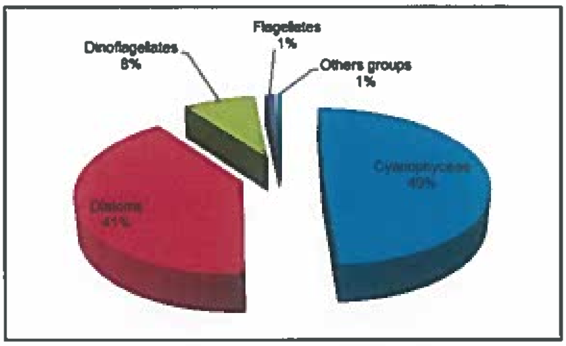



**Figure 4-28: Phytoplankton community composition measured in Block 15.**

Source: INIP, 2013a

The main conclusion from the above is that the phytoplankton community in the East Hub project area in Block 15/06, and probably elsewhere off Angola, is variable in taxonomic composition and biomass.

The **mesozooplankton** in the vicinity of the East Hub project area within Block 15 is taxonomically diverse with seven zooplankton groups being represented in 2011 and eleven in 2012 (Figure 4-29). Thus, as can be expected from the demonstrated variability in the phytoplankton zoopklankton varies over at least annual time scales and very likely shorter time periods linked to phytoplankton productivity. The presence of fish eggs and larvae in the 2012 data implies that Block 15 may be important for fish spawning.

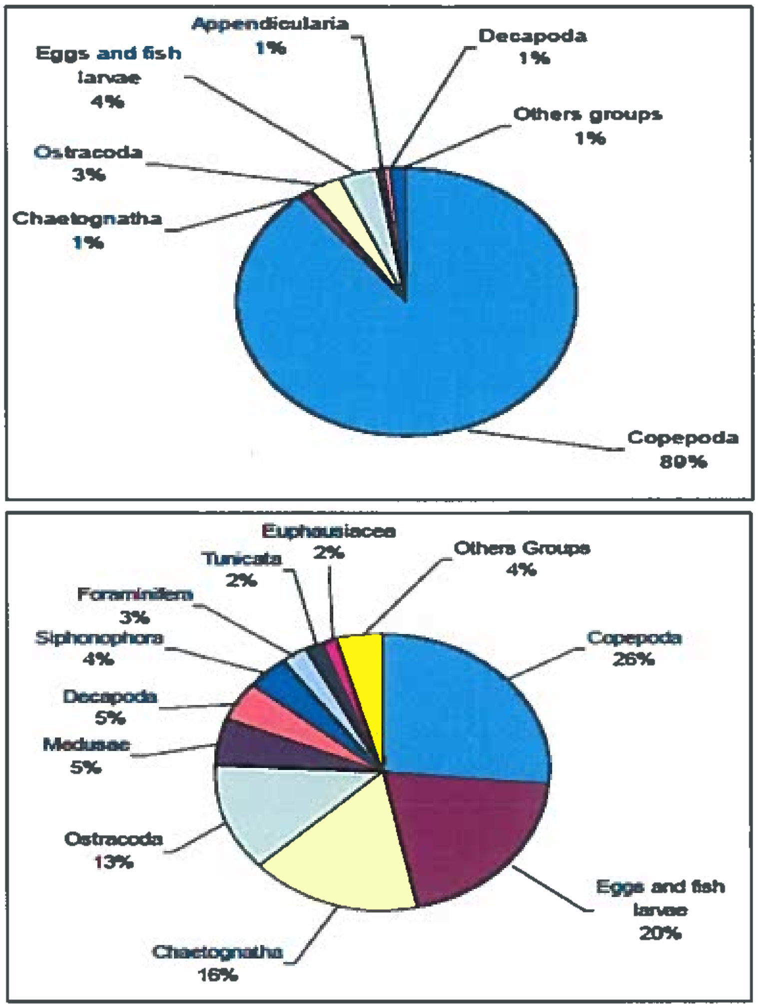



**Figure 4-29: Mesozooplankton community composition measured in Block 15 in 2011 and 2012.**
Source: INIP, 2013a

Estimates of zooplankton biomass in the Angola Current region between Luanda in the north and the Angola/Benguela Frontal Zone range between 2.439 and 4.522 g ash free dry weight (AFDW)/m$^2$ (Postel et al. 2009). These align with other estimates for the region cited by the authors. Biomass distributions in the region derived by Postel et al. (2007) show high levels (20-60 mg/m$^3$ AFDW in the surface layers (0-25 m), with these declining to 5-10 mg/m$^3$ in the 25-75 m depth range and ~1 mg/m$^3$ between 75 m and 200 m. According to acoustic signatures the distribution of biomass (as AFDW) in zooplankton larger than 1 000 µm was uniform across crustaceans (mainly copepoda), gelatinous forms, siphonophora, elastic shelled organisms (e.g. pteropods), thaliaceans, fish eggs and larvae and protozoans. In the 200-500 µm sized organisms crustaceans dominated contributing 78% of the measured biomass.

Diurnal vertical migration was noted by Postel et al. (2007) with bulk of the zooplankton biomass being located in the surface layers (<75 m depth) during nightime compared to daylight hours when the biomass more dispersed throughout the 500 m water column sampled.

**Ichthyoplankton** distributions (eggs and larvae of fish) are poorly known (or not reported) in Angolan waters but sardine *Sardinops sagax*, sardinella *Sardinella aurita*, anchovy *Engraulis encrasicolus*, horse mackerel *Trachurus trachurus capensis* and hake *Merluccius* sp. eggs and larvae occur in the area of the Angola-Benguela Front in addition to mesopelagic species. Sardinella (*S. aurita* and *S. eba* (= *maderensis*)) juveniles and immatures may be widely distributed on the Angolan continental shelf (Wysokinski 1986, INIP 2013a & b) and it is probable that these species will be important components of the ichthyoplankton in the East Hub project area along with Kunene horse mackerel *Trachurus trecae*.

## 4.5.2 Benthic Fauna

### 4.5.2.1 Soft sediments

INIP (2013a) surveyed benthic macrofauna in Block 15 and showed that, in agreement with other surveys in the region (e.g. Lwandle 2013a, b, 2012, and ERM 2005), polychaeta and crustacea dominated in terms of proportional abundance followed by echinoderms (Figure 4-30). Benthos abundances ranged from approximately 50 to >300 specimens per metre squared of seafloor (Figure 4-31) with the main determinant of this being polychaete abundance (Figure 4-32). Their station 10 lies closest to the East Hub development area and it is notable that this location exhibits lowest benthos abundance. This is largely in agreement with the Lwandle (2013a) results and those reported by ERM (2005) for Block 18. It is considered to be probable that the physical properties of the sediments in the East Hub project area are not conducive to the development of a rich macrobenthos community due to the unconsolidated muds overlying denser, more consolidated clay material.

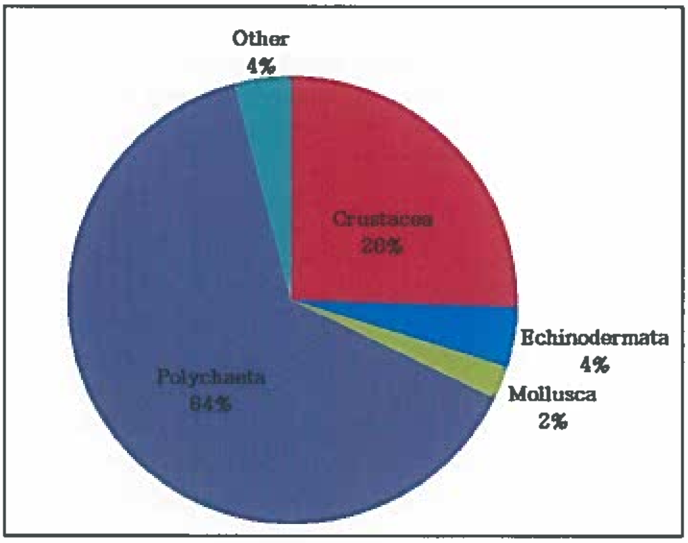



**Figure 4-30: Soft sediment benthic macrofauna community composition in Block 15.**
Source: INIP, 2013a

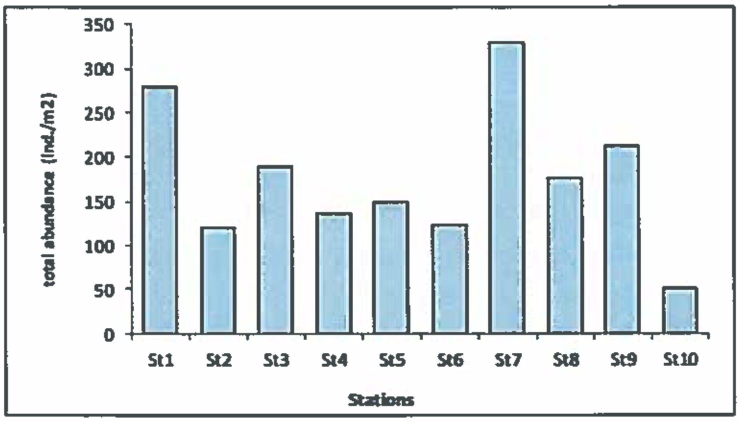



**Figure 4-31: Distribution of benthic macrofauna abundance across a sampling transect extending offshore to approximately 500 m depth in Block 15.**

Source: INIP, 2013a

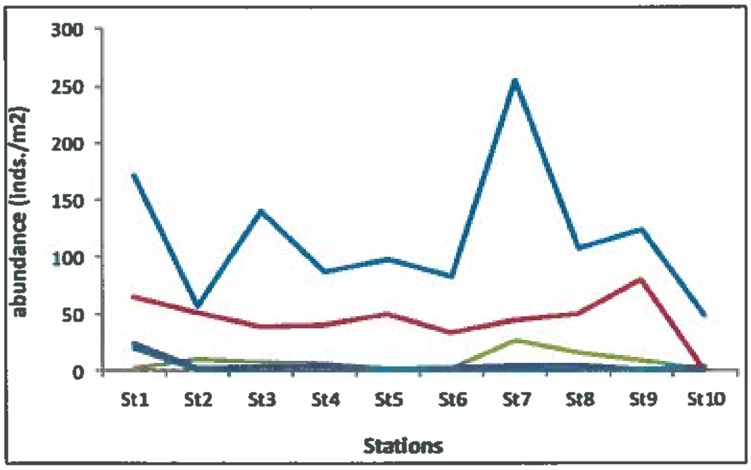



**Figure 4-32: Distribution of the major benthic macrofauna classes across a sampling transect extending offshore to approximately 500 m depth in Block 15.**

The blue line represents polychaetes, red crustacea, green echinoderms, purple molluscs and turquoise 'others'.

Source: INIP, 2013a

Other surveys in the region have also shown that the benthos is dominated by polychaetes (~55% of total species) followed by arthropods (crustaceans, ~23%), molluscs (~14%) and echinoderms (~3%) (ERM 2005, Sogreah-Magelis, 2005). It must be noted that, although 141 benthos taxa have been listed for the area (Appendix B), only 25% of these have been identified to species level and 46% to genus level. The remaining 29% have not been identified further than family and, in some cases, order or even phylum level. This is attributed to the fact that west African fauna are poorly known, e.g. it has been estimated that up to 70% of the fauna on the deeper continental shelf and slope areas are undescribed for the region (R. Bamber, British Natural History Museum, pers. comm.).

Distribution data for the fauna that have been identified to species level (available through SMEBD 2009) indicate that these have wide distributions; typically occurring in the North Atlantic or on the continental shelf of South America. Some species have wider distributions extending to Mozambique and China in the Indo-Pacific region. Thus the small component of the fauna identified to species level does not indicate a unique Angola/tropical west Africa faunal assemblage. However, this does not prove that there is no such assemblage as ~75% of the taxa are not classified to the required level.

Investigations into benthos species richness gradients in continental shelf sediments of the eastern Atlantic Ocean show that the areas spanning the equator from 15°N to 15°S are relatively uniform in terms of this metric (Macpherson 2002). Further, distributional investigations into marine benthic fauna of the Atlantic coast of Africa have revealed that drastic faunistic changes occur at Cape Blanc in Mauritania (20°50'N) and Cape Frio in Northern Namibia, near the Angolan border (18°30'S). These changes are correlated with the biogeographic barriers of the thermal fronts associated with the permanent upwelling regions north of Cape Blanc (Canary region) and south of Cape Frio (Benguela region) respectively. The tropical West African region, characterized by a specific marine fauna, is considered to be situated between these two limits (John and Lawson, 1991, Le Lœuff and von Cosel, 1998). According to these factors it is expected that the zoo-benthos in the overall region of the northern Angola continental shelf will be fairly homogenous in terms of species distribution. It does not appear to be especially distinct from other areas of the tropical West African coast or unique in its benthic fauna assemblage. Also, and similar to other continental shelf environments, governing factors determining benthic faunal composition will include sediment granulometry, water depth, and biogeochemical variables such as dissolved oxygen concentrations and sediment redox state.

#### 4.5.2.2 Deep reef fauna

Detailed bathymetric surveys and ROV inspections have revealed the presence of deep, cold water coral reef systems on the edge of the continental shelf (400 m depth) at 7° 30' S, 12° 40' E (Le Guilloux et al. 2009) south of Block 15/06. Given that Bianchi (1992) recovered unidentified hard corals in demersal trawls on the continental shelf and slope it is probable that such reefs have a broad, but patchy, distribution off Angola. Other 'hard ground' features in the region include tar mounds (Gardline, 2009) and emergent salt diapirs (e.g. ERM 2005) that extend at least to ~1 500 m depths, if not deeper. Pock marks and cold seeps are ubiquitous features in the deeper water areas of the region (1 000-5 000 m) and may have carbonate concretions associated with them (e.g. Olu et al. 2010).

The cold water corals reefs are three dimensional structures formed by mainly the scleractinian corals *Lophelia petusa* and, to a lesser extent, *Madrepora oculata*. The reefs mapped by Le Guilloux et al. (2009) comprised individual linear reefs of ~1 000 m by ~300 m in an area of 6 km x 2 km. Reef associated sedentary fauna include the glass sponge (*Aphrocallistes* sp.), gorgonians and echinoderms (mainly Echinothuridae). Le Guilloux et al. (2009) recorded 16 fish species directly or indirectly associated with the deep water coral reefs. Zoarcidae (pouts and eelpouts) and Macrouridae (grenadiers) were closely associated with the coral reef structures while eels, coffin fish, bat fish, angler and cod/codling were observed to be abundant on transitional reefs and in proximity to the reefs.

Tar mounds on the Angola margin support echinoderms, molluscs, crustacea, cnidarians and sponges. Included in the cnidarians are black corals (antipatharians) which are known to be long-lived (CORIS 2012). Fish associated with the tar mounds include spider fish, eel/eel pouts, halosaurs, slickhead, grenadier and angler. It is probable that fish observed on cold water coral reefs will also utilise tar mounds as foraging and/or refuge areas (d'Onghia et al. 2012).

Cold water seeps support microbial communities, microbial-symbiont bearing foundation species and associated heterotrophic species (Cordes et al. 2009). They thus represent biodiversity 'hotspots' that are typically patchy in distribution although they are widespread in both the western and eastern Atlantic (e.g. Olu et al. 2010). Important symbiont macrofauna include bivalve molluscs Mytilidae and Vesicomyidae and Siboglinidae polychaetes (Olu et al. 2007). These taxa are trophically dependent on methane (Mytilidae) and sulphide (Vesicomuidae, Siboglinidae). Heterotrophic organisms include alvinocaridean shrimps and galatheid crabs, amongst other organisms (Cordes et al. 2009). All of these fauna have wide distributions in the margins of the Atlantic Ocean at least, if not globally, and have adopted larval dispersal strategies to facilitate such distributions. Therefore, although important biodiversity resources in themselves seep structures do not appear to host many regionally endemic taxa.

### 4.5.3 Fish

The important groups of fish that occur in the region are those that support the industrial, semi-industrial, and artisanal fisheries. These are divided into pelagic and demersal fish, and crustaceans (shrimps (prawns) and crabs) as indicated in Table 4-2.

**Table 4-2: Species and species groups forming important components of Angolan continental shelf fisheries.**

| **Pelagic Species/species groups** | |
|---|---|
| Clupeids | *Sardinella aurita, S. maderensis* |
| Carangids | *Trachurus trecae, T. Trachurus capensis (rarely)* |
| Big eye grunt | *Brachydeuterus auritus* |
| Hairtails | *Trichiurus sp* |
| Barracudas | *Sphyraena sp* |
| Scombrids | *Skipjack tuna, Albacore, Yellow fin tuna, Big eye tuna, Sword fish* |
| **Demersal species/species groups** | |
| Sparidae | *Dentex Spp, Pagellus spp* |
| Croakers | *Sciaenidae:Pseudolithus spp* |
| Grunts | *Haemulidae: Pomadasys spp* |
| Groupers | *Epinephelus Spp* |
| Hakes | *Merluccius polli* |
| **Invertebrates** | |
| Deep sea rose shrimp | *Parapenaeus longirostris* |
| Striped red shrimp | *Aristeus varidens* |
| Red crab | *Chaceon maritae* |

Sources: INIP 2007 and FAO 1999

Distributions of these species groups on the continental shelf in relation to the East Hub are illustrated in Figure 4-33 to Figure 4-35. These figures show that the East Hub development area is largely offshore of the main fish distributions and fishing areas, with the exceptions that the:

- Eastern area, where the FPSO would be located, is in depths that overlap the western edge of the crustacean distribution (particularly of the Striped red prawn/shrimp (*Aristeus varidens)*; and
- Western drilling centres would fall within the area of directed fishing effort for large pelagic species, which is largely between 500-1000 m depths but tails off in the Congo River canyon area.

Other species that occur in the deeper areas of the continental shelf and slope include squid, shrimp, crab and cardinals (*Synagrops microlepis)*.

The large pelagic species important in the area are yellowfin tuna (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*) and albacore (*T. alalunga*) (INIP 2006). These species migrate through the region between spawning and feeding grounds being most common in early summer. All of the tunas have wide distributions (Shannon et al. in Payne and Crawford 1989).

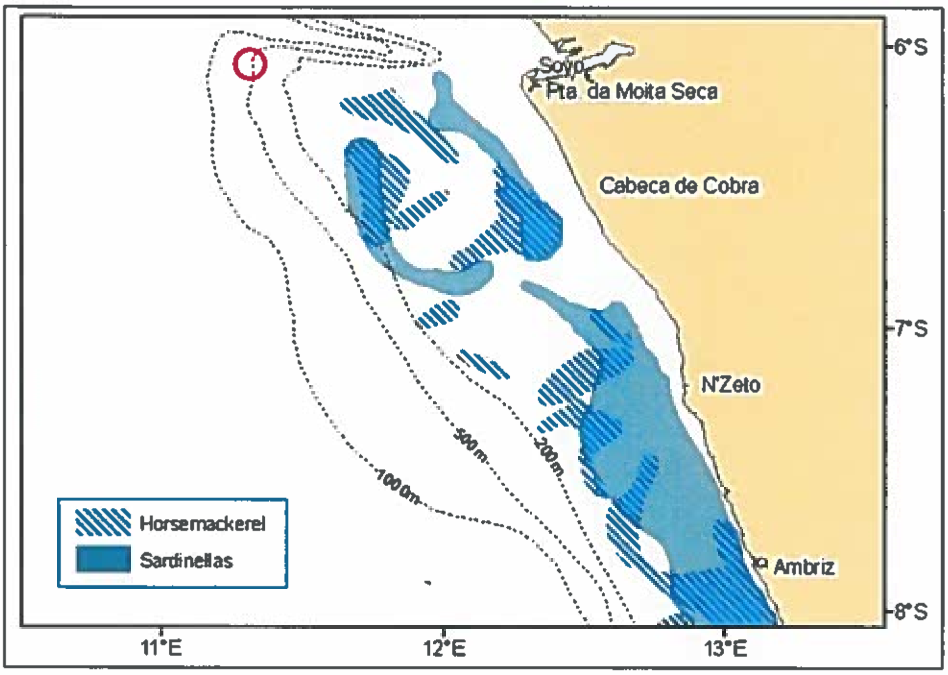



**Figure 4-33: Distribution of small pelagic sardinellas and horse mackerel in relation to the East Hub development area in Block 15/06.**

Source: Fish plot provided by Capricorn Fishing cc

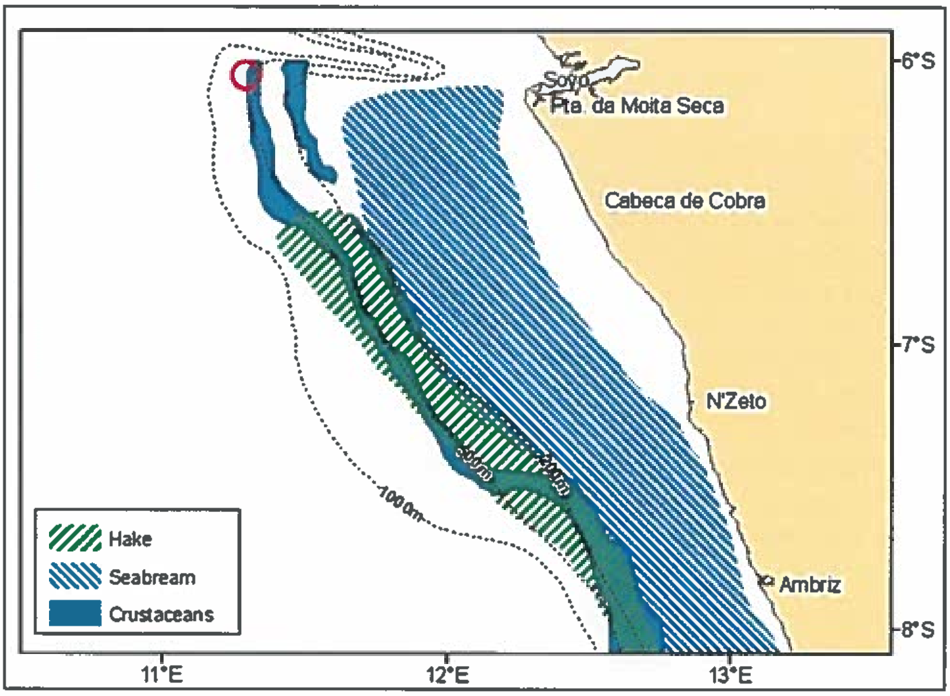



**Figure 4-34: Distribution of demersal seabreams (mainly Dentex), Benguela hake and crustaceans (e.g. deepwater prawns) in Northern Angola, in relation to the East Hub development area in Block 15/06.**

Source: Fish plot provided by Capricorn Fishing cc

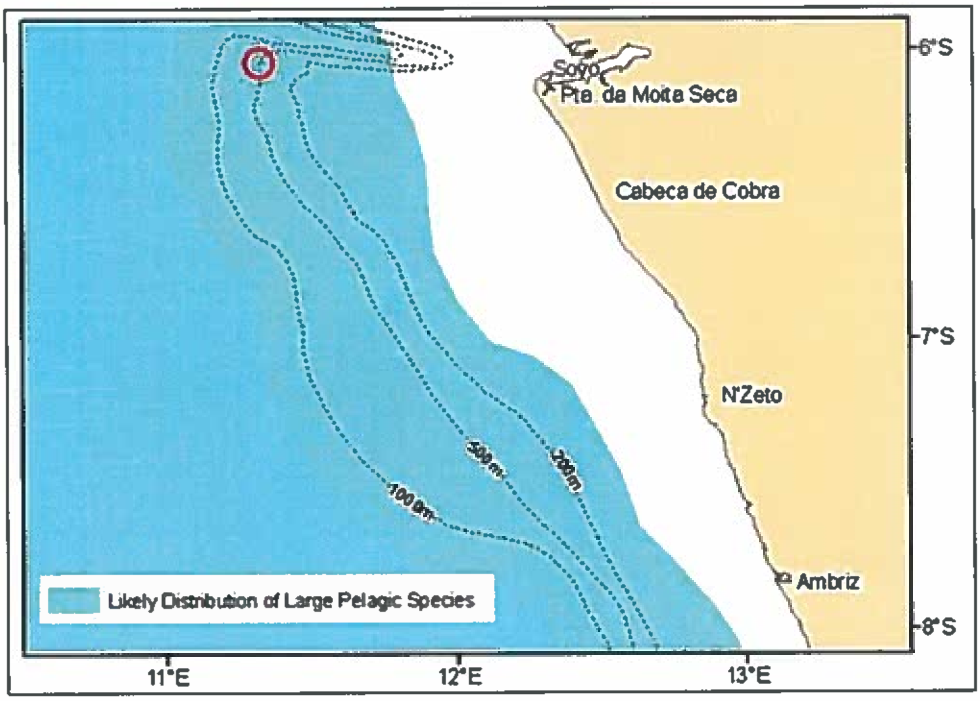



**Figure 4-35: Distribution of large pelagic species (Tuna) in relation to the East Hub development area in Block 15/06.**

The directed fishing effort is largely between 500-1000 m depths but tails off in the Congo river canyon area.

Source: Fish plot provided by Capricorn Fishing cc

### 4.5.4 Birds

CSIR (2003a) compiled an 'expected occurrence' bird list for the central Angolan coast and continental shelf areas identifying 22 species that may be found in the area. Actual counts that have been made in the area over the recent past have revealed the presence of 38 species (Table 4-3). There is large variability between the two data sets summarised in this table. This is attributed to natural variability in the species distributions and differing temporal and spatial coverage between the surveys from which the data sets have been compiled. For instance the Weir (2010) surveys were almost exclusively conducted on and offshore of the continental shelf break north of Luanda whilst the INIP (2006) survey extended well to the south of Lobito and covered inshore areas. Hence this survey recorded Cape gannets and Cape and white-breasted cormorants, species common in the extreme south of Angola and throughout Namibia and the western coast of South Africa, whilst the Weir (2010) surveys did not. Conversely, Weir (2010) recorded tropicbirds and boobys, although not in great numbers, which are species known to occur in the Gulf of Guinea and northwards, whilst INIP (2006) did not.

Apart from tropicbirds and booby all of the species listed in Table 4-3 have wide distributions in the Benguela Current system. Species that may extend into the region from the Gulf of Guinea include migrant palaearctic waders that overwinter in the extensive wetlands in countries to the north of Angola.

**Table 4-3: Seabirds observed in the study area during fishery research cruises and megafaunal observations during oil field activities.**

| Family | Species | Common name | Number (INIP 2006) | Status (Weir 2010) |
|---|---|---|---|---|
| Diomedeidae | Not differentiated | Albatross sp. | 16 | O |
| | *Thalassarche melanophris* | Black-browed albatross | 2 | - |
| | *Thalassarche chlororhynchos* | Atlantic yellow-nosed albatross | 127 | - |
| | *Thalassarche chrysostoma* | Grey-headed albatross | 1 | - |
| Procellariidae | Not differentiated | Shearwaters and Petrels | 5 | - |
| | *Macronectes giganteus* | Southern giant petrel | - | U |
| | *Bulweria bulweria* | Bulwer's petrel | - | U |
| | *Daption capense* | Cape petrel | 1396 | - |
| | *Puffinus puffinus* | Manx shearwater | 1 | O |
| | *Puffinus gravis* | Great shearwater | 10 | - |
| | *Puffinus griseus* | Sooty shearwater | 3 | R |
| | *Calonectes diomedea* | Cory's shearwater | - | F |
| | *Puffinus mauretanicus* | Balearic shearwater | - | U |
| | *Puffinus lherminieri* | Audubon's shearwater | - | U |
| Hydrobatidae | Not differentiated | Storm petrels | 648 | - |
| | *Procellaria aequinoctialis* | White-chinned petrel | 1 | U |
| | *Pterodroma mollis* | Great-winged petrel | 1567 | - |
| | *Hydrobates pelagicus* | European storm petrel | - | U |
| | *Oceanodroma leucorhoa* | Leach's storm petrel | - | R |
| | *Oceanites oceanicus* | Wilson´s storm-petrel | 26 | R |
| Phaethontidae | *Phaethon aethereus* | Red-billed tropicbird | - | U |
| Sulidae | *Morus capensis* | Cape gannet | 5106 | U |
| | *Sula leucogaster* | Brown booby | - | U |
| Phalaropodidae | *Phalaropus fulicarius* | Grey phalarope | - | U |
| Phalacrocoracidae | *Phalacrocorax capensis* | Cape cormorant | 2 | - |
| | *Phalacrocorax carbo* | White-breasted cormorant | 1 | - |
| Stercoraridae | Not differentiated | skuas | 1 | - |
| | *Stercorarius pomarinus* | Pomarine skua | 36 | R |
| | *Stercorarius parasiticus* | Parasitic (Arctic) skua | 1 | O |
| | *Catharacta antarctica* | Brown skua | 400 | U |
| | *Stercorarius longicaudus* | Long-tailed skua | - | R |
| Laridae | *Larus cirrocephalus* | Grey-headed gull | 110 | - |
| | *Larus dominicanus* | Kelp gull | 62 | U |
| | *Larus fuscus* | Lesser black-backed gull | - | U |
| | *Larus sabini* | Sabine´s gull | 1 | R |
| Sternidae | Not differentiated | Terns | 3 | - |
| | *Sterna hirundo* | Common tern | 194 | - |
| | *Sterna maxima* | Royal tern | 2 | U |
| | *Sterna sandvicensis* | Sandwich tern | 8 | U |
| | *Chlidonias niger* | Black Tern | 5 | R |
| | *Sterna dougallii* | Roseate tern | - | U |
| | *Sterna fuscata* | Sooty tern | - | O |
| | *Anous stolidus* | Brown noddy | - | R |

Weir (2010) classed birds as uncommon (U) if observation records were <10, occasional (O) if records 11-99, regular (R) if records 100-500 and frequent (F) if records >500.

Sources: INIP, 2006, Weir 2010

## 4.5.5 Marine Mammals

### 4.5.5.1 Cetaceans

Whales and dolphins are abundant off the Angolan coast with 11 dolphin and 14 whale species confirmed present in the region. Of these, four whales are classified as threatened under the IUCN criteria (IUCN 2013), sei, blue and fin whales are considered to be endangered whilst sperm is classed as vulnerable. Of the dolphins the Atlantic humpback is classified in the threatened category being rated as vulnerable.

The majority of whales and dolphins occur in the deeper water off the coast with some also frequenting the near-shore. Whales seen in the deeper water include sperm, dwarf sperm, fin, Cuvier's beaked, killer, false killer, and melon-headed (www.ketosecology.co.uk). Whales that are likely to be seen in shallow water areas as well as deeper water include: Bryde's, humpback, killer, and short-finned pilot whale (Best 2007, Weir 2010). Atlantic humpback dolphin are generally restricted to shallow inshore areas and do enter estuaries (Best 2007).

Humpback whales migrate into the region and through it into Gabon for calving in July–October, and are often accompanied by calves during September-October but they are generally more common on the shelf break (~200 m depth, Best 2007). However, direct observation provided by Weir (2010) indicates that this species can occur from nearshore (~25 depth) to far offshore (3 800 m). Sperm whales occupy the area throughout the year, being more common during calving in January–May but only in water deeper than ~850 m (www.ketosecology.co.uk). Best (2007) indicates that males may be found over the continental slope (200-500 m deep) but that females are rarely found in water <1 000 m deep. Southern Right whales (*Eubalaena australis*) may also occur as this species, (plus Bryde's and Humpbacks), were landed by pirate whalers in the 1970s (Best 2007).

Observations during oil field operations immediately north and offshore of Luanda indicate that sperm and humpback whales commonly occur in the region with short-finned pilot whale, Brydes, dwarf sperm and false killer whales being an order of magnitude less abundant. Species such as fin, sei, Cuvier's beaked, killer and melon-headed whales are apparently relatively rare in the region (Weir 2010). Risso's bottlenose, rough-toothed, Atlantic spotted, striped and common dolphin are the most abundant of the dolphins that occur in offshore waters in the region (Weir 2010).

### 4.5.5.2 Manatees

The African manatee *Trichechus senegalensis* occurs in the rivers and lakes of West Africa between Senegal and the Kwanza River, Angola, most commonly in estuaries and marshes where they feed on seagrass and mangroves. They are seriously threatened and are listed as internationally endangered by the IUCN. The main potential habitats in Angola are the Congo, Chiluango, Mbridge, Loge, Dande, Bengo and Kwanza rivers. There are apparently no recent confirmed sightings of manatees in Angola although it is considered likely that there are still some individuals in the Congo River and possibly some in the Kwanza River, south of Luanda. The species is definitely present in Gabon as recent studies have found that manatee meat is routinely available in coastal markets there (WCS 2013).

Due to diet and habitat preference it is considered unlikely that manatees would be encountered in the vicinity of the proposed East Hub development area in Block 15/06, although they could be affected by oil spills encountering the coastline in countries to the north of Angola, and perhaps be encountered by service vessels travelling to/from Soyo support base.

### 4.5.6 Turtles

Five turtle species have been recorded in Angolan coastal waters: leatherback *Dermochelys coriacea*, the olive ridley *Lepidochelys olivacea*, the green *Chelonia mydas*, the loggerhead *Caretta caretta* and the hawksbill *Eretmochelys imbricata* (Carr and Carr 1991, Weir et al. 2007). Of these, only the green, olive ridley and leatherback turtles are confirmed to breed in Angola (Carr and Carr 1991, Fretey 2001). Olive ridley is the most wide-spread and regularly encountered of all the turtle species in Angola (Weir et al. 2007). It is confirmed to nest along the entire coast from Cabinda in the north to the Kunene River in the south (Hughes 1982), and high nesting densities reaching 30 crawls on a 500 m stretch of beach, have been recorded in the past (Hughes et al. 1973). Leatherback turtles nest primarily in the northern and central regions of Angola (Fretey 2001), but have also been reported to nest from Cabinda south to Baia Farta (Hughes et al. 1973, Carr and Carr 1991). Weir et al. (2007) recorded an average of 122.7 olive ridley nests and 13.3 leatherback nests per breeding season at Palmeirinhas (a protected site just south of Luanda). However both Carr and Carr (1991) and Weir et al. (2007) note that the latter species may be part of a large population that nests in southern Gabon. It is noted that Gabon is particularly important for leatherback turtles and currently supports the largest aggregation of this species in the world. Aerial surveys indicate that 15 730-41 373 females may nest in the region with important areas being Corisco Bay and the protected areas south of Port Gentil (Witt et al. 2009).

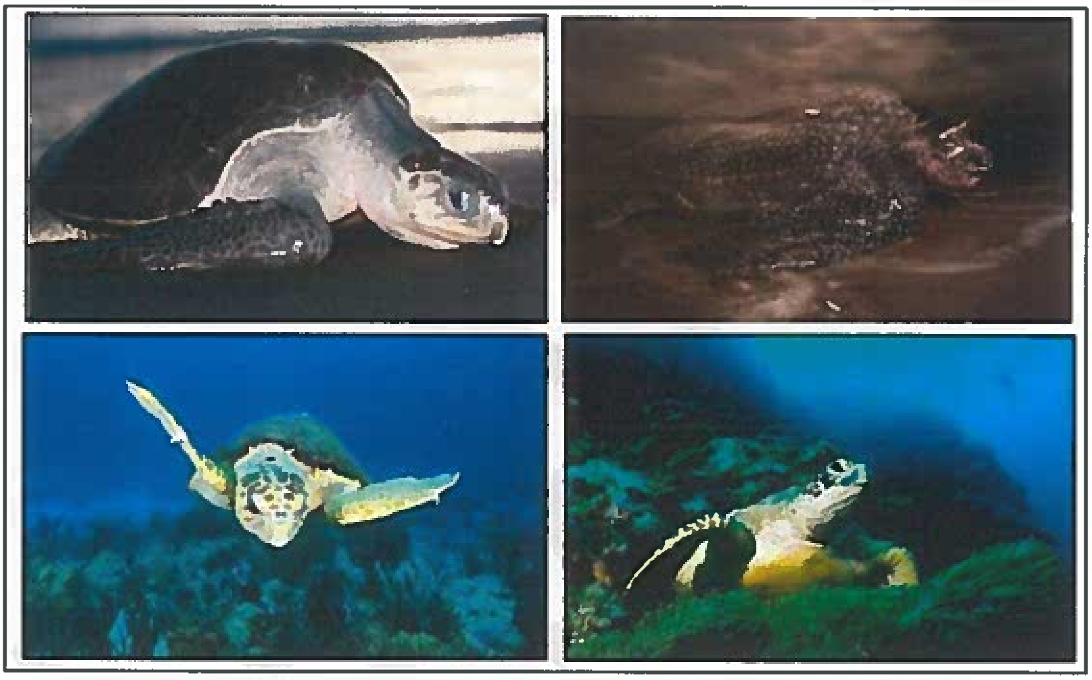


**Figure 4-36: Various turtles occurring in Angola**

Female Olive Ridley turtle Lepidochelys olivacea (top left), Leatherback turtle Dermochelys coriacea (top right), Loggerhead turtle Caretta caretta (bottom left) and a Green turtle Chelonia mydas (bottom right)

Source: http://animals.nationalgeographic.com

In Angolan waters of 82 offshore sighting records where the species could be identified 79% were olive ridley and 15% leatherback; the balance being loggerhead (5%) and green (1%) turtles (Figure 4-36). The latter species is locally common off the Kunene River mouth (personal observations Dr R Carter) and nest on Namibe Province beaches (Weir et al. 2007), with juveniles apparently foraging in Mussulo Bay, adjacent to Luanda (Carr and Carr, 1991, ERM 2005, Weir et al. 2007). Loggerheads appear to be rare in the region and Weir et al. (2007) did not record any nesting activity by this species, but apparently unpublished data exist about limited nesting activity on the northern Angolan coast. Hawksbills are similarly rare and recently have only been observed at sea (Weir et al. 2007).

All of the turtle species are widely distributed in the south eastern Atlantic and nest at least from Gabon in the north to Angola in the south. Figure 4-37 shows the known nesting sites for the region.

Turtle nesting appears to be linked to the commencement of the rainy season; the bulk of activity occurring in the period October-February although this may extend to March (Carr and Carr, 1991, Weir et al. 2007). Hatching would thus commence at the middle of this period and extend into May when juvenile turtles, with their relatively limited swimming ability could be present. In continental shelf near shore waters turtle density is highest during the breeding season (October – February) and lowest during April – September. Weir et al. (2007) reports that turtles appear to aggregate approximately 100 km offshore in the weeks immediately prior to the egg laying period and have observed olive ridley mating at sea during September.

All of the turtle species that occur in the region are classified as endangered or critically endangered (IUCN 2013). All of the populations face various threats including direct and indirect effects of fishing, hunting, egg collection, predation by jackals, genets, birds, dogs and pigs, and nest flooding and collapse. In areas where there are high levels of human habitation, e.g. beaches adjacent to Luanda, it is thought that there may be 100% nest mortality as well as a high level of hunting of mature females (Weir et al. 2007).


**Figure 4-37: Map of the turtle nesting areas on the coast from Cap Lopez in Gabon to Luanda in Angola,**

Source: compiled from Fretey (2001) and Weir et al. (2007) (background Google Earth).

Recent research has recorded alarming levels of mortality in various fishing operations, as large numbers are taken as bycatch in pelagic longline fisheries. In Angola, sea turtles are not only caught by industrial longliners but also by coastal artisanal fisheries (e.g. gill nets, beach seines and longlines, see photographs in Holisticos 2012). Most of the captured sea turtles are used for consumption and a small percentage are used commercially (carapaces and oil). No bycatch data exit for the Angolan fisheries and the level of bycatch can thus not be quantified, but it is clear that turtle bycatch is widespread in coastal fishing communities. All of the populations therefore merit especial attention in terms of conservation and reduction of anthropogenic disturbances.

## 4.6 The Coastal Environment

The coastal environment is discussed primarily because biological systems could be impacted in the event of an oil spill linked to the proposed East Hub development in Block 15/06.

### 4.6.1 Coastal Landforms

The northern Angolan coastline is largely characterized by a relatively narrow (~50 m) sandy intertidal zone which is backed by low red sandstone cliffs making coastal access difficult for large parts of the coastline. The cliffs are often severely undercut and the littoral zone may consist of boulders that have fallen from the cliffs and lie embedded in the sandy beaches. Of the ~390 km northern Angolan coastline extending from Peninsula Mussulo in the south to Soyo at the Congo River mouth, ~75% is sandy beach and ~25% rocky shore (boulder shores). An extensive cliff line lies between Lucunga River and the Congo River, extending for over 90 km, and smaller 20-35 km cliffs extend from Ponta do Musserra to N'Zeto and from Ponta Spilimberta to Ponta do Dande (Sogreah-Magelis 2005).

The Cabinda Enclave has a mainly sandy shoreline fronted in places by rocky reefs. Swamps and saltmarshes are present at the mouths of the Shiloango and Cabinda rivers.

The Republic of the Congo coastline is diverse with a mix of coastal platforms and sandy beaches backed by swampy areas, particularly in the southern half. Three major rivers, the Loeme, Kouilou and Noumbi, enter the sea on the south, central and north coast respectively.

The coast of Gabon south of Cap Lopez is very similar to that of the Republic of the Congo with mangrove and gallery forests in the vicinity of the river mouths. In Gabon, the narrow sand beaches south of Cap Lopez have been classified as moderately sensitive to pollution and exploitation, in a coastal sensitivity study by ELF (1996). The major features of these beaches are that they are high energy, high wave beaches; i.e. they will be naturally dynamic. The fish and subtidal/intertidal fauna are probably uniformly distributed and it is thus difficult to attach grades of sensitivity to these beaches. Further, human settlement and usage appears to be low.

Key features of the coastline are discussed below.

### 4.6.2 Rivers, Lagoons, Estuaries and Mangroves

#### 4.6.2.1 Lagoons, estuaries and estuaries/tidal inlets

The Gabon coast extending from Libreville in the north to Gamba in the south has a substantial number of estuary/lagoon systems, and mangroves (Gabon has a total of 1606 km$^2$ of mangrove cover (GCLME 2010)). Two extensive estuary/lagoon systems are the Ogooue River mouth and the Nkomi lagoon at the northern end of the Loango National Park.

The approximately 400 km coastline of 'Gabon Sud', south of Cap Lopez, consists of sandy beaches, which are interrupted by river mouths in several places. These may be associated with backshore lagoons which are generally shallow and brackish. Near the mouths of these systems the beach and coastal savanna form 3-10 km long narrow (<250 m-wide), nearly barren, sand spits. The sand spits are mostly situated on the southern sides of the mouths, except for the mouths of Lagune N'Komi and

Lagune Banio, where a sandy spit is also present on the northern side. The seaward side of the mouth and the mouth itself are very dynamic with strong currents, breakers and sand banks.

On the northern Angola coast there are 13 perennial rivers between the Congo River mouth and Luanda which are either permanently open to the sea or whose mouths are closed by a beach berm when the river flow is low. Of these, six have a coastal lagoon in the lower reaches (Nzombo (an example of a lagoon-like estuary, Figure 4-38), Maladi (Lagoa Muengi iá Tembe), Mbridge (Lagoa Saca & Lagoa Sangano), Sembo (Lagoa Muangalangone), Loge (Lagoa Quingombe), and Bengo rivers (Lagoa Panguila)). Lagoa Muengi iá Tembe on the Maladi River appears to be permanently isolated from the sea.


**Figure 4-38: Satellite image of the Nzombo River mouth on the northern coast of Angola.** Note the small mangrove forest at the mouth and extending southwards along a closed arm of the river. Image date 15 May 2006

Several lagoons are formed by north-south aligned sand spits (or 'restingas'), which are usually found at river mouths where high sediment levels coincide with northward long-shore drift. Restingas are dynamic in nature due to the influence of wave action, and are regarded as fragile coastal features. The largest restingas are found near Luanda between Ponta das Palmeirinhas and Baia do Bengo, while smaller ones have developed at the mouths of rivers such as the River Lucunga and River Sembo. In addition the extensive saline Lagoa Ganga (lake) lies immediately north of the town of Ambriz.

The characteristic animal of the upper sandy beaches in brackish-water habitats is the fiddler crab *Uca tangeri* which is often present in large numbers to the southernmost limit of its range in southern Angola. In muddy sand of the lower beach common animals are the polychaetes *Cirratulus filiformis, Diopatra neapolitana* and *Macroclymene monilis*. The blood cockle *Arca senilis* occurs in lagoons and is associated with other bivalves such as *Aloidis* sp. and *Tellina nyphalis*, and the whelk *Stramonita haemostoma*.

#### 4.6.2.2 Mangroves

Mangrove forests in Angola are most extensive in Cabinda and along the Congo River. They become sparser and with lower diversity further south towards Luanda as the coast becomes more arid and sea temperatures decline nearer the Angola Benguela Front. There is a transition between tropical and temperate marine flora and fauna species around Cape Santa Maria (13°27'S/12°31'E) ~800 km south of the latitude of the proposed East Hub development area in Block 15/06. Accordingly, those that occur on the Angolan coast north of Luanda, e.g. the extensive mangrove forests at the mouths of the Dande, M'Bridge and Congo, and smaller mangrove stands at river mouth/lagoon systems such as the Nzombo (Figure 4-38), are probably biologically similar.

Mangroves are biologically productive and ecologically important habitats that occur mostly at the river mouths at intervals along the northern Angolan coastline. They serve as fish nursery areas and stabilise the coast against erosional processes but are under threat from local people for firewood resulting in reduced fish landings and degradation of the coastal environment. Angola is estimated to have 700 km$^2$ of mangroves, most occurring in the more tropical northern area (north of Lobito 12°S).

The mangroves in the area of interest belong to the east Atlantic floristic zone. Three Rhizophora species are present, *Rhizophora racemosa* and *R. harrisonii* being fairly common whilst *R. mangle* occurs less frequently. Other species are *Avicennia nitida* and *Laguncularia racemosa*. The *Rhizophora* species mainly occur within the normal tidal range (mostly below mean high water), while *Avicennia* species occur relatively high in the tidal range on the inland side of the mangroves.

### 4.6.3 Intertidal Habitats and Associated Fauna

The area extending from Porto Amboim in Angola to Cap Lopez in Gabon lies in the tropical zone, in which the faunal and floral communities have more tropical affinities. It is therefore likely that the rocky shores north of Ambriz also belong to the Gulf of Guinea regime, although the frequent occurrence of low salinities from the Congo River outflow may affect and influence the distribution patterns of communities close to this river mouth. Little research has been done on the intertidal fauna of northern Angola and much of the information contained below is sourced from a 2006 survey of rocky shore habitat that extended as far north as Ambriz (Hutchings et al. 2007).

#### 4.6.3.1 Rocky Shores

In general the species composition and patterns of shore zonation surveyed between Luanda and Ambriz resemble those found in tropical countries to the north of Angola such as the Gulf of Guinea, although some differences are reported. The rocky beach is divided into the:

- Littoral fringe on the upper beach (dominated by gastropods *Echinolittorina pulchella* (=*Littorina punctata*) also with *Littorina angulifera*, which occurs on rocks and mangrove trees in the shores of estuaries);
- Upper mid-littoral, characterised by barnacles *Balanus amphitrite* and *Chthamalus dentatus* together with oysters *Saccostrea cucullata*, the limpets *Cymbula* (= *Patella*) *safiana* and *Siphonaria pectinata*, and the gastropod *Nerita senegalensis* at more exposed shores;
- Lower mid-littoral, characterised by a wide variety of algae, including *Basispora africana* a regional tropical west coast endemic. Animals found here include the brown mussel *Perna perna*, limpets (*C. safiana* and *Fissurella nubecula*), carnivorous whelks *Stramonita* (= *Thais*) *haemostoma, S. forbesi*, and *S. nodosa*, and the large barnacle *Austromegabalanus tintinnabulum*. Ranging over the entire littoral is the crab *Grapsus grapsus*, common throughout the region.

#### 4.6.3.2 Intertidal sandy beaches

The fauna of sandy beaches comprises primarily invertebrates that burrow beneath the surface with crustaceans, polychaetes and molluscs being the most conspicuous. Most burrowing invertebrates are filter-feeders (siphoning food out of water) or deposit feeders (consuming food at the surface). They provide an important food source for fish and birds. The coastline immediately south of the Congo River is predominantly of the narrow sandy beach type.

Steep and narrow sandy beaches are probably the norm along the open wave-exposed coastline of West Africa, whereas flatter and wider beaches tend to occur in bays, lagoons or estuaries where they are protected from direct wave energy.

Steep beaches with coarse sand are generally nearly devoid of biota with the ghost crab *Ocypoda hippeus* at the uppermost part and a sparse population of *Donax rugosus* clams at the low water mark. Less steep and wider (>50 m) beaches tend to have a richer fauna. The top of the beach is characterized by *O. hippeus*, the isopod *Excirolana latipes*, and the polychaete *Nerine cirratulus*. Lower down the beach the bivalve mollusc *Donax pulchella* is abundant, accompanied by amphipods (*Urothoe grimaldi* and *Pontharpinia intermedia*) and below the Donax population is the mysid *Gastrosaccus spinifer* and the mole crab *Hippa cubensis*. This structure is similar to beaches in Senegal and Sierra Leone.

### 4.6.4 Coastal birds

Inshore coastal birds include the phalaropes (Phalaropidae), gulls (Laridae) and terns (Sternidae) with terns being the most abundant group occurring along the Angolan coast with several breeding species found, including the Red Data-listed Damara tern *Sterna balaenarum*. Waders also occur in the region and can be especially numerous in and around the southern Gabon coastal wetlands. Here Schepers and Marteijn (1993) recorded 2 600-3 400 waders in their surveys of the region.

In the region in general large numbers of waterbirds associated with freshwater systems occur in the vicinity of river mouths and lagoons, e.g. herons, egrets, storks, ibises, flamingos and pelicans. Groups of birds comprising marabou stork *Leptoptilus crumeniferus*, lesser flamingo *Phoenicopterus minor*, little egret *Egretta garzetta*, grey heron *Ardea cinerea*, sacred ibis *Threskiornis aethiopicus* and vulturine fish eagle (palmnut vulture) *Gypohierax angolensis* have been observed on the beach at the mouth of the Bengo River, north of Luanda.

### 4.6.5 Coastal Conservation Areas

Figure 4-39 shows the formal conservation areas on the west African coast.


**Figure 4-39: Formal conservation areas on the west African coast in relation to the East Hub development**

1. Kissama National Park, 2. Ilha dos Passaros Integral Nature Reserve, 3. Reserve de Faune Conkouati, 4. Reserve de Faune et Domaines de Chasse de Sette Cama 5. Parc National des Mangroves

The closest conservation areas to the stretch of coast under discussion are Ilha dos Passaros Integral Nature Reserve in Mussulo Bay at Luanda, the Parc National des Mangroves on the north bank of the Congo River mouth in the Democratic Republic of Congo and Conkouati Reserve de Faune, a Transfrontier conservation area shared by Congo and Gabon. Associated with this is the Mayumba marine national park, central Africa's first such conservation area. The closest conservation area to the East Hub development is the Parc National des Mangroves. This occupies 100 000 ha of which 66 000 ha are designated a Ramsar Site (a Wetland of International Importance). Because of a number of threats to its status as a Ramsar Site, the park has been entered on the Montreux Record.

## 4.7 Threatened (IUCN Red listed) Species

IUCN (2013) red listed species which may potentially occur in the marine and coastal supra-tidal zone of Angola and which could be affected by East Hub development and operational activities and/or accidents are presented in Table 4-4.

**Table 4-4: Red Data-listed species that may occur in Angolan waters and along the coastline.**

| Species | Common name | IUCN Red List status |
|---|---|---|
| **Mammals:** | | |
| *Aonyx capensis* | African clawless otter | Least Concern |
| *Lutra maculicollis* | Spotted necked otter | Least Concern |
| *Trichechus senegalensis* | African manatee | Vulnerable |
| *Balaenoptera brydei (edeni)* | Bryde's Whale | Data Deficient |
| *Balaenoptera borealis* | Sei Whale | Endangered |
| *Balaenoptera physalus* | Fin Whale | Endangered |
| *Balaenoptera musculus* | Blue Whale | Endangered |
| *Megaptera novaeangliae* | Humpback Whale | Least Concern |
| *Physeter macrocephalus* | Sperm Whale | Vulnerable |
| *Cephalorhynchus heavisidii* | Heaviside's Dolphin | Data Deficient |
| *Sousa teuszii* | Hump-backed Dolphin | Vulnerable |
| **Turtles:** | | |
| *Caretta caretta* | Loggerhead Turtle | Endangered |
| *Chelonia mydas* | Green Turtle | Endangered |
| *Dermochelys coriacea* | Leatherback Turtle | Critically Endangered |
| *Eretmochelys imbricata* | Hawksbill Turtle | Critically Endangered |
| *Lepidochelys olivacea* | Olive ridley Turtle | Vulnerable |
| **Seabirds:** | | |
| *Sterna balaenarum* | Damara Tern | Near Threatened |
| *Phalacrocorax capensis* | Cape Cormorant | Near Threatened |
| *Charadrius pallidus* | Chestnut-banded Plover | Near Threatened |
| *Glareola nordmanni* | Black-winged Pratincole | Near Threatened |
| *Morus capensis* | Cape Gannet | Vulnerable |
| **Fish:** | | |
| *Carcharhinus leucas* | Bull Shark | Near Threatened |
| *Manta birostris* | Giant Manta Ray | Near Threatened |
| *Pteromylaeus bovinus* | Bull Ray | Data Deficient |
| *Rhynchobatus luebberti* | African Wedgefish/Lubbert's Guitarfish | Endangered |
| **Invertebrates:** | | |
| *Conus africanus* | | Vulnerable |
| *C. nobrei* | | Vulnerable |
| *C. zebroides* | | Vulnerable |

## 4.8 Offshore Activities/ Ecosystem Services

Other users of the sea in the vicinity of the East Hub development in Block 15/06 are fishing and other transport/ shipping primarily linked to the hydrocarbon industry. On the coast there is limited ecotourism and recreation.

### 4.8.1 Fisheries

The fisheries industry has been discussed under Section 4.5.3 above. It is unknown how many fishing vessels traverse the study area but as Block 15/06 is located west of all primary fishing grounds the most probable encounters would be with pelagic long line boats. (Long lines with evenly spaced baited hooks can extend 10 km or more in length). Also, as there are well established oilfield activities in

Block 15 and 15/06 this means that fisheries probably already avoid the area. The main fishing season is in November. Platform Service Vessels may encounter more fishing vessels inshore, particularly including those of artisanal fishers.

### 4.8.2 Shipping and Navigation

The major shipping routes along the coast of Angola are shown in the southern African context in Figure 4-40 and are between:

- Luanda and European ports;
- West Africa (Nigeria) and Cape Town, South Africa; and
- Cabinda and Cape Town.

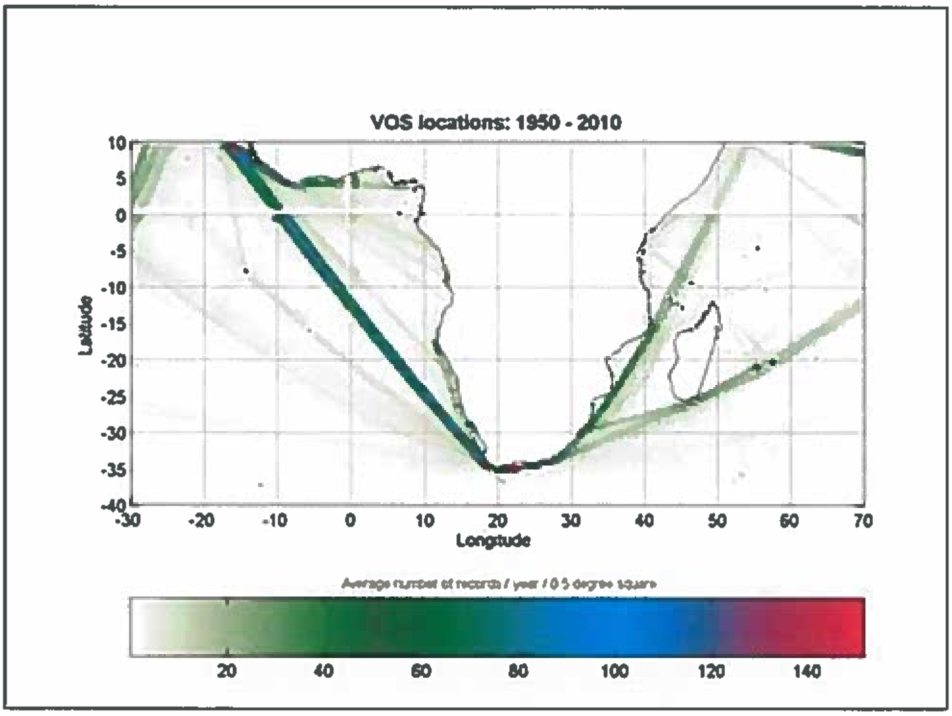



**Figure 4-40: Shipping routes off the west coast of Africa south of the equator based on Voluntary Observing Ships (VOS) data**
Source: SADCO

The major activity in the study area is hydrocarbon exploration and exploitation. Soyo and Luanda are major ports for servicing and supplying vessels operating in the oil fields. Much of the activity in the study area is probably linked to the movements of oil and freight tankers.

### 4.8.3 Ecotourism and Recreation

The infrastructure required to support a tourism industry in the region is not well developed; transport presents a problem and accommodation facilities are apparently limited. It is possible that local people visit beaches in the region for recreation, but evidence of population and development densities appears to be low, from satellite imagery.

# 5 Affected Social Environment

This chapter describes the social environment of Soyo, which may influence or be affected by activities associated with the proposed development and operation of Eni's East Hub in Block 15/06, and provides a detailed analysis of the socio-economic and health baseline in the Commune of Soyo. The description of the affected social environment was compiled by CEIS and SINFIC.

## 5.1 Methodology

As defined by the methodological report underlying the present study and attached as Appendix E, the methodological approach involved the use of primary and secondary sources, as well as the combination of quantitative and qualitative research techniques.

The combined use of quantitative and qualitative research techniques results in a complementarity of information, making it more rigorous, detailed and thorough. Distributing questionnaires was used as the major quantitative method; the qualitative research techniques consisted on focus groups and in-depth interviews.[7] The questionnaires allow obtaining indicators which set out the Commune of Soyo regarding the analysed themes; in-depth interviews and the focus groups allow specifying expectations, beliefs, feelings, perceptions and thoughts of the population regarding the issues under review.

In the quantitative research, questionnaires were applied to 1,093 households; the total number of respondents in all the households is 4,379. The number of questionnaires distributed respected what was expected regarding the types and size of communities – Table 5-1. The number of respondents in all households is 4,379. The Annex I shows the locations of the communities where questionnaires were applied. The number of surveys is representative of the Commune of Soyo, considering a confidence level of 95% and a variation of +/-3%. The surveys were applied from 9 to 19 January 2013.

**Table 5-1: Number of Questionnaires by Community.**

| | Community | No. of Questionnaires | % |
|---|---|---|---|
| Agriculture and Fishing Communities | Kintambi | 51 | 4.7% |
| | Kimpondo | 51 | 4.7% |
| | Conde | 53 | 4.8% |
| | Pungu | 48 | 4.4% |
| | Kitona | 57 | 5.2% |
| | Zulu | 40 | 3.7% |
| | Kitxitxi | 32 | 2.9% |
| | Kinganga Mavakala | 32 | 2.9% |
| Fishing Communities | Tombe | 72 | 6.6% |
| | Kifuma | 71 | 6.5% |
| | Kavuge | 16 | 1.5% |
| | Island[8] | 68 | 6.3% |

[7] For further detail, please consult the Methodologies Report in Appendix E.

[8] The inclusion of the Island as a point of data collection was due to the fact that, during the fieldwork, coordinators have found that Kavuge community was smaller than expected, according to information previously gathered from stakeholders, preventing the collection of the 60 questionnaires expected for this community. Thus, using as criterion the socio-economic characteristics, the missing questionnaires for this type of community were collected on the Island.

| | Community | No. of Questionnaires | % |
|---|---|---|---|
| | Impanga | 32 | 2.9% |
| | Bocolo | 40 | 3.7% |
| | Zola | 37 | 3.4% |
| | Kimpula | 32 | 2.9% |
| Urban Communities | Kunguyenguele | 100 | 9.1 |
| | Wolo | 104 | 9.5 |
| | Nona | 62 | 5.7 |
| | TGFA | 63 | 5.8 |
| | Kicala Kiaco | 31 | 2.8 |
| | TOTAL | 1,093 | 100% |

Health infrastructure survey questionnaires were applied in 3 of the 7 identified health units: Soyo Municipal Hospital, Concorde Clinic, and CSE Medis; in the other health facilities, it was not possible to collect data due to unavailability/non authorization to respond the questionnaire.

Within the qualitative research, the 10 expected focus groups (FG) were implemented, seeking to represent the three identified types of communities: agriculture and fishing (with 1FG with Men, 1 FG with women, 1 FG with young adults between 21 and 26 years old, 1 FG with Sobas), fishing (1FG with Men, 1 FG with women and 1 FG with Sobas) and urban (1FG with Men, 1 FG with women and 1 FG with Sobas).

The consultation of key informants and stakeholders in Soyo resulted in a set of 19 In-Depth interviews (IDI). The focus groups' moderation, as well as in-depth interviews, took place in Soyo, from 23 to 29 January 2013. Later in time, the research team came back to Soyo in order to collect some details missing, and there were conducted more 4 interviews.

At the central level, it was possible to consult representatives of the Ministries of Agriculture, Education and Industry.

Besides primary data collection, the stakeholder consultation through qualitative techniques allowed us to encompass concerns and expectations associated with the oil and gas industry; the stakeholders were able to share their opinions, fears and expectations; these data analysis is presented in section 5 of this report.

ENI sought to define priority intervention areas for the local communities, with a view to contribute to the local empowerment, aiming self-development; aligning with international good practices and in accordance with strict requirements, we highlight four instruments in this domain:

- Contextual Analysis
- Organised dialogue with stakeholders
- Social impact assessment and evaluation of impacts in health
- Initiatives for communities and for the creation and development of partnerships.

# 5.2 Population Characteristics

## 5.2.1 Socio-economic profile

### 5.2.1.1 Demographic overview

In the Commune of Soyo, households are on average composed of four people, varying in composition between 1 and 13 people. According to Figure 5-1, it can be seen that the majority of households are composed of three to five people.

The surveyed households are essentially composed of spouses, children, parents and grandchildren - Figure 5-2 - and have mostly male leadership (82.2%).

The marital status single predominates within the surveyed population (75%), followed by life partners, representing 14.6% of the sample - Figure 5-3.

With regard to nationality, there is a marked predominance of individuals born in Zaire Province (88.9%) - Figure 5-4.

