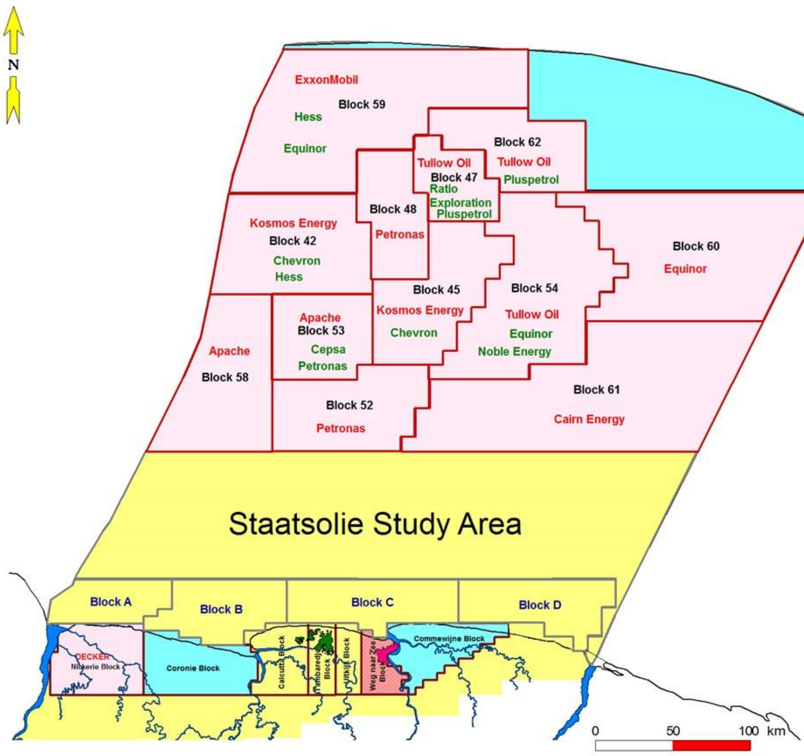
Limited Environmental and Social Impact Assessment (ESIA)

for

The Staatsolie Shallow Offshore 3D Seismic Acquisition Project



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Abbreviations

2D	Two Dimensional
3D	Three Dimensional
AEL	Apparent Effects Level
BAZ	Notice to Seafarers / Mariners (*Bericht aan Zeevarenden*)
BO	Board Supervisor *(Bestuursopzichter)*
BOG	Public Health Care Office (*Bureau Openbare Gezondheidszorg*)
BV	Inland navigation (*Binnenvaart*)
CCU	Corporate Communications Upstream
CEVIHAS	Center for Fishing Ports in Suriname (*Centrale voor Vissershavens in Suriname*)
CI	Conservation International
CISQG	Canadian Interim Sediment Quality Guidelines
CR	Critically Endangered
CSA	CSA Ocean Sciences Inc.
DC	District Commissioner *(Districtscommisaris)*
DD	Data Deficient
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EA	Environmental Assessment
EEZ	Exclusive Economic Zone (*Exclusieve Economische Zone*)
EMP	Environmental Management Plan
EN	Endangered
EOM	Extractable Organic Matter
ESIA	Environmental and Social Impact Assessment
ESL	Environmental Sciences Limited
ESMP	Environmental and Social Management Plan
EU	European Union
FAO	Food and Agricultural Organization
FLO	Fisheries Liaison Officer
FSA	Federation of Surinamese Farmers (*Federatie Surinaamse Agrariërs*)
GHFS	Green Heritage Fund Suriname
GoS	Government of Suriname
HSEQ	Health, Safety, Environment, and Quality
IFC	International Finance Corporation
ILACO	ILACO Suriname NV
IOC	International Oil Company
IUCN	International Union for Conservation of Nature
ITCZ	Inter-Tropical Convergence Zone
LBB	National Forestry Service *('s Lands Bosbeheer)*
LC	Least Concern

LVV	Agriculture, Animal Husbandry, and Fisheries (*Landbouw, Veeteelt en Visserij*)
MAS	Maritime Authority Suriname (*Maritieme Autoriteit Suriname*)
MUMAs	Multiple Use Management Areas
NCD	Nature Conservation Division (*Natuurbeheer-NB*)
NGO	Non-Governmental Organization
NIMOS	National Institute for Environment and Development in Suriname *(Nationaal Instituut voor Milieu en Ontwikkeling in Suriname)*
NR	Nature Reserves
NT	Near Threatened
OBC	Ocean Bottom Cable
OBN	Ocean Bottom Nodes
OBO	Under Board Supervisor *(Onder Bestuursopzichter)*
OWTC	Public Works, Transport and Communications *(Openbare Werken, Transport en Communicatie)*
PSC	Production Sharing Contracts
PTS	Permanent Threshold Shift
Q2	Second quarter
Q3	Third quarter
ROGB	Ministry of Special Planning, Land and Forest Management
SAIL	Suriname American Industries Limited
SIA	Social Impact Assessment
SK	Suriname Coast (*Suriname Kust*)
SKB	Suriname Coast Bangamary (*Suriname Kust* Bangamary)
SNMA	Suriname National Maritime Association
SRDP	Suriname River Dredging Project
SRK	SRK Consulting (South Africa) (Pty) Ltd
SSA	Suriname Seafood Association
STINASU	Foundation for Nature Conservation in Suriname
SUNFO	Suriname National Fisherfolk Organization
TOC	Total Organic Carbon
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
TRH	Total Resolved Hydrocarbons
TSS	Total Suspended Solids
UCM	Unresolved Complex Mixture
UNCLOS	United Nations Convention on the Law of the Sea
VOC	Volatile Organic Compounds
VSH	*Verenigde Surinaamse Holdingmij*
VU	Vulnerable
WB	World Bank
WHSRN	Western Hemisphere Shorebirds Reserve Network
WWF	World Wildlife Fund

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Glossary of Terms

Term	Definition
Community	Usually defined as a group of individuals broader than the household, who identify themselves as a common unit due to recognised social, religious, economic or traditional government ties, often through a shared locality
District	an administrative unit, comparable with a province. Each district has its own district government with limited powers of decision-making, headed by a District Commissioner (DC)
Exclusion zone	An established zone (during seismic activities) within which all local vessels are forbidden to enter for a certain time
Livelihood	The term ‘livelihood’ refers to the full range of means that individuals, families, and communities utilise to make a living, such as wage-based income, agriculture, fishing, and other natural resource-based livelihoods
Safety zone	A 500m zone around the seismic vessel for observations on aquatic life
Stakeholders	All individuals, groups, organisations, and institutions interested in and potentially affected by a Project or having the ability to influence a Project

Executive Summary

This document presents the results of the Limited Environmental and Social Impact Assessment (ESIA) for the Staatsolie Shallow Offshore 3D Seismic Acquisition Project.

The appointed Consultant has prepared this ESIA based on the environmental assessment and social impact guidelines of the National Institute for Environment and Development in Suriname (NIMOS, 2009) as guidance, as well as international best practice. The analysis and this report were prepared according to the approved Terms of Reference (Scoping Report, 25th of October 2019) as submitted to NIMOS. In the Screening Phase of the ESIA, NIMOS determined that the project is a Category B-path 2 project, whereby only limited ESIA is required.

The study was carried out in the period between September and December 2019.

Because many ESIA's have already been executed for the project area since 2010, the study was carried out mainly as a desktop study by reviewing and updating existing information, supplemented by stakeholder consultations. Since specialist studies were extensively covered in referenced ESIA studies, the current ESIA will only give special attention to the social and marine/coastal ecosystem assessment.

From the baseline conditions an assessment of the potential effects of the proposed project development was determined. In addition, the baseline environmental information can be used as a benchmark by which future monitoring results will be compared.

The collected data is considered adequate for the analysis of the impact and is covered in this ESIA report in ten (10) chapters and four (4) appendices.

Due to the resemblance with previous similar projects a range of standard best practice procedures and impact reduction measures (or inherent mitigation measures) are adopted from previous studies. The efficiency of proposed mitigation measures from previous studies have been evaluated based on monitoring results. In addition, experiences of stakeholders from previous projects have also been taken into consideration. Where necessary, any additional identified or cumulative impacts are discussed separately.

Environmental and social project risks and impacts will be managed through an effective Environmental and Social Management Plan (ESMP) which must be implemented as part of normal operations by incorporating the key components into daily activities, such as including environmental issues in the decision-making process and maintaining complete records. Also, all duties and responsibilities of all involved parties are contained in this plan.

Conclusions drawn from this study:
From the evaluation of the potential impacts, in total twelve (12) negative impacts (1 major, 3 moderate, 1 minor and 7 negligible) have been identified, for the biophysical components. For the socio-economic components in total four (4) negative impacts (1 major, 1 moderate and 2 negligible) and one (1) positive (minor) impact have been identified. These results are presented in detail in the main text of the report. After the implementation of the proposed mitigation measures, all impacts can be effectively reduced to minor or negligible.

Table 1 below presents a summary of the major and moderate impacts identified.

Table 1: Summary Table of Major and Moderate identified impacts

Component	Description	Impact	Residual impact (after proposed mitigation)

Negative impact			
Noise	Impacts of underwater sound pressure waves on all aquatic life (mammals, turtles, fish)	Major	Minor
Water resources	Water contamination around the seismic survey vessels due to diesel and gasoline spills	Moderate	Minor
	Water contamination around the seismic vessel from the discharge of sanitary sewage	Moderate	Minor
	Reduced water quality due to the discharge of solid wastes	Moderate	Minor
Commercial Fisheries	Reduction in industrial fishermen's income due to: Underwater noise produced during the seismic surveys may cause fish to avoid the survey area); Physical presence and movement of vessel and seismic survey equipment.	Major	Minor
Marine traffic (shipping/cargo transport and maritime operations)	Disruption or hindrance of freight ships and maritime operations (e.g. potential for minor route alterations) due to seismic survey vessel and deployed equipment movement and physical presence Impact on maritime transport and navigation activities due to response efforts (oil spill clean- up efforts) associated with an accidental Diesel fuel spill (small volume spill due to vessel collision or a bunkering accident)	Moderate	Negligible

1 Introduction

1.1 General

This document presents the results of the Limited Environmental and Social Impact Assessment (below indicated as the “ESIA”) for the Staatsolie Shallow Offshore 3D Seismic Acquisition Project. Based upon the findings of the Impact Assessment, recommendations are proposed to prevent or mitigate/minimize the impacts during all phases of the proposed project. These recommendations have been included in the Environmental and Social Management Plan (ESMP) This to make sure that appropriate measures to prevent or mitigate/minimize any adverse impacts through all the phases of project implementation are taken into consideration and that an Environmental and Social Management Plan (ESMP) for the proposed project is in place.

The ESIA has been carried out in compliance with the national regulatory requirements and the Environmental and Social Assessment guidelines of the National Institute for Environment and Development in Suriname (NIMOS 2005 and 2009). Furthermore, the Staatsolie Corporate Standards and relevant international standards, guidelines and best practices (World Bank (WB) Group/the International Finance Corporation (IFC)) are taken into account. The assessment and this report were prepared according to approved Staatsolie Terms of Reference (ToR), the NIMOS screening results (27^{th} of August 2019) and the ESIA Terms of Reference (ToR) as submitted to NIMOS (Scoping Report, 25^{th} of October 2019).

1.2 Project background and study area

Staatsolie is a fully integrated oil company completely owned by the Republic of Suriname. It was founded on 13 December 1980, initially to promote and manage the petroleum potential of Suriname, and holds the right to explore, produce and refine hydrocarbons in Suriname.

The company plans to conduct a 3D Seismic Acquisition Program in the Shallow Offshore area. The Shallow Offshore forms the southern part of the offshore area, with water depths mostly between 30 and 75 meters. It stretches from the north boundary of the nearshore zone to approximately 130-150 km from the coastline (**Figure 1**).

A number of seismic surveys have already been undertaken within the Shallow Offshore area (**Figure 1**). Currently, Staatsolie is still evaluating the available 2D and 3D seismic data acquired during previously executed seismic surveys within the Shallow Offshore area with the intention to identify and rank the most promising prospects in a prospect portfolio. The first version of this prospect portfolio was finalized in the third quarter (Q3) of 2019. Following expert review, the identified prospects are currently further being evaluated with the expected finalization by end of first quarter (Q1) 2020. Based on the outcome of the analysis, the best ranked prospects will be further explored through 3D seismic surveys and ultimately drilling one or more exploration wells. The project approach may be:

- Prospect size 3D seismic covering three or more prospects.
- Sub-regional multi-client 3D seismic covering the major part of the Shallow Offshore area[1].

The exact expanse of the 3D seismic acquisition (seismic lines) has not yet been defined, but it may cover a considerable portion of the Shallow Offshore area, and as such, the whole Shallow Offshore area was defined as the study area for the current proposed project.

[1] The exact acquisition parameters are not known yet, therefore the major part of the Shallow Offshore area is considered.

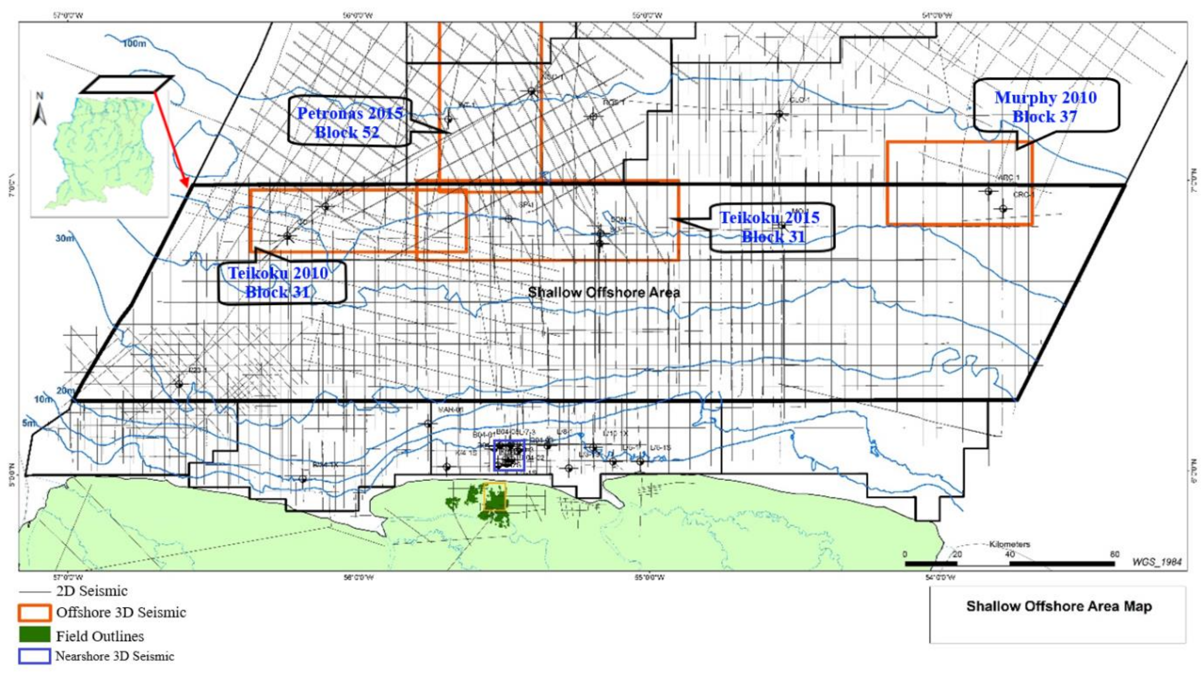

Figure 1: Overview of the Shallow Offshore area (bold black outline)

1.3 Objective and scope

Up to date, several ESIA's, specialist studies and compliance reports have been produced within or near the proposed project area. Also, Staatsolie has been granted several environmental permits previously for the execution of seismic and drilling programs within or near the Shallow Offshore:

- 2010, ESIA for the Block IV 2D/3D Seismic Survey.
- 2010, ESIA for the Drilling Program of Block 37.
- 2012, ESIA for the 2D Seismic Survey in the coastal plain of Suriname (River Seismic Survey Project).
- 2013, ESIA for the Seismic Survey Program in Block 31.
- 2014, ESIA for the Nearshore 2D Seismic Survey Program.
- 2015, ESIA for the Block IV Nearshore Exploration Drilling.
- 2015, ESIA for the Drilling Program of Block 31 and 52.
- 2016, ESIA for the 3D Marine Seismic Survey in Block 58 (covering part of the Shallow Offshore Area).
- 2018, ESIA for the Drilling Program in Block 58.
- 2018, ESIA for the 2D-3D Seismic Survey in Block 61.
- 2018, ESIA for the Nearshore Exploration Drilling Project 2019.
- 2019, Addendum ESIA for the Nearshore 3D Seismic Acquisition Project.

The current project has been classified by NIMOS as a Category B-path 2 project, whereby only a limited ESIA is required. Because many ESIA's have already been executed for the project area since 2010, the study was carried out mainly as a desktop study supplemented by stakeholder consultation.

The scope of the current study includes:

- Describe the existing environmental and socio-economic conditions which may affect or be affected by seismic survey operations, based on analysis and verification of baseline conditions as outlined in numerous ESIA and ESMP (Environmental and Social Management Plan) reports prepared for the Shallow Offshore and surrounding areas.

- To identify any new stakeholders and consult these and already known stakeholders about the current activities. Carry out stakeholder consultations to inform stakeholders including relevant authorities of the proposed project, to gather their feedback and address their relevant issues and concerns.
- Evaluate and update or amend the potential environmental and socio-economic effects, both positive and negative, of the proposed project, as presented in earlier ESIA reports and if required, make additional assessments.
- Review and update or adjust mitigation measures for avoiding or minimizing adverse effects and measures that promote or enhance potential benefits, as presented in previous ESIA reports.
- Identify and discuss additional impacts and mitigation/enhancement measures, if any, from the anticipated project activities in the Shallow Offshore area and surroundings.
- Compile a Limited ESIA report containing the outcomes of above listed objectives and provide input for incorporation into the ESMP of the project.

1.4 Team of experts

Staatsolie has appointed ILACO Suriname NV (ILACO) to undertake the ESIA for the Staatsolie Shallow Offshore 3D Seismic Acquisition Project. The ESIA has been undertaken by a team of highly motivated experts with ample national and international experience and under conditions similar to the assignment.

The team of experts consists of:

Dirk NOORDAM, M.Sc.	Sr. ESIA Expert
Shareen KOENJBIHARIE, B.Sc.	Team Leader/Environmental Specialist
Chantal LANDBURG, M.Sc.	Marine/Coastal Ecosystem Specialist
Rachelle BONG A JAN, M.Sc.	Social Assessment Specialist

2 Methodology and approach

2.1 Introduction

This chapter presents the methodology used to meet the objectives of the assignment as listed in paragraph 1.4. The approach involved an understanding of the project background, the technical details and implementation of the proposed project.

The current project has been classified by NIMOS as a Category B-path 2 project, whereby only a Limited ESIA is required. Because of the availability of sufficient existing information, the current study has predominantly been conducted as a desk study by reviewing and updating existing information, supplemented by stakeholder consultations. Specialist field studies were not foreseen since these were already covered in previous studies, but special attention was given to the social and marine/coastal ecosystem assessment.

The ESIA process follows the NIMOS guidelines (NIMOS 2005 and 2009). There are four phases in the ESIA process, namely Screening, Scoping, Environmental Assessment and NIMOS review.

The Screening Phase of the Project was completed by Staatsolie.

Following this the Scoping Phase was undertaken, resulting in a Scoping Report that was submitted to NIMOS on the 25th of October 2019. Given the fact that the project area and the potential impacts from seismic surveys are already well known from numerous previous ESIA studies, it was decided that a Public Scoping Meeting was not required. Instead, only key stakeholders have been consulted as part of the Scoping Phase. By accepting the Scoping Report on the 25th of October 2019 the methodology for impact assessment (see paragraph 2.3) as well as the methods used to gather baseline data have been approved by NIMOS.

The lessons learned regarding the efficiency of proposed mitigation measures based on monitoring results from previous studies have also been taken into consideration.

2.2 Baseline study

The baseline study comprises an environmental (physical and biological) and social-economic study of the baseline conditions in the study area. Baseline information was gathered through desktop review studies and public consultation of key stakeholders including discussions with the Project Proponent. The baseline descriptions are based on existing maps, photographs and images, literature reviews, documents and interviews. Baseline data also have been acquired from records held by government services and others. From the baseline conditions an assessment of the potential effects of the proposed project development was determined. In addition, the baseline environmental information can be used as a benchmark by which future monitoring results will be compared. Specific sources of information per component are listed in the table below:

Table 2: Overview of gathered bio-physical information and information sources

Component	Information and Data Sources	Fieldwork activity
Climate, Air Quality, Noise, Geology, Bathymetry, Bottom Sediments, Organic Carbons, Oceanography,	For all subjects, extensive use has been made from data collected by previous ESIA studies in the Shallow Offshore Block and beyond (see references). For the description of the climate and hydrology conditions, also baseline data have been acquired from published sources within Suriname, and from records held by the Meteorological Service and the Hydraulic Research	None.

	Division.	
Marine and Coastal Ecosystems: habitats, phytoplankton, benthic organisms, fish, threatened species, commercial species, turtles, marine mammals, birds and protected areas.	Inception report by ILACO (2019a). For all subjects, extensive use has been made from data collected by previous ESIA studies in the Shallow Offshore Block and beyond (see references). Additional literature, e.g. about legislation, management plans of coastal protected areas, coastal ecology, etc., was supplemented with reports/documentation available in the public domain (see references).	Stakeholder interviews: Green Heritage Fund Suriname (9th of October 2019), STINASU (14th of October 2019), WWF (15th of October 2019) and Nature Conservation (Natuur Beheer, 15th of October 2019)
Socio-economic	Desk study / literature review of existing secondary information including previously published ESIA reports for the study area (see references). Furthermore, secondary data was complemented by other relevant reports/documentation available in the public domain (see references)	Several stakeholder interviews between 9th of October 2019 and 11th of November 2019 (detailed in Appendix III).

In **Figure 1** the study areas of previous ESIAs in the Shallow Offshore Block are presented.

2.3 Impact assessment

The significance of all potential impacts that would result from the proposed project is determined in order to assist managers in the prioritization of actions and control measures to address issues identified through all the phases of the life of the project.

Key issues identified during scoping require further studies to determine whether they are likely to occur and to assess how they will manifest themselves.

For key potential impacts identified by the scoping study, it will be necessary to determine the significance of each impact, based upon qualitative or quantitative assessment of the following attributes:

- magnitude
- geographical scale
- duration
- probability of occurrence

The resulting impact will be indicated by their significance class; which are defined as:

Table 3: Classes of impact significance

< Impact significance >
Major (significant) effect: effect expected to be permanent or continuous and non-reversible on a national scale and/or have international significance.
Moderate (significant) effect: long-term or continuous effect, but it is reversible and/or it has regional significance.
Minor (not significant) effect: effect confined to the local area and/or of short duration, and it is reversible.
Negligible (not significant) effect: effect not detectable.
Unknown effect: insufficient data available to assess the significance of the effect.

In addition, impacts have been classified as:

- Positive: indicating whether the impact will have a positive (beneficial) effect; or
- Negative: indicating whether the impact will have a negative (adverse) effect on the environment, including affected people.

The degree of detail will enable the determination of required mitigation and possible enhancement measures, respectively to prevent or reduce significant negative impacts and to promote any positive impacts already in the planning phase. The implementation of mitigation measures will reduce negative environmental impacts to an acceptable level as much as possible.

After implementation of mitigation/enhancement measures, the significance of the impacts will again be determined.

The impact assessment methodology is described below.

The **significance** of an impact is defined as a combination of the **severity** of the impact occurring and the **probability** that the impact will occur. The significance of each identified impact will be rated according to the methodology set out below:

First, the **intensity/magnitude/size, scale** and **duration** of the impact are determined according to below tables (**Table 4** and **Table 5**).

Table 4: Defining the intensity / magnitude / size of the negative impacts

Rating	**Description of Rating for**		
	Natural environment	Socio-cultural	Health/safety
High	Irreversible damage to highly valued species, habitats or ecosystems	Irreparable damage to highly valued items of cultural significance, or social functions or processes are severely altered	Event resulting in loss of life, serious injuries or chronic illness; hospitalization required
Medium	Reversible damage to species, habitats or ecosystems	Repairable damage to items of cultural significance, or impairment of social functions and processes	Event resulting in moderate injuries or illness; may require hospitalization

Low	Limited damage to biological or physical environment	Low-level damage to cultural items, or social functions and processes are negligibly altered (nuisance)	Event resulting in annoyance, minor injuries or illness, not requiring hospitalization
Negligible	No relevant damage to biological or physical environment	No damage is done to cultural items and social functions and processes are not altered	Event is not experienced by receptors or only occasional minor annoyance

Table 5: Defining the intensity / magnitude / size of the positive impacts

Rating	**Description of Rating for**		
	Natural environment	**Socio-cultural**	**Health/safety**
High	Direct benefits to species, habitats and resources with significant opportunities for sustainability	Benefits to local community and beyond	Health and safety will be significantly improved
Medium	Moderate benefits to species, habitats and resources with some opportunities for sustainability	Benefits to many households or individuals	Health and safety will be improved
Low	Minor benefits to species, habitats and resources with possible opportunities for sustainability	Benefits to few households or individuals	Health and safety will be slightly improved

Table 6: Defining duration and scale of the impact

Rating	Definition of Rating
Duration– the time frame for which the impact will be experienced	
Short-term (ST)	Up to 3 weeks (operational time per sub area)
Medium-term (MT)	3 weeks to 5 months (maximum project time)
Long-term (LT)	More than 5 months
Scale– the area in which the impact will be experienced	
Small (SS)	Localized spot – working location
Medium (MS)	Part of study area – exclusion zone
Large (LS)	Study area or beyond

Then the **Severity Rating** of the impact is determined by combining the **magnitude** of the impact with **duration** and **scale** of the impact (**Table 7**) as set out below **(Table 8)**.

