Marine assessment guideline for BOPEC and NUSTAR operations

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Report number C056/16

Healthy reef- Bonaire

IMARES Wageningen UR
Institute for Marine Resources & Ecosystem Studies

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Summary

As part of the permit, Rijkswaterstaat requested an ecological monitoring and evaluation framework guideline to accompany the permit-application for the activities of BOPEC (Bonaire) and Nustar (St. Eustatius), related to the activities of the loading and unloading of oil and oil-related-products.
IMARES has been asked to develop a tailored guideline to assist in the design of a monitoring plan by BOPEC and Nustar.

The current document is the requested guideline. A complete monitoring proposal by the license holder must subsequently be developed on the basis of this guideline.

The generic framework developed by Becking and Slijkerman (2012) was applied and made more specific for this guideline. The basic steps undertaken were:

1. Establishing the context in which the project will take place.
2. Scoping of the project activities, their pressures and the environmental descriptors relevant to the potential impact area.
3. Assessment and evaluation of the anticipated pressures on the selected biological and environmental descriptors.

The guidance thus contains an overview of relevant activities and their pressures. In addition, biological descriptors were selected based on the most important relationships to the planned activities and anticipated pressures.

The scope of monitoring is based on the major linkages between activities, -pressures and -ecosystem descriptors. A distinction is made between baseline and accident monitoring.

Baseline monitoring is necessary to guarantee that background levels and patterns of change over time are known. This should be done also at control sites to make sure that a natural pattern (e.g. bleaching) is not confused as an effect of pollution on the impact sites. Both control sites and impact sites to perform baseline monitoring are recommended in this report.

Accident monitoring is the assessment of the environmental status following accidents. Polluted sites should be identified and monitored. In parallel, all baseline monitoring should be continued. Due to wind and currents, there is a high likelihood that oil spilled at Nustar will float to the coast of Saba. Therefor it is necessary to check the coast of Saba as well after an oil spill.

The baseline monitoring should be a continuous process with and regular effort, while accident related monitoring is incidental, only but directly after a spill or accident. Each type of monitoring requires different frequencies (Chapter 6).

Contents

1 Introduction

1.1 Background and aim of the study

Rijkswaterstaat requires an ecological monitoring and evaluation framework for the activities of BOPEC, Bonaire, and Nustar, St. Eustatius related to the loading and unloading of (oil) products and possible effects on the marine environment. All other activities and related pressures, risks and effects related to shipping are not part of the license. General protocols related to anchoring, de-ballasting, discharge of black and grey water, cooling water, and littering are regulated by international treaties such as ILT, IMO and MARPOL and are not addressed in this document.

The monitoring and evaluation framework is part of the license for both terminals. The current document provides guidelines to further development of a complete monitoring proposal by the license holder.

The framework developed by Becking and Slijkerman (2012) is applied to define the minimum standards for the required monitoring and evaluation protocol of the license holder.

1.2 Overview of the report

Chapter two provides a summary of the applied methodology, and sums up the basic steps as proposed by Becking and Slijkerman (2012). Chapter 3-5 provide the results for each step in the framework. Chapter 6 provides the monitoring guideline.

2 Methodology

2.1 The framework

The generic ecological assessment framework set up by Becking and Slijkerman (2012) for coastal systems in CN was meant as a guidance for license-applications of planned activities that could have consequences for biodiversity, water quality, and functioning of coastal ecosystems. This framework was commissioned by Rijkswaterstaat and the Ministry of Economic Affairs in 2012.

Though the 2012 framework provides guidance, it is limited to standard practices and general regulations. It is the responsibility of the license holders to customize an adequate and comprehensive ecological impact assessment and monitoring-plan, for subsequent evaluation by the relevant authorities.

The principle functions of the current guideline are to make it possible to:

- Establish baseline data for potentially impacted sites;
- Establish the extent and patterns of change in key ecosystem components;
- Measure the impacts of an action;
- Identify any undesirable condition;
- Allow evaluation of effectiveness of various management strategies.