The population distribution by gender is relatively proportional, with a slight predominance of males (52.8%) compared to the opposite gender (47.2%) - Figure 5-5. We observe an opposite situation when comparing to the national trend (IBEP, 2011), where there is a slight predominance of females (52%) compared to the opposite gender (48%).

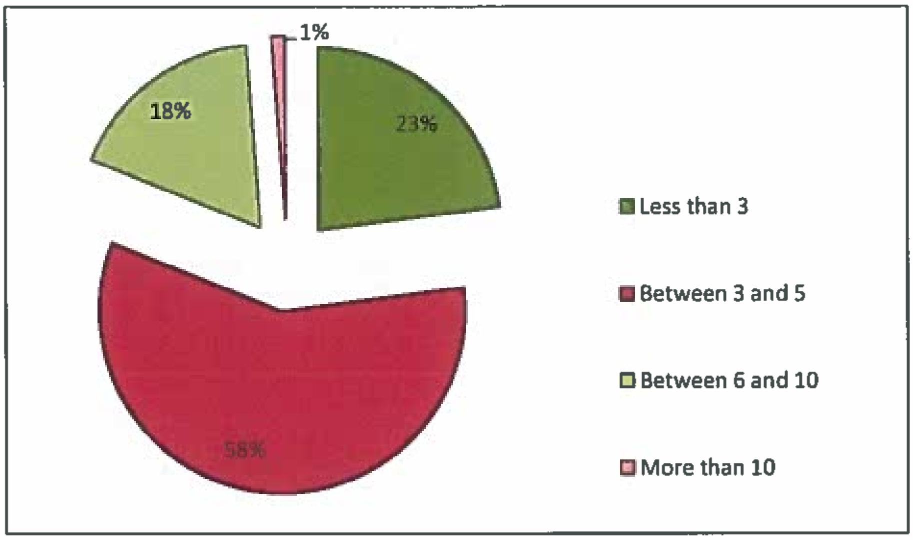



**Figure 5-1: Number of people who compose the household.**

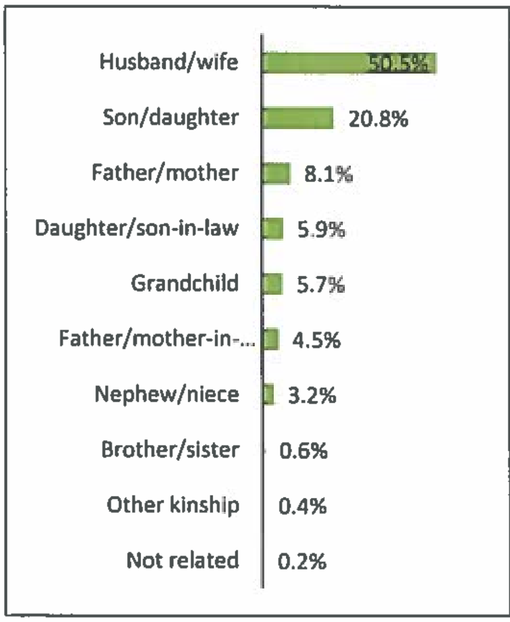



**Figure 5-2: Relationship between the respondents and the household head or his/her representative.**

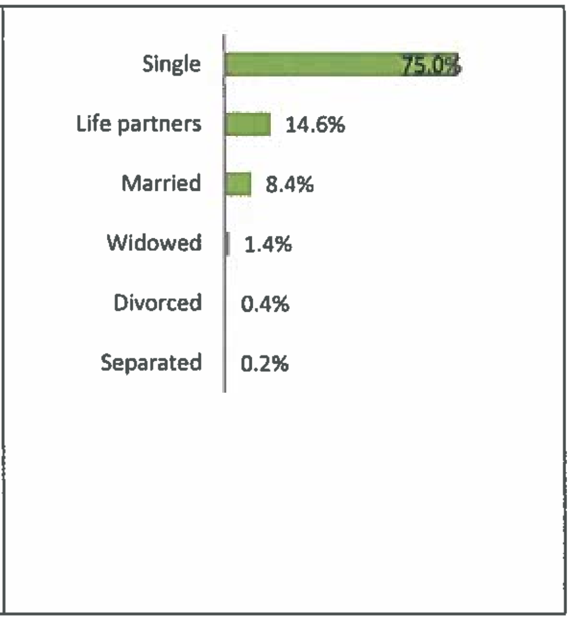



**Figure 5-3: Respondents' marital status.**

Regarding age, there is a predominance of young people. The percentage of population below 15 years is more than one fourth (27.9%), and this value was lower than the national indicators (IBEP, 2011) that point out that 48% of the population is below the age of 15. Data show that approximately 65% of the population is younger than 30 years. Population over 60 years old represents only 4% of the population - Figure 5-6.

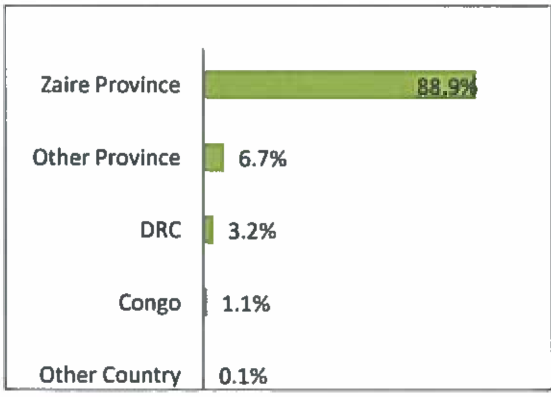



**Figure 5-4: Place of birth.**

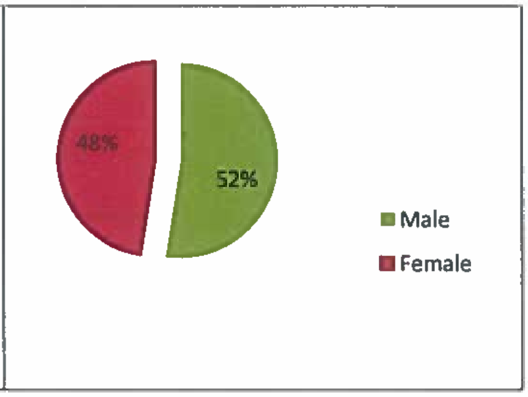



**Figure 5-5: Gender.**

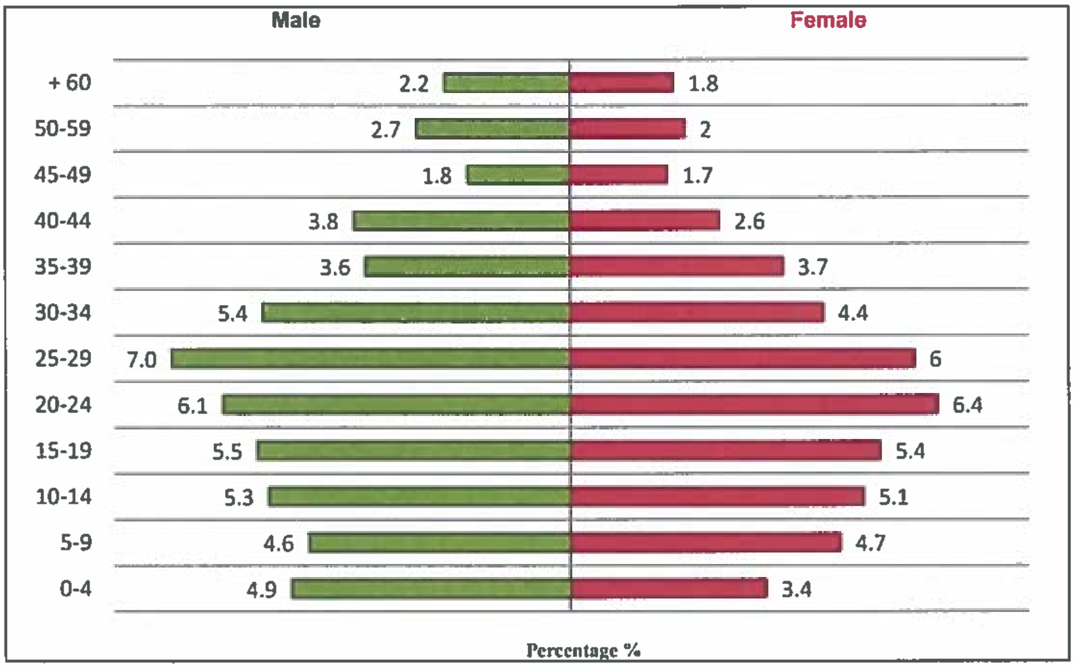



**Figure 5-6: Distribution by age and gender.**

#### 5.2.1.2 Socio-economic overview

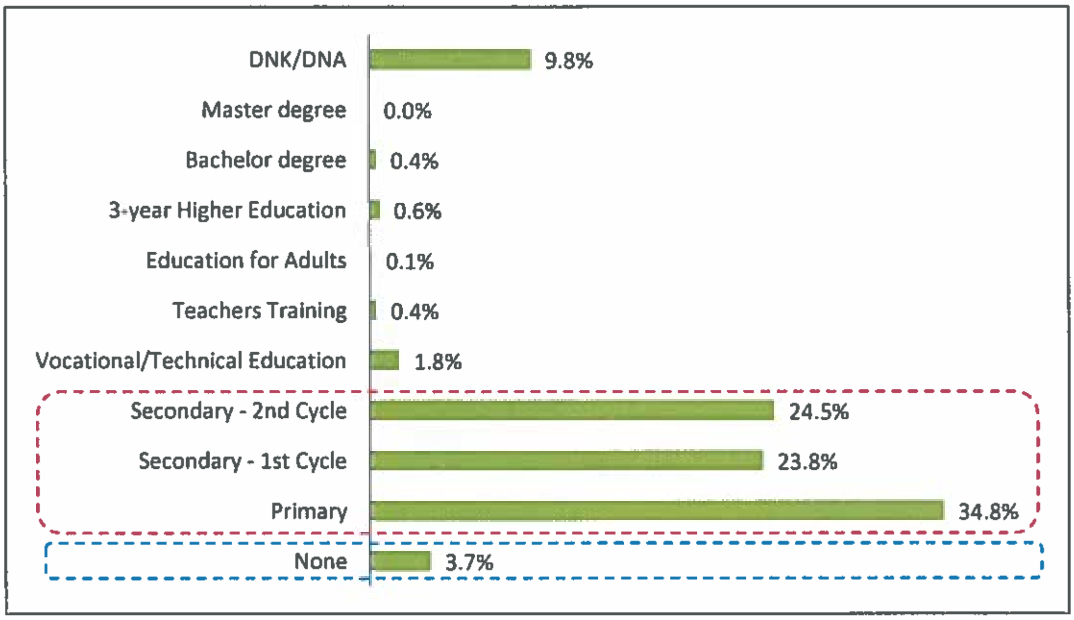



**Figure 5-7: Education.**

With regard to education (Figure 5-7), it should be emphasised that 4% of the sample does not have any education level. It should be stressed that 83.1% have between primary and 2nd cycle of secondary education. The percentage of individuals with higher education, however, is quite low, approaching 1%.

Currently, 51.2% aged over 5 years attend an educational institution. In cases of school non-attendance, the vast majority of situations are explained by three main reasons: lack of conditions allocated to school infrastructure (29.3%), low family income (27.6%) or entry into labour market (16%) - Figure 5-8.

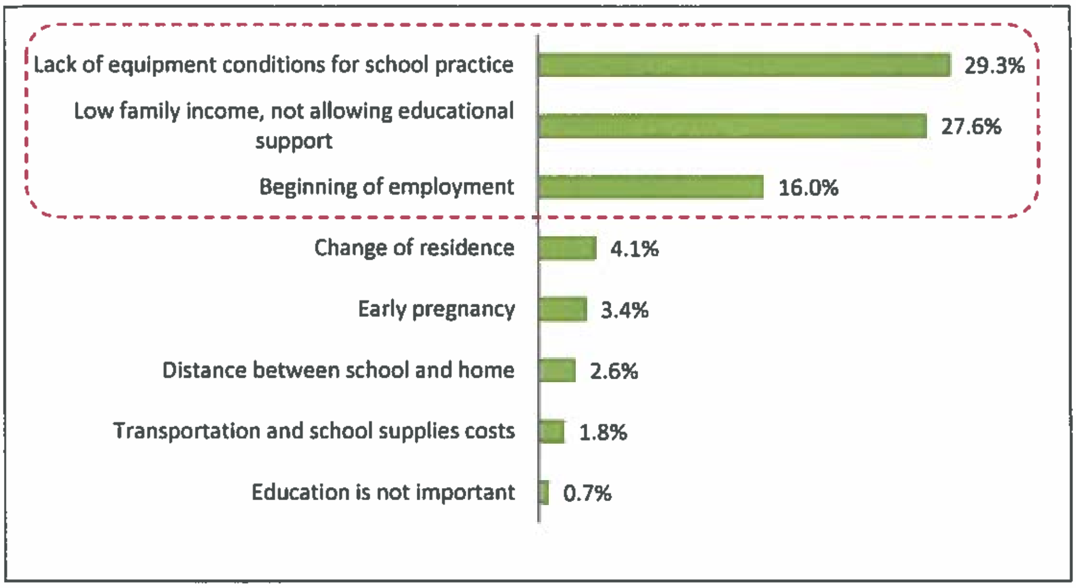



**Figure 5-8: Main reasons for school non-attendance.**

Currently, and taking into account the age structure of the population, predominantly young, 24.3% of the population is only student, and 15.3% said they were not working because they are underage – Figure 5-9. Subsequently, and in terms of relative importance in professional groups, we found farmers/fishermen, representing 11% of the population. After these come the unemployed (9.1%), employees with pay (6.8%), street vendors (5.3%) and civil servants (4.8%). The growing business and industrial development contributes to the frequent percentage of individuals associated with the private sector.

Presently, about 21% of the surveyed population shows to have a business on their own – Figure 5-10. The sample distribution by type of economic sector is almost proportional - 51% in the informal sector and 49% in the formal sector – Figure 5-11. Only 4.5% of the population has, in addition to the main occupation, another occupation.

The majority of the population commutes on foot (51.4%) or by collective taxi (34.5%). Due to the local productive structure and the constraints associated with the commute/mobility, most people study/work in their neighbourhood of residence (47.1%) or in the urban centre of residence (37.7%). It is noted that 12% of the population commutes every day to study and/or work in another commune of the municipality of Soyo

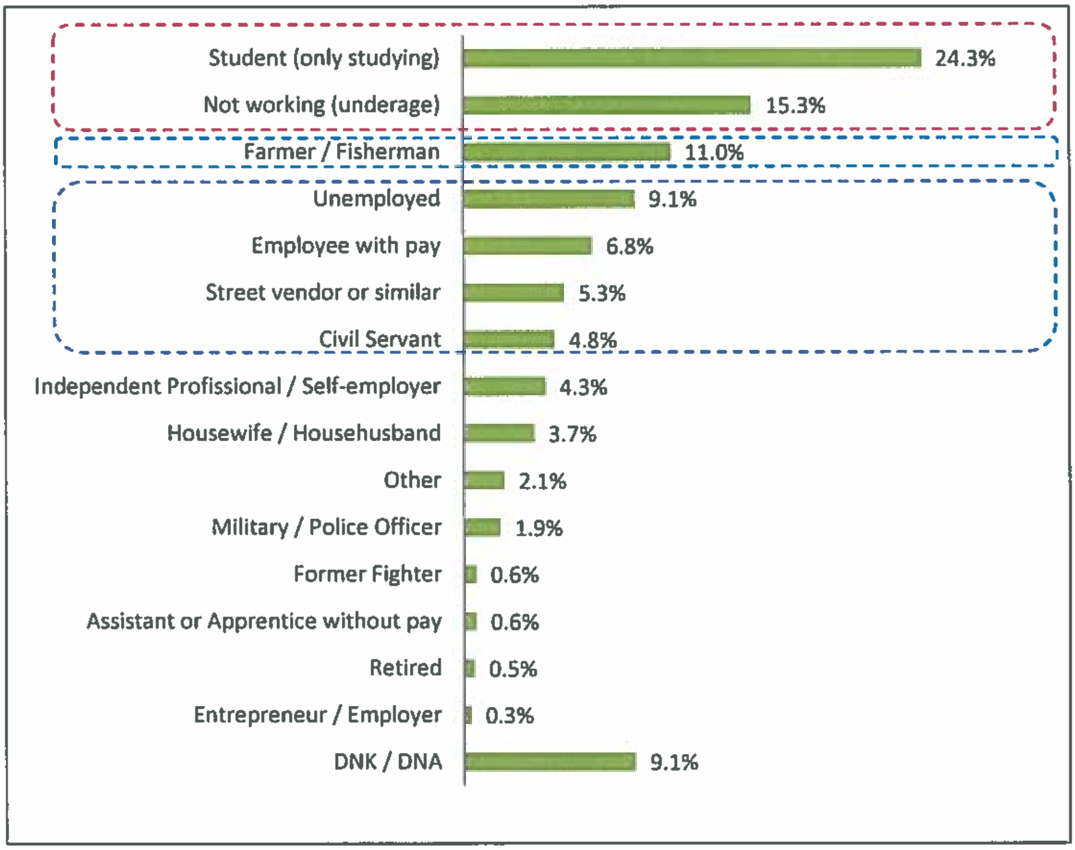



**Figure 5-9: Professional Occupation.**

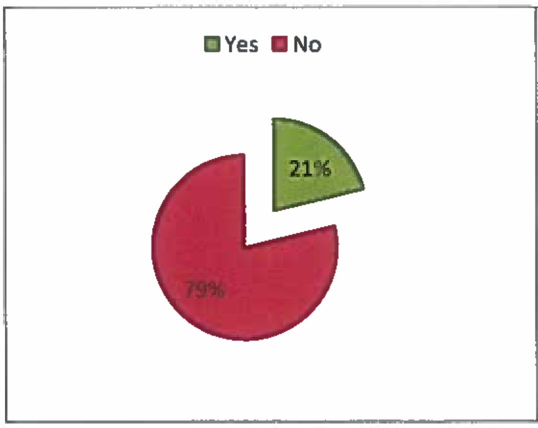



**Figure 5-10: Population with own business.**

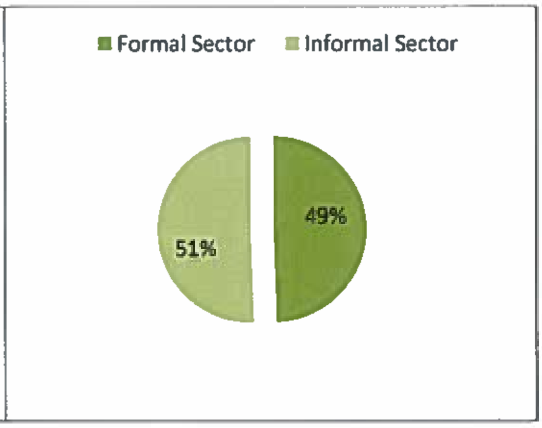



**Figure 5-11: Own business sector**

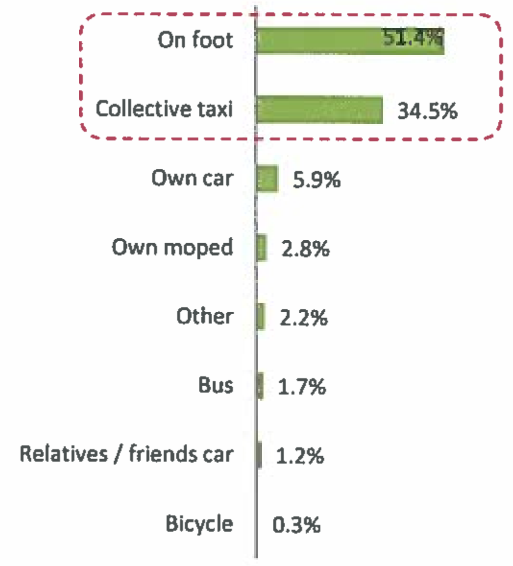



**Figure 5-12: Main means of transportation to place of study/work.**

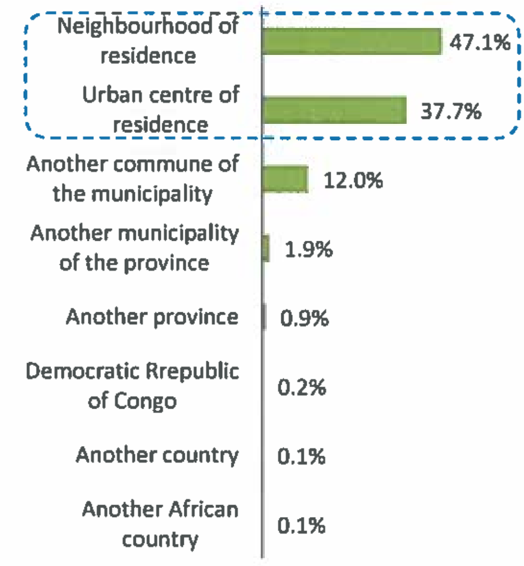



**Figure 5-13: Place of work/study**

As regards the languages spoken it is shown that 89% of the surveyed population speaks Portuguese - Figure 5-14. However, regarding the primary language spoken, the majority is divided between Portuguese (41.4%) and Kissolongo (39%) - Figure 5-15.

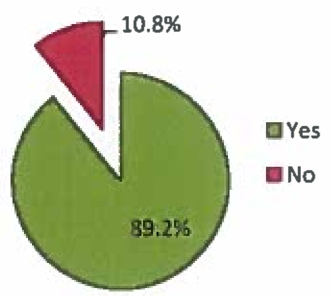



**Figure 5-14: Command of Portuguese.**

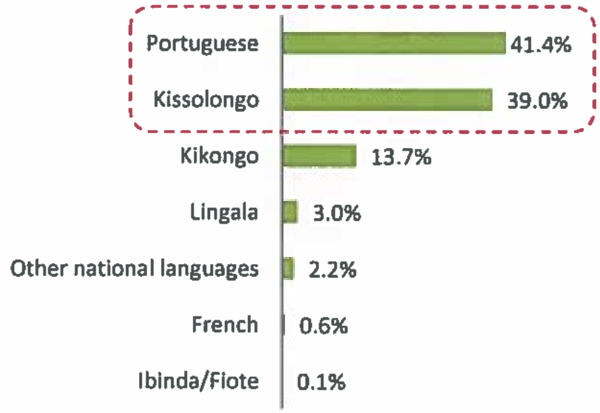



**Figure 5-15: Main language spoken.**

With regard to religious beliefs - Figure 5-16, about half of the surveyed population is Catholic (53.8%); 22% have a religious belief other than those specified in the questionnaire. Following Catholicism, the two religions most referred to, although in a substantially lower percentage, are Simon Mtoko (5.7%) and Assembly of God (5.0%).

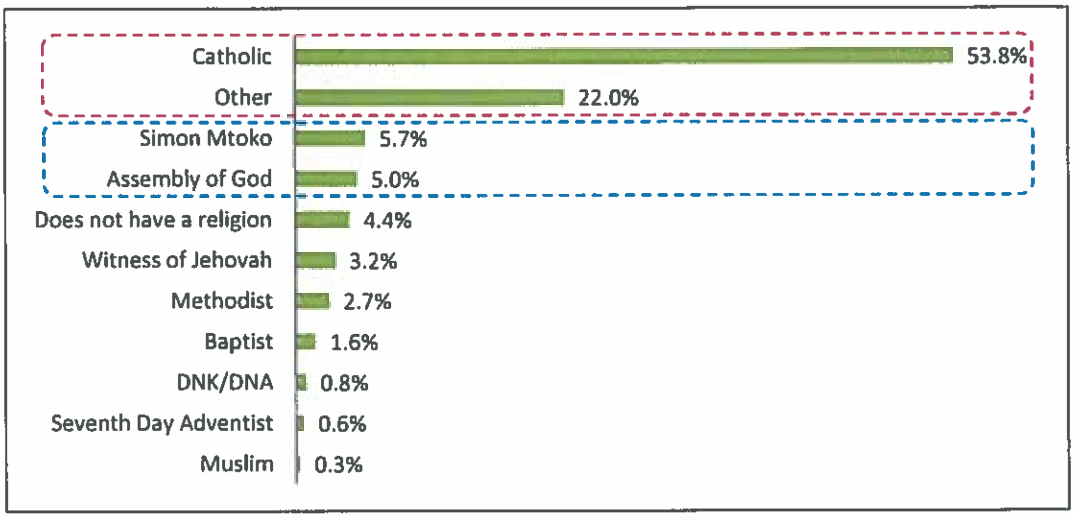



**Figure 5-16: Religious beliefs.**

It should be noted that only 24.4% of the population belongs to some cultural/religious or sports association.

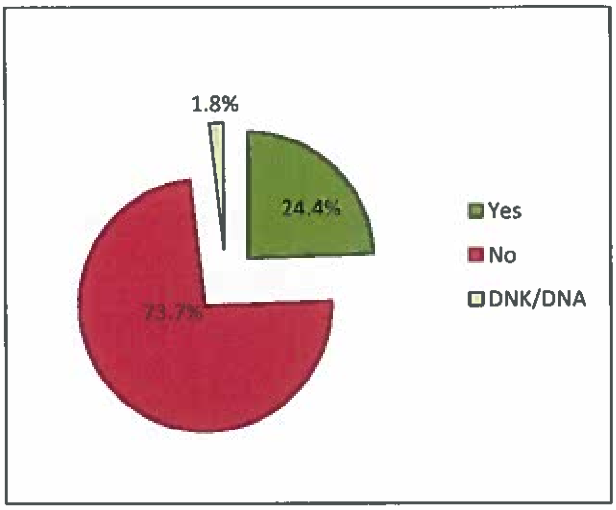



**Figure 5-17: Integration in Associations.**

#### 5.2.1.3 Migration and access to goods and services

Migration and the related accessibility to goods and services greatly impact the possibility to receive appropriate medical treatment for the population, and therefore become one of our major focus in the assessment.

Regarding migration within households, in the last year it affected approximately 21.7% of the surveyed households - Figure 5-18 - where on average 2 individuals per household moved out. Thus, about four fifths of the population remained within the household.

Regarding the main reasons associated with the moving out of household members in the last year (Figure 5-19), we found that motivations related to studies explain more than half of the members that moved out (51.6%). Secondly, other unspecified reasons are presented (19.8%), looking for job (13.1%) and workplace (11.4%).

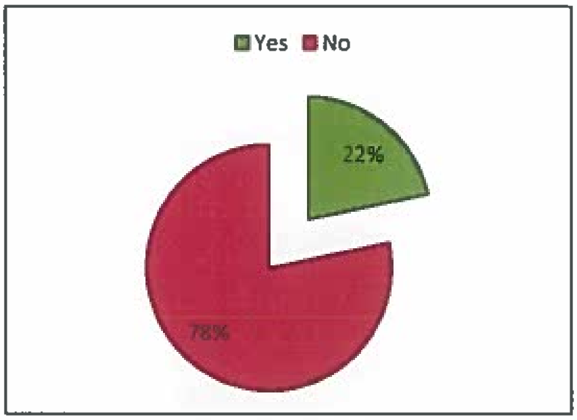



**Figure 5-18: Moving out of any household member in the last year.**

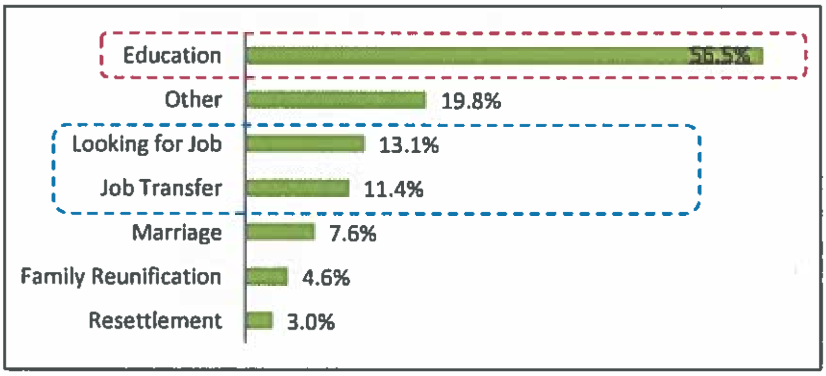



**Figure 5-19: Main reasons for moving out of household.**

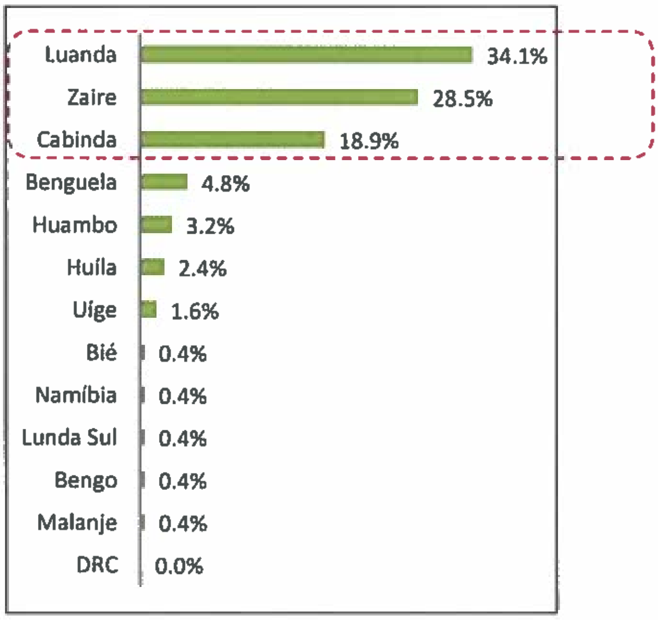



**Figure 5-20: Moving out main destinations**

With regard to the most common destinations (Figure 5-20), Luanda stands out (34.1%). It is also noted that a large percentage of individuals moving out of the household remains in the Zaire province

(28.5%). It should also be noted that Cabinda is the destination of 18.9% of the individuals who, in the last year, left their families in Soyo.

Considering the list of goods and services examined in the questionnaire, it appears that in most cases, purchases are made in the Municipality of Soyo, including Neighbourhood, Commune and Municipality - Figure 5-21.

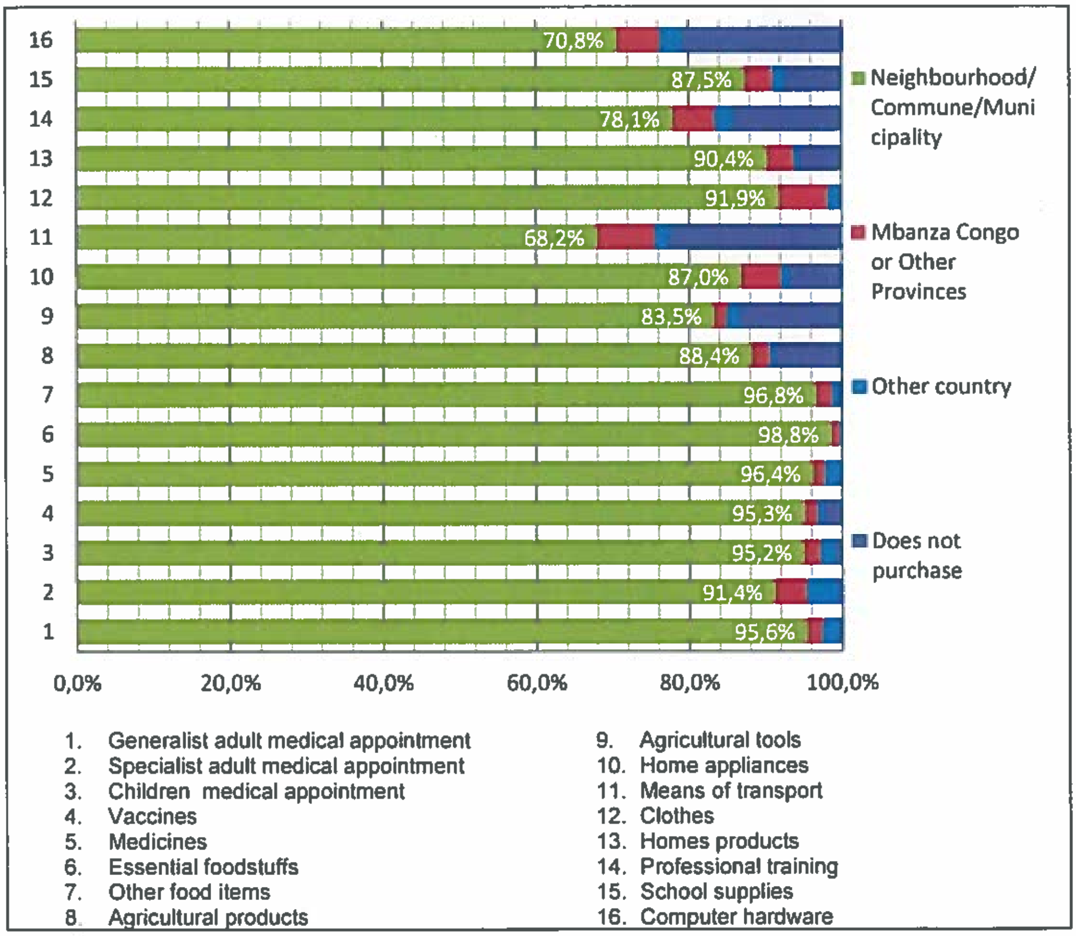



**Figure 5-21: Place of goods and services purchase**

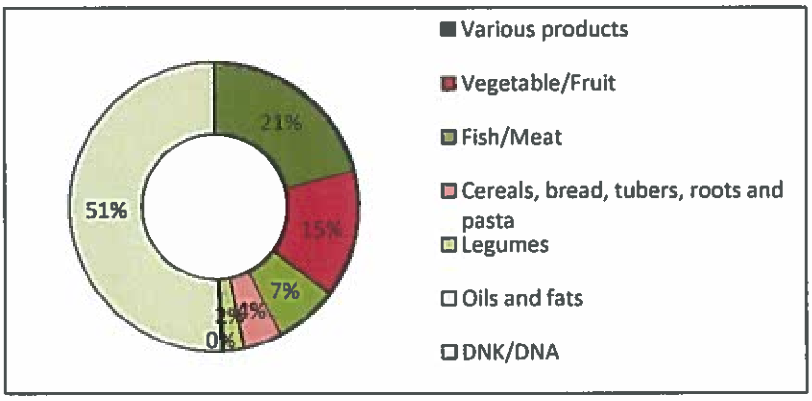



**Figure 5-22: Scarcer food products in the local market.**

Considering the local market, the surveyed population divides their opinions concerning scarcer products, with half of respondents answering this question with does not know / does not answer; about 20% considered that there is a lack of various food products and, taking into account the food pyramid, it appears that the categories most often mentioned are: vegetable/fruit (14.4%) and fish/meat (7.1%) - Figure 5-22.

### 5.2.1.4 Housing, housing conditions and family expenses

Housing, housing conditions and family expenses not only influence the general living condition but also represent, typically, their social status.

The residential space is marked by two predominant housing typologies (Figure 5-23):

- Detached house (42%)
- Traditional house (34%)

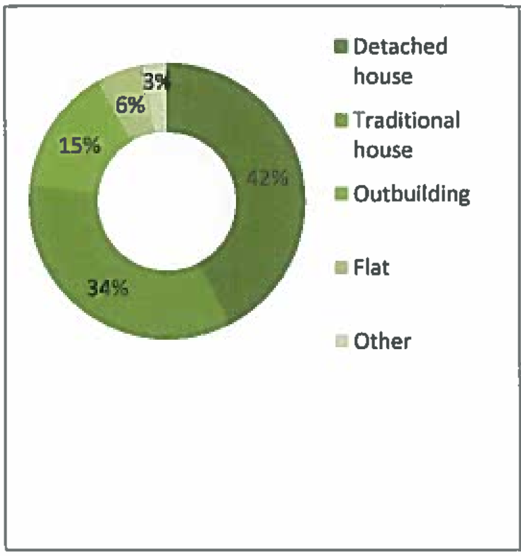



Figure 5-23: Type of housing.

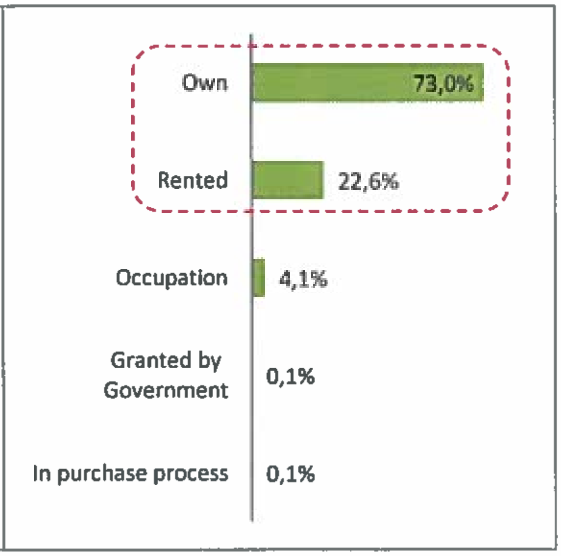



Figure 5-24: Scheme of occupation.

Regarding the occupation regime of the houses where they live with the household (Figure 5-24), most of the surveyed households said it was their own (73%) or rented (22.6%).

As functions of the residence (Figure 5-25), the residence may have multiple functions, including the following: only residential (45.7%), sale of beverages and other food products (36.1%) and meals (13.1 %).

Most of the houses have zinc sheeting (84.4%) and/or tiles (11.3%) as roofing - Figure 5-26; as regard to walls, concrete bricks predominate (57.2%) followed by adobe (29.7%) - Figure 5-27.

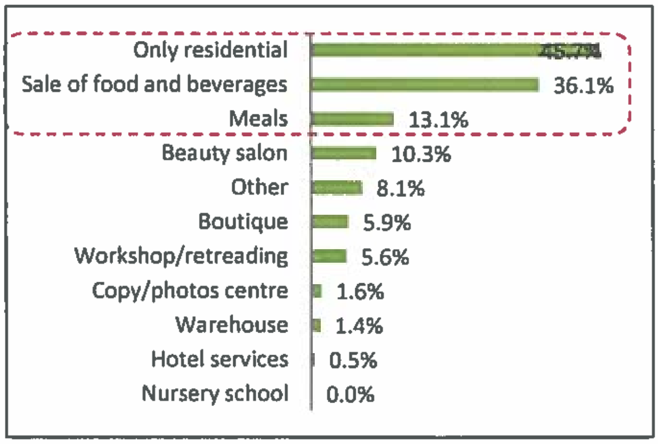



**Figure 5-25: Functions of residence.**

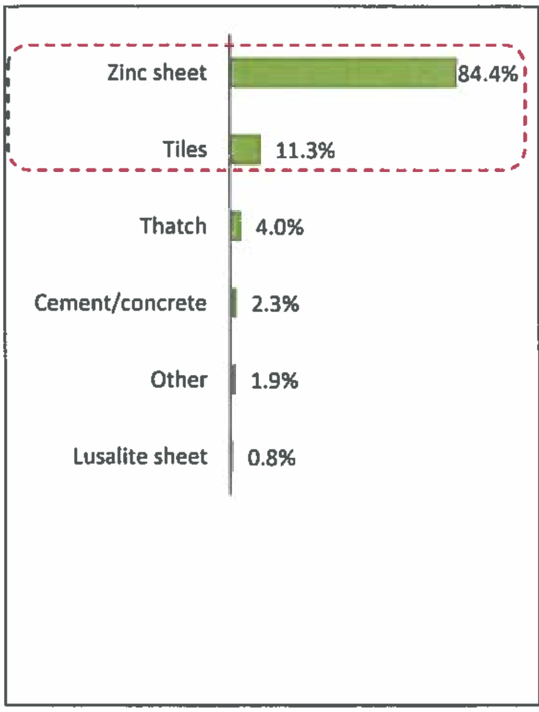



**Figure 5-26: House roofing.**

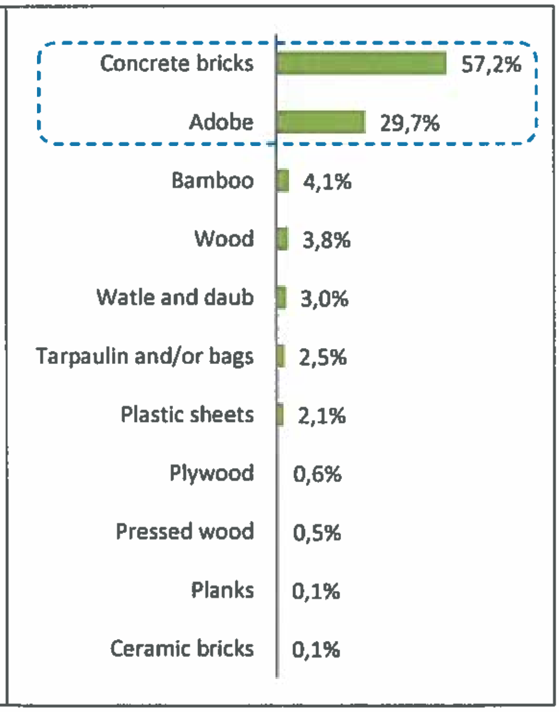



**Figure 5-27: Materials on housing walls.**

As regard the flooring used in houses (Figure 5-28), cement is mostly used (67.7%). However, unpaved (17.7%) and mosaic tiles (15%) are also commonly mentioned.

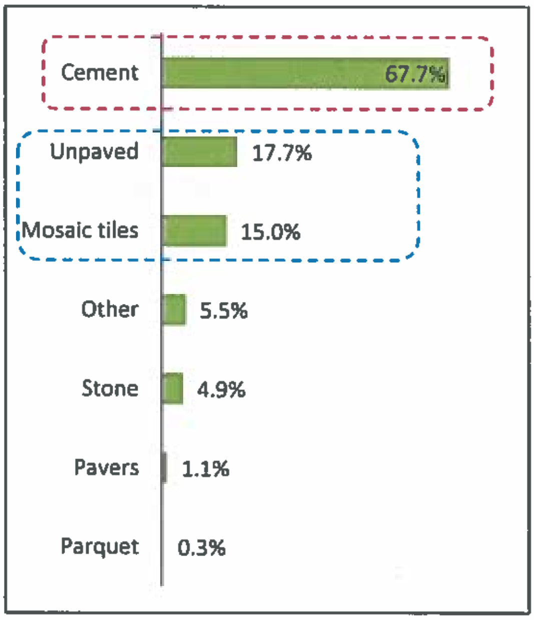



**Figure 5-28: House flooring.**

Regarding the main sources of water supply (Figure 5-29), five categories stand out: public fountain (21%), purchased from privates (20.1%), river/lake (18.4%), neighbours home (15.4%) and rainwater.

Tap water (in the house or building) covers only 9.1% of the households.

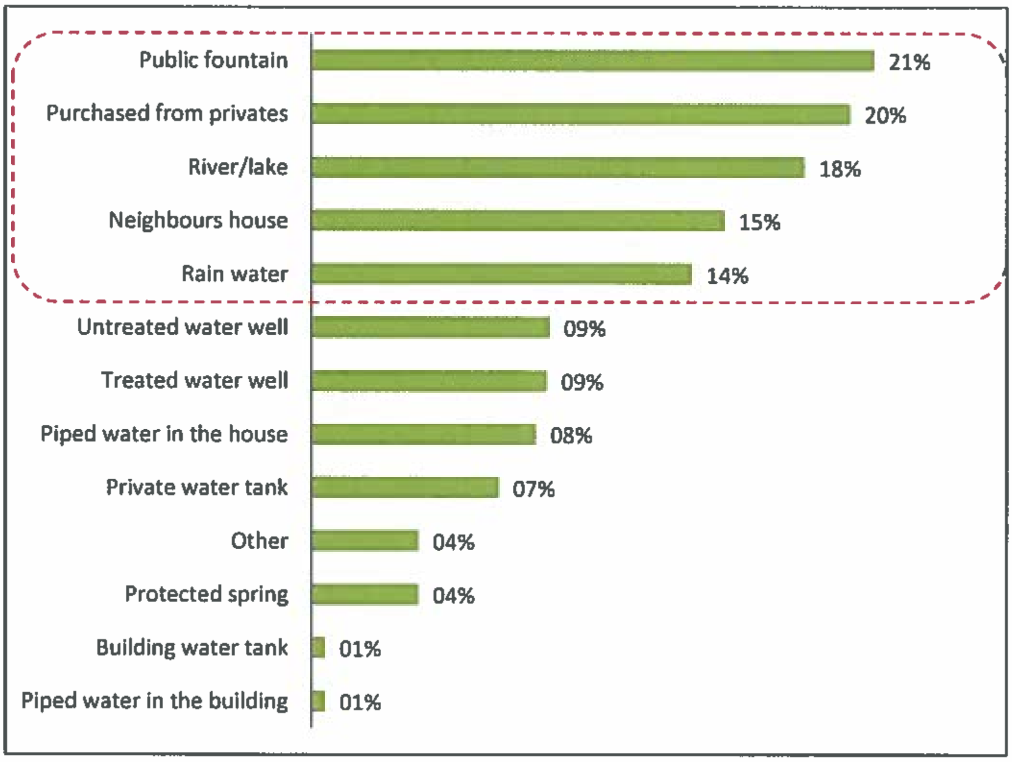



**Figure 5-29: Main source of water supply.**

The water is treated before consumption in 52.8% of the households - Figure 5-30. Among the various methods of treatment (Figure 5-31), we highlight the use of bleach (67.6%); the practice of boiling water is reported by 13.7% of the households.

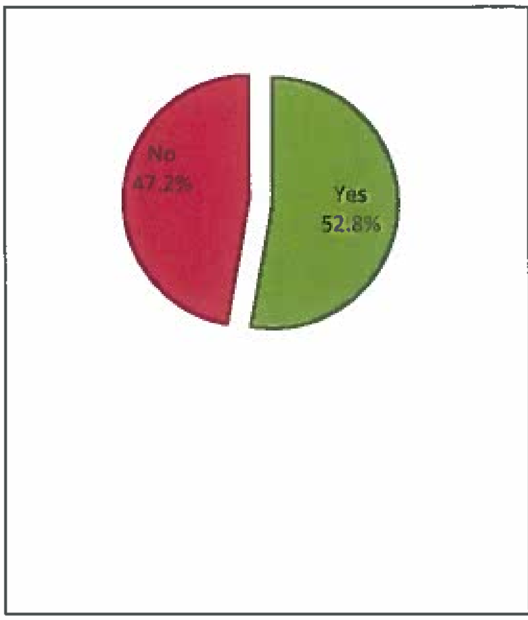



**Figure 5-30: Water treatment prior to consumption.**

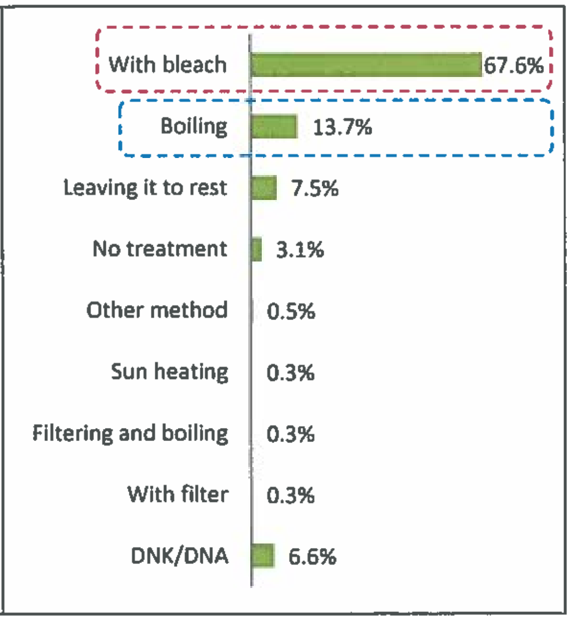



**Figure 5-31: Methods of water treatment.**

With respect to the type of illumination existing in the surveyed households (Figure 5-32), the use of own generator in order to obtain electric power (48.3%) and the oil lamp (47.3%) are resources that stand out.

The main energy source for food preparation in the surveyed households is coal (63.4%), followed by gas (46%) and firewood (27.9%) having both also substantial percentages - Figure 5-33.

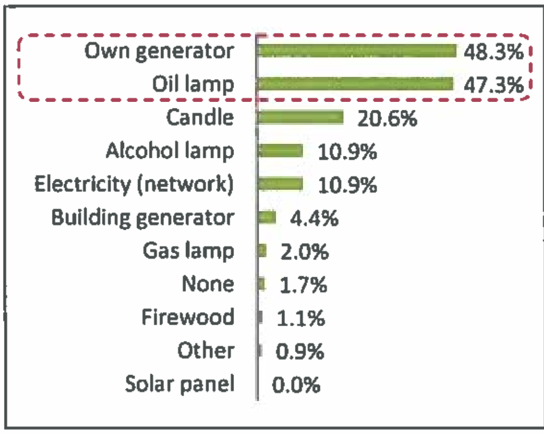



**Figure 5-32: Type of illumination.**

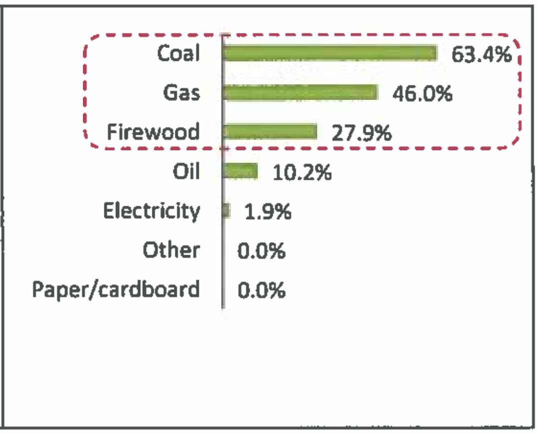



**Figure 5-33: Sources of energy for cooking.**

Regarding sanitary facilities in the house (Figure 5-34), we found that 30.7% reported not having any type of sanitary facilities; dry latrines or with manual unload represent 26.8% of the cases, and septic tanks or rotten sump (24.3%) and drainage system, with sink or toilet (23.8%) are proportionally represented in the population. As regards the connection of the sewerage system to the house (Figure 5-35), it is noted that 46.9% of respondents said that their house has no sewerage system; septic tanks represent 43.3% of the cases. The public network represents only 1.5% of the cases.

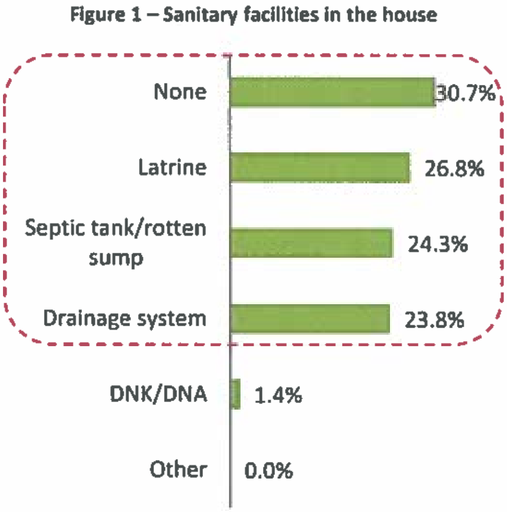



**Figure 5-34: Sanitary facilities in the house.**

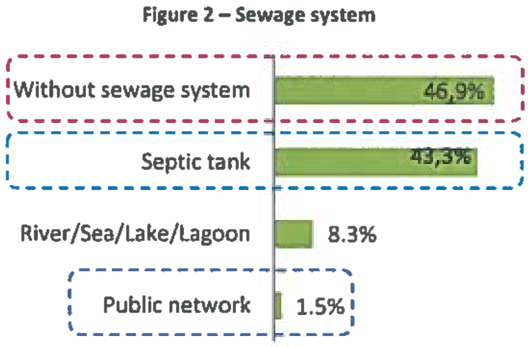



**Figure 5-35: Sewage system.**

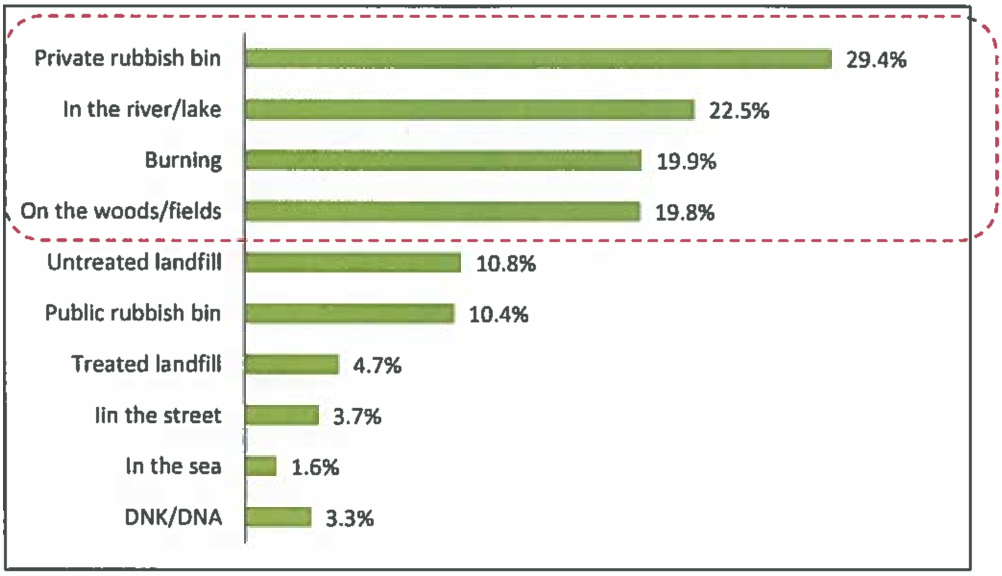



**Figure 5-36: Methods of waste dumping.**

The main method of waste-dumping is associated with the possession of private rubbish bin (29.4%) - Figure 5-36; this doesn't mean that these households don't have any other method of waste-dumping. In fact, people could choose more than one option. The waste-dumping in the river/lake represents 22.5% of the cases, and burning (19.9%) and waste-dumping on the woods/fields (19.8%) are proportionally represented in the dwellings of the Headquarters Commune of Soyo.

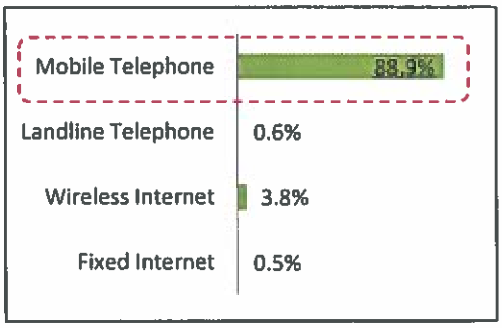



**Figure 5-37: Telephone and internet ownership.**

Regarding communications and access to information (Figure 5-37), it appears that the vast majority of the population has got mobile phone (88.9%), and the landline and internet are uncommon in the population of the Headquarters Commune of Soyo.

As for appliances and equipment (Figure 5-38), it appears that the majority of the surveyed households have radio (76.3%), television (73.4%) and gas cooker (50.2%). Fans are a reality for 49.7% of the population, while fridges/freezer are present in 41.5% of households and washing machines in 26.4%. The petrol stove and air conditioners are present in a smaller proportion of households, respectively in 15.1% and 13.9%.

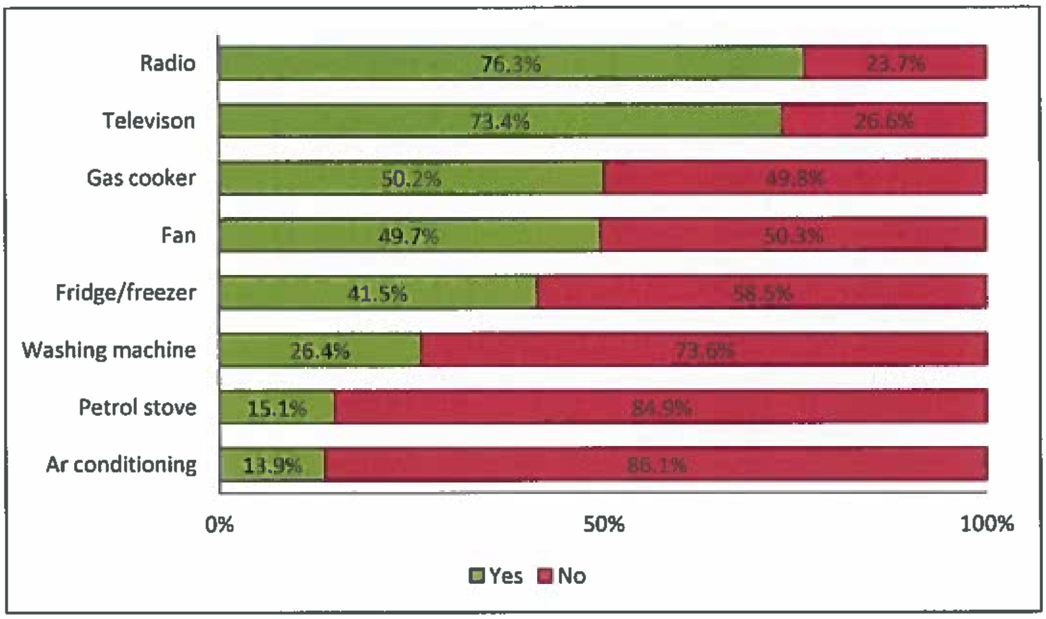



**Figure 5-38: Equipment and appliances ownership.**

The analysed houses have got between one and eight rooms (Figure 5-39), with an average number of rooms per dwelling equal to 2.25. Considering the registered number of rooms and the total population surveyed, the ratio is 1.8 persons per room. The majority of the houses have got between one and three rooms.

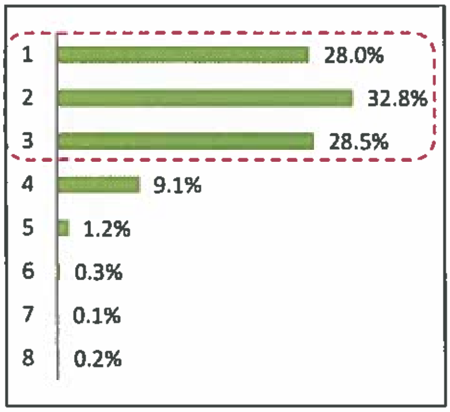



**Figure 5-39: Number of rooms per house.**

The distribution of monthly individual income is expressed in Table 5-2, and it is relevant that, of individuals who responded to this question, about half have monthly individual income not exceeding 25,000 Kwanzas. Table 5-3 shows the monthly family income and it reveals that the overwhelming majority of families in the Headquarters Commune of Soyo have a monthly income below 100,000 Kwanzas. However, these data should be viewed with some caution, given the high proportion of non-responses, and, in some cases, relate to the desire not to provide this information or, in other cases, the difficulty in accounting for this value. On the other hand, the expression assumed by the informal sector means that part of the income is not officially declared. The average monthly income per person in Angola is estimated at 8,767 Akz (IBEP, 2011); there are significant differences between areas of residence: 11, 077 Akz in urban areas and 5,967 Akz in rural areas (*idem*).

**Table 5-2: Monthly individual income.**

| Monthly individual income (in Kwanzas) | % | Valid % | Cumulative % |
|---|---|---|---|
| Up to 10,000 | 15.4% | 31% | 31% |
| 10,000 - 25,000 | 9.1% | 18.5% | 49.4% |
| 25,000-50,000 | 10.3% | 20.8% | 70.3% |
| 50,000-75,000 | 6.7% | 13.5% | 83.8% |
| 75,000-100,000 | 3.7% | 7.4% | 91.1% |
| 100,000-150,000 | 2.9% | 5.9% | 97% |
| 150,000-200,000 | 1.2% | 2.4% | 99.4% |
| 200,000-300,000 | 0.1% | 0.2% | 99.6% |
| 300,000-400,000 | 0.1% | 0.2% | 99.8% |
| More than 400,000 | 0.1% | 0.2% | 100% |
| Total | 49.6% | 100% | |
| DNK/DNA | 50.4% | | |
| Total | 100% | | |

**Table 5-3: Monthly family income.**

| Monthly individual income (in Kwanzas) | % | Valid % | Cumulative % |
|---|---|---|---|
| Up to 49,900 | 22.3% | 77% | 77% |
| 50,000-99,000 | 5% | 17.4% | 94.3% |
| 100,000-149,000 | 0.7% | 2.5% | 96.8% |
| 150,000-199,000 | 0.6% | 2.2% | 99.1% |
| More than 200,000 | 0.3% | 0.9% | 100% |
| Total | 29% | 100% | |
| DNK/DNA | 71% | | |
| Total | 100% | | |

#### 5.2.1.5 Satisfaction and Expectations

The evaluation of the place of residence is positive (Figure 5-40), considering that the majority of the population reported to be very pleased (7%) or pleased (60%) with the neighbourhoods where they reside.

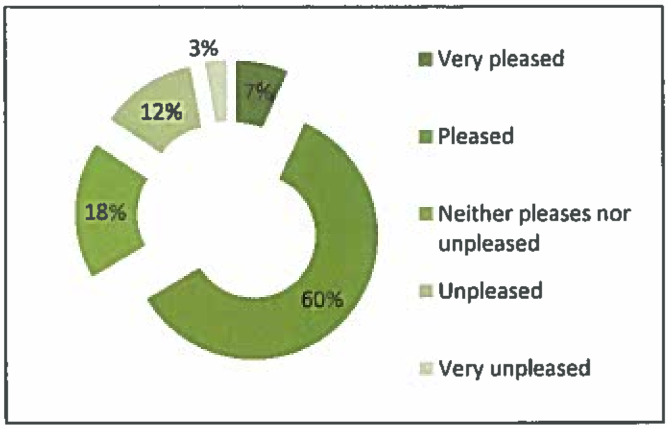



**Figure 5-40: Satisfaction with place of residence.**

When the focus is on major problems (Figure 5-41), the constraints on access to energy clearly stand out, being considered problematic by 86.7% of respondents, as well as access to drinking water, which was identified as a problem by 80.1% of the surveyed individuals. Basic sanitation, refuse collection, poor street layouts are also considered problematic for a considerable percentage of the population. Individuals who refer to other problems beyond the options listed pointed to particular constraints associated with access to health and education, as well as access to transports, access to food and unemployment.

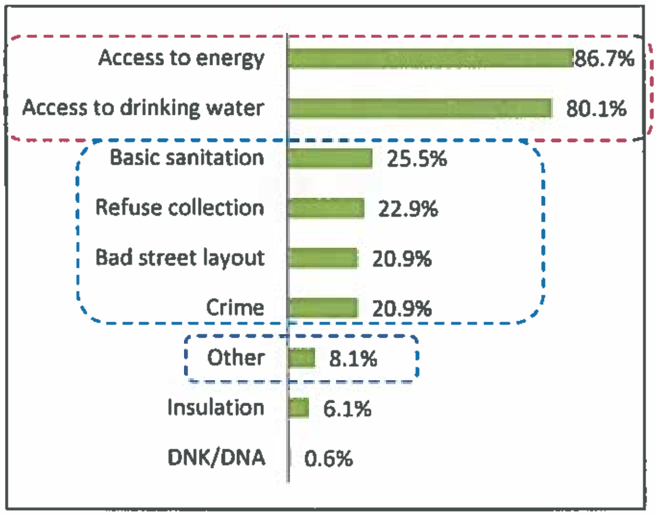



**Figure 5-41: Major problems.**

The propensity to change residence was manifested by 44.4% of the surveyed population - Figure 5-42.