Table 7: Defining duration and scale of the impact

Magnitude	High	Medium	Low	Negligible
Duration and/or Scale				
LT-LS, LT-MS or MT-LS	High	High	Medium	Negligible
LT-SS, MT-MS, MT-SS, ST-MS or ST-LS	High	Medium	Low	Negligible
ST-SS	Medium	Low	Negligible	Negligible

The next step is to define the **probability** of an impact to occur, as defined below (**Table 8**).

Table 8: Defining the probability of the impact

Probability*– the likelihood of the impact occurring*	
High	Sure to happen, or happens often
Medium	Could happen, and has happened in Suriname
Low	Possible, but only in extreme circumstances

Finally, the overall **significance** of the impact is determined as explained below (**Table 9**).

Table 9: Determination of the overall Significance of the impact

Severity	High	Medium	Low	Negligible
Probability				
High	Major	Moderate	Minor	Negligible
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible

3 Legal and Institutional Framework

3.1 Introduction

This chapter provides a brief overview of the applicable policies and legislation that form the enabling environment of the project.

Suriname's legislation is exercised through a suite of different legislative instruments, including Laws or Acts of Parliament *(Wet, also called Landsverordening prior to 1975)*, Decrees[2] (*Decreten*), and regulations which are in the form of State Orders (*Staatsbesluiten*), Presidential Orders *(Presidentiële besluiten*), Presidential Resolutions (*Presidentiële Resoluties*) and Ministerial Orders (*Ministeriële Beschikkingen*).

The legal basis for environmental protection in the Country is provided by the 'Grondwet van de Republiek Suriname S.B. 1987 no.116 z.l.g bij S.B. 1992 no.38 (Constitution of the Republic of Suriname S.B. 1987 no. 116 as amended by S.B. 1992 no. 38)'. It is stated that one of the social objectives of the State is directed towards *"The creation and promotion of conditions, necessary for the protection of nature and for conservation of the ecological balance" (article 6g)*.

Despite this constitutional provision, Suriname's environmental regulatory regime has not fully evolved and there is no legislation dealing specifically with environmental management. In general, the legislation regarding environmental and natural resource management is fragmented, dispersed between different pieces of legislation. Responsibility for the management of the environment and natural resources resides within different government institutions whereas there is a lack of coordination and enforcement.

In this light, in 1998, the National Institute for Environment and Development in Suriname (NIMOS) was established with a mission to initiate the development of a national legal and institutional framework for environmental policy and management in the interest of sustainable development in the Republic of Suriname. The legal and regulatory framework for environmental impact assessments in Suriname is governed by NIMOS using the generic Environmental and Social Assessment Guidelines (NIMOS 2005 and 2009). The Draft Environmental Act (2002) was submitted as Initiative Act to the Parliament (DNA) on the 25th of January 2019. When promulgated, the Environmental Act will provide the legal base for the implementation of the Environmental Assessment Guidelines.

A review of the key regulatory requirements pertaining to the proposed project and the ESIA has been executed and includes the following:

- Suriname government policy.
- Suriname legislation, regulations and guidelines.
- NIMOS Environmental Assessment (EA) guidelines of the National Institute for Environment and Development in Suriname (NIMOS 2009)
- International best practice standards, such as the guidelines of the WB Group, including the IFC.
- Relevant international conventions that address environmental issues and are significant drivers behind the development and implementation of environmental legislation.
- Staatsolie Corporate Environmental Policies and Standards as relevant for the proposed project.

[2] Decrees date from the Period of Military Ruling (1980-1986) and have the same status as a law.

3.2 Relevant laws and regulations

A review of all applicable regulations, regulatory bodies governing environmental quality, health and safety, protection of natural and cultural resources, protected areas has already been detailed in several of the previous ESIA studies in the Shallow Offshore Block and beyond (see references). A summary table (Del Prado, 2012 and ESL, 2019) with the relevant laws and regulations is presented in **Appendix I.**

3.3 Relevant International Conventions

Beside the national legal regime, there are a number of International Conventions ratified by Suriname, which have to be taken into consideration. However, due to our law system, these conventions are only enforceable when transformed into national legislation. A summary table (Del Prado 2012 and ESL 2019) with the relevant International Conventions is presented below.

Table 10: Summary table relevant International Conventions

Title	Purpose	Relevance to Suriname/proposed project
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) Ratification 1985. Focal point: RGB/NB	Provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources and recognizes the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.	The Coppename-monding Nature Reserve is a Ramsar site.

United Nations Convention on Biological Diversity (CBD) **Ratification 1996.** **Focal point: ATM**	Conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.	- In 2006 a National Biodiversity Strategy (NBS) has been approved. The Vision of Suriname's Biodiversity Strategy is to value and protect our biological diversity, including all natural and cultural resources through equitable and sustainable use for present and future generations. More recent update: National Biodiversity Action Plan (NBAP) 2013; The National Biodiversity Action Plan (NBAP) 2013, was formulated as per Suriname's National Environmental Policy under the jurisdiction of the then Ministry of ATM. As an elaboration of the NBS, the NBAP 2013 identifies 8 objectives consistent with article 6 of the United Nations Convention on Biological Diversity for the protection of biodiversity. These objectives are as follows: Conservation of biodiversity; Sustainable use of biodiversity; Regulated access to genetic material and associated knowledge, with fair and equitable sharing of benefits; Knowledge acquisition through research and monitoring; Capacity building; Raising awareness and empowerment through education and communication; Cooperation at local and international level; and Sustainable financing.
Convention on Nature protection and Wildlife Preservation in the Western Hemisphere **Ratification 1985.** **Focal point: RGB/NB**	The convention has provisions to establish a set of protected areas: national parks to provide recreational and educational facilities; strict wilderness areas to be maintained; co-operation in the field of research between governments; species listed in annex to enjoy special protection and controls to be imposed on trade in protected fauna and flora and any parts thereof.	The Coppename-monding Nature Reserve is a Western Hemisphere Shorebird Reserve.
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the "London Convention") **Ratification, 1974.** **Focal point: ATM**	The objective of this Convention is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes.	The London Convention was one of the first global conventions to protect the marine environment from human activities and has been in force since 1975.

Protocol to the London Convention on Prevention of Pollution by Dumping of Wastes and Other Matter 1972 Ratification, 2006. Focal point: ATM	The objective is to protect the marine environment and to promote the sustainable use and conservation of marine resources.	In 1996, the "London Protocol" was adopted to modernize the Convention and, eventually, replace it. The London Protocol entered into force in March 2006.
The United Nations Convention on the Law of the Sea (UNCLOS) Ratification, 1998. Focal point: MAS	The 1982 UNCLOS is the most comprehensive attempt at creating a unified regime for governance of the rights of nations with respect to the world's oceans. This convention addresses a number of topics including navigational rights, economic rights, pollution of the seas, conservation of marine life, scientific exploration, piracy, and more.	UNCLOS settled the question of the extent of national sovereignty over the oceans and seabed, the various regions of the oceans, who has sovereignty over each, and to what degree. It also explains both how the maritime regions are divided (internal waters, territorial sea, contiguous zone, exclusive economic zone) and the sovereign powers that nations may exercise over each region.
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969 Ratification, 1976. Focal point: MAS	The Convention affirms the right of a coastal State to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate danger to its coastline or related interests from pollution by oil or other substances or the threat thereof, following upon a maritime casualty.	The coastal State can only take such action if it is necessary, and after due consultations, in particular, with the flag State or States of the ship or ships involved, the owners of the ships or cargoes in question and, where circumstances permit, independent experts appointed for this purpose. A coastal State which takes measures beyond those permitted under the Convention is liable to pay compensation for any damage caused by such measures.
International Convention for the Prevention of Pollution From Ships (MARPOL) Ratification, 1989. Focal point: MAS	To objective is to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances.	MARPOL is one of the important conventions designed to minimize pollution of the seas, including dumping, oil and exhaust pollution. All ships flagged under countries that are signatories to MARPOL are subject to its requirements, regardless of where they sail, and member nations are responsible for vessels registered under their respective nationalities.
International Convention on the Safety of Life at Sea SOLAS Ratification 1989. Focal point: MAS	The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety.	Flag States are responsible for ensuring that ships under their flag comply with its requirements, and a number of certificates are prescribed in the Convention as proof that this has been done.

3.4 International Best Practice

Where national legislation, standards or guidelines are lacking or where international standards are more stringent, international standards like the IFC World Bank standards are used where applicable for this study.

The World Bank Sourcebook for Environmental Assessment should be used as a guidance document for this study. The Sourcebook is a reference document that provides practical guidance for identifying and addressing negative environmental impacts of development projects. The Sourcebook aims to collect all World Bank policies, procedures, guidelines, precedents and best practice that reside in different World Bank publications into a single source. The document is continually updated and covers a wide range of subjects.

The EHS Guidelines recommend a number of prevention and control measures which, if applicable, can be included in the Environmental and Social Management Plan which is part of the current study.

The IFC Performance Standards will also guide the project where relevant and feasible. For the current project, the following standards are applicable:

- *PS 1 Social and Environmental Assessment and Management Systems*

This standard requires the identification and assessment of all social and environmental impacts and risks in a project's area of influence. It aims to avoid, or where avoidance is not possible, minimize adverse social and environmental impacts and to ensure that affected communities are appropriately engaged. The standard promotes the use of management systems to improve social and environmental performance.

- *PS 2 Labor and Working Conditions*

This standard aims to establish, maintain and improve worker-management relationships through fair treatment of workers and compliance with national labor and employment laws. It aims to prevent unacceptable forms of labor, e.g. child and forced labor and promotes safe and healthy working conditions. The standard addresses issues such as human resources policy, non-discrimination and equal opportunity, retrenchment, occupational health and safety, contract labor, etc.

- *PS 3 Pollution Prevention and Abatement*

Application of the principles of the World Bank's Pollution Prevention and Abatement Handbook at Policy level is addressed by this standard which aims to avoid or minimize pollution from project activities. Key issues addressed include resource conservation and energy efficiency, hazardous materials, waste management, emergency preparedness and response, ambient and cumulative considerations, greenhouse gas emissions, pesticide use and management.

- *PS 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources*

The objective of this standard is to protect and conserve biodiversity. Maintain the benefits from ecosystem services. Promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

PS 4 (Community Health, Safety and Security), PS 5 (Land Acquisition and Involuntary Resettlement), PS 7 (Indigenous people) and PS 8 (Cultural Heritage) are not applicable for the current project.

3.5 Corporate Environmental Policies and Standards

Staatsolie has prepared a number of environmental policy documents that apply to the current study. Staatsolie intends that this ESIA reflects its Corporate Vision and Values, particularly in regard to sustainability. These principles are further detailed in the Health, Safety and Environmental Policy, the Risk Management Policy and the Community Relations Policy **(Corporate Standards are presented Appendix II)**.

4 Project Description

4.1 Introduction

Staatsolie intends to conduct a 3D Seismic Acquisition Program in the Shallow Offshore area. Currently, Staatsolie is still evaluating the available 2D and 3D seismic data acquired during previously executed seismic surveys within the Shallow Offshore area with the intention to identify and rank the most promising prospects in a prospect portfolio. The first version of this prospect portfolio was finalized in the third quarter (Q3) of 2019. Following expert review, the identified prospects are currently further being evaluated with the expected finalization by end of first quarter (Q1) 2020. Depending on the findings, the best ranked prospects will be further explored by acquiring 3D seismic and ultimately drilling one or more exploration wells. The 3D seismic may be:

- Postage size 3D seismic covering three or more prospects.
- Sub-regional multi-client 3D seismic covering the majority of the shallow offshore area[3].

The project description is presented in a more general way, and once Staatsolie has selected the contractor to conduct the seismic survey, the further details of the project will be made available and shared with NIMOS. At that point the ESIA and ESMP may need some editing, and company or site-specific information (waste management plan, traffic plan, emergency plan, and other supporting plans as relevant) will be incorporated in the ESMP.

Irrespective of the seismic contractor not yet selected, the project will entail the use of air guns, streamers and a seismic vessel which will be operating 24hrs on a daily basis. The possible locations and dimensions of the 3D Seismic Program are currently unavailable because the area including seismic lines have not yet been determined. The area may cover the major part of the Shallow Offshore and therefore, the full Shallow Offshore area will be considered as project area (see **Figure 1**).

4.2 Project Components

4.2.1 Planning

Seismic acquisition is planned to start in the second quarter (Q2) of 2020 with an expected duration of 3-5 months. The Seismic Streamer Technology will be used for the execution of the program.

4.2.2 Seismic Streamer Technology

Acquisition will be done by the 3D Streamer technology using air guns **(Figure 2)** with a total volume between 3560 and 4700 cu in, deployed at a depth between 6-12 meters, with an air pressure between 1900 and 2100 psi. The air guns are generally fired within milliseconds of each other at intervals of between 10 to 20 seconds. The seismic data will be acquired through the use of hydrophones insulated within 10 to 12 solid streamers **(Figure 3)**; the streamers will be deployed at a depth between 8-12 meters. Streamers lengths will be between 6000-6600 m (**Figure 4**). In all cases, the limiting factor of acquisition will be the safe passage of the acquisition vessel over the seabed. Towed streamers are appropriately ballasted to be neutrally buoyant in the waters in which they are deployed. This buoyancy is such that the streamers do not touch the sea floor during acquisition

[3] The exact acquisitions parameters are not yet known

Figure 2: Single Air gun

Figure 3: Solid Stream with sensitive hydrophones inside

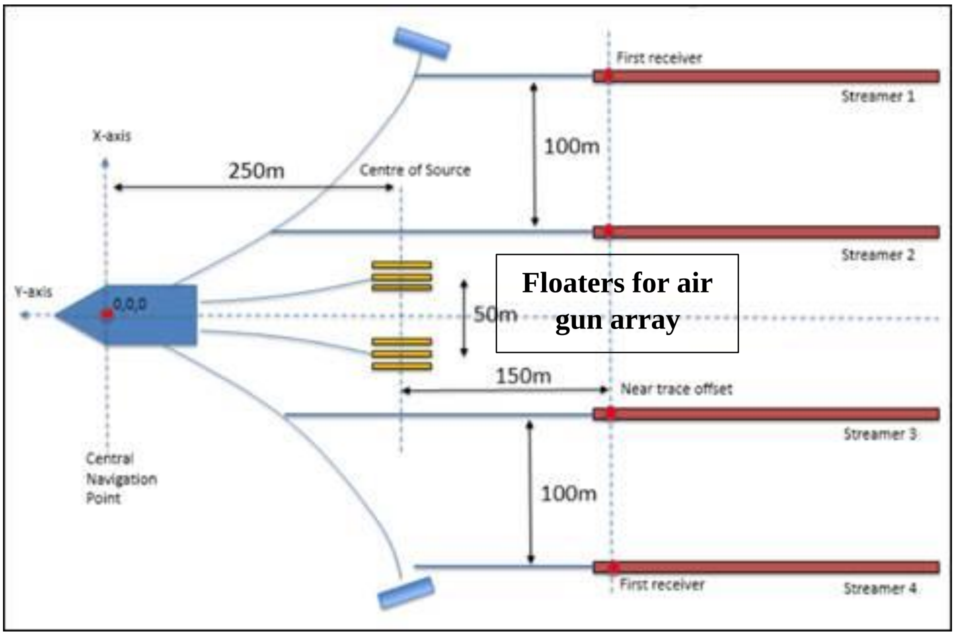

Figure 4: Plan view of 3D Streamer Technology Configuration Operations

In seismic surveys an air gun is used. Under pre-calculated and controlled conditions, energy is released from compressed air under the water surface in order to generate shock waves. Reflected vibrations from rock layers below subsurface are recorded with highly sensitive underwater microphones. These microphones are located in a bundle with plastic sheathed cables (streamers), which are towed by the vessel **(Figure 5)**.

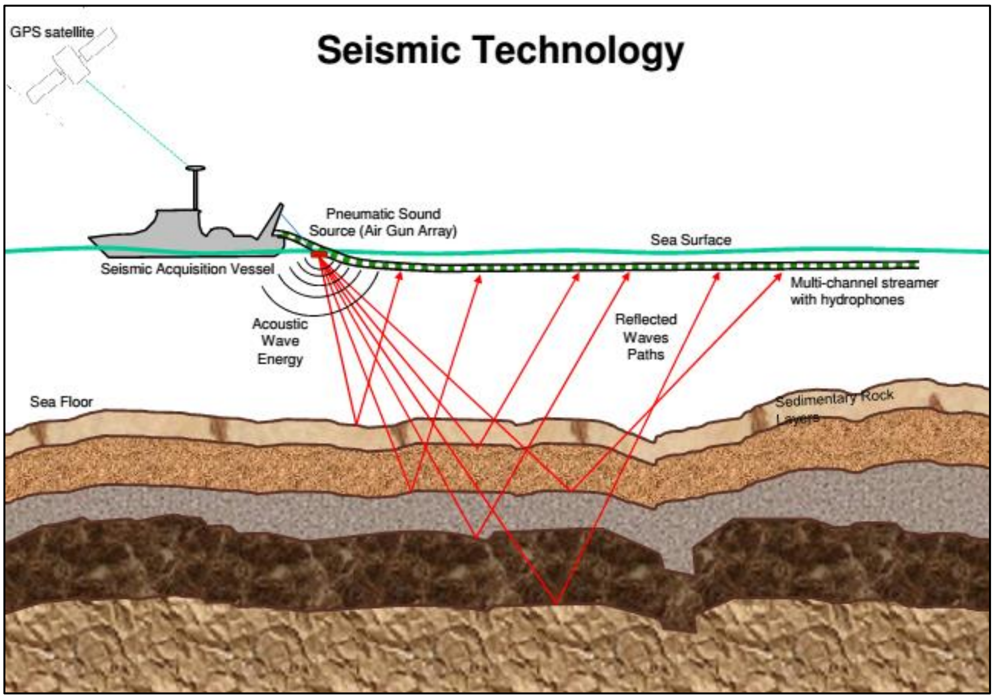

Figure 5: Profile view Seismic Technology Configuration/Operations

The result of the streamer technology is a cubic representation of the subsurface (3-dimensional, **Figure 6**).

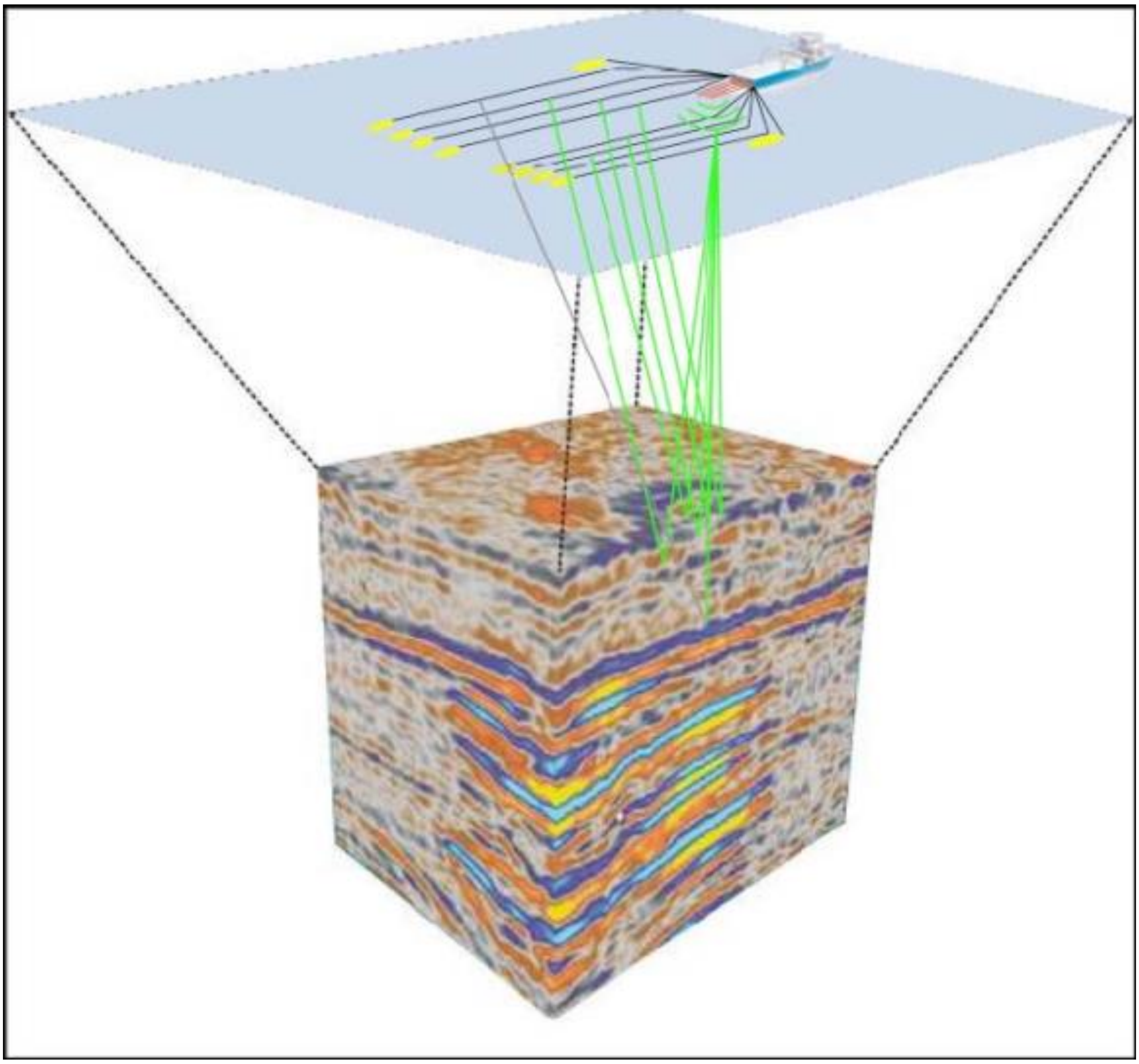

Figure 6: 3D Seismic acquisition and processing result: 3D cubic representation of the subsurface

4.2.3 The operation

Pre-project site investigations

In preparation for this program, a pre project site investigation will be carried out. Site inspections have to confirm the accessibility of pre-planned survey lines. A contractor will be selected to make observations of the survey area, noting amongst others locations with too shallow water depths, unknown underwater hazards and local fishing areas. Areas of concern will be plotted on the overall design plan, following adjustments to the survey design if necessary. Also predominant sea conditions will be previewed in order to determine if the safest and most effective vessel will be used in certain areas. Examples of things that will be observed include the overall sea state, shoals, reefs, tides, currents, etc. Another issue of importance during this stage of the project will be the presence of other actors in the survey areas. Areas of concern, like known congestion spots, where traps and nets are located, busy times in the area, what routes are strongly traversed, etc., will be identified and where necessary changes to the project design will be made. Scouting of the survey area will take place by a local vessel outfitted with an echo sounder and basic hazard detection apparatus. Optionally side scan sonar can be added with output included as deliverable. Options for carrying out scouting with satellite data might be investigated as well. The scouting will be planned and undertaken in close cooperation with the Maritime Authority Suriname (MAS). The final seismic survey line locations will be delineated on the basis of the reconnaissance results.

Daily Acquisition & Vessel Operations

Prior to the start of the seismic survey all equipment will be calibrated and tested to check its performance according to the required specifications.

The fleet is expected to consist of a seismic acquisition vessel and the guard vessel. The acquisition vessel for the Shallow Offshore as used in previous projects were in general about 100m long and 20-25 m wide, with net tonnage of about 4000 – 5000 tons. This vessel will mainly stay in the project area (3D seismic outline) while the other vessel (guard vessel) will remain close to the acquisition vessel. The seismic acquisition crew will be accommodated on the seismic acquisition vessel, so that there is no need for accommodation on land. The general sailing schedule for seismic surveys will alternate from east to west and vice versa. The majority of the lines will be shot parallel to the coast (east to west and vice versa). A few tie-lines (connecting lines) will be shot in the North-South direction. This happens continuously 1x24 hours also during the weekends (24/7 operation). A shift in the offshore usually takes 12 hours. Project supplies (food, water, fuel) will be purchased from local businesses and delivered to the seismic fleet via river transport. In the case of postage size 3D seismic coverage, the seismic vessel comes with a full supply and a re-supply is not necessary. In the case of sub-regional multi-client 3D seismic, supplies will be added. It depends on the size of the ship whether this can happen in Suriname or in Trinidad. No stop will be made in case of postage stamp size survey. At a regional survey a stop may be made, but over a period of 3-5 months. Unlike drilling projects, seismic surveys have a relatively small crew on board and do not require many supplies. Supplies are mainly food, water and fuel.

During the investigation, an exclusion zone is determined of which the size depends on the length and width of the working area. The length of the streamers will be determined by modeling. The correct streamer length is determined on the basis of the depth of the target earth layers and other factors, such as the required quality of the data. Streamer length in previous projects was around 5-7 km. It is forbidden for all local vessels to come within this zone for a certain time period when seismic activities are being carried out. The location of the exclusion zone will change from day to day during the investigation. Fishermen and other relevant actors will be informed in advance about the location of the exclusion zone. A guard vessel will be used to ensure that no other vessels enter this zone. Fishermen and other boats are allowed to make use of the area outside the seismic activity zone.

Land-based operation and crew

At this moment the need for landing stages and shore base accommodation is not foreseen. Information on waste management and crew details will be submitted as soon as it becomes available.

5 Physical Baseline

5.1 Introduction

The coastline of Suriname is characterized by the presence of extensive mangrove forests and sections with sandy beaches in eastern Suriname. Directly in front of the coast many slowly east-west moving mud banks with mudflats are found. The zone with the mud banks is indicated as the nearshore, with water depths till approximately 20 meters. Directly north of the nearshore area, the offshore area starts.

The section of the offshore with water depths between 20 and 150 meters is indicated as Shallow Offshore. The Shallow Offshore Block of Staatsolie has water depths ranging between 30 and 75 meter (**Figure 1**).

The Shallow Offshore comprises the deeper part of the continental sea, which also comprises the nearshore.