In this report the minimum requirements for environmental monitoring are provided for the operations of both BOPEC and Nustar. A distinction is made in assessing **a baseline environmental status** and the **environmental status following accidents** related to the loading and unloading of products. The baseline monitoring is a continuous and regular effort, while accident-related monitoring is incidental.

The broad strategy of the ecological assessment framework consists of three steps:

1. Context phase: establishing the context in which the project will take place. The context phase results in a first overview of all relevant values and risks.
2. Scoping phase: scoping of the project activities, their pressures and the environmental descriptors relevant to the project area. The scoping phase results in an overview of all relevant activities, pressures, and environmental descriptors.
3. Assessment and evaluation phase: in this phase the pressures on the environmental descriptors are assessed and evaluated. The assessment and evaluation phase results in the prioritization of the impact-relationships. All significant impact-relationships should be monitored and evaluated.

2.2 Generic outline of the guideline

In general, the context and scoping phases are a process of problem formulation, planning, and establishing the goals, breadth, and focus of the project. They allow the characterization of the ecosystems in which the activity and pressures may occur as well as the biota that may be exposed in a spatio-temporal scale. The last phase develops profiles of the effects of the project-activities on the environmental descriptors by assessing the degree of impact of the pressures resulting from the activities, as well as identifying key issues of concern at an early stage in the planning process. Impact can be estimated using a variety of techniques including the comparison of individual exposure and effects values, the comparison of the distributions of exposure and effects, or the use simulation models. The impact can be expressed as a qualitative or quantitative estimate, depending on the available data. New data are frequently required to conduct analyses that are performed during the assessment. Data from verification studies can be used to validate the predictions of a specific assessment. Ecological effects or exposure monitoring can aid in the verification process and suggest additional data, methods, or analyses that could improve future assessments. The assessment and permitting process should thus be iterative.

The guidelines developed in this document identify the environmental values to be protected, an overview of all relevant activities, pressures, and environmental descriptors related to the loading and unloading of (oil) products, the data required, and outlines a monitoring scheme to be used for setting up a monitoring plan.

Documents cited in Becking and Slijkerman (2012) were consulted and complemented with specific documentation provided by Rijkswaterstaat and others (see reference list).

3 Context

The context of the monitoring refers to the possible accidents related to Nustar and BOPEC operations concerning loading and unloading of (oil) products. These are extensively described in RWS (2014).

Relevant treaties, ordinances and national regulations are listed by Becking and Slijkerman (2012) and Verweij et al.(2015). In RWS (2014), relevant habitats and species groups are evaluated. The species and habitats that are discussed in the two reports and that are relevant to the current project were used to prepare this monitoring and evaluation framework. We refer to these documents as the sources for the rationale and more extensive descriptions.

Currently no structural monitoring is being done which may help detect or prevent potential or undesirable risks, nor are there structured baseline biological and environmental data available for the relevant areas. At present, information on the ecological status of the project areas is limited to exploratory project-related surveys. Available information is documented at www. DCBD.nl .

3.1 BOPEC, Bonaire

The Oil Terminal is used as a storage and trans-shipment facility for crude oil and derivatives. The terminal is owned and operated by Petróleos de Venezuela SA (PDVSA). The BOPEC terminal is located at Bonaire, and designed for an expected throughput of 19.3 million m3 of fuel oil and blend products annually. It functions primarily as a storage facility for multiple grades of refined and non-refined oils from Venezuela and refineries on Curacao and Aruba. BOPEC also has mixing and blending capabilities for its stored fuels. Transfer takes place on two piers that each have their own characteristics in terms of length and depth, as described in the port regulations. Approximately 380 incoming tankers per year with an average size of 50,000 m^3 of (oil) product which are unloaded. The unloading of incoming tankers takes about 12.5 hours per tanker. The outgoing Very Large Crude Container tankers (VLCC) have an average size of 300,000 m^3. The loading of these VLCCs takes about 38 hours per tanker. About 64 VLCCs are handled at the terminal each year.