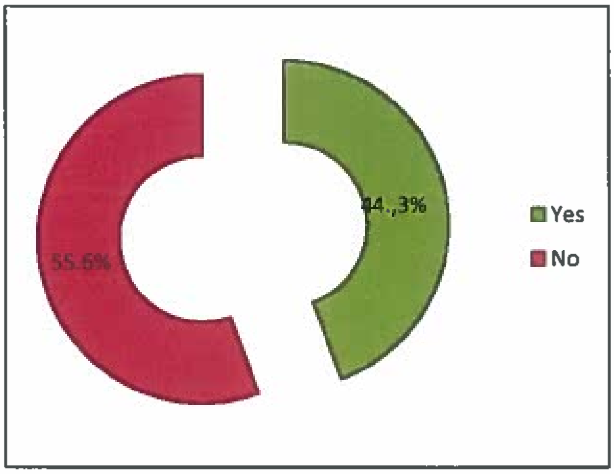



**Figure 5-42: Willingness to change residence.**

#### 5.2.1.6 Agricultural Production

Most of the surveyed households does not own land for cultivation (58.6%) - Figure 5-43.

Those who have agricultural land, most produce only for family consumption (69.1%) and the percentage of population that produces only for commercial purpose is residual - Figure 5-44.

Regarding the importance accorded to crops (Figure 5-45), the most significant crops are corn (98.7%) and cassava (85.7%), followed by sweet potatoes (67.1%) and cowpeas (66.9%); moreover, within the six more important crops we found peanuts (27.8%) and tomato (26%).

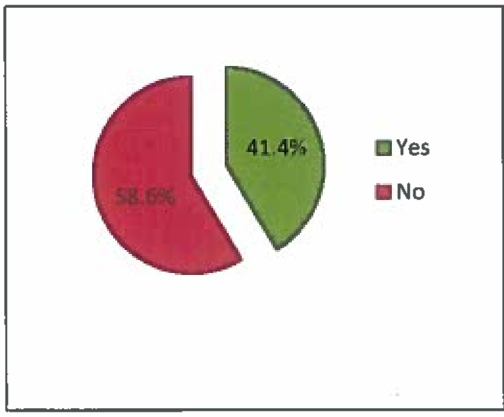



Figure 5-43: Ownership of land for cultivation.

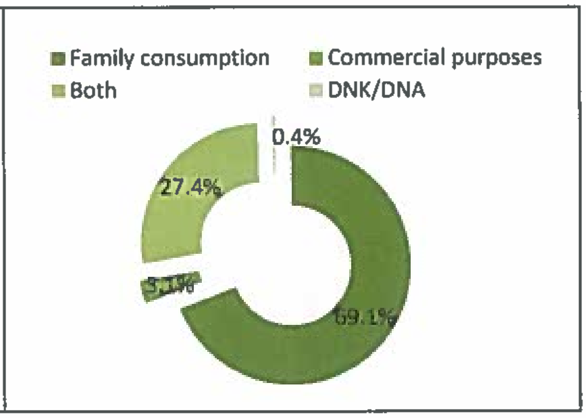



Figure 5-44: Purpose of agricultural practice.

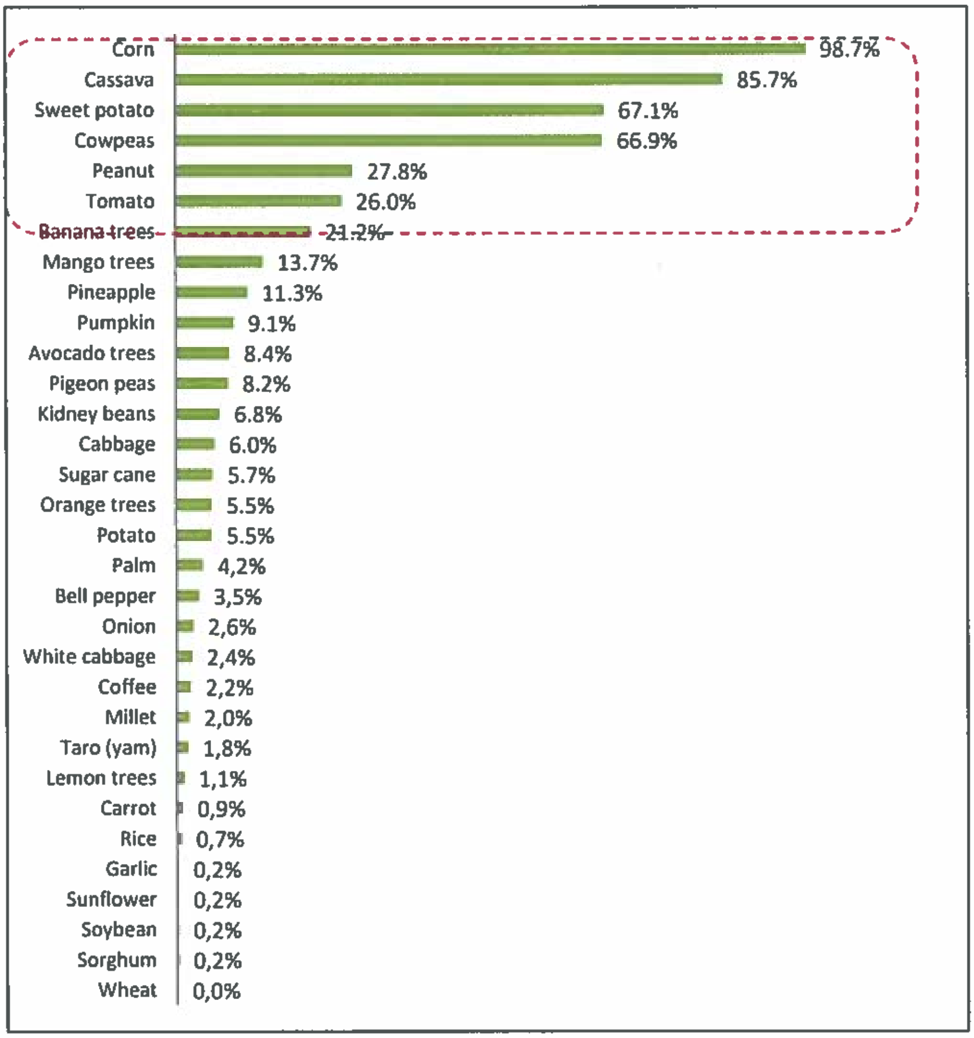



**Figure 5-45: Most important crops.**

Looking at animal rearing, it appears that only hen/poultry rearing has some expression being performed by 57.6% of the households - Figure 5-46. Taking into account the total number of hens/poultry identified in the questionnaire, and the number of households that claim to have these animals, it was concluded that on average, each of these households has approximately 10 hens/poultry.

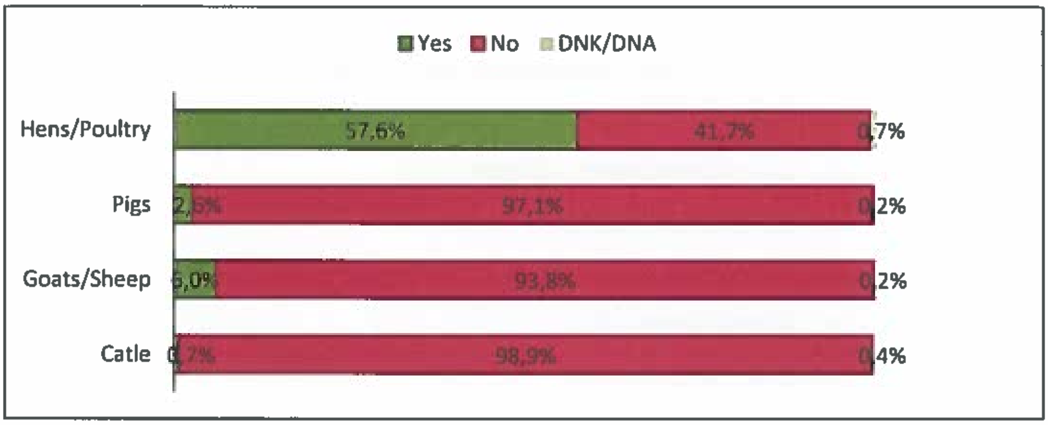
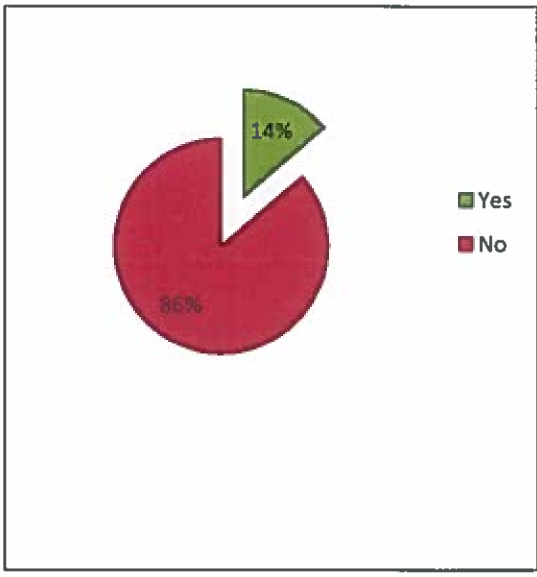



**Figure 5-46: Animal rearing.**

The percentage of producers/farmers associated to a cooperative and/or association is 4.4%.

#### 5.2.1.7 Fishing

The majority of the households are not engaged in fishing activities - Figure 5-47, only 13.7% stated to carry out this kind of activity. From those who do fish, about half assumes a dual purpose, household consumption and trading (55.3%); fishing with exclusively commercial purposes is residual (6%) - Figure 5-48.



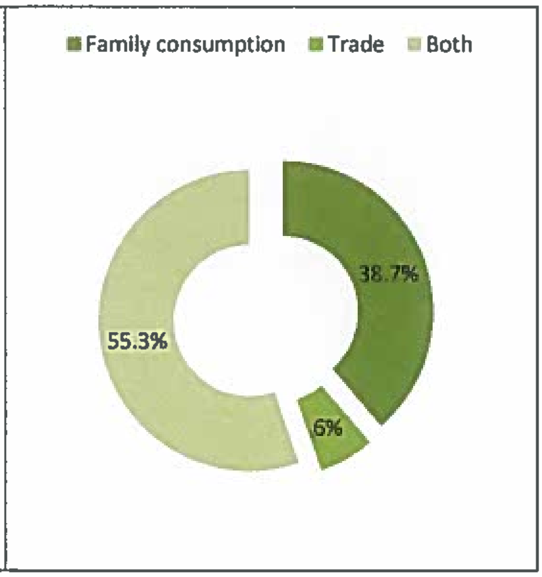




**Figure 5-47: Fishing activity.** **Figure 5-48: Purpose of fishing.**

As regards the main type of fish - Figure 5-49 - more than half of the population surveyed reported: croaker (75.3%), catfish (62.7%) and snapper (51.3%). Noteworthy is also grey triggerfish (45.3%), shark (32.7%), southern meagre (26.7%) and ray (25.3%) referred to by at least ¼ the population practicing fishing:

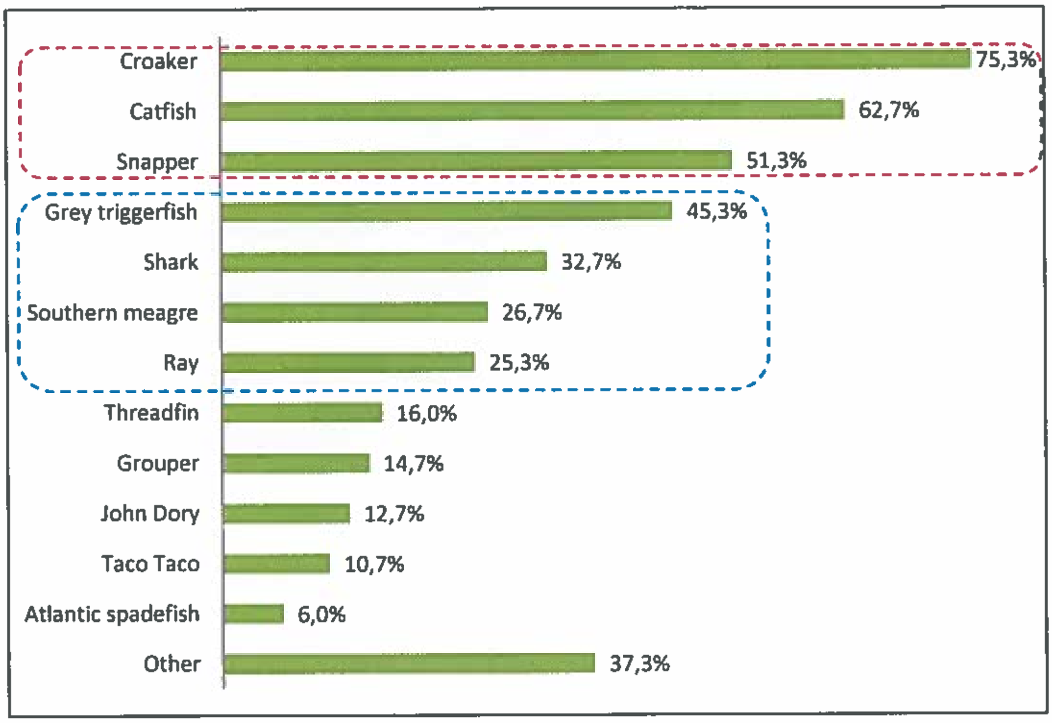



**Figure 5-49: Major type of fish.**

The majority of the surveyed population that practices fishing activities does not have their own boat (58.7%), and 24.7% has own boat without engine and 16.7% has own boat with engine - Figure 5-50.

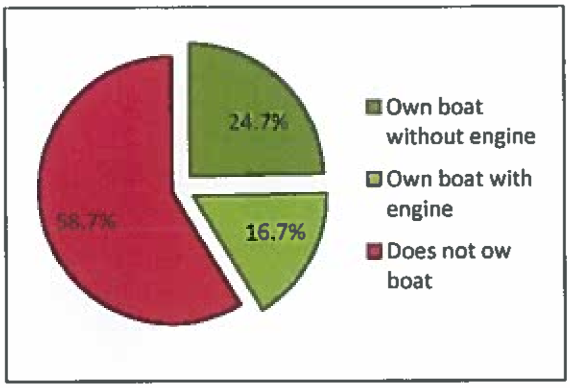



**Figure 5-50: Boat ownership.**

On average, each fisherman goes fishing approximately five times a week (4.87). Only 15.3% of the fishermen belong to a cooperative and/or association.

According to information gathered from the Representative of the Provincial Institute of Artisanal Fishing, fishing activity is seasonal, with the distinction being related to the tides, and not in association with the rainy season/cacimbo. From November to July follows the normal fishing, and between August an October, the fishermen don't fish with the same frequency due to strong currents caused by the trade winds. The unit of measure used is the kilogram (kg); however, the *zungueiras*, women who sell the fish, tend to make the price of fish by unit, measuring from the "eye". The fish with scales is sold at 350/400 Akz/ kg and scaleless fish is usually sold for 200/250 Akz / kg.

### 5.2.2 Health profile

In Angola, the health system is divided into three levels of care; the delivery of which one is related with government levels. Starting from the basis, the primary care, comprising municipal hospitals, health centres and posts and company health units is under control of Municipal Administration. The secondary level of health care – provincial hospitals and private hospitals – is responsibility of Provincial Government. The National Government is responsible for the tertiary level of health care which comprises the national and specialized hospitals.

When looking for the effectiveness of health care, the situation seems to be much similar than the overview presented in the assessment developed under the Angola Block 15/06 West Hub Development Project. Analysing some health key indicators (Table 5-4), we can easily state a high rate of maternal mortality, estimated to 610 per 100 000 births in 2008 (WHO, 2010); nevertheless, it should be noted that in 2010 the maternal mortality rate was estimated in 880 per 100 000. Also the number of children dying before the age of five knew a large improvement, being actually measured at 193,5 per 1000 live births (IBEP, 2011). The major causes of death in children under five years are still related to preventable and treatable conditions such as pneumonia, diarrhoea and malaria (Connor et al, 2010). The HIV prevalence in the country is low comparing to African standards, being of 2% the prevalence estimated (República de Angola et al, 2010). The life expectancy at birth is only 50, less than the average for other Sub-Saharan countries fixed on 53 years (World Bank, 2010).

**Table 5-4: Key health indicators.**

| Indicator | Definition | Angola | Soyo |
|---|---|---|---|
| **Life expectancy** | Life expectancy at birth (years) | 50 | Data not available |
| **Infant mortality rate** | Infant deaths per 1000 live births | 115,7 | 1,9%* |
| **Under five mortality rate** | Deaths among children under-five, per 1000 live births | 193,5 | |
| **Maternal mortality rate** | Maternal deaths per 100 000 live births | 610 | Data not available |
| **HIV prevalence** | Percentage of total population with HIV | 2 | Data not available |
| **Malaria prevalence** | Percentage of population that have been ill from fever or malaria last 30 days | 10,7 | Data not available |

Source: Froystad, Maestad & Villamil, 2011; * Household Survey

One of the axes of the Government Programme 2012-2017 "Angola Growing More and Distributing Better" is to expand and significantly improve the quality of health services. In line with the National Health Policy, 4 strategic vectors are pointed:

- Consolidation of sector reform and strengthening their capacity, particularly at the level of the municipality;
- Expansion of health infrastructures and initiatives, aiming the strengthening of their performance capability;
- Reduction of maternal mortality, infant and juvenile, as well as the morbidity and mortality from diseases of the nosological national frame, paying special attention to chronic non-communicable diseases;
- Training of health staff, individuals, families and communities to promote and protect health.

In order to better understand the health situation in Soyo, an analysis of data of various sources was conducted: data from desk-based research and data collected from primary sources – in-depth interviews, focus groups and questionnaires.

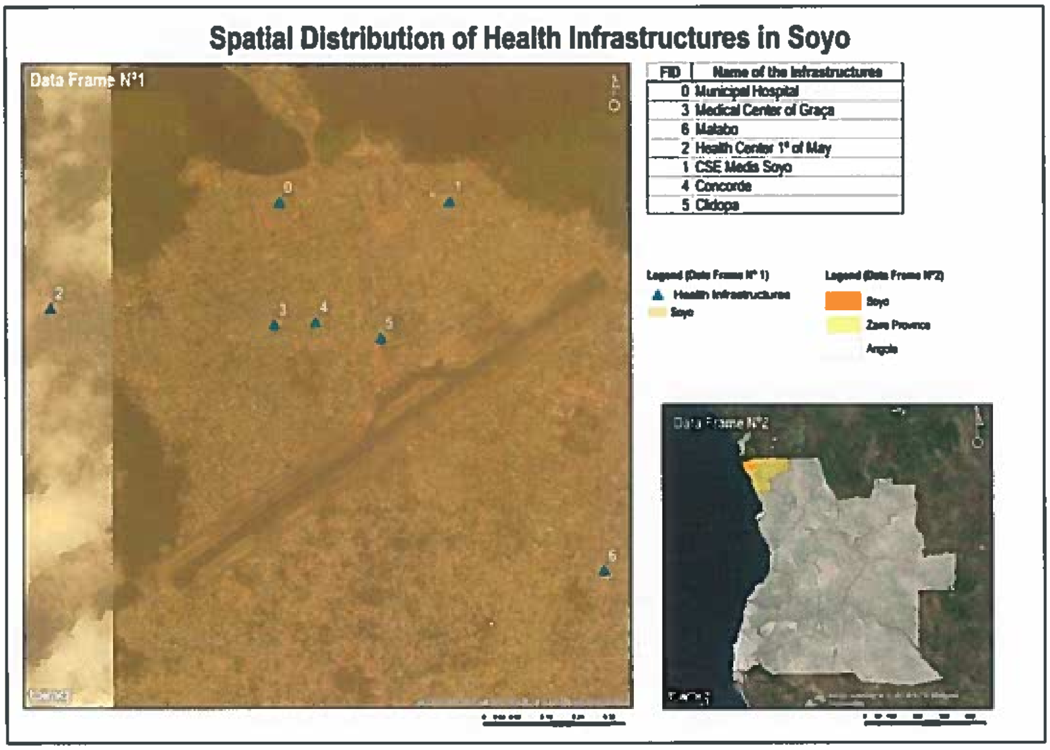



**Figure 5-51: Spatial distribution of health infrastructure in Soyo.**

The municipality has only one Municipal Hospital, there is a huge influx of people to this service, being this demand explained not only by the lack of local health infrastructures but also because, even when they exist, the population tends to resort immediately to a hospital. We also identified six other health infrastructures (Annex II: Spatial Distribution of Health Infrastructures in Soyo)[9]: Clidopa, Medis Clinic of Soyo, Health Centre 1º de Maio, Malabo Clinic, Concorde Clinic and Medical Centre of Graça – Illustration 1.

"The health network is not very good. This is the only hospital in the municipality and people should first seek the local health centres or clinics, and only then, if the problems could not be solved there, they should come here. Such is not the case and they immediately come here, creating an overload in this institution."

*(Municipal Hospital of Soyo Director IDI)*

**Table 5-5: Description of Municipal Hospital of Soyo.**

| Available Services | |
|---|---|
| **Preventive Services** | • Immunization (EPI)<br>• Oral rehydration<br>• Nutritional Recovery and Re-education |
| **Social Work Services** | • Paediatric Consultation |

[9] The application of the health infrastructure survey questionnaire was only accepted by in the Municipal Hospital, Medis Clinic and Concorde Clinic.

| Available Services | |
|---|---|
| | • Adults Consultation<br>• Dental Consultation<br>• Curative Care and Surgical Care<br>• Emergency and Emergency Room<br>• Hospitalization<br>- General medicine - short stay<br>- Maternity - short stay<br>- Paediatrics - short stay |
| **Ancillary and Clinical Support Services** | • X-Rays<br>• Laboratory<br>• Radiology<br>• Sterilization<br>• Pharmacy |
| **General Services** | • Medical transport<br>• Laundry<br>• Kitchen<br>• Morgue |
| **Infrastructure Conditions** | |
| **No. of Rooms** | • 4 Consultation Rooms<br>• 6 Treatment Rooms<br>• 15 Hospitalisation Rooms<br>• 5 Rooms for Administrative Services |
| **Rehabilitated Infrastructure and in reasonable condition** | |
| **Roofing** | Tiles / Cement and Concrete |
| **Masonry** | Ceramic bricks |
| **Floor** | Mosaics/Paves |
| **Water supply** | Purchased to Privates |
| **Power supply** | Electricity (network) and Own Generator |
| **Sanitary facilities** | • 12 Toilets<br>• Sewage system (sink or toilet)<br>• Sewage System connected to river/sea/lake/pond |
| **Human Resources** | |
| **Technical Services / Health Professionals Team** | • 3 General Physicians<br>• Other physicians<br>• 150 Nurses<br>• 15 Midwives<br>• 13 Diagnose and Therapeutics Assistants<br>• 3 X-Ray Technicians<br>• 3 Pharmacy Technicians<br>Note: 11 physicians are displaced and need to apply for housing. There is support for them. |
| **Administrative Services Team** | • 2 Medical Directors<br>• 1 Administrator Middle Technician<br>• 4 Typists<br>• 1 Accountant<br>• 1Archivist<br>• 1 Maintenance Responsible<br>• 2 Laundresses<br>• 4 Drivers<br>• 1 Hygiene Responsible<br>• 1 Cleaning Responsible |

The lack of human resources is pointed as a very serious constraint in Soyo – Table 5-6.

**Table 5-6: Number of health professionals in Soyo.**

| Health Carers | Number |
|---|---|
| Generalist | 4 |
| Orthopaedics | 2 |
| Surgery | 4 |
| Paediatrics | 1 |
| Genecology | 1 |
| Stomatology | 1 |
| Anaesthetist | 1 |
| Cardiology | 1 |
| Nurses | 260 |
| Communitarian Health Agents | 71 |
| Traditional birth attendant | 132 |

Source: Director of Municipal Bureau of Health SI

The main epidemiological indicators available are presented in the table below.

**Table 5-7: Main epidemiological quantitative indicators.**

| | Cases Registered 2012 |
|---|---|
| HIV/AIDS | 239 |
| Deaths in people with HIV/AIDS | 35 |
| Malaria | |
| • Total | 19 399 |
| • Children | 10 684 |
| • Pregnant woman | 2022 |
| Deaths associated with malaria | |
| • Total | 116 |
| • Children | 116 |
| Tuberculosis | 151 |
| Deaths associated with tuberculosis | 41 |
| Respiratory infections | 24 73 |
| Deaths associated with respiratory infections | 0 |
| Sexually transmitted infections | 206 |
| Diarrhoeal diseases | 1380 |
| Typhoid fever | 6098 |
| Varicella | 0 |
| Tetanus | 0 |
| Sleeping sickness | 0 |
| Viral haemorrhagic fevers | 0 |
| Poliomyelitis | 0 |
| N.º of children who received DTP3 immunisation | 28.237 |
| Asthma and Chronic Obstructive Pulmonary Disease | 0 |
| Cerebrovascular accident | 0 |
| Protein-energy malnutrition | 5 |
| Admissions/Medical consultations due to road traffic injury | * |
| Admissions/Medical consultations related to injuries due to violence | * |

Source: Director of Municipal Bureau of Health SI / Annual Report of 2012, * Data not available

Also, it should be noted that there are some health programmes in course in Soyo, seeking for health promotion and disease prevention, namely those pointed out by the Director of Municipal Bureau of Health: malaria, child care, epidemiological surveillance, HIV / AIDS, health Promotion, antenatal, tuberculosis and leprosy, acute diarrheal diseases and trypanosomiasis.

#### 5.2.2.1 Knowledge, Attitudes and Behavior in pursuing Health Care Services

The majority of the population (83.9%) resorts to health services only in case of illness - Figure 5-52 - being relevant the exclusive resort to public health services (66.5%) - Figure 5-53.

Regarding satisfaction with the health services available in Soyo, most individuals are pleased (60.2%) - Figure 5-54; however, the percentage of those who consider themselves very unpleased (37.8%) is quite expressive.

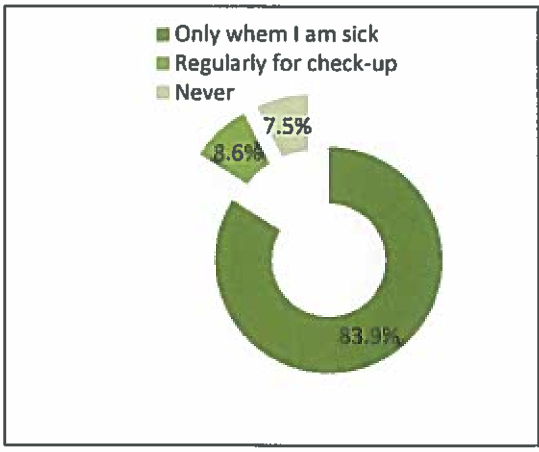



**Figure 5-52: Use of health services.**

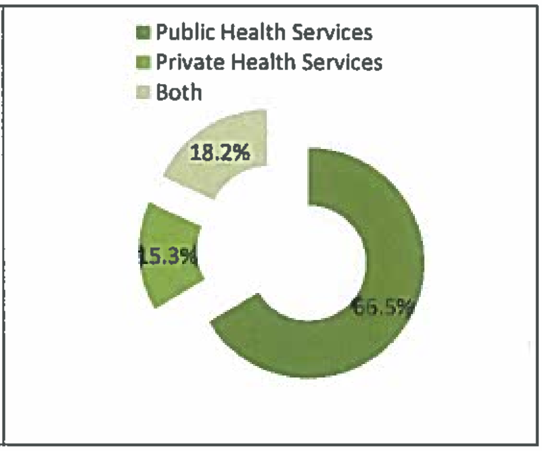



**Figure 5-53: Health services sector.**

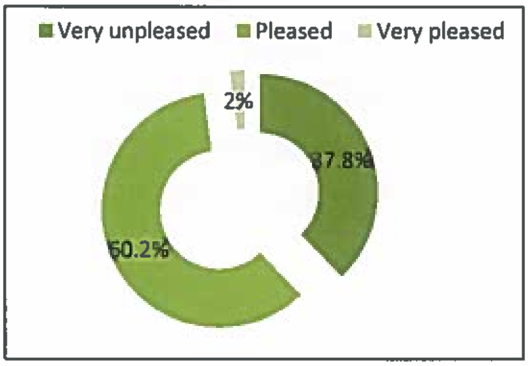



**Figure 5-54: Satisfaction with health services in Soyo.**

The Municipal Hospital is the most frequent option for diagnosis and treatment, irrespective for treating adults or children (Figure 5-55). Either in the case of adults or children, the use of traditional care providers is residual (0.5% and 0.2%, respectively).

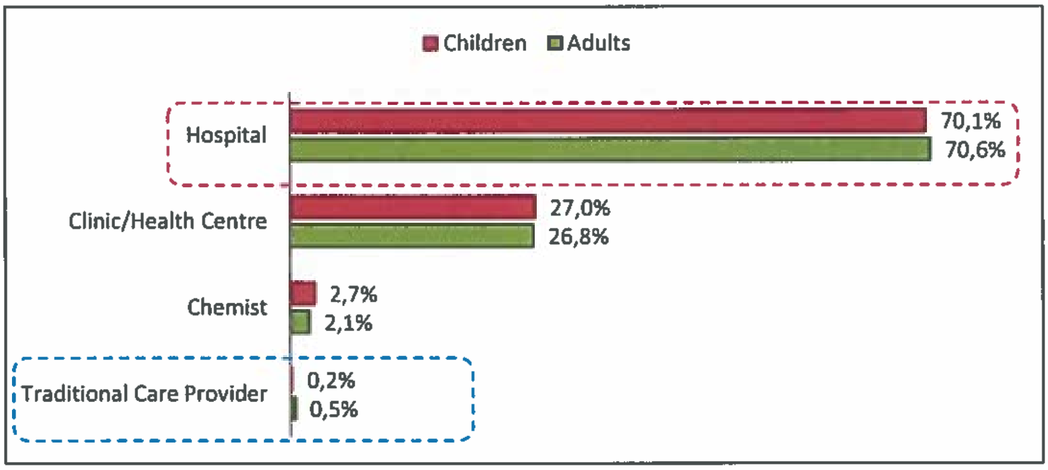



**Figure 5-55: Services sought for diagnosis and treatment.**

The vast majority of the surveyed population deem to have knowledge of the mandatory vaccines (86.4%); however, when confronted with six mandatory vaccines, only polio is recognised as mandatory, and measles vaccine is considered mandatory by more than half of the population - Figure 5-56. Vitamin A and yellow fever vaccines are not considered mandatory by more than 50% of the surveyed population and pentavalent and BCG vaccines are rarely recognized as mandatory.

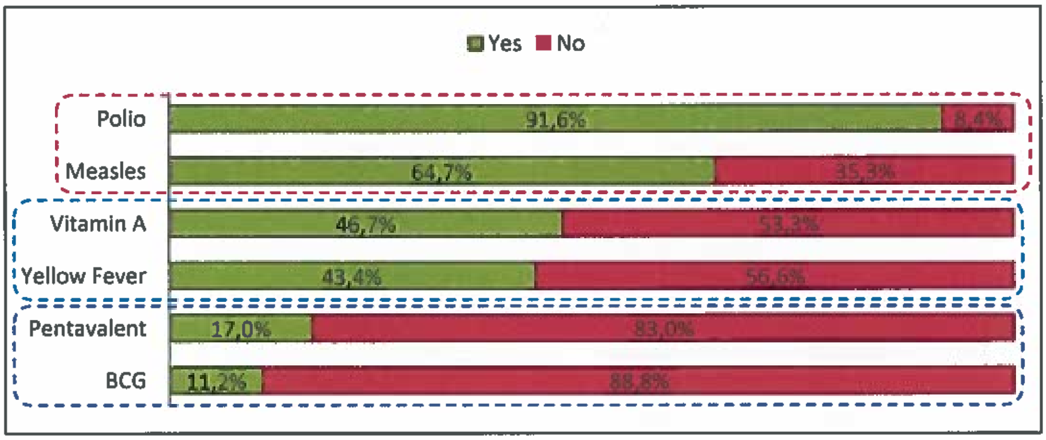



**Figure 5-56: Recognition of mandatory vaccines.**

**Self-rated health status and risky behavior**

The majority of the surveyed population assesses its current state of health positively, being the assessments focused between "good" and "fair" - Figure 5-57; negative ratings ("bad" or "very bad") represent 6.3% of the cases.

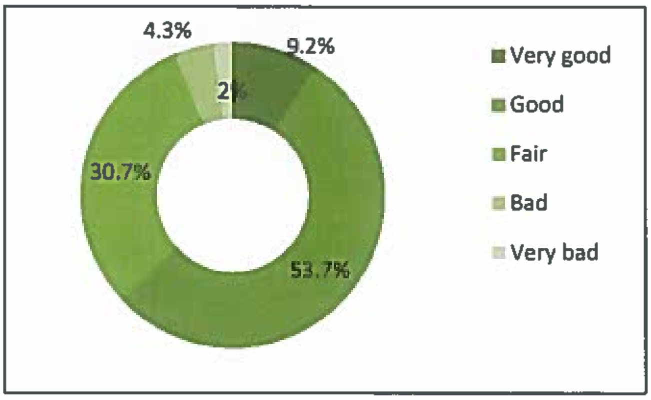



**Figure 5-57: Self-assessment of the current state of health.**

In relation to smoking products (tobacco, cigars, cigarillos or other), the vast majority of people do not smoke - Figure 5-58. Taking into account the population that claims smoking every day, it appears that on average it is a behaviour that persists for 12 years.

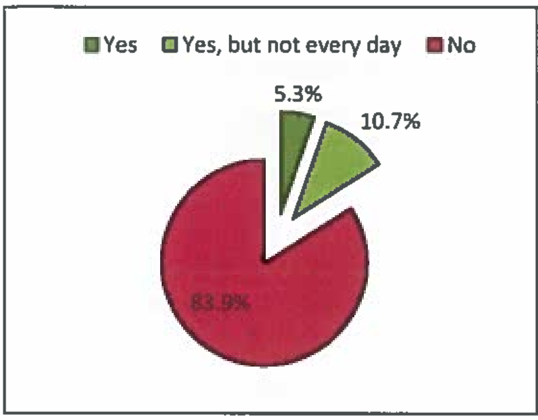



**Figure 5-58: Consumption of smoking products.**

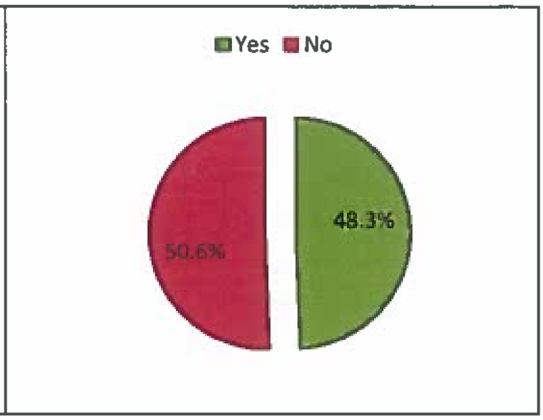



**Figure 5-59: Intake of alcohol apart from being in a religious ceremony or simply to try it.**

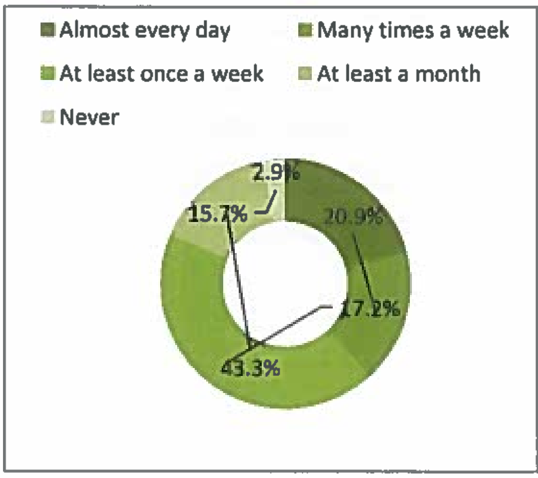



**Figure 5-60: Frequency of alcohol consumption.**

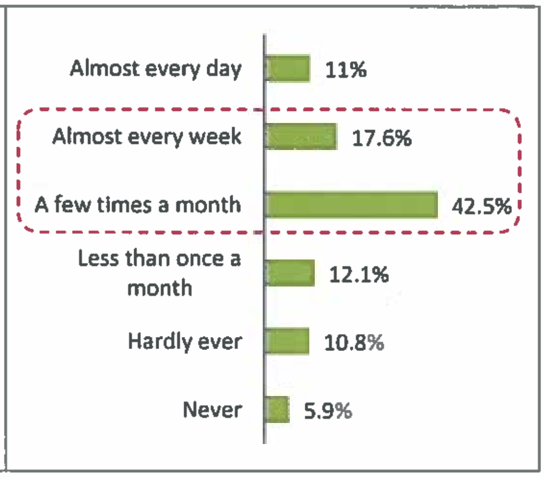



**Figure 5-61: Frequency of excessive alcohol consumption.**

With regard to alcohol consumption, it appears that approximately half of the surveyed population has already taken an alcoholic drink, considering, for this purpose, consumption not associated with religious ceremonies or just to try – Figure 5-59. Analysing the profile of the population regarding the frequency of consumption – Figure 5-60 – it is revealed that 20.9% has a daily intake of alcoholic beverages, 17.2% do it frequently during the week and 43.3% at least once a week. Considering the excessive consumption of alcoholic beverages[10], it is possible to highlight that 42.5% of the population that consumes alcohol in excess does it a few times a month and 17.6% almost every week – Figure 5-61.

In the context of sexual health, it is concluded that approximately one fourth of the population usually has extramarital sex (24.3%).

Considering the last 12 months, the analysis of the presence of the four symptoms below presented – Figure 5-62 – allows highlighting diarrhoea, present in 40.3% of the population; cough, lasting for three or more months, reaches 11.5% of the population and the presence of blood in stools 9.8%.

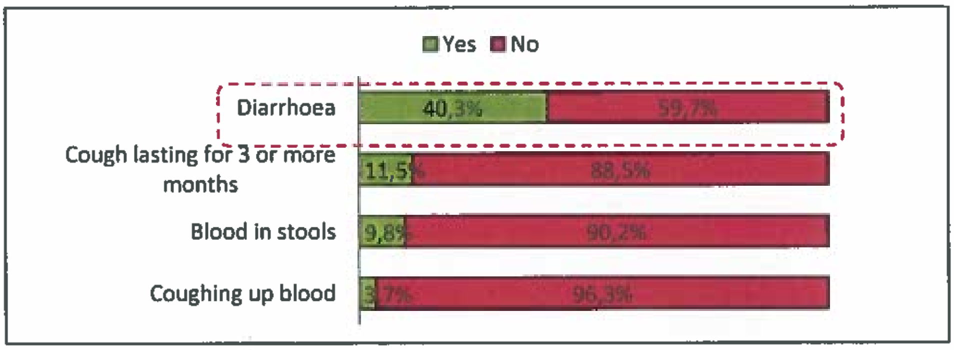



**Figure 5-62: Presence of symptoms in the last 12 months.**

Regarding the screening tests for diseases/infections, it appears that the malaria screening test was performed, within the past 12 months, by 56.5% of the population; a considerable percentage performed the HIV/AIDS screening test, which was carried out by 46% of the population – Figure 5-63.

The screening tests for tuberculosis, cholera and polio are less frequent in the population, ranging between 11.4% and 8.3%.

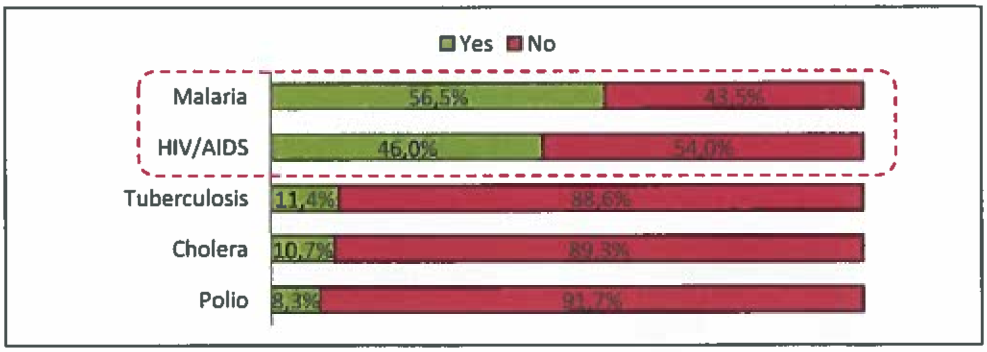



**Figure 5-63: Screening tests for diseases/infections in the past 12 months.**

**Malaria**

Regarding the use of mosquito nets, half the population sleeps with mosquito net – Figure 5-64; and of these, approximately 85% uses sprayed mosquito nets – Figure 5-65.

[10] Consumption is considered excessive when it reaches or exceeds 5 (for men) and 4 (for women) alcoholic beverages on a same occasion (Gunzerath, Faden, Zakhari & Warren, 2004; Carey, 2001).

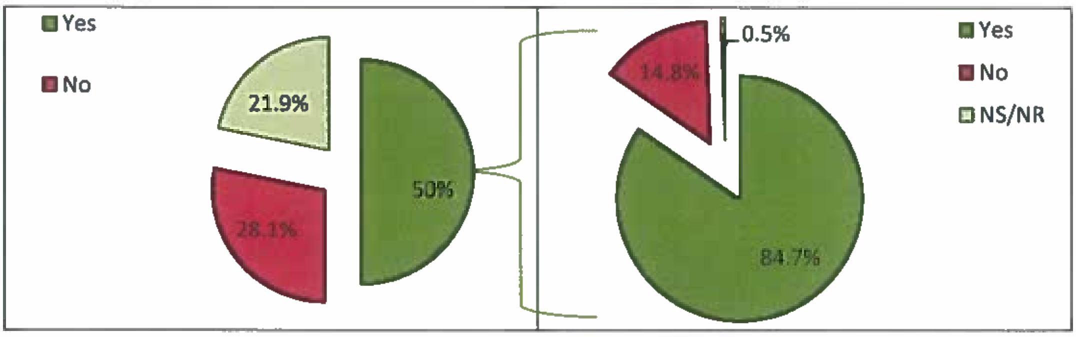



**Figure 5-64: Use of mosquito nets.** **Figure 5-65: Use of sprayed mosquito nets.**

As stated previously in this document, according to data from the Municipal Health Bureau Soyo, in 2012 were recorded 19 399 cases of malaria, being 2022 on pregnant women and 10 684 in children. Malaria was associated with 116 deaths, all in children population. In 2011 the Health Municipal Bureau registered a total of 28 273 and 1596 in pregnant women; apparently, the incidence of malaria is decreasing (ANGOP 2013a).

The frequency of malaria is highly variable, according to self-evaluation; however, it appears that the trend falls mainly in the categories "sometimes" and "often" – Figure 5-66.

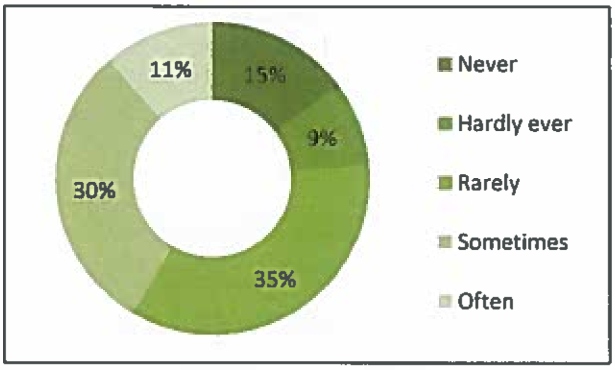



**Figure 5-66: Frequency of malaria.**

In patients diagnosed with malaria, the type of treatment preferred lies mostly in medicines prescribed by a doctor (89.8%) – Figure 5-67.

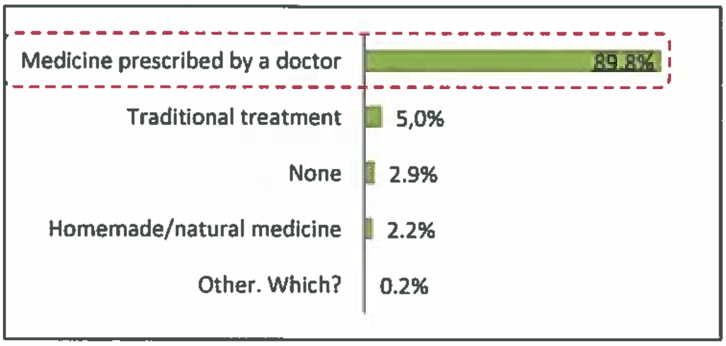



**Figure 5-67: Treatment for malaria.**

**Tuberculosis**

The majority of the population (86.3%) recognizes the possibility of transmission of TB from one person to another – Figure 5-68; however, it should be noted that 8.9% of the population does not believe in this way of transmission.

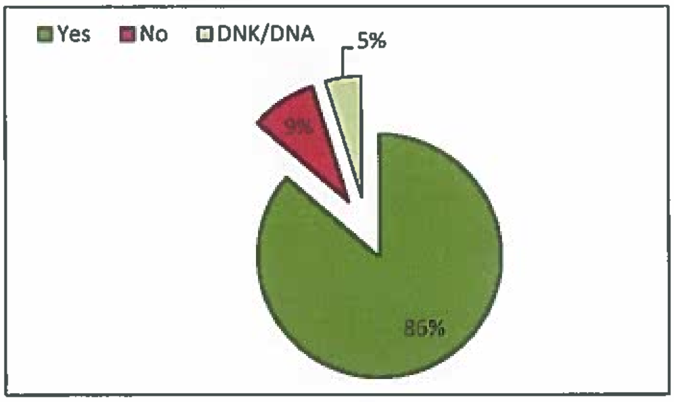



**Figure 5-68: Possible transmission of TB from one person to another.**

As regards the ways of infection, it appears that, excluding sex, contact with the same toilet and mosquito bite, all other behaviours are considered ways of infection by the majority of the population – Figure 5-69. It should be noted that contamination from one person to another is associated with contaminated air with the *Koch* bacillus, excreted by patients with untreated tuberculosis through talking, coughing or sneezing (WHO, 2013); tuberculosis is not transmitted through blood or sex.

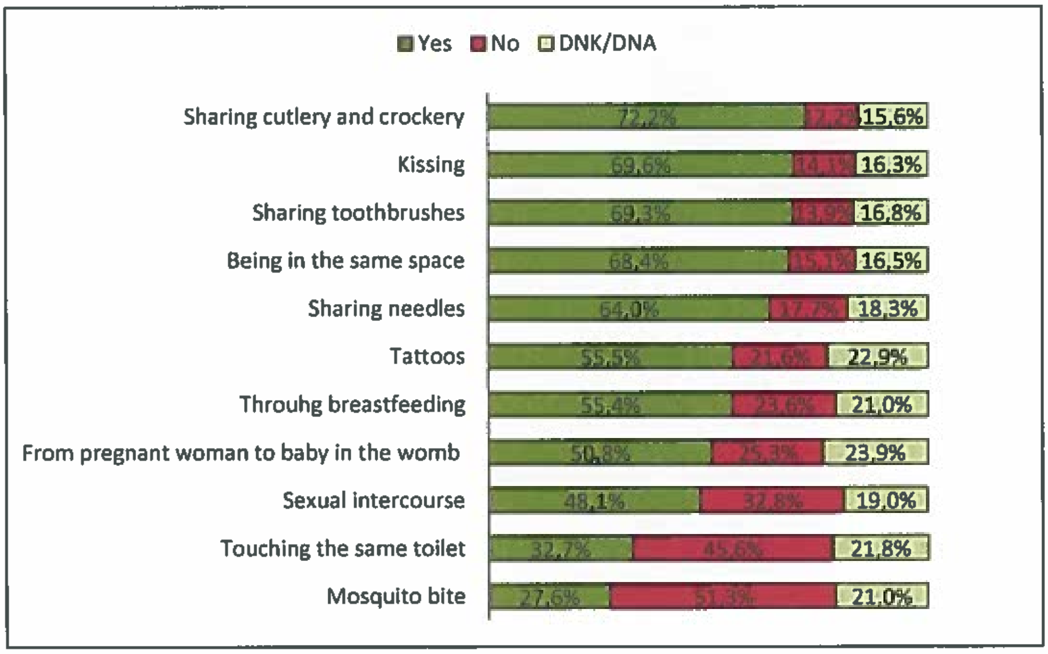



**Figure 5-69: Transmission of tuberculosis.**

The vast majority of the population recognizes the existence of treatment for tuberculosis – Figure 5-70.

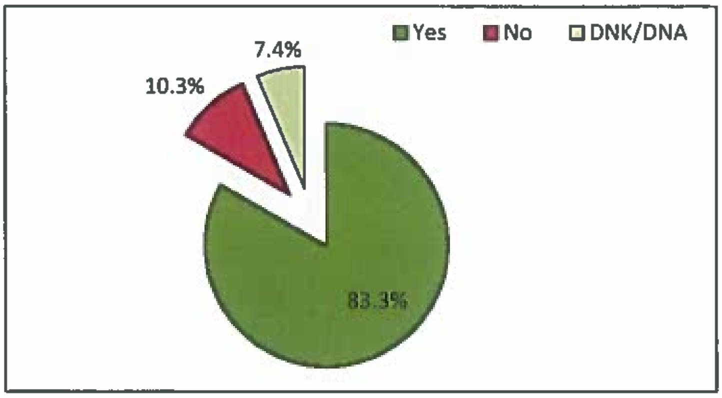



**Figure 5-70: Existence/Availability of treatment for tuberculosis.**

Regarding the indication of which treatment, from those who recognize its existence, it is noteworthy that 34.9% do not know / do not answer to this question; the antiretroviral drugs are considered the correct category for a larger number of people (21.1%); it stands out, however, that the treatment associated with traditional medicine is reported by 10.9% of the population - Figure 5-71.

As for the duration of the treatment, it stands out again the tendency for a high number of responses does not know / does not answer – Figure 5-72 - and the most frequent response is a duration of 6 months (34%), followed by treatment until the person feels better (24.9%).

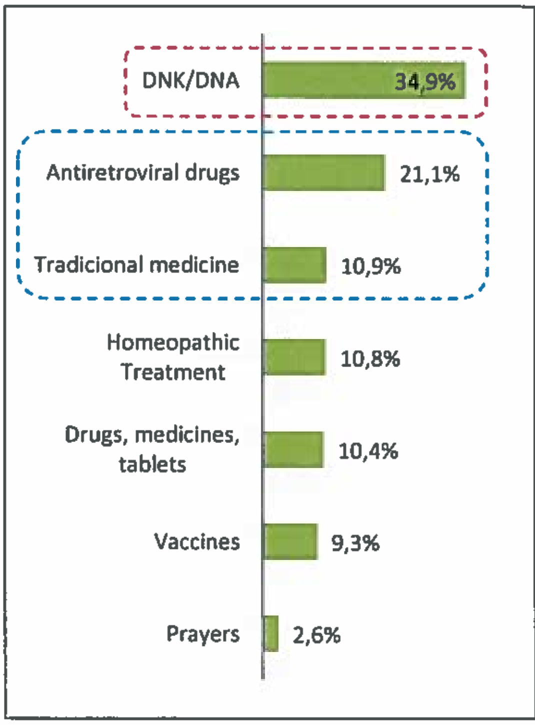



**Figure 5-71: Methods of treatment for tuberculosis.**

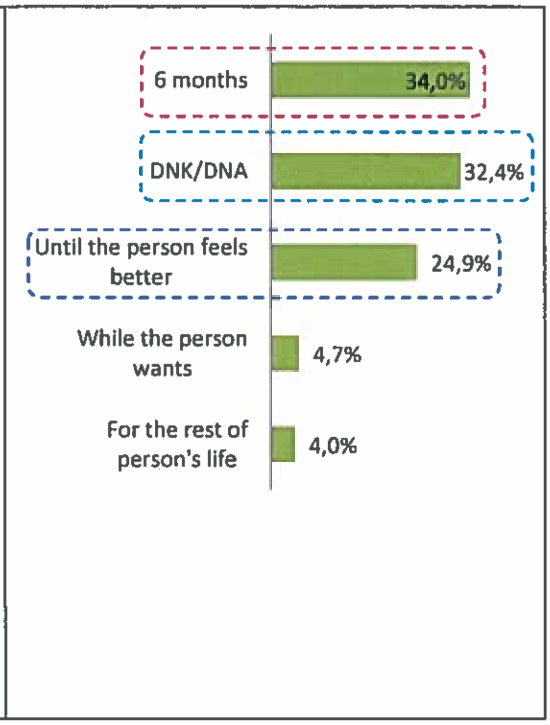



**Figure 5-72: Duration of TB treatment.**

**HIV/AIDS**

Accordingly to the Interview of the Head of Municipal Health Bureau, in 2012, there were 239 cases of HIV / AIDS, compared to 87 recorded in 2011 (ANGOP, 2013a), and 35 deaths associated with

HIV/AIDS; the apparent increase is explained, according to the leaders of the Municipal Health Bureau, through a greater adherence of population to voluntary testing (*idem*).

There is broad consensus that HIV can be transmitted from one person to another – Figure 5-73.

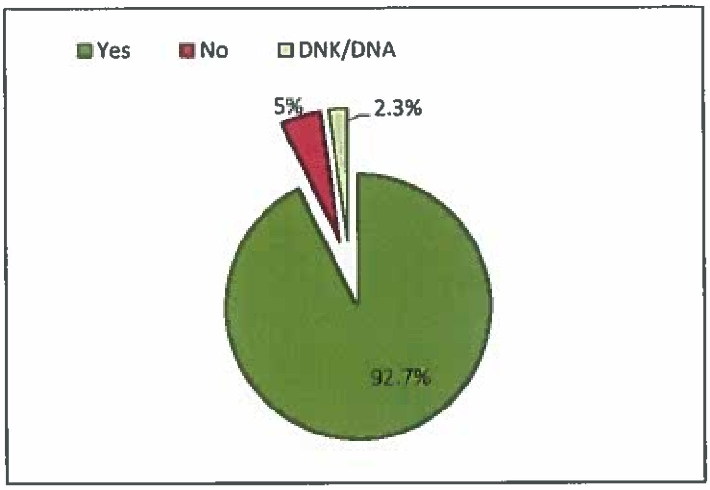



**Figure 5-73: Possible transmission of HIV/AIDS.**

Regarding ways of transmission, it is emphasized that sexual intercourse (91.4%), needle sharing (88.7%) and tattooing (78.4%) are the most recognized ways of transmission by the surveyed population – Figure 5-74. The transmission from mother to baby through breastfeeding or via intrauterine, is recognized by about 63% of the population. The sharing of a toothbrush is, however, wrongly associated with HIV transmission by 60.2% of the surveyed population.

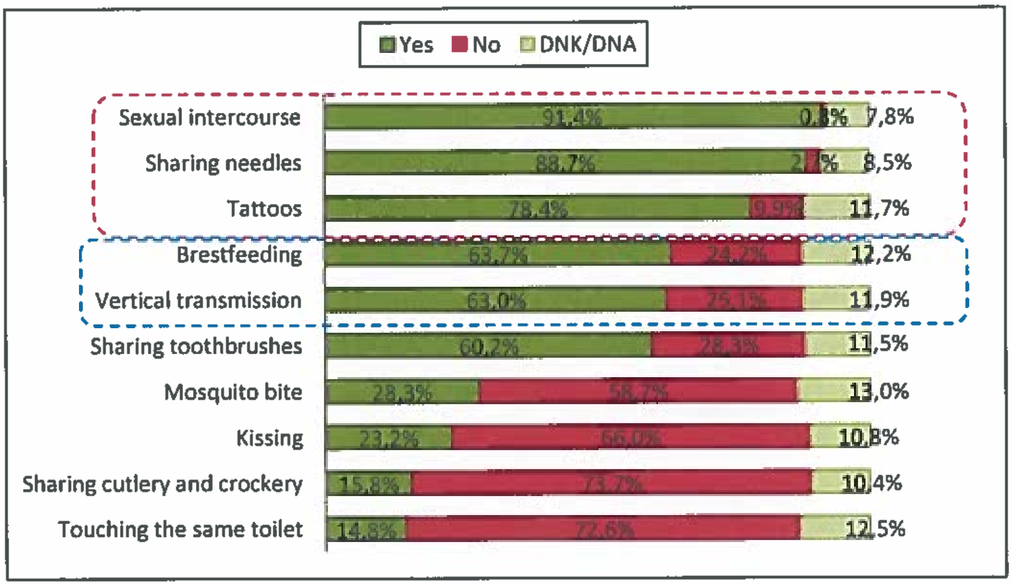
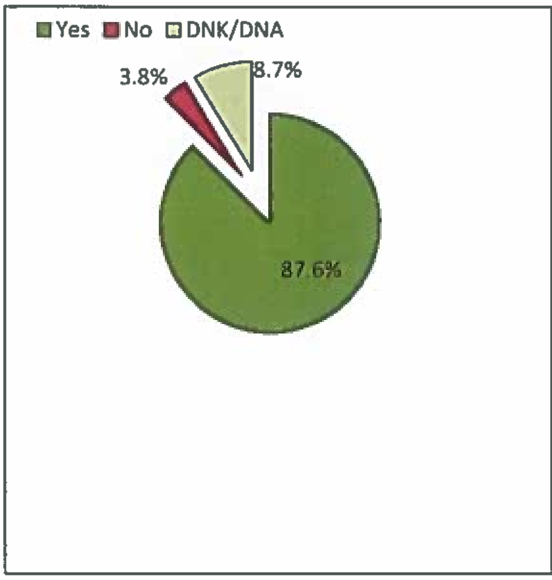



**Figure 5-74: Ways of HIV transmission.**

HIV prevention is considered possible by 87.6% of the individuals – Figure 5-75 – being the use of condom the most often way of prevention mentioned and the only way recognized by more than half the population – Figure 5-76.



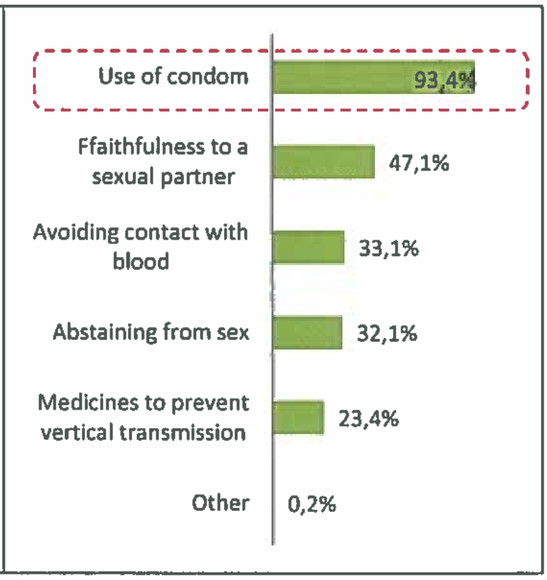
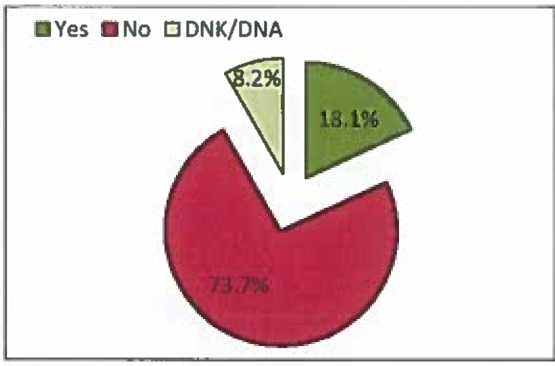




**Figure 5-75: Possible transmission of HIV.** **Figure 5-76: Ways of HIV prevention.**

Approximately one third of the population (23%) says they know someone close, family member or friend who has AIDS.

The percentage that believes it is possible to cure HIV/AIDS (18.1%) is substantially lower than the population that acknowledges the possibility of treatment (74.2%) – Figure 5-77 and Figure 5-78.



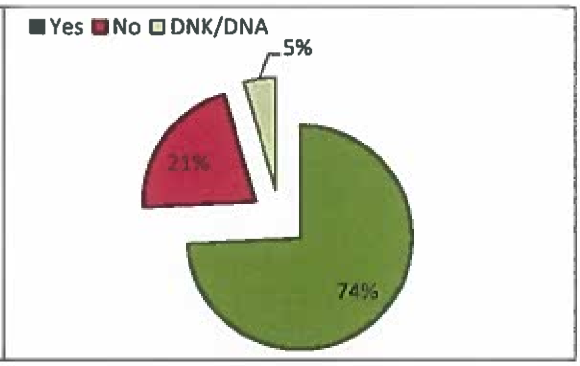




**Figure 5-77: Possible cure for HIV / AIDS.** **Figure 5-78: Possible treatment of HIV / AIDS.**

Antiretroviral drugs are identified by 78.9% of the cases as the treatment for HIV/AIDS – Figure 5-79 – and 61% of the population recognizes that this is a lifetime treatment –Figure 5-80.