5.2 Climate

This section discusses the climate of the Shallow Offshore 3D Seismic study area. The study area comprises a block at 130-150 km from the coastline across the full length of the Suriname coast. In the virtual absence of meteorological stations at sea or directly along the coastline, information for stations more inland is used to get an overview of climatological conditions in the coastal zone and the neighboring Atlantic Ocean to the north. Only one meteorological station was ever present at sea area in front of the Suriname coast, but this station was closed in 1970. Inland stations closest to the coastline have been selected. Currently operational stations within 2 km from the coastline are Weg naar Zee, Coronie and Nickerie, but most operational stations are farther away (**Figure 7**). Usually no complete data sets are available for the whole period, and sometimes even complete years are lacking.

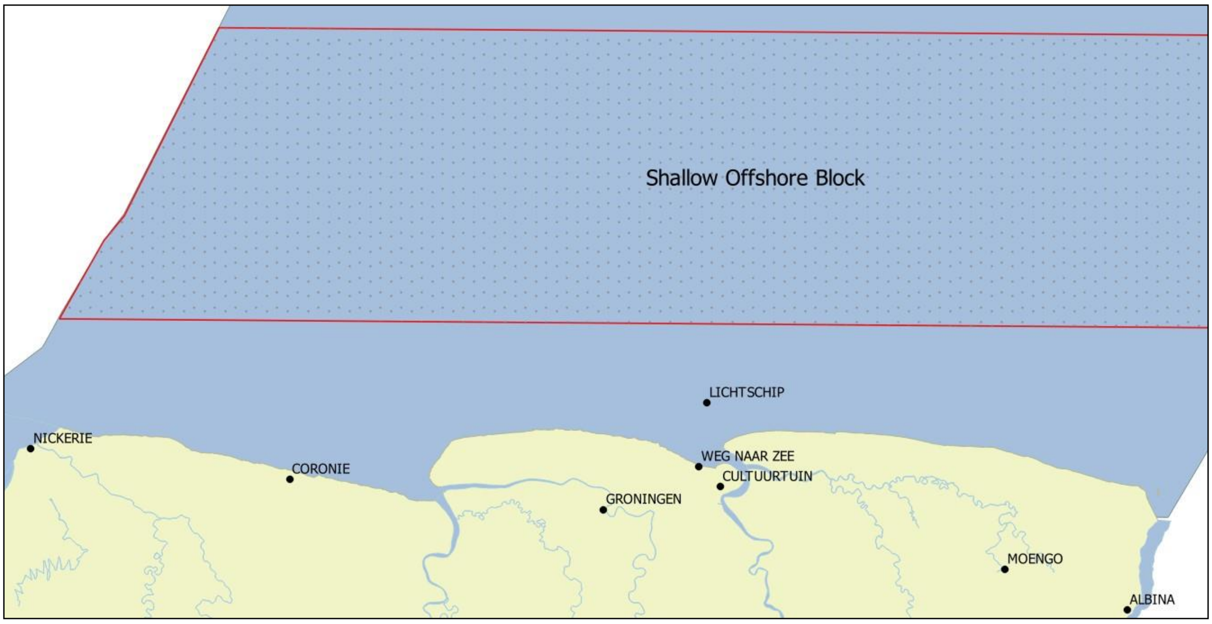

Figure 7: Location of meteorological stations used for this study

5.2.1 General climate conditions

Most of Northern Suriname has a Tropical Rainforest Climate (Af climate in Köppen's classification). Within this climate type the average rainfall exceeds 60 mm in the driest month(s). A narrow strip along the coast, which has drier conditions, forms an exception. Here a Tropical Wet and Dry, or

Savanna Climate (Aw climate in Köppen's classification) is found with less than on average 60 mm in one or more months (Amatali & Naipal 1999).
The driest months in Suriname are September, October and November.
The average annual rainfall in the eastern and central part of northern Suriname predominantly ranges between 2,000 and 2,500 mm. In a narrow coastal strip it is between 1,500 and 1,750 mm (**Figure 8**). This dryer zone extends to the north above the Atlantic Ocean (only shown in **Figure 8** left) and above the ocean average annual rainfall is below 1,500 mm. At station Lichtschip an average of 811 mm of rainfall per year was recorded. The western coastal region (west of the Coppename River) is overall dryer with rainfall between 1,500 and 2,000 mm/year, and in some near-coastal parts even less than 1,500 mm (**Figure 8**).

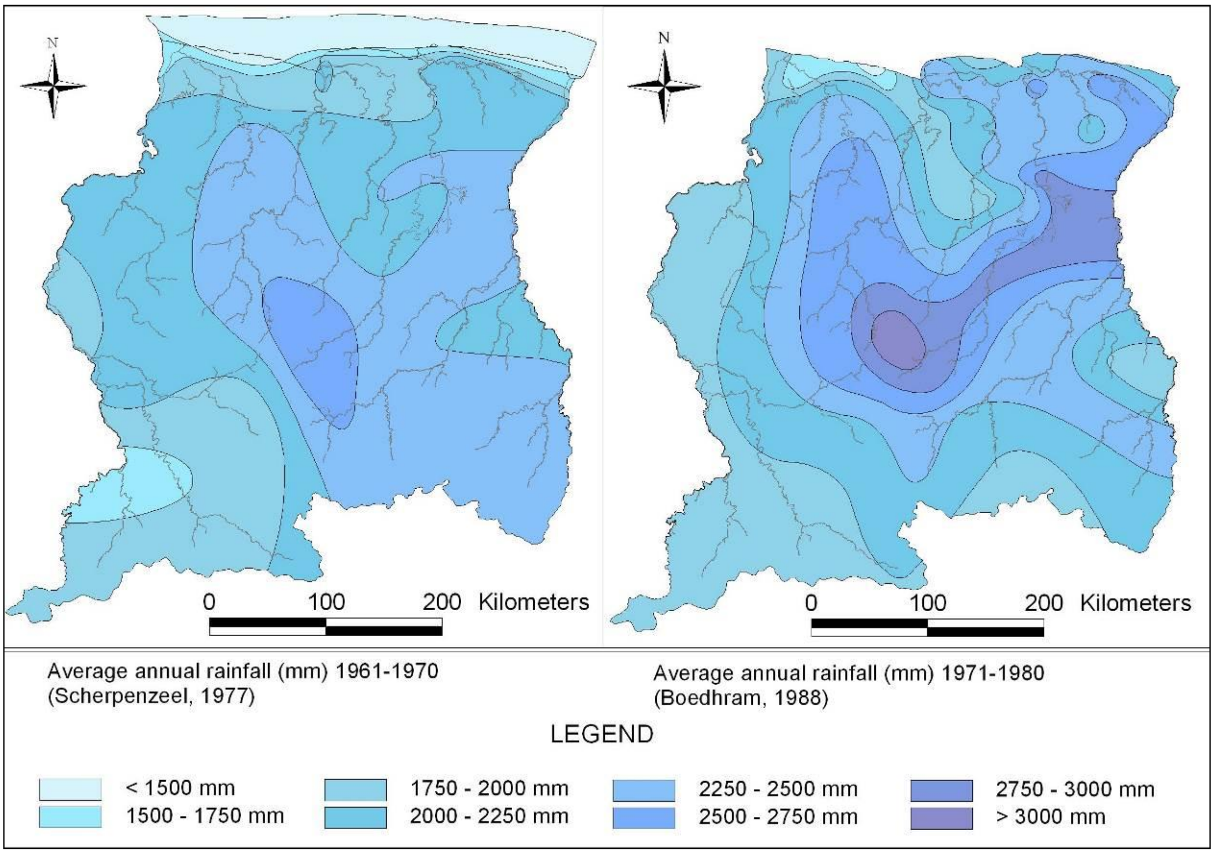

Figure 8: Average annual precipitation over the periods 1961-1970 and 1971-1980.

Like in most parts of Suriname, consistently high temperatures and a high humidity characterize the study area with the main variation being rainfall and the associated cloud cover. The mean annual air temperature at Paramaribo is 27.3 º C, with a daily range of 7-10 ºC and with an annual range of about 2ºC.

The weather of Suriname is dictated mainly by the northeast and southeast trade wind system called the Inter-Tropical Convergence Zone ("ITC" zone also known as the "Equatorial Trough").
The ITCZ follows the sun in its movement to the north to about 15º latitude and to the south to about 10º latitude south of the Equator. The ITC zone passes over Suriname two times per year bringing heavy rainfall when it is overhead. This results in four seasons based upon rainfall distribution (Scherpenzeel 1977).

- Long Rainy Season End April-Mid August
- Long Dry Season Mid August-Early December
- Short Rainy Season Early December-Early February

- Short Dry Season Early February-End April

The above classification of the seasons is developed for Paramaribo, the capital of Suriname, using the recorded rainfall data at station Cultuurtuin, but it is applicable for the whole northern part of the country.

The average distribution of the annual rainfall throughout the year at Paramaribo is presented in **Figure 9**.

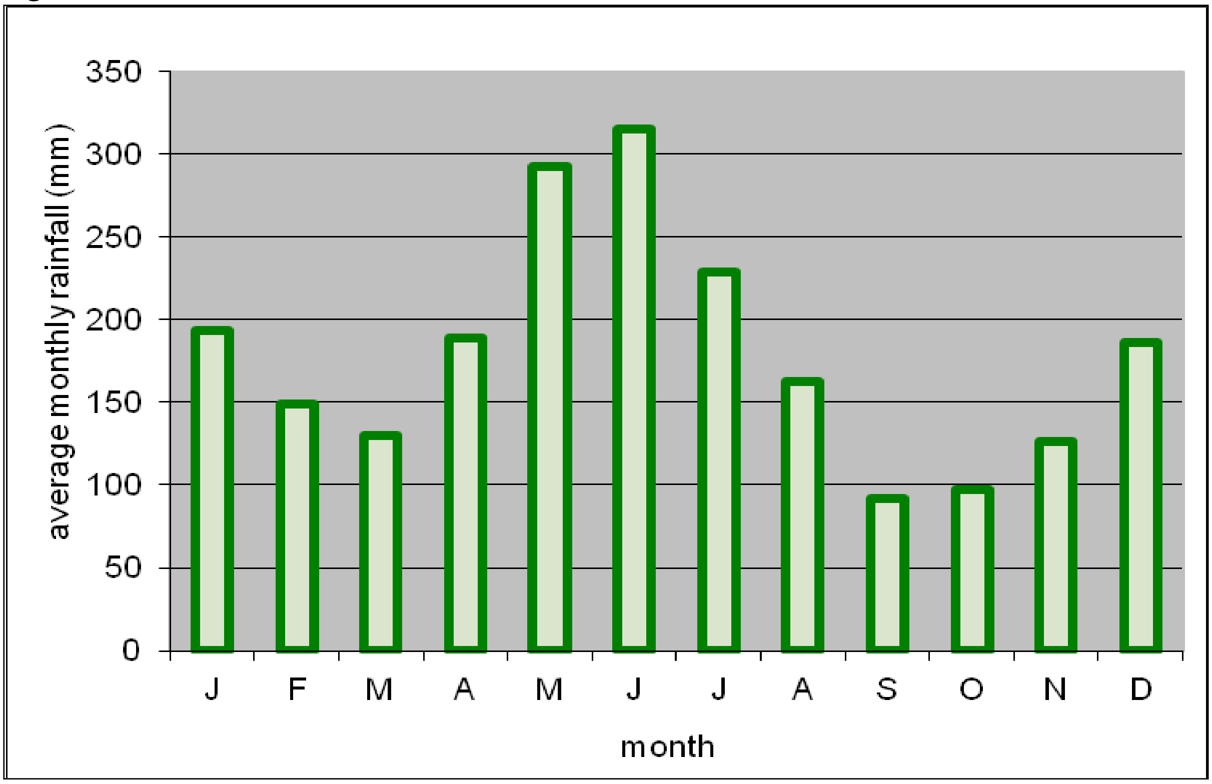

Figure 9: Mean monthly rainfall at Paramaribo (Cultuurtuin: 1961-2016; total 2,162 mm)

Northern Suriname has a northeast to southeast wind direction, with the first dominating in the February-April and the latter during the July-September period. The other months show directions mostly ranging between northeast and southeast. However, closer to the coast northeastern to eastern winds tend to dominate throughout the year.
Calm winds, *i.e.* winds with hourly average speeds less than 0.5 m/s, are very frequent. During the night and early morning, it is usually calm. During the day, the wind speed may increase to about 5 m/s, and in some seasons to 5-8 m/s, in particular in the February-April and the September-October periods. In the coastal zone, wind speeds are usually higher than further inland (Scherpenzeel 1977).
Wind speeds of 20-30 m/s have been occasionally recorded during thunderstorms, but only for a very short period (locally known as 'sibibusi'). Suriname is free of hurricanes.

5.2.2 Rainfall

Figure 10 shows a number of meteorological stations in the coastal area and their average annual precipitation over a longer period (period 1961-2016). The stations in eastern and central North Suriname have annual rainfall of about 2,000-2,250 mm, but stations in western North Suriname and those near the Atlantic Ocean have lower annual rainfall.
Highest total average monthly rainfall is during the months May, June and July, which are in the Long Rainy Season, and minimum values are found during the months September to November, which are in the Long Dry Season. All stations have the same seasonal distribution, but rainfall near the ocean is

less in all months, with in total almost 600 mm less rainfall over the year. Weg naar Zee and Coronie have 2 months (September and October) and Nickerie one month (October) in which the average rainfall is below 60 mm, and these areas thus have an Aw climate. The other stations have an Af climate.

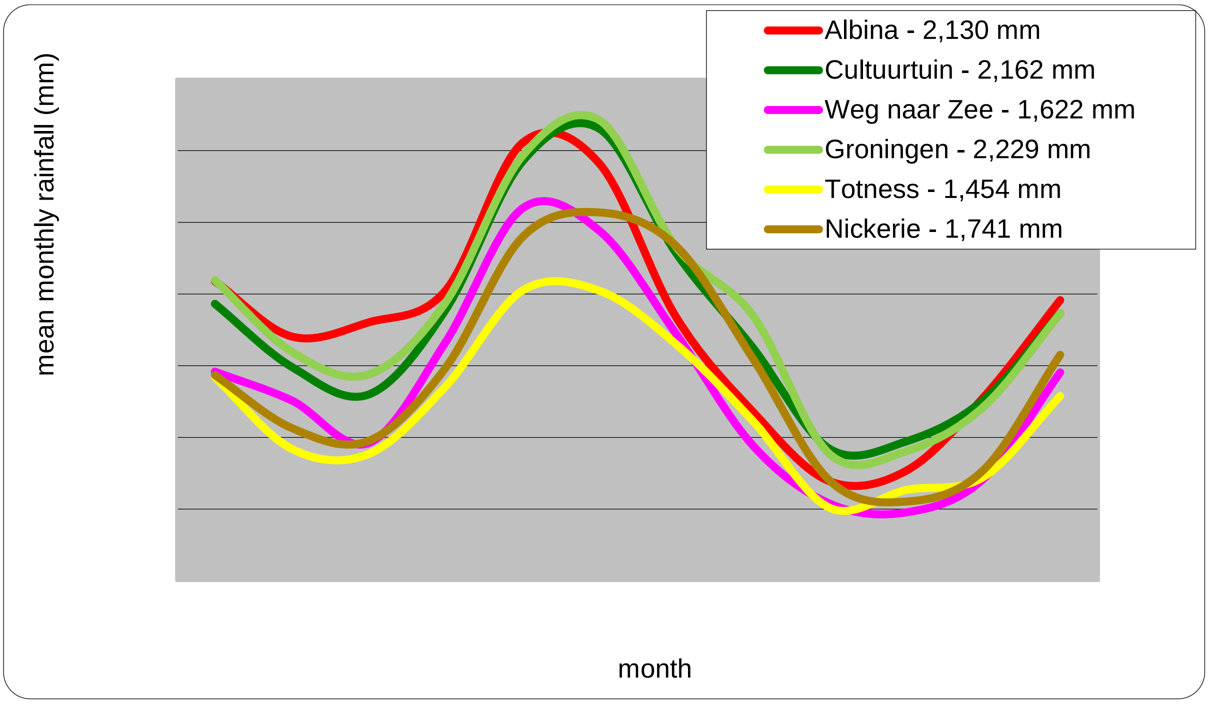

Figure 10: Mean monthly and total annual precipitation for regional stations

For the ocean area, meteorological data are limited to observations at station Lichtschip during the period 1961-70. These data are presented in **Figure 11** where they are compared with those of Weg naar Zee and Cultuurtuin for more or less the same period.
In **Figure 8** it is clearly shown that the rainfall at sea is considerably lower than on land, with an annual difference of approx. 800-1,100 mm.

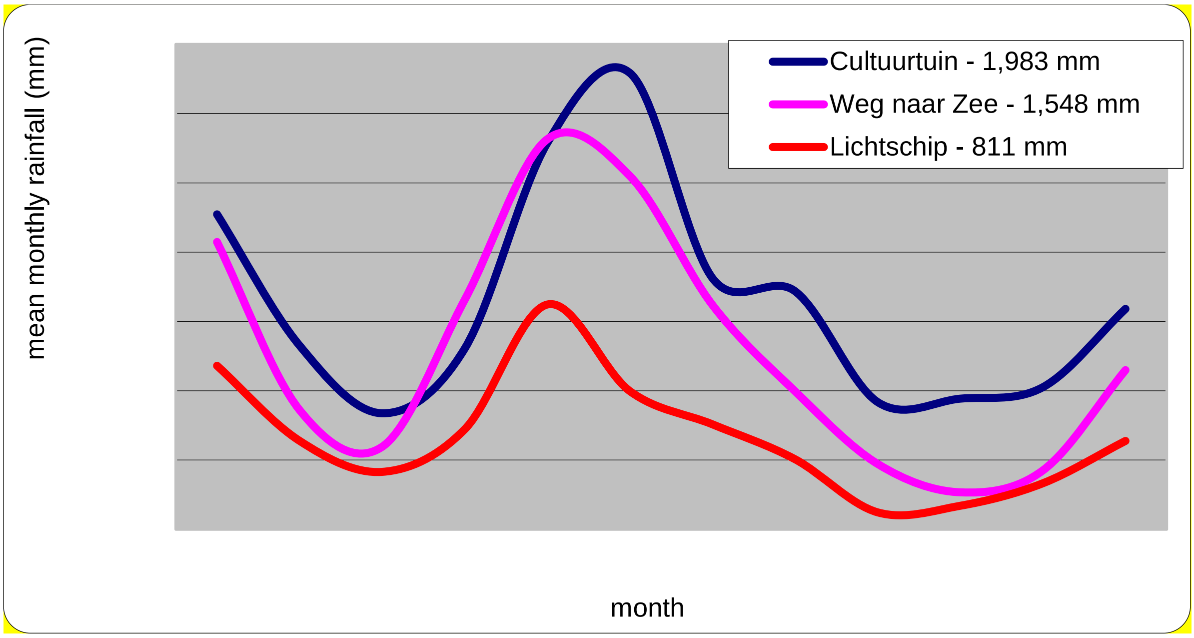

Figure 11: Mean monthly and total annual precipitation for selected stations over the period 1961-70 (1964-70 for Weg naar Zee).

5.2.3. Temperature

The long-term (1971-2016) monthly averages of the minimum, mean and maximum temperature at station Cultuurtuin is presented in **Figure 12**. The average annual temperature at this station over this period is 27.5 °C In general the warmest months are September and October, when the average monthly and average maximum temperatures are the highest. The monthly average temperature during these months is 28.5 °C and the monthly average maximum is almost 32.2 ºC. The coldest months are January and February, when the average monthly temperature is 26.7 – 26.8 °C and the average monthly minimum temperature is as low as 23°C.

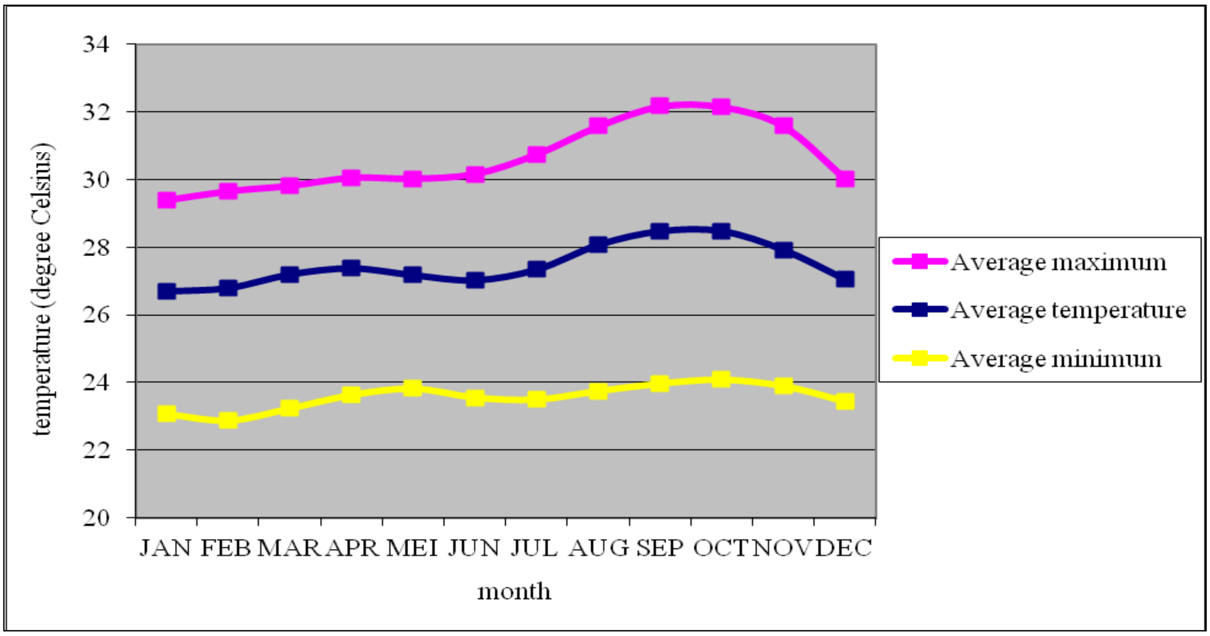

Figure 12: Average monthly temperatures at station Cultuurtuin (1971-2016).

In **Figure 13**, temperatures for three stations are compared in order to give some insight about the influence of the sea on the air temperatures. Zorg en Hoop is inland at about 10 km from the coastline, Totness (Coronie) is close (2 km) to the coastline and Lichtschip is at the Atlantic Ocean 5 km off the coast. For reasons of comparability the period 1961-70 is chosen, because no more recent data for Lichtschip are available. The mean annual air temperature at Lichtschip is 27.0 º C, which is only slightly lower than Zorg en Hoop (27.1 º C) and Totness (27.3 º C).

Mean monthly maximum and minimum temperatures at Lichtschip are respectively lower (28.6 versus 30.5º C) and higher (24.6 versus 22.8ºC) than those of Zorg en Hoop, due to the presence of the Atlantic Ocean, which during night retains the heat longer than land, while it takes longer to heat at daytime. For Zorg en Hoop the daily temperature range is 7-10 ºC and the annual range is about 2ºC. For Lichtschip variations are smaller with 3-6 º C for the daily range and only 1.2ºC over the year.

Data for Totness are in between these two extremes (**Figure 13**).

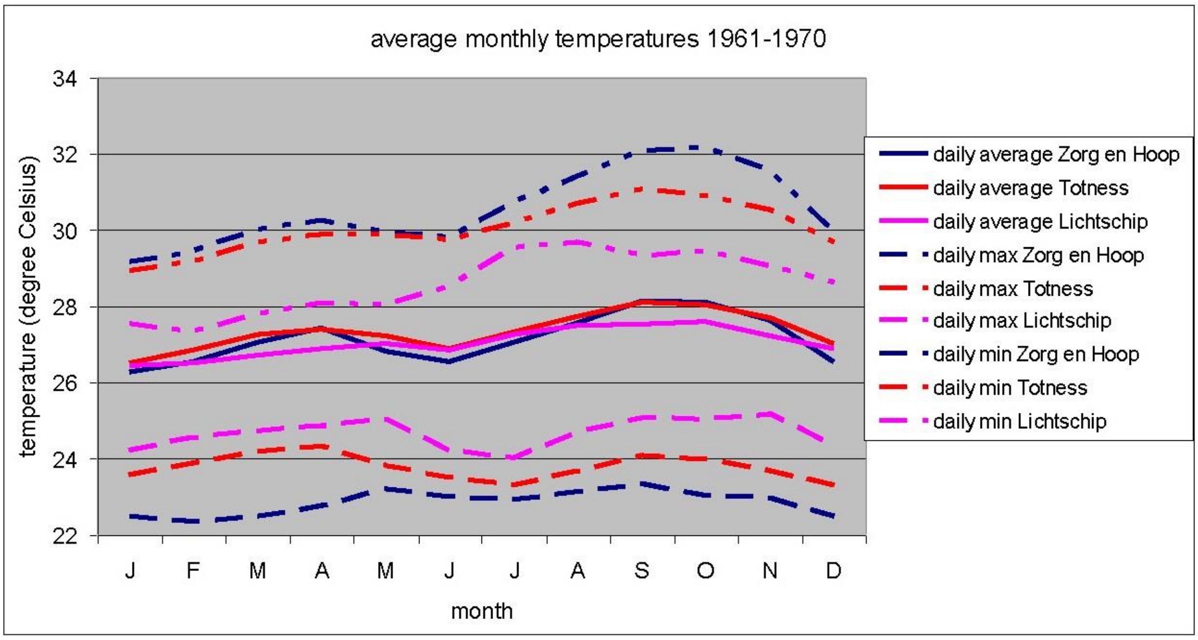

Figure 13: Monthly average temperatures for Lichtschip compared with Totness and Zorg en Hoop

5.2.4 Wind speed and direction

In **Figure 14** the monthly mean wind speed is presented for four stations in the coastal area, including one station at sea. Lowest speeds are recorded for inland stations with values ranging between 0.7 and 1.5 m/s for Cultuurtuin, which has an annual average of 1.2 m/s.