The Bonaire National Marine Park (BNMP) extends from high water to 60 m depth contour. The Bonaire National Marine Park encompasses the entire coast of Bonaire, including the smaller island of Klein Bonaire and Lac Bonaire. The Bonaire National Marine Park is managed by the Bonaire National Parks Foundation (STINAPA). STINAPA is responsible for actively regulating potentially damaging activities in the Park. The study area thus lays within the BNMP. The marine habitat in the area consists of fringing coral reef which already is in an impacted, but functioning, state (Van Beek & Meesters 2013).

3.2 NUSTAR, St. Eustatius

NuStar fuel oil storage terminal is located at Sint Eustatius and owned and operated by the American oil company NuStar Energy L.P. It functions primarily as a storage facility for multiple grades of refined and non-refined oils with a total active storage capacity of 11 million barrels. The NuStar terminal has several marine facilities.

In general the marine habitat near the Nustar jetty at Statia is sandy at the inshore areas. Further at sea (500-900 m) from shore, habitat consists of mixed substrata with small boulders and cobbles, and seagrass, all encrusted with life, resulting in a high biodiversity (Haskoning, 2011). Large numbers of sponges and conch are reported. Stenapa is responsible for regulating all activities in the marine park which extends around the entire island from the high water mark out to a depth of 30 metres. The Nustar operations site thus lays within the marine park. The northern reserve is located approximately

1 km from the jetty of Nustar. The reserves of St. Eustatius are set up to conserve marine biodiversity, restore fish stocks and safeguard the marine ecosystem.

In addition to Sint Eustatius, the Saba coastal environment is relevant with regard to spills at Statia because currents, waves and wind may transport material quickly from Statia to Saba. Much of Saba's coastline contains small cliffs and shores of volcanic rocks. The Saba National Marine Park stretches from the high tide mark to the 60 m depth contour, which protects the narrow coral reef system encircling the island.

4 Scoping

4.1 Activities

Activities that are assessed in the current guideline are the loading and unloading of (oil) products and the maneuvering of the ships towards the jetties.

Loading/unloading: the operation of filling and emptying a ship's tank. Cargo can be moved on or off of an oil tanker in several ways. One way is for a ship to moor alongside a pier or jetty, and connect with cargo hoses or marine loading arms. Another method involves mooring to offshore buoys, such as a single point mooring, and making a cargo connection via underwater cargo hoses. Despite all efforts and protocols to prevent spilling during operation of loading and unloading, accidental spills might occur.

Mooring (including manoeuvring) is the operation to secure the ship in a particular place, as by cables and anchors or by lines to the moor on a pier, quay or jetty in order to be able to load and unload.

4.2 Pressures

To place the ship in line with the pier during mooring, manoeuvring and engine power is used, leading to increased suspension of sand resulting in altered sedimentation and turbidity. These alterations mainly affect corals, seagrasses en benthic communities and to a lesser extent also fish.
The impact of spills depends largely on the volume, type of product and circumstances such as wind and wave direction. However, all products form floating layers, and contain polycyclic aromatic hydrocarbons (PAHs) which in general are very difficult to clean up, and last for years in the sediment and marine environment. Species exposed to PAHs can be affected in various ways. Birds, sea turtles and sea mammals can be smothered at the sea surface, corals, seagrasses and benthic communities can be smothered when layers sink onto the sea bottom. Exposure to the altered water quality can lead to various environmental impacts, depending on the species and concentration. Air pollution results from normal tanker engines operation. Cargo fires are a serious concern related to air and water quality.

With regard to the listed activities the following pressures are relevant:

Smothering by oil: oil or oil product layer at seafloor, intertidal zone or sea surface due to oil spill. Organisms can be smothered (birds, mammals, turtle, benthic, corals, seagrass)

Sedimentation: the settling of suspended particles. Increased suspended particle load caused by ship manoeuvring and thus sedimentation can smother organism or lead to an energy drain due to energy diverted from other essential life functions to cleaning.

Changes in turbidity: Turbidity is opacity of a fluid caused by particles. Turbidity changes as a result of changed number of particles in the water (see sedimentation) and leads less light for corals and seagrass thereby reducing their energy for growth and maintenance.

Abrasion: damage due to contact with the bottom.