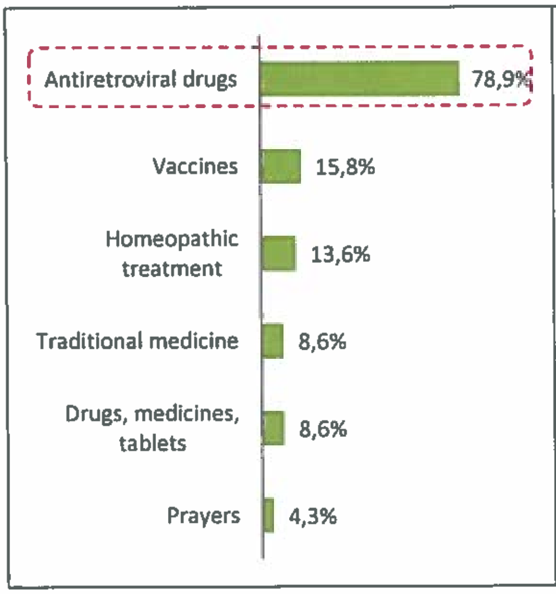



**Figure 5-79: Treatment for HIV / AIDS.**

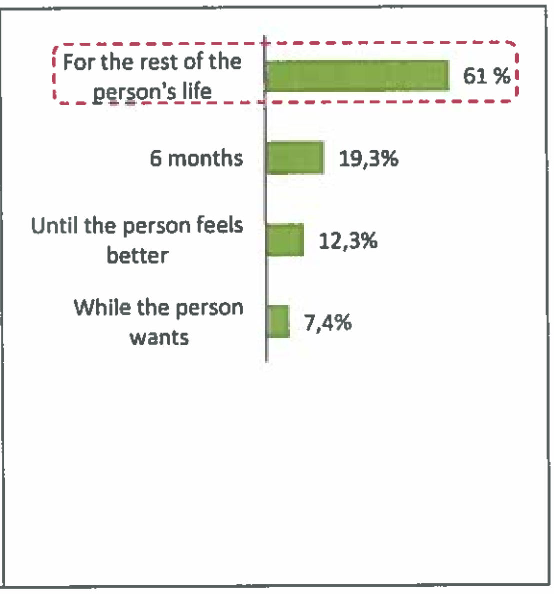



**Figure 5-80: Duration of HIV / AIDS treatment.**

As regard opinions and attitudes towards HIV / AIDS (Table 5-8), it appears that:

- The majority of the population: would keep friendship with someone even if he/she discovered that this person has HIV; thinks everyone should get tested for HIV, and believes that a person can have HIV and look healthy.
- There is a minority percentage of people who: believes that life stops making sense when you know you have HIV; would be embarrassed to be seen with someone that everyone knows to have HIV/AIDS; thinks HIV is more easily transmitted within six weeks from the time of infection, and believes that a circumcised man does not need to use condoms to avoid being infected with HIV.

**Table 5-8: Opinions/Attitudes towards HIV / AIDS.**

| | Agree | Disagree | DNK /DNA |
|---|---|---|---|
| Would still be friend of someone even if he/she found out that person has got HIV. | 77.2% | 21.6% | 1.2% |
| When a person knows he/she has HIV, life stops making sense, it ends. | 33.0% | 64.5% | 2.5% |
| Would be embarrassed to be seen with someone that everyone knows to have HIV / AIDS. | 36.5% | 62.5% | 1.0% |
| Everyone should get tested for HIV. | 78.9% | 19.2% | 1.9% |
| HIV is transmitted more easily within the first 6 weeks after a person has been infected. | 31.7% | 50.1% | 18.1% |
| A circumcised man does not need to use condoms to avoid contracting HIV. | 26.6% | 63.9% | 9.5% |
| A person can have HIV and appear healthy. | 75.8% | 21.4% | 2.8% |

#### 5.2.2.2 Fertility and Child Mortality

For this section, the sample is constituted by 684 surveyed women, including women in the reproductive age, considered between 12 and 49 years old.

The percentage of women currently pregnant is 18.9% – Figure 5-81.

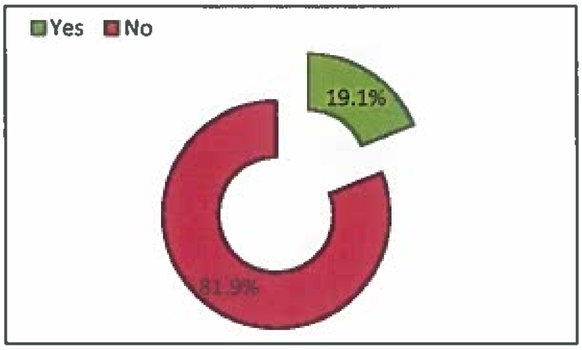



**Figure 5-81: Women currently pregnant.**

There are a total of 1,547 children, an average of 2.26 children per woman, and the median is two children – Table 5-9.

**Table 5-9: Number of children births by woman to date.**

| No. of Children | Frequency | % | Cumulative% |
|---|---|---|---|
| 0 | 117 | 17.1% | 17.1% |
| 1 | 167 | 24.4% | 41.5% |
| 2 | 146 | 21.3% | 62.9% |
| 3 | 113 | 16.5% | 79.4% |
| 4 | 57 | 8.3% | 87.7% |
| 5 | 40 | 5.8% | 93.6% |
| 6 | 13 | 1.9% | 95.5% |
| 7 | 13 | 1.9% | 97.4% |
| 8 | 13 | 1.9% | 99.3% |
| 9 | 2 | 0.3% | 99.6% |
| 10 | 3 | 0.4% | 100% |
| Total | 684 | 100% | |

The mortality rate in this area is limited as 1.9%. As regards the time of death, it appears that the most frequent situation is death after birth and due to a known disease – Figure 5-82.

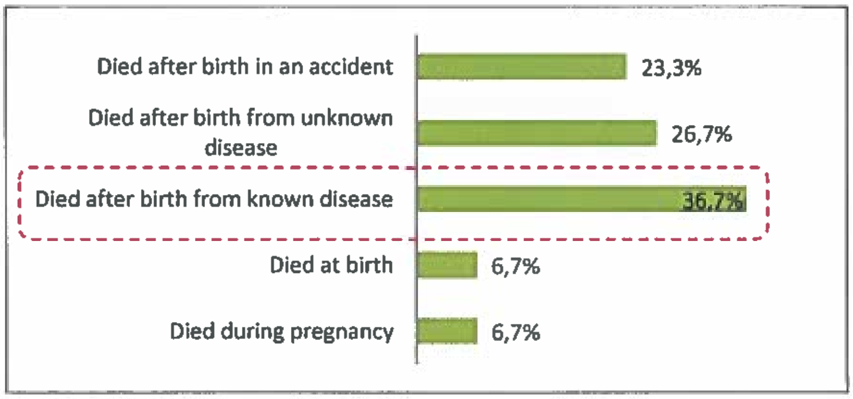



**Figure 5-82: Neo-natal death time.**

For live births, and analysing their age distribution, it is noted that about half (46.6%) are aged less than 10 years, and about one fifth (19.7%) aged over 20 years – Figure 5-83.

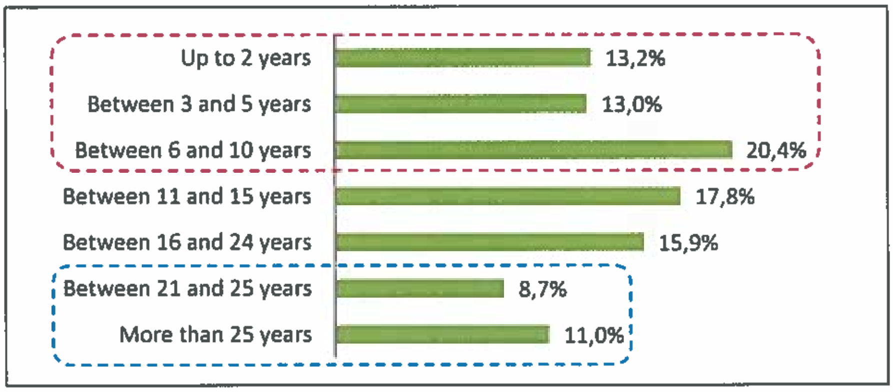



**Figure 5-83: Distribution of children by age.**

Most pregnancies had been monitored by health professionals – Figure 5-84. There is a predominance of births attended by skilled physicians (64.6%), followed by deliveries attended by general practitioners (26.7%); deliveries using the services of traditional birth attendants represent 5.3% of the cases – Figure 5-85.

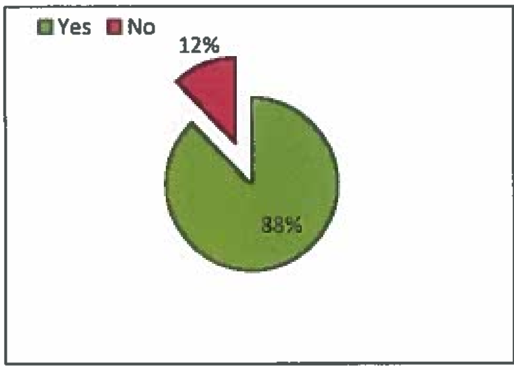



**Figure 5-84: Pregnancy monitored by health professionals.**

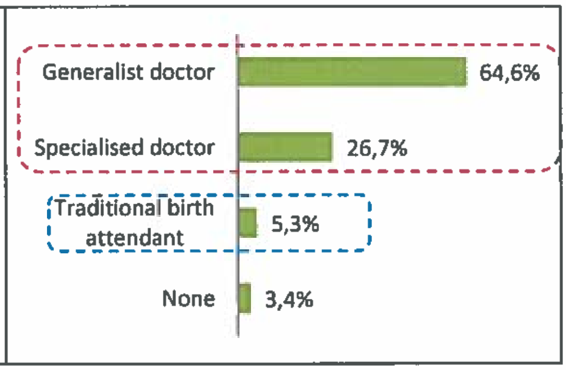



**Figure 5-85: Deliveries monitored by health professionals.**

Noteworthy are births in the hospital (44%) and maternity (32.8%); it should be also noted that, after these places, the house where the woman lives/lived at delivery is the third most mentioned place (13.7%) during the study about the birthplaces of their children – Figure 5-86.

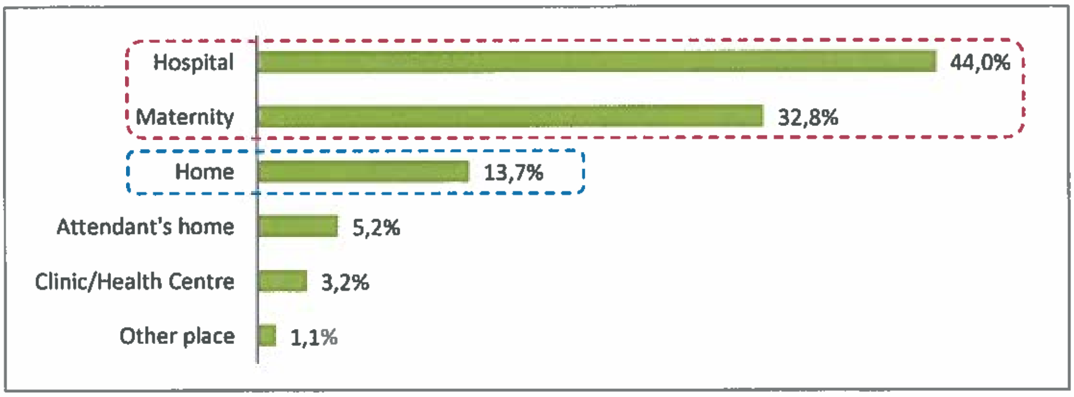



**Figure 5-86: Place of birth.**

Finally, as regards vaccination considered mandatory, there is a majority proportion of those whose mothers have claimed to have made the vaccines - Figure 5-87.

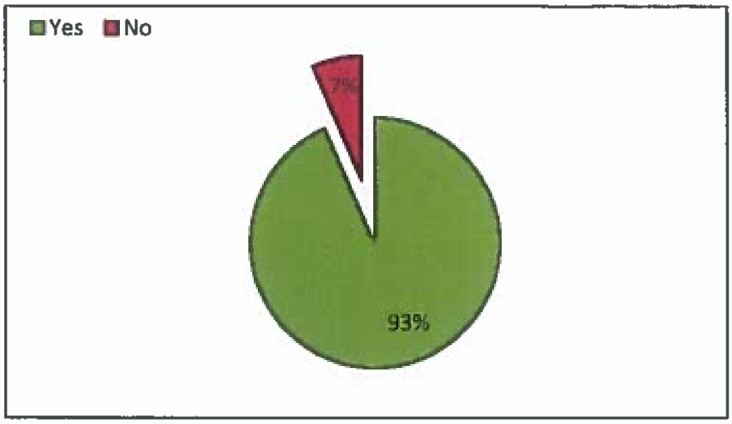



**Figure 5-87: Children who made compulsory vaccination**

### 5.2.3 Communities

According to what was defined by ENI in the scope of this research (Scope of Work - Doc. N. º 000287_DV_CS.HSE.0481.000_00), this analysis will be made taking into account three types of communities:

a. Agriculture and Fishing Communities: communities located outside the urban centre of Soyo and where agriculture is predominant in terms of subsistence.

b. Fishing Communities: communities predominantly oriented to fishing with respect of subsistence.

c. Urban Communities: communities located in the urban centre of Soyo.

However, due to the integration of diverse occupation groups, the following four categories are also identified:

a. Predominantly farming communities

b. Predominantly fishing communities

c. Complementary communities in the primary economic base (farming and fishing)

d. Predominantly urban communities

For all intended purposes, the concept of community used in this report will be the distinct population cluster which presents homogeneous socio-economic characteristics, both in terms of the main sources of income and economic occupation, and in terms of cultural practices.

The long lasting war in Angola produced effects on the population way of life; the national reconstruction process has been evident, however there are some signs that have extended to the present at different levels. The communities of Soyo are essentially agricultural, although fishing has a great importance in coastal and fluvial areas, and even in urban areas. Both activities are, however, essentially performed without great use of technology, therefore the generated incomes are low and production destined largely for subsistence.

Agriculture is widespread and constitutes the core business of many families. Although in some areas fishing is comparatively more important, the diet of the population of this municipality is based on the most abundant agricultural products - cassava, beans and *kisaca* - and fresh and dried fish, whereas meat consumption is more sporadic .

Among the major problems registered by the economic activities, the need to mechanise agriculture and modernization of fishing activity through the use of more modern vessels stand out. Employment in the formal sector, including the oil industry, is the area of greatest opportunity but does not absorb the working population of the municipality, and young people in general register low qualification in relation to the needs in this area.

Local management of both urban and rural districts is done through an administrative structure that includes various levels of traditional authorities (sobas, sekulos, and aldermen). In Soyo, the ultimate authority is King Pedro Tona (Mani-Soyo), dependent on the king of Congo. The articulation between traditional structures and the government is very close and occasionally it also involves oil companies.

"Even Angola LNG, before its implementation, did the ritual in Ponta do Padrão, in order for the company to prosper." (Urban Sobas FG)

The family in Angola and in Zaire region constitutes a wide range of family networks, with links between countryside and city and structured in accordance with rather pronounced assumptions of mutual aid and solidarity. The household is generally wide, implying the coexistence of various types and degrees of family members. Although formal marriage is not common, conjugal relations are usually started early and polygamy is widespread. The family disputes are usually arbitrated in the sphere of traditional rules, and traditional authorities play very important functions in this area; they are also responsible for mediating disputes between families, conflicts over land issues and those concerning matters of witchcraft.

In terms of housing and access to infrastructures, there is a marked difference between the constructions predominantly in cement bricks in the city, in planks and adobe in rural areas, and the temporary and removable type (burlap, plastic and planks) in fishing areas, although in recent years both in rural and fishing areas the number of buildings has increased. Accessibility to electricity and drinking water is higher in the city, although in this area their supply has also registered several difficulties. The most widely used fuel for cooking in the countryside and fishing areas is firewood and coal while in the city families with more resources can use gas in addition to coal.

The daily commutes of the population are relatively intense, implying that in the rural environment long distances are travelled on foot between villages and croplands. In the city, it is more common to use private taxis between centre and periphery. The population in the fishing areas typically resort to rowing or motor boats. Transportation is more expensive in rural areas and the state of the roads is still precarious, either between rural and urban areas or within the city, which makes transportation in rural areas even more expensive; it also makes it rarer and more time consuming and, in the city, it implies that some roads become impassable during the rainy season.

In the field of health infrastructures, the city has a large number of equipment and human resources, although in general terms shortages are registered throughout the county. The main problems related to health are closely linked to access to water and its quality and garbage - cholera, malaria which spreads due to stagnant water.

In the education field, although there are more school facilities in the city, both in rural and in the city, schools are not sufficient to address the population growth and demand, thus there are many students out of the education system. This insufficiency is even more evident at the higher levels of education, since middle education institutes only exist in Soyo city and the university has just begun to operate in the city three years ago.

#### 5.2.3.1 Agriculture and Fishing Communities

While it is important to bear in mind the specificities of the different areas that compose the rural municipality of Soyo – inner land areas, riverside areas and coastal areas – it is possible to identify key common features related to ways of life, social dynamics and main challenges.

**Context and Way of life**

With the gradual process of national reconstruction, the rural-urban relations in Soyo municipality intensified. In general, the population living in rural areas recognizes the advantages of country life, in their areas of origin, taking into account the calmer pace of life.

"The air here is better, we live more comfortably. Cities have noise, a lot of people, other diseases such as high blood pressure, and typhoid fever." (Urban Men FG)

"People prefer living here, the city is very congested." (Urban Sobas FG)

However, in rural areas shortages still occur at various levels that are a factor of preference for the city over the countryside, especially among younger people.

"The older people live better in the country. For young people the city is better." (Urban Sobas FG)

The main advantages of city life are related to access to employment and paid work.

"Husbands do not work ... they only go to the field to have something to eat." (Agriculture Women FG)

The development of rural areas is admittedly slower than in cities.

"There is a lot that arrives in Luanda and Soyo but it does not get to people here." (Agriculture Men FG)

From the perspective of rural people, bringing together city and countryside - namely through improvement in transportation and communication routes - would bring additional advantages, allowing on the one hand, the access to goods and services that the city offers, and, on the other hand, the possibility of deploying enterprises closer to the rural areas, with benefits in terms of employment.

"The companies should also extend here from the cities." (Urban Men FG)

"People like and prefer living in the countryside. But they would live much better if they could have roads to travel to the city so that they meet their needs." (Urban Sobas FG)

**Productive Activities**

Both fishing and farming are important in Soyo as a source of subsistence and income generation. Both predominantly farming and fishing communities are dedicated mainly to the growth of cassava, which is a staple food. Complementarily, they grow peanut, corn, cowpea, sesame; more irregularly, sweet potatoes and some kind of grain. Additionally, people resort to growing and harvesting fruits – such as banana, papaya – and sugar cane. Once abundant, cashew production has suffered a sharp decline for decades.

On average, a family can produce one tonne of cassava per year and the remaining products in smaller quantities, mainly depending on the rain. The produced food products are usually considered sufficient to feed their families.

In most cases, families arrange these activities between the various members and according to the working capabilities. Families are usually busy all day with fishing and farming: women go to the field in the morning and return in the evening; men go fishing in the morning (before 5:00 am) and then, at noon, they join the women in the fields.

"Men go first to the beach (from 5:00 am to 12:00 am) and then they join the women in the fields (until 5:00 pm) every day. The only resting day is Sunday." (Agriculture Men FG)

"Some people go to the fields on Sunday because there are monkeys that destroy the crops." (Agriculture Men FG)

Farmers can walk about 20 km a day (over two hours) to go to the fields. The closer fields are smaller, for example, peanut fields; the larger fields, cassava, are typically located further away from villages.

"The farmer who is a fisherman has to walk to the sea and then even more miles to fish." (Agriculture Men FG)

Agricultural surpluses (and the fish) are sold, more rarely in their own communities, to buyers who go there or more often in the markets of Soyo city. Fish is more often sold fresh than dry because the villages are close to the city. Elsewhere, when farther from the city, the fish is dried in higher quantity.

"We sell the fish in the city and here... We do not sell many agricultural products because we produce few." (Agriculture Women FG)

"Sometimes buyers come here, go to the beach and buy directly from the fishermen. But there is more profit selling in the city." (Fishing Men FG)

The profits from these sales are used to buy products that are only found in cities:

"Soap, cooking oil, sugar, coffee, OMO (washing detergent), salt, oil, are the most necessary things." (Agriculture Men FG)

Animal rearing should also be mentioned - like chickens (in higher numbers), goats and pigs; there are several problems facing this type of activity, such as the existence of snakes that kill animals and, in some instances, outbreaks of plague that infect the chickens.

"There are few families growing goats, but almost all have chickens. There have been plagues infecting chickens and we do not know how to defend ourselves from these plagues." (Agriculture Men FG)

In order to supplement the incomes and diet, some families still resort to harvesting fruits (mangoes, bananas), hunting and harvesting honey. More rarely, they may resort to odd jobs in the city or temporary work for companies that deploy locally (construction of roads, bridges, etc.).

Among the identified needs to improve the current activity and start new projects, farmers refer particularly to the need of mechanized farming, lack of working tools (chain saws, wood saws, machetes) and improved seeds.

"Agriculture is subsistence; mechanized agriculture is needed, or at least oxen to support agriculture, as there are in the south." (Urban Sobas FG)

Moreover, a major problem for farmers is the lack of access to transportation - either because it does not exist in certain areas, or because it is too expensive, or because some roads are impassable – which does not allow them to distribute their products and/or increase their production to obtain higher yields.

Other issues related to agricultural work and these difficulties are found at the level of rainfall dependence, poor access to improved techniques and dependence on physical effort of family members for production.

"Last year it did not rain, we were empty-handed." (Agriculture Men FG)

"We do not have seeds or machinery and therefore the fields are smaller. This is because we are working with hoes." (Agriculture Women FG)

"Sometimes there are poorer families – weaker for work, older – who cannot produce and they may even starve. And there are also the lazy ones. Many cannot handle this pace of work all day." (Agriculture Men FG)

Notwithstanding, one of the ways designed to enhance the production relies on the product conservation, which would be a factor for increasing the production and consequently the farmers' incomes.

Attention should be drawn to the fact that young people demonstrate that they have some ambition in obtaining a job in the city. Most young people in the farming areas try to get a job – and a qualification

– in the city, though some of them mentioned that being so difficult to get, they do not even try. Resorting to odd jobs in the city is also common, as well as temporary employment in construction works.

**Figure 5-88: Access to rural community.**

Regarding support available for farmers, the possibilities are still irregular in the city. To a large extent, farmers are unaware of the activity of the Agrarian Development Stations (EDA) and there are only a few farmers associations. Sometimes the agriculture municipal office provides seeds to sobas, who distribute them; however, for the population of villages the lack of transportation often prevents access to these products.

"It is not worthy to pay for transportation to get the seeds" (Agriculture Men FG)

**Housing and Family**

The rural family is an extension of large family networks, with connections to the city and structured in accordance with rather pronounced assumptions of mutual aid and solidarity.

"Family members who live at home are the husband, the wives, children, nephews/nieces, cousins, grandparents, uncles/aunts ... All depending on the families." (Agriculture Women FG)

Although formal marriage is not common, conjugal relations usually start early and polygamy is a common practice.

The most common conflicts within families are mainly related to poverty and cases related to alcoholism are also referred to.

"In the municipality of Soyo, ladies drink ... There are churches that come from Congo which cause confusion ..." (Agriculture Women FG)

As for the house, in rural areas it still is very common to have construction of adobe and grass roofs. However, the rural residential landscape transformation in recent years is notorious, with an increasing demand for materials such as concrete or brick and zinc sheets for roofing. The lack of economic resources is the main reason for which not everyone can build a house of concrete bricks.

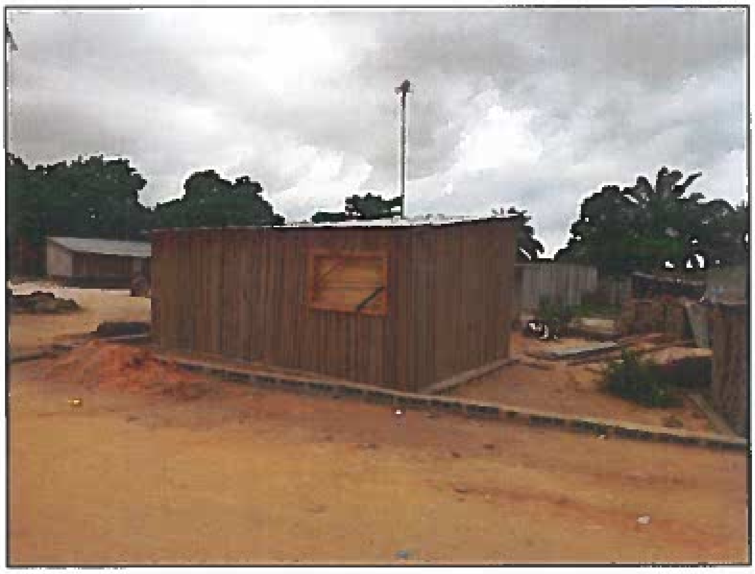


**Figure 5-89: House built with planks (bordão) and covered with zinc sheet.**

"There are houses made of adobe, trailer, and also of bricks, but these latter are not well because there is no cement and it is expensive. There is also lack of sheets for the roofs." (Agriculture Women FG)

"The building materials are expensive but if the person has the ambition to have a better house, that person can try. But it is difficult to have the money to buy cement. There is only a minority who is building. Previously these neighbourhoods were straw and plank houses. Now, there are more adobe and brick houses. Our people, by nature, like to build." (Agriculture Men FG)

Most houses have a living room and one or two bedrooms, lacking, however, bathrooms. The kitchens are normally external, and most households use wood for cooking and, in some cases, locally produced coal.

Most villages have no water or electricity. Lighting is mainly done with the use of oil lamps. In some cases some villages may have generators, these are not sufficient for their needs and for all the houses. The same happens with water supply, and in the villages where a deposit or some kind of fountain was installed, they cannot cover all the population needs, being usual the use of water brought from the nearby rivers.

"There is no electricity; Kifuma and Tombe have generators but do not have the capacity to supply the entire population, they have little capacity. The poles were not enough for the whole village." (Men Agricultural FG)

"The company CMC [roads] has supported the supply of barrels for the population but it is not drinking water." (Agriculture Sobas FG)

"Kavuge and Impanga recently had projects for the placement of a well, through a probe, a project with support from the state of Pesnorte; but since communities were not able to ensure the maintenance, the wells are not working. Each *buala* should have its well. In all villages, there are colonial water tanks, which operate by gravity and were never recovered. The water here cannot be drunk. We have taken samples to Soyo, it looks like diesel." (Agriculture Sobas FG)

**Mobility and Commute**

The daily commute to work is usually by foot, and each journey can last on average two hours. The trips to the city for shopping and trading – there are not enough trade or stores in rural areas - or to deal with any other matter, are done by taxi.

"We have no cars or motorbikes. There were a few buses but they are stopped." (Agriculture Women FG)

Transportation is considered too expensive. Depending on the area, rural populations have to spend an average of 1,500 Akz to go the city.

Travelling out of the country (like to Democratic Republic of Congo) or to Luanda is rare and depends on the need of a particular service or is related to family visits that are more sporadic.

"We only go to Congo because of health issues. But not often, because it is expensive" (Agriculture Women FG)

**Figure 5-90: Road linking Luanda to Soyo.**

One of the major problems which increases the price of transport and makes the trips more time consuming is the state of the roads. There are no public transports – although they have been thought – and even some villages near the main roads cannot rely on long distance buses (Luanda-Soyo, Mbanza Congo-Soyo) that most of the times are crowded. Private transportation to certain villages can cost between 1,000 and 1,500 Akz.

"The ministry of transport has already brought buses to the area but they are not being used; there must be interest on the part of those who have taxis. Some buses pass here and go to Luanda but they do not always stop." (Agriculture Sobas FG)

Occasionally some locally established companies (construction of roads, bridges) can support people with transport, but this is not always the case.

"The CMC sometimes supports with transport to the city. The company CARMO does not support the population on anything, does not help the population in the territory." (Agriculture Sobas FG)

**Health and Education**

The main disease that affects the population is malaria, especially children. The main reason is the high density of mosquitoes. There are also references to the spread of other diseases like typhoid fever, measles and diarrhoea.

Some preventive campaigns have been done in some villages, although unevenly and sporadically, as well as vaccinations against polio. In general, people are aware of some prophylactic measures, including the use of mosquito nets and boiling water. Health services have also done campaigns and distributed mosquito nets.

The main difficulty with these diseases is related to the fact that there are no sufficient health services, although in individual cases there may be some local support.

"In Soyo there is only treatment in the city. The military barracks of Kifuma sometimes supports the population making diagnoses and prescribing medicines" (Agriculture Sobas FG)

"Only Tombe has got a health centre and just a nurse; a doctor should come at least once a month the medical appointments; a medical appointment with a physician is different than a nurse. There is a lack of medicines and the distances are too large to go to health centres." (Agriculture Women FG)

In light of primary education, it is currently achieved through schools through various villages. Frequently, to study after primary school, children have to travel, taking about an hour on foot to get to a school.

Another major difficulty relates to the price of enrolment (600 Akz) and school supplies costs (books, etc.), especially among families who are in charge of many children.

"In our school we have not reached the 200 enrolments and the school has had about 260 children a year." (Agriculture Sobas FG)

"No child should stay out of school due to money reasons; the directors should enrol even those who have no money" (Agriculture Sobas FG)

There are still difficulties with teachers' settlement in the villages, especially those in more remote areas:

"I have a teacher living in my house for 8 years; always giving her all during this time, house, food, etc." (Agriculture Sobas FG)

#### 5.2.3.2 Fishing Communities

With the national reconstruction process, the population was less prone to migration, which increased the degree of settlements in communities. This settlement process happened either in rural areas or along the coast.

Though it is important to bear in mind the specificities of the various fishing areas that compose the municipality of Soyo – fishing areas in rivers and fishing areas in the sea, areas of greater or lesser influence of agricultural activity – it is possible to identify the main common characteristics related to way of life, social dynamics and key challenges.

**Context and Way of Life**

In the municipality, development of activities related to fishing had a big boost in recent years, making this sector one of the largest major opportunities in terms of income generation taking into account the maritime and river context of the municipality. Nevertheless, the development of fishing areas and fishermen activities is still low, maintaining a close liaison between the fishing areas and the city. Access to goods and services is still very dependent on this relationship.

**Figure 5-91: Place of fishermen concentration.**

Furthermore, in most of these places where fishing communities settle, the different needs in terms of infrastructure and services lead people to believe that life is better in the city.

"This is just a workplace, although we spend more time here, living in the city is better; we prefer living in the city. There are no good things to live here ... "(Fishing Women FG)

"Grown women are no longer here, they went to the city. And others look for job such as household cleaning and cooks" (Fishing Women FG)

Among the main problems highlighted, the lack of access to health and education equipment and services is often point out, as well as the difficult - and in many cases non-existent - access to drinking water and electricity.

**Productive Activities**

The fishermen settlement in certain areas of the municipality is closely connected to activities that they develop.

"The fishermen have to follow the fish and in this area that is easy"

(Fishing Men FG)

In general, fishing communities are simultaneously agricultural. Both activities contribute to the livelihood of families but fishing is the main source of income. Only about one third of the fish is solely intended for household consumption, with the remainder channelled to commercialization.

Among the species that are caught, threadfin, sea bream, croaker, catfish, shark, southern meagre, snapper, and grey triggerfish stand out. The sardine is also caught but to be used as bait. Among the species caught in larger quantities are croaker, sardine and twaid shad, since most of the fishing is done over short distances and using rowing boats. Snapper and grouper are caught in the high sea, requiring boats with engine, which is rare among the fishing communities.

In terms of labour distribution between men and women, men are especially devoted to fishing and women to fish trading, working as fishmongers at landing places and in the city of Soyo (especially in the Bureau of Fisheries area) .

Fishermen work between four and five consecutive days in the sea, where they remain with the support of ice for preserving fish. Among the groups of fishermen, there are various specialties and functions: skippers/boat-builders that repair the canoes; ship-owners, and the crew that the ship-owner sends the sea.

**Figure 5-92: Arrival at Ponta do Padrão.**

In the communities, some fishermen wives may additionally trade products that they bring from the city's markets (cooking oil, *leite moça*, beverages, rice, pasta, etc.).

The fishing trade, primarily performed by women, involves an early trip to the beach, when the boats arrive, loading this fish to the city and its sale in markets or street vending, until the end of the day, when they return to their villages.

Profits from the sale of the fish are used to purchase products that do not exist locally for household consumption and, in large part, for the acquisition of other key products to the maintenance of fishing activity, as fuel and ice.

However, the fishermen believe that their profits are not significant because in the region the fish is very cheap given the high supply and the number of existing fishermen. Additionally, they indicate that they have high expenses with permits and other required documentation:

"You have to pay for licenses and many have failed due to low profits: 30,000 for the port authorities and 51,000 for the captaincy to pay for fisheries." (Fishing Men FG)

Another difficulty is related to the uncertainty in respect of profits and incident activity.

"We are required to make an association between fishermen and split the profits. If a fisherman loses his fishing nets, he needs to be associated in order to earn something and continue." (Fishing Men FG)

The families still rely on animal rearing such as chickens and ducks. In fishing communities, there is less growth of goats or pigs, because the settlement areas of the villages are limited and such animals could destroy crops, which already have small dimensions.

In general, the populations mostly engaged in fishing record the need to develop their business and access tools and more sophisticated ways of working, such as engines for the boats which allow fishing in the high sea.

"As a result men only catch small fish along the beaches." (Fishing Women FG)

"Once the fish came to us; now we need to look for it. And for that, we need to travel more miles and we must have engine boats." (Fishing Men FG)

Another problem relates to the lack of access to technologies that allow fish conservation and processing, hindering the production flow and/or increasing it to obtain higher incomes.

Issues related to these problems and other difficulties allow us to highlight, in the case of fishing communities, factors such as siltation of coastal areas, large-scale fishing with trawlers, pollution and the inability of high sea fishing because of the type of vessels that have .

"Before there were agricultural areas here, but with the tides that have taken everything are falling into decay, and the fishing activity does not produce large incomes." (Fishing Women FG)

"The incomes from fisheries trade are good when there are fish in abundance. When there are not, life becomes difficult. And other fishing boats, coming from other fishing areas, pass over the fishermen nets and thus they produce very little." (Fishing Women FG)

"The trawlers appear (from Luanda, Namibe) and destroy the fishing nets that we receive as support. In the market, the fishing nets are very expensive (4,000 to 5,000 AKZ). Worldwide fishermen are poor. The money is not enough to buy nets." (Fishing Men FG)

"Some say that all the fish disappeared since Petrangol settled here; but the truth is that fishermen have no way to get to fish in the high sea; between July and September, there are fewer fish, the sea currents change and sometimes the fish is dead. "(Urban Sobas FG)

"Previously cashews production was good; during the festive seasons bibe [traditional drink] was always drunk and now it disappeared since 1982, when the petroleum companies arrived here. Today buy a litre we have to pay 1,500 Kwanzas. The Angola LNG has ensured that this will end soon, we are waiting." (Fishing Men FG).

Among the fishing communities is also notorious the disappearance of previously existing possibilities and the less attraction for urban wage labour because competition and offers are discouraging, especially for young people.

"There are no other activities; now Angola's law prohibits the marketing of Angolan fish in the DRC; it may result in 10 years of imprisonment. The fisherman is limited." (Fishing Men FG)

"Me and another we are even working on the project for the protection of marine turtles in Angola; it is a job that we have. Others may be carpenters, masons, etc., even teachers. But it is difficult to find employment in Soyo; there are many Chinese but they employ [preferably] the Congolese in Soyo. The young people flee from these jobs because they work there as contractors and it does not pay. Young people prefer to stay here in the fishery activity, rather than being used as cheap labour." (Fishing Men FG)

The associations and even private companies owned by fishermen are practically non-existent. An association was formed in Bocolo but currently is not working.

In terms of support and private projects there is the record that, in the late 1980s, the Swedish cooperation supported the fishermen in the municipality of Soyo, providing working equipment (barges, fishing nets, etc.) in exchange for fish - a project that was welcomed; in addition, it is also recorded between 2000 and 2008 a partnership between Pesnorte, the Ministry of Fisheries and the International Fund for Agricultural Development (IFAD), which has been given support to fishermen, without, however, similar adherence:

It was for a short time, and then it went bankrupt in 2005. They sold the nets too expensive; they should also exchange them for fish, as the Swedes. If it were for exchange, by exchanging for fish, it would be worth." (Fishing Men FG).

This project has also developed training activities, built community centres in several places along the coast and provided fishing equipment.

"But it is over now and since they are gone, it came to zero." (Fishing Men FG)

Some fishermen also obtained support from the Angola LNG through the IPA (Institute of Artisanal Fisheries) in terms of boats, engines, nets, buckets, machetes, knives. This support was granted under a compensation for dredging the channel at the time for the company implementation.

"At some point the Angola LNG gave derisory amounts from 100 to 200 USD to some women, but was insufficient." (Fishing Women FG)

Currently, it is expected the commissioning of systems for granting credit - which some fishermen have already applied for in 2012 - especially since the entry into operation of the Entrepreneur One-Stop Shop (BUE) in Soyo.

Another area of concern is the formal employment, which is largely absent in these areas.

"We have to find our own way. The little we earn with fishing, we have to use when there is a calamity, for example, cholera outbreaks, to take care of the children. It is enough to minimize some problems, but without support, the fisherman will go down the drain." (Fishing Men FG)

Locally, there are no private fishing companies and across the province there are no large boats for fishing. The fishermen consider that they could hardly create private companies, although there are some cooperatives along the coast.

"There was once a fisherman who had a private company, Raúl, but it was in the colonial era." (Fishing Sobas FG)


**Figure 5-93: Facilities of the Entrepreneur One.-top Shop (BUE).**

**Housing and Family**

As in the predominantly farming communities that we have already characterized, family in fishing communities tends to be composed by extensive family networks, structured on the basis of mutual aid and solidarity among its elements. Although formal marriage is not common, conjugal relations are usually started early and polygamy is widespread.

"There is polygamy; here it is natural for men to have more than one wife." (Fishing Women FG)

The family disputes are usually arbitrated in the sphere of traditional rules, and traditional authorities play very important roles in this area. They are also responsible for mediating disputes between families, conflicts over land issues and those concerning matters of witchcraft. The most common conflicts within families are mainly related to poverty but many cases related to alcoholism are also referred to.

"There are disputes when there is money for food, there are frequently problems with alcohol from time to time" (Fishing Women FG)

Constructions in the predominantly fishing areas, although they have become more and more definitive are mostly temporary.

"Previously, there were no constructions here; they were only to stay overnight. Then the houses of bags (burlap) came and now even the houses made of bricks are appearing. But the population fears the erosion." (Fishing Men FG)

Some houses are made of planks or burlap, with only one bedroom and one living room, and the kitchen is external, demonstrating the sojourn on the beach in fishing locations. Most families use wood for cooking and, in some cases, the locally produced coal.

"People cook with firewood; there is no money to buy stove, coal. A coal bag costs 1,500 and a bucket 250. Here people can help themselves and charge little between families." (Fishing Sobas FG)

"Generally men who are here have permanent houses in other areas. These are working houses; all have another house in the city, here is only for work. The fishermen and fishmongers only stay here for a while." (Fishing Men FG)

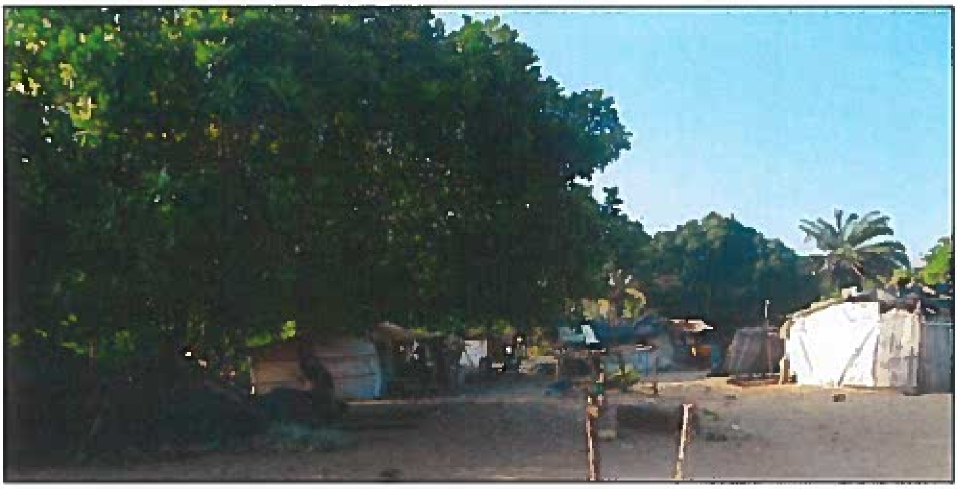


**Figure 5-94: Houses, Ponta do Padrão.**

In most homes there is no bathroom or latrine. Access to electricity is reduced and drinking water, especially in coastal areas, is difficult to obtain and often brought from the city, costing on average 100 Akz per container of 25 litres, in Soyo.

"And if you do not have a boat, you still have to pay for the shipping/canoe. Two weeks ago we received the deputy governor and there are prospects that they will come here to dig a well to supply us with water. Yesterday also appeared a team of LNG which is doing a study for the treatment of brackish water (from river/sea) to make it drinkable." (Fishing Men FG)

"There is no electricity here, some have small private generators. Most have nothing." (Fishing Men FG)

Some communities were given support in order to minimize the problems of access to electricity but, besides being insufficient, they were difficult to maintain the populations.

"LNG gave us a generator but the cables got damaged and we were unable to get the contribution of all to buy new cables. And it is not enough for all the houses. That is sufficient for about 20 houses and now there are here around 86/89 houses. People want to have freezers, televisions, etc. and it is not enough for everyone. And at night people put other things working, apart from lights." (Fishing Sobas FG)

The power outages in the city also affect the activity of fishermen:

"We usually get ice from IPA but sometimes there none if there is a power failure for several days in Soyo." (Fishing Men FG)

**Mobility and Commutes**

Although fishermen mostly remain in the fishing areas, it is common for them to possess a permanent house in the city or another rural area.

Depending on the area, the majority of commutes the city for shopping and trading and to deal with diverse issues are made using canoes and the journey can last about 30 minutes in a motorboat and two hours in rowing canoes.

"Fishermen have to go to Soyo every day to buy cheaper things [food, fuel, ice, water]." (Fishing Sobas FG)

There are a few taxi-boats but most people organized together a transport, and the commute is not charged to fishermen, among the community.

**Figure 5-95: Population commuting from Ponta do Padrão to the city and vice versa.**

Most fishermen do not feel isolated because it is fairly easy to travel by sea and/or river. There are roads to get to the city from the fishing villages but:

" ... You can take many hours, over 10 hours, for example this is a peninsula." (Fishing Men FG)

Commutes within the city are made usually by taxi.

In terms of traveling greater distances, routes may include sporadically Congo to access specific services (usually health) or for family visits. Nonetheless, it is necessary to get a pass to do so, although families on either side of the border are connected and in constant contact.

**Health and Education**

The main identified diseases are malaria, cholera, typhoid fever and fevers. A major cause for the incidence and severity of cholera in fishing areas is related to the water quality that people have access to.

"The main disease is cholera; it has taken many lives, about 30 fishermen. It appears between January and April." (Fishing Men FG)

"The water in Zaire river is very polluted, it passes by many villages along the river that dump waste into the water." (Fishing Men FG)

The greatest need that was detected is the existence of aid stations in the most distant areas of the city.

"You cannot get to the hospital at certain times. Previously there was a health centre here with nurses every day. It ended in 1992 with the outbreak of war." (Fishing Men FG)

Through radio and local awareness-raising campaigns, many people have heard of ways to prevent these diseases and know and rely on prevention through the use of mosquito nets and boiling water. Among the fishermen, the intake of medication against cholera before heading to the sea for several days is also mentioned.

Fishing communities often pursue healthcare through health centres and Soyo hospital. Although these services are free, a major reason for medical delay is due to the overcrowded health service. Sometimes it can compensate the consultation of private physicians.

Education is an area quite in need among fishing communities. There are no schools in the areas where they reside and children usually have to study in Soyo, where they stay with other family members. One of the main constraints is the high cost of education that many parents cannot afford.

"Those, whose parents cannot afford to pay for school, stay here without studying." (Fishing Men FG)

Likewise, adult formation needs to attract more attention. Furthermore, the population have certain ways, though limited to access information - for example, in Bocolo, the vast majority of the population has radio and there are two or three television sets.

### 5.2.3.3 Urban Communities

The city of Soyo has exponentially grown in recent years, especially since the end of the war and through the development of activities related to the oil sector. The city, like other cities in the national context, has increasingly become a pole of attraction for people, either from other regions and provinces, or coming from the rural areas of Soyo.

While it is important to bear in mind the specificities of the various areas of the city of Soyo - urban centres, more or less consolidated and structured suburbs- it is possible to identify the main common features relating to way of life, social dynamics and key challenges.

**Context and Way of life**

The pull factors of the city that stand out are the better access to services, especially education and health, as well as the possibilities of getting employment. Similarly the trade and business areas have remarkably developed in recent years, contributing to a growing rural exodus.

"Young people hardly go to the fields that are located in Sereia, because if they have applied for a job and are in the field, they may lose the opportunity to be hired; and the round trip to the fields costs 200 Akz." (Urban Sobas FG)

"If young people are studying and attending the 7th or other grades (8th, 9th grade) they have to go to the city centre and have to buy books and other materials, so they have to get a job to be able to afford that." (Urban Sobas FG)

"In the city there is electricity and fuel and in the rural areas they are decreasing... the girls of the city no longer marry rural men" (Urban Sobas FG).

"Most people do not work in agriculture. They are more mechanics, carpenters, blacksmiths, and masons. Traders are not from the neighbourhood, are mainly Congolese." (Urban Sobas FG)

Despite the fast and highly visible growing, life in the city has still many difficulties and challenges for the population that lives there and for those who wishes to settle there.

"The city growth has been gradual. Since the end of the war, the government is doing something, but it has to meet all the needs and the progress is slow." (Urban Sobas FG)

Among the main highlighted problems, the water and electricity supply conditions to residents of urban neighbourhoods are always the most pointed out.

"We ask for more light in neighbourhoods, because here there is darkness and if there is a street, it will be better." (Urban Sobas FG)

**Productive Activities**

The income generating activities in the cities are essentially related to jobs in the formal sector, particularly in trade and services. Only a small percentage of contributions for food are obtained through farming and fishing. Agriculture made by the urban population is located in areas somewhat remote, in the Sereia area, but many of these fields were taken from the occupants by the Administration that, at the time, compensated the farmers (indemnification considered very low).

"All food has to be bought, because only older people go to the fields, and they are few. They work primarily with the hoe, which does not allow working more than 100 meters." (Urban Sobas FG)

In general, urban communities recognize the importance of the oil industry with regards to job creation in the region but they mention that the support provided to local populations is very scarce and/or unobtrusive.

"There are several oil companies ... Petrofina, Petrangol; Finapetróleo was the first to arrive. But they have never given a visible aid to Soyo and are so old." (Urban Sobas FG)

"For example, the project Cajueiro Sonangol has energy 24/7 and could extend the electricity power to the neighbourhoods to help people." (Urban Sobas FG)

"Oil companies should clarify directly with the people their performances [within the as social responsibility scope] so that information passes clearly and directly. For example, Angola LNG has two or three projects but they have a lot of publicity; they have a department of community support." (Urban Sobas FG)

"Companies that come to the municipality do not recruit locally; they should contact the sobas to recruit when they come here." (Urban Sobas FG)

**Figure 5-96: INEFOP facilities.**

The entrance into paid jobs in the city is highly and increasingly dependent on the academic and/or professional qualifications. The jobs in trade and services provided in the informal sector require fewer qualifications and are, therefore, those covering a larger number of people. Young people seeking these qualifications and employment come from all types of environments, rural and urban, thus a large number of young people seeking opportunities concentrates in the cities.

Apprenticeship can be made by attending vocational training courses or through practice. Many young people learn trades in private workshops with relatives or others close people.

The main problems experienced by the urban population in terms of economic activities are related to the labour market which is very low and which increasingly requires skills that most people - especially young people - do not have. However, most of the young people, coming both from urban or rural areas, remain in the cities because they have to seek for employment there.

**Housing and Family**

The extent of wide family networks also characterizes the families in urban communities, and are also ruled, like previously, based on assumptions of solidarity and mutual aid. Formal wedding is also a minority, conjugality is started early and polygamy is frequent.

The resolution of family conflicts is usually done by following traditional rules. Traditional authorities are also responsible for mediating disputes between families, conflicts over land issues and those concerning matters of witchcraft. The most common conflicts within families are mainly related to poverty but some cases related to alcoholism are also referred to.

The urban construction is dominated by the use of more permanent materials - cement blocks and even brick, zinc sheet or even tile roofing - and certain structures such as bathrooms and toilets are more common than in rural areas. Most of the new houses, more modern, are built by the residents themselves.


**Figure 5-97: Main road of Soyo: media library and houses.**

In the city it is more common to use coal for cooking - although it is considered expensive, the bag costs between 1,500 to 2,000 Akz - and even the gas among families that have stoves and more resources.

Although access to water and electricity supply is easier in cities, it suffers from several deficiencies and peripheral neighbourhoods are those deal with more difficulties to access these services. The houses that have constant power are the families who can afford to buy and maintain a generator and the houses that have a regular supply of water are those that have storage tanks.

"An area without power does not develop. Today there are many offenders at night and we fear assaults." (Urban Men FG)

"Energy is very important for less banditry." (Urban Young People FG)

The failures in electricity supply also affect the development of several activities that require the use of electrical appliances, although in some cases it may mean creating another type of business by those who have access to generators.

"The lack of power leads that Congolese who have generator charge 50 Akz for recharging the batteries of the phones." (Urban Sobas FG)

In some cases, families also rely on opening ponds that can also be used by their neighbours.

**Mobility and Commutes**

In the city is also required to make daily commutes for shopping, trading or dealing with diverse issues - job search, commute to school or health services - and the most peripheral neighbourhoods are the least well served in terms of transports. In the city, transportation is comparatively cheaper than in rural areas - 100 Akz each trip. However, even within the city, there are difficulties related to transport as roads - especially in more remote areas - are also in bad condition, and some neighbourhoods can even become isolated during the rainy season.

**Figure 5-98: Access road, Soyo.**

As for traveling longer distances, some people in trade sector go to Luanda or Cabinda. Some people also prefer to go directly to the capital when they need documents because it is faster and in many cases much cheaper.

"In Mbanza Congo [a document] can take three months and in Luanda just three days." (Urban Women FG)

**Health and Education**

The main diseases reported are malaria and cholera. In the cities, the prevalence is directly related to standing water that accumulates in the neighbourhoods due to garbage and the lack of drainage systems.

**Figure 5-99: Market of Soyo.**

"There are mosquitoes and there have been outbreaks of cholera." (Urban Young People FG)

In several neighbourhoods, vaccination and awareness-raising campaigns are made to prevent diseases like cholera and malaria. The main preventive measure against malaria is the use of insecticides and mosquito nets.

""Last year there were three campaigns, in which vaccines were given to sobas who called young people to take them." (Urban Sobas FG)

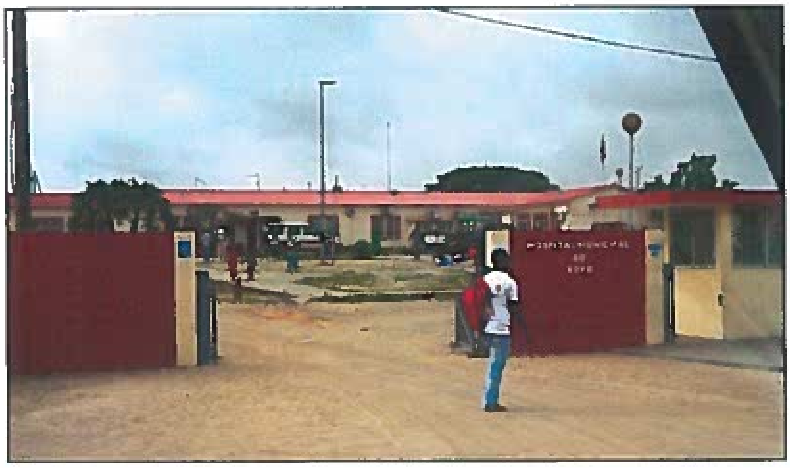


**Figure 5-100: Municipal Hospital of Soyo.**

Although there is a municipal hospital in the city and there are large number of health centres and clinics in total, differences between diverse neighbourhoods are huge. The more peripheral are the most in need.

"It is necessary to have a health centre in each neighbourhood, because if there are no vehicles, it is difficult to arrive at the hospital and people can die their way." (Urban Sobas FG)

Some neighbourhoods are still using complementary health services - such as private or religious institutions.

As the municipal hospital serves a large number of people of the entire county, it is still not enough for the entire population; sometimes, and in some cases, it is necessary to travel to hospitals in the Democratic Republic of Congo.

"And when we go to Congo we feel discomfort because we have to deal with documents and Congolese look at us with bad faith, they have contempt." (Urban Sobas FG)

Moreover, certain specialties such as ophthalmology are not available in Zaire and require travelling to other provinces.

Still, one of the concerns of the population in relation to the services provided by the hospital has to do with the lack of medicines; patients are thus forced to buy them off the market and the price is high.

Although in the city the number of schools is higher, in some neighbourhoods schools are not enough to cover all the needs of the population. Due to rapid urban growth in Soyo, there are still shortcomings at this level, mostly related to the lack of classrooms.

"In Kikudo, there are three classrooms of the 1st Cycle, where there are lessons from the 3rd to 6th grade, and the lessons of younger children [primary education] are given under a tree." (Urban Sobas FG).

In the neighbourhoods, some churches support the local population through the provision of rooms but, even though, the total number available is insufficient. Moreover, education is considered too expensive, especially among families with more school-age children.

**Figure 5-101: Elementary School No. 2 (left) and 2nd Cycle and Teacher Training School (right).**

## 5.3 Identification of Critical Points

Based on the information gathered and presented in previous chapters we proceed to the analysis of critical points.

Before this analysis, the weaknesses previously identified in the Social and Health Baseline Study developed under the Angola Block 15/06 Development Project should be pointed out.

The needs identified in the scope of the project are numerous and transversal to various sectors. High levels of poverty, expressed in a multitude of unmet basic needs were found. It highlights a cycle of poverty perpetuated by socio-economic weaknesses such as unemployment and low educational level, accompanied by low skills. Moreover, it was also highlighted under the previous study, the lack of social infrastructure such as schools and hospitals, compromising the welfare and progress of local communities. The practice of activities in the primary sector – farming and fishing – is essentially for self-consumption and without making use of technology, making it highly rudimentary. Another identified weakness is related to the incidence of diseases, whose prevention is possible and, for several reasons, is not performed. Clearly, none of these points, or others which will be mentioned, can be solved by isolated action; influences are multiple and reciprocal, constituting the designated "vicious cycle of poverty":

"A poor man cannot get enough to eat, being undernourished, his health can become weak; being weak, his ability to work is low, which means that he is poor, which in turn means he will not have enough to eat, etc. Such evaluation, placed at the level of a country as a whole, can be summarised in the old proposition: "a country is poor because it is poor." (In Costa and Figueiredo, 1981, p. 139).

The above-mentioned critical points were used as the starting point for the construction of tools for data collection for the present study – guidelines and questionnaires – looking for more specified and detailed information about the socio-economic and health conditions. Furthermore, the consultation of various stakeholders through in-depth interviews and Focus Groups allowed identifying a set of critical points not yet analysed.

In a comprehensive and generic approach, the main identified needs are related to:

- Access to drinking water and electricity;
- The conditions of production and income generation through rudimentary and artisanal farming and fishing practices, which require mechanization, better access to resources and labour and access to credit;

- The lack of employment and training opportunities, primarily but not exclusively for the youth population.
- The low number of school infrastructure, as well as disparities in their access, where more rural communities are more severely affected since in these areas the closest schools may be far away, with a transportation network virtually non-existent; in the field of education, the difficulty that families have to fund tuition and materials is still evident.
- Insufficiency of equipment and personals regards to health; the number appears to be lower than the necessary and their geographical distribution also encourages uneven access; it is important to mention the lack of some medical specialties, for example, ophthalmology and cardiology.

The critical points analysis will follow a sectorial approach, analysing and exemplifying each of the above-mentioned points in different sub-sections. At the end of this report, in conclusion, the SWOT matrix will allow systematizing the information on the threats and opportunities. However, it is possible for us to perceive beforehand that, as concluded in the previous study, the various weaknesses contribute to the maintenance of the aforementioned "cycle of poverty", which is important to break and fight.

## 5.3.1 Access to Water and Energy | Sewage and Waste Dumping

Access to basic services of water and electricity is very limited, especially in rural areas; although in urban areas the situation is less critical, there are several irregularities and peripheral neighbourhoods have less access to these services.

**Table 5-10: Comparative table of indicators related to water, sewage, waste dumping and energy (%).**

Source: Conducted survey.

| Indicator | Agriculture and Fishing Communities | Fishing Communities | Urban Communities | Total area under study |
|---|---|---|---|---|
| Piped water | 7.65% | [illegible] | 18.33% | 8.4% |
| Adequate water | [illegible] | [illegible] | [illegible] | [illegible] |
| Houses with Sanitary/sewage system | 27.05% | 9.78% | 34.72% | 23.8% |
| Sewage system connected to public network | 0.00% | 0.00% | 4.17% | 1.4% |
| Waste dumping in woods/fields, river/lake, sea and street | 29.51% | 75.27% | 37.22% | 47.5% |
| Access to public network electricity | 2.73% | 3.53% | 26.67% | 10.9% |

**Table 5-11: National indicators related to water and sanitary system.**

Source: IBEP, 2011.

| Indicator | National | Urban | Rural |
|---|---|---|---|
| Water consumption from adequate/safe origin: piped in the house or in the house of the neighbour /public fountain | 28% | 37,6% | 8% |
| Treatment of drinking water | 33,1% | 52,5% | 9,7% |
| Use of an adequate sanitary installation | 59.6% | 82.5% | 31,9% |

The adequate water supply along with sanitation contributes to the improvement of living conditions, allowing the control and prevention of some diseases, and the absence of water constitutes one of the major world problems (IBEP, 2011). In Angola, diseases resulting from inappropriate/non-treated water consumption are one of the main causes of morbidity and mortality (*idem*).

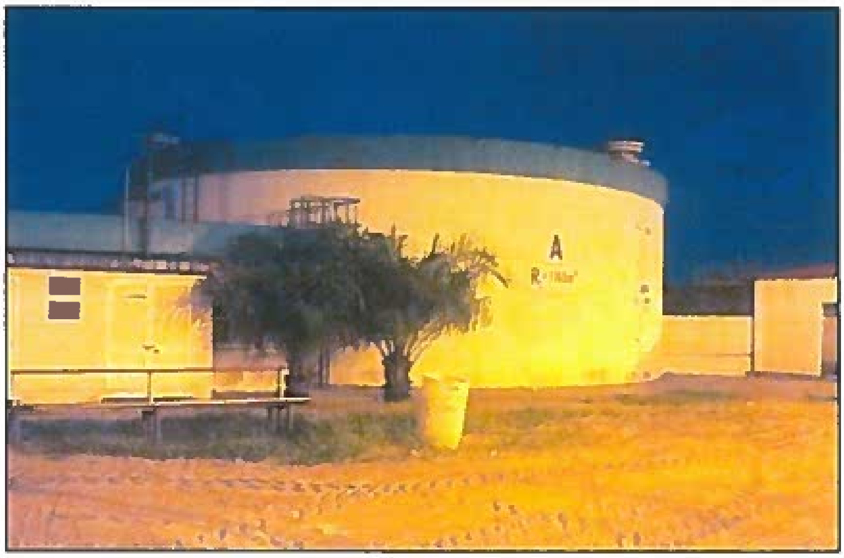


**Figure 5-102: Water Reservoir.**

The water distribution system has a capacity of 300 $m^3$/hour. The storage capacity is 1160 m3 twice. There are 6 fountains; actually, they are all under repair.

Only approximately 1/10 of the population of Soyo has access to piped water in the houses, and the use of other forms of water supply is more common. The evident asymmetries in access to piped water in the houses and/or buildings should be mentioned, as in fishing communities this percentage is residual: 0.82% (Table 5-10); in Agriculture and fishing communities, this percentage rises to 7.65% and in urban communities to 18.33%.

On the other hand, the costs related to the private acquisition of water should also be mentioned, since this option represents about 1/5 of the population. Similarly to the national reality, the public fountain constitutes the main source of drinking water for domestic consumption (21%), the proportion of those using this type of water is higher than the national percentage (7% to 15%; IBEP, 2011); however, a comparative analysis of communities by type (Table 5-10) allows observing obvious differences, being this situation more common in Agriculture and Fishing Communities (48.09%) and less common in Fishing Communities, falling below the national reality – 4.35%.

Even if half the population claims to treat water prior to consumption, the percentage of population that does not perform this treatment, or that does it but in inappropriate ways, constitutes an obvious risk, and therefore it could result in obvious health hazards. In this area, it is concluded that, comparing to the national reality, which indicates that only about 44% of the people treat water for consumption (IBEP, 2011), being of 33,1% the percentage of those who treat it correctly (idem) – Table 5-11 –, the overall situation in Soyo is slightly more encouraging; bleach, the preferred option as appropriate form of treatment, follows the national trend. As regards the treatment of drinking water, it is possible to perceive asymmetries, being more frequent in urban communities (67.2%) and mixed (59.8%) and less common in fishing communities (31.5%) – Table 5-10. It should be noted that this asymmetry follows the national trend of the difference between urban and rural realities, considering the adequate treatment of water before consumption: 52,5% vs. 9,7%, respectively – Table 5-11.

"The paramount needs in Soyo are water and light. With them, the development would be great." (Municipal Deputy Administrator IDI)

"There [is no canning and processing industry], because as I said there is a lack of transport and industries. We also are not very well in terms of energy and water which are important to the industry." (Head of the Municipal Agriculture Section IDI)

"There is no drinking water or energy which are an obligation of the State." (IPA Provincial Representative IDI)

The lack of an extended sewage network, efficient and generalized to most of the population, is equally critical, posing a risk not only to individual but also to public health. It is known that, in places where there is a poor or a lack of sewage systems and where solid waste is disposed in the open, the probability of infectious diseases associated with excreta, garbage and vectors increases enormously (IBEP, 2011).

**Figure 5-103: Waste dumped and accumulated in the street.**

In Soyo, there is no treatment plant wastewater; there is only a drainage ditch to the river water. There is a minority population connected to the public sewerage network, accounting for less than 2% of the general population; the analysis by type of community emphasizes that the connection to the public sewerage network is a reality in only 4.17% of the reporting population in urban communities, and non-existent in the others – Table 5-10. The situation in Soyo seems much more warning than the national trend, where 39% of the households are connected to public sewerage network (IBEP, 2011).

**Figure 5-104: Machines supporting the waste collection plan.**

There is a plan for waste collection, with specific collection points. This service is done with the support of 3 machines, 1-port container truck, 2 trucks, 1 loader and 1 backhoe. According to the Bureau of Community Services, it is urgent to acquire more means of waste disposal, including agricultural machines with type trailers.

Regarding the methods of waste dumping most often used by the households, half of households usually dumps the waste in the woods, in the street, in the sea, river and/or lakes; the analysis by community emphasizes the predominance of these waste dumping methods in fishing communities, representing 75.27% of the cases in these communities – Table 5-10.

The described situations are a warning signal regarding the public health, taking visible proportions when visiting the market of Soyo, where along with the bad conditions of the roads, there is stagnant accumulated water and clusters of garbage that accumulates there, causing obvious dangers to the population's health, which caused the wide-spread mosquito transmitted diseases; it is often seen product stalls side-by-side with mud and accumulated garbage.