The highest peaks are in February-April, ranging between 1.4 and 1.5 m/s and the second highest ones in September-October, with a value of 1.4 m/s. The lowest values are in May-August, ranging between 0.7 and 1.1 m/s, and the second lowest ones in December-January (1.1 m/s). The wind speed is thus correlated with the seasons, with higher wind speeds in the dry seasons and lower ones during the rainy seasons.

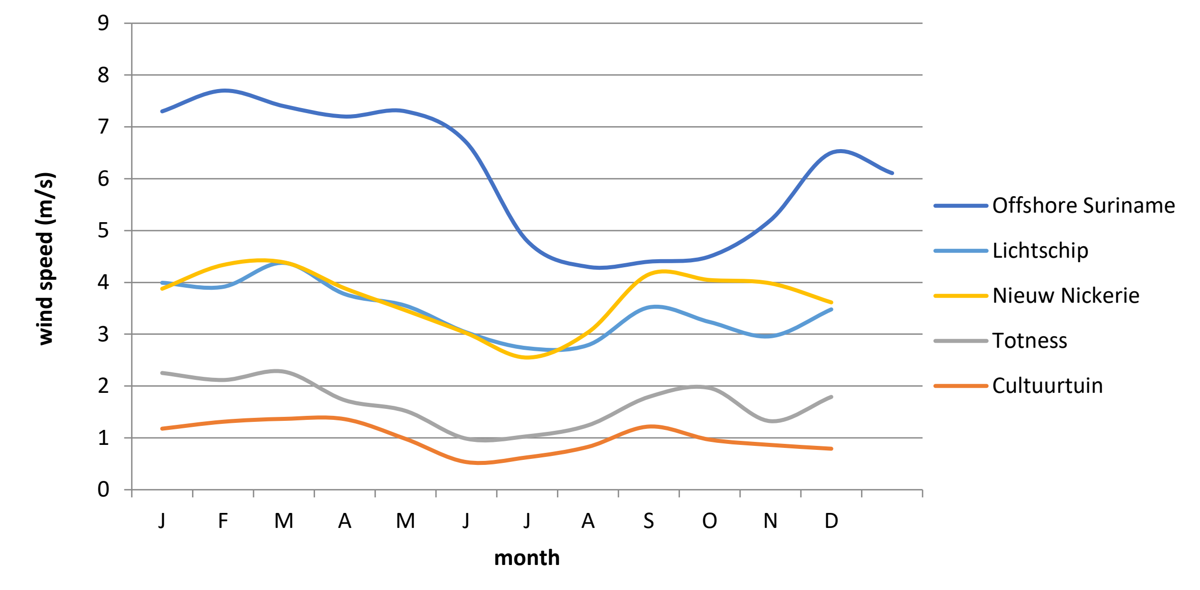

Figure 14: Mean monthly wind speed for selected stations for the 1961-1971 period, and comparison with more recent data for the offshore

Wind speeds at sea (Lichtschip) and along exposed coastlines (the station at Nieuw Nickerie is located at the airport that is directly along the coast) are much higher. The monthly means range between 2.5 and 4.5 m/s. The annual pattern of these stations is similar to that of Paramaribo (Cultuurtuin).

Wind speeds farther offshore Suriname are considerably higher than at Lichtschip (data adapted from U.S. Navy Marine Climatic Atlas of the World Version 1.1, cited in CSA 2010a). High mean monthly wind speeds (6.5-7.7 m/s) are recorded in the period December to June, while from July to November wind speeds are much lower (4.3-5.2 m/s).

Calm winds, *i.e.* winds with hourly speeds less than 0.5 m/s, are very frequent in Paramaribo and most of Suriname, and occur over 50% of the time, and even over 60% of the time in the June-July period (Scherpenzeel 1977).

During the night and early morning, it is usually calm in the coastal zone. This is caused by the southerly land wind, which especially from May to December is well developed during the nights. This land wind dampens the effect of the trade winds, resulting in calm water during the night and the early morning. During the day the wind speed may increase to about 5 m/s, and in some seasons to 5-8 m/s, in particular in the February-April period.

In the offshore area, the daily pattern is different. Calm conditions do hardly occur. There is a fairly constant wind speed over the day with an increase to slightly higher wind speeds in the late afternoon and during night. In the early morning wind speeds drop again.

Like Northern Suriname, also offshore Suriname has wind directions that predominantly range between NE and SE, whereby the directions NE to E usually have the highest frequencies. The predominant wind direction between January and May is from the northeast and east. From June to December winds blow mostly from an easterly and northeasterly direction, but occasionally also from the southeast.

5.3 Air quality

Given the location and the scale of existing emissions around and within the study area it can be stated that the ambient air quality in project area is still close to its natural state, because very few sources of relevant air emissions affect the air quality in the project area. The shallow offshore area is over 40 km from shore and the only source of emissions is formed by passing ships but these are very few and their emissions are mobile and therefore easily spread over a large area. Generally speaking, the air quality of the study area is good with hardly any air pollution.

This conclusion is confirmed by measurements by ESL (2010) in nearshore Block 4, which yielded 0 µg/m3 of NO_2, SO_2, H_2S, CO and VOCs.

5.4 Noise

5.4.1 Above-water Noise

Predominantly natural sources will contribute to the ambient above-water noise level in the shallow offshore area. These comprise the noise made by marine birds, noise from the wind, and wave action. Manmade activities that can contribute to ambient above-water noise level are mechanical noises generated by the engines of passing vessels.

Some data are present for ambient noise for the nearshore area. These are summarized by ESL (2018). In September 2010, daytime readings throughout the study area ranged from 53.8 dBA to 54.9 dBA. Measurements in February 2013 show higher daytime readings ranging between 57 and 62dBA. Some outliers where recorded in that year, but these are left out, because they cannot be explained. Generally speaking, it can be concluded that the natural above-water noise levels will be in the range of 53-62 dBA, with higher levels in case of human activities.

However, no above-water noise impacts on coastal communities are to be expected, due to the distance of the proposed project from shore.

5.4.2 Underwater noise

In September 2010, the background or baseline underwater noise levels within Block IV were found to have third-octave band spectrum levels between 90 – 100 dB re 1µPa at most frequencies and an average background underwater noise level of 112 dB re 1µPa for a frequency range of 50 – 10,000 Hz. Over the frequency range of 10 – 10,000 Hz, the overall average background noise levels were recorded as 133 dB re 1µPa. This level of background noise is indicative of an area with distant shipping which may be attributed to shipping noise.

During the 2D Nearshore Seismic Survey in 2014, CSA (2015c) conducted monitoring measurements of the sound pressure level. The seismic survey was initiated on 29 June 2014 and was completed 28 November 2014. Measurements were made along three S-N lines in front of the districts of Commewijne, Saramacca and Nickerie, with three measuring locations along each line. Ambient sound levels ranged from 115 to 125 dB re 1 µPa.

5.5 Geology

The Shallow Offshore Block is located on the continental shelf north directly north of mainland Suriname. About three quarters of mainland Suriname is occupied by the Precambrian basement, which consists mainly of igneous and metamorphic rocks of the Guiana Shield. The remainder consists of sediments, which have been deposited since the Late Cretaceous to the north of the basement.

The Coastal Plain of Suriname, together with those of French Guiana and Guyana, forms the marginal part of the large Guiana Basin. This basin originated in the Late Jurassic-Early Cretaceous with the opening of the Atlantic Ocean. Progressively younger sediments are unconformably overlying gently northward dipping basement rocks. The age of the sediments in the Coastal Plain of Suriname ranges from Late Cretaceous to Holocene. In the offshore area also older sediments of the Early Cretaceous are encountered. The thickness of the sediment is 5 kilometers at the northern edge of the Continental Shelf to 10 kilometers and more at the Guiana Marginal Plateau to the north of the shelf. A cross section showing the sediments is presented in **Figure 15**. Due to the small scale the Holocene sediments are not indicated in this figure.

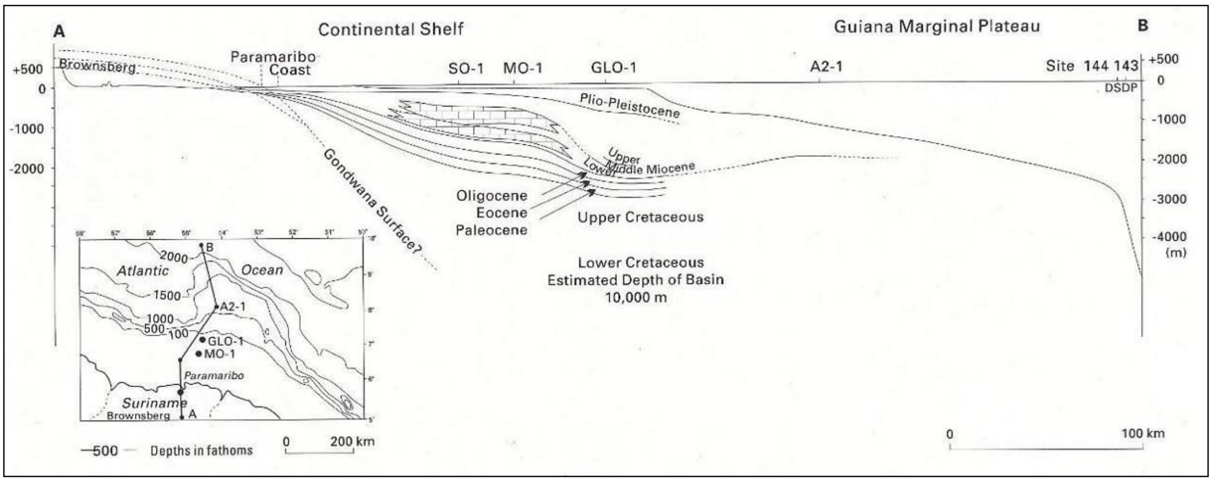

Figure 15: North-South section through the coastal plain, the continental shelf and the Guiana Marginal Plateau (after Krook 1994)

Recent deposition is predominantly confined to the nearshore mud belt, where Amazon mud is transported alongshore. A small portion of this mud is deposited along the coastline of Suriname in the form of mudbanks. The huge masses of Amazonian mud extend from the coast to some 20-30 km outwards. The mud has a thickness of approximately 20 meters and the zone is approximately bounded by the 25 m depth line.

To the north of the mud zone, a very sandy surface sediment, with an admixture of varying amounts of fine particles (pelite) and water worn calcareous fragments of marine organisms is present. The bottom configuration of the deeper part of the shelf is considered to be a relic of the Late Pleistocene-Early Holocene transgression. The pelite component is presently being supplied in suspension, while the sand-size material is old and only set in motion periodically. The sand was left during the lower Pleistocene sea levels in a nearshore or fluvial environment (Nota 1958, 1967). The project area is almost fully located on the outer shelf area with sandy bottom sediments.

5.6 Bathymetry

The Shallow Offshore Block is located on the Continental Shelf that can be considered as the flooded margins of the land. Water depths within the block are between 30 and 75 meter. During glacial periods in the Pleistocene it was part of the land, but during interglacial periods it is undersea, forming a shallow shelf sea in front of the coast. Passive continental margins such as those of the Suriname coast have wide and shallow shelves, made of thick sedimentary wedges derived from long erosion of the Guyana Shield and other parts of the South American continent, in particular the Amazon catchment. The shelf forms a rather smooth platform, sloping gently towards the shelf edge and then bending down to the deep-sea floor. The shelf usually ends at a point of increasing slope. The change in the continental shelf slope from gentle to steep is often called "shelf-break". For Suriname this change in slope occurs at a depth of about 100-120 meters. This is in line with the average depth of about 130 meters of the shelf-break all over the world. The sea floor below the break is the continental slope leading to the Demerara Rise or Guiana Marginal Plateau. The width of the Continental Shelf of Suriname is about 150 km and the Continental Shelf measures about 65,000 sq. km. The sea area here is indicated as the Continental Sea.

5.7 Bottom Sediments

Information on bottom sediments has been collected during previous studies in the Shallow Offshore Block. These comprise CSA 2010a, b and CSA 2015 a, b. Below this information is summarized. The respective study areas are shown in **Figure 1**.

5.7.1 Particle size distribution (Texture)

Dominant bottom textures in the above study areas are sandy loam and loam, which occur in 83% of the samples. Another texture with over 2.5% occurrence is loamy sand, which is only encountered in the Teikoku 2010 study area.

The bottoms of the study areas of Petronas and Teikoku (2015 study) contain only sandy loam and loam.

The bottom of the Teikoku 2010 study area is dominated by loamy sand to sandy loam. The majority of samples (69%) in this area contain gravel, usually between 2 and 15%, but in 6% of the samples >15 % was found. The gravel fraction comprises shells and broken shells, and coral fragments.

The Murphy study area is again dominated by sandy loam and loam bottoms. Other textures like loamy sand, siltloam, clayloam or clay are only found in 1 or 2 samples, but overall the texture in this area shows more variation than in the other areas. In 18% of the samples small quantities (<5%) of gravel are found.

5.7.2 Total Organic Carbon

Total Organic Carbon (TOC) in all sediment samples is below 1%. The averages for the sampled study areas range between 0.22 and 0.41%. The range is 0-10-0.72% (90% of samples, upper and lower 5% excluded). TOC tends to be higher in samples with a higher clay and silt percentage.

5.7.3 Organics (Extractable Organic Matter - EOM, Total Petroleum Hydrocarbons - TPH)

The above mentioned studies present data for TPH (Total Petroleum Hydrocarbons), TRH (Total Resolved Hydrocarbons), UCM (Unresolved Complex Mixture) and EOM (Extractable Organic Matter) in sediment. TRH and UCM are component subsets of TPH. The TPH are the sum of the TRH and the UCM. The TRH are the non-degraded hydrocarbons.

The presence of TPH points to hydrocarbon pollution from natural or anthropogenic sources. The average levels of TPH within most of the above study areas is between 11.3 and 12.9 µg/g dry sediment, with a range between 4.6 and 60.4 µg/g. An exception if formed by the 2010 Teikoku study area where the average value is much lower with 3.8 µg/g, and a variation between 1.4 and 7.8 µg/g. The TRH comprise 57-63% of the TPH for the first three study areas, and 100% for the 2010 Teikoku study area. This indicates that the TPH in the areas consists predominantly of non-degraded hydrocarbons.

There are no defined standards or guidelines for TPH or EOM in marine sediments. But the TPH values for the current study areas are lower than those of sediments in the offshore area of Trinidad & Tobago CSA 2015b.

5.7.4 Metals

For previous studies in the Shallow Offshore Block total metals have been determined in sediment samples. For all samples in the four study areas, levels were below the average for marine samples, except for Arsenic (As) for which a maximum value of 22.9 µg/g was recorded, while the average for marine samples is 7.7 µg/g. However, all Arsenic values are well below the Apparent Effects Level (AEL) for Arsenic, which is 35 µg/g.

Only cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn) are metals that are considered of concern, and recommendations for threshold guidelines for sediment quality determinations are available. Data for mentioned metals are presented in **Table 11** together with prescribed standards as outlined in the Canadian Interim Sediment Quality Guidelines (CISQG). The values in **Table 11** do not exceed these standards.

Table 11: Summary of metals concentrations in sediment samples from previous study areas within the Shallow Offshore Block (CSA 210a, b and 2015a, b).

Study	Sample	Cadmium	Chromium	Copper	Lead	Mercury	Zinc
Murphy 2010, block 37	Maximum	0.07	14.2	6.1	9.9	0.03	34.6
	Minimum	0.02	8.8	1.4	3.3	<0.02	13.3
	Average	0.03	11.9	3.2	6.2	0.03	25.8
Teikoku 2010, block 31	Maximum	0.11	16.0	3.3	7.8	ND	22.8
	Minimum	0.03	6.7	0.7	2.6	ND	6.2
	Average	0.06	10.7	2.0	5.4	ND	15.7
Teikoku 2015, block 31	Maximum	ND	20.5	7.9	8.3	0.01	54.2
	Minimum	ND	6.9	3.4	2.9	0.01	25.3
	Average	ND	11.3	5.5	4.8	0.01	37.5
Petronas 2015, block 52	Maximum	ND	36.7	9.2	16.8	0.02	63.0
	Minimum	ND	10.4	4.1	2.9	0.01	30.5
	Average	ND	20.7	6.6	8.2	0.01	46.5
CISQG		0.7	52.3	18.7	30.2	0.13	124

5.8 Physical oceanography- Rivers

5.8.1 General Descriptions of the rivers

From the Amazon River in Brazil up to the Orinoco River in Venezuela, rivers from the Guiana Coast are discharging into the Atlantic Ocean. The Amazon River is by far the greatest one (**Figure 16** and **Table 12**). The mean discharge of the most important rivers, from east to west, is presented in **Table 12** below (Stuip 1982, Amatali 1993, Amatali & Naipal 1999).

Table 12: Discharge of main rivers along the Guiana Coast in m^3/s

Amazon	Marowijne	Suriname + Commewijne	Coppename + Saramacca	Corantijn + Nickerie	Essequibo	Orinoco
175,000	1,785	553	745	1,740	3,000	30,000

The outflowing fresh water of the Amazon is taken to the west by the Guyana Current. This leads to the development of large eddies, and the fresh water of the Amazon is mixed with the saline sea water. The influence of this mixing is also noticeable along the Suriname coast, together with the influence of the freshwater outflow of the local rivers and coastal swamps.

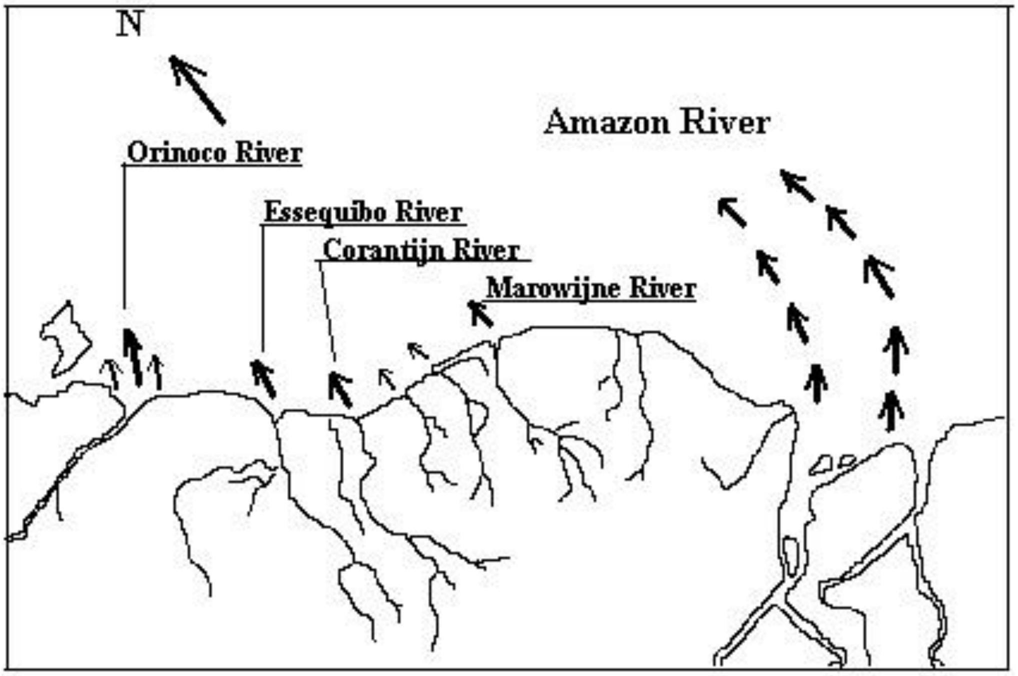

Figure 16: Main Rivers discharging into the Guiana Coast

At the eastern portion of the study area the Marowijne River is flowing towards the ocean. At the western boundary of the study area the Corantijn/Nickerie estuary river system is discharging into the ocean.

All rivers mentioned in **Table 13** flow more or less northward and parallel to each other except within the Young Coastal Plain, where the smaller rivers show a bending to the west, following which they discharge into the larger river (Commewijne into the Suriname River, Saramacca into the Coppename River and Nickerie into the Corantijn River).

5.8.2 Discharge

Table 13 provides discharge characteristics of the main rivers of Suriname.

Table 13: Hydrological characteristics of the main rivers in Suriname (Amatali & Naipal 1999)

Main river	Catchment Area in Km^2	Estimated discharge at outfall m^3/s			Specific discharge ($l/s/km^2$)
		average	maximum	minimum	
Marowijne	68,700	1,785	6,160	48	25.9
Commewijne	6,600	113	215	-	18.2
Suriname	16,500	440	1,800	220	25.8
Saramacca	9,000	255	1,260	5	25.0
Coppename	21,700	490	2,200	6	23.0
Nickerie	10,100	160	880	2	17.6
Corantijn	67,600	1,580	7,070	41	23.2

Comparing the estimated average freshwater discharge at outfall, the Corantijn and Marowijne rivers have by far the largest discharge, followed by the Coppename River and the Suriname River. The discharges of the east-west flowing rivers are all much smaller (**Table 13**).

The average mean monthly discharge over the period 1952-1987[4] of the main rivers is presented in **Figure 17**. The information refers to stations beyond the tidal limit. The figure illustrates the considerably higher discharge of the Marowijne and Corantijn Rivers compared with the other rivers. Of these two rivers the Marowijne has a significant higher discharge in the January-June period. The pattern across the year is more or less the identical for all rivers.

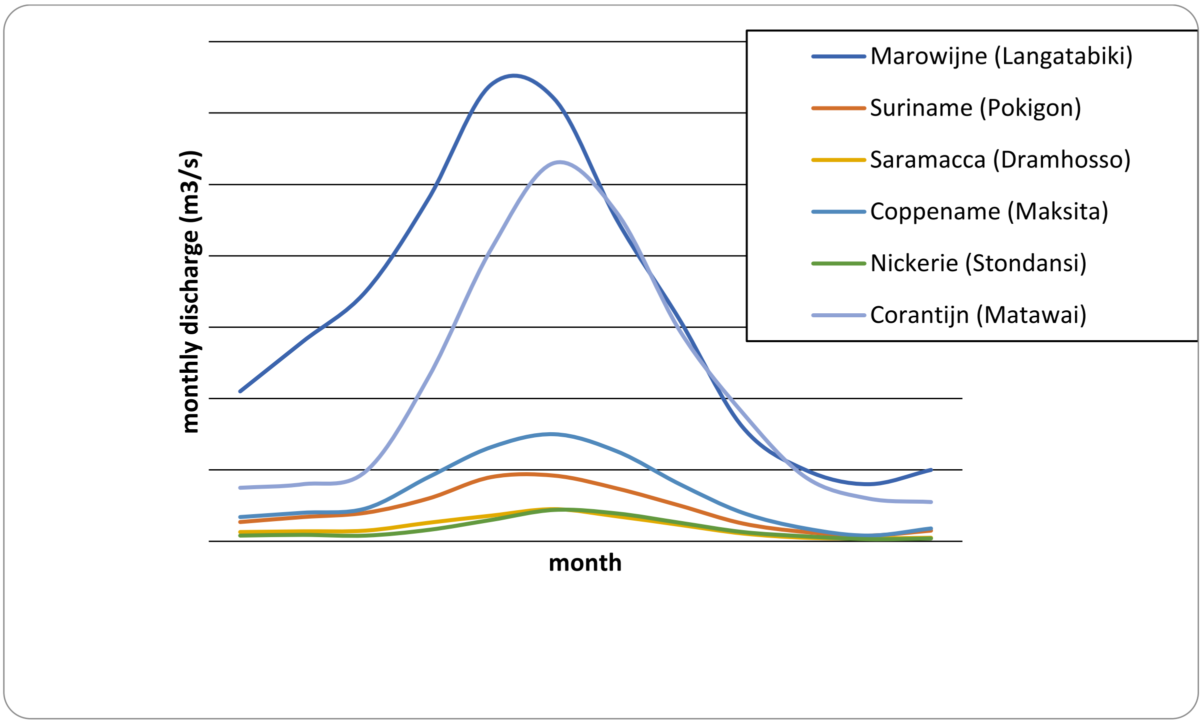

Figure 17: Annual variation mean discharge of the main rivers of Suriname

All rivers show peak discharge in the May-July period and lowest discharge in October and November. The Marowijne River has its peak earlier than the other rivers. The Suriname River is regulated by the dam at Afobaka. Due to this, the discharge downstream of Afobaka is very gradual across the year, with only a minor increase in the May-June period (**Figure 18**).

4 For most rivers data are only available for part of this period

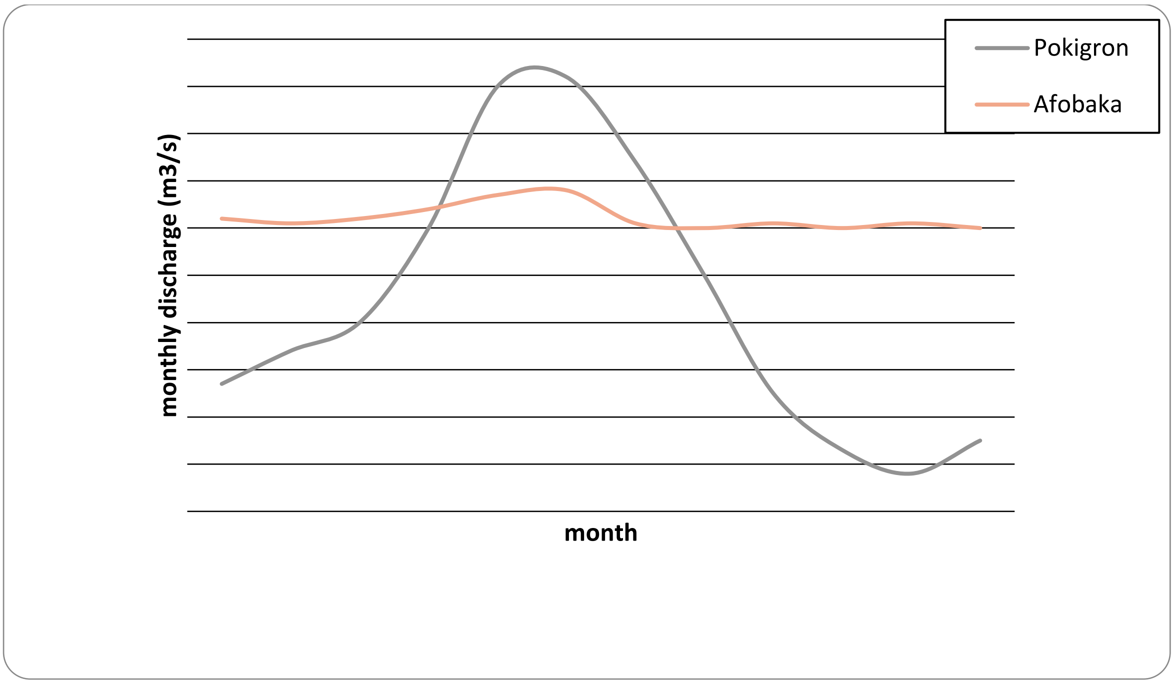

Figure 18: Annual Variation Mean Discharge of the Suriname River at Afobaka (downstream of dam) compared with Pokigron (upstream of dam).