Underwater noise: Human generated noise caused by engines and propellers has impact on marine mammals especially leading to displacement. Impacts of fish species include disruption of their intraspecific communication that is essential to reproduction.

Marine litter: Human created waste released into the marine environment. Impacts are not only due to ingestion en entanglement but disintegration of litter is also an assumed cause of uptake of microplastics and contaminants into the foodweb.

Input of pollutants: pollutants are a broad group of substances, as certain chemicals or waste products, harmful for the environment. In this context pollutants are mainly substances- but not limited to- originating from shipping, oil and petrochemical industry. The main focus depends on the type of product, but is likely to be PAH, mineral oil. Also, the clean-up chemicals applied can alter water quality and should be taken into account in this context. Altered water quality can adversely affect the ecosystem by causing an undesirable change in the population structure of species by affecting rates of mortality, reproduction, or growth and development (EPA 2003). The toxicity of clean-up chemicals should always be measured as concentration and exposure duration (Rijkswaterstaat 2010a,b).

Air pollutants: Relates to emissions of noxious gasses and small particulate matter that can cause adverse effects in air and water.

Noise (air): Strong noises related to mooring and (un)loading of ships. This can adversely affect behaviour of terrestrial animals.

Shading: Ships moored at the jetty cause shading on the reef, resulting in lowered light conditions. Effects are as under turbidity.

4.3 Environmental descriptors

Based on Becking and Slijkerman (2012) and in the scope of the planned activities we suggest that the ecological assessment of coastal systems near BOPEC and NUSTAR operations should consist of at least the following environmental and biological descriptors:

- Benthic diversity
- Coral health
- Species requiring special attention
- Water quality

Biological descriptors

The descriptors “Benthic diversity”, “Coral health”, and “Species requiring special attention” allow the evaluation of the biological condition using biological surveys and other direct measurements of resident biota (EPA 2009). Indicators related to these descriptors offer an understanding of the status and functioning of the community based on the numbers and kinds of organisms expected to be present in the environment (Jameson et al. 1998 & 2003, EPA 2011). Because biota are constantly exposed to the impact of various pressures, these communities reflect not only current conditions, but also changes in conditions over time and their cumulative impacts (EPA 2011). Impairment of the environment is judged by its departure from the reference situations (Jameson et al. 1998 & 2003, EPA 2002).

Water quality descriptor

Water quality in general steers the ecosystem and its biota which means that alterations in water quality may directly and indirectly affect the ecosystem.

The effects of oil and dispersants on marine species will vary greatly. Oil and applied dispersants may affect the ecosystem in various ways, which largely depends on the species and habitat, type of oil spilt, applied dispersant concentrations, extent of weathering and appearance and duration of the contamination. Oil can cause layers or sludge in the water, directly affecting animals, seagrass, corals and shore habitats by smothering and suffocation. Indirectly and more chronically, water chemistry is altered by specific compounds, potentially affecting growth, reproduction, behaviour and normal life development of species.

The proposed protocol for water quality monitoring concerning oil related indicators can be found in Annex 1- based on the oil spill consistency plan (RWS, 2014) during and shortly after oil spills.. It comprises visual monitoring of oil layers, and water chemistry monitoring after oil spills.

For chemical substances, threshold values can be found in literature (so called PNEC values- Predicted No Effect Concentrations) for multiple species (Ecotox database EPA- http://cfpub.epa.gov/ecotox/).

In addition, baseline monitoring of PAHs is advised. Baseline monitoring of poly-cyclic aromatic hydrocarbons (PAHs) is relevant due to their relevance to the products loaded and unloaded at the terminals. Because of their persistence, the potential for accumulation, and toxicity in marine organisms and ultimately in the humans that consume them (Baussant et al., 2001) it is advised to include these compounds in the baseline monitoring. More specifically, monitoring in biological tissues of e.g. mussels or oysters is common in order to obtain a time integrated concentration relevant for local organisms. At the study sites, relevant tissues are however not easy to collect and instead the use of passive samplers is advised.