"The people go to the market that is rotten; there is a lack of quality and food safety." (Priest of Kikudo Mission IDI)

**Figure 5-105: Accumulated waste and stagnant water, Market of Soyo.**

The capacity of power distribution in Soyo is currently 22 megawatts; the previous system had a capacity of only 6.6 megawatts.

The minority of the population with access to electricity is evident – only 11% of the general population enjoys this service which, compared to 36% representing the population with access to network electricity in Angola (Table 5-12), is quite a low number. The analysis by communities (Table 5-10) revealed an obvious asymmetry in access to energy: 26.7% of the population in urban communities, compared to 2.37% and 3.53%, respectively, in the mixed and fishing communities. This asymmetry is also noted in the national trend, where the access to public network energy is much more common in urban communities – Table 5-12. The population recognizes the energy issue as an obvious hurdle in development and as an obstacle to overcome in their day-to-day life, resulting in the use of alternative energy sources or high costs for acquisition and maintenance of generators.

**Figure 5-106: Energy distribution system in Soyo.**

**Table 5-12: Access to electricity.**

| Indicator | National | Urban | Rural |
|---|---|---|---|
| Access to public network electricity | 36% | 62,5% | 7,3% |

Source: IBEP, 2011.

Energy consumption is closely related to the sustainable development of a country, and its impact is transversal: social, economic and environmental (IBEP, 2011). Apart from the direct constraints associated with the lack of electricity and its difficult access, the population also recognizes other constraints resulting from it, particularly in terms of security. Thus the access to electricity is seen as a factor which enables the development of economic activities but also as a factor which minimizes safety problems.

"[Problems] Water and energy ... Every three days we have to buy a water cistern. And we always work with the resource of a generator; fuel must be bought." (Local Company IDI: Restaurant Cachupa)

"There is no electricity; Kifuma and Tombe have generators but they do not have the capacity to supply the entire population, they have little capacity." (Agriculture Men FG)

"We usually get ice from IPA but sometimes there is none, if the electricity fails for several days in Soyo." (Fishing Men FG)

"An area without electricity does not develop. Today there are many offenders at night and we fear the assaults." (Urban Men FG)

"Energy is very important for less banditry." (Urban Young People FG)

## 5.3.2 Productive Activities for self-consumption: rudimentary farming and artisanal fishing

Farming and fishing are mainly for subsistence, generating very low incomes.

"The big challenge for 2013-2015 is to promote family farming to commercial agriculture. (...) The producer must be able to sell before producing." (Head of Studies, Projects and Planning Department of the Ministry of Agriculture IDI)

"Family farming is more oriented to the local market segment... the market itself does not give them chance to grow; there are constraints in the market and in the flow." (idem)

"In Soyo, the situation is different from the country in general; here agriculture and animal rearing is for the family subsistence... there are no big producers." (Head of the Municipal Agriculture Section IDI)

According to the Head of Municipal Agriculture Bureau, there are registers of:

- 1 Agricultural cooperative;
- 2300 Families enrolled;
- Agricultural associations, with a total of 168 members (111 men and 57 women).

The constraints in access and transport prevent a profitable agricultural practice, in view of a production that exceeds family subsistence. In general, the fields for agricultural cultivation are distant from the houses, so the everyday life in a field involves a routine in which the commute takes a significant part of the time. Besides the issue of commuting and transport, not only of the farmers but also of the goods, there is also rudimentary nature of the production; the driving force of the work is essentially human, with a reduced mechanization which is urgent for the growth of this sector. The lack of products, equipment and materials that could contribute to a more profitable agricultural practice also stands out. Likewise the training of farmers is low, and it seems necessary to update their knowledge and skills.

"If there is transport to take the products to the markets, the rest can develop." (Agriculture Sobas FG)

"Another difficulty is the evacuation, the products from the fields lack transport. It is difficult to bring commerce to the field ... and there are problems with the road network." (Head of Trade, Hotels and Tourism Municipal Section IDI)

"The lack of mechanization is a difficulty. Another difficulty is the roads from the fields to the city that constrains the products' flow. (...) Today here in the Municipality about 60% of the products rot in field due to lack of transport. And the candongueiros... do very high prices." (idem)

"We sell the fish in the city and here; you can occasionally bring about 8,000 or 10,000 from the city. We do not sell many agricultural products because we produce few." (Agriculture Women FG)

"Agriculture is for subsistence; mechanized agriculture is needed, or at least oxen to support agriculture, as there are in the south." (Urban Sobas FG)

"We do not have seeds or machinery and so the fields are smaller. This is because we are working with hoes." (Agriculture Women FG)

"And here there is not enough production ... just one or other product. And buying in Luanda is cheaper because we buy in bulk." (Local Company IDI: Restaurant Cachupa)

**Figure 5-107: Access to a mixed community.**

With reference to fisheries, the situation is similar and fishing is essentially artisanal, lacking resources, equipment and training to enhance the practice of this activity, and concomitantly to allow greater catches and higher profit margins. The possibility of access to credit, as well as grants to improve this sector by acquiring fishing nets, materials and, above all, better boats and engines for boats, is really crucial.

In short, as regards the economic activities associated with the primary sector, the need for agricultural mechanization, as well as better agricultural tools and instruments, is clear and better fishing means are also necessary. The connections and access to transport for commuting between rural areas and the city are also a critical point that is important to develop, for better access to markets and services.

"In Soyo, fishing is artisanal. There is a lack of industrial fishing." (IPA Provincial Representative IDI)

"... lack of resources and fishing equipment and supply is not immediate, because there are no people specialised in selling or reselling fishing equipment ..." (idem)

"Once the fish came to us; now we need to look for it. And for that, we need to travel more miles and we must have engine boats." (Fishing Men FG)

### 5.3.3 Employment and training: lack of opportunities

Job opportunities are considered low, and most of them are on the oil & gas field or related to the national reconstruction process. Tourism seems to be a great opportunity for development but is still under developed; a few hotels and guesthouses are, however, available for travellers in the Soyo town area. Most of customers are related to the oil and gas industry activities.

In fact, the key industry in Soyo is the oil and gas sector; the investments in the field of petroleum industry are real because there are several reserves offshore from the area. Kwanda Base is the logistical centre in Soyo. Angola LNG plays an important role in local development and economic growing.

"With regard to employment, in the municipality the offer is too low. Only Kwanda Base has been a major employer." (Local Company IDI: Jocaju)

"The reconstruction of the country: civil construction, oil industry and operators of welding production, scaffold assembly, manager of human and material resources, plumbers, masons ..." (Local Company IDI: FDF)

There are no data about the number of disabled professionally integrated.

The unemployment situation is an evident concern for the population, highlighting an apprehension about the impact of this problem on the young people; on the other hand, gender asymmetries in access to employment are also mentioned.

"There are more opportunities for men in the oil companies. Women are more in the trade sector because men have higher qualifications." (Local Company IDI: Restaurant Cachupa)

"Educated women are no longer here, they went to the city. And others look for job such as household cleaning and cooks" (Fishing Women FG)

The analysis of the population's situation regarding employment showed that approximately 9.1% of the respondents were unemployed; nonetheless, urban communities contribute to this percentage more evidently than the others, followed by unemployment among mixed communities – Figure 5-109.

**Figure 5-108: Base of Kwanda.**

The unemployed are mostly men (Figure 5-110), and when we analysed their age distribution, we found data that meet the concern expressed by the population regarding the unemployment among the younger population. Approximately 60% of the unemployed population is aged less than 30 years, and 35% is at most 24 years old (Figure 5-111).

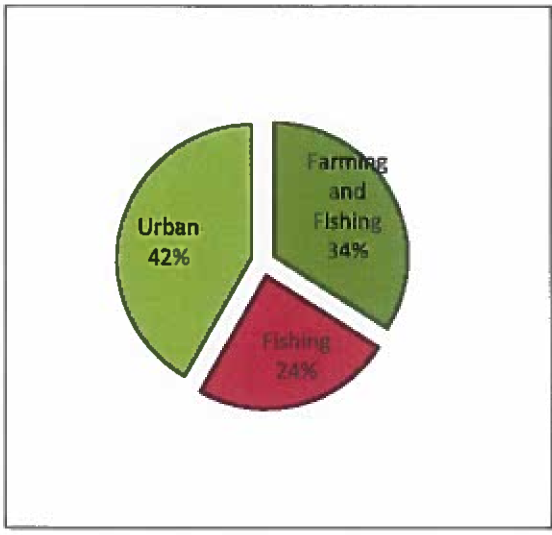



**Figure 5-109: Weight of each type of community in general unemployment.**

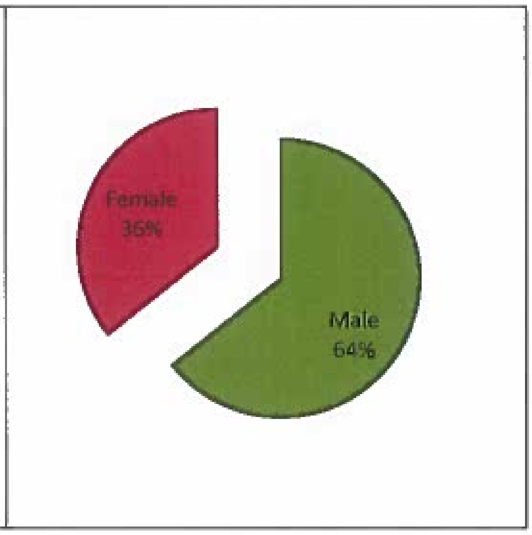



**Figure 5-110: Unemployment and Gender.**

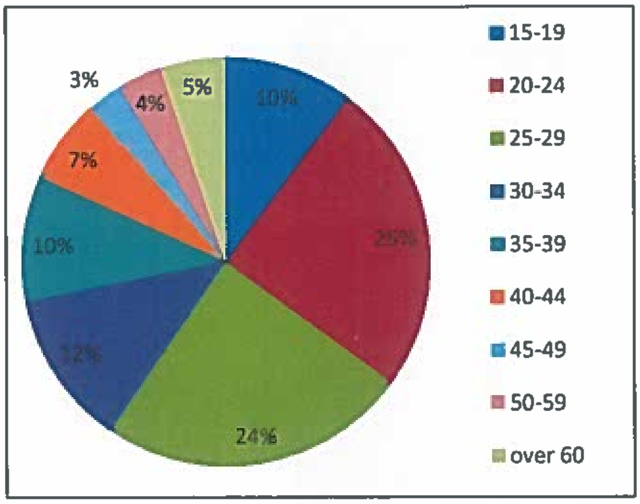



**Figure 5-111: Distribution of the unemployed population by age.**

"The market does not absorb the youth trained by INEFOP. Most graduates do not find a place in the labour market and even to develop their own business is difficult." (INEFOP IDI)

"We have been following the direct and indirect impacts of the project ... unfortunately we had a lot of youth working during the construction phase and now we had to send the men back home. It is our good intention; we are trying to help the youth ... [training them] where they could learn how to write a CV [curriculum vitae], face an interview ..." (Angola LNG Public Relations IDI)

"Each person has to find his/her own way. There are few companies and young people do not work because there is no employment. The elder survive finding their own way, by farming, fishing and others can sell those goods." (Chief of the Health Centre 1º de Maio IDI)

"Me and another we are even working on the project for the protection of marine turtles in Angola; it is a job that we have. Others may be carpenters, masons, etc., even teachers. But it is difficult to find employment in Soyo; there are many Chinese but they employ [preferably] the Congolese in Soyo. The young people flee from these jobs because they work there as contractors and it does not pay. Young people prefer to stay here in the fishery activity, rather than being used as cheap labour." (Fishing Men FG)

"Young people hardly go to the fields that are located in Sereia, because if they have applied for a job and are in the field, they may lose the opportunity to be hired; and the round trip to the fields costs 200 Akz." (Urban Sobas FG).

Analysing further the profile of the unemployed according to their level of education, there is a predominance of unemployed with primary and secondary education (I and II cycles) – Figure 5-112 – following the trend of the population's distribution by level of education. However, if we look within each level of education, the proportion of employed and unemployed people, the percentage of unemployed within the group of people with higher education (Figure 5-113) stands out; still, the analysis of these percentages should be made with caution taking into account the high percentage of people involved in farming/fishing work just for subsistence, but that do not identify themselves as unemployed, describing themselves as farmer/fisherman, despite low or no cash income arising from such activity.

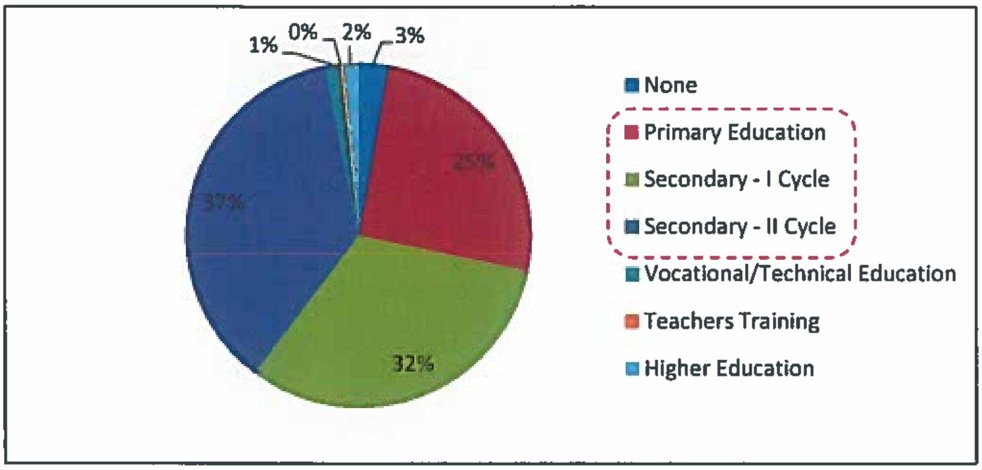



**Figure 5-112: Distribution of the unemployed population by education level.**

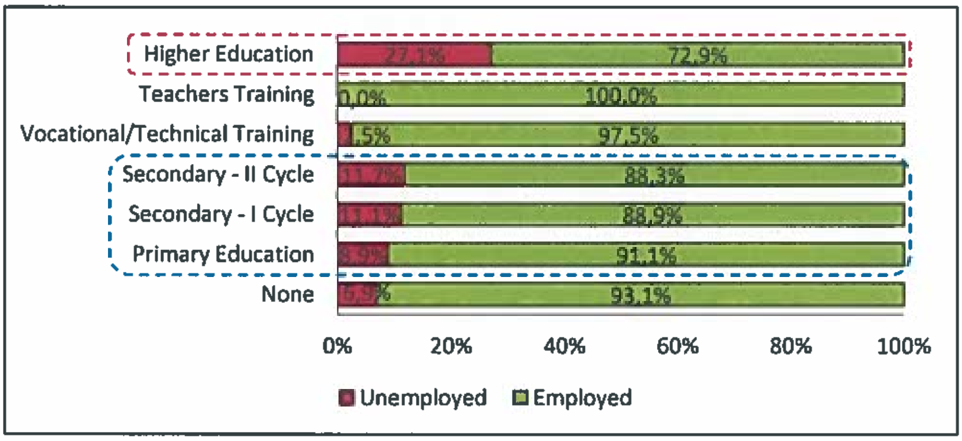



**Figure 5-113: The situation regarding employment by education level.**

The local hand labour is low-skilled in technical and scientific terms. The information gathered from the consulted stakeholders reveals some barriers to vocational training, such as the lack/shortage of local trainers, implying hiring trainers from outside, which in turn implies additional costs, or the trainees have to go somewhere else, an option which also has adjacent costs. The local hand labour has poor training, although the idea is described that the labour market does not always absorb the local technically qualified workers.

"In Soyo there is already a school of higher education, but there is still not enough know-how." (Deputy Chief of Kwanda Base IDI)

"The existing training in Soyo is little. The training issues depend on the companies themselves. Some prefer to bring the trainers from Luanda, and others send trainees to the training sites." (Local Company IDI: Jocaju)

"[The difficulties] are financial and mobilization of resources. The trainers are insufficient because there are few in the municipality (they have to come from Luanda). And the public institutions do not pay immediately." (Local Company IDI: Jocaju)

"There is a lack of training in the hotel and tourism sector (the companies themselves try to train their staff. There is also a lack of training in the business management sector." (Head of the Municipal Commerce, Hospitality and Tourism Section IDI)

"However, there is difficulty in finding qualified elements, but there are some. Those who are here took the hotel management course in Cabinda and pass on the knowledge to the youngers." (Local Company IDI: Restaurant Cachupa)

The weak hiring of local skilled labour is another problem identified by the population, stressing that there should be some protection to the inhabitants of Soyo and closer linkage between the companies that set up and, for example, INEFOP in order to channel the local labour to industries and other economic sectors.

"Higher education in Soyo will allow increasing the hiring of technicians in Soyo." (Deputy Chief of Kwanda Base IDI)

"The job opportunities are not that many as they increasingly require higher qualification." (INEFOP IDI)

"Most companies that are set up in Soyo bring their own workers and therefore they do not hire locally; this is very frustrating for young graduates." (INEFOP IDI)

"Companies (mainly oil) never contact the INEFOP; that relationship does not exist, they will not hire graduates through INEFOP." (INEFOP IDI)

### 5.3.4 Access to education: disparities and difficulties in access

The school complex in the Headquarter Commune in the Municipality of Soyo is composed of:

- 29 Elementary Schools[11]
- 6 1st Cycle Schools / 50 classrooms
- 1 2nd Cycle School / 11 classrooms
- 1 Private school of primary and 1st cycle education / 12 rooms
- 1 Teacher training school/ 11 classrooms
- 1 Teachers of the Future[12] school, operating since 2001
- 1 University: University of 11 de Novembro

It is recognized by various stakeholders that despite the lack of infrastructure, Soyo has seen an obvious evolution as regards education, and oil companies play an important role in improving access to education. Population growth motivates a growing demand to the education system, therefore, despite the progress, the infrastructure is still not sufficient for all students' inclusion.

"[In terms of education] Soyo is evolving periodically." (Director of 2nd Cycle School IDI)

"Angola LNG is the largest partner that the school has. We received the equipment for the computer room, it opened us the internet. Angola LNG provides children with backpacks, balls; they equipped the library room, and also the laboratory." (Director of Primary School No. 2 IDI)

[11] It was not possible to get the exact number of rooms in primary education of the Headquarters Commune; however, the whole municipality includes 232 classrooms in primary education. Likewise, the number of students was only presented referring to the entire municipality: Primary Education – 17,456 (includes adult training in different modules I, II and III), 1st Cycle – 5,038 (includes adult training), 2nd Cycle – 3,550 and Vocational/Technical Training – 1,207. The University 11 de Novembro had, at the time of data collection, 503 enrolled students.

[12] The Teachers of the Future Schools are public utility institutions, incorporated under the laws in force, which are managed by ADPP Angola; they are included fit in the national education system and comply with the plans and curricula of Primary Teaching Education and educational system of the Ministry of Education. The first TFS started their activities between 1995 and 2001.

"We have to thank Sonangol and Angola LNG, through its partners that were involved in the construction of classrooms." (Municipal Director of Education IDI)

"In Kikudo, there are three classrooms of the 1st Cycle, where there are lessons from the 3rd to 6th grade, and the lessons of younger children [primary education] are given under a tree." (Urban Sobas FG)

"The children attend classes in the Church; two classes study there." (Director of Primary School No. 2)

"Guidance came from MINEDU in order that the classes do not exceed 45 students. We have always worked with classes of 55/60 students. There is concern that many will not have room." (Director of 2nd Cycle School IDI)

"Each school [of the 1st Cycle] provides lists of 3/6 classes to enrol in 10th grade. We are unable to integrate everyone. Perhaps those who have family in other provinces can send their children there." (Director of 2nd Cycle School IDI)

"There are more people enrolled than vacancies. 463 Applicants. There are only 16 vacancies in the industry organization and maintenance course for 96 applicants. In computer engineering daytime course there are 40 vacancies for 85 applicants and 40 vacancies for 62 applicants in the evening classes." (Vice-Rector of the University 11 de Novembro IDI)

Besides the shortage of infrastructure, education provision and specific and specialized training, including higher education, also show some weaknesses. Similarly in this area, the industry sector, namely Angola LNG, has made a visible contribution, improving the availability and quality of training.

**Figure 5-114: Primary School No. 2 Facilities.**

"We have some third party support here, they are from ALNG and come once a week [to teach physical education classes]. It should be three times a week. (...) They are employees and because the school is being supported by ALNG some volunteers appear to entertain a little the children" (Director of Primary School No. 2 IDI)

"The children are forced to attend teacher training schools or second cycle because there is a lack of schools in other areas: health, electricity or other related to engineering." (Director of 2nd Cycle School IDI)

"We have Cuban teachers who have been giving support. But they are not enough!" (Vice-Rector of the University 11 de Novembro IDI)

"We must invest in technological courses, but the technological courses ... it's easier to have courses in the humanities." (Vice-Rector of the University 11 de Novembro IDI)

The accessibility and the lack of a transport network capable of meeting the needs of students who live farther away are also as a cause for concern and a factor that may contribute to school dropout and absenteeism.

"We have not got cars or motorbikes. There were a few buses but they are stopped." (Agriculture Women FG)

"Now we are a bit stressed by teachers and students who live far away from the school. (...) There has been a lack of transport means to support the school, either on the part of teachers, the school direction and students." (Director of Primary School No. 2 IDI)

"[A priority] Build 2nd Cycle schools in several areas of the municipality. There are children in the neighbourhoods, even within the city, who cannot get to the centre." (Director of 2nd Cycle School IDI)

The difficulties in accessing the education system are also related to economic constraints, since the poorest households face some difficulties with expenses related to schooling.

"With respect to books and school supplies, we are provided by MINEDU, even though the books are not enough for all the students." (Director of Primary School No. 2 IDI)

"Students seek a lot computer and English courses. And to do these courses out of public school, they depend on the financial capacity of the family." (Director of 2nd Cycle School IDI)

"In our school we have not reached the 200 enrolments due to lack of money from parents, and the school has had about 260 children a year." (Agriculture Sobas FG)

"No child should stay out of school due to money reasons; the directors should enrol even those who have no money" (Agriculture Sobas FG)

"Those, whose parents cannot afford to pay for school, stay here without studying." (Fishing Men FG)

Access to new technologies and information is recognized as an asset, increasingly needed in a world of constant and steady development.

The existence of computer technology in schools, however, is sparse and inadequate given the number of students.

"There is a great disparity between the children from Angola and other countries. One should invest in access to information technology to minimize inequities. A student here usually has access to computers only from the 10th grade ... and very few! This school only has about 16 computers for 4,000 students. It is impossible for all to access." (Director of 2nd Cycle School IDI)

"Nowadays the world is dynamic and students need new technologies." (*idem*)

**Figure 5-115: University of 11 de Novembro, Higher Polytechnic Institute of Soyo, Zaire.**

Access to education, despite many advances inherent in the process of national reconstruction, still reveals, albeit slight, some asymmetries, either in terms of gender and as regards the dichotomy urban *versus* rural.

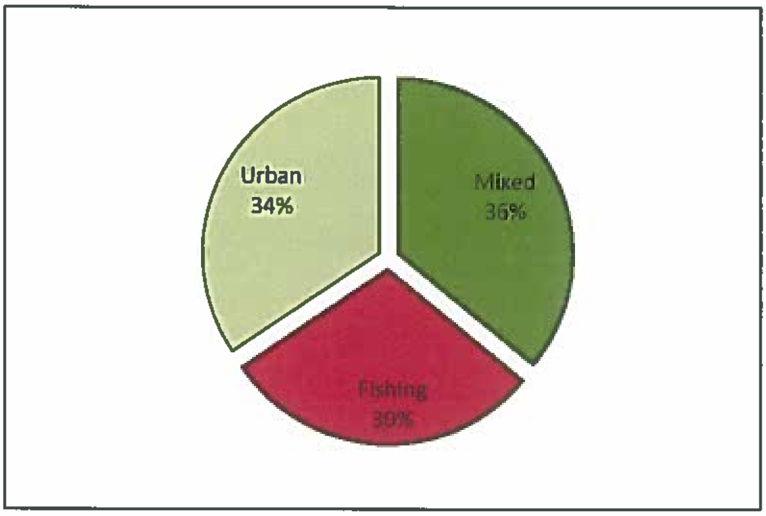



**Figure 5-116: Students currently enrolled in any educational institution, distributed by type of community.**

Although the difference is not significant, fishing communities show a minor contribution to the total number of students currently attending schools – Figure 5-116.

Regarding gender issues, it appears that the group of surveyed people who are currently enrolled in any educational institution is balanced, with a slight predominance of males – Figure 5-117. The admission of female students has been increasing:

"The number of girls and women in the education system has increased." (Director of the Municipal Bureau of Education IDI)

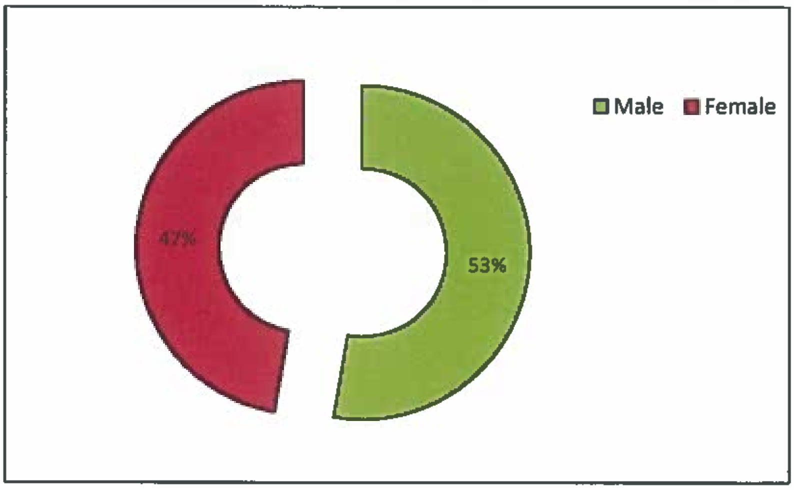



**Figure 5-117: Distribution of the population currently attending the school system, according to gender.**

**Table 5-13: Population with 6 or more years old, according to school attendance.**

| | Attending school | | |
|---|---|---|---|
| | Men | Women | Total |
| Conducted survey | | | |
| Agriculture/Fishing Communities | 57.9% | 59.9% | 58.8% |
| Fishing Communities | 47.7% | 42.6% | 45.2% |
| Urban Communities | 58.1% | 58.9% | 58.5% |
| IBEP Data (2011) | | | |
| Angola | 45.2% | 39.9% | 42.4% |
| Urban environment | 47.6% | 46.2% | 46.8% |
| Rural environment | 42.3% | 32.1% | 37.0% |
| Zaire Province | 42.3% | 38.0% | 40.0% |

Table 5-13 makes a comparison between the reality assessed by the questionnaire used in the present study and data from IBEP (2011), showing a comparatively less critical scenario, as the percentages of enrolled people, total and partial, are higher than the national reality; however, it should be taken into account that the national figures refer to data collected in 2009. In view of gender, despite the tenuous differences in mixed and fishing communities, in urban communities the access to education is balanced.

**Figure 5-118: Municipal Bureau of Education and Culture.**

**Figure 5-119: School, Kitona Neighbourhood.**

### 5.3.5 Access to health care: disparities in access and difficulties

Access to health care arises as one of the weaknesses regarding the socio-economic and health profile of the Headquarters Commune in the Municipality of Soyo, despite the recognition of numerous achievements in this field.


**Figure 5-120: Entrance of the Municipal Hospital of Soyo.**

The access to health services is still very limited, especially in rural and more remote areas, and shortcomings of various specialties are highlighted. As stated previously, there is only one hospital located in the centre of town. The issue of mobility, accesses and transport is traversal to various services and is also referred to as a difficulty in the healthcare field.

"In terms of health, this [development] is felt in terms of infrastructures, which have been enlarged and better equipped. The development is not felt by the increase of physicians' number, but by the number of nurses and therapeutics technicians." (Municipal Hospital of Soyo Director IDI)

"Health in the countryside is very worrisome... even minimal things, they have not got. You need to have means of rapid evacuation of the communes further from the city." (Municipal Administrator Deputy IDI)

"In health centres there are no doctors, only nurses. And these are from the basic level, because there is no health intermediate or advanced training in the province." (idem)

"There are indeed limitations such as insufficient physicians' number, lack of housing conditions and housing for the physicians who go to health centres in the city outskirts. Likewise the roads that take the patient to the hospital are very time-consuming..." (idem)

"It is reasonable. Health reaches all communes. But there is lack of medicines; physicians only exist in the Municipality Headquarters and there is a lack of medicines, transport and roads are not favourable." (Chief of Health Centre 1º de Maio IDI)

"More doctors, more nurses, more medicines, more transportation because people who move from other communes have no means to... sometimes they die on the way ... because the people who come here are essentially from the farming areas." (idem)

"Only Tombe has got a health center and just a nurse; a doctor should come at least once a month the medical appointments; a medical appointment with a physician is different than a nurse. There is a lack of medicines and the distances are too large to go to health centres." (Agriculture Women FG)

"The state health centre is for free, the private ones are expensive. But we can go to private health centres because it takes longer going to the state health centre, it is crowded, the doctors are not there... and it is expensive" (Urban Sobas FG)

"You cannot get to the hospital at certain times. Previously there was a health centre here with nurses every day. It ended in 1992 with the outbreak of war." (Fishing Men FG)

**Figure 5-121: Population in the Health Centre 1º de Maio.**

Despite the reported asymmetries in access to health, as regards the communities farther from the urban centre, the analysis of satisfaction with health services shows greater dissatisfaction in urban communities – Figure 5-122.

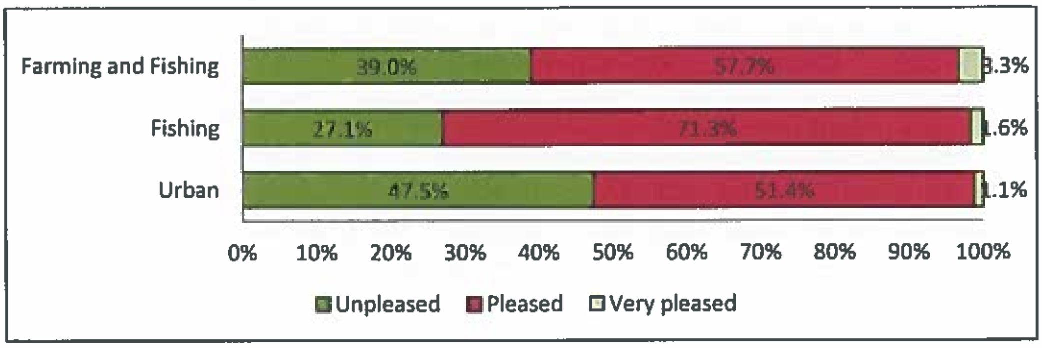



**Figure 5-122: Level of Satisfaction with Health Services by Community type.**

The analysis of the health system typical used by the population shows some uniformity in the pattern of access to these services; however, it is possible to make some observations (Figure 5-123):

- The general trend is to seek health services only in cases of illness.
- Fishing communities record more respondents who never use health services (8.9%).
- Urban communities have a higher percentage of individuals who regularly use health services for a check-up (11.7%), and this behaviour is more uncommon (4.1%) among the fishing communities.

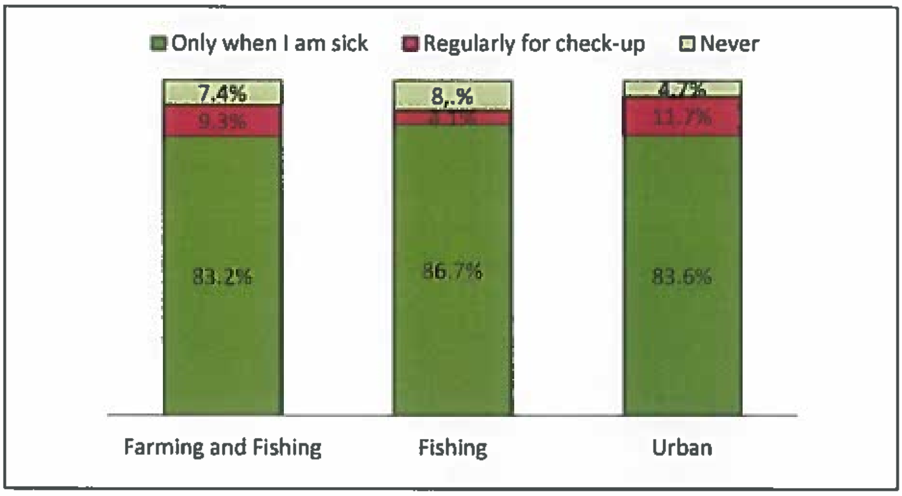



**Figure 5-123: Frequency of access to health services by community type.**

Hence, access to health services is done with difficulties related not only with the lack of technical expertise and necessary technical equipment, but also with basic structural conditions, such as water, energy and accessibility.

**Figure 5-124: Office of the Health Centre 1º de Maio.**

In Angola, malaria stands out as the major cause of mortality and morbidity among women and children (MINPLAN, 2010). It explains about one third of the demand for curative medical care, one fifth of all hospital admissions, 40% of perinatal deaths and one fourth of maternal mortality (Cosep/ICT, 2011). When the prevalence and incidence of diseases such as malaria, typhoid fever, cholera or tuberculosis, is addressed we cannot ignore the personal and contextual variables contributing to it: deficient or non-existent basic sanitation network, poor personal and housing hygiene practices and, among others, inappropriate water intake.

Malaria, with 19 399 cases registered in 2012 in Soyo, is one of the evident concerns in the discourse of key informants consulted about health, and cholera, diarrheal diseases, typhoid fever and tuberculosis are also mentioned. Naturally, the link with risk factors associated with the already covered critical points such as water, sanitation and waste management arises. These concerns are in line with key epidemiological indicators, according to the report of the Municipal Health Bureau, previously presented in Table 5-7.

"Most people have no life quality. There is a lack of energy and water and they have no money." (Chief of Health Centre 1º de Maio IDI)

"The most frequent diseases are malaria, diarrheal diseases, and typhoid fever. These are more common because we are in an endemic area." (*idem*)

"[Risk factors] are scattered waste, stagnant waters and grass because of the mosquitos' multiplication." (*idem*)

"The most frequent diseases are those occurring across the country: Malaria, diarrheal diseases, respiratory diseases such as tuberculosis, and infectious diseases such as measles. These are disorders that are related to people's life quality and the lack of sanitation and poor water quality." (Municipal Hospital of Soyo Director IDI)

"[Concerns] the lack of drinking water; last year there was a serious outbreak of cholera." (*idem*)

**Figure 5-125: Users in Consultation, Health Centre 1º de Maio.**

"The main disease is cholera; it has taken many lives, about 30 fishermen. It appears between January and April." (Fishing Men FG)

"The water in Zaire River is very polluted, it passes by many villages along the river that dump waste into the water." (Fishing Men FG)

Despite the panorama described, some advances are recognized in prophylactic measures, often associated with the campaigns of the oil and gas industry, particularly of Angola LNG, which have had a double contribution of promoting of health/disease prevention and supporting improvement of health infrastructures. Maternal mortality is a concern allied and associated with poor responsiveness of the maternity.

"We can say that now with the expansion of the hospital, which was funded by Angola LNG and to be inaugurated, the changes will come ... And it is preconized a training activity with doctors and nurses from Portugal also funded by Angola LNG." (Municipal Hospital of Soyo Director IDI)

"There are many health programs that are linked to preventive medicine ... They have as support Angola LNG. The company is the main partner of the hospital and other health centres in Soyo." (Municipal Hospital of Soyo Director IDI)

"In recent years and with the policies that have been being implemented, such as the distribution of insecticide sprayed mosquito nets, there has been a reduction in infant mortality. At this time, maternal mortality is an issue that brings more worries." (*idem*)

"The maternity does not only support deliveries ... and what happens is that we have few beds for maternity, frequently women and even new-borns have to lie down on the floor." (*idem*)

"[Infant mortality] In the past more were dead. Now, there are now more vaccine campaigns and awareness through lectures." (Chief of Health Centre 1º de Maio IDI)

"In the area of maternal and child health there is shortage of medical tables, lack of desks, chairs and equipment for blood pressure measuring..." (*idem*)

"The health sector is awful. In hospital I saw a new-born and mother lying on the floor ... 15 days later, the baby died." (Priest of Kikulo Mission IDI)

## 5.4 Identification of Potential Areas of Intervention

### 5.4.1 Impacts and Risks

The risk analysis in socio-economic and health is buoyed by several factors, including the fact that the project will have logistical support in Luanda, as well as the fact that the operations will be fully offshore. The direct negative impacts on the population are thus reduced. However, it is pertinent to keep in mind the risks identified in the table below - Table 5-14.

**Table 5-14: Risk Assessment Matrix.**

| Risk | Probability | Intensity | Possible Mitigation Measure |
|---|---|---|---|
| Weak employment of local population | High | Low | - Support to local hiring<br>- Social Responsibility initiatives in the employment domain |
| Reduction of fish | Reduced | High | - Contingency plan: compensations plan for fishermen |
| Injury to touristic activities | Reduced | Medium | - Encouragement of touristic sector |

The first risk identified may be associated with various facts; as stated previously, the local hand labour is low-skilled in technical and scientific terms and is dissonant of project exigencies. So, we expect that the project won't contribute with the employment of local hand labour; in spite of this risk identified, the action plan on social responsibility focuses the possibility of contributing to local hand labour training.

Secondly, we refer to the possibility of reduction of fish, in case of spillage and contamination of water. The project has environmental concerns and a lot of studies act to prevent this incidents; that's why we think that this risk has a reduced to probability to occur. But, if occurs, a contingency plan may be prepared in order to compensate the fishermen for the prejudices in the catching the fish.

The last risk identified is also related with an improbable spillage and water contamination and it refers to damages in touristic activities. The tourism is still poorly developed, in spite of the great touristic potential of Soyo. That's why we point out a medium intensity. In other hand, and again under social responsibility action plan, some measures should be taken into account in order to contribute for developing tourism in Soyo.

### 5.4.2 Impacts and Opportunities

In spite of having reduced risks for the population of the target area, the project will be located in the map of local natural resources. Being a highly technological project, the risks are low but the opportunities of contributing to local development are high.

In general, and as regards the battle against poverty, there is a set of strategies to be taken into account (Capucha, 2005):

- Extension of social and civic rights;

- Job creation;
- Reinforcement of the education system and investment in qualification;
- Facilitation in mobility and encouragement of trade and cultural exchanges;
- Restructuration of the social protection systems;
- Development of specific measures to fight poverty and social exclusion.

In terms of government, there is an interim plan, whose achievement is due this year (2009/2013), and in which key points of intervention are highlighted: poverty reduction, democratic governance, crisis prevention and recovery, and finally sustainable development (MINPLAN & PNUD-Angola, 2009).

We must not ignore the advantages associated with the conversion of natural resources in financial resources, the training often associated with these exploration projects as well as the development of infrastructures and the application of economic resources resulting from business in environmental and social programs (Franks, 2012). Consequently, the identification of potential areas of intervention arises from the previously analysed information, including:

- Detailed description of the socio-economic conditions and population's health, retrieved through the questionnaire to households.
- Characterization of each of the three types of community (Agriculture and Fishing, Fishing and Urban), based on the analysis of the Focus Groups and in-depth interviews.
- Identification of critical points resulting from the analysis of the information referred to above, whether quantitative or qualitative.
- Expectations and concerns of the general population and consulted stakeholders, regarding the ENI's project.

The figure below summarizes the potential areas of intervention identified – Figure 5-126.

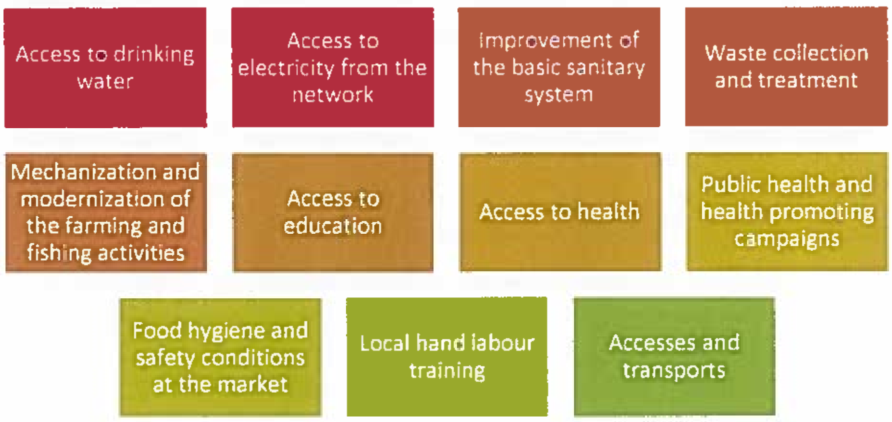



**Figure 5-126: Identification of Potential Areas of Intervention.**

The intervention in the various mentioned areas, based on assumptions related to social responsibility, allows intervening at several points of the abovementioned "vicious circle of poverty". It is difficult or impossible to reach a full resolution of all mentioned critical points; however, breaking some of the circle pillars, eliminating or reducing the impact of some of the points mentioned so far there will be a poverty phasing out (Figueiredo and Costa, 1981).

The issue of water is undoubtedly important in the context of promoting community development, with obvious implications in contributing to the improvement of global health status, enabling the reduction of the incidence and prevalence of numerous diseases related to water consumption.

The street and domestic lighting, through the network was established as a critical factor in the case of Soyo, the population associates it with other issues indirectly enhanced by the gaps in access to energy, such as public safety and crime.

The percentage of households with connection to the sewage system is low and the treatment of household waste, which is not appropriate, competes with other factors to negative effects in terms of environmental and public health.

The passage of productive activities to a more commercial and planned logic in order to produce/fish according to sales is crucial. Moreover, access to equipment and more technologically advanced material, as well as vocational and technical training on how to handle them, seems an obvious asset, with clear impact on improving the life quality life, even increasing their fixed incomes.

"We need to counteract the welfarism. (...) And it takes not only production knowledge, but also technical and management awareness." (Head of Studies, Projects and Planning Department of the Ministry of Agriculture IDI)

Access to education is a *sine qua non* condition for social development. The number of children enrolled in the school system is increasingly significant; though the ideal that all children and young people of school age should attend school is not yet reached, it is undeniable the effort put in this field and the concomitant progress made in this area. In the process of national reconstruction as well as the fight against poverty, the generalised and equal access to a quality education appears to be a crucial ingredient.

The identified needs in terms of education are multiple, recording asymmetries in access which is important to counteract, being crucial the expansion of infrastructures. Moreover, the need for more and better trained technicians also applies as needed. The challenge of including all school-age children in the education system demands for better transport network, allowing counteract the distances that, despite efforts, will continue to exist.

Regarding the healthcare field, another cornerstone for social development, several constraints related to the lack of infrastructure were also identified, but also with the lack of technical and human resources to enable the provision of better health care to the population.

Given that many of the diseases/infections that affect the population arise from behaviour and can be prevented, the health promoting actions show as an opportunity to provide the population with preventive behavioural skills that lead to better personal and house hygiene practices, aiming ultimately to a better health status. School is a privileged context to reach a large number of people, so health promotion in this area allows influencing not only the students but also the staff, families and community health, with impact at present and in future generations; therefore, actions and initiatives to promote health in schools are considered as an asset.

Even within the public and environmental health, an intervention in the local market is urgent, having been found evident gaps in relation to the poor conditions in which the products, including food, are sold. The population feels this as an obstacle to development and a threat to their health. The rehabilitation of the municipal market can constitute itself as a further incentive to the development of local production.

"The farmer produces but he/she must have a place where to sell." (Head of Studies, Projects and Planning Department of the Ministry of Agriculture IDI)

No less important than the intervention needs already focused, now training and development of local hand labour upraises. If we think of the huge industrial potential in Soyo and the high percentage of unemployed, especially among the young people of the population, we find that the jump to a more developed society can be in the training of local people so that they become specialised hand labour for the local industry; the population complains that local employability mostly happens in construction and edification phases, feeling subsequently left behind in relation to foreigners. Thus, it is necessary to create better training conditions for the people of Soyo, in order to enable their specialization, to meet the needs of the local market, qualifying hand labour and simultaneously fighting unemployment.

A transversal aspect of social development relates to transport and accessibility, which can become an incentive or barrier to trade, experiential and cultural, or even a critical factor when we analyse, for example, access to health and education issues. Efforts in this area are recognized and some progress in terms of rehabilitation of some roads are perceived; however, and especially during the rainy periods, many major roads such as the road from Luanda to Soyo, become virtually impassable, hindering the mobility of the population.

In short, stemming from the analysis of the information gathered in this report, an identification of potential areas of intervention is made. In this sense, it is important to underline that the intervention in one of the critical points produces effects in several ones, since many of them have mutual influence relationships.

In the current scenario of global development, the "Zorro syndrome", i.e., the idea that isolated action by a person or entity can solve all problems has little applicability (Dhume, 2001); the need of collective action to overcome individual and institutional boundaries is increasingly recognized. In line with this reasoning, the social responsibility projects, particularly associated with the exploitation of natural resources industry, are assumed as a strategy of extreme importance in contributing to the socio-economic development, with a clear impact on the life quality of local communities adjacent to where the industry is located.

## 5.5 Conclusions

ENI Angola has a project for oil exploitation whose location will be in the area of Headquarters Commune in the Municipality of Soyo. Prior to the platforms construction, national legislation provides for obtaining an environmental license, under which this socio-economic and health baseline study is based on. ENI's own institutional regulations point to a detailed evaluation of impacts on social and health services, as part of the final assessment of environmental, social and health impacts – ESHIA.

This report allows projecting a socio-economic and health profile, based on the identification of critical points but also the identification of expectations and challenges facing by the population that is in the area of the Headquarters Commune in the Municipality of Soyo (Appendix G – Occupation and Organization of the Commune of Soyo).

The description of the population, despite finding an effect of effort and commitment to national reconstruction, highlights a set of vulnerabilities and critical points on which is important to intervene in a matter of fighting poverty by promoting socio-economic development.

The SWOT matrix presented below summarizes the information collected under this study.

**Table 5-15: SWOT Analysis.**

| STRENGHTS | WEAKNESSES |
|---|---|
| • Young population<br>• Recognition of the need for vocational/technical training for later integration into the labour market, in more qualified and better paid posts. | • Low skilled professionals<br>• High incidence of diseases/infections symptoms which are preventable<br>• Gaps in knowledge about tuberculosis and HIV. |

| | |
|---|---|
| • Appreciation/Recognition of the importance of education within the education system<br>• Gradual awareness of the importance of preventive behaviours regarding health (patent, for example, in the use of mosquito nets)<br>• Recognition of safety in health services *vs.* tradition<br>• Gradual awareness of the importance of testing, especially malaria and HIV<br>• Possibility of acquiring almost all products/services without leaving the Municipality | • Ignorance of mandatory vaccines<br>• Excessive alcohol consumption<br>• Low individuals and families monthly incomes<br>• Municipal market with poor conditions<br>• Education system: asymmetries in access, lack of infrastructure, lack of teachers and equipment<br>• Health system: asymmetries in access, lack of infrastructure, lack of technical staff and equipment |
| **OPPORTUNITIES** | **THREATS** |
| • Strong industrial development – social responsibility projects<br>• High local economic growth – attractive for new businesses<br>• Settlement of population coming from abroad – cultural and knowledge exchange (training)<br>• Increased health knowledge due to health prevention campaigns implemented by the government and/or partnerships with private companies. | • Absence/Unavailability of water from safe sources<br>• Widespread lack of sanitation and no waste treatment<br>• Access to energy – insecurity and crime<br>• Interference of industrial development in cultural practices<br>• Increased contrast between the progressive industrial development and poverty of the population, if the "cycle of poverty" is not broken. |

The identified vulnerabilities constitute a "cycle of poverty" that feeds on itself by mutual and reciprocal implications of its several elements. Weaknesses are found in relation to access to water and energy, as well as regarding the lack of a sanitation system and also waste treatment that is rarely done, many of them being thrown to sea/river/lake or simply left in the streets, in the open. Countless health hazards arise from this and are exacerbated by a health system whose access is not equal, being privileged the communities closer to urban centres; there is similarly a lack of infrastructure, lack of human resources, with some specialties non-existent, and insufficient technical means and equipment for the proper provision of health services. Factor to be taken into account is the major diseases affecting the population can be prevented. Access to education is made with the same difficulties; there is also inequality in access, lack of schools, lack of teachers and gaps in their education and teaching preparation. The production activities are practiced mainly for self-consumption and their practices as well as their commercial extension are rudimentary; the modernization of farming and fishing, through training and associated technology, is urgent, in order to establish a commercial reasoning that allows increasing household incomes. Another social vulnerability identified relates to the gaps in vocational/technical training and unemployment; the lack of skilled labour results in the creation of more and better opportunities for foreigners to the detriment of local hand labour.

Soyo has experienced a huge industrial growth. The population recognizes some benefits of industrial growth, associating it mainly to the intervention of Angola LNG under social responsibility. However, the population's poverty level over the exponential proliferation of industries on site is still contrasting. One of the key points of intervention may involve the local hand labour training, which would meet the needs of the local industry, to allow the entry of more Soyo people in industrial manufacturing sector. Thus, even in social responsibility reasoning, it will be promoting the development of social skills in a personal and social responsibility perspective, contrasting with merely welfare actions. Moreover, interventions in health, education, accessibility, water, energy and sanitation are critical, in order to improve the life quality and allow a gradual breakdown of the "cycle of poverty".

It should be noted a general acceptance of industrial development projects, being made a balance of concerns and expectations, which results essentially of an accumulation of expectations associated with improved life quality that ultimately outweigh the concerns of negative impacts in the discourse of the consulted stakeholders.

Valuing a participatory assessment of impacts and risks, ENI engaged on the realization of this study, whose information will be part of the final ESHIA. Furthermore, and in an action/research viewpoint, the social and health analysis contained in this report may constitute solid foundations for planning a

Social Responsibility Program strictly aligned with the profile of vulnerabilities he outlined. Consequently, and establishing itself as a foundation on which can be based a future Action Plan within the framework of Social Responsibility, the table below (Table 5-16) shows the generic priorities and goals, pointing out some possible projects to achieve them.

**Table 5-16: Action Plan under the Social Responsibility (SR).**

| | Entities | | |
|---|---|---|---|
| | PSR[13] | CG[14] | LA[15] |
| **Priority 1- Access to drinking water** | | | |
| Program 1.1. – Improve access to drinking water<br>Objectives: Facilitate the access to drinking water, reducing the risk associated with consumption from unsafe water sources. | | | |
| Project 1.1.1. Rehabilitation of the existing water network | | • | |
| Project 1.1.2. Enlarge the drinking water network | | • | |
| Program 1.2. – Sensitize the population about the importance of treating drinking water<br>Objectives: Raise awareness of the population of risks associated with untreated water | | | |
| Project 1.2.1. Awareness-raising Programme on Water Treatment | • | | |
| Project 1.2.2. Distribution of Means for Water Treatment | • | | |
| **Priority 2 – Energy and Lighting** | | | |
| Program 2.1. – Increase access to network electricity<br>Objectives: Increase the percentage of population with access to network electricity | | | |
| Project 2.1.1. Rehabilitation of the existing electrical network | | • | |
| Project 2.1.2. Enlarge supply network | | • | |
| Program 2.2. – Improve illumination and reduce insecurity<br>Objectives: Increase the number of public places with illumination | | | |
| Project 2.2.1. Increase public roads with illumination | | • | • |
| Project 2.2.2. Raise awareness about risks and public safety | • | | |
| **Priority 3 – Sewage System** | | | |

[13] PSR – Involvement of Partners under the Social Responsibility
[14] CG – Central Government
[15] LA – Local Administration

| | Entities | | |
|---|---|---|---|
| | PSR[13] | CG[14] | LA[15] |
| Program 3.1. – Improve the municipal sewage network<br>Objectives: Increase the percentage of population connected to the sanitary sewer system | | | |
| Project 3.1.1. Rehabilitation of the existing sewage network | | • | |
| Project 3.1.2. Increase the number of households with toilets connected to public sewage networks | | • | |
| Project 3.1.2. Awareness-raising actions among the population about the benefits of the connections to the public sanitary sewage network. | • | | |
| **Priority 4 – Ware Collection and Treatment** | | | |
| Program 4.1. – Improve Waste Collection System<br>Objectives: Improve the collection and treatment of household waste | | | |
| Project 4.1.1. Increased number of public containers for depositing household waste | | | • |
| Project 4.1.2. System effective waste collection. | | | • |
| Program 4.2. – Education and awareness to the population<br>Objectives: Raise awareness of the importance of the public deposit of waste in appropriate locations | | | |
| Project 4.2.1. Raising awareness of the importance of household waste disposal in appropriate locations, warning of risks arising from its warehouse in inappropriate places. | • | | |
| Project 4.2.2. Distribution buckets household garbage bags and suitable for laying waste at home, prior to depositing the containers public. | • | | • |
| **Priority 5 – Farming Activity** | | | |
| Program 5.1. – Modernization of Agricultural Activity<br>Objectives: To contribute to the transition from a farming family and mainly for self-consumption for an agriculture-oriented trade. | | | |
| Project 5.1.1. Actions training to farmers in areas associated with cultivation techniques | • | | • |
| Project 5.1.2. Actions training local farmers in areas related to management and production planning | • | | • |
| Project 5.1.3. Facilitating access to products (fertilizers, seeds ...) and equipment (agricultural tools, tractors ...). | • | | |
| **Priority 6 – Fishing** | | | |
| Program 6.1. – Modernization of Fishing Activity<br>Objectives: Contribute to the practice of fishing in a commercial logic. | | | |
| | • | | • |

| | Entities | | |
|---|---|---|---|
| | PSR[13] | CG[14] | LA[15] |
| Project 6.1.1. Training actions for fishermen in technical areas related to fisheries, including the fish conservation | • | | • |
| Project 6.1.2. Training actions for local fishermen in areas associated with fishery planning and management | • | | |
| Project 6.1.3. Facilitated access to useful equipment for fishing and fish conservation<br>Project 6.1.4. Compensatory Plan for local fisherman in case of water contamination. | • | | |
| **Priority 7 – Access to Education** | | | |
| Program 7.1. – Reduce disparities in access<br>Objectives: Contribute to the reduction of disparities in access to local education system | | | |
| Project 7.1.1. Increase school infrastructure | | • | |
| Project 7.1.2. Transport network to school for those in more isolated communities | | • | • |
| Program 7.1.3. Provide schools with materials and equipment | • | | • |
| Program 7.1.4. Distribution of school supplies kits | • | | |
| **Priority 8 – Access to Health** | | | |
| Program 8.1. – Improve access to health<br>Objectives: Contribute to the reduction of local asymmetries in access to health | | | |
| Project 8.1.1. Increase health infrastructure | | • | |
| Project 8.1.2. Facilitate access to transportation (bicycles, motorbikes) to community health workers | • | | |
| Program 8.1.3. Raise awareness to the people in First Aid | • | | |
| Program 8.1.4. Distribution of First Aid Kits | • | | |
| Program 8.2. – Provide health Infrastructure<br>Objectives: Contribute to the improvement of services provided by sanitary infrastructure | | | |
| Project 8.2.1. Distribution of equipment, materials and missing products in local health facilities. | • | | |
| Project 8.2.2. Distribution of birth kits, with products aimed not only at birth but also to postpartum care for the mother and for the baby first care | • | | |
| Program 8.3. – Specialised Human Resources<br>Objectives: Train the existing health technicians and contribute to the increase of the specialties covered by local health services | | | |
| Project 8.3.1. Health Technical Training Programme, promoting knowledge updating | • | | • |
| | • | | |

| | Entities | | |
|---|---|---|---|
| | PSR[13] | CG[14] | LA[15] |
| Project 8.3.2. Facilitate recruitment of technical expertise, particularly in areas identified as deficient (cardiology, ophthalmology ...) | | | |
| **Priority 9 – Public Health and Health Promotion** | | | |
| Program 9.1. – Knowledge and Practices in Health Promotion/Disease prevention<br>Objectives: Raise awareness to people about the importance of preventive behaviours in terms of health and provide them with the behavioural skills for these prevention practices. | | | |
| Project 9.1.1. Seminars on major diseases and prevention methods | • | | |
| Project 9.1.2. Raise awareness about the risk of major diseases in childhood and adolescence | • | | |
| Project 9.1.3 Distribution of mosquito nets and spraying insecticides | • | | |
| Project 9.1.4 Distribution of products for treating drinking water | • | | |
| Project 9.1.5. Seminars on Public Health | • | | |
| **Priority 10 – Market: food hygiene and safety** | | | |
| Program 10.1. – Improve overall market conditions<br>Objectives: Improve access, environmental health and hygiene of the products sold in the market. | | | |
| Project 10.1.1. Improve market accessibility and conditions | | • | • |
| Project 10.1.2. Raise awareness among market vendors about hygiene practices and exhibition/conservation products for sale. | • | | |
| Project 10.1.3. Access to drinking water in the market | | • | • |
| **Priority 11 – Local hand labour training** | | | |
| Program 11.1. – Local hand labour training<br>Objectives: Improve the professional qualifications of the local hand labour | | | |
| Project 10.1.1. Partnership with INEFOP in vocational/technical training | • | | • |
| Project 10.1.2. Establish partnerships with educational institutions (2nd Cycle School and University) within the specialized technical training | • | | • |
| Project 10.1.3. Training Courses in technical areas related to the ENI's project | • | | |
| **Priority 12 – Accessibility and Transport** | | | |
| Program 12.1. – Improve the accessibility network to and in Soyo<br>Objectives: Improve the road infrastructure in Soyo and the main exits | | • | • |

| | Entities | | |
|---|---|---|---|
| | PSR[13] | CG[14] | LA[15] |
| Project 10.1.1. Asphalting the main roads | | | |
| Program 12.2. – Improve the transport network | | | |
| Objectives: Improve the transport network in Soyo | | | |
| Project 10.1.1. Increase the efficiency of the transport network, improving, for example, access to farming fields and health services. | | • | • |

# 6 Stakeholder Engagement

This chapter describes the stakeholder engagement process that was conducted by SINFIC for this ESHIA process.

## 6.1 Activities Undertaken

The identification and consultation of stakeholders are essential processes within an environmental, social and health impact assessment. Taking into account the guidelines of ENI, stakeholders are defined as individuals or groups:

- Over whom the project has legal, financial and operational responsibilities;
- That are affected by the action of the project;
- And/or may have influence and impact on the project.

As stated in the Methodologies Report (Phase 1), a team of CEIS went to the Headquarters Commune in the Municipality of Soyo, to consult a wide range of interested parties.

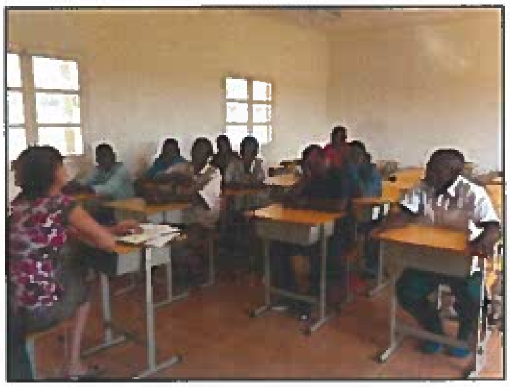
According to plan, 10 Focus Groups were conducted with the population (Appendix F); it was considered important that the discussion group, whose participants were yet to define at the moment of execution of the mentioned report, should be composed of representatives from the young people of an urban community. A list of the conducted Focus Groups is shown below:

**Table 6-1: Conducted Focus Groups.**

| | |
|---|---|
| **Agriculture and Fishing Communities** | • 1Sobas FG<br>• 1 Men FG<br>• 1 Women FG |
| **Fishing Communities** | • 1 Sobas FG<br>• 1 Men FG<br>• 1 Women FG |
| **Urban Communities** | • 1 Sobas FG<br>• 1 Men FG<br>• 1 Women FG<br>• 1 Young People FG |

FGs Participants - Agriculture and Fishing Communities

Men Discussion Group - Agriculture and Fishing Communities



Participant Sobas in FG - Fishing Communities

Men FG - Fishing Communities

FGs Participants - Urban Communities

FGs Participants - Urban Communities

Participants in the Men and Young People FGs - Urban Communities

**Figure 6-1: Photos from stakeholder engagement activities.**

As for the in-depth interviews, 22 were conducted[16], and the preliminary list of stakeholders identification was updated, according to assumptions of availability/response to interview requests, as well as increased utility of information to be collected (Appendix F).

The consultation of stakeholders above mentioned was based on the achievement of several objectives:

- Collect primary basic information about Soyo development, constraints, challenges and progress in socio-economic and health terms, main concerns associated with life in the Headquarters Commune in the Municipality of Soyo (referred to in previous chapters).
- Inform about the ENI project, contextualizing it and doing a brief description of its scope.
- Collect the main expectations and fears associated with the project's impact on communities and development of Soyo.
- Understand the social acceptance of the project.

The public inquiry process, provided in national legislation, as well as in the standards of ENI itself, was held in Soyo, between 23 and 31 January and, in Luanda, between 1 and 22 February. For this purpose, the guidelines for the Focus Groups and in-depth interviews previously approved by ENI and presented in the scope of the Methodological Report were used.

The analysis of the collected information allows grouping the main concerns, as well as main expectations associated, in general, with the proliferation of oil and gas industry in Soyo, concretely measured in relation to the ENI project.

## 6.2 Concerns

Regarding the identified concerns, essentially three categories stand out. It is clear that the consultation of the population's concerns is always based on a logical comparison with the effects associated with the industry already established and operating in Soyo.

The creation of a new industry is associated with the creation of new jobs; however, with regard to filling these vacancies, there are some concerns, particularly with regard to increasing opportunities for expatriates to the detriment of the local population. On the other hand, and by analogy with other projects, the concern arises associated with the duration of contracts, confirming the fear that the job increase would be limited to the construction and edification phases.

[16] In order to have more in depth information, were made more 4 structured interviews, as can be seen in Appendix F.

"Many of us have already worked in Angola LNG; some for two years, other for four years. The contracts have ended and we still do not have any answer on new contracts." (Urban Young People FG)

"There is a lack of jobs and school; the Angolan always comes off second best to foreigners." (Urban Men FG)

"The natives of Soyo are not hired by the companies that are established here." (Urban Young People FG)

"Nowadays they are asking for English; I do not know if it is a way to reject applicants." (Urban Young People FG)

"Companies that come to the municipality do not recruit locally; they should contact the sobas to recruit when they come here." (Urban Sobas FG)

The topic of pollution/environmental impact emerges several times, when seeking the concerns and impacts attributed to the project. Although aware of the environmental impact studies and a set of security measures associated with oil and gas industry, the consulted stakeholders show some concern, especially with regard to the impact of pollution in productive activities, farming and fishing, and also in regard the very way of life. Again, sharing concerns is made in light of experience and previous situations related to other industries implanted there.