5.8.3 Tidal influence in rivers

The estuary at the mouths of all river systems is tidal. The tidal amplitude moves upstream through rivers and creeks, far into the Young Coastal Plain and beyond, during which it is gradually decreasing. The variation of the propagation speed of the tide is fairly large. Between Paramaribo and Geleidelicht this speed is about 25 km/hr, and it takes longer than one hour for the tidal wave to travel from Geleidelicht to Paramaribo.

During a tidal cycle a volume of water is flowing into the river during the flood-flow and during the ebb-flow this same volume of water is flowing back towards the sea, together with the freshwater discharge from the river. The volume of water flowing into the river and back to the sea, the so-called tidal prism, depends upon the tidal range. Tidal characteristics of the Suriname rivers are presented in **Table 14**.

Table 14: Tidal characteristics of the rivers in the study area

River	Mean tidal range at outfall (m)	Tidal volume (10^6 m^3)
Corantijn	2.0	300
Coppename	2.0	75
Suriname	1.8	125
Saramacca	n.d.	50
Nickerie	2.0	10
Commewijne	1.9	40
Marowijne	2.0	200

5.8.4 Salt intrusion in rivers

The mean salinity of sea water is $34^0/_{00}$ and in tropical areas it may increase up to $36^0/_{00}$ due to evaporation. Going upstream the river the salinity decreases due to dilution with fresh river water. In the estuaries of the Surinamese rivers the salinity depends upon the tidal effect of the Atlantic Ocean in the water system and on the freshwater discharge from upstream, including from the Amazon River. Near the coast the salinity is lower than further into the sea.
During the rainy seasons, when the freshwater discharge is maximum, the salt intrusion is minimum, and during the dry seasons when the freshwater discharge is minimum the salt intrusion is maximum.

5.8.5 Sediment transport

The rivers in Suriname have a low sediment load. The sediment discharge of all Surinam rivers combined is estimated at 3.3 million tons a year (adapted from Amatali 1993). This is only a fraction of the sediment load from the Amazon River that is transported along the Suriname coast every year (150 million tons; Eisma et al. 1991).

5.9 Physical oceanography- coastal waters

The continental shelf north of Suriname has an average width of 150 km and a smooth slope (averaging 1:1,500) to about 90 to 100 m depth. The coast of Suriname is very dynamic whereby continuously there is accretion and erosion, associated with westward movements of mudbanks in front of the coast. Sediments originating from the Amazon River Basin are transported by the water in western direction in front of the coast. This transport of material in the Surinamese coastal waters is caused by combined activity of the waves and currents, including the tidal streams. The Guiana Current is an important component influencing the currents in front of the coast of Suriname and north coast of South America. It is actually the continuation of the confluence of the South and North Equatorial Currents, whereby the South Equatorial Current is the most important one along the Suriname coast **(Figure 19** and **Figure 20**).

5.9.1 Currents

The wind stress to the Atlantic Ocean is doubtless the most important driving force for currents in the upper strata of the ocean. The exchange of heat and water across the air-sea boundary is next in importance, inducing thermohaline currents. Both components are not independent of each other. The trade wind system in the Atlantic induces the South and North Equatorial Currents. The South Equatorial Current carries South-central Atlantic water along the Brazilian and Guiana Coast and mixes with water coming from the North Equatorial Current into the Caribbean Sea, as shown in **Figure 19**.

The wind-driven Guiana Current represents an extension of the South Equatorial Current, and flows in a northwest direction parallel and close to the Guiana Coast in the relatively shallow fore-shore. The current pattern has some significant deviations from the average northwest going current. The Equatorial Countercurrent is flowing southeastward during spring and summer, which results from balancing the westward flow of water due to the Equatorial Current, see **Figure 19**. The velocity of the latter is less than the Guiana Current and occurs more offshore. Besides, the prevailing trade winds blowing from southeast directions also produce waves that result in a steady long-shore current flowing northwestwardly in the shallow water along the shore.

As mentioned before the Guiana Current is an extension of the South Equatorial Current, and flows in northwest direction parallel and close to the coast. The discharge of the Guiana Current is estimated at 5 to $10x10^6$ m3/s over a width of 250 km off French Guiana up to 500 km off Suriname. The maximum velocity is 1.5 to 2 m/s at upstream location at French Guiana and decreases in western directions. In East Suriname the Guiana Current varies between 1.1 and 0.75 m/s respectively during the rough season (April/May) and calm season (September-October), decreasing to 0.5 and 0.3 m/s for western Suriname locations. The main current leaves the coast at a point west of French Guiana.

Here the trade winds blowing from the southeast theoretically give a surface current in the northeast direction, so offshore. The water on the continental shelf should be replaced by the bottom waters that flow up the continental slope. Measurements have indicated that the angle between the velocity vector at the surface and the bottom tends to become larger with increasing depth. The resultant current velocities in the surface layer are 0.20 to 0.90 m/s and slightly directed offshore. In deeper layers the current is flowing landward, velocity of about 0.10 to 0.60 m/s. This circulation pattern holds qualitatively for the area off French Guiana, adjacent Brazil, Suriname and Guyana (Augustinus 1978, NEDECO 1968, Stuip 1982).

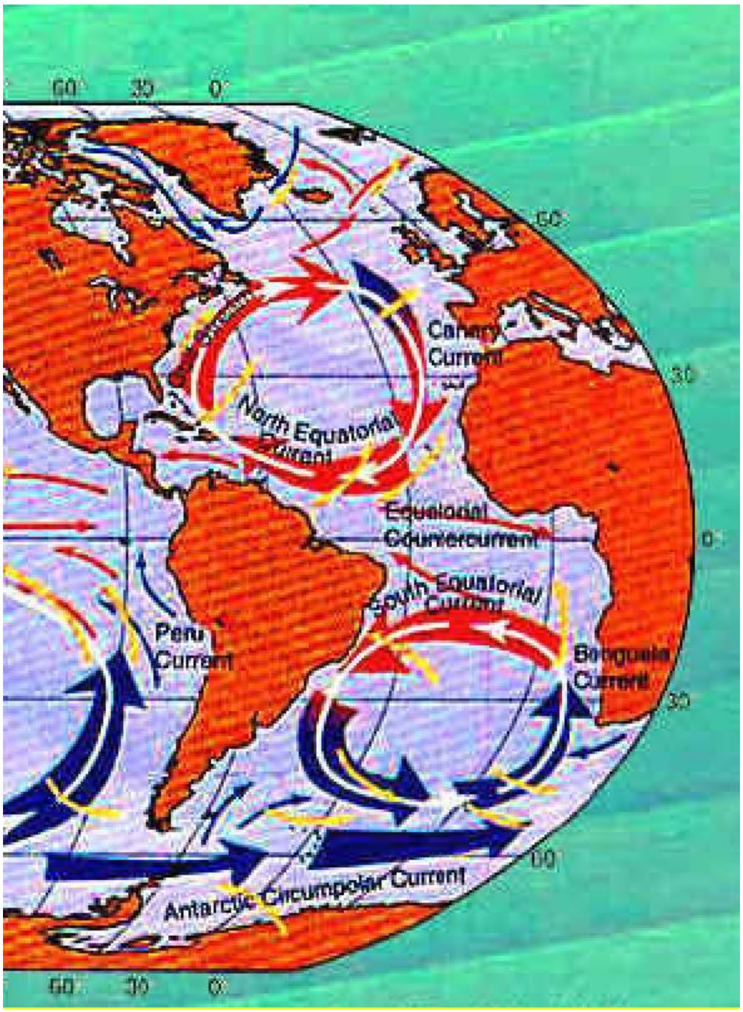

Figure 19: The South and North Equatorial Current

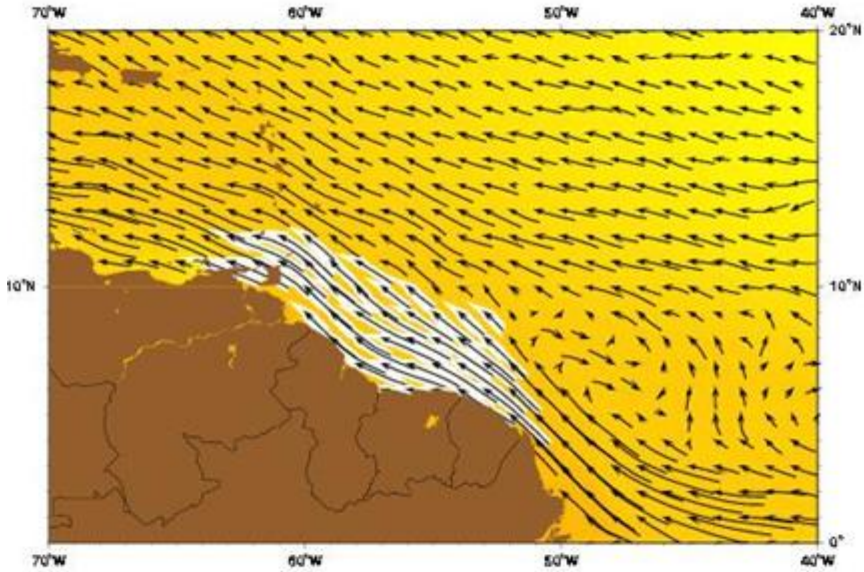

Figure 20: The Guiana Current (After Gyory *et al*.)

Results of velocity measurements by Eisma & Van Bennekom in 1966 confirm that the flow direction is different at different depth (**Figure 21** and **Figure 22**).

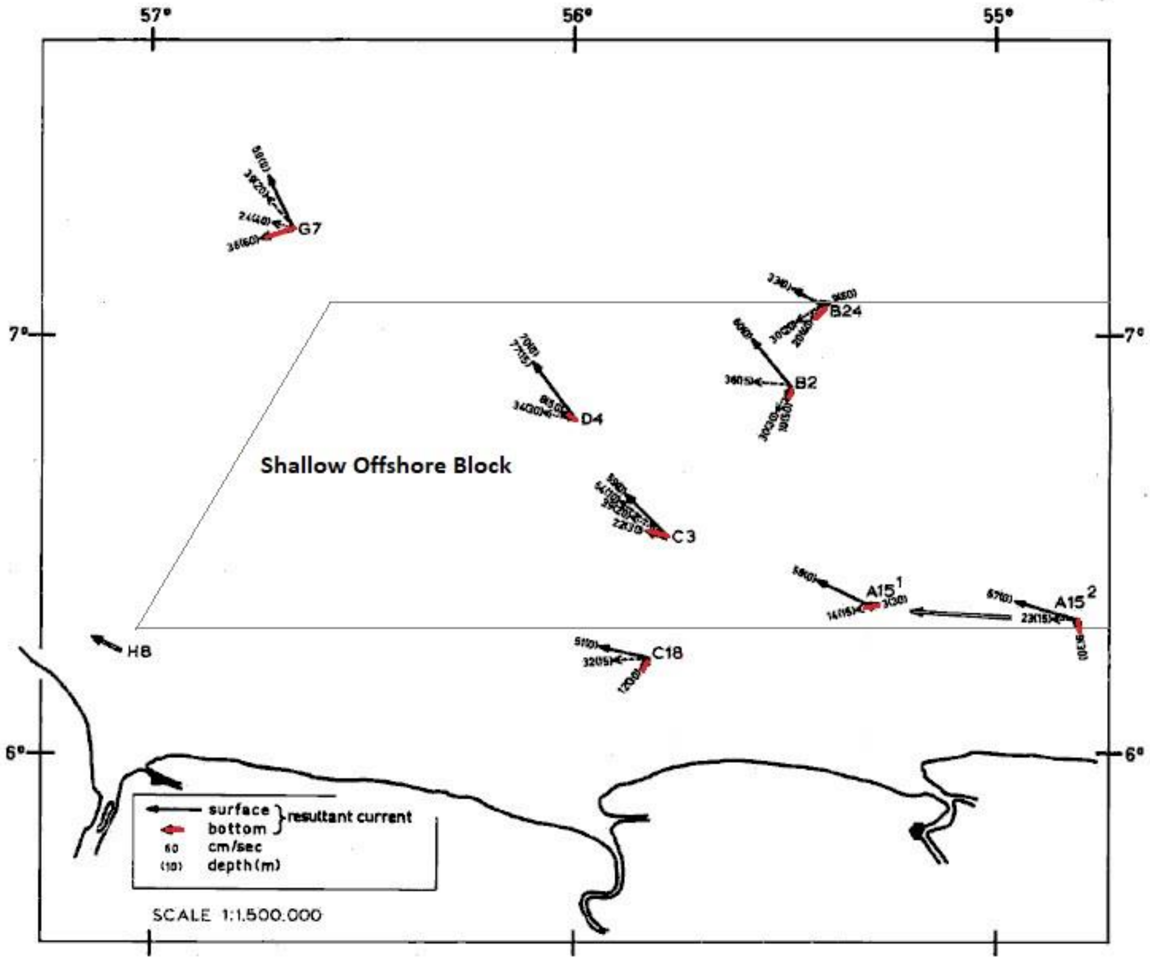

Figure 21: Resultant currents at various depths (Eisma 1967).

From measurements by Eisma & Van Bennekom (1967) at location C18, found near the NW corner of Staatsolie Block IV (shown in red in Figure 18) it can be concluded that the flow direction at the surface is mainly varying between west and northwest, whereby the flow is mainly seaward directed. At a depth of 15m the flow direction is varying between southwest and northwest. And at a depth of 30 m there are southeastern to southwestern flow directions, with clearly landward directed flows.

Similar results were obtained during measurements (April 2010-April 2011) in block 31 (CSA 2015a), which is situated approximately 100 km north of District Coronie. Near-surface currents here are mostly to the west and northwest with a speed most of the time between 0.6 and 1.2 m/s. Peaks up to 1.6 m/s were recorded in September 2010 and April 2011. At mid-water depth the direction of the currents is variable but with dominating north and westerly vectors and with speeds typically between 0.3 and 0.8 m/s. Near-bottom currents have opposing directions to the south-southwest and north-northeast, while the speed is between 0.1 and 0.3 m/s.

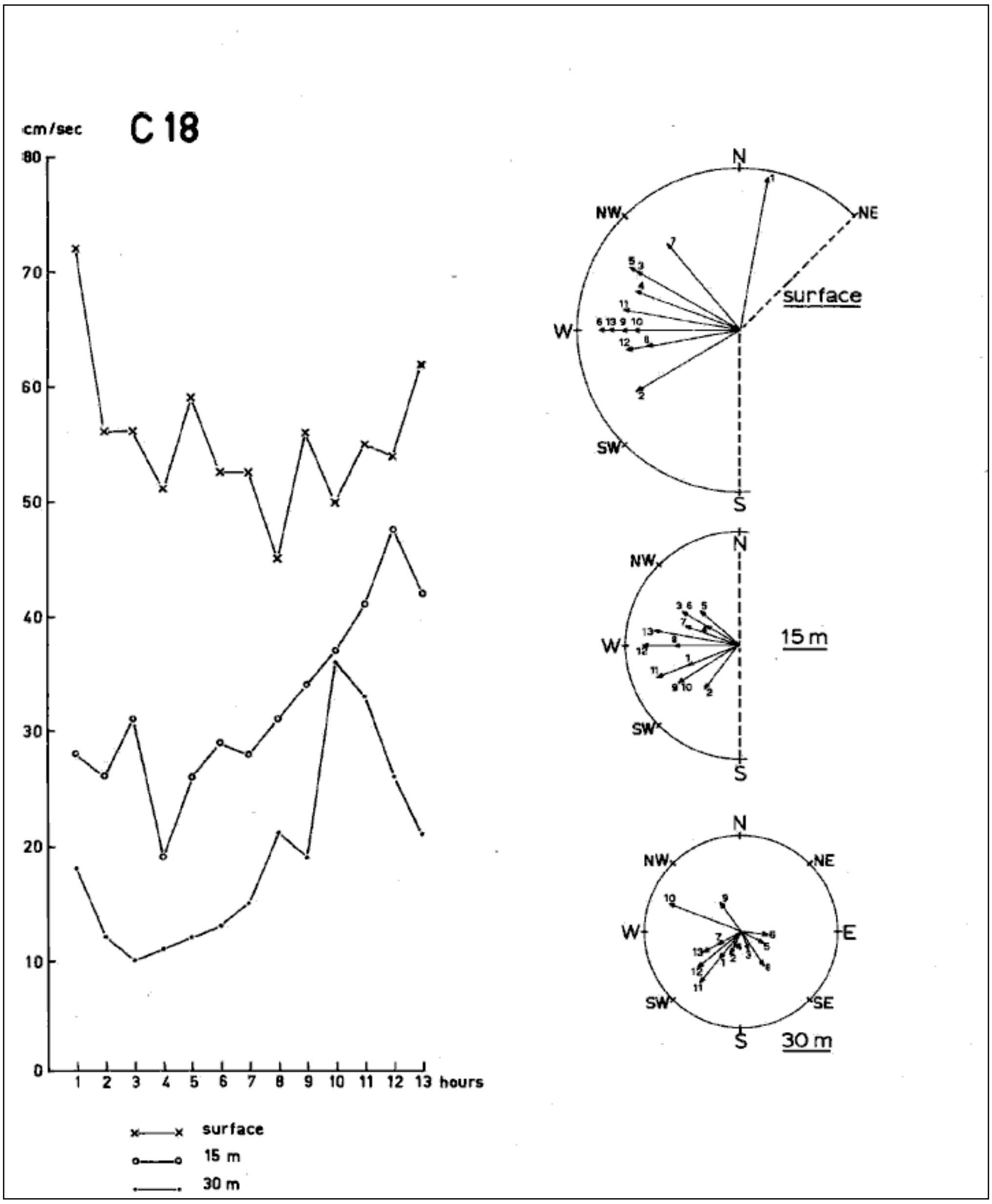

Figure 22: Current velocity and current direction at various depths during 13 hours at station C18 (Eisma 1967).

5.9.2 Tides

The tide along the Suriname coast is semi-diurnal and occurs almost synchronously along the Surinamese coast. Generally, the tidal range varies between 1.00 m at neap tide and 2.80 at spring tide, of which the average is 1.8 m. Due to this relatively large amplitude and the rather flat shelf gradient, there is an extensive intertidal area along the coast and the river estuaries. There is a cycle of 18.6 years in the tide (Augustinus 2004).

The tidal wave is almost perpendicular to the coast with tidal currents straight onto the coast and backwards. The velocities are very low except in the estuaries. The tidal currents affect the water movement along the coast, with a southwestern deflection of the generally westward flow by the prograding flood wave, and a northwestern deflection due to the receding ebb wave.

5.9.3 Waves

According to data of the Royal Netherlands Meteorological Institute, which are results of visual wave observations from a great number of Dutch merchant vessels all over the world, for the area between 5º and 10º N and 50º and 60º W, the highest waves in front of Suriname would occur from December to March. According to the same data, September used to be the calmest period of the year; see **Figure 23** where the 10% and 50% significant wave heights are presented for all the months throughout the year, as well as the mean direction from which the waves come. The last-mentioned parameter varies between 50º and 80º, meaning predominantly northeasterly tot east- northeasterly directions (NEDECO 1968).

According to current information from fishermen, the Fishery Department of the Ministry of Agriculture, Husbandry and Fishery, and the Maritime Authority Suriname, nowadays the sea is very rough during the months December to February. In March/April it is still rough, however the sea is becoming calmer. During the months July to September the sea is calm, whereby September is the calmest month. In October the sea is still calm but it is gradually becoming rougher and in November it is already rough. This is in agreement with the data presented in **Figure 24**.

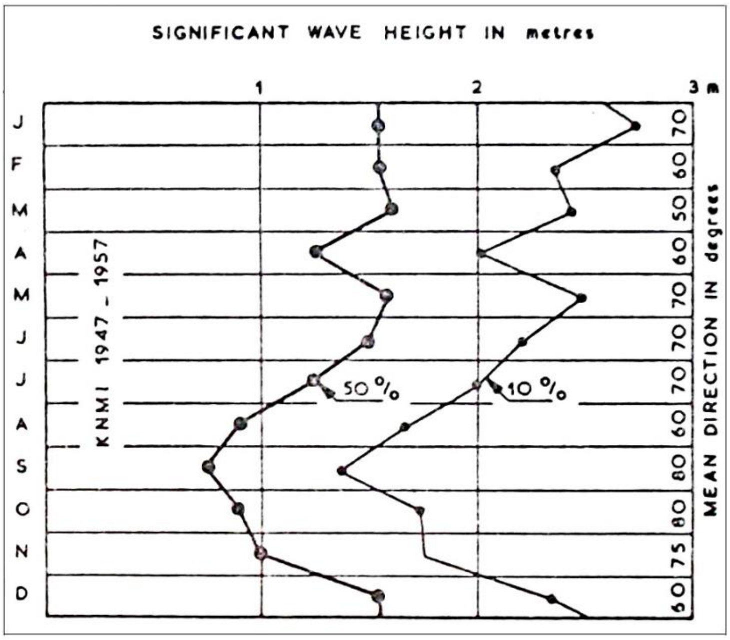

Figure 23: Significant Wave Height throughout the year (NEDECO 1968)

The average wave height over the period December to March is about 1.6 m, while a height of 2.5 m is exceeded during 10 % of the time **(Figure 24**). The month September appears to be the calmest period with an average height of 0.75 m. A height of 1.35 m is exceeded only during 10% of the time during this period. Generally speaking, higher monthly average wave heights are associated with higher monthly wind speeds, but apart from the interaction with local wind conditions, also currents, and regional level forcings such as ocean swells have an effect on wave height.

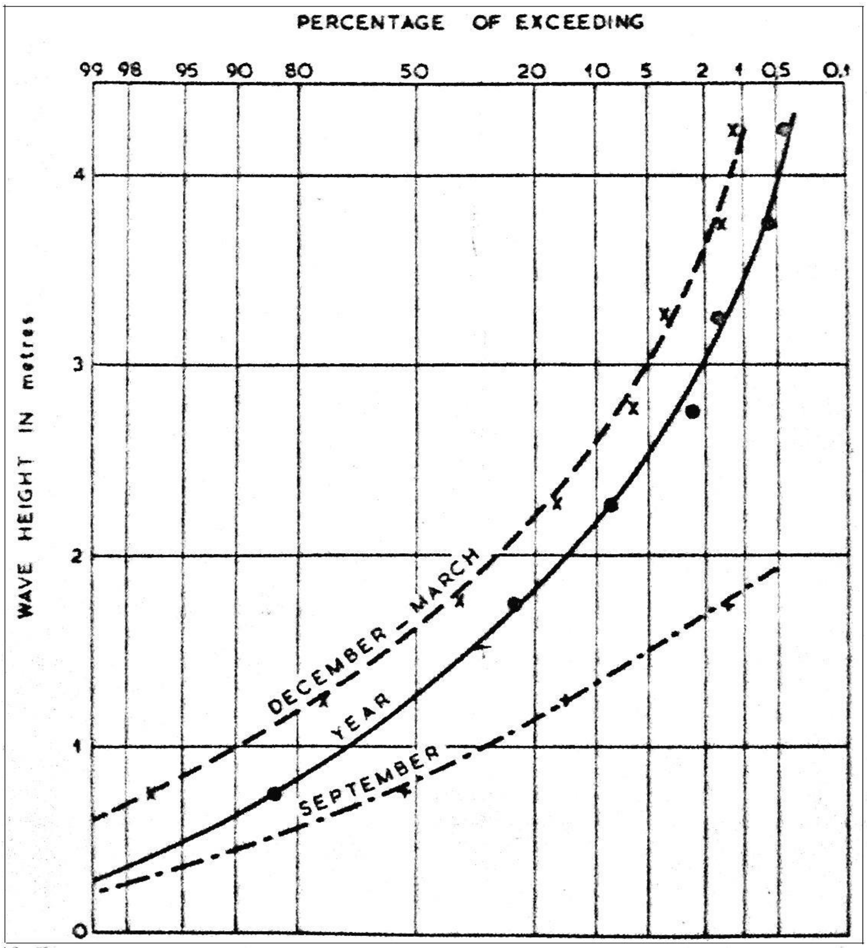

Figure 24: Probability of Wave Height (NEDECO 1968)

Observations made during the CSA studies (2010a,b and 2015 a, b) are in line with the above; see for example **Figure 25** that presents the results of wave height measurements in Block 31 (CSA 2015a).