Passive samplers represent an innovative monitoring tool for time-integrated measurement of bioavailable contaminants in the environment. These devices are now-a-days being considered as a part of an emerging strategy for monitoring a range of priority and emerging pollutants in Europe http://water.europa.eu/). As activities of concern take place in marine parks and close by marines reserves, we advise to include these innovative techniques in baseline monitoring, and evaluate the results after a few years. Thereafter decide on continuation.

5 Assessment and evaluation

In this chapter, the linkages between activities, pressures and environmental descriptors are described. The relevance and significance within the impact chains are evaluated by taking into account the spatio-temporal co-occurrence of the pressures and environmental descriptors based on information within relevant documents (Haskoning 2011, Klok et al., 2011, RWS 2014) and expert judgement. An indication of pressures and the relevance of those pressures in terms of the proposed environmental descriptors is given in Table 1.

The table presents a qualitative assessment of relevant linkages. The linkages are given a relative weight score to each relevant linkage, which orders the priorities in deciding whether an impact of a pressure on the environment is acceptable or unacceptable. All relations depend on intensity, frequency and persistence of the pressure. Assessment of the likelihood of occurrence, and vulnerability of the ecosystem component was done using guidance schemes provided by Becking and Slijkerman (2012).

In chapter 4 relevant pressures were listed. Evaluation resulted in the following four most important related pressures (

Table 1): smothering, sedimentation, and pollution. Pressures of minor importance are: Changes in turbidity, abrasion, underwater noise, marine litter, air pollutants, noise (air), shading.
All biological descriptors are sensitive to smothering and pollution

Table 1 provides the full overview of the evaluation results.

Table 1 Qualitative assessment of relevant linkages between activities, their pressures and ecosystem descriptors.

Activity \ Pressure	smothering by oil	Sedimentation	Changes in turbidity	Abrasion	Underwater noise	Marine litter	Pollutants	Air pollutants	Noise (air)	Shading
loading/unloading	**X**				x	x	**X**	x	x	
mooring (incl manouv)		**X**	x	x	x			x	x	x
Environmental descriptors	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Corals	**X**	**X**	**X**	**X**		x	x			x
Fish	**X**	x	x			x	x			
Marine mammals	**X**				x	x	x			
Sea turtles	**X**					x	x			
Benthic species	**X**	**X**	**X**	**X**			x			x
Birds	**X**					x	x		x	
Seagrass	**X**	**X**	**X**	**X**			x			x
Cliffs	**X**					x	x			
Sandy beaches	**X**					x	x			

X: relatively large intensity or vulnerability
x: relevant
x: relevant, but of minor intensity or sensitivity in comparison to previous category
blank: no significant relevance

6 Proposed monitoring

6.1 Scope

The scope of monitoring is based on the major linkages between activities- pressures-ecosystem descriptors (Table 1). Furthermore, the proposed monitoring is sub-divided into two categories: baseline- and accident- monitoring.

Baseline monitoring is necessary to guarantee that background levels and patterns of change over time are known. This should also be done on control sites to make sure that a natural pattern that is happening is not confused as an effect of pollution on the impact sites. Accident monitoring is necessary right after a spill or accident. Each type of monitoring requires different frequencies (Table 2).

Table 2 Proposed monitoring scheme for both baseline and accident monitoring

Monitoring			
Biological	**Baseline**	**Frequency**	**Accident**
Corals	X	Yearly	x
Marine mammals			x
Sea turtles			x
Benthic species	X	Yearly	x
Birds			x
Seagrass	X	Yearly	x
Cliffs	X	2/year	X
Sandy beaches	X	2/year	X
Pressures			
Smothering by oil	X	Yearly	x
Turbidity	X	Monthly	x
Sedimentation	X	Monthly	x
Pollutants	X	4/year	x

6.2 Baseline monitoring

Monitoring techniques for assessing the diversity and health of coral reef communities should follow accepted methodology such as described by AGRRA (http://www.agrra.org/) and GCRMN (http://www.icriforum.org/gcrmn). The ultimate monitoring program should, however, be evaluated by the appropriate authorities before it is accepted. Furthermore, regular re-evaluation of monitoring should be planned.