... they had a problem due to gases and fumes from burning the oil to the air ... cashew trees stopped producing cashew, only now they are re-appearing. The coconut is another situation ..." (Provincial Representative Provincial of the Institute of Artisanal Fisheries IDI)

"There were variations in the amount of fish which we believe were due to thermal changes of the waters." (idem)

"Some of the plants have stopped producing because of the pollution. But nowadays there is little pollution because of the measures of Angola LNG – "currently there is less gas flaring." (Chief of the Municipal Trade, Hotels and Tourism Section IDI)

"Before there were agricultural areas here, but with the tides that have taken everything are falling into decay, and the fishing activity does not produce large incomes." (Fishing Women FG)

"The water here cannot be drunk. We have taken samples to Soyo, it looks like diesel." (Agriculture Sobas FG)

"Some say that all the fish disappeared since Petrangol settled here; but the truth is that fishermen have no way to get to fish in the high sea." (Urban Sobas FG)

"Previously cashews production was good; during the festive seasons bibe [traditional drink] was always drunk and now it disappeared since 1982, when the petroleum companies arrived here. Today buy a litre we have to pay 1,500 Kwanzas. The Angola LNG has ensured that this will end soon, we are waiting." (Fishing Men FG)

Aware of the importance of the Social Responsibility associated with the industry, particularly when it comes to exploitation of natural resources, the population is however concerned about the true effectiveness and fairness of compensation measures.

"At some point the Angola LNG gave derisory amounts from 100 to 200 USD to some women, but it was insufficient." (Fishing Women FG)

"There are several oil companies ... Petrofina, Petrangol; Finapetróleo was the first to arrive. But they have never given a visible aid to Soyo and are so old." (Urban Sobas FG)

"For example, the project Cajueiro Sonangol has energy 24/7 and could extend the electricity power to the neighbourhoods to help people." (Urban Sobas FG)

"Oil companies should clarify directly with the people their performances [within the as social responsibility scope] so that information passes clearly and directly. For example, Angola LNG has two or three projects but they have a lot of publicity; they have a department of community support." (Urban Sobas FG)

## 6.3 Expectations

Familiar with industrial growth and development, particularly as regards the exploitation of natural resources, the population Soyo reveals awareness of concepts such as impact and social responsibilities. In fact, the need to consider side effects, positive and negative, particularly as regards the social impact of implementing a particular project is now increasingly recognized (Frank, 2012). We talk about social impact, a concept that alone does not explain the success of a project, but it should be part of its profound evaluation. Acquainted of the potential of this impact, the consulted stakeholders manifest a particular set of expectations associated with the ENI's project, which are also extended to the entire oil and gas industry.

The generation of new jobs, helping to reduce the problem of unemployment, appears side by side with any industrial project; in this case, that expectation is also clear.

"One priority is employment, the companies coming here; but there should be transparency in recruitments." (Urban Young People FG)

Moreover, and as secondary and indirect effect, there is a wide range of expectations in social responsibility.

Investment in training and education of the population of Soyo is seen as an asset, being assigned a prominent role to industrial development projects in this area. The training is required and expected in many sectors, and the possibility of funding higher education courses through partnerships with the University of 11de Novembro is also referred to. Thus, it is assumed that oil industry can play an active role in the passage from rudimentary and family productive activities to commercial, entrepreneurial and more specialized activities in terms of updated technical knowledge.

"And private companies could contribute creating horticulture course funding programs." (Head of the Municipal Agriculture Section IDI)

"... a partnership with education for the expertise. We can not achieve development without technical trained people ... We must think of creating an institution of technical education." (Consultant to the Minister of Education / Coordinator of Committee for Monitoring and Evaluation of Education Reform IDI)

"The city needs a good hotel training school because we have to hire outsiders to perform this service." (Local Company IDI: Cachupa)

"There is a need for a fishing school (basic training), because there is the potential of young people who are traditionally fishermen, but it's an intuitive fishing (it is necessary to help in the conservation of bio-diversity)." (Provincial Representative of the Institute of Artisanal Fisheries IDI)

"We welcome new businesses and investments and that companies allow the staff to train and participate in the development ... Require training for the development of the region." (Head of the Municipal Commerce, Hotel and Tourism Section IDI).

"The course of industrial organization and maintenance is a course with many applicants but those people are employed ... It is a course that expensive that requires investment which oil companies could finance." (Vice-Rector of University of 11 de Novembro IDI)

The contribution to the improvement of the population's living conditions, in those that are their main concerns, aligned with the critical points identified in the previous chapter. It is thus expected an effective collaboration to improve access to education and health, as well as regarding the issues of water and energy, which remarkably are one of the constraints with obvious repercussions on the life quality these populations.

"A study on how oil companies could contribute more to local development should be conducted." (Deputy Municipal Administrator IDI)

"The strategy is the creation of infrastructures, improvement of education managers." (Head of the Municipal Bureau of Education, Culture and Sport IDI)

"What we want is that many partners come here, so they can know the needs and support." (EP Director of Primary School No. 2)

"Priority is building 2nd cycle schools in several areas of the municipality. There are children in the neighbourhoods, even within the city, who cannot get to the centre." (Director of 2nd Cycle School IDI)

"Companies can support schools, leaving the government as supervisor. They each could, for example, support with the construction of a room." (Director of 2nd Cycle School IDI)

"They have to invest in building schools, hospitals, water, electricity and roads. The church must speak, advice and encourage the government to invest. Oil companies are ordered to do things only with the consent of the government." (Priest of Kikudo Mission IDI)

"Oil companies contribute with about 60% of the national GDP and can help, but without being impeded by the government. They should directly do what they consider right in terms of social responsibility. This aid must be direct." (idem)

"The issues of health, water and energy are very weak so they should also be improved. Angola LNG is the company that has helped in some initiatives, such as construction and rehabilitation of health and education infrastructure." (Local Company IDI: JOCAJU)

"The municipal hospital has shortages of medicines – the companies that invest here have to think about the health and education issues and should also invest in these areas." (Local Company IDI: FDF)

As part of the implementation of social responsibility projects, the need for closer collaboration and effective cooperation between private companies and government agencies is highlighted.

"Companies pay their taxes to the state, however they may participate more in social activities ... but the Government request them ... and such requests must be explicit and transparent." (Deputy Chief of Kwanda Base IDI)

"The articulation of provincial and municipal government with companies to develop well established protocols is important. But the provincial government should do the projects for companies to support." (idem)

"Local businesses should implement the plans carried out for development plans with local government." (Provincial Representative of the Institute of Artisanal Fisheries IDI)

It is still expected a number of initiatives and measures that promote the local associativism, as a bridge to development.

"Developing local associations so that they can access support such as tractors, windmills, which increase production. It is necessary to promote the local self-organization." (Director of the Municipal Bureau of MINARS IDI)

Finally, it was possible to identify a set of expectations associated with the contribution to a more informed society, in terms of their rights and duties, as well as with regard to access to services in the community, starting with information within its employees.

"We have conducted seminars that will continue to exist in order to explain to people what they should do. The municipal administration has helped these seminars making the opening and closing remarks.

As for private companies, they should provide more information to their employees." (Head of the Municipal Services at the National Institute of Social Security IDI)

In short, balancing the fears and expectations, the social acceptance of the project poses no problems and it is seen as an opportunity for local growth and development.

"There may be a need to relocate people. But then these actions bring benefits to the whole world. In fact if environmental issues are not seized, it may also be a risk to the populations. But today, if one wants a license for an industrial activity, environmental impact studies have to be made. This situation has to be safeguarded ... So I do not think that is a problem or a constraint for the population. It will be a benefit to the region as it will promote industrial development and industrial and technological development always brings many benefits in terms of well-being." (Head of Technical and Technological Support Department of the National Directorate of Industry IDI)

"There are a number of opportunities that are foreseen for the sector [agricultural] with the increasing oil activity (...) And, indeed, where there is a whole set of new things, work, there has to be those impacts that we anticipate and those others that we do not. But I believe we all have the capacity to overcome them when they arise." (Head of Studies, Projects and Planning Department of the Ministry of Agriculture IDI)

# 7 Marine Impact Assessment

This section provides an analysis of potentially significant impacts on the marine and coastal environment (below the high water mark) as a result of the proposed development and operation of the East Hub of Block 15/06 offshore Angola. Mitigation measures are recommended, for incorporation into management plans, to avoid or reduce negative impacts and/or enhance any benefits. The marine impact assessment was compiled by Sue Lane and Associates.

## 7.1 Impact Assessment Criteria, and Methodology

Potential impacts on the marine environment, generated by activities involved in the development and operation of the East Hub of Block 15/06, are identified through professional experience gained from working in the field with specialists in the relevant disciplines. These potential impacts are also cross-correlated with those assessed in Eni's final (May 2013) impact assessment for the West Hub development located approximately 38 km to the west (ARC, 2013). This approach obviates the need for separate 'scoping' to identify the relevant impacts that need to be addressed by Eni for their proposed East Hub development.

The potential impacts of the proposed project are assessed using the following criteria and scoring method in a-c below, as per Eni's ESHIA standard, and added to for marine purposes. Notes on our interpretation of the methodology are included in boxes.

**Box 7-1: Adjustment of duration criterion.**

Eni defines Duration as: The temporal scale of the impact, ranging from 1 year or less to 10 years or more/irreversible, which, however, also takes into consideration frequency, i.e. continuous or intermittent nature, of the impact;

In this assessment the 'critical' ranking is extended to "over 15 years/ beyond project life" of impact on the receptor and the 'high' ranking of long term is amended to "5 to 15 years" to cater for the life of the East Hub project. In addition, the word 'irreversible' is removed from the 'critical' ranking under Duration as it may not be true, and is already catered for under the 'Extreme Magnitude' criterion.

**a)** The sum of the scores in **Table 3-1** below, ranging from 4 to 16, are used to predict the **consequence/severity** of impact.

**Table 7-1: Criteria used to determine the Consequence/Severity of the Impact.**

| RANKING | EVALUATION CRITERIA | | | |
|---|---|---|---|---|
| | Duration: (and continuous or intermittent during the time) | Extent: geographical scope of the impact | Magnitude: Importance / resilience of receptor / resource. | No. of elements involved |
| Low<br>1 | Less than 1 year / Temporary (short term) | Local scale: the proposed operating site and its immediate environs (or <3 km of coastline) | Low value/sensitivity of receptors or resources, able to recover or adapt to the change without interventions | Affecting a small no. of individuals and/or a small no. of species (a small proportion of a population of a given species). |
| Medium<br>2 | Between 1 and 5 years (medium term) | Regional scale: as determined by country's administrative boundaries (in this case Cabinda & Zaire provinces i.e. northern fishing area from Cabinda to Luanda) | Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions | Affecting a higher no. of species and habitat (a moderate proportion of a population of a given species). |

| RANKING | EVALUATION CRITERIA | | | |
|---|---|---|---|---|
| | Duration: (and continuous or intermittent during the time) | Extent: geographical scope of the impact | Magnitude: importance / resilience of receptor / resource. | No. of elements involved |
| High 3 | Between 5 and 15 years (long term/ project lifetime) | National scale: Entire country (Angolan waters to 200 nm EEZ). | High value/sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions | Affecting a great no. of habitats and ecosystems (a high proportion of a population of a given species). |
| Critical 4 | Over 15 years (beyond project lifetime) | Transboundary/ international scale: (i.e. beyond Angolan waters and coastline). | Extreme value/sensitivity of receptors or resources, resulting in permanent changes | Affecting huge no. of individuals, and/or habitats structure and ecosystems functions (nearly all of a population of a given species). |
| SCORE | 1 – 4 | 1 – 4 | 1 – 4 | 1 – 4 |

Note: blue highlights are elaborations for this particular assessment.

b) The **probability of** occurrence of the impact is rated as one of four, almost equally weighted, categories, defined as follows:

- **Unlikely**: Unlikely to occur in normal operating conditions but may occur in exceptional circumstances;
- **Possible:** May occur under normal operating conditions, but not likely;
- **Probable**: Likely to occur under normal operating conditions; and
- **Definite**: Will occur under normal operating conditions.

Consequence/severity and probability are thus established quantitatively or qualitatively, by drawing on information contained in the baseline report, the project description and other relevant literature which is referenced.

c) The **significance** of the impact is then rated as Low, Medium or High using Table 7-2 below.

**Table 7-2: Significance ratings.**

| Severity / Consequence Score | Probability | | | |
|---|---|---|---|---|
| | Unlikely | Possible | Probable | Definite |
| 4 – 6 | Low | Low | Low | Low |
| 7 – 9 | Low | Low | Medium | Medium |
| 10 – 12 | Low | Medium | Medium | High |
| 13 – 16 | Medium | Medium | High | Critical |

Summary tables in this assessment indicate the significance rating as either " - " (negative) or " + " (positive).

**Box 7-2: Control and management systems beyond report scope.**

The Significance Rating for each impact relates to the amount of effort, beyond complying with the law and Company policy, that Eni would need to put into mitigation (avoidance/ corrective / remedial actions).

The integrated significance to the Company (Eni) takes into consideration available resources and competencies, on-site conditions, public concerns and technology, which involves risk assessment.

Accordingly, the specific control and management systems necessary to implement any additional recommended mitigation measures (as set out in Appendix C) are beyond the terms of reference for, and do not form part of, this specialist report.

**Mitigation and Confidence levels**

Once the potential impacts identified have been analysed according to the impact assessment methodology outlined above, additional mitigation measures are recommended which are necessary to avoid or reduce the severity of negative impacts. These are also drawn from previous project experience and literature on best practice.

Confidence in the predictions is noted as Low, Medium or High. This is dependent on the availability and adequacy of data about a) the characteristics of the impact (e.g. synergies, cumulative effects, etc.), and b) how successfully the impacted natural systems/ populations/ species or ecosystem services would maintain their structure and functions in the face of natural fluctuations including, imposed stress and irregular events.

## 7.2 Identification of Issues and Impacts

Activities in the offshore environment with potentially significant impacts on marine life and/ or ecosystem services are:

***Development stage:***

- Drilling and discharge of drill cuttings and muds, which impact marine life through modifying sea bed and water column properties,
- Installation of structures on the sea bed (subsea production system, PLETS, xmas trees, manifolds, pipelines, umbilicals and mud-mat supports), which impact benthic habitat, and
- Discharge of hydrotest water, which impacts life in the water column.

***Development, commissioning and operational stages:***

- Operation of increased numbers of vessels and helicopters for installation, drilling, product shipment and servicing. The resulting physical presence, lighting and noise impacts other users of the sea and marine life;
- Discharge of produced (formation) water, which impacts life in the water column, and
- Accidents such as well blow-outs, pipeline ruptures, spills from vessel collisions, which impacts marine life in the path of the spill, and ecosystem services at sea and on the coast.

***Decommissioning stage:***

- Secure abandonment practices, which impact on established benthic communities.

**Box 7-3: Activity stages (above) not separated out.**

In the East Hub development in Block 15/06 certain commissioning and operational activities will be taking place simultaneously. For this reason no distinct activity stages, as listed above, are assessed.

## 7.3 Assessment of Potential Impacts

This assessment assumes that Eni and all subcontractors will obey the law and adhere to Company best practice Health, Safety and Environment (HSE) policies.

In the absence of detailed field investigations to determine the baseline conditions in some of the affected environments a precautionary approach has been applied in the assessment of the potential impacts. Wherever information is lacking or uncertain, a realistic worst case scenario has been assumed which might tend to overstate the significance of adverse impacts and understate benefits; this assessment is therefore considered conservative.

### 7.3.1 Impact M1: Potential Impacts of the Increased Number of Vessels on Navigation

Stationary or slow moving ships, including drilling rigs, pipe-lay and heavy-lift vessels and the FPSO, all with 500-1,000 m radius exclusion zones, and supported by service vessels taking regular trips to and from the supply base in Soyo, could pose a hazard to other vessels navigating the area, i.e. the impact on navigation would continue for the life of the project (*long term*) during which there is an increased potential/ possibility for an accident through vessel collision in the seas off Zaire and Cabinda provinces (the '*Region*').

Because the East Hub development area is located approximately 100 km offshore it is likely that only larger commercial shipping and fishing vessels would be encountered (*small numbers*), and these would be well equipped with navigational aids and safety equipment. Notices to Mariners publish warnings about the location and duration of oil field development and operational activities (e.g. South African Navy Hydrographic office NAVAREA www.sanho.co.za/_nav_area7_bulletins), and the vessels involved will all use the warning signs required by law. In addition, this region is well known to be populated by hydrocarbon exploration and production activities (*low magnitude*). For all these reasons the hazard posed to navigation should have an impact of *low* significance, and no additional mitigation measures are suggested.

**Table 7-3: Significance of potential impacts of increased vessel nos. on navigation.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Regional 2 | Low 1 | Small 1 | 7 | Possible | LOW - | High |

### 7.3.2 Impact M2: Potential Impacts of the Increased Number of Vessels Blocking Access to Fishing Areas

The East Hub development area is located largely offshore of the main fish distributions and fishing areas, except that: the FPSO is located in depths that overlap with the western edge of the distribution of commercial crustacean species (particularly of the Striped red prawn/shrimp (*Aristeus varidens*), and would fall within the area of directed fishing effort for large pelagic species, which is largely between 500-1000 m depths but tails off in the Congo River canyon area. These distributions in relation to the East Hub are illustrated in Figure 4-33 to Figure 4-35. Accordingly, there is a chance of long-line fishing vessels, specifically, being blocked from accessing these fishing areas during operations as tuna migrate through the region between spawning and feeding grounds most commonly in early summer each year.

By law Eni would request that a Notice to Mariners is published and warnings be broadcast about the location and timing of drilling and infrastructure establishment activities.

It is probable that, for the life of the project (*long term*), some long-line commercial fishing vessels (*small no.*) will be excluded from the development area (*local scale*); but they would be able to fish elsewhere as the extent of the habitat occupied by the species targeted is vast compared with the area to be occupied by the East Hub development in Block 15/06. Accordingly, the impact is rated to be of *low* magnitude, and is evaluated as of *low* significance. Additional mitigation measures are deemed unnecessary.

**Table 7-4: Significance of potential blocking of access to fishing.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Local 1 | Low 1 | Very small 1 | 6 | Possible | LOW - | High |

### 7.3.3 Impacts M3 to M5: Potential Impacts on Marine Fauna of Vessel Movements, Noise and Lighting

The presence of and noise from the well drilling rigs, equipment laying vessels, FPSO, tankers and support vessels may affect the movements and behaviour of marine fauna; there is also a risk of collision between fauna and these vessels. Noise from any helicopters travelling between Luanda and the East Hub may disturb marine fauna. Lighting from the vessels, and from flaring at the FPSO, may also attract and disorient certain species at night.

#### 7.3.3.1 Impact M3: Potential Impacts on Seabirds, Fish and Squid of Vessel and Helicopter Movements, Noise and Lighting

The proposed East Hub construction and operational activities including (at various stages and sometimes simultaneously) drilling, pipe laying, FPSO operation etc. over the oil fields will take place for 24 hrs a day over the project lifetime, estimated at about 15 years. The strong lighting used to illuminate the vessels at night may attract fish and squid where they may be more easily preyed upon by other fish and by seabirds. Vessel movements and noises are unlikely to be detrimental to this group of animals although their short term behaviour may be affected. On the other hand, noise from helicopters travelling between the onshore base and the offshore vessels may disturb seabirds as each year, especially during austral winter months; some migrant seabirds from the Southern Ocean will be present.

The potential impacts on fish, squid and seabirds would be in the vicinity of each vessel/ aircraft in the oil field or travelling to base (*regional* extent), and over the *long term*, for the duration of East Hub operations. Even in severe cases of disturbance there would be only chronic level or *low magnitude* effects *on a minute proportion* of any of the fish, squid and/ or bird populations concerned. The potential impact is *possible* and evaluated to be of *low significance*.

Mitigation such as light-shielding may serve to reduce effects on individuals and should be implemented; this will reduce the probability of any impact occurring, however the significance rating is not modified.

**Table 7-5: Significance of potential impacts of vessel and helicopter movements, noise and lighting on seabirds, fish and squid.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Regional 2 | Low 1 | Small 1 | 7 | Possible | LOW - | High |

#### 7.3.3.2 Impact M4: Potential Impacts on Cetaceans of Vessel Movements and Noise

Whale migration patterns in the region are not well known, but available information indicates that most migrating whale species occur in deeper offshore waters. All of the recorded species in the region may occur in the East Hub development area but humpback and southern right whales would be rare as these generally occur on or inshore of the continental shelf break (Best 2007), but note that humpback have been recorded in deeper water (Weir 2010). Three mysticete species of the genus *Balaeonoptera* listed as *Endangered* by the IUCN (2013) are known to occur in the region (including in deep water), namely the Sei (*B. borealis*), Blue (*B. musculus*) and Fin whales (*B. physalus*), although only in very low numbers.

Similar to whales, all of the dolphin species recorded off Angola may occur in the area with the exception of the Atlantic humpback and possibly Heaviside's. The former species appears to be restricted to shallow inshore waters whilst the latter occurs mostly on the continental shelf (Best 2007).

The short and long-term effects of noise on marine mammals are not well understood, but depending on the intensity and degree of exposure, effects on marine mammals can be physiological and/or behavioural. Cetaceans can detect sounds (low frequency tones of <1 kHz) over distances of hundreds of kilometres. Hearing damage in marine mammals is thought possible at sustained exposure to levels from 120-180 dB (ERM, 2005), but in most cases noise will elicit a behavioural effect in that mammals, if disturbed, will tend to move away. Richardson et al. (2001) have shown that cetaceans that vocalise at levels of between 145 and 190 dB (ERM, 2005) exhibit no measurable change in behaviour even in close proximity (<100 m) to operating drilling units, which in the East Hub development are expected to create most 'noise' underwater.

Further, there is a chance that fast moving vessels may collide with individual cetaceans, particularly whales, causing serious injury and usually mortality. It is also possible that whales, particularly, at the sea surface would be disturbed by helicopters flying directly overhead.

These impacts would occur for short periods of time but many of them over the lifetime of the project. The latter would be rated as intermittent *long term* sources of impact that could be experienced by cetaceans in the area (*regional* extent extending between the East Hub and supply bases). Because Cetaceans in general have low breeding rates and species turnover, physical injury to a single member of a rare species can have consequences for the population. Because of their international conservation status the impact on adult whales, and eventually the breeding populations, would be rated of *high magnitude*. Because relatively few individuals could be affected the impact rating would be *small*. The likelihood of the impact occurring is *possible*, and the potential impact is assessed to be of *medium* significance. The implementation of the recommended mitigation measures (below) would reduce the likelihood of the impact occurring.

**Table 7-6: Significance of potential impacts of vessel movements and noise on cetaceans.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Regional 2 | High 3 | Small 1 | 10 | Possible | LOW - | Medium |

### 7.3.3.3 Impact M5: Potential Impacts on Turtles of Noise and Lighting

Five endangered, critically endangered or vulnerable species of turtles occur in the Angolan and southern Gulf of Guinea coastal waters and, largely owing to non-sustainable levels of exploitation by coastal communities, all the turtle populations are deemed to merit special attention in terms of conservation and reduction of anthropogenic disturbances.

Turtle nesting starts around October and continues into February/March. Hatching occurs between December and May when juvenile turtles find their way down the beaches to the sea and inshore waters.

There are known turtle breeding sites on beaches in Angola's Zaire Province and it is therefore probable that the East Hub area will be frequented by turtles. The effect of vessel and drilling noise on turtles is unknown but it is expected that adult turtles will tend to move away from the noise source.

Disturbance by lighting (and noise) is likely to be of greater significance when hatchlings are entering the sea and migrating offshore (January-May, Fretey 2001). Lights are known to attract hatchlings, making them more susceptible to predation and contributing to increased mortality (Witherington, 1992 referenced in Ierino, 2003). Preliminary research results (Pendoley, 1998 referenced in Ierino, 2003) suggest the extent of impact may be determined by the phase of the moon (with disorientation being greatest on new moon nights) as well as brightness and wavelength of the light sources.

Although turtle aggregation patterns at sea are not well known it is *possible* some turtles will be affected over the *regional extent* of the development site and service vessel operations. This would be largely due to increased levels of predation on juveniles attracted by lights. This increase in mortality is unlikely to significantly increase the overall predation mortality on juvenile turtles, and would have a concomitantly low effect on overall turtle populations occupying the Gulf of Guinea and northern Angolan marine systems. Despite this, because of the high conservation importance of all turtles the magnitude is rated as *moderate magnitude*. This is likely to affect a small proportion of any cohort of hatchlings so is rated as a *small no. of elements*. The impact duration is rated as *'long term' because of the* duration of the project. The potential impact is considered to be of *low* significance. Confidence is this assessment is rated as *medium*.

The implementation of the recommended mitigation measures will reduce the likelihood of the impact occurring but does not affect the significance rating of the impact.

**Table 7-7: Significance of potential impacts of noise and lighting on turtles.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Regional 2 | Moderate 1 | Small 1 | 8 | Possible | LOW - | Medium |

To reduce the effects on marine organisms of noise, lighting and vessel speed the following mitigation measures are recommended for all impacts assessed above:

- Reduce travelling speeds if whales, dolphins or turtles are encountered in order to allow the animals the opportunity to move out of the way.
- Marine mammal observers should be present on stationary or slow moving (e.g. pipe-lay) vessels, particularly during any drilling and construction works, to keep a watch for the presence of marine mammals and groups of turtles, and to record sightings to assist research and planning additional avoidance strategies, if necessary.
- If any species of marine mammal, particularly whales, is sighted near the path of a vessel, the vessel should gradually divert to avoid the marine mammal or slow down to idling speed, if this can be done safely.
- Instruct helicopters to maintain a minimum height of 500 m over bird foraging areas, surfacing cetaceans or groups of turtles and prohibited them from circling or hovering over marine mammals (eg for casual viewing) unless essential for safety or emergency purposes.
- Minimise non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water.
- Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme.
- Prohibit all crew members from killing or causing injury to marine fauna.

- Undertake environmental awareness training of all crew members, which includes training on the conservation status of cetaceans and turtles.

## 7.3.4 Impacts M6 to M11: Potential Impacts of Pollution at Sea During Routine Operations

Angolan domestic law requires adherence to *Operational Discharge Management Regulations* of 16 July 2012.

The potential impacts of pollution at sea are discussed below for each of the following routine activities:

- Disposal of drill cuttings and fluids/muds to sea;
- Vessel operational emissions, discharges and waste disposal to sea;
- Intermittent or accidental loss of hydrocarbons from subsea equipment;
- Discharge of hydrotest water to sea, and
- Release of produced (formation) water to sea.

The potential impact of contamination of the seabed/benthos, especially by zinc released from sacrificial anodes used on subsea infrastructure, is not considered to be an issue in the open ocean; accordingly it is not addressed herein[17].

### 7.3.4.1 Impacts of disposal of drill cuttings and muds at sea

Due to the absence of a riser system during initial drilling, of the uppermost portions of a well, drill cuttings with Water Based Muds (WBM) will be discharged directly to the seabed (Figure 7-1). Cuttings from the deeper well sections, with low toxicity oil based muds (LTOBMs) are by law from January 2014 required to be transported to shore by service vessels for treatment and reuse or disposal at registered sites, accordingly only discharges from the "top-hole" section are discussed.

Each of the 12 production wells will be drilled to a depth of about 1,600 m below the sea bed, and the 11 injection wells to about 3,000 m. The estimated quantity of cuttings to be discharged from the top hole section of each well is approximately 304 $m^3$. It is calculated by Eni that 5 000 barrels of WBM drilling fluid, containing mainly bentonite with some barite (barium sulphate), will be discharged with the cuttings at each well site; this would be done at a maximum rate of <1 000 barrels per hour as required by Article 7 in the Regulations.

[17] Conservative modelling by Eni for the Block 15/06 West Hub ESHIA (ARC, 2013) used to evaluate the effects of heavy metal dispersion in water from such anodes indicated that released metal concentrations to a maximum of 4 $\mu g/m^3$ (ppb) occurred in the immediate proximity of the pipeline and decreased to negligible amounts within 1 metre.

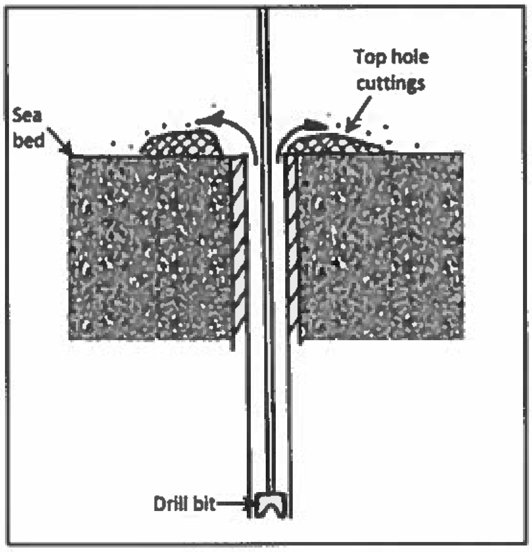



**Figure 7-1: Illustration of top hole section drill cuttings being discharged directly to the seabed.**

By definition top hole drill cuttings and associated drilling muds are deposited at the drilling location. Theoretical estimates of top hole cuttings pile dimensions indicate a maximum pile height of 3.8 m and a radius of 43 m (Koh and Teh 2011). Using the estimates of Koh and Teh (2011) the predicted total deposition footprints for 23 wells would be 13.4 hectares. The principles behind sedimentation of coarse and fine sediments are well established, being underpinned by Stokes law. The main governing factor is the density difference between the particles and the sea which determines the overall sedimenting velocity. Density differences in the host medium (sea) such as are expected to occur in the study area are insufficient to materially retard the sinking rate. Therefore the initial sedimentation pattern is likely to be consistent with that determined by Koh and Teh who employed well established algorithms to model cuttings discharges. In their environment (South China Sea) tidal flow near the seabed was significant and it was probable that there was redistribution of the finer material, particularly, post deposition; accordingly, their observations did not fully match their model predictions. Measured near seabed current velocities on the Angolan outer continental shelf, although episodic, have low velocities (<10-15 cm/sec) (Vangriesheim et al 2009). Consequently the Koh and Teh model predictions are considered to be an adequate estimate of cuttings behaviour in the East Hub. These deposition footprints are used here to predict the magnitudes of ecological effects and their environmental significance.

The deposition of top-hole drill cuttings and fluids onto the sea bed can impact on the marine environment through:

- Physical inundation effects on benthic marine organisms; and
- Chemical toxicity effects on benthic and water column marine organisms.

**a) Impact M6: Potential smothering of benthos and modifications to benthic habitats by drill cuttings and muds**

The sea bed at well sites would be rapidly inundated by a mound of cuttings (Figure 7-1) which would destroy existing benthic habitat and smother benthos.

The bulk of the cuttings deposited will have sediment particle sizes in excess of 100 µm (ERM 2005). Sediments on the surface of the seafloor in the proposed well drilling sites are classed as sandy silt with size modes at 10 and 110 µm (Lwandle 2013a). This indicates that turbulence is insufficient to re-suspend and advect sediment particle sizes larger than ~10 µm and therefore the drill cuttings will not be dispersed out of their deposition area. Consequently, modifications to the benthic habitat due to sediment changes by discharged cuttings are likely to be long term to permanent.

Benthos in the affected areas would be smothered due to clogging of respiratory and feeding apparatus. This would result in benthos mortality and possibly altered benthos community structure. Both of these effects may have implications for organisms higher in the marine food chain such as demersal fish and their predators. Benthos communities in the continental slope sediments are generally dominated by polychaete worms (Lwandle 2013a), with molluscs and crustaceans also being important components in terms of abundance (e.g. ERM 2005, Sogreah-Magelis 2005) and biomass. Smit et al (2008) compiled benthos species sensitivity curves for burial by inter alia drill cuttings and drilling muds in a continental shelf environment from a data base consisting of 39 effect values for 32 benthos species including molluscs, crustaceans and polychaetes. The $EC_{20}$ effect estimate (mortality) derived from this data base is 10 mm (i.e. the cuttings pile will result in significant mortality of benthic organisms only if it is more than 10 mm thick). From this research it can be assumed that the major organism classes within the benthos in the cuttings pile area would be deleteriously affected to the extent that most would probably die.

As pointed out above effects of drill cuttings discharge on the benthic habitat, and the benthos and overall biodiversity, should be restricted to an estimated maximum 13.4 Ha of the sea bed affected by drill cuttings released from the 23 wells to be established. Although the modified habitat (isolated areas extending over <2.7% of the development area) could remain permanently it would be colonised by benthos as populations would be able to recover from any toxicity effects of WBM which are minimal and short-lived. For these reasons this is rated as an impact of low magnitude). This is a small fraction of the total habitat available and populated therefore any effects that may occur would affect a small number of elements.

Any effects that may be generated from modifications to the benthic habitat and benthos community will therefore be localised. It is assumed drilling could occur intermittently during the medium term as the development progresses. The significance of the potential impact of modifications to the benthos and benthic habitat is probable and rated to be of medium significance. The implementation of mitigation measures, even if they were possible, would not materially reduce the significance of this impact.

**Table 7-8: Significance of potential modifications to benthos and benthic habitat by disposal of drilling cuttings and muds.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Duration** | **Extent** | **Magnitude** | **No. of elements** | **Score** | | | |
| Beyond project life 4 | Local 1 | Low 1 | Small 1 | 7 | Probable | **MEDIUM -** | **Medium** |

Confidence in the predictions about the impacts on marine organisms from physical/inundation effects is medium because information about recovery and recolonisation rates of biological communities on the sea bed in these depths is inadequate.

**b) Impact M7: Potential toxicity effects on benthos as a result of deposits of drill cuttings and muds on the sea bed**

Drill cuttings per se are considered to be inert as they are mostly natural rock. The discharge of associated WBMs directly to the seabed is standard industry practice and is largely accepted by environmental protection authorities globally, providing the concentrations of mercury and cadmium in the barite do not exceed 1 mg/l and 3 mg/l respectively. Article 6(3)(b) in the Angolan Regulations in Decree 224/12 requires the following minimum specifications be met: bioaccumulation factor log Pow

=< 5 or molecular weight less than 700; LCor EC50 greater than 1 mg/l. It is assumed that the barite used for drilling will comply with this specification; e.g. as also required by the United States Environmental Protection Agency.

Accordingly, toxicity effects on marine organisms from discharged WBMs would be of a *low* magnitude and affect a *small* proportion of any population of animals, and be restricted to the location of the well-sites within the development area (*local*). Owing to the density of the mixture there is unlikely to be any turbidity effect on the water column above. In contrast to the longer term effects of smothering, owing to low heavy metal levels and rapid dilution toxicity effects on the benthos should be *short term* if they occur at all (i.e. *unlikely*). The potential impact of toxicity effects on benthos is therefore assessed to be of *low* significance.

No mitigation measures are deemed necessary, beyond compliance with the relevant regulations regarding drilling fluid and cuttings disposal.

**Table 7-9: Significance of potential toxicity effects on benthos by disposal of drilling cuttings and fluids.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term 1 | Local 1 | Low 1 | Small 1 | 4 | Unlikely | LOW - | High |

#### 7.3.4.2 Impact M8: Routine vessel operational emissions, discharges and waste disposal to sea

The direct or indirect discharge or disposal to sea of solid waste, liquids, gases and particulates is regulated by the Angolan Ministry of Petroleum Executive Decree No. 224/12 of 16 July 2012 "*Operational Discharge Management Regulations*". These are based partially on the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).

The different types of wastes and discharges, their potential effects in the marine environment and relevant MARPOL requirements[18] are discussed below.

- *Sewage:* Untreated sewage imposes an organic and bacterial load on the natural biodegradation processes of the sea. Many marine micro-organisms such as bacteria metabolise sewage, resulting in its rapid breakdown. The availability of raw sewage as a food source leads to a rise in bacterial levels in the water and an increased demand for oxygen. Treated sewage should not increase the bacterial load of the sea but would increase biological oxygen demand. MARPOL Annex IV (Prevention of pollution by sewage from ships) requires that sewage discharged from vessels be treated or comminuted (pulverised) and disinfected before discharge at a distance of more than 3 nautical miles from the shore.
- *Deck drainage:* Washings off the decks of the smaller vessels that may not have 'clean' and hazardous drain systems ensuring no contaminant thresholds are exceeded, could contain small amounts of oils, solvents and cleaners, which are potentially toxic to marine organisms. The volumes lost overboard would be small. There are no MARPOL standards for deck drainage.
- *Machinery space drainage and bilge water:* Machinery space drainage (including oily wastes from generators, fuel tanks and pumps) and bilge water will contain traces of oil, which is a complex mixture of petroleum hydrocarbons. Many marine micro-organisms such as bacteria can metabolise hydrocarbons to some degree, and rapid biodegradation of certain oil fractions can

[18] Note that new amendments to MARPOL Annex IV - Sewage and MARPOL Annex V Garbage came into effect internationally from the 1 January 2013.

occur. Other fractions are relatively persistent. Low concentrations of petroleum hydrocarbons in water are readily absorbed or ingested by most marine organisms, with significant concentrations being taken up in a few hours. MARPOL Annex 1 (Prevention of pollution by oil) stipulates that the oil content of discharges originating from machinery space drainage of vessels must not exceed 15 ppm without dilution. No vessels may discharge oily wastes above these concentrations at sea and oily water must be processed in a suitable separation and treatment system before discharge. Non-complying oily wastes must be properly disposed of on shore.

- *Emissions to the atmosphere:* The FPSO has a no flaring policy so the emissions here are due to internal combustion engines where for example 8 engines on board of one rig consume about 17.4 $m^3$/ day of fuel. Heavy fuel oils and diesel exhaust gases comprise $SO_2$, CO and $CO_2$ and NOx, plus "carbon-black" (soot) which contains some polyaromatic hydrocarbon particulates. There is some concern that soot is carcinogenic. Ozone depleting substances can be released either accidentally, during maintenance operations or at other times (e.g. fire fighting). Smoke and fumes from fire incidents onboard the vessels could also be released to the atmosphere. These emissions would also contribute to the cumulative impact that 'greenhouse gases' have on global warming. MARPOL Annex VI (Prevention of air pollution from ships) sets limits on $SO_2$ and $NO_x$ emissions and prohibits the emissions of ozone depleting substances.
- *Galley waste and garbage:* Galley (food) wastes are biodegradable and add to the organic and bacterial load in the sea. The volumes of galley wastes generated at sea will be low. Other wastes such as packaging, plastics, metal and glass can be hazardous, particularly to marine fauna if discharged overboard or may constitute a visual pollutant and may end up on the shore or on the sea bed. Plastics in particular can persist for decades and can maim and kill marine mammals, turtles and birds which become entangled in or ingest it. The impacts of the quantities of persistent or toxic rubbish that could be discarded by the vessels could be highly significant in the local area. According to MARPOL Annex V (Prevention of pollution by garbage from ships), biodegradable food waste and general garbage should be macerated to less than 25 mm size and disposed of into the sea at a distance of greater than 3 nautical miles from the shore. Other wastes such as plastic, metals and other non-combustibles must be segregated, stored securely on board, transferred safely to shore for recycling, where possible, or disposal at appropriate land facilities. MARPOL Annex V as well as the London Convention prohibits the disposal of all plastics anywhere at sea.

If the law and Eni's company policy are adhered to the potential pollution impacts of routine operational emissions, discharges and waste disposal at sea will be *localised*, of *low magnitude* and affect a *small* proportion of marine life. They would *definitely* occur over the *long term* of the project life but would be of *low* significance. Implementation of recommended mitigation measures would make it possible that that some negative impacts could still occur but at an insignificant level.

**Table 7-10: Significance of potential impacts of routine vessel operational discharges/ emissions & solid waste disposal to sea.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Duration** | **Extent** | **Magnitude** | **No. of elements** | **Score** | | | |
| Long term 3 | Local 1 | Low 1 | Small 1 | 6 | Definite | LOW - | High |

It should be noted that any non-compliance with the relevant regulations regarding routine operational emissions, discharges and waste disposal at sea may result in impacts of increased significance.

#### 7.3.4.3 Impact M9: Intermittent or accidental minor loss of hydrocarbons from subsea equipment

During operations, small volumes of hydraulic fluid may be vented into the marine environment at the seafloor, for example from valve regulators in the subsea infrastructure or BOPs in wells during drilling. These comprise fresh water with a very low percentage of biodegradable, glycol-based additives or mineral-oil base-stocks. Operations can also introduce hydrocarbons into the marine environment via oil escaping from drilled wells or junctions in flowlines, and polycyclic aromatic hydrocarbons associated with natural oil (petrogenic) and flaring (pyrogenic) sources.

In general most of these compounds become associated with particulate material and deposit on and in the sediments of the seafloor. Here they can exert toxic effects on benthos.

Several studies have been directed at the distributions of hydrocarbons around oil field installations. Examples are investigations on hydrocarbon distributions and benthos community structure at a North Sea drill site where elevated hydrocarbon levels and apparently associated modifications to the macrobenthos were restricted to within 750 m of the site (Daan et al. 1992). In support of this Patin (1999) lists data showing that elevated hydrocarbon concentrations in sediments around a rig tend to decline to background levels within 1000 m radius. In a topical investigation in Cabinda NORAD/BCLME (2007) show that elevations of total hydrocarbons and PAH in sediments around platforms are typically restricted to within 500 m distance. Further, even when present at apparently elevated levels these compounds have not generated detectable adverse effects on benthic macrofauna as revealed by taxon numerical distributions in geometric abundance classes, a robust method for determining effects of organic compounds on benthos (Gray and Pearson 1982). The apparent absence of detectable effects on benthos was also evident in the Sogreah-Magelis (2005) investigation in Block 3 offshore Angola where no differences in community structure between samples in oil extraction and reference areas were found.

Intermittent releases over the project lifetime (*long term*) of minor quantities of petroleum hydrocarbons could occur. The hydraulic fluid would dilute rapidly and other hydrocarbons would affect limited areas until they dissipate and are broken down by bacteria (*local and low magnitude* impacts). The percentage of populations affected would be *small*. It is possible the impacts may occur, and the combined impacts on the marine environment are assessed to be of *low* significance (see Findlay et al. 2006). No mitigation measures are deemed necessary, although sound operational procedures would reduce the risk of wastage and/or accidental spills.

**Table 7-11: Significance of potential impacts of intermittent release of hydrocarbons from subsea equipment.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Local 1 | Low 1 | Small 1 | 6 | Possible | LOW - | High |

#### 7.3.4.4 Impact M10: Impacts on Water Quality and Biodiversity of Hydrotest Water discharged to sea

Before commissioning, the structural integrity of the subsea system is determined using a hydrostatic pressure test, in which all pipelines are filled with water, pressurised above the intended operating pressure and monitored for leaks or pressure loss over a specified time. Additives such as oxygen scavengers and biocides are added to the water to inhibit corrosion and micro–organism growth in the pipes.

Once a pressure test is completed, the pressure is released and the pipelines dewatered by pushing a 'pig' through the line using pressurised air or gas. The hydrostatic test process, including filling, testing and depressurising, can range from a few days to a few weeks depending on pipe sizes and lengths. The discharged water typically contains the contaminants and particulate matter present in the pipelines, and the additives. Additives are customarily added at concentrations of 1 000 ppm. It is likely that the hydrotest water will either be reinjected into the wells or released at the gathering manifolds in the oil fields, and in phases as segments of the infrastructure are tested.

The composition of discharged hydrotest waters is mainly determined by the characteristics of the source water, anti-corrosion additives, any residues not removed during flushing, and reactions occurring within the pipe during testing, such as corrosion. Contaminants are mainly due to mill scale breakdown e.g. iron oxides and traces of manganese and copper, and unreacted additives and their reaction products e.g. inorganic salts such as ammonium bisulphite when oxygen scavengers are used. CSIRO (2005) found that contaminant levels in the disposal water are generally not toxic but that treatment is often required specifically to lower turbidity (can attain 4 000 NTU) and to raise dissolved oxygen levels (can be reduced to <1 mg/l).

Hydrotest water may contain inorganic sulphite salts, residual biocides, dyes and be turbid. If it is discharged at the manifolds in the offshore oil fields at ~500 m depth it will compromise bottom water quality in the East Hub. It is predicted to occur as a number of short events (*short term*) just before oil extraction starts and to impact water quality at the *local* scale, but with negligible or undetectable effects on marine ecology and/or marine ecological processes (*low magnitude*) because of natural dilution processes (e.g. CSIRO 2005). The percentages of populations of benthic fauna that would be affected is rated *small*, and the impact significance rated as *low*.

**Table 7-12: Significance of hydrotest water discharges from offshore infrastructure on water quality and biodiversity.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term<br>1 | Local<br>1 | Low<br>1 | Small<br>1 | 4 | Unlikely | LOW - | Medium |

Confidence in this assessment is medium as, should the test water be discharged to sea, there are no measurement data for the behaviour of discharged hydrotest water at the planned release depths. Such data would be extremely difficult to acquire as the constituents and quantities of additives to be used, are not yet known.

### 7.3.4.5 Impact M11: Release of Produced (Formation) Water to Sea

The produced, or formation, water is the 'waste water' separated from the production stream during oil production operations. The largest constituent is typically fossil water found with the oil (and gas) in the geological reservoirs. It is common practice in the offshore industry to use physical or enhanced separation techniques and then discharge the produced water to the sea surface. This separation is not 100% effective and the produced water is known to contain, *inter alia,* dispersed oil, volatile hydrocarbons, polycyclic aromatic hydrocarbons, phenols, ketones and alcohols along with zinc, lead, manganese, iron and barium and naturally occurring radioactive materials (NORM) (Veil et al. 2004).

Volumes of extracted formation water depend on the rock strata hosting the oil and also the characteristics of the well itself (horizontally vs vertically drilled), type of well completion, etc. (Veil et al. 2004). Consequently it is difficult to generalize water quality and/or flow volumes across oil fields or over the production lifetime of the reservoirs. Although only small concentrations of these compounds are released there is normally a continuous discharge of large volumes of produced water during operations. Ecotoxicology experiments under laboratory conditions have demonstrated that undiluted produced water can be toxic to marine organisms (e.g. Neff, 2002) but, in contrast, detecting a measurable impact on marine ecosystems in the vicinity of produced water discharges is difficult.

This is because dilution and biodegradation in the receiving environment reduces contaminant concentrations to levels below which they can have an impact on marine organisms. Where concentrations do exceed thresholds, exposure times for free-moving organisms are generally short. Accordingly, most of the world's national or regional regulatory authorities set limits on the concentration of petroleum hydrocarbons that can remain in the water for ocean disposal.

In this case produced formation water will be discharged to sea for the lifetime of the project (*long term*). The above mentioned compounds would also be released and probably rapidly diluted towards background levels. Organic and heavy metal components would be scavenged out of the water column by sedimenting organic and inorganic particulate matter (Zoumis et al. 2001). The impact would occur at the *local* scale and, owing to dilution and recovery rates be rated of *low magnitude* and affecting a *small proportion* of the populations of marine organisms. This would be rated of *low* significance.

Additional mitigation would aim to further reduce the concentration of dispersed oil, and further treatment should focus on removing polycyclic aromatic hydrocarbons (PAHs) and reducing the toxicity of input process chemicals which are the compounds of most concern in produced water.

**Table 7-13: Significance of produced water discharges on water quality and biodiversity.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Long term 3 | Local 1 | Low 1 | Small 1 | 6 | Probable | LOW - | Medium |

Confidence in this assessment is medium due to the sparse water quality baseline for formation water.

### 7.3.5 Impact M12: Physical Effects of Structures on the Sea Bed Changing Benthic Habitats, Especially Reefs

The impact assessed here is of changes to the character of the sea bed by adding hard substrate, including oil field equipment, cuttings piles and spilled cement during well drilling, which changes benthos community structure, i.e. crushes some organisms and provides an altered habitat for colonisation by others.

The subsea production system of PLETS, xmas trees, manifolds, pipelines, umbilicals and carbon steel mud-mat supports will be installed within an area of 64 km² on the sea bed. Items will be lowered through about half a kilometre of water by dynamically positioned vessels on the sea surface. Unmanned, remotely operated vehicles will assist in their placement. Final locations and layout will be made as reservoir engineering work continues. The subsea system will be operated via electro-hydraulic controls from the FPSO.

Cementing of the casing in the upper sections of the 23 wells may result in a release of excess cement from the top of the wells into the marine environment. Such spilled cement would settle on the seafloor and may smother benthic marine life in the vicinity of the wells, although the affected areas are likely to be very small.

The placement of the approximately 62 km of risers and flowlines ranging from 4-10 inch diameter plus some corrosion allowances covers 0.013 km² of sea bed area. Assuming an average area of disturbance of 20x20 m by the other 80 hard structures (anchors, maniflolds, PLETs, xmas trees, etc.) an additional area of 0.032 km² of sea bed would be disturbed, and top-hole cuttings piles with an estimated radius of 43 m would cover a maximum of 5 800 m² per well, so the 23 wells with possibly some leaked cement from well casings, will permanently modify approximately 0.135 km² of the seabed environment. In total 0.28% of the well field area will be directly, and permanently, transformed (i.e. *irreversible impact*).

The extent of the impact would be *local*, at the project scale, and a *small* proportion of the benthic community would be affected; this would cause permanent changes (*beyond project lifetime*) to the benthic habitat. This would comprise relatively isolated disturbances located in an extensive undisturbed area of more than 64 km² within the developed well field area. However, a minor proportion of this area may host deep reef systems (see Baseline Chapter showing bathymetry and field survey sites). As most of the area appears to be fine sandy silt (Lwandle, 2013a), at a kilometre scale these reef systems will probably be important habitats, for deep water fish especially, so damage to these features could have important effects on the natural biodiversity of the region. Impacts on reef structures would occur at similar scales and durations and would be at a *high magnitude*. These impacts would be rated as *medium* in terms of significance.

The extent of effects would be reduced by surveying all candidate pipeline corridors by ROV and realigning them if they intercept deep reefs. For the balance of the areas sound operational procedures would reduce the risk of unnecessary disturbance by the placement and movement of infrastructure on the sea bed. The residual impact would be confined to addition of hard structures to the apparently vast area of unconsolidated sediments in the East Hub and would reduce the significance.

**Table 7-14: Significance of impact of structures on the sea bed changing reef habitats.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Beyond project life 4 | Local 1 | High 3 | Small 1 | 9 | Definite | MEDIUM - | High |

Confidence in these predictions is high.

### 7.3.6 Impacts M13 to M20: Accidental (Non-routine) Major Releases of Hydrocarbons

**a) Introduction**

The two very different types of hydrocarbons that may be accidentally released into the sea are the more volatile diesels and the less volatile crude oils. The impacts of a major spill of these are assessed below irrespective of their source; sources can include:

- The accidental loss of diesel fuel during refuelling or by support shipping;
- Crude oil spills during tanker loading from the FPSO;
- Crude oil spilled from accidental pipeline rupture; and
- Accidental blowouts from well drilling and/or crude oil released at the sea floor due to well failure.

(Minor operational leaks or losses that may occur from vessels are covered under routine discharges above, and are considered unlikely to generate adverse effects in the sea).

**b) Oil spill modelling**

Oil spill modelling was undertaken by RPS-ASA, 2013, to predict spill trajectories for surface spills close to the East Hub FPSO site, located 95 km offshore, at coordinates S 6.06392°, E 11.36697° (full report in Appendix D). Based on the parameters provided by Eni a light crude oil was chosen from ASA's oil database as representative of the crude oil in the pipeline rupture and well blowout scenarios, and a representative diesel was chosen from the same database[19]. The scenarios modelled were of

[19] Selection of oil solely based on its density/API gravity is not ideal since oil behaviour and weathering are dependent on other oil properties such as boiling point distribution and/or viscosity. In the event that further information regarding the

a 1 000 m³ (~6 290 US bbl) marine diesel fuel spill occurring over 24 hrs that may arise during refuelling of vessels at sea, a 304 m³ spill over 6 hrs from a surface rupture of a crude oil import pipeline, and a very much larger 300 000 bbl spill of crude oil, lasting for 30 days, arising from a blowout from a well site on the seafloor (Table 7-15). For each spill type two significantly different wind speed simulation periods are modelled:

- **Period-1** from February to July with winds mainly from south and surface currents mainly from east at 20-27 cm/s; and
- **Period-2** from August to January with winds mainly from southwest and surface currents variable at 19-21 cm/s.

Details of the model input parameters for the surface oil spill scenarios are available in Appendix D. Behaviour of the discharged oil as predicted by OILMAP was used to identify the possible environmental consequences that may be generated by these accidental discharges.

**c) Stochastic modelling results**

The stochastic modelling results for the six spill scenarios modelled are summarised in the tables below.

**Table 7-15: Surface Oil Spill Stochastic results – Predicted shoreline impacts for each spill scenario from the FPSO site (RPS-ASA, 2013).**

| Spill Event | Oil Type | Period | Total Volume Spilled | Spill Duration | Sims.(1) Reaching Shore | Time to Reach Shore (days) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Min. | Avg. |
| Diesel Surface Spill | MDO | 1 (Feb-July) | 1,000 m³ | 24 hours | 8.5% | 6.0 | 10.0 |
| Diesel Surface Spill | MDO | 2 (Aug-Jan) | 1,000 m³ | 24 hours | 19.5% | 4.8 | 8.7 |
| Import Pipe Surface Rupture | Crude | 1 (Feb-July) | 304 m³ | 6 hours | 8.0% | 6.1 | 9.5 |
| Import Pipe Surface Rupture | Crude | 2 (Aug-Jan) | 304 m³ | 6 hours | 15.5% | 4.8 | 8.5 |
| Surface Blowout | Crude | 1 (Feb-July) | 300,000 bbl | 30 days | 67.5% | 5.6 | 18.3 |
| Surface Blowout | Crude | 2 (Aug-Jan) | 300,000 bbl | 30 days | 84.5% | 4.8 | 14.5 |

The following conclusions can be derived from the table above:

The stochastic model predicts that all six spill scenarios have a chance of reaching the shoreline. Due to the more persistent offshore, westerly currents during Period 1 (February – July), spills during this time have lower probabilities (expressed as the proportions of modeled spill events) of reaching the shore than those during Period 2 (e.g. Figure 7-2) (August – January). The time these spills would take to reach shore is also longer.

oil characterization becomes available at a later date, the description of the oil provided by RPS-ASA and used in the modelling study should be reviewed.

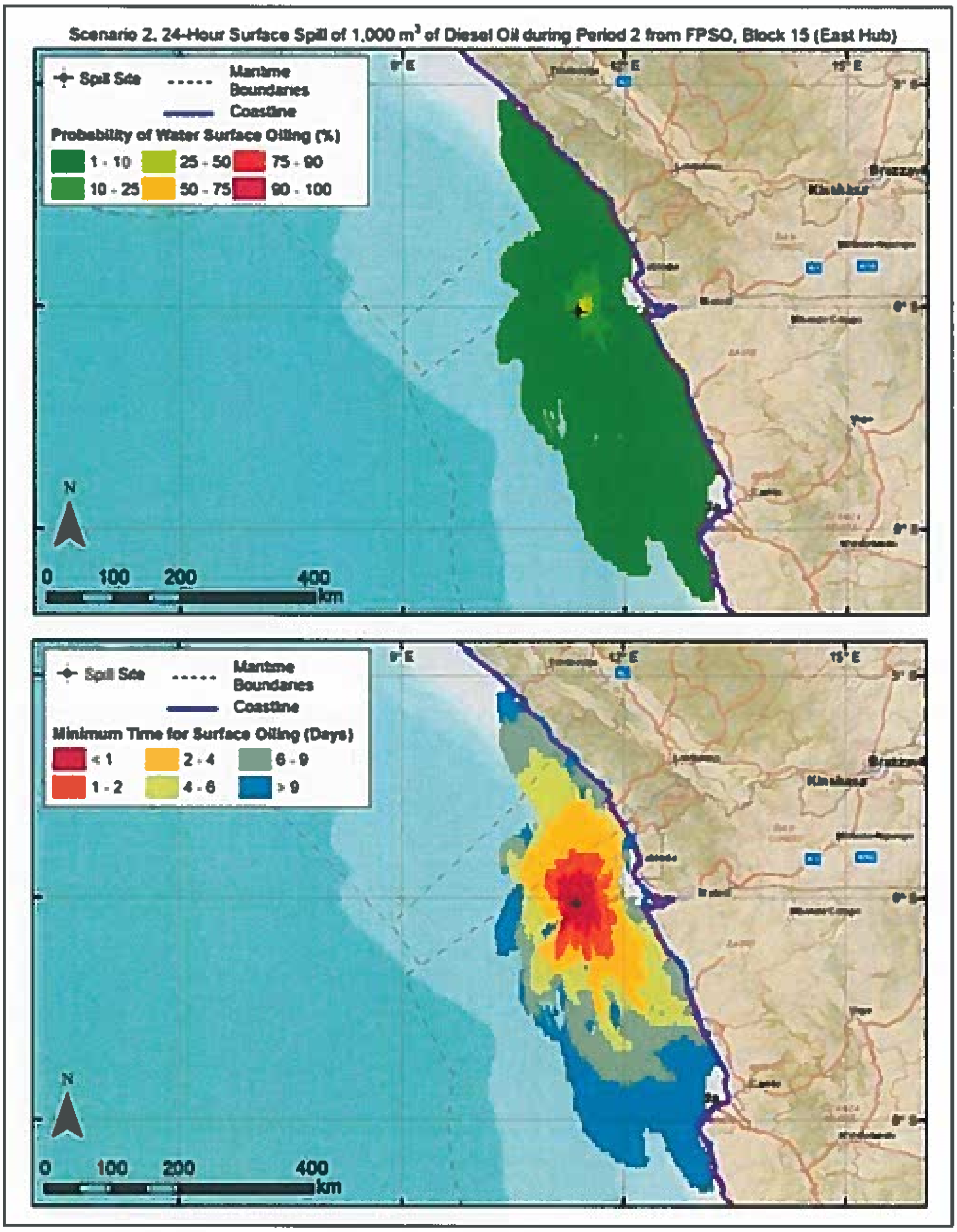



**Figure 7-2: 24-hour surface spill of 1,000 m3 of diesel oil during Period-2 (August to January).**

The maps show probability of water surface oiling (top) and travel times (bottom)

Source: RPS-ASA, 2013.

Due to the higher volumes released the crude oil blowout scenarios have much higher probabilities of reaching shore than the MDO or crude import pipe rupture scenarios (e.g. Figure 7-3).

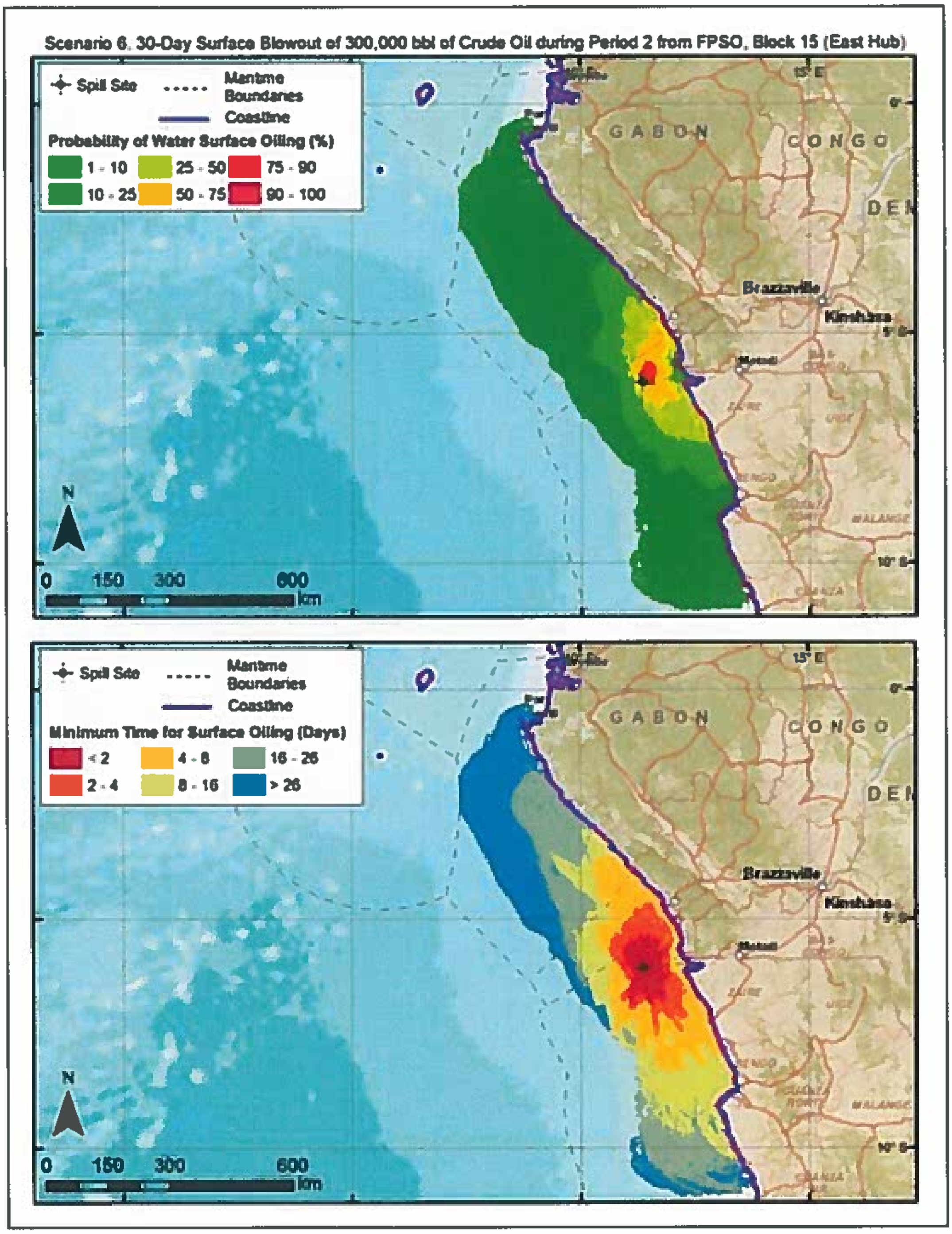



**Figure 7-3: 30 day surface blowout of 300,000 bbl of crude oil from the FPSO during Period-2 (August to January).**

The maps show probability of water surface oiling (top) and travel times (bottom)

Source: RPS-ASA, 2013

Table 7-16, based on Figures 8 to 13 in Appendix C, including the examples in Figure 7-2 and Figure 7-3 above, provides a summary of water surface and shoreline oiling stochastic results.