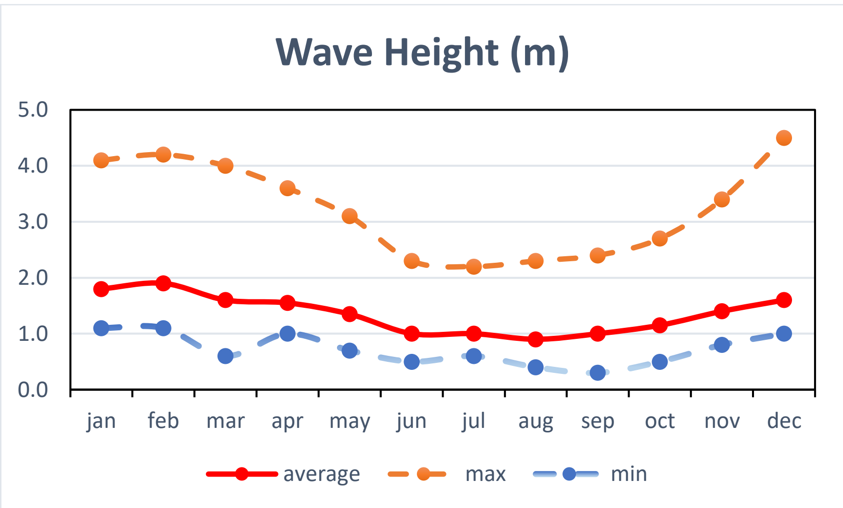

Figure 25: Wave height (m) Block 31 study area from April 2010 to April 2011 (CSA 2015)

Figure 26 presents information about the wave period, which is the time between two waves. During the months December to March the average wave period is slightly less than 7 seconds, with variations between 5 and 13 seconds. During September the periods are about 2 seconds shorter. Similar results are reported by CSA (2015b) based on measurements in block 52 in the period October 2014 to February 2015.

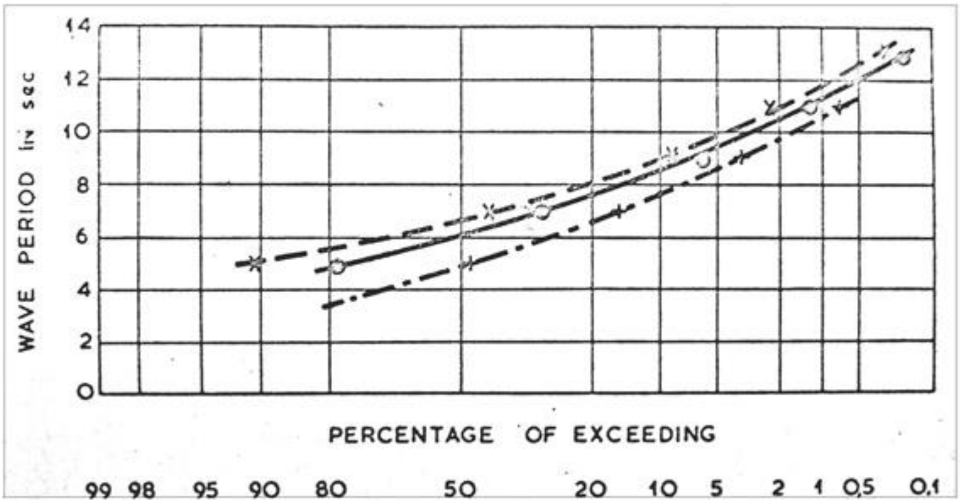

Figure 26: Probability of the Wave Period (NEDECO 1968)
+ = September
x = December-March
o = Year

5.10 Hydrography

In total 13 water column profiles have been obtained during previous studies in the Shallow Offshore Block (CSA 2010 a, b and 2015 a, b). The profiles provide hydrographic parameters and profiles through the water column with information of the physical nature, water quality, and probable source of the water masses in an area.

All four studies conclude that the collected hydrographic data are indicative of tropical open ocean conditions with good water quality, with a strong influence of riverine input.

The water was less saline near the surface at virtually all locations. The salinity of deeper layers is usually around 36 psu, which is typical for ocean water. The measured salinity in the surface water is normally 2-6 psu lower than the salinity of the deeper water. In some cases, a halocline[5] is present. The lower salinity of the surface water is explained from the input of river water, with a considerable contribution from the Amazon River.

Surface waters are warm (27-28 degree Celsius) but going downwards the water becomes cooler. Temperatures of 23.0-24.5 degree Celsius were occasionally recorded at depth, and sometimes a clear thermocline[6] is present. The latter could indicate upwelling of water from the deeper ocean.

The pH of the water is virtually always 8.0-8.2, which is normal for sea water. Usually there is a slight decrease with depth.

Turbidity is low throughout, with values typically between 0.1 and 0.5 NTU. In many profiles the turbidity of the surface water and of the near-bottom water is slightly higher (up to 2.5 NTU). For the surface water this is caused by input of sediments from rivers or near-coastal (brown) water influences. The higher near-bottom turbidity is the result of resuspension of bottom sediments.

[5] A halocline is caused by a strong, vertical salinity gradient within a body of water.
[6] See halocline, but for temperature

Dissolved Oxygen (DO) is normally 6.0-6.5 mg/L in the surface water, with a slight decrease in deeper water (5.0-6.0 mg/L). An oxycline[7] is incidentally observed. In two profiles a DO of 3.5 mg/L has been measured in the upper water layer.

5.11 Chemical Oceanography

Water samples were taken at three depths at all hydrographic profile locations (13) during the previous studies in the Shallow Offshore Block (CSA 2010 a, b and 2015 a, b).
Total Petroleum Hydrocarbon (TPH) concentrations in all samples for all study areas were below the detection limit, while Extractable Organic Matter (EOM) ranged between 101 and 433 μg/L. The value is below the detection limit for about 25% of the samples. The absence of detectable levels of TPH in the water column would be expected for open ocean conditions in the absence of oil and gas activity and nearby natural sources such as seepage areas.
The distribution of EOM through the water column varies between locations, with sometimes higher levels in the near-surface samples, or the midwater samples (both 27%), but more often in the near-bottom samples (46%). Primary production in the upper water column is likely the source of organic matter in the water column, but also riverine input and outflowing from coastal mangroves could provide organic matter.
The Total Suspended Solids (TSS) in the water column is generally low, with less than 10 mg/L, except for Block 37 (CSA 2010a) where values up to 20 mg/L were recorded. There is no specific distribution pattern within the water column and between locations. In general, the TSS values were higher than typical open ocean values. The solids are originating from the sediment-laden coastal waters and brought to the study areas by fluctuating currents. For the near-bottom samples the suspended solids could also be the result of resuspension of bottom mud.
It is to be expected that the Total Organic Carbon (TOC) and the Dissolved Organic Carbon (DOC) are subjected to similar conditions as TSS. CSA 2010 a, b report fluctuating values with day and depth for the DOC and TOC in water samples, while CSA 2015a, b have highest values in the near surface samples.

In the past a number of studies have been conducted on the water quality of the continental sea of Suriname. These included oceanographic observations in 1966 (Eisma 1967) and 1969 (Eisma & Van Bennekom 1971), and measurements for primary production in 1970/71 (Cadee 1975). The following is a summary on the nutrient status of the waters of the continental shelf.

Surface water concentrations of phosphate, nitrate and nitrite generally are highest in near-shore turbid zone. The main source of these nutrients is mineralization of terrestrial organic detritus. In the less turbid offshore water further offshore (Green Zone), the nutrient concentrations are lower, as nutrients are apparently used by phytoplankton.
Notwithstanding the relatively high nutrient concentrations in the Brown Zone, primary production is highest in the Green Zone, with light being the limiting factor for production in the very turbid Brown Zone.
The nutrients that are responsible for a relatively high primary production in the Green Zone originate from three sources: upwelling, mineralization of terrestrial organic detritus in the coastal zone, and the Amazon River (Cadee 1975).

[7] See halocline, but for oxygen.

6 Biological Baseline

The biological baseline assessment includes the description of the habitats in the study areas as well as associated phytoplankton, benthic organisms, fish and shellfish, marine turtles and mammals, and birds.

6.1 Habitats

The study area is situated above the Continental shelf of Suriname's marine area. This Continental shelf starts where the littoral zone (tidal area) ends and extends to approximately 150-165 km north of the coast where it gives way to the Continental slope (starting at approximately 100m depth). According to Teunissen (1988) the water column in the study area can be divided into different ecological zones / habitats based on depths (pelagic zones) and benthic characteristics (benthic zones). The pelagic zones above the Continental shelf include:

- Epipelagic zone: also known as the euphotic, illuminated or sunlight zone, is very thin (a few decimeters) near the coast and thickens towards the Continental slope where it almost as deep as 100m. The epipelagic zone contains many fast-swimming and silver-colored fish (e.g. Tuna, Barracuda), marine turtles and mammals, jellyfish and birds;
- Mesopelagic zone: also known as the twilight zone, starts almost at the surface near the coast and basically includes the entire water column between the epipelagic zone and the ocean bottom above the Continental shelf. The mesopelagic zone is home to fauna which is accustomed to darker environments, e.g. fish with relatively large eyes or fluorescent body parts;
- The Bathypelagic (200-1500m depth) and Abyssopelagic (1500>m depth) zones or midnight zones are pitch black and cannot be found above the Continental shelf (i.e. not within the study area) and are therefore not expanded upon as part of this study. See **Figure 27**.

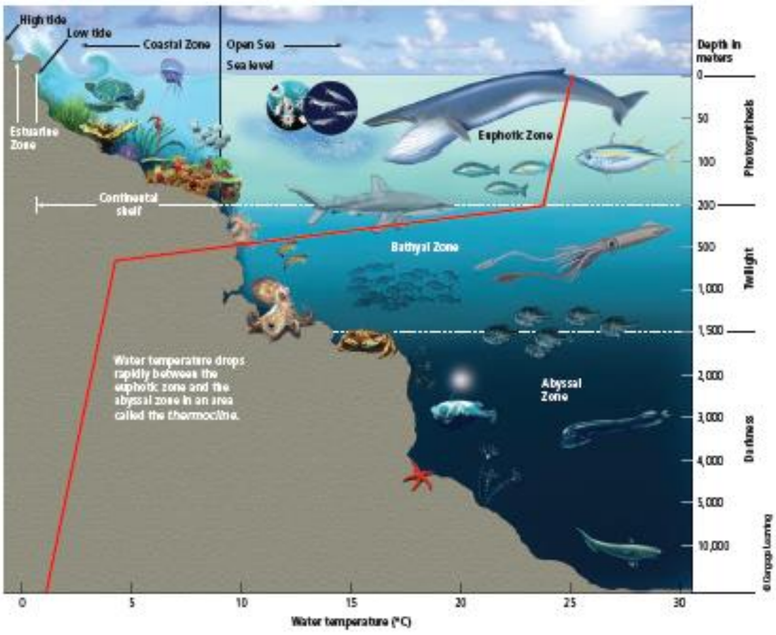

Figure 27: The Bathypelagic (200-1500m depth) and Abyssopelagic (1500>m depth) zones (Miller G.T & Spoolman S. 2016. Environmental Science. Fifteenth Edition. Cengage Learning, USA)

Benthic zones (i.e. upper layer of bottom sediment) are dependent on water depth and characteristics of the ocean bottom. Right at the coast, the benthic zones start with the littoral or tidal zone and include mud-banks and sandy beaches. The bottom of the remaining continental shelf (>20 m) consists of sandy to loamy sediments, locally with gravel comprising shells and coral fragments.

In the Continental Sea three sub-zones, each approximately 50 km wide, are distinguished (**Figure 28**). These zones have been distinguished based on depth classes, but the actual locations of the boundaries have not been checked in the field. Therefore, the depth classes of the zones are rather arbitrary and moreover they are subjected to changes over the season and in time. Variations in mud supply, waves and currents, wind direction and speed all have influence on the boundaries of the zones.

The sub-littoral area which extends to 100m depth can be subdivided into three general zones:

- The inner- or brown zone (0-30m depth, 20,000 sq. km): the water in the brown zone is loaded with sediments originating from the Amazon River and driven north-west by the Guiana current; these floating sediment particles cause its brown color and high turbidity. Although the water in this zone is high in nutrients coming from the sediment and dead organic matter there is little primary production as a result of the high turbidity. Light penetration is often less than 10 cm. Within this zone, the shallower coastal waters (between the 6 m depth contour and the coastline) are known as the *Shallow Sea (sub) Zone*. This zone is 7-18 km wide (about 12 km on the average) and measures about 4,500 sq. km. This latter (sub) zone is part of the existing Multi Use Management Areas (MUMA's). The bottom mostly consists of fine sediment (sludge). The absence of primary production makes local fauna dependent on the dead organic material which is supplied by tidal creeks and rivers. The resulting fauna therefore consist mostly of detritivores (e.g. shrimp);
- The middle- or green zone (30-60m depth, 20,000 sq. km): the green zone has a lower sediment load than the brown zone and therefore has a thicker euphotic (light) zone. The color in the green zone is caused by algae which are abundant due to the abundance of nutrients (offshoot from the brown zone) and the availability of light. The bottom is sandy and receives detritus from the euphotic zone (above). Benthic fauna therefore consists of detritivores such as shrimp, crabs, lobsters, etc.;
- The outer- or blue zone (>60m depth, 25,000 sq. km): water in the blue zone is clear since it does not receive sediments from the coast nor from the ocean-bottom. Although there is sufficient sunlight, the low nutrient content results in very low primary production. Along the edge of the shelf (fossil) coral reefs are found. The Blue Water Zone extends from the continental sea to the north into the deep sea. Due to the lower primary production and therefore lower deposition of dead organic material onto the ocean bottom, the population densities of benthic fauna are lower than in the green zone.
- In between the Green and Brown Zone is a mixed zone, partially also indicating the variation between zones in time.

All zones are present in the Shallow Offshore Block, but the blue and green zone are dominating. The majority of previous ESIA studies were undertaken in the Blue Zone.

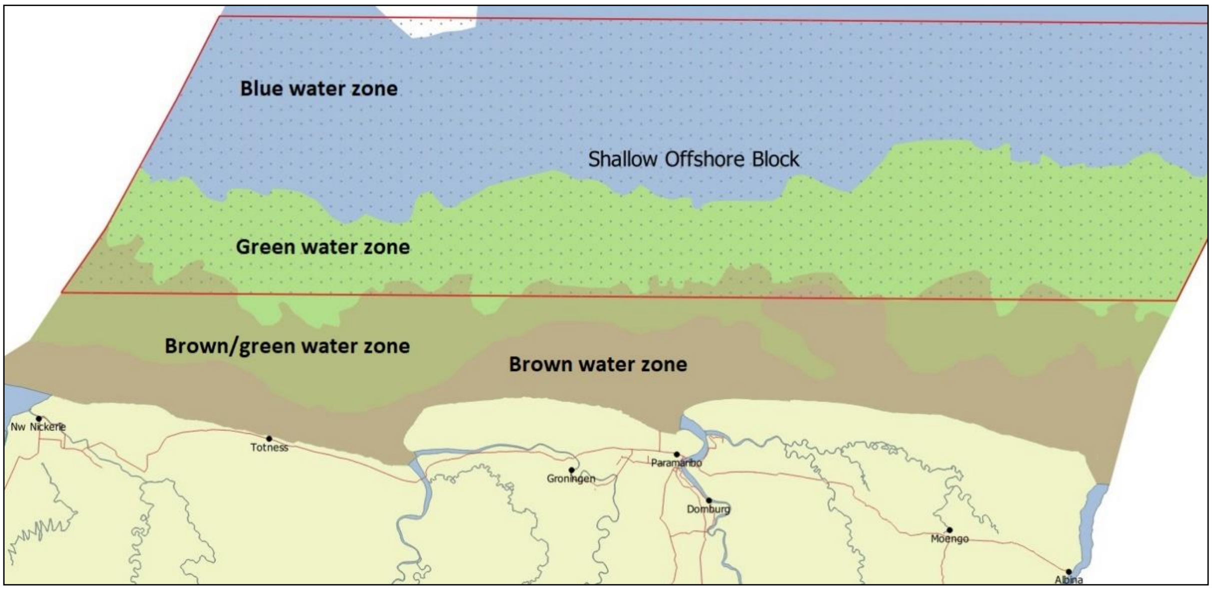

Figure 28: Marine Zones of Suriname (Map of the Coastal & Marine area of Suriname, WWF 2018?)

6.2 Phytoplankton

In addition to nutrient load and light availability, as mentioned in the section above (3.1.1 Habitats), the phytoplankton composition depends on hydrological (upwelling, vertical stratification) and seasonal variation (rains). As reported in previous studies (CSA International, Inc., 2010; CSA Ocean Sciences Inc., 2018) and based on data from the SeaWiFS Project8, phytoplankton in Suriname's ocean varies seasonally with the highest productivity occurring between March and August in shallow waters. Although not specified in these studies, it can be assumed that the latter (i.e. shallow waters) refers to the green zone (30-60m depth). A more recent global study of phytoplankton distribution (Righetti et al. 2019) found that phytoplankton richness is highest and least variable throughout the year in the tropics. A time-lapse GIF map created as part of this study (https://scx2.b-cdn.net/gfx/news/hires/2019/5cdd71f4e5604.gif) indeed shows a constant presence of many phytoplankton species in Suriname's ocean with some seasonal variation and probably the highest diversity in August. To date, very little is known about the geographic and seasonal diversity of phytoplankton on a global scale (Righetti et al. 2019). This is also the case for Suriname.

6.3 Benthic organisms

Information regarding invertebrate communities in offshore Suriname waters is limited and mostly restricted to surveys performed as part of previous EIA's. These benthic surveys (summarized in CSA Ocean Sciences Inc. 2015) found a diverse assemblage of infaunal feeding and motility types, with all primary feeding modes represented. Of the top 20 taxa found (**Table 15**), annelid or polychaete worms were numerically dominant followed by arthropod crustaceans' amphipods and decapods. Mollusca most probably also occur but not in such substantial numbers. Towed video surveys identified the substrate as relatively smooth and featureless with fine sediment typically overlaying coarser material. Algae, sea pens and black corals were identified as main feature in benthic communities.

[8] Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Project is part of the National Aeronautics and Space Administration Earth Science Enterprise. SeaWiFS uses satellite remote sensing to measure phytoplankton concentrations in the ocean. During the current desk study, the webpage of this program (http://oceancolor.gsfc.nasa.gov/) was not accessible and therefore prevented an update on these findings.

Table 15: To individual taxa collected during surveys in Block 31 and 37 offshore Suriname (adapted from CSA Ocean Sciences Inc. 2015)

Taxon	Feeding Mode	Motility
Ampelisca paria	Deposit feeder; filter feeder	Sessile
Amphipod sp. D	Deposit and/or filter feeder (est.)	Sessile
Marphysa sp. A	Carnivore	Motile
Prionospio sp. A	Surface deposit feeder	Discretely Motile
Lumbrineris sp. A	Carnivore	Motile
Ophionephthys sp. A	Surface/subsurface deposit feeder	Motile
Notomastus sp. A	Subsurface deposit feeder	Motile
Amphicteus sp. A	Surface deposit feeder	Sessile
Glycera sp. A	Carnivore	Discretely Motile
Amphipod sp. C (Aoridae)	Deposit feeder; filter feeder	Sessile
Penaeus sp. A	Omnivore	Motile
Cirratulus sp. A	Surface deposit feeder	Motile
Onuphis sp. A	Carnivore	Motile
Magelona sp. A	Surface deposit feeder	Discretely Motile
Harmothoe sp. A	Carnivore	Motile
Eunice sp. A	Carnivore	Motile
Hesione sp. A	Herbivore	Motile
Alpheus sp. A	Omnivore	Motile
Nephtys sp. A	Carnivore	Motile
Terebellides stroemi	Surface deposit feeder	Sessile
Lucifer sp. A	Omnivore	Motile

Figure 29 below displays locations of some of the benthic organisms found, e.g. sea pens & corals (NOAA 2019). Sea pens are located on the Continental shelf, while the corals and sponges are on the Continental slope.

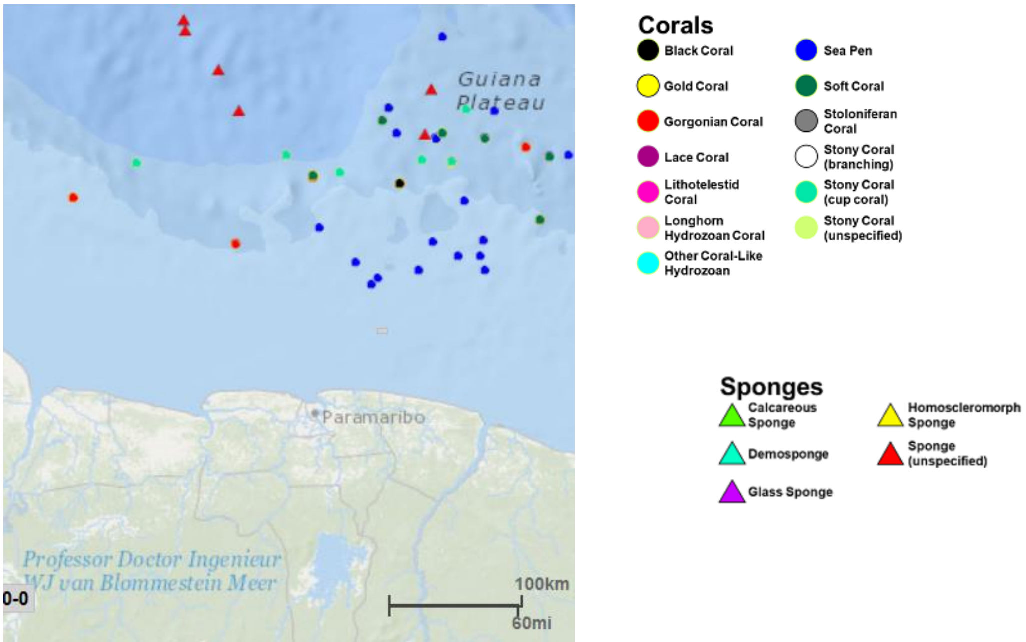

Figure 29: Deep-Sea Coral & Sponge Map (NOAA 2019)

6.4 Fish & Shellfish

A survey conducted by the Food and Agricultural Organization (FAO 1988) determined the fish species composition of Suriname's Continental shelf. This survey provides a comprehensive overview of fish diversity and is used for most of the description below. A more recent online database, Fishbase (Froese and Pauly 2012) lists 694 marine fish occurring in Suriname[9], with 3 commercial and 43 (potential) game species, no endemic and 32 listed on the IUCN Red List. Given the time that has elapsed since the FAO (1988) survey, the general character of information provided by Fishbase and the many changes that might have occurred over the years as a result of fisheries and other disturbances, an updated study at least as comprehensive as the FOA (1988) survey would have to confirm what current fish diversity and densities are.

Pelagic Fish

Most of the fish biomass were found close to the river mouths where production is high. Small pelagic fish from the families Engraulidae (anchovies), Clupeidae (herrings, sardines, shads, hilsa and menhadens), and Carangidae (jacks, pompanos, jack mackerels and scads) were mainly restricted to the inner shelf area throughout the year and moving somewhat more offshore in May. Predators such as barracudas, scombrids and sharks accompanied these smaller pelagic fish which form their main food source. Fish densities at depths ranging from 50-100m were much smaller and often found to be distributed in small schools and aggregations. In addition, the species diversity was much lower, i.e. Engraulidae were absent, Clupeidae were exclusively represented by adult *Sardinella aurita* and the Carangidae mainly by *Trachurus lathami* and *Selar crumenophthalmus.*

Fish abundance in general varies considerably throughout the year with particularly low rates in August for all groups. This coincides with reduced upwelling and thus decreased local primary productivity.

Demersal Fish

Suriname's demersal species groups (i.e. fish occurring near or at the bottom of the ocean) mainly consist of snappers, croakers and grunts. While snappers dominate the outer shelf, the inner shelf holds important resources of snappers, croakers and grunts. Inner shelf species include lane snapper *Lutjanus synagris*, Corocoro grunt *Orthopristis ruber*, king weakfish *Macrodon ancylodon*, acoupa weakfish *Cynoscion acoupa*, dwarf goatfish *Upeneus parvus*, American harvestfish *Peprilus paru* and Jamaica weakfish *Cynoscion jamaicensis* in decreasing order of quantity. For the outer shelf the main species are vermillon snapper *Rhomboplites aurorubens*, southern red snapper *L. purpureus* and cardinal snapper *Pristipomoides macrophthalmus*.

Preliminary findings suggest that snapper stocks seasonally migrate in summer from the offshore Suriname shelf into more inshore Guyanese waters.

Sharks

The presence of sharks is also determined by the presence of small pelagic fish. As a result, a greater density of sharks occurs on the inner shelf. Requiem sharks include the smalltail shark *Carcharhinus porosus* and the night shark *C. signatus*, the Caribbean sharpnose shark *Rhizoprionodon porosus* was by far the most common of this group and the scalloped hammmerhead *Sphyrna lewini* dominated this group. Given the semi-pelagic behavior of sharks, it could be that both quantities and species are underestimated given the sampling method (slow-moving bottom trawl).

Squid

Squid catches were found to be small or modest with the highest recorded catches in May. Distribution was patchy, which suggested special 'squid grounds'. Over 95% of the squid consisted of

[9] It must be noted that the list is for the entire marine area of Suriname, i.e. not only the study area

Loligo species with *L. plei* dominating and with smaller amounts of *L. pealei*, somewhat uncertain because of taxonomic difficulties.

Shrimp

Shrimp data was based on incidental observations. It was found that behavior and distribution differ by species. The brown shrimp *Penaeus subtilis* and the white shrimp *P. schmitti* were mostly found in shallower parts of the shelf during the day, while the red spotted shrimp *P. brasiliensis* was generally found in deeper areas with highest catches during the night. The pink shrimp *P. notialis* appeared in catches both at daytime and during the night. The data obtained on the small sized seabob *Xiphopenaeus kroyeri* and the white belly prawn *Nematopalaemon schmitti* have not been included in the analysis. They appeared sporadically with often high catch rates, but it is believed that the surveys only covered a smaller outer part of their more inshore distribution.

Threatened species

The International Union for the Conservation of Nature (IUCN) maintains a 'Red List' (IUCN 2019) of species around the world and their status, which is based on range, population size, habitat and ecology, use and/or trade, threats, and conservation actions. Species occurring in Suriname's marine area which are marked by Fishbase as threatened by the IUCN are listed in **Table 16** below.