**Table 7-16: Summary of water surface and shoreline oiling stochastic results.**

| ASA report Figure Number | Water Surface Oiling Summary | Shoreline Oiling Summary |
|---|---|---|
| ***Scenario 1: 1,000 m³ Diesel Surface Spill, Period 1*** | | |
| ASA Figure 8 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the NW of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Gabon (low), DRC (low), Congo (medium), Angola (high) | No individual shore segment has a probability of oiling greater than 3%. |
| ***Scenario 2: 1,000 m³ Diesel Surface Spill, Period 2*** | | |
| ASA Figure 9 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the E of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Gabon (low), DRC (low), Congo (low), Angola (high) | No individual shore segment has a probability of oiling greater than 3%. |
| ***Scenario 3: 304 m³ Crude Oil Import Pipe Surface Rupture, Period 1*** | | |
| ASA Figure 10 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the N of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Gabon (low), DRC (low), Congo (medium), Angola (high) | No individual shore segment has a probability of oiling greater than 2%. |
| ***Scenario 4: 304 m³ Crude Oil Import Pipe Surface Rupture, Period 2*** | | |
| ASA Figure 11 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the E of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Gabon (low), DRC (low), Congo(low), Angola (high) | No individual shore segment has a probability of oiling greater than 3%. |
| ***Scenario 5: 300,000 bbl Crude Surface Spill, Period 1*** | | |
| ASA Figure 12 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the N and NW of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Equatorial Guinea (low), São Tomé and Príncipe (low), Gabon (medium), DRC (medium), Congo (high), Angola (high). | Medium probabilities of shoreline oiling along coastal segments of the Congo (30-50%), Gabon (25-40%), and Angola (20-40%). |
| ***Scenario 6: 300,000 bbl Crude Surface Spill, Period 2*** | | |
| ASA Figure 13 | Footprint is oriented mainly to the NW and SE along the coast. Higher probabilities are toward the NE and E of the spill site.<br><br>Territorial waters potentially affected (and probability of oiling):<br>Gabon (low), DRC (medium), Congo (high), Angola (high). | Medium probabilities of shoreline oiling along coastal segments of the Congo (30-50%) and Angola (30-50%). |

Source: RPS-ASA, 2013.

### d) Deterministic modelling results

For each stochastic scenario for a diesel spill, one deterministic trajectory/fate simulation was run to investigate a specific spill trajectory identified in the stochastic analysis that represented an event that resulted in high shoreline impacts within short time periods of release, i.e. a worst case scenario requiring the greatest clean-up response effort within a short time. The trajectory/fate simulation was run using the same wind and current forcing used for the corresponding stochastic simulation from which it was identified. Table 7-17lists the deterministic cases that were selected for each surface spill scenario.

**Table 7-17: Selected worst case deterministic runs for each spill scenario.**

| Spill Event | Total Volume Spilled | Spill Duration | Period | Selected Deterministic Case | Time to Shore (days) | Amount of Oil | |
|---|---|---|---|---|---|---|---|
| | | | | | | Peak | End |
| Diesel Surface Spill | 1,000 $m^3$ | 24 hours | 1 | February 2007 | 6.0 | 342.8 $m^3$ | 304.1 $m^3$ |
| Diesel Surface Spill | 1,000 $m^3$ | 24 hours | 2 | September 2004 | 6.3 | 332.9 $m^3$ | 292.7 $m^3$ |
| Import Pipe Surface Rupture | 304 $m^3$ | 6 hours | 1 | February 2007 | 6.1 | 139.5 $m^3$ | 131.7 $m^3$ |
| Import Pipe Surface Rupture | 304 $m^3$ | 6 hours | 2 | September 2004 | 6.2 | 138.2 $m^3$ | 128.4 $m^3$ |
| Surface Blowout | 300,000 bbl | 30 days | 1 | July 2011 | 10.5 | 86,188.6 bbls | 86,096.5 Bbls |
| Surface Blowout | 300,000 bbl | 30 days | 2 | September 2007 | 6.6 | 146,682.0 bbls | 146,682.0 bbls |

Source: RPS-ASA, 2013.

Figure 7-4 and Figure 7-5 below illustrate the selected worst case scenario for each weather period modelled for a blowout of crude oil. The maps for each scenario show the surface area swept by the oil slick as well as the shoreline area oiled, and the mass balance graphs show the degree of weathering that the oil undergoes during the period of the simulation. Lesser spills of oil from pipeline ruptures or spills of diesel are predicted to fall within these ranges and result in less surface area swept by the slick as well as less shoreline area oiled (Appendix C). Table 7-18 present the results of the deterministic simulations for each scenario.

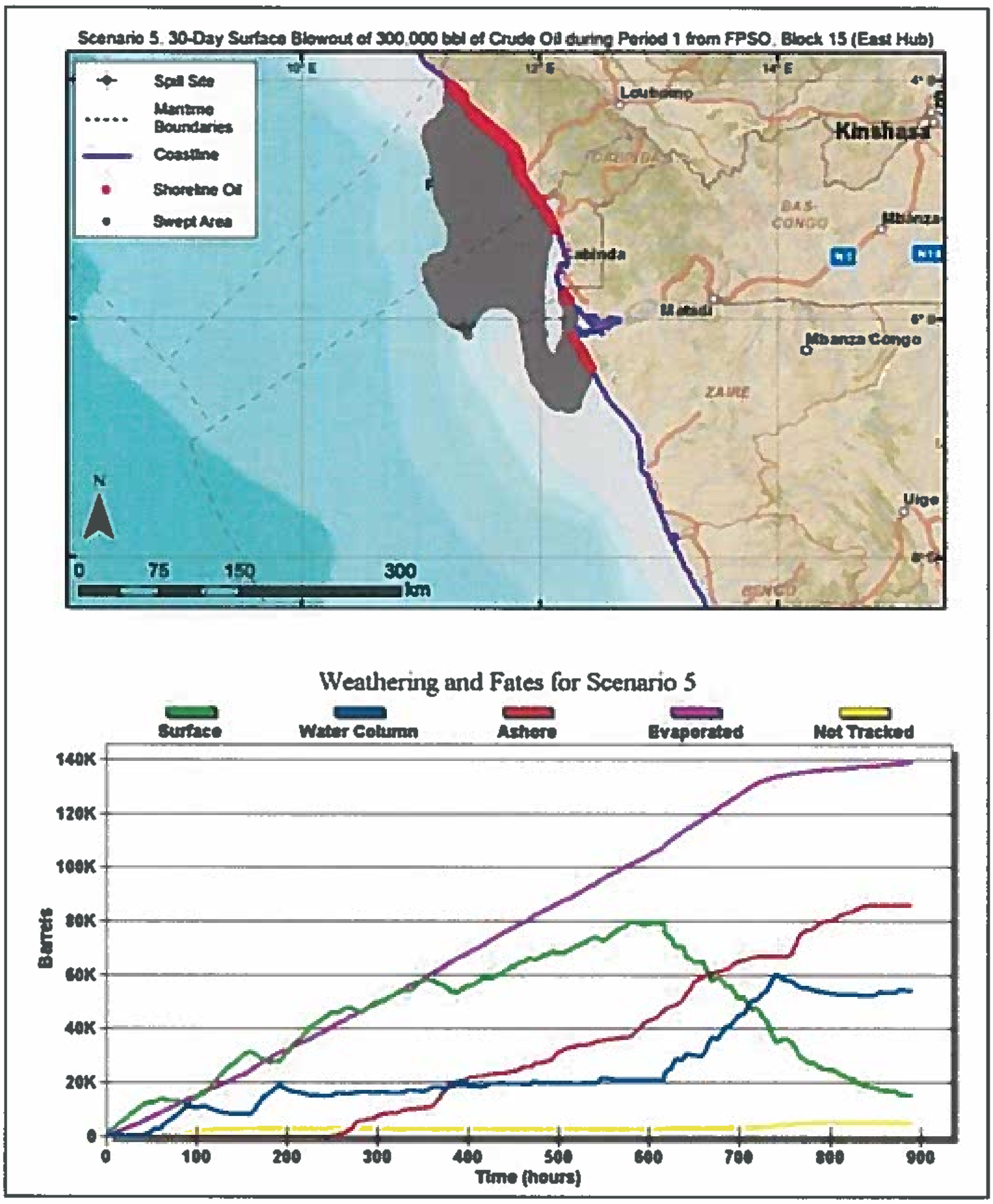
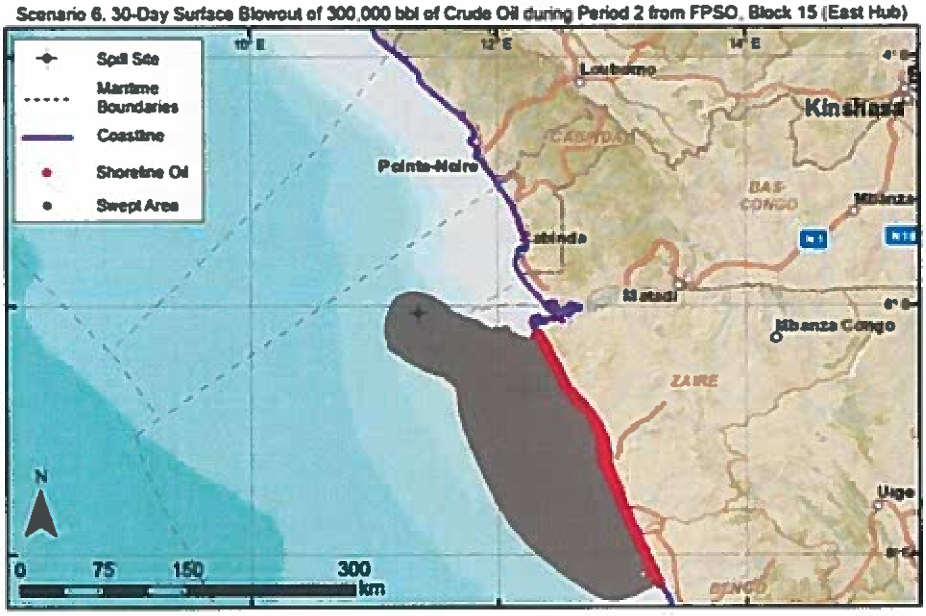



**Figure 7-4: A worst case (fastest time to shore of most crude oil) 30 -day blowout of 300,000 bbl of Crude Oil during Period-1.**

The map shows oiling at the end of the simulation and the predicted oil trajectory, and the graph shows predicted mass balance for weathering and fate of oil.

Source: RPS-ASA, 2013.

Scenario 6. 30-Day Surface Blowout of 300,000 bbl of Crude Oil during Period 2 from FPSO, Block 15 (East Hub)




Weathering and Fates for Scenario 6

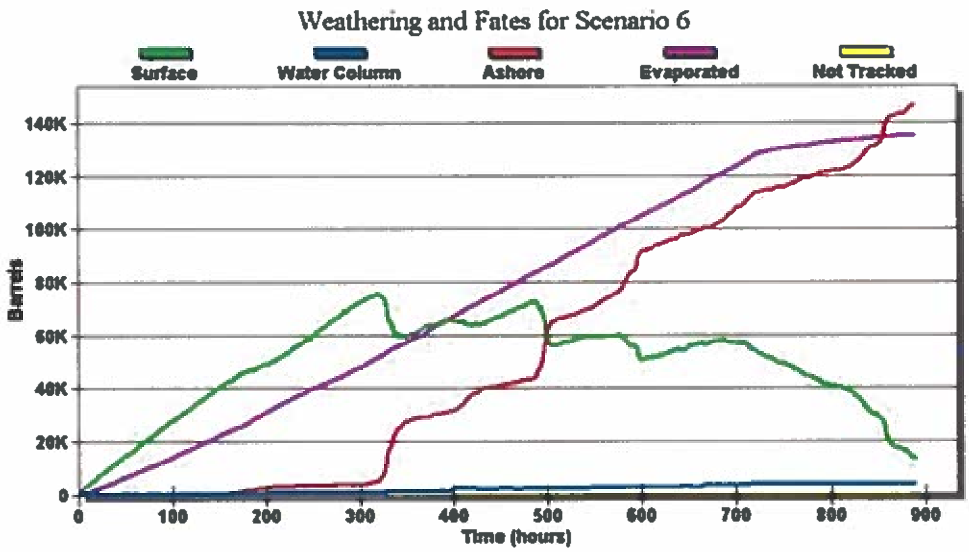



**Figure 7-5: A worst case (fastest time to shore of most crude oil) 30 -day blowout of 300,000 bbl of Crude Oil during Period-2.**

The map shows oiling at the end of the simulation and the predicted oil trajectory, and the graph shows predicted mass balance for weathering and fate of oil.

Source: RPS-ASA, 2013.

**Table 7-18: Description of deterministic results, including trajectory descriptions and mass balance summaries.**

| ASA report Figure Number | Trajectory Description | Mass Balance Summary |
|---|---|---|
| ***Scenario 1: 1,000 $m^3$ Diesel Surface Spill, Period 1*** | | |
| ASA Figure 3-2 left | Trajectory heads initially to the SE, then turns NE before making landfall along the coast of Angola.<br><br>Time to shore: 6.04 days<br>Length of shoreline oiled at end of simulation: 50 km | • Evaporation plays a major role in removal, with about 675 $m^3$ (67.5%) evaporated, most of which occurred during the first 2 days after the spill.<br>• Peak volume on the water surface is about 560 $m^3$ (56.0%), after 24 hours (the spill duration). Virtually no oil remains on the water surface after 6.7 days.<br>• Peak volume on the shoreline is about 340 $m^3$ (34.0%), at 6.7 days into the spill. At the end of the spill, about 300 $m^3$ (30.0%) remains on shore.<br>• At the end of the simulation, about 20 $m^3$ (2.0%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |
| ***Scenario 2: 1,000 $m^3$ Diesel Surface Spill, Period 2*** | | |
| ASA Figure 3-2 right | Trajectory heads initially to the SE, then turns NE before making landfall along the coast of Angola.<br><br>Time to shore: 6.25 days<br>Length of shoreline oiled at end of simulation: 67 km | • Evaporation plays a major role in removal, with about 690 $m^3$ (69.0%) evaporated, most of which occurred during the first 2 days after the spill.<br>• Peak volume on the water surface is about 590 $m^3$ (59.0%), after 24 hours (the spill duration). Virtually no oil remains on the water surface after 7.3 days.<br>• Peak volume on the shoreline is about 330 $m^3$ (33.0%), at 7.3 days into the spill. At the end of the spill, about 300 $m^3$ (30.0%) remains on shore.<br>• At the end of the simulation, about 20 $m^3$ (2.0%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |
| ***Scenario 3: 304 $m^3$ Crude Oil Import Pipe Surface Rupture, Period 1*** | | |
| ASA Figure 3-3 left | Trajectory heads initially to the SE, then turns NE before making landfall along the coast of Angola.<br><br>Time to shore: 6.04 days<br>Length of shoreline oiled at end of simulation: 13 km | • Evaporation plays a major role in removal, with about 155 $m^3$ (50.9%) evaporated, most of which occurred during the first day after the spill.<br>• Peak volume on the water surface is about 240 $m^3$ (78.9%), after 6 hours (the spill duration). Virtually no oil remains on the water surface after 7.3 days.<br>• Peak volume on the shoreline is about 140 $m^3$ (46.0%), at 6.7 days into the spill. At the end of the spill, about 130 $m^3$ (42.7%) remains on shore.<br>• At the end of the simulation, about 20 $m^3$ (2.0%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |
| ***Scenario 4: 304 $m^3$ Crude Oil Import Pipe Surface Rupture, Period 2*** | | |
| ASA Figure 3-3 right | Trajectory heads initially to the E, then SE, and then turns NE before making landfall along the coast of Angola.<br><br>Time to shore: 6.25 days<br>Length of shoreline oiled at end of simulation: 30 km | • Evaporation plays a major role in removal, with about 160 $m^3$ (52.6%) evaporated, most of which occurred during the first day after the spill.<br>• Peak volume on the water surface is about 235 $m^3$ (77.3%), after 6 hours (the spill duration). Virtually no oil remains on the water surface after 7.3 days.<br>• Peak volume on the shoreline is about 140 $m^3$ (46.0%), at 7.3 days into the spill. At the end of the spill, about 130 $m^3$ (42.7%) remains on shore.<br>• At the end of the simulation, about 20 $m^3$ (2.0%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |
| ***Scenario 5: 300,000 bbl Crude Oil Surface Spill, Period 1*** | | |

| ASA report Figure Number | Trajectory Description | Mass Balance Summary |
|---|---|---|
| ASA Figure 3-4 left | Trajectory heads to the NE, and SE, making landfall at three sections of coastline (Angola, Congo, and DRC).<br>Time to shore: 10.42 days<br>Length of shoreline oiled at end of simulation: 155 km (Congo), 53 km (Angola), and 9 km (DRC). 217 km total. | • Evaporation plays a major role in removal, with about 140,000 bbls (46.6%) evaporated by the end of the simulation.<br>• Peak volume on the water surface is about 80,000 bbls (26.6%), after 25 days. About 18,000 bbls (6.0%) remains on the water surface at the end of the simulation.<br>• Peak volume on the shoreline is about 85,000 bbls (28.3%), at 35.4 days into the spill, where it would continue to evaporate after the simulation period.<br>• At the end of the simulation, about 50,000 bbls (16.6%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |
| ***Scenario 6: 300,000 bbl Crude Oil Surface Spill, Period 2*** | | |
| ASA Figure 3-4 right | Trajectory heads to the SE and makes landfall along the coast of Angola.<br><br>Time to shore: 6.7 days<br>Length of shoreline oiled at end of simulation: 250 km | • Evaporation plays a major role in removal, with about 135,000 bbls (45.0%) evaporated by the end of the simulation.<br>• Peak volume on the water surface is about 75,000 bbls (25%), after 12.5 days. About 15,000 bbls (5.0%) remains on the water surface at the end of the simulation.<br>• Peak volume on the shoreline is about 145,000 bbls (48.3%), at the end of the simulation period, after which it would continue to evaporate.<br>• At the end of the simulation, about 3,000 bbls (1%) remains entrained in the water column in nearshore waters, and over time will tend to move with the prevailing currents. |

Source: RPS-ASA, 2013.

**e) Assessment of potential impacts of major accidental hydrocarbon spills**

Oil can have toxic and/or smothering effects on organisms in the path of a spill. The environmental receptors/components that are considered vulnerable to the potential effects of a diesel or light crude oil spill are:

- Seabird populations;
- Marine turtle populations;
- Cetaceans;
- Open coastal habitats;
- Estuarine and lagoon habitats;
- Coastal conservation areas;
- Fishing activities; and
- Tourism and recreation activities.

Based on the above modelling results, an assessment of the potential impacts on these receptors/components is presented below. It should be noted that the assessment is based on the premise that a hydrocarbon spill occurs, which is considered highly unlikely. In other words, the probability ratings as presented in the assessment tables below are of the probability of the effects described occurring *should a major spill take place*, and not of the probability of a spill occurring.

Furthermore, because of the almost limitless variation in volumes of spills that could occur, and/or their precise location and timing, only the results of the worst case/major spill simulations for diesel and for crude are used in the assessment ratings below, i.e. those predicted to have the "highest impact" on the coast, combining maximum volume of oil on shore and shortest time to reach shore. It follows that any lesser spills should have less significant environmental impacts.

**f) Key recommended mitigation measures**

The following measures are designed to assist in preventing a spill from occurring, and in minimising the extent of a spill should it occur:

- Implement the MinPet approved Oil Spill Emergency Response Plan, including *inter alia* informing MinPet of any spills, applying biodegradable dispersants only after consultation with MinPet and deploying oil protection booms in sensitive coastal areas when possible. The latter should focus on preparedness in areas predicted to be in the path of spills (Figure 7-6);
- Regularly test the BOP during drilling operations;
- Refuel only in calm weather and sea conditions and during daylight;
- Use reinforced hosing for fuel transfers and use weak links and associated shut-off valves to reduce losses to sea should rupture occur;
- Use well designed crude oil transfer pipes and links with associated cut-off valves etc to offload oil from the FPSO to tankers, and
- Replace deteriorating pipelines before rupture could occur.

### 7.3.6.1 Impact M13: Potential Impact of an Accidental Release of Hydrocarbons on Seabird Populations

Seabirds are primarily affected by diving or swimming through a slick with resulting oiling of their plumage and loss of insulating properties, and ingestion of oil during preening causing liver and kidney damage. The species that may be at risk from spilt diesel or crude oil include pursuit diving and/or surface swimming birds such as terns, gannets and cormorants although the latter two are generally sparsely distributed in this region. Given their large natural ranges if oiling of these inshore bird species were to occur, effects at each species' population level should be unlikely. Damara terns have been recorded from the region and nest on the upper portions of sandy beaches, generally on or in dune slacks behind the primary dune. Due to their location, nests should not be affected by diesel or crude oil that may come ashore.

Although any oiling of seabirds could be of *transboundary* extent (Table 7-16 and Table 7-18), as spills are predicted to extend into the waters (and perhaps reaching the shores) of countries to the north of Angola, the impact would be over a *short duration* as diesel oil is predicted to evaporate within a week and crude oil would remain on the surface of the sea for up to 37 days. Due to the sparse distribution in the region and large natural ranges of the seabirds the impact would be at a *low* magnitude on a *small* number of individuals. The potential impact on seabird populations is assessed to be of *low* significance.

**Table 7-19: Significance of potential impact of a hydrocarbon spill on seabird populations.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term<br>1 | Transboun-dary<br>4 | Low<br>1 | Small<br>1 | 7 | Possible | LOW - | High |

#### 7.3.6.2 Impact M14: Potential Impact of an Accidental Release of Hydrocarbons on Turtles

Olive ridley, green and, more infrequently, leatherback turtles are known to occur in the northern Angola area that may be affected by an accidental release of hydrocarbons while leatherback turtles may be more numerous north of the Congo River mouth; Gabon is particularly important for leatherbacks as it currently supports the largest aggregation of this species in the world (Freytey 2001). Olive ridley turtles are known to nest on central and southern Angolan beaches while Leatherback turtles may also do so. Green turtles may traverse the region. An offshore spill would have the greatest impact on turtles when they congregate at sea in August and September prior to nesting, while spills reaching the near-shore waters and shoreline would have the greatest risk of impacting turtles during hatching (December to May).

The primary agents for lethal effects on turtles are complete covering by thick oil for juveniles or the ingestion of tar balls (Milton et al. 2008). Neither should be caused by diesel as it does not emulsify (water content = 0%). Sub-lethal effects may occur, as turtles do not appear to demonstrate avoidance effects for oil slicks. Prolonged exposure (days) may thus generate respiratory-linked pathologies such as reduced dive times and foraging success, with increased risks of starvation. All of the recorded species occur in the areas that may be affected by an accidental release of hydrocarbons (modelling predicts that a diesel spill could be at a *transboundary extent* -Table 7-16 and Table 7-18) and all of these species are Red Data-listed. We consider that a *small proportion* of any seasonal cohort of hatchlings may be affected and that the effects on the breeding populations will be chronic (sub-lethal) in terms of physical and or physiological effects. But because of their conservation status this is considered to be of a *Moderate magnitude*. Given that diesel does not emulsify and evaporates relatively rapidly it would persist in the *short term*

The potential impact of a **marine diesel spill** is assessed to be of *low* significance.

**Table 7-20: Significance of potential impact of a marine diesel spill on turtle populations.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term 1 | Transboun-dary 4 | Moderate 2 | Small 1 | 8 | Possible | LOW - | High |

A crude oil spill could endure for 37 days on the water surface and for a few to many years on the coast if buried in the intertidal, so protected from weathering (i.e. oil will be present for the *medium term)*. Turtle nests are supratidal, i.e. above high water mark, and should not be affected. If oil is buried beneath sand layers it should be of no consequence for juveniles crawling over the sand surface as they move from their nests to the sea after hatching. However, should these hatchlings encounter a spill near the coast it is likely they will become immersed in oil and die. It could affect a greater geographical area than a diesel spill and affect more turtles or a greater proportion of any population, especially in the wet season when turtle nesting is at its highest. This could result in a *transboundary* impact, but would affect a *small* proportion of the local populations, and the impact would also be rated of *Moderate magnitude*. The potential impact of a crude oil spill on marine turtles is therefore assessed to be of *medium* significance. Implementation of the recommended mitigation measures would reduce the likelihood of a spill occurring, and, should a spill occur, would reduce the intensity of the impact.

**Table 7-21: Significance of potential impact of a crude oil spill on turtle populations.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Medium term 1 | Transboun-dary 4 | Moderate 2 | Small 1 | 9 | Probable | MEDIUM - | Medium |

Confidence is medium as we are dealing with uncertainties of modelling.

#### 7.3.6.3 Impact M15: Potential Impact of an Accidental Release of Hydrocarbons on Cetaceans

Whales and dolphins may be affected by a spill either by effects on mating/courting behaviour or food sources (e.g. fish for dolphins). In most cases these species will tend to move away from the affected area resulting in *low magnitude* effects, and this would be on a *small* proportion of the community that would be present at any one time. Because of their swimming abilities, the relatively limited surface area of the sea affected (~8,000 km² area swept by a diesel spill in the worst case deterministic model results), and the relatively *short* time scale of a diesel spill (about a week on the sea surface before most has evaporated) impacts on cetaceans as a group are considered to be *unlikely*. Consequently, the potential impact of a marine diesel oil spill on cetaceans is assessed to be of *low* significance.

**Table 7-22: Significance of potential impact of a marine diesel spill on cetaceans.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Duration** | **Extent** | **Magnitude** | **No. of elements** | **Score** | | | |
| Short term 1 | Transboun-dary 4 | Low 1 | Small 1 | 7 | Unlikely | LOW - | High |

A markedly greater area of sea surface may be affected by spilt crude oil; ~30,000 km² could be swept by a blowout according to the worst case deterministic model results, and this could also be *transboundary* in extent (Table 7-16 and Table 7-18). Oil is predicted to remain on the sea surface for a longer period of time (~5% after 37 days) which is rated as *short term*. Accordingly, although there would be a higher potential likelihood of whales being affected, being strong swimmers they will be able to avoid the area of the oil spill resulting in a *low magnitude* impact and on a *small* proportion of the community that would be present at any one time. The potential impact is thus assessed to be of *low* significance.

**Table 7-23: Significance of potential impact of a crude oil spill on cetaceans.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Duration** | **Extent** | **Magnitude** | **No. of elements** | **Score** | | | |
| Short term 1 | Transboun-dary 4 | Low 1 | Small 1 | 7 | Possible | LOW - | High |

Implementation of the recommended mitigation measures is not expected to reduce the significance further, but would assist in preventing a spill from occurring.

#### 7.3.6.4 Impact M16: Potential Impact of an Accidental Release of Hydrocarbons on Open Coastal Habitats

A combination of the results of the oil spill modelling scenarios predicts the total area within which there is even a very small (1% or more) chance of some oil reaching the coast *at some point* extends along about 1,300 km of coastline between Gabon's Cap Lopez in the north to near Angola's town of Sumbe in the south. A synthesis of areas at risk, in the unlikely event a spill occurs, is illustrated in Figure 7-6 (Also see Table 7-16 and Table 7-18).

Accordingly, an accidental release of diesel may reach the shoreline at some point anywhere between the Sette-Cama Marine Protected Area (WDPA, 2007) in Gabon in the north, and the Kisama National Park in Angola in the south. Much of this area has long stretches of narrow sandy beach and cliffed coastline with sandstone rock rubble at the base of the cliffs, and shorter lengths of rocky shorelines. Numerous estuaries are located on this section of coast, including the Congo River mouth. The probability of shoreline oiling is 1-3%; the average predicted time to reach the shore is 9.4 days and the shortest time 4.8 days.

It is considered *unlikely* that a diesel spill would reach the shore, but if it did it could be somewhere from as far north as southern Gabon to as far south as Luanda (*transboundary extent*), but the highest likelihood is that it could be restricted to northern Angola (**Tables 3-16 & 3-18**). The worst case diesel oil spill trajectories indicate that approximately 50 km (during spill Period-1) to 67 km (during spill Period-2) of Angolan shoreline may be impacted. Wave action on these shorelines is energetic so physical weathering through this and associated sand abrasion should reduce and remove the diesel oil relatively quickly, especially when coupled with evaporation (*short term* impact). Diesel does not emulsify so the formation of tar balls or asphalt pavements is considered to be unlikely (*low magnitude*). Sandy beach fauna is sparse but widely distributed and thus direct effects at the population level are likely to be minimal. Similarly, possibly due to sand abrasion and erosion of soft sandstone rock surfaces, intertidal rocky shore biological communities are not well developed and consist of taxa with wide distributions (*small number of elements)*. Effects at species population levels are also likely to be small.

If the diesel reaches the shore the impacts described would be definite, but the overall probability of the diesel reaching the shore is 3% so the probability of the impact occurring is *unlikely*. The impact significance is assessed to be *low*. Given the rapid weathering rate of diesel implementation of any mitigation measures is not warranted.


**Figure 7-6: Illustration of the predicted areas at risk of some oiling at some point.**

Stochastic distributions indicate the areas within which a variety of spills could reach the shore at some point: crude oil (orange dotted line) and diesel (white dotted line). The solid red lines indicate areas within which deterministic trajectories predict the largest volumes of oil could reach the coast in the shortest time, extending from within about 266 km north to 256 km south of the Congo River mouth (satellite image base map).

**Table 7-24: Significance of potential impact of a marine diesel spill on open coastal habitats.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Short term 1 | Transboun-dary 4 | Low 1 | Small 1 | 7 | Unlikely | LOW - | High |

Stochastic results indicate <50% probability of shoreline oiling (*possible impact*). Deterministically spilled crude oil is predicted to impact greater lengths of sandy and/or cliffed coastline; the worst case scenario predicts about 217 km of coastline largely in the Congo for Period-1, and 250 km of coastline all in Angola for Period-2 (worst case trajectory and fate scenarios in Appendix-C). The extent is *transboundary*.

There would be a powerful effect, initially of high magnitude, on a large *(rated moderate) number of elements* linked to shoreline length that could be affected. But given that these systems, rocky and sandy beach ecology, are expected to be resilient to this, with recovery periods within 3-5 years (*medium term*) without intervention, it renders this as a *low magnitude* rating.

The potential impact of a crude oil spill on open coastal habitats is assessed to be of *medium* significance.

**Table 7-25: Significance of potential impact of a crude oil spill on open coastal habitats.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Medium term 1 | Transboun-dary 4 | Low 1 | Moderate 2 | 9 | Possible | LOW - | High |

Implementation of the recommended mitigation measures would not reduce the significance of the impacts further, but would assist in preventing a spill from occurring.

#### 7.3.6.5 Impact M17: Potential Impact of an Accidental Release of Hydrocarbons on Estuaries and Lagoons

The stochastic distribution for spilled diesel during Period-1 indicates that estuaries and associated lagoons between Sette-Cama and Luanda, and for Period-2 between just south of Sette-Cama to Kisama, would have a 1-3% probability of being oiled should a spill occur (Table 7-16 and Table 7-18). The deterministic analyses show that estuaries on the coastline of Zaire province may be affected; for spills generated during Period-1 this would include estuaries between the Zanga and Quinguengue Rivers over a ~50 km stretch, and during Period-2 would include estuaries between the Nzombo and Quintana Rivers, over about 67 km.

Although *unlikely* for diesel to reach the shore, if it penetrated into estuary/lagoon systems (e.g. through tidal exchange when river mouths are open) it could have severe repercussions in terms of long-term damage to associated mangrove forests as diesel is acutely toxic to mangroves; effects can extend for 5 year periods or longer (IPIECA, 1994a and 1994b) and be of *extreme* magnitude because of the sensitivity of the receptors. Part the importance of mangroves in the overall ecology of the region is that they provide fish nursery areas for estuary-dependent fish, and foraging areas for coastal birds (*moderate* number of elements). Effects on salt marshes can be similarly acute, but are expected to manifest over shorter periods (less than a year) due to more rapid recovery from the toxicity effects of diesel. The length of time the receptors would be subjected to receiving impacts from diesel before it breaks down or evaporates is rated as *short term*.

The potential impact of a marine diesel spill in the East Hub development area on estuary systems would be of *transboundary extent* and is therefore rated to be of *medium* significance. The implementation of the recommended mitigation measures could reduce the magnitude of the impact.

**Table 7-26: Significance of potential impact of a marine diesel spill on estuaries and lagoons.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term<br>1 | Transboun-dary<br>4 | Extreme<br>4 | Medium<br>2 | 11 | Unlikely | LOW - | High |

The estuaries and lagoons that may be affected by spilt crude oil, at a 1-10% probability (stochastic distributions), are those between Gabon's Cap Lopez and Luanda (Period-1) to just north of Sumbe in Angola (Period-2). The combined areas are illustrated in Figure 7-6.

Deterministic analyses indicate that, should a spill occur, the length of coastline affected during Period-1 would include almost all of the Congo coastline (from just south of Gabon), parts of Cabinda and the DRC and the northernmost stretch of Angola's Zaire Province. During Period-2 this area shifts southwards to extend from the north end of Zaire Province to approximately the Quincacala River in northern Bengo Province. These areas contain a number of estuary and estuary/lagoon systems.

Effects, and their duration, would depend on the amount of oil that penetrates the systems. A small amount would mean recovery periods of salt marsh areas and mangroves could be relatively short, but if the salt marshes and mangroves and the substrates in which they grow were thickly covered in oil then recovery of the full biological diversity associated with these habitats would only occur over decades (IPIECA, 1994a and 1994b). This may have important implications for the functions of these estuary systems in terms of provision of fish nursery and foraging areas for coastal birds. The worst case impact duration would be *beyond project lifetime/ critical*. The extent of the area affected is predicted by the modelling to be *transboundary* and the impact could be at an *extreme magnitude*, mainly because of the length of time it would take mangrove habitats, especially, to recover. Because of the nursery and foraging grounds provided by estuarine and lagoon systems the number of elements involved is rated as '*great*'. Stochastic results indicate <50% probability of shoreline oiling (*possible impact*). The potential impact of an accidental release of hydrocarbons on estuarine and lagoon habitats is therefore rated to be of *medium* significance. Implementation of the recommended mitigation measures may reduce the volume of crude oil that may enter the estuary and lagoon habitats but would not change the significance rating of the impact.

**Table 7-27: Significance of potential impact of a crude oil spill on estuarine and lagoon habitats.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Beyond project life<br>1 | Transboun-dary<br>4 | Extreme<br>4 | Great<br>3 | 15 | Possible | MEDIUM - | Medium |

### 7.3.6.6 Impact M18: Potential Impact of an Accidental Release of Hydrocarbons on Conservation Areas

Declared conservation areas within the trajectories predicted by stochastic and deterministic modelling for an accidental release of hydrocarbons from the East Hub are illustrated in Figure 7-7. Stochastic modelling indicates that a diesel spill could reach coastlines of conservation areas between Mayumba and Porto Ambiom, with a very low 1-3% probability, while the coastline between Cap Lopez and Sumbe could be affected by crude oil spills, with a higher probability of 1-10%.

The volume of diesel reaching the shore could at worst oil 67 km of shoreline (*regional scale*). It is predicted to evaporate or break down rapidly (days, *short term*) and because it does not emulsify it would have an impact of *low magnitude* and affect a *small number of elements*. The impact rating would be of *transboundary* extent because conservation areas that could be affected are No, 1 the Kissama National Park, No. 2 the Ilha dos Passaros Integral Nature Reserve, No. 3 the Conkouati Reserve de Faune which is a Transfrontier conservation area shared by Congo and Gabon, and No.

5 the Parc National des Mangroves on the north bank of the Congo River mouth in the Democratic Republic of Congo (Figure 7-7).

**Table 7-28: Significance of potential impact of spilled diesel on conservation areas.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term 1 | Transboun-dary 4 | Low 1 | Small 1 | 7 | Possible | LOW - | Medium |

The reserves that may be affected by a spill of crude include those listed above as well as No. 4 the Reserve de Faune et Domaines de Chasse de Sette Cama in Gabon. The most crude oil in the shortest time, as predicted by deterministic modelling, would affect No. 3 the Conkouati Reserve de Faune, a Transfrontier conservation area shared by Congo and Gabon, and No. 5 the Parc National des Mangroves on the north bank of the Congo River mouth in the Democratic Republic of Congo (Figure 7-7). The worst case is predicted to take a minimum of 6.7 to 10.4 days to reach shore (Table 7-17).

If this were to occur then coastal conservation efforts may be compromised. As the conservation areas would contain estuaries/lagoons, which are the most sensitive systems, the potential impacts would be rated similarly with a *great no. of elements* affected and the worst case impact duration being *beyond project lifetime/ critical*. Effects would be of *extreme* magnitude. Impacts on conservation areas may therefore be of *medium* significance. The implementation of the recommended mitigation measures would reduce the intensity of the potential impact and its significance to low.

**Table 7-29: Significance of potential impact of spilled hydrocarbons on conservation areas.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Beyond project life 4 | Transboun-dary 4 | Extreme 4 | Great 3 | 15 | Possible | MEDIUM - | Medium |

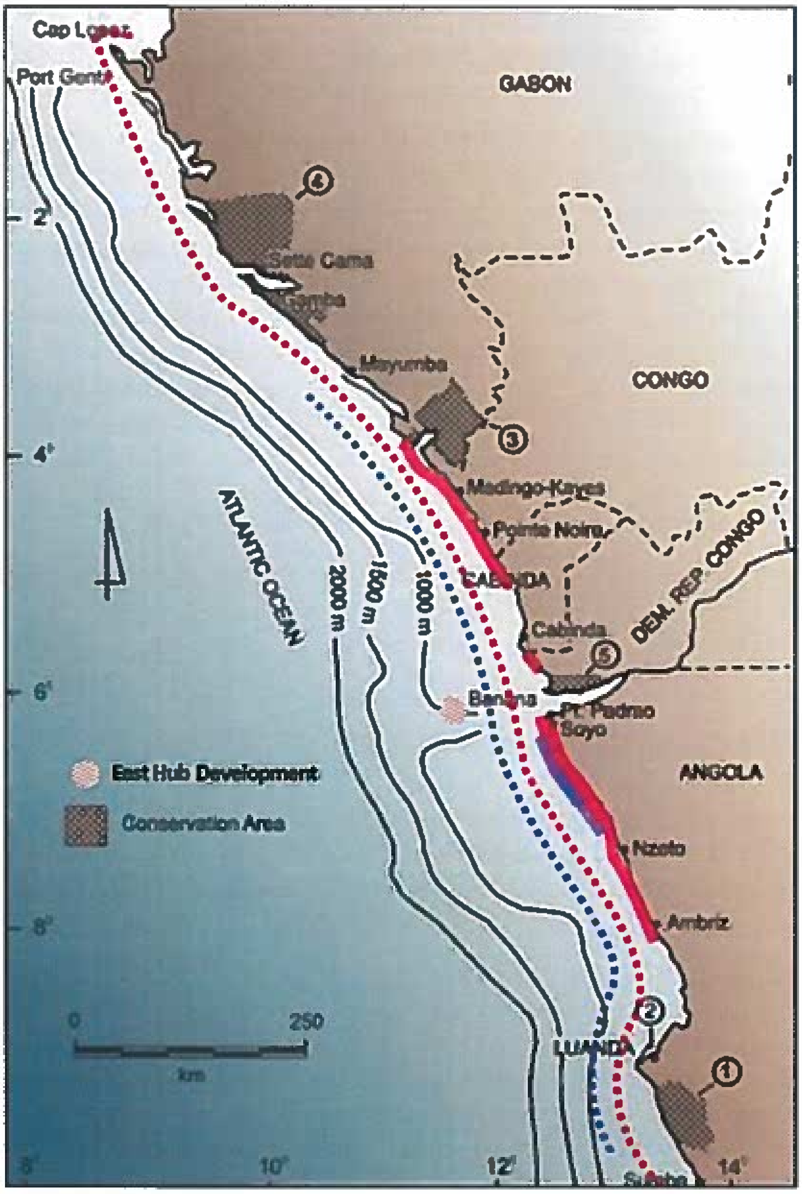



**Figure 7-7: Areas that could be affected by an oil spill**

The purple dotted line is opposite coastal areas that could be affected by a diesel spill, and the red dotted line where oil could reach the coast.

Solid lines indicate where the most oil could reach the coast in the shortest possible time, i.e. areas within which coastal conservation areas could be at highest risk.

#### 7.3.6.7 Impact M19: Potential Impact of an Accidental Release of Hydrocarbons on Fishing Activities

The oil spill trajectory for water surface oiling crosses through all commercial fishing areas which are dispersed across the length of the coasts in specific depth ranges, and purse seine fishing could be affected most through gear fouling. Artisanal fishing occurs in each coastal area and could also be affected by spilt oil and/or diesel. The probabilities of Territorial Waters being affected, for all spills modelled, are Angola (highest) followed by Congo> DRC> Gabon> Sao Tome and Principe and Equatorial Guinea (Table 7-16).

If a spill does occur, disruptions to fishing (oiling of gear) may extend for about 7 days for diesel, as this is the predicted period of time that diesel will be on the sea surface (Figure 7-2). For a crude oil spill from a well blowout the exposure period is predicted to be much longer >37 days (Figure 7-3).

Accordingly, because of the location of the East hub development over the Congo River canyon, the potential impact of either a diesel or a crude oil spill on fishing activities would be of *transboundary* extent. Because diesel evaporates and weathers fairly rapidly it could be avoided by most fishers and is not assessed further. A crude oil slick could be avoided by all except some artisanal fishers (rated a *small number*) in the path of a spill who may therefore experience a *moderate magnitude* effect for up to month (short term). Stochastic results indicate <50% probability of shoreline oiling so, in the unlikely event of a major spill occurring this comprises a *possible impact*, which is assessed to be of *low* significance. The only mitigation possible would be compensation to artisanal fishers for missed catches as their mobility is limited. Boats fishing for large pelagic species should be able to avoid any oil spill that may occur.

**Table 7-30: Significance of potential impact of a crude oil spill on fishing.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Short term 1 | Transboun-dary 4 | Moderate 2 | Small 1 | 8 | Possible | LOW - | Medium |

#### 7.3.6.8 Impact M20: Potential Impact of an Accidental Release of Hydrocarbons on Tourism and Recreation

Outside of some urban beaches and national parks, tourism infrastructure is not highly developed in these countries. Although it is expanding, transport still presents a major problem and accommodation facilities are limited. It is possible that local people visit beaches in the region for recreation, but from satellite imagery population densities appear to be very low.

The potential impact of a diesel or a crude oil spill on tourism and recreation could be *transboundary* in extent. It is rated to be at a *low magnitude* because diesel will weather rapidly, but crude can persist on the shore for a few to many years (*medium term*) and where required can be removed. Owing to the undeveloped nature of the coast a relatively *small number* of individuals would possibly be affected; it is therefore rated as of *low* significance. There does not appear to be any practical mitigation for this other than compensation of tourism owners/ Municipalities for clean-up costs.

**Table 7-31: Significance of potential impact of a hydrocarbon spill on tourism and recreation.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Medium term 2 | Transboun-dary 4 | Low 1 | Small 1 | 8 | Possible | LOW - | Medium |

### 7.3.7 Impact M21: Effects of Decommissioning on Marine Life

The license holder/operator remains contractually liable for decommissioning the infrastructure which, for the East Hub development, is currently estimated to occur in about 20 years' time. Closer to this time comparative assessments for the key removal and disposal options would need to be undertaken and regulatory approval obtained. In carrying out these assessments Eni would need to take into consideration safety and the availability of suitable technology as well as the environmental, economic and social impacts of the different removal and disposal options. Accordingly, impacts cannot be accurately evaluated at present, but despite this **a generic assessment is provided** as all items left *in-situ* as part of any decommissioning programme remain the licence holders property, for which they have a continuing liability.

Typically, all pipelines would be cleaned/ purged of their contents to the FPSO or a retrieval vessel. The FPSO would be towed from site and refurbished for re-use, or dismantled. Its mooring lines would be removed, but the anchors may be abandoned on the seafloor. As many other components as possible, particularly metal fittings, would be retrieved for reuse or recycling. Larger pipelines would be made secure to stop them from being shifted by currents on the seabed, and so prevent damage to benthos and possibly to navigation. Typically, flexibles would be retrieved for disposal to landfill. Finally there would be seabed debris removal and survey work done. Notices to mariners would warn vessels to avoid the area during decommissioning activities.

Presuming decommissioning is undertaken appropriately, i.e. that no pollution occurs, the main concern to marine life would be the physical re-disturbance of the seabed environment from the removal of structures, and also the securing and abandonment of other artificial structures. This will have the impacts of either disrupting established communities that have colonised the structures and adjoining seabed, or allowing the established communities to persist into the future. (The assumption is that all equipment will be cleaned and there will be no leakage of soluble materials to sea).

Disturbance of the benthos would *definitely* occur and would be *permanent/ beyond project lifetime* (there would be a permanent change to hard substrates through scarring and to soft substrates by having infrastructure on them where there was none before). Impacts would cover the *local scale* over which the subsea structures were placed, and be of *low* magnitude and on a *small proportion* of the population which are in isolated areas within a very extensive area of sea bed type. The impact will definitely occur and the significance is rated as *medium*.

Mitigation would be to cause as little disruption as possible to sea life and other vessels. Measures required to achieve this would include: constructing the infrastructure so that it can be readily dismantled and retrieved and, where feasible, recycled, or securely stabilized and/or buried when necessary; leaving the area in a condition where no further disturbance to the seabed or water column would occur so natural processes can continue, and ensure there would be no structures remaining that could be a hazard to fishing and navigation.

**Table 7-32: Significance of potential impact of decommissioning on marine life.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| Beyond project life 4 | Local 1 | Low 1 | Small 1 | 7 | Definite | MEDIUM - | High |

Confidence in these predictions is low because future options, capacity and requirements for decommissioning are uncertain.

### 7.3.8 Impact M22: Potential Impacts of Released Ballast Water on the Spread of Alien Species Near-Shore

Vessels may be brought in from foreign ports to service the East Hub development, and make use of Angolan or other Southern African ports. This increases the risk of non-indigenous organisms entrained in source ports being released into receiving ports' environments through ballast water exchange. For example Carlton and Geller (1993) recorded >350 taxa in 'Japanese' ballast water samples taken from vessels in Oregon, USA. Most of these were holo- and meroplanktonic forms but all of the major marine taxa were represented. This case shows that it is possible to transport entire plankton species assemblages across oceans. Further, Hutchings (1992) has provided evidence that, when ballast water is drawn from heavily populated areas with inadequate waste water treatment systems, viral pathogens and contaminants can also be translocated through ballast water exchanges. In this regard IMO cites cases of cholera (*Vibrio cholerae*) apparently attributable to ballast water discharges (http://www.imo.org/ Conventions).

Once released into ports, alien species can become invasive through the establishment of populations and disrupt ecological processes. Carlton and Geller (1993) record 45 'invasions' attributable to ballast water discharges in various coastal states around the world. The invasives include planktonic dinoflagellates and copepoda, nektonic Scyphozoa, Ctenophora, Mysidacea and fish, and benthos such as Annelid oligochaeta and polychaeta, Crustacean brachyura and Molluscan bivalves.

In view of the globally recorded negative effects of alien species transfers, the International Maritime Organisation (IMO) considers their introduction to new environments via ship's ballast water or other vectors as one of the four greatest current threats to the world's oceans (Awad et al., 2004). To reduce these risks IMO has instituted ballast water management regulations (http://www.imo.org/ Conventions), including requirements for open ocean ballast water exchanges and associated ballast water management record books. Implementation of open ocean ballast water exchange has been shown to reduce plankton concentrations within ballast water holding tanks on container vessels by 90% (Ruiz and Smith et al, 2005).

Even if ballast water volumes are small and there are minimal exchange requirements the potential risk of invasion can be very high (*extreme magnitude*) and potentially affect a critical (*huge) number* of ecosystem functions. The probability of successful invasions occurring here is *unknown* because one might only see the results some decades after an alien species has been released - on the other hand it might not become invasive. Accordingly this potential impact cannot be awarded a significance rating according to Eni's criteria.

The only thing Eni can do to reduce the risk of any spread of alien species, is to enforce open ocean ballast water exchange before 1st entry into Angolan Territorial Waters for all vessels contracted for the East Hub project. This should be included in Eni's Environmental Management Programme as a check on compliance with IMO guidelines.

# 8 Social and Health Impact Assessment

This section provides an analysis of the potential direct and indirect socio-economic and health impacts, both positive and negative, that will result from all phases of the planned East Hub development project.

A key consideration in this assessment is the fact that the East Hub project is predominantly an offshore development, with the largest majority of activities taking place in the marine environment. There will therefore be few direct interactions between the project and other human activities, other than limited interactions with other users of the sea that utilise the area. Limited onshore activities will involve routine logistics support, supplies and equipment storage and waste handling. These activities will utilise existing facilities at the Kwanda base in Soyo, and no new onshore facilities will be constructed for the proposed development.

It should also be noted that the East Hub development is only one of numerous offshore oilfield developments currently in operation in the northern Angolan offshore environment. The majority (if not all) of these offshore developments also utilise the onshore facilities at Soyo. As a result, the socio-economic and health environment in the northern Angolan offshore environment as well as the Soyo region is already well adapted to the (cumulative) impacts of the offshore oil and gas industry.

Socio-economic and health impacts of the proposed East Hub are therefore expected to be limited to impacts on human activities in the offshore environment in the vicinity of project activities (mainly deepwater fishing and commercial shipping), as well as impacts on the local communities on the adjacent coastline and in the vicinity of the onshore support base. Economic impacts can also be expected at national (Angolan) level.

The identification and assessment of the potential socio-economic and health impacts of the proposed East Hub development are subject to specific limitations and assumptions, which should be borne in mind when considering this assessment:

- Socio-economic and health impacts are not easily objectively measured and therefore often need to be inferred rather than measured. A combination of insight into social processes in general and knowledge of the affected communities are important in order to draw valid inferences;
- Communities are dynamic and often in a continual process of change. The proposed East Hub development is one factor contributing to this change, but it is often difficult to identify when an impact is solely attributable to one project or to other factors (or a combination thereof); and
- Human beings are naturally continuously adapting to changes in their environment, including project impacts. As such, over time these impacts change in significance for those affected.

## 8.1 Significance Rating Methodology

The significance of each potential impact is assessed in order to determine whether impact mitigation is required to ensure that the potential negative impacts of the proposed project are managed to acceptable levels (or to ensure that potential benefits are maximized). ENI's corporate procedures includes an ESHIA Standard which prescribes a set impact significance rating methodology to be used when assessing the potential environmental and socio-economic impacts of ENI's activities. This standard methodology is presented below.

In assessing the significance of each potential impact (positive or negative) using ENI's standard methodology, the following criteria are applied to determine the consequence score (severity) of a potential impact (see Table 8-1):

- **Duration:** the temporal scale of the impact, ranging from less than 1 year to more than 10 years/permanent;
- **Extent:** the spatial scale of the impact, ranging from local to international/transboundary;
- **Magnitude[20]:** the extent of the likely change in the environment that will result from the impact, with reference to the baseline; and
- **Number of elements involved:** the extent of the impact with regard to the number of individuals, households, enterprises, etc. (i.e. portion of the population) that would be affected.

Each criterion is assigned a rating and the consequence score is the sum total of the four criteria ratings (ranging from 4 to 16) (see Table 8-1).

**Table 8-1: Impact consequence criteria scoring.**

| | Criteria | | | | Score |
|---|---|---|---|---|---|
| | Duration | Spatial Extent | Magnitude[20] | No. of Elements | |
| Ranking | Less than 1 year | Local – Soyo area | Low – negligible change, receptors able to recover or adapt to the change without intervention | Very small number of individual elements involved | 1 |
| | 1 – 5 years | Regional – Zaire province | Moderate – notable change, receptors able to adapt with some difficulty and which may require interventions | Small number of communities, groups of individuals or habitats / ecosystems involved | 2 |
| | 5 – 10 years | National – entire country | High value / sensitivity – substantial change, receptors able to adapt to changes only with strong interventions | Great number of individuals, habitats or ecosystems involved | 3 |
| | More than 10 years / Permanent | International - transboundary | Extreme value – massive change, resulting in permanent changes | Huge number of individuals, habitats or ecosystems involved | 4 |

Once the impact consequence score is calculated, the probability (likelihood) of the impact occurring must be considered in order to determine the impact significance (e.g. an unlikely impact with a high consequence score would not be considered a significant potential impact). Probability is rated as:

- **Unlikely:** the impact is unlikely to occur under normal operating conditions but may occur in exceptional circumstances;
- **Possible:** the impact may occur under normal operating conditions;
- **Probable:** the impact is likely to occur under normal operating conditions; and
- **Definite:** the impact will occur under normal operating conditions.

The significance of the impact is determined by combining the impact consequence score with impact probability, as set out in Table 8-2 below.

**Table 8-2: Impact significance ratings.**

[20] Note: Magnitude is considered a more appropriate criterion for the assessment of socio-economic and health impacts, in place of the "Importance/Resilience of the Receptor/Resource" criterion used in the assessment of biophysical impacts. Both criteria are allowed for in ENI's standard significance rating methodology.

| Consequence score | Probability | | | |
|---|---|---|---|---|
| | Unlikely | Possible | Probable | Definite |
| 4 – 6 | Low | Low | Low | Low |
| 7 – 9 | Low | Low | Medium | Medium |
| 10 – 12 | Low | Medium | Medium | High |
| 13 – 16 | Medium | Medium | High | Critical |

The impacts are also considered in terms of their status, namely negative (indicated with -) or positive (a benefit, indicated with +). The degree of confidence in the prediction (based on available information, the professional judgement of the ESHIA team and/or specialist knowledge) is also indicated as being Low, Medium or High.

## 8.2 Assessment of Potential Impacts

### 8.2.1 Impact S1: Increased Local (Angolan) Employment

An increase in local (Angolan) employment, either through direct employment in the project or in secondary businesses (suppliers and services providers), has the potential to improve the socio-economic well-being of the affected employees and their dependants. Unemployment and the lack of employment opportunities is a key concern in Angola, particularly among the local communities in the Soyo region, and formal employment is generally speaking more lucrative than many of the economic activities on which local communities currently rely. A reliable regular income would increase financial security and material wealth, and improve the ability of the employees to better their standards of living, invest in their future and access better health care and education.

ENI's project management team (direct employment) will comprise 150 full-time personnel located in Angola (Luanda) and at ENI's headquarters in Italy (Milan). It is not known how many of ENI's directly employed employees will be Angolan nationals, but it is likely that most positions will be filled by individuals already employed by ENI (e.g. on the West Hub development project). New direct employment opportunities available to Angolan nationals are therefore likely to be very few, if any.

While upstream oil and gas projects in general are known to create relatively few new direct employment opportunities once operational, construction activities (fabrication and/or refurbishment of oilfield equipment and facilities) typically create significant employment in the early stages of project implementation. However, as noted in Chapter 3, the East Hub development will largely be executed through EPC contracts, with ENI appointing various Contractors to undertake detailed design, procurement and management of the required construction/refurbishment activities. These Contractors, their employees and sub-contractors could be located in various locations around the world and it is not known how many Angolan nationals will benefit from a large number of construction phase employment opportunities.

The oil and gas industry also employs the services of other sectors and will require a wide range of services during the lifetime of the project, such as finance and retail, the provision of materials and equipment, catering and cleaning services, etc. The use of such services will result in the creation of additional employment opportunities in these industries (indirect employment). Furthermore, spending by ENI's direct employees located in Angola would also support employment opportunities in the communities where this spending takes place (induced employment). The oil and gas industry is generally regarded as having a relatively high employment multiplier[21] when compared to many other

[21] An employment multiplier measures the total number of employment opportunities (direct, indirect and induced jobs) created (or lost) for every direct job created in a specific industry.

industries, but the Angolan oil and gas industry employment multiplier is not known. However, as indicated above the number of local direct employment opportunities as a result of the East Hub development is likely to be very few, and therefore local indirect and induced employment is also expected to be minor.

Compliance with local content requirements set out in Angolan legislation will ensure that some employment benefit accrue to Angolan nationals (probable impact), but as demonstrated above, the potential increase in Angolan employment (national extent) is rated to be of low magnitude and would involve only a very small number of elements. Although employment opportunities will exist for the duration of the project lifespan, new opportunities will only be created during the first few years of project implementation, with new opportunities tapering off soon after first oil, which is expected in early 2016 (i.e. impact duration of 1 – 5 years). The **positive impact** of increased local employment is therefore assessed to be of **medium significance** (Table 8-3).

**Table 8-3: Significance of increased local (Angolan) employment.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| 1 – 5 years<br>2 | National<br>3 | Low<br>1 | Very small<br>1 | 7 | Probable | MEDIUM + | Medium |

### 8.2.2 Impact S2: Increased Social Conflict in Local Communities due to Influx of Employees and Work Seekers

Labour demand generated by a new development project often necessitates the in-migration of employees and work seekers attracted to the area by perceived employment or business opportunities, creating a boom effect in the local demography. In turn, rapid population growth can lead to a range of socio-economic and health implications for the local communities, e.g. increased pressure on existing social services and infrastructure (from housing through to schooling, electricity, water, sanitation and health structures). This can result in conflicts between members of the communities and the new inhabitants. An influx of employees and work seekers and subsequent mixing of populations often poses an increased risk of antisocial behaviour (e.g. alcohol and drug abuse), crime as well as socio-cultural conflicts resulting from the mixing of cultures. (Note: health implications of an influx of employees and work seekers are addressed in Section 8.2.4 below).

Based on experience, these are realistic expectations for most large new development projects. However, the proposed East Hub project is unlikely to be a significant source of these impacts, based on the very limited number of employment opportunities that will be created (see above). In addition, offshore employees work on a rotational shift basis (e.g. 12-hour shifts for 7, 14, 21 or 28 days at a time) and few if any of these employees will need to reside in the Soyo region in between their offshore rotation, as they would be able to return home. Furthermore, it is anticipated that any direct employees and those of contractors requiring temporary housing in Soyo would utilize existing accommodation facilities on Kwanda Base or in the urban areas of Soyo town (i.e. no new housing would be required for the project).

Of greater concern than an influx of workers employed on the project would be that local people from outside Soyo might migrate into the region upon hearing of the proposed project, prompted by an expectation of increased job demands from the industry as well as other linked work opportunities. However, it should be noted that the Soyo region already experiences a high level of in-migration, partly due to its proximity to the border with the DRC to the north. In addition, large numbers of people continuously migrate from the rural areas to the city where there are more employment opportunities. Soyo is particularly attractive because of the oil industry activities at Kwanda Base and specifically large projects such as the Angola LNG project that recently commenced production. Large numbers of expatriated workers already settle in the Soyo region temporarily or on rotational schedules for work related to the construction or oil industries. In addition, Angolan communities, particularly in oil-rich areas such as Soyo, are already exposed to oil industry activities and it can be assumed that they are already familiar with the fact that offshore oilfield development projects present very limited employment opportunities for unskilled workers.

The negative impact of increased social conflict due to an influx of employees and work seekers into Soyo (local extent) will have a low magnitude and affect a very small number of elements. While employees and work seekers may be attracted to the Soyo region for the duration of the project lifespan, the dynamic nature of the socio-economic environment in Soyo means that any social conflicts as a result would have a limited duration (rated as 1 – 5 years). The **negative impact** of increased social conflicts due to an influx of employees and work seekers into the region is therefore assessed to be of **low significance** (Table 8-4).

**Table 8-4: Significance assessment of increased social conflicts due to an influx of employees and work seekers into the Soyo region.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| 1 – 5 years<br>2 | Local<br>1 | Low<br>1 | Very small<br>1 | 5 | Possible | LOW - | Medium |

### 8.2.3 Impact S3: Disruption of Fishing Activities and Offshore Navigation

As discussed in Section 7.3.2, the presence of and exclusion zones in effect around the drilling unit(s) and FPSO, and the movements of an unspecified number of supply vessels, crew boats and shuttle tankers between the drilling units/FPSO and the onshore base at Soyo, may impede access to fishing areas and disrupt navigation by fishing and other vessels utilising the offshore region in the vicinity of the East Hub development area.

While the exclusion zones around fixed-position vessels involved in the oilfield development (i.e. drilling units, FPSO) are intended to prevent collisions and reduce risks, the movement of support and service vessels between the offshore location and the onshore logistics base could present hazards to other vessels that cross their paths, increasing the risks of collisions that could cause damage and/or injury. The exclusion zones and increase in marine traffic associated with the proposed development may necessitate any vessels that may pass through the area to re-route to avoid it. This is essential for safety of life at sea, but it could marginally affect commercial activities and livelihoods of vessels utilising the areas in the vicinity of the offshore development and the Kwanda Base.

Any impacts on the ability of fishing and other vessels to operate normally may lead to a loss of income or indirect financial costs (in the case of damaged gear) and, for artisanal fisherman in particular, decreased food security, which is of concern in the Soyo region where coastal communities are reliant on subsistence fishing. Interviews with local stakeholders, including the Institute for Artisanal Fishing (IPA) and fishing cooperatives, revealed that fishing catches have decreased in recent years and the causes were believed to be due to trawling, dredging and oil industry activities already existing in the region.

Both industrial (commercial) and artisanal (subsistence) fishing takes place off the coast of Zaire Province. While larger cargo vessels travelling along the coast towards West Africa or Europe would tend to travel in deeper waters and would be unlikely to be affected, smaller vessels utilising the coastal regions and Congo River mouth may be affected. These activities could all be disrupted by the physical presence and movements of vessels associated with the proposed East Hub development, and would be exposed to a higher risk of collisions and other hazards associated with increased marine traffic. In addition, the biophysical impacts of pollution at sea as a result of routine operational discharges (e.g. drilling cuttings and mud, production water, etc.) could affect fish populations and therefore catches, while subsea infrastructure and any equipment lost overboard could become obstacles to bottom trawlers and pose a risk of injury and/or damage to gear.

The proposed East Hub development is located well offshore of the known distributions of most of the species targeted by commercial fishing activities in Angolan waters, with the exception of large pelagic species and deepwater crustaceans. The East Hub development will therefore result in impeded access to fishing areas for fishermen targeting these species. Further interference with fishing vessels would be caused by vessels travelling between the offshore development and the Kwanda Base at Soyo, as such vessels may cross the northern extent of the known distributions of small pelagic species (sardinella and horse mackerel), demersal seabreams, as well as the large pelagic species and deepwater crustaceans.

Artisanal fishing is restricted to nearshore waters (within approximately 8 nm offshore) and the type of gear used by most artisanal fishermen limit their ability to venture far from shore. Most artisanal fishing along the coast of Zaire Province is expected to take place well inshore of the proposed East Hub development area, which is more than 70 nm offshore. However, movement of oilfield vessels in the nearshore regions (within 8 nm offshore) and in the Congo River mouth may interfere with artisanal fishing activities. In the case of the latter, popular areas frequented by artisanal fisherman include the Baía de Diogo Cão, where the Kwanda Base is located, as well as canals and channels leading off from the bay, including Pululu and Moita Seca.

The extent of the habitat occupied by the species targeted by all of the fisheries discussed above is vast relative to the areas anticipated to be affected by the East Hub development. In addition, the offshore activities associated with the proposed East Hub development will take place in a region with extensive historical and current oilfield development and high levels of marine traffic travelling between the offshore developments and the Kwanda Base at Soyo. It can therefore be assumed that all other offshore traffic is well-adapted to the presence of oilfield developments and related vessels operating in the area, and would already be avoiding the area and/or familiar with safety procedures in this regard.

Standard communication (constant bridge watch and radio contact) and navigation systems (lighting and signalling systems) will be in use on the vessels and Notices to Mariners would be used to warn other users of the sea of the presence of oilfield development vessels. The physical hazard posed by the vessels should therefore have little effect on other vessels in terms of collision risks. As no bottom trawling is known to take place in the deep waters where the East Hub development is to take place, protruding well casings and items left on the seafloor are unlikely to present a hazard to such fishing activities.

Disruption of fishing activities and offshore navigation would be limited to the project area and immediate surroundings (local extent) and will be of low magnitude, involving a small number of elements. As disruption would occur for the entire lifespan of the project (>10 years duration), this negative impact is assessed to be of **medium significance** (Table 8-5).

**Table 8-5: Significance of disruption of fishing activities and offshore navigation.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| **Duration** | **Extent** | **Magnitude** | **No. of elements** | **Score** | | | |
| >10 years<br>4 | Local<br>1 | Low<br>1 | Small<br>2 | 8 | Probable | **MEDIUM -** | Medium |

### 8.2.4 Impact S4: Increased Community Health Risks

The proposed East Hub development can affect the health of the local communities in the Soyo region in various ways, e.g. through the degradation of air quality, noise emissions, waste generation and increased pressure on water and sanitation systems. Increased pressure on local health care systems as are result of an influx of employees and work seekers into the region may also affect health service quality and local communities' access to these systems.

Emissions and discharges as a result of onshore activities during the East Hub development may reduce air and water quality and increase noise levels, which may affect the health of the local communities in which it operates. Pollutants from air emissions, if persistent and quantitatively appreciable, could potentially result in increased health problems such as respiratory diseases and decreased respiratory functions. Access to clean water is crucial for the health of the local population and decreased quality and stagnant water could encourage the breeding of disease vectors and result in poor sanitation conditions.

Waste generated offshore will be taken to shore for storage, disposal and/or transfer. This may increase pressure on the local waste management systems, which can lead to further pollution incidents and may affect community health (through disease vectors, exposure to hazardous chemicals, etc.). However, onshore activities will take place in the Kwanda Base, which is equipped to provide the relevant services such as waste management to the oil and gas industry.

Employees at the offshore facilities and at the onshore base are most at risk of the effects of the health impacts discussed above, but the implementation of standard occupational health and safety standards, including the use of personal protective equipment (PPE), and adequate training would reduce these risks.

Increased contact between members of the local communities and newcomers (employees and work seekers) to the Soyo area may increase the incidence of communicable diseases in these communities. Of particular importance is the possible increase of Sexually Transmitted Infections (STIs) such as HIV/AIDS as well as other communicable diseases such as tuberculosis and respiratory tract infections (pneumonia). The increase in urban waste generation, (with relevant increase of vectors breeding sites) and poorer water supply and sanitation can also result in an increase of malaria transmission as well as all other arthropod and water borne diseases.

Although data on HIV/AIDS prevalence in the Soyo region is limited, indications show relatively high levels of infection with particular regard to some at-risk social groups. Malaria is considered the key cause of morbidity and mortality in the Soyo region, with high numbers of local inhabitants reporting to have experienced malaria, and numerous deaths resulting from the disease. Tuberculosis is also considered a leading cause of mortality in the Soyo region (which may indirectly indicate a rampant HIV infection), while respiratory infections are reportedly an important cause of ill-health in the area. The existing health situation is already poor and a potential increase in communicable diseases in the Soyo region could have a potential impact on population. However, as noted above, any influx component of newcomers into the Soyo area as a specific result of the proposed East Hub development is anticipated to be minimal and considered unable to produce a marked increase in the incidence of communicable diseases in the local communities

Usually, any increase in health risks and a decline in the health conditions in any region would increase pressure on the local health care system. The baseline study conducted for this ESHIA found that local healthcare providers in the Soyo area cannot meet current demand in terms of equipment, facilities, training opportunities and staff, and have limited access to medicines. This implies that even minimal additional pressure on the local health care system as a result of the proposed East Hub development could reduce local communities' access to these services.

The potential impact of increased community health risks in the Soyo area (local extent) as a result of the proposed East Hub development is assessed to be of low magnitude, but it will affect a great number of individuals in the Soyo communities, and would persist for the duration of the project lifespan (>10 years). The potential negative impact is therefore assessed to be of low significance (Table 8-6).

**Table 8-6: Significance of increased community health risks.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| >10 years 4 | Local 1 | Low 1 | Great 3 | 9 | Possible | LOW - | Medium |

## 8.2.5 Impact S5: Reduced access to resources for local communities

The proposed East Hub development will require resources such as water and electricity for both the offshore and onshore activities, which may reduce access to these resources by the local communities.

No information is available with regard to the water, energy or other resource needs of the proposed East Hub development. Nevertheless, it is known that the local communities have limited access to these resources. Very few of the inhabitants of the Soyo region are served by the public potable water supply, which is delivered by truck to certain parts of Soyo town and nearby communities, although supply is unreliable. Those inhabitants not served in this way have to collect/purchase their water elsewhere and spend up to two hours every day to do so. Water use by the project that exceeds local availability may result in a lack of adequate access to potable water. The same applies to electricity consumption, which is an uncontrolled use with respect to local capacity. Similarly, very few of the homes in Soyo have access to electricity through the municipal network, which covers only the centre of the city and petroleum gas and firewood are used as fuel for cooking and lighting. This may be of detriment to communities and local businesses dependent on these sources. In addition, competition for use of these resources may also lead to an increase in the price of the affected resources, which may further affect the local communities' access.

The potential negative impact of reduced access to resources by local communities (local extent) for the duration of the East Hub project (>10 years) is expected to be of low magnitude, but would affect a great number of individuals in the Soyo communities. The impact is therefore assessed to be of medium significance (Table 8-7).

**Table 8-7: Significance of reduced access to resources for local communities.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| >10 years 4 | Local 1 | Low 1 | Great 3 | 9 | Possible | LOW - | Medium |

## 8.2.6 Impact S6: Increased government revenue

Oil production from the proposed East Hub development will contribute to Angola's economy through taxes, royalties and other fees that ENI would have to pay to the government of Angola, the procurement of local goods and services, employment and income generation, government's share of revenue received, etc. This would contribute to Angola's oil revenue, increase Gross Domestic Product (GDP) and generally benefit the economy at a national scale. The high growth rate in Angola's economy in recent years was largely due to high international prices for its oil: oil production and associated activities contribute approximately 85% to Angola's GDP.

The value of the taxes and other fees that ENI would have to pay is not known, and it is also not known how much of the estimated CAPEX of US$ 4.493 million, average annual OPEX of US$ 296 million and decommissioning and abandonment cost of US$ 302 million will be spent in Angola and/or on Angolan goods and services. However, oil production from the East Hub project is expected to commence in early 2016, reaching a peak of approximately 86 000 bbl per day (bbl/d) by late 2016. The East Hub development will therefore contribute approximately 5.4% to Angola's total production in 2016, which is forecast at approximately 1 600 000 bbl/day. After 2016, production in the East Hub field will continue at a decreasing rate until at least 2030, by when the production rate would have dropped to approximately 15 000 bbl/day. The East Hub reservoirs are estimated to contain total recoverable reserves of approximately 225.5 mllion bbl.

While the East Hub development would therefore not contribute a very large part of the upstream oil industry's contribution to Angola's economy, it will nevertheless make a valuable contribution.

The use of revenue received as a result of projects such as the proposed East Hub development is the responsibility of the government and how the government would use the revenue generated from the East Hub project is outside the control of the project. However, the increased availability of finance could facilitate the government's investment in the country's socio-economic development, including the development of much-needed infrastructure and provision of social, education and health services, which would be of great benefit to the affected communities. This would have a permanent (>10 years) impact on the economy of Angola (national extent) of low magnitude, affected a small number of elements (proportion of Angola's population).

The **positive** impact of a contribution to Angola's economy as a result of the East Hub development is therefore assessed to be of **medium significance** (Table 8-8).

**Table 8-8: Significance of the development's contribution to the Angolan economy.**

| Consequence | | | | | Probability | Significance | Confidence |
|---|---|---|---|---|---|---|---|
| Duration | Extent | Magnitude | No. of elements | Score | | | |
| >10 years<br>4 | National<br>3 | Low<br>1 | Small<br>2 | 10 | Definite | MEDIUM + | Medium |

# 9 Environmental Management, Monitoring and Auditing

This chapter presents the environmental management, monitoring and auditing measures that will be implemented during all phases of the planned East Hub development project. Eni Angola has designed these measures in line with its Health, Safety and Environment (HSE) policy and in accordance with ISO 14001 Environmental Management System specifications. Compliance with the legal standards on safety and environment is regarded as the minimum requirement, and must be satisfied during all phases of the project. An objective of the engineering design will be to apply the "As Low As Reasonably Practical" (ALARP) principle (see Figure 9-1) in order to minimise the risk of adverse effects on the environment.

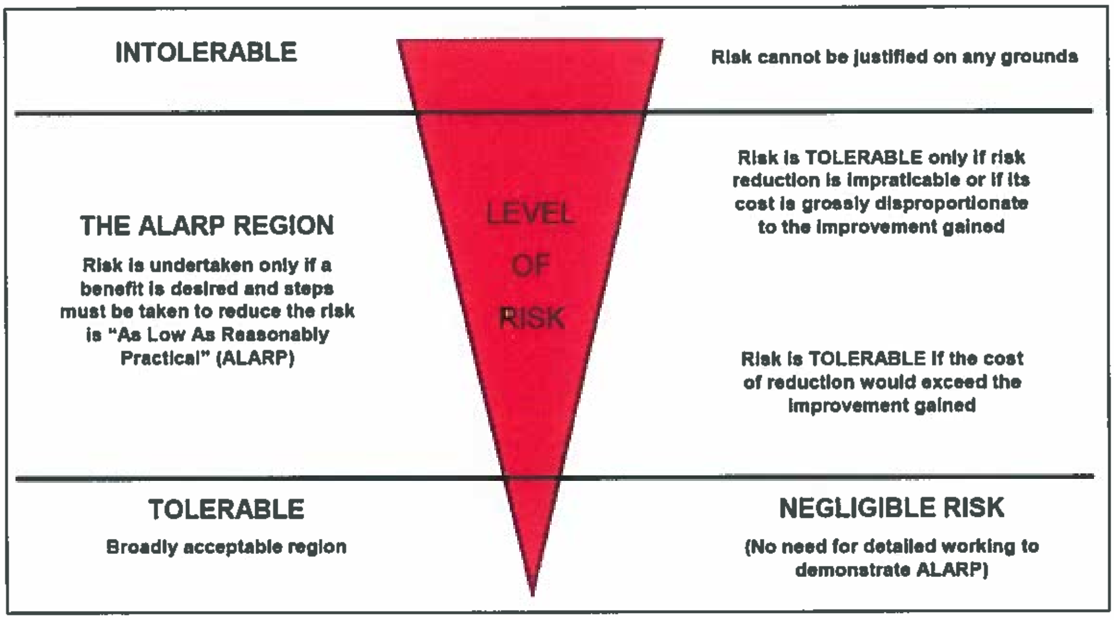



**Figure 9-1: Risk and the ALARP principle.**

## 9.1 Eni's Health, Safety and Environment (HSE) Policy

Environmental performance will be managed, monitored and improved through the implementation of the environmental management procedures and plan described in this chapter, as well as the associated operational control procedures. Eni's environmental policy is personally endorsed by the Managing Director and is well documented and circulated within the system. It requires all contractors to manage HSE in line with this policy.

In line with the Eni HSE Policy commitment to 'Protect the environment', Eni and all contractors shall ensure that:

- Impact on watercourses, the aquatic environment, terrestrial habitats and all species therein are minimised;
- Emissions to the atmosphere are minimised;
- Environmental legislation applicable to all activities are complied with and contractual obligations are met;

- Performance is monitored and procedures are reviewed to ensure continual improvement; and
- Company-wide awareness of environmental issues is raised.

## 9.2 Environmental Management Objectives

Environmental management objectives for the East Hub project are to:

- Ensure that all mitigation measures prescribed in the ESHIA document for avoiding and minimising negative impacts, and enhancing any benefits, are fully implemented; and
- Inform the overall planning, monitoring, auditing and review of environmental and socio-economic performance throughout the project activities.

These objectives shall be achieved by:

- Ensuring compliance with all relevant international and local (Angolan) regulations, as well as Eni's HSE policies;
- Integrating environmental and socio-economic issues fully into the project development and operational philosophies;
- Promoting awareness on the management of the biophysical and socio-economic environment among workers;
- Ensuring that only environmentally and socially sound procedures are employed during the project implementation; and
- Continuous consultations with the relevant regulatory bodies, community leaders, youth leaders, community based organisations (CBOs), and other stakeholders throughout the project lifecycle.

## 9.3 Framework for Environmental Management

Environmental management will be implemented within an established framework that is strongly based on a repeated process of continuous improvement and comprises of eleven key elements, each with underlying principles and set expectations:

1. *Management Leadership, Commitment, and Accountability*: Ensures that all workers understand the goals and management commitment to excellence in HSE and operational integrity;
2. *Risk Assessment and Management*: Ensures that risks involved in operations are recognised so that they can be appropriately addressed through facility design and/or operating practices;
3. *Facilities Design and Construction:* Ensures elements for the protection of people and the environment are incorporated into the design of facilities and the plans for installation and operation;
4. *Process and Facilities Information/Documentation:* Ensures that the systems designed to protect people and the environments are appropriately documented;
5. *Personnel and Training*: Ensures that personnel understand the systems that are in place and are appropriately trained to perform required roles with respect to their functions;
6. *Operations and Maintenance*: Ensures that facilities are maintained and operated in ways that ensure the protection of people and the environment;
7. *Management of Change*: Ensures that new personnel are informed of existing systems, that all affected personnel are informed of changes in the systems, and that safety and environmental aspects are considered when making changes;

8. *Third Party Services*: Through contract, oversight and other mechanisms, third party contractors are held to the same standards as Eni Angola;
9. *Incident Investigation and Analysis*: Seeks to understand the causes of any incidents so that effective controls or systems can be implemented to prevent recurrence;
10. *Community Awareness and Emergency Preparedness*: Ensures appropriate outreach and awareness programmes are implemented to establish effective emergency procedures and to allay concerns (but not highly applicable in offshore projects far removed from communities); and
11. *Operations Integrity Assessment and Improvement:* Ensures that safety and environmental performance is monitored against targets to ensure Eni Angola is meeting its goals to protect people and the environment, and seeks the means to improve the systems and processes, particularly when goals are not being met.

## 9.4 Environmental Management Procedures, Plans and Guidelines

A number of environmental management procedures, plans and guidelines covering various project phases, activities/aspects and impacts will be implemented during the East Hub development. The main procedures and plans as discussed in this section comprise the following components:

- Roles and responsibilities;
- Environmental awareness training;
- Communications;
- Environmental control, monitoring and auditing;
- Waste management;
- Wastewater management;
- Oil spill contingency;
- Safety philosophy; and
- Guidelines for decommissioning and abandonment.

Each of these components are discussed in more detail below.

### 9.4.1 Roles and Responsibilities

Environmental management will be achieved through the management structure illustrated in Figure 9-2 below. Key roleplayers with regard to environmental management are indicated in green and their specific responsibilities are summarised below.

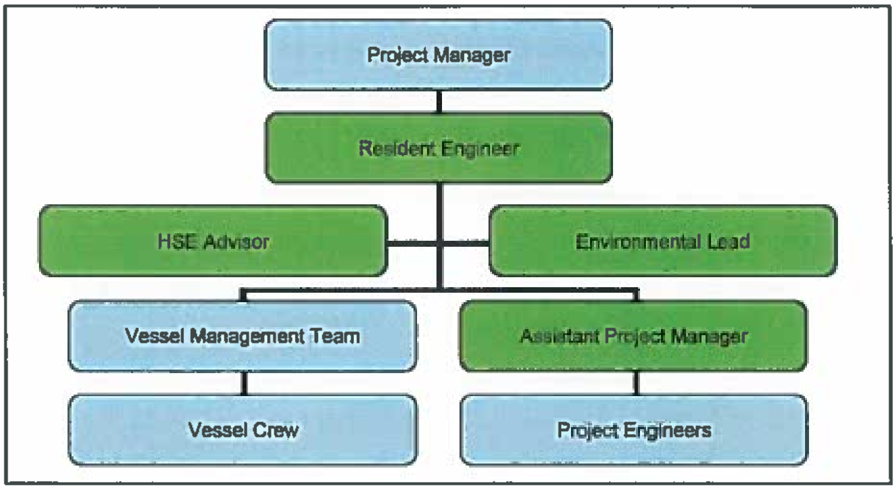



**Figure 9-2: East Hub management structure organisation chart.**

#### 9.4.1.1 Resident Engineer

The Resident Engineer will be responsible for HSE management during all phases of the project and will:

- Provide visible leadership, systems and resources for environmental management;
- Initiate actions required to maintain compliance with requirements; and
- Specify and participation in project audits/reviews, as required.

#### 9.4.1.2 HSE Advisor

Eni's HSE Advisor will be pro-active in promoting HSE management during East Hub project and will be required to:

- Follow-up/monitor requirements with relevant parties;
- Provide specialist HSE advice;
- Facilitate project risk assessment, as required;
- Lead/participate in audits, as required;
- Maintain the HSE Activities Matrix and monitor the close-out of the project's Environmental Review; and
- Develop project-specific HSE documentation.

#### 9.4.1.3 Environmental Lead

The East Hub project Environmental Lead will:

- Provide specialist environmental advice;
- Jointly monitor project environmental aspects with the project team;
- Review relevant project documentation;
- Facilitate project environmental review;
- Lead / participate in audits and inspections, as required; and
- Review project environmental documentation.

#### 9.4.1.4 Assistant Project Manager(s)

The Assistant Project Manager(s) will be required to:

- Review procedures for environmental aspects;
- Follow up actions from project risk assessments and environmental reviews;
- Be the focal point(s) for environmental matters with subcontractors, as required; and
- Participate in project audits/review, as required.

### 9.4.2 Environmental Awareness Training

All Contractor employees and subcontractors involved in the project will be given a comprehensive induction before they start work. This environmental training will take place in conjunction with safety awareness training. The environmental aspects will include:

- An overview of the environmental management procedures, plans and guidelines as well as environmental management goals and objectives.
- Awareness in relation to the risk, consequences and methods of avoiding noise pollution, oil/diesel spills, disturbance of wildlife and disturbance of fishing activities;
- Awareness of individual environmental responsibilities and environmental constraints to specific jobs.
- Location and sensitivity of the proposed East Hub development area.

All personnel will be required to attend environmental training and will sign a register which will be kept on the project files.

Toolbox talks, based on the specific activities being carried out, will be given to personnel by the nominated project representative. These will be based on the specific activities being carried out. These talks will take place either on the appropriate offshore vessel or on-site and will include environmental issues particular to the proposed East Hub project, namely:

- Oil/diesel spill prevention, including safe refuelling practices;
- Emergency response procedures used to deal with an oil/diesel spill; and
- Minimising disturbance to wildlife such as cetaceans.

### 9.4.3 Communications

Environmental issues will be communicated to the workforce on a regular basis. Daily project meetings, which follow a set agenda incorporating HSE issues will be held on board the project vessels and a daily report will be generated and distributed. All staff and sub-contractors involved in all phases of the project will be encouraged to report environmental issues.

All external communications with local interest groups, external agencies and also responses to any complaints received will be managed by Eni. Contractors shall notify the onsite Eni representative if any communications are received from external stakeholders.

The EPC Contractor(s) will report environmental issues to Eni on a regular basis. These reports will summarise the key environmental issues arising in each reporting period and identify any non-conformances, as well as any corrective actions taken.

Initiatives and project information developed as the project progresses will be communicated to all employees as required. Typically, this will include campaigns to raise environmental awareness, circulars to inform staff of key environmental issues, such as lessons learnt from incidents or accidents, and the impact of any new legislation.

### 9.4.4 Environmental Control, Monitoring and Auditing

#### 9.4.4.1 Environmental control procedures

Operational control is required to ensure the management of all project operations and associated activities with significant environmental aspects, policies, objectives and/or targets.

The required level of control is achieved through the implementation of approved project procedures, which document the methodology for executing the works. As part of the development and approval of project procedures, the methodology is subject to peer review and risk assessment processes that consider environmental impacts and the required mitigation measures. The internal audit process will check that these procedures are being implemented correctly and that they are effective. Although project procedures, execution plans and method statements represent the most significant control mechanism, controls also include communication of company requirements, particularly to contractors and suppliers, the provision of HSE training, and carrying out effective checking and monitoring.

Project procedures will be reviewed and amended as necessary. The amended procedure will be reviewed to ensure that any new regulation or training requirements are identified and acted upon.

All activities are required to demonstrate that the project team have considered the requirements of Eni's HSE Policy in the design, construction and installation of the project. The key environmental goal for the East Hub development is that **"Discharges and emissions associated with the development and subsequent production of hydrocarbons from the proposed East Hub development shall be minimised as far as reasonably practicable, and the disturbance to the environment shall be kept to a minimum"**.

For the project, this environment goal means minimising the impact on benthic communities, marine fauna (fish, mammals), sensitive users (fisheries, etc.), seawater quality, air quality, etc. The stated goal shall be achieved primarily through minimising pollution ('reduction at source'), by the effective control of all operations and the monitoring of the potential sources of impact to ensure that the legislative and regulatory limits are maintained and also to track the progress towards the environmental targets.

#### 9.4.4.2 Monitoring and reporting

Environmental monitoring is essentially a process aimed at detecting negative impacts of a project on the environment early enough to take preventative and/or remedial actions. Eni representatives on board each project vessel will be responsible for routine day-to-day monitoring of environmental compliance and shall submit the environmental data for all HSE and community relations aspects.

The environmental concerns identified will be controlled through adherence to the Environmental Operational Control Procedures, method statements and recommendations. The project will be monitored by inspections of work activities and internal auditing. The HSE Advisor shall work with Eni to assess the need for further monitoring.

Table 9-1 shows the parameters to be monitored and the relevant performance indicators.

**Table 9-1: Impact monitoring indicators.**

| Parameter | Unit of measure | Performance Indicator |
|---|---|---|
| Electricity generation | kWh | Total kWh |
| Diesel consumption | Kg | Kg diesel / kWh |
| $CO_2$ emission | Kg | Kg $CO_2$ / kWh |
| $CH_4$ emission | Kg | Kg $CO_2$eq. / kWh (Global Warming Potential) |

| Parameter | Unit of measure | Performance Indicator |
|---|---|---|
| $SO_x$ emission | Kg | Kg $SO_x$ / kWh |
| $NO_x$ emission | Kg | Kg $NO_x$ / kWh<br>Kg $SO_x$eq. (Acidification Potential) |
| Waste generation | Kg | Total kg |
| Water consumption | Litre | Total litres |

#### 9.4.4.3 Environmental audit

Eni Angola shall conduct periodic HSE audits (monthly / quarterly / annually, etc.) of the activities in the East Hub development area in order to ascertain the extent of compliance with policy and regulatory requirements. The audits shall be carried out by certified auditors and in accordance with ISO 14001 guidelines. The scope of the audits must include the following, as a minimum:

- Audit compliance with all necessary codes, standards and procedures;
- Examine line management systems, plant operations, monitoring practices, etc.;
- Identify current and potential environmental problems especially during the operational phase of the project;
- Check the predictions in the ESHIA and assure implementation and application of recommended practices and procedures;
- Make recommendations for the improvement of the management system of the operation; and
- Produce an Environmental Audit Report, which shall be submitted to Eni Angola and the operating contractor.

The audit and inspection frequencies will be established by Eni Angola, and may be increased or decreased according to the findings and degree of confidence arising from the on-going audit program.

All audit findings will be reviewed by the HSE and Community Relations teams and, where corrective actions are deemed necessary, specific plans (with designated responsibilities and timing) will be developed with the aim of achieving continuous improvement in performance. In addition to assessing operational aspects and monitoring, audits will also assess the effectiveness of the environmental management measures and its implementation. These measures will therefore be subject to ongoing review and development to ensure that it remains appropriate for all aspects of the project.

### 9.4.5 Waste Management

#### 9.4.5.1 Waste management strategy

All domestic waste discharges will comply with the requirements of MARPOL 73/78. Solid and chemical waste will be treated on board and recycling will take place wherever practicable. Incineration of combustible, non-hazardous waste will take place wherever an approved onboard incinerator is available. Bilge water will be treated to MARPOL standards prior to discharge on all vessels. All waste discharges will be monitored and recorded as per vessel procedures. Compliance will be monitored throughout the duration of the project through the project monitoring process.

#### 9.4.5.2 Eni's waste management policy

With regard to waste management, Eni's policy is to:

- Adopt effective and responsible measures to minimise the generation of solid and liquid waste as well as reduce emissions into the air;

- Track and maintain records of the full life-cycle of waste streams and provide an auditable trail as to its management and disposal; and
- Manage and dispose all waste in line with relevant regulatory requirements and in an environmentally responsible manner.

#### 9.4.5.3 Solid wastes

No solid waste, other than food waste will be disposed of into the sea. Food waste will only be disposed into the sea at least 12 nautical miles from the nearest land, after passing through a dedicated grinder and in accordance with MARPOL 73/78 standards. Any other solid waste that cannot be incinerated on board shall be brought to shore for disposal and a record will be kept on the type and quantities of waste brought to the shore for disposal.

#### 9.4.5.4 Waste identification

Eni's existing Marine Wastes Management Plan summarises the primary types of waste streams generated during vessel operations. Descriptions for typical waste streams, main sources and possible environmentally significant constituents are also given.

The physical, chemical and toxicological properties of hazardous wastes shall be identified via Material Safety Data Sheets, manufacturer information, process knowledge and historical information or lab analysis. Wastes will be grouped according to their health and environmental hazards.

#### 9.4.5.5 Waste minimisation

To minimise the quantity of waste to be disposed of onshore, vessels will be equipped with a food grinder and/or waste compactor, where possible. On a monthly basis, project vessels will report the amounts of hazardous and non-hazardous waste generated by the vessels, as per the vessel operator's environmental management system. This data will be used to establish baseline data and targets for improvement.

#### 9.4.5.6 Onshore waste management and disposal options

A local contractor / agent will arrange onshore transport and disposal of waste generated on the project vessels. Any waste that cannot be processed on the vessels will be transported to shore for transport by a permitted waste handler to a permitted/licensed facility, which may be a landfill site or a transfer station. Scrap metals and chemical wastes will be transported to port for reprocessing through approved recycling facilities.

### 9.4.6 Wastewater Management

#### 9.4.6.1 Ballast Water Discharge

Ballast tanks will be separated from any hydrocarbon storage areas on board the vessels and no potentially contaminated drain systems will be routed to the ballast tanks. De-ballasting shall be undertaken offshore in accordance with IMO guidelines, and away from sensitive environmental areas to prevent introducing marine organisms from outside the project location.

#### 9.4.6.2 Bilge Water Discharge

All construction vessels will be equipped with oil-water separation systems in accordance with MARPOL requirements.

#### 9.4.6.3 Deck Run-Off Water

Any spills on deck will be contained and controlled using absorbing materials. This will be collected in dedicated drums to avoid contamination of deck run-off water.

#### 9.4.6.4 Sewage Discharge

Construction vessels will be equipped with a sewage treatment system. If a vessel does not have a sewage treatment system it will have a suitable holding tank, wastewater will then be brought back to shore for treatment by a licensed contractor.

### 9.4.7 Oil Spill Contingency

Some of Eni's most important objectives include: enhancing safety, reducing health risks and protecting the environment. In light of this, Eni has developed a structured and comprehensive oil spill contingency plan to cover activities in the East Hub project area. The Oil Spill Contingency Plan outlines coordinated and integrated response actions to be implemented in the event of an oil spill. It highlights the roles and responsibilities of key personnel in Eni operations and lists equipment and materials available to combat oil spills. The plan is designed to cover the control and removal of any oil spill occurring at any of the facilities operated by Eni. It is a generic plan to be used in conjunction with a separately designed specific operational annex applicable to the particular project area. The main components of the contingency plan include spill categorisation, offshore response action plans, reporting and notification guidelines.

#### 9.4.7.1 Pollution Emergency Procedures

Procedures for pollution prevention and emergency response are laid down in each vessel's Shipboard Oil Pollution and Emergency Plan (SOPEP). Details on project-specific (oil) pollution combat equipment will be available onboard, along with the locations of equipment, availability and contact details for support personnel / services. Each individual vessel SOPEP will liaise with Eni's Oil Spill Contingency Plan, which contains detailed procedures to be followed in the event of a pollution emergency.

### 9.4.8 Safety Philosophy

The project shall incorporate an Integrated Control and Safety System (ICSS) that shall provide an integrated monitoring, control, protection and safety system for the entire production, topsides, marine and subsea facilities. The safety systems shall be separate from the Process Control System. The ICSS shall include detailed systems and procedures with regard to:

- Fire and gas detection;
- Lifeboats and life rafts;
- Safety shutdown systems;
- Active fire protection;
- Accommodation areas;
- Hull equipment spaces;
- Deluge and water mist systems;
- Escape routes and means of evacuation, including equipment room evacuation, deck escape routes and muster areas;
- Life saving and helicopter crash equipment;
- Fast rescue boats;
- Vessel security;

- Gangway access; and
- Riser support and protection security.

### 9.4.9 Decommissioning and Abandonment Guidelines

Eni Angola shall ensure that all assets (including wells, production facilities, flowlines/risers, pipelines, etc.) that have reached the end of their useful life span are decommissioned and either dismantled and removed or abandoned, in accordance with statutory requirements and standards.

Eni shall develop a sound and acceptable plan, which will describe how all assets are to be decommissioned and their planned state after abandonment. The plan will consider all technically feasible options for decommissioning and abandonment, including alternative uses for the assets, in accordance with Eni policy and government regulations. Well suspension or abandonment operations will be carried out in accordance with the regulatory guidelines and industry best practice. Once drilling activity has been completed, the well will either be producing or suspended and may be later abandoned, depending on production. During abandonment, an abandonment programme will ensure the isolation of the various zones from each other and from the surface, in accordance with the regulatory guidelines. Casing and wellhead equipment will be recovered from the well and the well will be capped at least 3 m below the seabed.

In the event that a well is suspended for future entry for any purpose, downhole formations will be isolated from each other and from the surface using cement and mechanical plugs as required. Once the BOP and riser assembly has been removed, a corrosion cap will be installed on the subsea wellhead.

A recorded site survey will be carried out using the ROV to record any debris and dropped objects wihtin a 100 m radius around the well positions.

Eni shall prepare a final report on condition of all assets abandoned prior to relinquishment. The Abandonment Report will include as a minimum:

- Operating and technical data (data on the asset throughout its operating life, e.g. location, maintenance and repairs, etc.);
- Financial data on the abandoned asset; and
- Final abandoned condition.

# 10 Conclusions

This document reports on the findings of the ESHIA undertaken for the proposed East Hub development and associated activities in Block 15/06 off the coast of northern Angola, in fulfilment of Angolan legislative requirements. The ESHIA has examined the available project information and baseline data to identify and evaluate the potential impacts of the proposed development on the marine environment, as well as on the Angolan socio-economic environment, with a particular focus on the Commune of Soyo.

This report aims to inform decision-makers, notably MinAmb and MinPet, of the key decision-making considerations by providing an objective and comprehensive analysis of the potential impacts and benefits of the project, and has created a platform for the formulation of mitigation measures to manage these impacts.

This chapter summarises the evaluation of potential impacts associated with the proposed East Hub development, followed by a discussion of the key factors MinAmb (and MinPet) will consider to decide whether and with what conditions to issue an Environmental License for the project.

## 10.1 Key Findings

The environmental risks and potential impacts of offshore oilfield developments are generally well documented and the industry has developed a range of management and control measures that aim to minimise and, in some cases, avoid these risks. These mitigation measures have been adopted as standard Health, Safety and Environment (HSE) practice by most offshore operators, and many will be implemented by Eni during the planned development of the East Hub oil fields. The assessment of potential impacts assumes that Eni will adhere to these corporate HSE standards, and will comply with all relevant legislative (Angolan and international) requirements.

The significance of potential impacts of the proposed East Hub development during **normal, routine operations** is summarised in Table 10-1 below. Relevant observations with regard to the impact ratings, which are *based on the assumption that the relevant Angolan and international regulations and Eni's corporate standards are complied with* are:

- The potential *impact of the physical presence of vessels* involved in the East Hub development – in particular vessel movements, noise and lighting and the general increase in the number of vessels off northern Angola – on the marine environment, including marine fauna and other users of the sea, are assessed to be of *low significance*, largely due to the small number of elements (individuals and/or proportion of a population of given species) and other users that may be affected;
- The potential *impact of pollution at sea*, including impacts on water quality, toxicity effects on marine organisms and impacts on biodiversity, as a result of discharges to sea (drilling cuttings and muds, routine emissions and discharges, intermittent releases of small volumes of hydrocarbons from subsea equipment and the discharge of hydrotest and produced water) are assessed to be of *low significance*, largely due to the dispersive nature of the receiving marine environment and limited spatial extent of any impact;
- Potential *modifications to the benthic environment* (benthos and habitat) by the planned disposal of drilling cuttings and muds, which may smother benthic organisms, change benthic habitat (sediment size and distribution) and result in changes to benthic community structures, as well as the installation and presence of subsea infrastructure, which may change the character of the sea bed by adding hard substrate, could both change benthic community structures and composition and are assessed to be of *medium significance*;

- The majority of the potential *impact on the socio-economic environment and health* of Angolan communities, particularly the Commune of Soyo, include increased social conflicts due to an influx of employees and work seekers into the Soyo region, increased community health risks and reduced access to resources for local communities, and are assessed to be of *low significance*, as these communities are not considered particularly vulnerable to the effects of another large offshore oilfield development;
- The potential *impact of decommissioning on marine life* is assessed to be of *medium significance*, largely due to the long-term implications of the abandoned infrastructure for marine life;
- The *socio-economic impact of the potential disruption of fishing activities and offshore navigation* is assessed to be of *medium significance*, largely due to the importance of these activities to the coastal communities that rely on fishing as an important source of protein as well as income; and
- The *potential economic benefits* of the proposed East Hub development in the form of increased local (Angolan) employment and increased government revenue are assessed to be of *medium significance*.

**Table 10-1: Summary of significance of potential impacts of the planned East Hub development during normal operations.**

| Potential Impact | Significance* |
|---|---|
| **Potential impacts on marine environment** | |
| M1: Impact of increased number of vessels on navigation | Low –ve |
| M2: Blocking of access to fishing areas | Low –ve |
| M3: Impact of vessel and helicopter movements, noise and lighting on seabirds, fish and squid. | Low –ve |
| M4: Impact of vessel movements and noise on cetaceans. | Low –ve |
| M5: Impact of noise and lighting on turtles | Low –ve |
| M6: Modifications to benthos and benthic habitat by disposal of drilling cuttings and muds. | Medium –ve |
| M7: Toxicity effects on benthos from disposal of drilling cuttings and fluids. | Low –ve |
| M8: Impact of pollution at sea due to routine vessel operational discharges, emissions and solid waste disposal to sea. | Low –ve |
| M9: Impact of intermittent releases of hydrocarbons from subsea equipment. | Low –ve |
| M10: Impact of hydrotest water discharges on water quality and biodiversity. | Low –ve |
| M11: Impact of produced water discharges on water quality and biodiversity | Low –ve |
| M12: Impact of structures on the sea bed changing reef habitats | Medium –ve |
| M21: Impact of decommissioning on marine life | Medium –ve |
| **Potential socio-economic and health impacts (with a focus on Soyo)** | |
| S1: Increased local (Angolan) employment | Medium +ve |
| S2: Increased social conflicts due to an influx of employees and work seekers into Soyo region | Low –ve |
| S3: Disruption of fishing activities and offshore navigation | Medium –ve |
| S4: Increased community health risks | Low –ve |
| S5: Reduced access to resources for local communities | Low –ve |
| S6: Increased government revenue | Medium +ve |

* **Note** that negative impacts are indicated with –ve, while positive impacts are indicated with +ve.

In addition to the potential impacts of normal, routine operations, the potential impacts of accidental events resulting in a spill of a large volume of hydrocarbons (i.e. oil spill impacts) are also assessed in this report. Accidental events that could cause a spill of a significant volume of hydrocarbons include:

- A pipeline disconnect or other accident during refuelling at sea, resulting in a spill of a large volume of marine diesel at the sea surface; or
- A pipeline rupture, disconnect during tanker loading and/or a well blowout due to well failure, resulting in spill of a large volume of crude oil at the sea surface or the sea floor.

Oil spill modelling was undertaken to determine the fate and extent of an oil spill and the probability of surface and coastal oiling, based on which potential impacts were identified and assessed. The significance of the potential impacts **in the unlikely event of an oil spill** during the East Hub development project is summarised in Table 10-2 below. Relevant observations with regard to the impact ratings are:

- The *potential impact of a marine diesel spill* at the sea surface during the East Hub development would be of *low significance*, since diesel will persist only for a short period in the dynamic marine environment;
- The *potential impact of a large crude oil spill* at the sea surface or sea floor *on seabirds, cetaceans open coastal habitats, fishing activity and tourism and recreation* is also assessed to be of *low significance*. Reasons for this significance rating vary and include the sparse distribution and extensive natural ranges of seabirds, the mobility and ability of cetaceans to avoid crude oil spills, the natural resilience of open coastal habitat (sandy and rocky shores) to oiling and the relatively low number of individuals affected in the case of fishing activity and tourism/recreation;
- The *potential impact of a large crude oil spill on turtle populations* is assessed to be of *medium significance* due to the likely geographical extent of surface oiling and, consequently, the proportion of the turtle population likely to be affected, as well as vulnerability of turtles to oil spills (low mobility) and the conservation status of the species known to occur in the study area;
- The *potential impact of a large crude oil spill on estuaries and lagoons* is also assessed to be of *medium significance* due to the ecological importance of these systems, the sensitivity of mangroves and salt marshes and the long time that these systems would need to recover from the effects of oiling; and
- Similarly, the *potential impact of a large crude oil spill on coastal conservation areas* is assessed to be of *medium significance*. Oil spill modelling results indicate that several coastal conservation areas from Gabon to the DRC would be at risk of oil contamination. These areas contain sensitive coastal habitats (such as mangroves, etc.) and conservation efforts would be compromised by the effects of an oil spill.

It must again be noted that the occurrence of an oil spill during the planned East Hub development project is considered highly unlikely and various measures will be implemented to ensure that this likelihood is kept at a minimum, as well as to ensure that any spill, should one occur, is contained and the effects avoided and/or minimised. These measures include the implementation of various prevention and emergency response plans, including (but not limited to):

- MinPet-approved Oil Spill Emergency Response Plan;
- Shipboard Oil Pollution Emergency Plan; and
- Spill Prevention Plan.

**Table 10-2: Summary of significance of potential impacts in the unlikely event of an oil spill during the East Hub development project.**

| Potential Impact | | Significance |
|---|---|---|
| Potential impact of a marine diesel or crude oil spill on: | Seabird populations | Low –ve |
| | Fishing activity | Low –ve |
| | Tourism and recreation | Low –ve |
| Potential impact of a marine diesel spill on: | Turtle populations | Low –ve |
| | Cetaceans | Low –ve |
| | Open coastal habitats | Low –ve |
| | Estuaries and lagoons | Low –ve |
| | Conservation areas | Low –ve |
| Potential impact of a crude oil spill on: | Turtle populations | Medium –ve |
| | Cetaceans | Low –ve |
| | Open coastal habitats | Low –ve |
| | Estuaries and lagoons | Medium –ve |
| | Conservation areas | Medium –ve |

Most of the impacts described in the impact assessment have the potential to contribute to cumulative effects when assessed in combination with impacts from other existing or planned activities and operations off northern Angola and/or in Soyo. The East Hub development is located in a region with extensive historical and current oilfield activities, and the project is not expected to contribute significantly to the cumulative offshore impacts of the oil and gas industry in Angola. Irresponsible waste disposal on land will contribute to the cumulative and existing pollution problem experienced in Angola as a result of inadequate waste collection and management.

## 10.2 Recommendations

As noted above, a number of management and control measures have been developed to avoid and/or mitigate the potential impacts of offshore oilfield development activities. Many of these measures have been incorporated into local and international regulations (e.g. Angolan ED 224/12 and MARPOL 73/78), and Eni has adopted many of these measures as standard practice in their corporate procedures.

Compliance with the relevant regulatory requirements and with Eni's corporate standards and procedures in all aspects of the planned East Hub development project is therefore considered essential and the evaluation of the potential impacts of the project presented in this report is based on the assumption that compliance will be ensured.

Various additional mitigation measures are recommended in this report to manage any unforeseen environmental impacts and/or ensure that all negative impacts are avoided or minimised. These measures must be shown to have been considered by Eni and sound reasons provided if not implemented.

Recommended mitigation measures include:

- Divert vessels to avoid marine mammals or slow down to idling speed (if this can be done safely done), if any species of marine mammal, particularly whales, is sighted near the path of vessels, to afford mammals the opportunity to move out of the way of approaching vessels;

- Employ marine mammal observers on stationary or slow moving (e.g. pipe-lay) vessels, particularly during any drilling and construction works, to keep a watch for marine mammals and groups of turtles, and to record sightings to assist research and plan additional avoidance strategies, if necessary;
- Instruct helicopters to maintain a minimum height of 500 m over bird foraging areas, surfacing cetaceans or groups of turtles and prohibit them from circling or hovering over marine mammals (e.g. for casual viewing) unless essential for safety or emergency purposes;
- Minimise non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water;
- Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme;
- Prohibit all crew members from killing or causing injury to marine fauna;
- Undertake environmental awareness training of all crew members, which includes training on the conservation status of cetaceans and turtles; and
- Maximise employment of local (Angolan) nationals and the procurement of Angolan goods and services.

The following recommended mitigation measures are designed to assist in preventing a spill from occurring, and in minimising the extent of a spill should it occur.

- Ensure that the Oil Spill Emergency Response Plan includes requirements to use biodegradable dispersants only in consultation with MinPet, and t to deploy oil protection booms in sensitive coastal areas, focusing on preparedness in areas predicted to be in the path of a spill;
- Regularly test the BOP during drilling operations to ensure integrity of the valve systems;
- Refuel only in calm weather and sea conditions and limit refuelling at sea to daylight hours;
- Use reinforced hosing for fuel transfers and use weak links and associated shut-off valves to reduce losses to sea should rupture occur;
- Use well-designed crude oil transfer pipes and links with associated cut-off valves to offload oil from the FPSO to tankers;
- Replace deteriorating pipelines before rupture could occur; and
- Consider, and consult with local authorities with regard to, payment of compensation to artisanal fishermen for the opportunity cost of missed catches and loss of income, and to tourism facilities and local communities (municipalities) for the costs of required clean-up.

## 10.3 Conclusion

This ESHIA has identified and assessed the potential impacts of the proposed East Hub development on the marine environment, as well as on the Angolan socio-economic environment, with a particular focus on the Commune of Soyo. The ESHIA has found that, with responsible management of activities, including compliance with the relevant international and Angolan regulations, as well as Eni's corporate standards and procedures, the planned East Hub development and associated activities pose minimal threat of serious or irreversible damage to the environment. While certain adverse environmental impacts are unavoidable, the significance of these is influenced by the nature of the receiving environment and location of the proposed development in the deep offshore environment.

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# Appendices

# Appendix A: Marine Environmental Survey Report

# Appendix B: List of Benthos Taxa

| Phylum | Class | Order | Sub-Order | Family | Genus | Species |
|---|---|---|---|---|---|---|
| GRANULORETICULOSA | | FORAMINIFERA | Textulariina | Textulariina i.s. | Schizammina | furcata |
| PORIFERA | DEMOSPONGIAE | ASTROPHORIDA | | Geodiidae | Geodia | sp |
| CNIDARIA | HYDROZOA | | | | indet | indet |
| | ANTHOZOA/Octocorallia | PENNATULACEA | Subsessiliflorae | Pennatulidae | Pennatula | rubra |
| | ANTHOZOA/Hexacorallia | ACTINIARIA | | Edwardsiidae | Edwardsia | sp |
| | | CERIANTHARIA | | Cerianthidae | indet ! | indet ! |
| ANNELIDA | POLYCHAETA | SPIONIDA | Spioniformia | Spionidae | Prionospio | dubia? |
| | | | | | Prionospio | spp. |
| | | | | | Pseudopolydora | socialis? |
| | | | | | Spiophanes | soedersbomi? |
| | | | | Heterospionidae | indet ! | indet ! |
| | | | | Poecilochaetidae | Poecilochaetus | serpens? |
| | | | Chaetopteriformia | Chaetopteridae | Spiochaetopterus | sp |
| | | | | | S. | costarum? |
| | | | | Magelonidae | Magelona | spp. |
| | | | Cirratuliformia | Cirratulidae | Aphelochaeta | spp. |
| | | | | | Chaetozone | sp |
| | | COSSURIDA | | Cossuridae | Cossura | coasta? |
| | | FAUVELIOPSIDAE | | Fauveliopsidae | indet ! | indet ! |
| | | | | | | |
| | | FLABELLIGERIDA | | Flabelligeridae | indet ! | indet ! |
| | | | | Amphinomidae | indet spp. | indet spp. |
| | | | | | Amphinome | rostrata |
| | | | | | Paramphinome | trionyx |
| | | CAPITELLIDA | | Capitellidae | Mediomastus | sp |
| | | | | | Notomastus | spp. |
| | | | | Maldanidae | Euclymene | spp. |
| | | | | | Maldane | sarsi |
| | | | | | Praxillella | sp |
| | | | | | Clymenura | sp |
| | | | | Dasybranchidae | Dasybranchus | sp |
| | | STERNASPIDA | | Sternaspidae | Sternaspis | acutata |
| | | TERREBELLIDA | | Ampharetidae | Ampharete | spp. |
| | | | | | Ampharete | acutifrons? |
| | | | | | Melinna | spp. |
| | | | | | Amphicteis | gunneri |
| | | | | | Anobothrus | sp |
| | | | | | Glyphanostomum | sp |

| Phylum | Class | Order | Sub-Order | Family | Genus | Species |
|---|---|---|---|---|---|---|
| | | | | Terebellidae | *Pista* | *spp* |
| | | | | | *Lanice* | *conchilega* |
| | | | | | *L.* | *norgensis?* |
| | | | | | *Eupolymnia* | *nebulosa* |
| | | | | Trichobranchidae | *Terebellides* | *stroemi* |
| | | | | Pectinariidae | *Pectinaria* | *sp.* |
| ANNELIDA (cont) | POLYCHAETA (cont) | SABELLIDA | | Sabellidae | *indet spp.* | *indet spp* |
| | | | | | *Sabellides* | *octocirrata* |
| | | | | Serpulidae | *indet !* | *indet !* |
| | | | | | *Dentalium* | *sp.* |
| | | PHYLLODOCIDA | | Acoetidae | *Panthalis* | *oerstedi* |
| | | | | Nephtyidae | *Nephtys* | *spp* |
| | | | | Sigalionidae | *Labioleanira* | *yhleni* |
| | | | | Polynoidae | *Harmothoe* | *antilopes* |
| | | | | | *Eunoe* | *nodosa* |
| | | | | | *Lepidasthenia* | *brunnea* |
| | | | | | *Malmgreniella* | *lunulata* |
| | | | | Hesionidae | *Leocrates* | *sp.* |
| | | | | | *Oxydromus* | *sp.* |
| | | | Nereidiformia | Pilargidae | *indet !* | *indet !* |
| | | | | | *Ancistrosyllis* | *sp.* |
| | | | | Nereididae | *Ceratocephale* | *sp.* |
| | | | Glyceriformia | Glyceridae | *Glycera* | *alba* |
| | | | | Goniadidae | *Goniada* | *sp.* |
| | | | | Paralacydoniidae | *Paralacydonia* | *paradoxa* |
| | | EUNICIDA | | Onuphidae | *Diopatra* | *cuprea?* |
| | | | | | *Paradiopatra* | *sp.* |
| | | | | | *P.* | *quadricuspis* |
| | | | | | *Hyalinoecia* | *tubicola* |
| | | | | Lumbrineridae | *indet !* | *indet !* |
| | | | | | *Drilonereis* | *sp.* |
| | | | | | *Marphysa* | *spp* |
| | | | | Eunicidae | *Eunice* | *sp.* |
| | | ORBINIIDA | | Orbiniidae | *Scoloplos* | *armiger* |
| | | | | | *Phylo* | *sp.* |
| | | | | Paraonidae | | *spp* |
| | | | | | *Aricidea* | *spp* |
| | | | | | *Aricidea* | *longobranchiata?* |
| | | | | | | |
| | | OWENIIDA | | Oweniidae | *indet !* | *indet !* |
| | OLIGOCHAETA | | | | | |
| | | | | | | |
| ECHIURA | ECHIUROIDEA | ECHIUROIDEA | | Echiuridae | *Echiurus* | *sp.* |

| Phylum | Class | Order | Sub-Order | Family | Genus | Species |
|---|---|---|---|---|---|---|
| Arthropoda/CRUSTACEA | MALACOSTRATA | DECAPODA | Pleocyemata | Polychelidae | *Stereomastis* | *sculpta* |
| | | | | | *Polycheles* | *typhlops* |
| | | | | Upogebiidae | *Upogebia* | *sp.* |
| | | | Pleocyemata/Anomura | Paguridae | *indet spp.* | *indet spp.* |
| | | | Pleocyemata/Caridea | | *indet* | *indet* |
| | | | | Crangonidae | *indet I* | *indet I* |
| | | | | Thalassinidae | *Calocaris* | *sp.* |
| | | | | | *indet* | *indet* |
| | | | | Pandalidae | *indet I* | *indet I* |
| | | | Pleocyemata/Brachyura | | *indet I* | *indet I* |
| | | | | Pinnotheridae | *indet I* | *indet I* |
| | | | | Leucosiidae | *indet I* | *indet I* |
| | | AMPHIPODA | Gammaridea | Ampeliscidae | *Ampelisca* | *sp.* |
| | | | | Leucothoidae | *indet I* | *indet I* |
| | | | | Lysianassidae | *indet I* | *indet I* |
| | | TANAIDACEA | | Apseudidae | *indet spp* | *indet spp.* |
| | | ISOPODA | | Bopyridae | *indet spp* | *indet spp.* |
| | | | | Cirolanidae | *Natatolana* | *sp.* |
| | | STOMATOPODA | | | *indet I* | *indet I* |
| | MAXILLOPODA | POECILOSTOMATOIDEA | | Philichthyidae | *Sphaerosoma* | *hystrix* |
| MOLLUSCA | BIVALVIA | ANOMALODESMATA | | Cuspidariidae | *Cuspidaria* | *cuspidata* |
| | | | | | | |
| | | NUCULANOIDA | | Yoldiidae | *Yoldiella* | *lucida* |
| | | | | | *Y.* | *philippiana* |
| | | | | | *Y.* | *sp.* |
| | | | | | | |
| | | EU-HETERODONTA s.l. | | Thyasiridae | *indet I* | *indet I* |
| | | | | | *Thyasira* | *sp.* |
| | | | | Kelliellidae | *indet I* | *indet I* |
| | | | | Montacutidae | *indet I* | *indet I* |
| | | | | | *Davonis* | *sp.* |
| | | | | Veneridae | *indet I* | *indet I* |
| | | | | Mactridae | *Spisula* | *sp.* |
| | | | | Semelidae | *Abra* | *sp.* |
| | | | | Lucinidae | *Lucinoma* | *sp.* |
| | | | | | *Myrtea* | *spinifera?* |
| | | | | Psammobiidae | *indet I* | *indet I* |
| | | NUCULOIDEA | | Nuculidae | *Nucula* | *sp.* |
| | | | | | *Nuculana* | *sp.* |
| | | | | | *Ledella* | *sp.* |

| Phylum | Class | Order | Sub-Order | Family | Genus | Species |
|---|---|---|---|---|---|---|
| MOLLUSCA (cont) | GASTEROPODA | NEOGASTEROPODA | | Turridae/Marcellinae | *indet* | *indet* |
| | | | | Nassariidae | *Nassarius* | *megalocallus* |
| | | | | | *Nassarius* | *elatus* |
| | | | | | *Bullia* | *sp.* |
| | | | | Muricidae | *indet* | *indet* |
| | | | | Marginellidae | *Marginella* | *spp.* |
| | | | | Conidae | *Mangelia* | *sp.* |
| | | LITTORINIMORPHA | | Naticidae | *indet* | *indet* |
| | | | | Tornidae | *Cochliolepis* | *sp.* |
| | | | | Lamellariidae | *indet* | *indet* |
| | | CEPHALASPIDEA | | Cylichnidae | *Cylichna* | *sp.* |
| | | | | Philinidae | *Philine* | *sp.* |
| | SCAPHOPODA | GADILIDA | | Pulsellidae | *indet* | *indet* |
| | | | | Gadilidae | *Cadulus* | *sp.* |
| ECHINODERMATA | STELLEROIDEA | OPHIURIDA | | Ophiactidae | *indet* | *indet* |
| | | | | Ophiuroidae | *Ophiothrix* | *tomentosa* |
| | | | | Amphiuridae | *indet* | *indet* |
| | | HOLOTHUROIDEA | | Stichopodidae | *Stichopus* | *regalis* |
| | | | | Dendrochirotida | *indet spp* | *indet spp.* |
| | ECHINOIDEA | CIDAROIDA | | Cidaridae | *Cidaris* | *cidaris* |
| | CRINOIDEA | MILLERICRINIDA | | Antedonidae | *Leptometra* | *celtica* |
| SIPUNCULA | SIPUNCULIDEA | GOLFINGIIDA | | Phascolionidae | *Onchnesoma* | *steenstrupi* |
| | PHASCOLOSOMATIDAE | ASPIDOSIPHONIDA | | Aspidosiphonidae | *Aspidosiphon* | *sp.* |
| NEMERTINA | | | | | *indet* | *indet* |
| HEMICHORDATA | ENTEROPNEUSTA | | | | *indet* | *indet* |

# Appendix C: Eni's approaches to impact mitigation

## Eni's Approach to Impact Mitigation[22]

"Finally, having assessed potential impacts, appropriate control and management measures should be defined and undertaken according to the significance rating of each impact.

The approaches to the mitigation measures include enhancement (for the positive impacts), prevention, reduction, avoidance and compensation (for the significant negative impacts). The mitigation measures for each (significant and adverse) impact of the proposed Project activities were generally identified, basing on the associated effect to the environment. The significance of the impact, probability or likelihood that the impact would occur and the severities of its consequence (as determined from the risk assessment matrix) were indices used for determining the mitigation requirements as illustrated in **Table 1** and **Figure 1**. Moreover subsequently, the specific mitigation measures satisfying the mitigation requirement were established putting into consideration available resources and competencies, on-site conditions, public concerns and technology.

**Table 1: Impact significance, control and management actions**

| Ranking | Impact level | Control and Management Actions | |
|---|---|---|---|
| 4 – 6 | Low | Actions in the short term | Ensure that policy and control measures are adequate to control the impact |
| | | Actions in the long terms | Verify that monitoring and reporting activities are properly established to guarantee the correct application of policy and ensure that control measures remain adequate |
| 7 – 9 | Medium | Actions in the short term | Check if current policy and control measures are adequate, and revise them according to set appropriate objectives for improvement |
| | | Actions in the long terms | Develop adequate plans and activities for control measures, ensuring that they are approved and implemented with timescales set and resources (budget and personnel) allocated. |
| 10 – 12 | High | Actions in the short term | Plans and activities are implemented to mitigate the impact as soon as possible. Interim reduction measures are established. |
| | | Actions in the long terms | Long-term plans and activities are developed. parameters and KPIs are set and properly measured, monitored, reported and verified. Targets are set for improvement and feedback used for corrective actions. |
| 13 – 16 | Critical | Actions in the short term | Immediate emergency measures to reduce impact. Align the current level of control and implemented measures to best available practices to address the issue. Parameters and KPIs are measures, monitored, reported and verified. Targets are set for improvement and feedback used for continuous improvement. |
| | | Actions in the long terms | The company demonstrates the delivery of continuously improved performance through Research and Development, technology and innovation, training of the personnel, strategic partnership and input and feedback from internal and external stakeholders. |

[22] As set out in ARC's Block 15/06 West Hub ESHIA report for ENI dated January 2013.

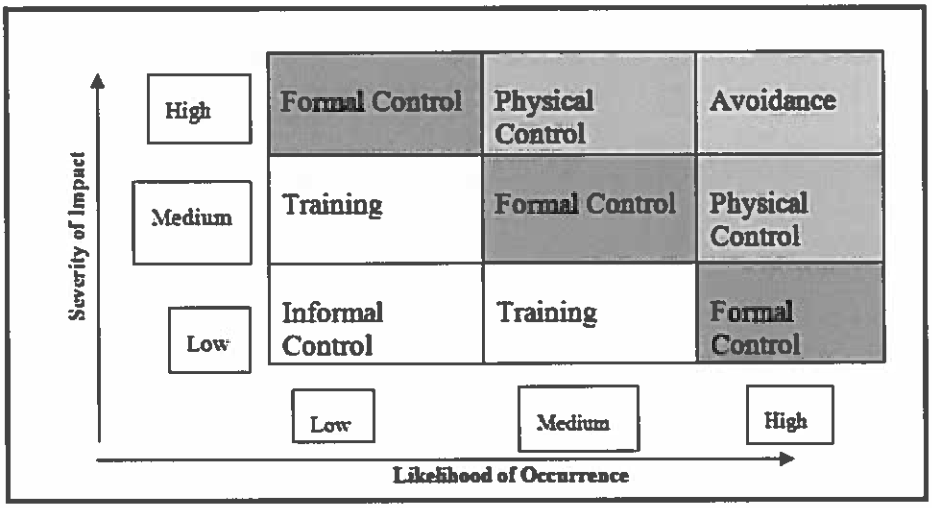


**Figure 1: Matrix for determination of mitigation measures:**

The definitions of the various approaches to impact mitigation considered are presented below:

- **Enhancement**: These are measures proffered to ensure that significant beneficial impacts of the existing facilities and proposed project are encouraged.
- **Prevention**: These are measures proffered to ensure that significant and adverse potential impacts and risks do not occur.
- **Reduction**: These are measures proffered to ensure that the effects or consequences of those significant associated and potential impacts that cannot be prevented are reduced to a level as low as reasonably practicable.
- **Formal control**: This involves the application of documented policy, process or procedure in mitigating the impacts of the project activities.
- **Informal Control**: This involves the application of sound judgment and best practice in mitigating the impacts of project activities.
- **Physical control**: This involves the application of physical processes or instruments (pegs, flags, sign post etc), not necessarily requiring any special technology, in order to mitigate the impacts of a project or impacts.
- **Avoidance**: This involves the modification of plans, designs or schedules in order to prevent the occurrence of an impact or impacts.
- **Training**: This involves personnel awareness in specific / specialized areas.

***Management Procedure for Mitigation Measures***

The management procedures employed for the establishment of mitigation measures for the identified impacts is presented in Figure 2. Mitigation measures were subsequently proffered for adverse significant potential impacts. These measures (prevention, reduction, control strategies) were developed for the adverse impacts through review of industry experience (past project experience), consultations and expert discussions with multi-disciplinary team of engineers and scientists.

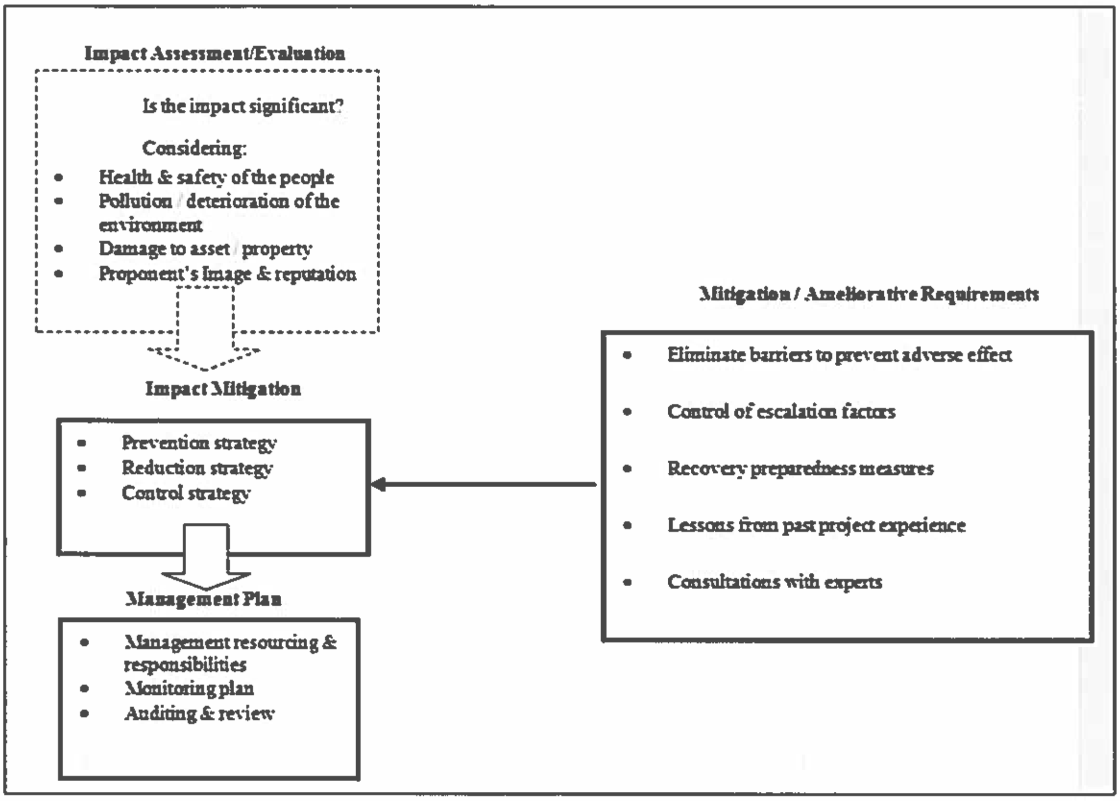


**Figure2: Management Procedure for Mitigation Measures**

# Appendix D: Oil Spill Modeling Report

# Appendix E: Social and Health Baseline Study Methodologies Report

# Appendix F: List of In-Depth Interview Participants

# Appendix G: Occupation and Organization of the Commune of Soyo