Table 16: List of threatened marine fish species in Suriname

Species	Common name	IUCN Red List category*
Alopias vulpinus	Thresher	Vulnerable (VU)
Balistes capriscus	Grey triggerfish	Vulnerable (VU)
Carcharhinus falciformis	Silky shark	Vulnerable (VU)
Carcharhinus limbatus	Blacktip shark	Vulnerable (VU)
Carcharhinus longimanus	Oceanic whitetip shark	Vulnerable (VU)
Carcharhinus obscurus	Dusky shark	Vulnerable (VU)
Diplobatis pictus	Painted electric ray	Vulnerable (VU)
Epinephelus itajara	Atlantic goliath grouper	Vulnerable (VU)
Epinephelus morio	Red grouper	Vulnerable (VU)
Epinephelus striatus	Nassau grouper	Critically Endangered (CR)
Hyporthodus flavolimbatus	Yellowedge grouper	Vulnerable (VU)
Hyporthodus niveatus	Snowy grouper	Vulnerable (VU)
Isogomphodon oxyrhynchus	Daggernose shark	Critically Endangered (CR)
Kajikia albida	Atlantic white marlin	Vulnerable (VU)
Lachnolaimus maximus	Hogfish	Vulnerable (VU)
Lopholatilus chamaeleonticeps	Great northern tilefish	Endangered (EN)
Lutjanus cyanopterus	Cubera snapper	Vulnerable (VU)
Makaira nigricans	Blue marlin	Vulnerable (VU)
Megalops atlanticus	Tarpon	Vulnerable (VU)
Mobula birostris	Giant manta	Vulnerable (VU)
Pomatomus saltatrix	Bluefish	Vulnerable (VU)
Pristis pectinata	Smalltooth sawfish	Critically Endangered (CR)
Rhincodon typus	Whale shark	Endangered (EN)
Rhomboplites aurorubens	Vermilion snapper	Vulnerable (VU)
Sciades parkeri	Gillbacker sea catfish	Vulnerable (VU)
Sphoeroides pachygaster	Blunthead puffer	Vulnerable (VU)
Sphyrna lewini	Scalloped hammerhead	Vulnerable (VU)
Sphyrna mokarran	Great hammerhead	Endangered (EN)
Sphyrna tudes	Smalleye hammerhead	Vulnerable (VU)
Thunnus obesus	Bigeye tuna	Vulnerable (VU)
Thunnus thynnus	Atlantic bluefin tuna	Endangered (EN)
Xiphias gladius	Swordfish	Endangered (EN)

* Evaluated species are classified between: DD = Data Deficient (sufficient information on species and abundance lacking to categorize species as threatened); LC = Least Concern (species is widespread and abundant); NT = A species that does not

currently qualify for CR, EN or VU, but is close to qualifying for or is likely to in the future; VU = Vulnerable (species is considered to face a high risk of extinction in the wild); EN = Endangered (species faces a very high risk of extinction in the wild); CR = Critically Endangered (extremely high risk of extinction in the wild)

Commercial Species

According to FAO (2008 & 2019) and LVV (2004) commercial fishery in Suriname includes multi-species and multi-gear vessels, trawlers, snapper boats, and open or decked wooden vessels. Industrial fisheries include shrimp trawling, finfish trawling red-snapper and mackerel hand-liners and large-pelagic long-liners. The main commercial species are listed in **Table 17**.

Table 17: Main commercial marine fish species (table adapted from FAO 2008)

Family	Scientific name	Common / local name
Ariidae	*Arius acouma*	Koemakoema
	A. Grandicassis/quadriscutis	Kodokoe
	Arius parkeri	Jarabaka
	Arius proops	Koepila
	Arius passany	Pani
	Bagre gagre/B. marinus	Barbaman
	Ariidae	Other catfishes
Batoidae	All species	Rays
Carangidae	*Caranx hippos*	Zeezalm
Centropomidae	*Centropomus spp.*	Snoek
Elopidae	*Elops saurus*	Dagoefisie
Lobotidae	*Lobotes surinamensis*	Paoema
Lutjanidae	*Lutjanus purpureus*	Red snapper
	Lutjanus synagris	Lane snapper
	Rhomboplites aurorubens	Vermillion snapper
	Lutjanidae	Snapper (unidentified)
Megalopidae	*Megalops atlanticus*	Trapoen
Mugilidae	*Mugil spp.*	Aarder
Rachycentridae	*Rachycentron canadus*	Batjawvis
Sciaenidae	*Cynoscion acoupa*	Bang bang
	Cynoscion steidachneri	Blakatere
	Cynoscion virescens	Kandratiki
	Macrodon ancylodon	Dagoetifi
	Micropogon furnieri	Krokus
	Nebris microps	Botrofisie
	Sciaenidae juveniles	Wit wittie
	Sciaenidae unidentified	Other croakers
Scombridae	*Scomberomorus spp.*	Makreel
Serranidae	*Promicrops itajara*	Graumurg
Sharkoids	All Sharks	Sharks
Marine finfish (unidentified) Tri (miscellaneous small pelagics)		

6.5 Marine Turtles

Five marine turtle species are known to frequent Suriname waters, namely the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricate*) and loggerhead (*Caretta caretta*) turtles. All of these species are on the IUCN Red List (IUCN 2019) and are categorized as follows:

- Critically Endangered (CR): Hawksbill turtle (*Eretmochelys imbricata*);
- Endangered (EN): Green turtle (*Chelonia mydas*); and
- Vulnerable (VU): Leatherback turtle (*Dermochelys coriacea*), Loggerhead turtle (*Caretta caretta*), and Olive Ridley turtle (*Lepidochelys olivacea*).

Nesting beaches in Suriname include sandy beaches at the Marowijne River mouth and nearby coast, and sandy beaches north of Commewijne until the Suriname River mouth (Goverse and Hilterman, 2005). The Green and Leatherback turtles are known to nest quite heavy, Olive Ridley and Hawksbill turtles barely ever nest and Loggerhead turtle has been observed to only have nested once. The nesting seasons for turtles in Suriname overlap and cover the period from February to July (Oceanic Society 2007). The website of the Sea Turtle Conservancy (2019) contains maps of routes travelled by satellite-tracked Leatherback and Green turtles.

The Leatherback turtle (*Dermochelys coriacea*) grows the largest, dives the deepest, and travels the farthest of all sea turtles. They average 1.8 m in length and range in weight from 300 to 600 kg. Leatherbacks have a cosmopolitan global range and are found in all tropical and subtropical oceans, with a range that extends well into the Arctic Circle (Márquez, 1990). The most significant Atlantic nesting sites are in Suriname, French Guiana, and Trinidad and Tobago in the Caribbean, and in Gabon in Central Africa. Off the northeastern coast of the South American continent, a few select beaches between French Guiana and Suriname are primary nesting sites for several species of sea turtles, the majority of which are leatherbacks (National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Service, 2007). Leatherback nesting colonies are the largest in Suriname. During the period from 1968 to 1989, the number of leatherback turtles nesting in Suriname increased from 200 in 1968 to 12,401 in 1985 (Reichart and Fretey, 1993). This increase occurred due to the erosion of nesting beaches in neighboring French Guiana (Schulz, 1975). Leatherback nesting season is from March to July, peaking from April to June (Schulz, 1975).

The Green turtle (*Chelonia mydas*) are widely distributed in tropical and subtropical waters (Márquez, 1990). This species is a solitary nektonic animal that occasionally forms feeding aggregations in shallow water areas with abundant seagrasses and algae. Adult green turtles average 1.3 m in length and weigh about 200 kg. Green turtles are an endangered species around the world with the largest nesting site in the Western Hemisphere being Tortuguero, Costa Rica. The nesting population is stable in Suriname and increasing in Tortuguero, but there is insufficient information from other nesting sites to determine a species trend worldwide (Sea Turtle Conservancy 2019). In Suriname, green turtles nest mainly on the beaches of Baboensanti and Galibi in the Galibi Nature Reserve and the sandy beaches between Matapica and the mouth of the Suriname River. Their nesting season runs from February to July, peaking around April to May. The nesting population of this species is relatively stable and is estimated to be between 3,700 and 7,200 females (Schulz, 1975; Mohadin and Reichart, 1984).

The Olive Ridley turtle (*Lepidochelys olivacea*) is the smallest sea turtle that occurs in the project area. Adults average 68.5 cm in length and weigh from 35 to 50 kg. It is considered a facultative carnivore, feeding mainly on fishes, salps[10], crustaceans, molluscs, and algae (Márquez, 1990). The nesting population in Suriname has declined more than 80 percent since 1967 (Sea Turtle Conservancy 2019 and Schulz 1975). The olive ridley population nests in the Galibi Nature Reserve. The nesting season in Suriname is from mid-May to the end of July, with only a few nests laid before and after this period (Schulz 1975).

The Hawksbill turtle (*Eretmochelys imbricate*) is distributed in tropical waters throughout the central Atlantic and Indo-Pacific regions. Adult hawksbills range from 53 to 114 cm (Márquez 1990). They are carnivorous, feeding on corals, tunicates, algae, and sponges. Hawksbills nest only sporadically in Suriname, with rarely more than 25 nests per year in the entire country. The nesting period typically takes place during May through July. Neither intra- nor inter-seasonal nesting frequency is known for Suriname. It has been reported that an average of 146 eggs are laid per nest (Schulz, 1975). While hawksbills nest on beaches throughout the Caribbean, they are no longer found anywhere in large numbers (Sea Turtle Conservancy 2019).

[10] https://en.wikipedia.org/wiki/Salp

The Loggerhead turtle (*Caretta caretta*) is widely distributed in coastal tropical and subtropical waters around the world. This species commonly wanders into temperate waters and to the boundaries of warm currents (Márquez, 1990). It is considered rare in waters off Suriname (Schulz, 1975). There are no data available for age or size classes present in Suriname waters, or whether these individuals are migratory or resident. Loggerhead turtle mating season is from late March to early June. These turtles nest at night, with the average interval between nesting seasons being between 2 to 3 years, although this can vary from 1 to 6 years.

6.6 Marine Mammals

To date, 30 marine mammals are known to occur in Suriname waters. Many of them are attracted seasonally between March and August when high phytoplankton blooms occur. **Table 18** lists the species found (CSA 2010 & 2015 and ERM 2019) and their threatened status (IUCN 2019).

Table 18: Marine mammals known to occur in Suriname waters (based on CSA 2010 & 2015 and ERM 2019)

Scientific name	Common name	IUCN Red List category*
Whales & Dolphins		
Balaenoptera acutorostrata	Minke whale	Least Concern (LC)
Balaenoptera borealis	Sei whale	Endangered (EN)
Balaenoptera edeni	Bryde's whale	Least Concern (LC)
Balaenoptera musculus	Blue whale	Endangered (EN)
Balaenoptera physalus	Fin whale	Vulnerable (VU)
Megaptera novaeangliae	Humpback whale	Least Concern (LC)
Feresa attenuate	Pygmy killer whale	Least Concern (LC)
Globicephala macrorhynchus	Short-finned (Indian) pilot whale	Least Concern (LC)
Kogia breviceps	Pygmy sperm whale	Data Deficient (DD)
Kogia sima	Dwarf sperm whale	Data Deficient (DD)
Orcinus orca	Killer whale	Data Deficient (DD)
Peponocephala electra	Melon-headed whale	Least Concern (LC)
Physeter macrocephalus	Sperm whale	Vulnerable (VU)
Pseudorca crassidens	False killer whale	Near Threatened (NT)
Mesoplodon densirostris	Blainville's beaked whale	Data Deficient (DD)
Mesoplodon europaeus	Gervais' beaked whale	Data Deficient (DD)
Ziphius cavirostris	Cuvier's beaked whale	Least Concern (LC)
Grampus griseus	Risso's dolphin	Least Concern (LC)
Delphinus delphis	Short-beaked common dolphin	Least Concern (LC)
Delphinus capensis	Long-beaked common dolphin	Data Deficient (DD)
Lagenodelphis hosei	Fraser's dolphin	Least Concern (LC)
Stenella attenuate	Pantropical spotted dolphin	Least Concern (LC)
Stenella clymene	Clymene dolphin	Least Concern (LC)
Stenella coeruleoalba	Striped dolphin	Least Concern (LC)
Stenella frontalis	Atlantic spotted dolphin	Least Concern (LC)
Stenella longirostris	Spinner dolphin	Least Concern (LC)
Steno bredanensis	Rough-toothed dolphin	Least Concern (LC)
Tursiops truncatus	Bottlenose dolphin	Least Concern (LC)
Sotalia guianensis	Guiana dolphin	Near-Threatened (NT)
Manatee[11]		
Trichechus manatus	West Indian manatee	Vulnerable (VU)

[11] ESIAs for Blocks 31, 37 and 59 (Shallow Offshore): Manatees theoretically occur in the oceanic-epipelagic zone (0-200m depth) but actual sightings have not been confirmed.

* Evaluated species are classified between: DD = Data Deficient (sufficient information on species and abundance lacking to categorize species as threatened); LC = Least Concern (species is widespread and abundant); NT = A species that does not currently qualify for CR, EN or VU, but is close to qualifying for or is likely to in the future; VU = Vulnerable (species is considered to face a high risk of extinction in the wild); EN = Endangered (species faces a very high risk of extinction in the wild); CR = Critically Endangered (extremely high risk of extinction in the wild)

Species listed as threatened (to some extent) by the IUCN are described below, based on Carwardine et al. (1998).

Sei whales (*Balaenoptera borealis*) occur in tropical to subpolar world waters. They can grow up to 21m long, feed on krill, copepods, amphipods, small fish and shrimp, usually travel in groups of two to five individuals. However, when feeding grounds are good, they can be found in larger groups.

Blue whales (*Balaenoptera musculus*) migrate between tropical and polar waters. Blue whales are the largest living animals and can grow up to 33.6m. They feed on euphausiids with some squid, amphipods, copepods and red crabs. Blue whales usually feed alone or in pairs, often widely spaced.

Fin whales (*Balaenoptera physalus*) migrate between warm temperate and cold polar world waters. Being the second-largest living animal, they grow up to 27m long, feed on schooling fish, euphasiids and other invertebrates, copepods and squid, are often alone or in pairs. On feeding grounds, they can be found in groups of up to 10-20 individuals or sometimes even 100 loosely grouped.

Sperm whales (*Peponocephala electra*) occur in tropical to subpolar waters, can grow up to 20 m, and feed on deep-water squid, including giant squid and larger fish. Sperm whales spend most of their lives in either nursery schools (includes females of all ages and immature males) or bachelor schools (includes sexually / almost sexually mature males) of up to 50 individuals.

False killer whales (*Pseudorca crassidens*) occur in tropical, subtropical and sometimes temperate world waters, can grow up to 5.9m, feed on various fish, cephalopods and rarely dolphins, and travel in pods of 10-50 individuals. Sometimes superpods, i.e. groupings of multiple pods, of several hundred are spotted.

Guiana Dolphin (*Sotalia guianensis*) occur in tropical waters of the western Atlantic Ocean where they can be found along coastal estuaries of Central and South America from Nicaragua to Brazil where the brackish waters and rivers intermingle (De Dijn 2018). They can grow up to 1.8m, feed on a variety of (manly schooling) fish and cephalopods, and usually travel in groups of 2-7 individuals. Larger groups may exist of 20 in rivers and up to 50 along the coast (Carwardine et al. 1998).

West Indian manatee (*Trichechus manatus*) is divided in the northern and southern subspecies. Northern subspecies is common around Florida but ranges from North Carolina to Louisiana. The southern subspecies can be found from the Brazil to Mexico and in the Caribbean. In Suriname it is found in the coastal region and up to 60km upstream in most rivers. West Indian manatees grow up to 3m with a weight of 400kg and are herbivores that eat primarily aquatic plants (De Dijn 2018).

6.7 Birds

The avifauna of Suriname comprises 726 species of which 620 are resident and 82 migratory species which visit Suriname during their non-breading season (De Dijn 2018). About 30 of the migratory species (**Table 19**) fly toward Suriname from the north and 20 of these species are shorebirds. Together, the 20 migratory shorebird species total up to more than two million birds when visiting Suriname. Conspicuous species that migrate from the north include the osprey, peregrine falcon, blue-winged teal, and various species of terns (black, gull-billed, common, and least tern), yellow-billed cuckoo, barn swallow, and the yellow warbler. The migration toward Suriname is usually between end of July and early August, while the migration back north is in May. The migration routes are either directly across the Atlantic Ocean to the east coast of North America or through the Caribbean towards the Mississippi valley. Suriname's shoreline is home to some of the largest concentrations of migrant shorebirds in the Western hemisphere (Spaans 2003).

Table 19: Migratory bird species visiting Suriname (adapted from CSA Ocean Sciences Inc. 2015; with additions from IUCN 2019)

Scientific name	Common Name	IUCN Red List category*
Haematopus palliatus	American Oystercatcher	Least Concern (LC)
Setophaga ruticilla	American Redstart	Least Concern (LC)
Riparia riparia	Bank Swallow	Least Concern (LC)
Hirundo rustica	Barn Swallow	Least Concern (LC)
Coccyzus melacoryphus	Black-billed Cuckoo	Least Concern (LC)
Dendroica striata	Blackpoll Warbler	Near-Threatened (NT)
Anas discors	Blue-winged Teal	Least Concern (LC)
Sterna hirundo	Common Tern	Least Concern (LC)
Spiza Americana	Dickcissel	Least Concern (LC)
Tyrannus tyrannus	Eastern Kingbird	Least Concern (LC)
Contopus virens	Eastern Wood-Pewee	Least Concern (LC)
Catharus minimus	Gray-cheeked Thrush	Least Concern (LC)
Calidris minutilla	Least Sandpiper	Least Concern (LC)
Sterna antillarum	Least Tern	Least Concern (LC)
Chordeiles acutipennis	Lesser Nighthawk	Least Concern (LC)
Tringa flavipes	Lesser Yellowlegs	Least Concern (LC)
Paerkesia noveboracensis	Northern Waterthrush	Least Concern (LC)
Pandion haliaetus	Osprey	Least Concern (LC)
Protonotaria citrea	Prothonotary Warbler	Least Concern (LC)
Progne subis	Purple Martin	Least Concern (LC)
Arenaria interpres	Ruddy Turnstone	Least Concern (LC)
Calidris alba	Sanderling	Least Concern (LC)
Charadrius semipalmatus	Semipalmated Plover	Least Concern (LC)
Calidris melanotos	Pectoral Sandpiper	Least Concern (LC)
Tringa solitaria	Solitary Sandpiper	Least Concern (LC)
Piranga rubra	Summer Tanager	Least Concern (LC)
Bartramia longicauda	Upland Sandpiper	Least Concern (LC)
Calidris mauri	Western Sandpiper	Least Concern (LC)
Numenius phaeopus	Whimbrel	Least Concern (LC)
Charadrius wilsonia	Wilson's Plover	Least Concern (LC)
Setophaga petechia	Yellow Warbler	Least Concern (LC)
Coccyzus americanus	Yellow-billed Cuckoo	Least Concern (LC)

* Evaluated species are classified between: DD = Data Deficient (sufficient information on species and abundance lacking to categorize species as threatened); LC = Least Concern (species is widespread and abundant); NT = A species that does not currently qualify for CR, EN or VU, but is close to qualifying for or is likely to in the future; VU = Vulnerable (species is considered to face a high risk of extinction in the wild); EN = Endangered (species faces a very high risk of extinction in the wild); CR = Critically Endangered (extremely high risk of extinction in the wild)

In addition to the migratory birds, there are a number of birds that can be spotted at sea (i.e. not necessarily going on land). Below species list (**Table 20**) is compiled from report from the MARGATS survey (2016).

Table 20: Birds sighted during the MARGATS survey (2016)

Scientific name	Common Name	IUCN Red List category*
Fregata magnificens	Magnificent Frigatebird	Least Concern (LC)
Oceanodroma leucorhoa	Leach's Storm-petrel	Vulnerable (VU)
Oceanites oceanicus	Wilson's Storm-petrel	Least Concern (LC)
Anous stolidus	Brown Noddy	Least Concern (LC)
Sterna fuscata	Sooty Tern	Least Concern (LC)

Sternula antillarum	Least Tern	Least Concern (LC)
Phaethon aethereus	Red-billed Tropicbird	Least Concern (LC)
Calonectris diomedea	Scopoli's Shearwater	Least Concern (LC)
Puffinus puffinus	Manx Shearwater	Least Concern (LC)
Stercorarius maccormicki	South Polar Skua	Least Concern (LC)
Stercorarius parasiticus	Arctic Jaeger	Least Concern (LC)
Stercorarius pomarinus	Pomarine Jaeger	Least Concern (LC)
Sula dactylatra	Masked Booby	Least Concern (LC)
Sula leucogaster	Brown Booby	Least Concern (LC)
Sula sula	Red-footed Booby	Least Concern (LC)
Charadrius semipalmatus	Semipalmated Plover	Least Concern (LC)
Pluvialis squatarola	Grey Plover	Least Concern (LC)
Arenaria interpres	Ruddy Turnstone	Least Concern (LC)
Calidris alba	Sanderling	Least Concern (LC)

* Evaluated species are classified between: DD = Data Deficient (sufficient information on species and abundance lacking to categorize species as threatened); LC = Least Concern (species is widespread and abundant); NT = A species that does not currently qualify for CR, EN or VU, but is close to qualifying for or is likely to in the future; VU = Vulnerable (species is considered to face a high risk of extinction in the wild); EN = Endangered (species faces a very high risk of extinction in the wild); CR = Critically Endangered (extremely high risk of extinction in the wild)

Species listed as threatened (to some extent) by the IUCN are described below:

Blackpoll Warblers (*Dendroica striata*) are migrant birds that breed in boreal forests throughout Canada and Alaska and into the extreme north-east of the USA and overwinter in north-eastern South-America where they utilize a range of habitats including lowland forest, cloudforest, secondary growth and plantations (Birdlife International 2019).

Leach's Storm-petrels (*Oceanodroma leucorhoa*) are marine and pelagic birds, often occurring in areas of convergence or upwelling or over continental shelves. During the breeding season these birds are highly pelagic in their foraging habitats, travelling to deep and relatively unproductive waters over and beyond continental slopes. Its diet comprises of small fish, squid, planktonic crustaceans and offal. It sometimes follows marine mammals to feed on their leftovers and faeces (Birdlife International 2019).

6.8 Protected Areas

6.8.1 Nationally Protected Areas

Almost the entire coastal area of Suriname is under some sort of protection. There are four Multiple Use Management Areas spanning most of Suriname's coastline and include a portion of the near-shore marine area (except for Paramaribo and north Wanica) and four coastal Nature Reserves on land (**Figure 30**).

Figure 30: Multiple Use Management Areas and Nature reserves in coastal Suriname (SBB 2019)
MUMAs are indicated by numbers as follows: 1. Bigi Pan, 2. North Coronie, 3. North Saramacca, 4 North Commewijne-Marowijne. NR are indicated by letters: A. Hertenrits, B. Coppename Monding, C. Wia Wia, D Galibi.

Multiple Use Management Areas (MUMAs) are areas designated under legislation on the issuance of state-owned lands (1982 Decree L-2 on the Allocation of State-property Lands SB 1982, No 11). These MUMAs are placed at the disposal of the Minister of Spatial Planning, Land and Forest Management (Min. RGB) in order to manage the areas in the sense of a "Special Management Area" as defined in the Planning Act 1973 (GB No 89). This is defined as "areas where integrated management by or on behalf of the Government is needed for a rational use of its natural resources", which includes the conservation of the protective and productive functions of vulnerable ecosystems. MUMAs are not established to protect the areas from developments. On the contrary, their specific management goal is to optimize its long term natural productivity and conservation, which takes into consideration the demands of vulnerable natural ecosystems (Teunissen 2003). MUMAs stretch into the nearshore marine area until the six-meter isobath at low tide. However, the location of this isobath will shift in response to the presence or absence of mudflats. The MUMAs along the Suriname coast are (from west to east):

- Bigi Pan MUMA situated in north-west Suriname (northern Nickerie and part of Coronie), was established in 1987 and comprises 679 km^2 of land (excluding Hertenrits NR);
- North Coronie MUMA situated north of Coronie, was established in 2002 and comprises 272 km^2 of land;
- North Saramacca MUMA situated north of Saramacca, was established in 2002 and comprises 884 km^2 of land (excluding Coppename-monding NR); and
- North Commewijne-Marowijne MUMA situated in north-east Suriname (northern Commewijne and Marowijne), was established in 2002 and comprises 615 km^2 of land (excluding Wia-Wia NR).

Nature Reserves (NR) are established under the Nature Protection Act of 1954 (G.B. 1954 no. 26) which forbids any form of destruction of soil, nature, fauna and flora. Furthermore, it is forbidden to camp, hunt and fish in NR unless a special license is obtained from Min. RGB. Between 1961 and 1972 a number of coastal NRs were established to protect important estuarine ecosystems which included marine turtle nesting beaches, nesting and feeding areas of coastal birds, feeding grounds for migratory birds and nursery grounds for shrimps and fishes. The NRs in Suriname coastal area are ((Teunissen 2003, Schurman Advocaten 2012):

- Hertenrits NR situated in north Nickerie (within the Bigi Pan MUMA), was established in 1972 and comprises 1 km^2 of land. It was established because it contains pre-Colombian archeological remains;
- Coppename-monding NR situated in north Saramacca (within North Saramacca MUMA), was established in 1966 and comprises 120 km^2 of land. It has been designated a wetland of international importance (RAMSAR site) and it is included in the Western Hemisphere Shorebird Reserve Network. It is an important roosting and feeding area for scarlet ibises, egrets and herons. It is also a wintering station for thousands of migratory birds, especially waders (STINASU 2008);
- Wia-Wia NR situated in north Marowijne (within the North Commewijne-Marowijne MUMA), was established in 1961 and comprises 360 km^2 of land. It is an important area for migratory birds and marine turtles, although it is not a current popular nesting site due to issues of beach erosion (STINASU 2008). The Wia-Wia bank is an important feeding ground for several species of migratory birds and the area has international standing as a Western Hemisphere Shorebird Reserve;
- Galibi NR situated in north Marowijne (Marowijne river mouth), was established in 1969 and comprises 40 km^2 of land. It is an important marine turtle nesting site which use its long sandy beaches during the months of February to July.

6.8.2 Areas of International Significance

Suriname's coastal areas are considered internationally important for the following reasons (Teunissen 2003):

- Wintering grounds: The Surinamese coast is considered the principal South American wintering ground for migratory shorebirds from Nearctic regions; over 52% of the total of shorebirds populations in South-America overwinter in Suriname;
- Scarlet ibis: For the South-American endemic Scarlet ibis, the coast of Suriname is of critical importance with up to 35,000 breeding pairs during top years;
- Wetlands and waterfowl: Suriname’s coastal zone is important for 21 waterfowl species. In 1985 the Coppename-monding NR received the status of “wetland of International Importance” based on the RAMSAR Convention;
- Western Hemisphere Shorebirds Reserve Network (WHSRN): in 1989 the Bigi Pan MUMA, Coppename-monding NR and the Wia-Wia NR were designated as Hemispheric Reserve within the WHSRN twinning these areas with two protected areas in the Bay of Fundy in Canada. Shorebirds breeding in Canada visit Suriname during the winter; and
- Marine turtle nesting areas: Sand and shell beaches in Suriname and French Guiana are ranked among the most important nesting beaches for the Leatherback and Green turtles.

7 Socio-Economic Baseline

7.1 Introduction

The socio-economic baseline outlines the stakeholders who can be found in the marine environment of the Shallow Offshore area (e.g. commercial fishermen, marine transport vessels, international offshore operators), describes the type of activities occurring within that area (commercial fisheries, oil and gas exploration (seismic surveys), and marine transport/(freight) shipping), and identifies stakeholders that may be indirectly affected by the proposed project (e.g. ports, shipping agents, port terminal operators, local suppliers of goods and services to seismic contractor, and environmental NGOs).

A summary of the socio-economic environment is presented in the next section. The detailed results are presented in **Appendix III**.

7.2 The Socio-Economic Environment

From the report it can be concluded that resource users that can be found within the study area that are likely to be affected by the proposed project comprise: commercial fishermen and other marine traffic/ transport users. Currently, there are no active or planned exploration activities within the Shallow Offshore.

Fisheries

The Fisheries in the Shallow Offshore area is industrial and consists of finfish trawls, shrimp trawling fleets, red snapper and mackerel manual lines, and large-pelagic long liners. Target species of the mainstream commercial fish production are: red snapper – *Lutjanus purpureus* (caught by hook and line fishing in water depths > 18 fathom; >33 meter)), penaeid shrimp and sea bob shrimp (both caught by trawler nets at different water depths). Other target (fish) species include tuna (*Thunnus* spp.) and mackerel (*Scomberomorus* spp.). Shrimp and snapper trawling, and snapper longlining transpires up to a depth of 80 m.

The number of licenses issued to industrial fishers in 2018 (based on data provided by the Fisheries Department), totaled 329 licenses (Line fishing: 235 licenses, Shrimp trawling: 24 licenses, sea bob trawling: 26 licenses, and Fish trawling: 44 licenses). Although the bulk of the foreign vessels present in Surinamese waters are registered and known, there is an occurrence of illegal fishing boats in Suriname’s waters.

With regard to the industrial fishery, shrimp and fish are caught year round. Trawler fishing does not distinguish a fishing high season. Vessels used for snapper fisheries are commonly foreign owned, while shrimp are primarily caught by locally owned outrigger trawlers (e.g. sea bob shrimp processors SAIL and Heiploeg). The ideal period for catching fish is from May to November, because the sea is calmest at that time.

The Venezuelan boats (more than 200) are fishing in Surinamese territorial waters from February/March until November, with the most active period (fishing intensity) occurring between May and September, and again in October and November. Calmer periods are in December-January and around the Easter Holiday (in April). The Taiwanese (about 40 boats) do not distinguish a high or low fishing season, but fish the whole year round. The Chinese fishing boats (five boats) catch fish from February until mid-December and usually stop their fishing activities to take care of necessary boat repairs.

The Suriname Seafood Association is an umbrella organization that comprises fishing companies, processing plants, and exporters, representing more than 90% of the industrial fishing industry. In the western part of the sea off the Suriname coast, the SAIL catches sea bob shrimp ((*Xiphopenaeus* *kroyeri*) between the 10 fathom and 15 fathom lines (between approximately 18 m and 27 m water depth), while in the eastern part the shrimp is caught between 10 and 18 fathom water depth (between about 18 m and 33 m water depth).

Major boat landing sites for commercial fisheries fish are located in the Suriname River.

Shipping sector

The shipping sector can be divided in different groups: the international freight/cargo ships, coasters (small ocean going vessels), terminal (port) operators, shipping agents and other marine traffic.

International freight/cargo traffic

The majority of vessels in Suriname enters and passes through the Suriname River, which offers passageway to Paramaribo, the capital city and main port of Suriname. Marine transport is the primary means of transportation used for import / export of merchandises to and from Suriname. Freight carriers use the area beyond 6 nautical miles (11.1 km) from shore thereby sailing the main navigation routes

Direct maritime connections exist between Suriname and several EU (European Union) countries, the United States, and countries in the Caribbean. Chief navigation routes depart from Paramaribo with cargo ships travelling in northeastern or northwestern direction. Vessels operating between Trinidad and Brazil and between Guyana and Suriname, navigate near the 20 m water depth line. Ships may enter and leave Suriname through four navigation channels situated at the mouth of the main rivers. In addition, freight vessels also utilize so-called “ship to ship” locations (situated in the vicinity of the navigation channels) for cargo transfer between ships.

Access to the ports located in the Suriname River is restricted by shallow parts of the navigation channel that limit the amount of cargo that large vessels can carry, their speed and maneuverability, and the time taken to reach the inland ports.

The navigation routes for cargo transport between Suriname and Guyana and Suriname and Trinidad traverse the nearshore area, while the maritime traffic routes between Trinidad and Brazil and Suriname and the Netherlands pass through the Shallow Offshore area (**Figure 31**).

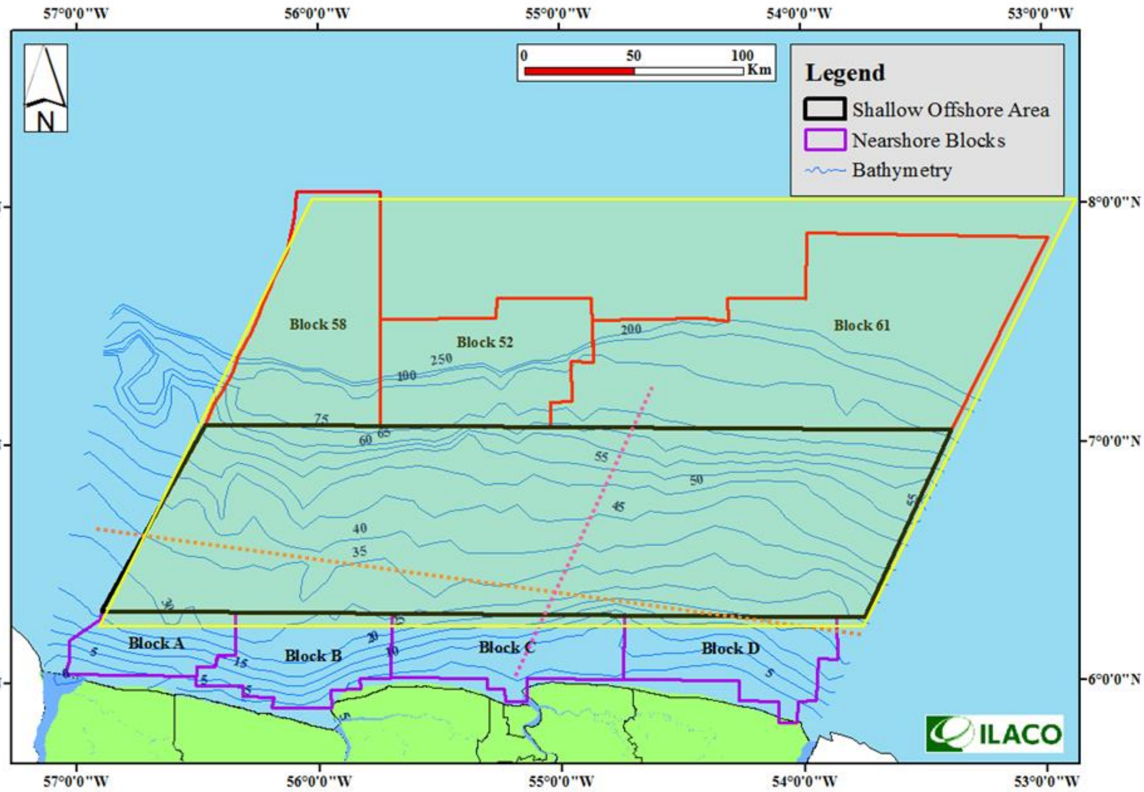

Figure 31: Estimated shipping routes (dotted and dashed lines)

Figure 31 Estimated shipping routes (dotted and dashed lines), approximated commercial fishing grounds (yellow shading) and marine concession blocks (purple and red outlined) that can be found in or near the shallow offshore area (Source: adapted from ILACO)

Terminal/port operators

Besides the Port of Paramaribo, the Port of Nieuw-Nickerie, situated in the western district of Suriname (Nickerie), is also considered a key port. The Government of Suriname (GoS)'s role in port management is executed by the NV Havenbeheer Suriname (founded in 1971). NV Havenbeheer is responsible for managing the ports of Paramaribo, Nickerie and the so-called Oliesteiger (Oil Jetty).
The main port of Suriname, the Dr. Jules Sedney Terminal processes about 50% of Suriname's seaborne trade capacity and berths on average 35 vessels per month.

The busiest season/time of year for the port of Paramaribo (Dr. J. Sedney Terminal): October-December and also towards the school vacation (July-August). Data collected on the number of vessel calls for 2019 at the Dr. J. Sedney Terminal, shows that the greatest number of port calls were received in the months of July, August and September (around 70 vessel calls each month). The Oil Jetty received the most number of vessel calls (19 vessel calls) in the month of May.
The NV Havenbeheer has constructed a new port facility specially to accommodate/support the oil and gas offshore operators. This facility is expected to be completed before the end of 2019.

There are two terminal operators working at the Jules Sedney terminal namely the N.V. Verenigde Surinaamse Holdingmij (VSH) and Integra Port Services NV / DP World Paramaribo (DP World). These operators work with different carriers under agency and/or terminal contract and take care of cargo handling. The busiest time of the year regarding cargo handling / processing is experienced from the end of October until the end of December, also January of the following year. The terminal operators are not necessarily dealing with more ships, but rather an increase in cargo volume.

Regarding the number of ships that arrive at the terminal during the year, a peak period cannot be clearly distinguished.

Coasters
The port of Nieuw-Nickerie is frequented by small oceangoing vessels (so-called coasters). In addition to the international shipping traffic, marine traffic is also caused by cargo transports from District Nickerie to Paramaribo on pontoons that are hauled by barges (about ten barges). The coasters sail between 15 and 20 nautical miles from the coast at 5°20’ geographic latitude and travel from Apoera (situated along the Corantijn River), Nickerie (located at the Nickerie River) and the Coppename River to Paramaribo. The coasters usually transport wood logs, rice and sometimes sand and/or gravel.

Shipping agents
There are 17 shipping agents registered with the NV Havenbeheer of which two have their offices located in District Nickerie, while the remainder operates from Paramaribo.
The interests of shipping agents are represented by the recently established (in 2019) SNMA (Suriname National Maritime Association) presided by the chair Patrick Healy.

Other marine transport/traffic
Several International Oil Companies (IOCs) are currently (partly) active in or near the Shallow Offshore area with data collection (seismic surveys) for their exploration drilling programs e.g. Petronas (block 52), Cairn (block 61), Apache (block 58). The IOCs Tullow Oil and Cosmos Energy are planning on conducting exploration drilling programs in 2020 in the offshore area.

Furthermore local contractors (such as Kuldipsingh NV and EQ Recycling) are involved in offshore activities; hence supply vessels traverse the mouth of the Suriname River, the Nearshore and Shallow Offshore area, in order to supply the oil and gas operators working in the offshore area. The supply vessels travel about 1-2 times a week to the offshore area.

The Maritime department of the Police Corps Suriname is responsible for the safety on inland waterways. The Navy guards the sovereignty of the State and operates on the Border Rivers. The Coast Guard has jurisdiction over an area extending from zero to 340 miles away from the coast in any direction. The working area of the Coast Guard concerns the EEZ (Exclusive Economic Zone), the territorial waters of Suriname and the airspace above. The Coast Guard is in possession of 3 vessels and 7 vehicles, and collaborates with other organizations towards securing the Nearshore and offshore areas and will respond to emergency situations if needed.

Vulnerable groups
Given that no human settlements are located within the project area or the vicinity thereof, safeguards for the presence of vulnerable groups are not applicable.

8 Public Consultation

Public consultation is a key component that runs throughout the ESIA process. During the first phase of the process, key stakeholders are identified and consulted.

The study started with the official Contract Signing. The project approval and official kick-off meeting at the Staatsolie Sarah Maria- HSEQ Conference Room was held on the 26th of August 2019. Also, on the 27th of August 2019 NIMOS was consulted about the approach and methodology as well as the additional concerns to be included in the study.

Only key stakeholders were consulted during this Scoping Phase. Stakeholder consultations/interviews were undertaken to inform persons and organizations with special interest in the proposed project area about the projected activities, and to elicit their concerns and suggestions to minimize negative project impacts and maximize project benefits.

In all the initial meetings, preliminary ESIA findings (potential issues and impacts the proposed project may have) were discussed. No extensive scoping was undertaken and no Public Scoping meeting was organized, because a number of ESIA studies have already been conducted in the Shallow Offshore area over the past years, including ESIA studies for seismic surveys, and impacts are sufficiently known. All minutes of meetings with key stakeholders are included in **Appendix III.**

In general, various stakeholders emphasized the importance of timely and appropriate communication of the seismic schedule to key stakeholders, also timely sharing of adjustments made to the schedule of activities. Windows of passage must be created to allow for all marine traffic to pass through the Shallow Offshore area without any hindrance. Access to the port entry (river mouth) must not be blocked. In addition, stakeholders were concerned about the potential impacts of the seismic survey on marina fauna e.g. mammals/dolphins, sea turtle hatchlings and adults that migrate through the Shallow Offshore area. It is stressed to avoid the execution of seismic activities in the sea turtle nesting and hatching seasons (February to August with peak period March to June).

Regarding the seismic activities conducted in the Shallow Offshore area to date: no stakeholder complaints, no issues or non-compliance reports are known to Staatsolie and no complaints were registered by NIMOS. Furthermore, no relevant incidents have been reported by stakeholders.

Suggestions for improvement of communication, offered by stakeholders, were minor except that it would be wise to share with the MAS, the contact list of all the primary stakeholders involved in nearshore and offshore activities; also it would be helpful to add the contact info of a second contact person for each of the stakeholders or stakeholder groups involved.

The ESIA Consultation is still to be continued after this document is submitted to NIMOS for review. In this consultation meeting the Environmental and Social Baseline conditions together with the Impacts Assessment of the proposed Project (see Chapter 9) will be presented to the stakeholders. The comments of the stakeholders and NIMOS will be processed in this document to complete the final ESIA report for the proposed project.

9 Potential Impacts and Proposed Mitigation

9.1 Introduction

In this chapter, the actual and potential impacts of the proposed project and their mitigation measures will be discussed. The applied methodology is explained in the Chapter 2.

In below sections the potential impacts of the Shallow Offshore 3D Seismic Acquisition Project will be evaluated. Due to the resemblance with previous seismic projects a range of standard best practice procedures and impact reduction measures (or inherent mitigation measures) are adopted from previous studies. The lessons learned regarding the efficiency of proposed mitigation measures based on monitoring results from previous studies have been taken into consideration. In addition, experiences of stakeholders from previous projects have also been taken into consideration. Where necessary, any additional identified or cumulative impacts are discussed separately.

9.2 Impact Assessment

Table 21 summarizes the biophysical and socio-economic impacts that can result from the proposed project and proposed mitigation measures.

Table 21: Biophysical and Socio-Economic Impacts with Proposed Mitigation Measures

Biophysical										
Component	Impact Description	Scores impact							Mitigation Measures	Residual Impact
		Intensity	Duration	Scale	Severity	Probability	Significance	Status		
Air	Reduction of air quality due to project emissions	Negligible	Medium-term	Small	NEGLIGIBLE	High	NEGLIGIBLE	neg	The impact cannot be further reduced. Recommended: Select the quietest and most effective equipment available. See that all equipment is in a well-maintained condition; in particular the mufflers should be in optimum condition.	NEGLIGIBLE
Noise	Above water noise impacts on human receptors	Negligible	Medium-term	Small	NEGLIGIBLE	Low	NEGLIGIBLE	neg	The impact cannot be further reduced. But see above recommendations	NEGLIGIBLE
	Above water noise impacts on fauna (marine mammals, turtles) causing behavioral change	Low	Medium-term	Small	LOW	Low	NEGLIGIBLE	neg	The impact cannot be further reduced. But see above recommendations	NEGLIGIBLE
	Impacts of underwater sound pressure waves on all aquatic life (mammals, turtles, fish)	High	Medium-term	Medium	HIGH	High	MAJOR	neg	Mitigation measures: General: At least 30 minutes before start-up during daylight hours, experienced visual observers should monitor a safety zone of a 500m radius around the source vessel. Start-up of the array cannot begin until no aquatic life has been observed within this safety zone for at least 20 minutes. Use a soft start to allow time for aquatic life to move away before the array reaches full power. The process should begin at a low air pressure, which is gradually build up in 500 psi steps over at least 20 minutes to operational pressure. Limit noise emission as much as possible (also from support vessels)	MINOR

									Minimize vessel presence and movements Visual monitoring of the water surface by experienced observers (MMO/MFO) should continue while the seismic array is operating, and the array should be shut down if aquatic life is seen moving towards the seismic vessel within a zone of 100 meter (safety zone where sound levels are above 180 dB) during visual monitoring. If line change time is expected to be greater than 40 minutes, air gun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. The pre-shooting search should also be undertaken within the 500-meter safety zone. Halt gun use when weather conditions make monitoring ineffective in areas with known concentrations of animals <u>Sea turtles:</u> Maintain a 500m buffer zone from the vessel with the sound source from sandy beaches. Provide adequate PAM system on vessels; also have PAM operators for night and low visibility operations.	
	Impacts of underwater sound pressure waves on divers and swimmers	Negligible	Medium-term	Medium	NEGLIGIBLE	Low	NEGLIGIBLE	neg	The impact cannot be further reduced	NEGLIGIBLE
Water resources	Water contamination around the seismic survey vessels due to diesel and gasoline spills	Medium	Long-term	Large	HIGH	Low	MODERATE	neg	Use leak proof containers and storage tanks Provide adequate containment for containers or tanks Have the oil spill contingency and emergency response plans in place	MINOR

									for the vessel operation Carry oil spill clean-up materials on-board Conduct transfer operations only during calm weather conditions	
	Water contamination around the seismic vessel from the discharge of sanitary sewage	Medium	Medium-term	Large	HIGH	Low	MODERATE	neg	Implement waste management plan Comply with MARPOL standards for effluent discharges	MINOR
	Reduced water quality due to the discharge of solid wastes	High	Medium-term	Large	HIGH	Low	MODERATE	neg	Implement waste management plan Comply with MARPOL standards for effluent discharges	MINOR
	Loss of Streamer Fluid results in water contamination	Medium	Short-term	Small	LOW	Low	NEGLIGIBLE	neg	Have the oil spill contingency and emergency response plans in place for the seismic operation	NEGLIGIBLE
Marine mammals/turtles	Vessel strikes/ entangling with seismic equipment causing physical injury or mortality	High	Short-term	Small	MEDIUM	Low	MINOR	neg	Implement JNCC guidelines Provide adequate PAM system on vessels; also have PAM operators for night and low visibility operations. Have MMO/MFO on the vessel Use of turtle guards on tail buoys.	NEGLIGIBLE
Birds	Disorientation of migratory birds as a result of night light emissions from seismic. The effect is even stronger under bad weather conditions (cloudiness).	Low	Short-term	Small	NEGLIGIBLE	Medium	NEGLIGIBLE	neg	Not required	NEGLIGIBLE
Plankton	Water contamination around the seismic vessel from the discharge of sanitary sewage causes a temporary	Low	Short-term	Small	NEGLIGIBLE	High	NEGLIGIBLE	neg	Implement waste management plan Comply with MARPOL standards for effluent discharges	NEGLIGIBLE

	plankton bloom around the vessels. This can cause a change in Biochemical Oxygen Demand and subsequently reduced Oxygen availability for other marine life. However, rapid dilution of the wastewater by surrounding water reduces the consequences.									
Socio-economic										
Component	Impact Description	Scores impact							Mitigation Measures	Residual Impact
		Intensity	Duration	Scale	Severity	Probability	Significance	Status		
Commercial Fisheries	Reduction in industrial fishermen's income due to: Underwater noise produced during the seismic surveys may cause fish to avoid the survey area); Physical presence and movement of vessel and seismic survey equipment.	High	Short-term	Medium	HIGH	Medium	MAJOR	neg	-Establish exclusion zones around the locations where seismic acquisition will be carried out and clearly communicate the coordinates and dimensions of the exclusion zones with the industrial fishermen in a timely manner, through: • 'Notices to Mariners' • Broadcasting of the survey schedule on suitable communication media • Notifications to relevant stakeholders -Use the lowest possible airgun size to minimize the disturbance to fishes;	MINOR

									-Use of radar and detection equipment by seismic contractor -Use of support / guard vessel with FLO (Fisheries Liaison Officer) on board -In case of claims brought forward by fishermen; implement complaints procedure and compensate in case of a valid complaint.	
	Impact on fishing activities due to response efforts (oil spill clean- up efforts) associated with an accidental Diesel fuel spill (small volume spill due to vessel collision or a bunkering accident)	Medium	Short-term	Small	LOW	Low	NEGLIGIBLE	neg	-Refer to oil spill response plan -In case of claims brought forward by fishermen; implement complaints procedure and compensate in case of a valid complaint	NEGLIGIBLE
Marine traffic (shipping/cargo transport and maritime operations)	Disruption or hindrance of freight ships and maritime operations (e.g. potential for minor route alterations) due to seismic survey vessel and deployed equipment movement and physical presence	High	Short-term	Medium	HIGH	Low	MODERATE	neg	-Provision of ‘Notices to Mariners’ -Broadcasting the survey schedule on suitable communication media -Notifications to relevant stakeholders -Use of radar and detection equipment -Use of support/guard vessel	NEGLIGIBLE
	Impact on maritime transport and navigation activities due to response efforts (oil spill clean- up efforts) associated with an accidental Diesel fuel spill (small volume spill due to vessel collision or a bunkering accident)	Medium	Short-term	Small	LOW	Low	NEGLIGIBLE	neg	Refer to oil spill response plan	NEGLIGIBLE

Onshore socio-economics	Increased business incomes for local companies / businesses that provide services and/or goods to the seismic contractor	Low	Medium-term	Small	LOW	Medium	MINOR	pos (bene-ficial)	Project proponent should encourage the seismic contractor to source services and goods locally, wherever possible (e.g. purchase of food, fuel, and water supplies; solid waste handling, recycling, and disposal, local transportation, and vessel pilot and berthing fees.	MINOR

10 Conclusions and Recommendations

This document presents the results of the Limited Environmental and Social Impact Assessment (ESIA) for the Staatsolie Shallow Offshore 3D Seismic Acquisition Project.

The ESIA has been carried out in compliance with the national regulatory requirements and the Environmental and Social Assessment guidelines of the National Institute for Environment and Development in Suriname (NIMOS 2005 and 2009). Furthermore, the Staatsolie Corporate Standards and relevant international standards, guidelines and best practices (World Bank (WB) Group/the International Finance Corporation (IFC)) are taken into account. The assessment and this report were prepared according to approved Staatsolie Terms of Reference (ToR), the NIMOS screening results (27^{th} of August 2019) and the ESIA Terms of Reference (ToR) as submitted to NIMOS (Scoping Report, 25^{th} of October 2019).

The current project has been classified by NIMOS as a Category B-path 2 project, whereby only limited ESIA is required.

Because many ESIA's have already been executed for the project area since 2010, the study was carried out mainly as a desktop study by reviewing and updating existing information, supplemented by stakeholder consultations. Since specialist studies were extensively covered in referenced ESIA studies, the current ESIA will only give special attention to the social and marine/coastal ecosystem assessment.

From the baseline conditions an assessment of the potential effects of the proposed project development was determined. In addition, the baseline environmental information can be used as a benchmark by which future monitoring results will be compared.

Due to the resemblance with previous seismic projects a range of standard best practice procedures and impact reduction measures (or inherent mitigation measures) are adopted from previous studies. The lessons learned regarding the efficiency of proposed mitigation measures based on monitoring results from previous studies have been taken into consideration. In addition, experiences of stakeholders with previous projects have also been taken into consideration.

From the evaluation of the potential impacts in total twelve (12) negative impacts (1 major, 3 moderate, 1 minor and 7 negligible) have been identified for the biophysical components. For the socio-economic components in total four (4) negative impacts (1 major, 1 moderate and 2 negligible) and one positive (minor) impact have been identified. After the implementation of the proposed mitigation measures, all impacts can be effectively reduced to minor or negligible.

Environmental and social project risks and impacts will be managed through an Environmental and Social Management Plan (ESMP) which must be implemented as part of normal operations by effectively incorporating the key components into daily activities, such as including environmental issues in the decision-making process, carrying out operations in accordance with the standard procedures, and maintaining complete records. Also, all duties and responsibilities of all involved parties are contained in this plan.

A Non-Technical Summary (in Dutch) of this report will be distributed to stakeholders and to other interested parties.

Way Forward

The potential impacts associated with the proposed project have been evaluated and assessed in this Draft Limited ESIA Report. This report, together with the ESMP, will be sent to NIMOS. Both draft reports (ESIA and ESMP) will be made available for public comments and stakeholders will be invited to review the report and to participate in the stakeholder’s involvement process (ESIA consultation meeting).

After the ESIA consultation meeting, this report will be updated, all comments will be processed, after which it will be submitted as final, for final advice from NIMOS.

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Appendices