Biological: Corals, benthic species

What	Suggested Indicators: Cover by corals, seagrass, macro-algae down to species level. Cover by sponges, cyanobacterial mats, algal turfs, sand, crustose coralline algae as groups; maximum coral colony diameter, cover by newly dead coral (by species), coral bleaching (by species), coral disease (by species), coral recruitment, Diadema abundance, major invertebrate species and abundance, crustose corraline algae cover, fleshy macroalgae and turf algae cover, Cyanobacteria cover, Non-indigenous (benthic) species, sand.
Frequency	1/year
How	- Areas (reference and impact) monitored both up and down current from terminal. - Minimum of 3 sites monitored per study area, minimum distance between sites 200m - Within the impact area, sites at increasing distance from the jetty, e.g. 0, 200 and 400 m from the jetty. - 3 transects of 50 m/site, each square metre a photograph of sufficient resolution to guarantee species identification of corals and algae. - Transect and sites in control and impact areas are located in comparable coral communities and similar depth. Suggested protocols are AGRRA, GCRMN (see Becking and Slijkerman 2012)
Where	See Figure 1, 2 for study areas. Note GPS coordinates for each transect, note the depth, and direction of transect.

Abiotic: Cliffs, sandy beaches

What	tar balls and residue
Frequency	Half yearly
How	- Walk along coast and record with GPS where tar balls and oil remains are seen and determine the size and #tar balls/m coastline - Always at low tide, within the wrack line[1] - Per monitoring area, minimum of 3 x 100m transect along the coast
Where	Baseline: coastlines of the impact and reference sites (i.e. representative locations down and up current of Bonaire, Sint Eustatius (consider Saba as well) During and after a spill: Specified by models RWS to identify most likely impacted sites

Abiotic: Sedimentation, Turbidity

What	sedimentation, turbidity
Frequency	monthly
How	- Sedimentation rate: set out sediment traps - Turbidity: Secchi-disc or turbidity meter
Where	Same locations as biological monitoring. See Figure 1, 2 for study areas.

Pollutants:

What	- Levels of oil (-products) and PAHs in biological tissue. When biological tissues are hard to select on site, instead use passive samplers as an time integrated pollution indicator (Baussant et al., 2001). Type of sampler to be specified in extended monitoring proposal. - Depending on the dispersant applied monitor the dispersant concentrations (accident)
Frequency	- Baseline: 4/year (Passive sampler) - Monthly (after a spill for year)
How	- Passive sampler. E.g. low-density polyethylene (LDPE). Deploy for a month.
Where	Same locations as baseline biological monitoring See Figure 1, 2 for study areas. One site per transect and polluted sites after accident

6.3 Location of baseline sampling sites

The baseline monitoring should be done in the impact area of BOPEC and NUSTAR harbour (yellow shaded areas Figure 1, 2) as well as 2-4 reference/control areas (blue shaded, poligones). Reference areas allow to check that a naturally occurring trend is not confused as an effect of pollution on the impact sites.

We have proposed reference areas using best available information about the physical and biological characteristics of the environment to ensure that they represents suitable reference conditions (according to Becking and Slijkerman 2012). In Bonaire reef areas should be selected as reference, and in St. Eustatius seagrass areas with sand and rubble should be selected, as these are representative areas of the terminals. See annex 2 for habitat maps of St. Eustatius and Bonaire.

[1] Wrack line is part of the shore just above the mean high tide line where debris is deposited on the sand

Sites selected should consist at least:

- 3-4 areas must be monitored: 1 impact area and 2-4 reference areas.
- Per area a minimum of 3 sites must be recorded. For the impact area select sites at increasing distance from the jetty, e.g. 0, 200 and 400 m from the jetty.
- Distance between sites should be minimally 150 meters
- 3 transects of 50 m/site, each square metre a photograph of sufficient resolution to guarantee species identification of corals and algae.
- Transect and sites in control and impact areas are located in representative benthic communities and at similar depth

Turbidity, sedimentation, and pollutants should be measured at all sites where biological monitoring is done, where there is at least 1 site that is near the pier, under the ships.

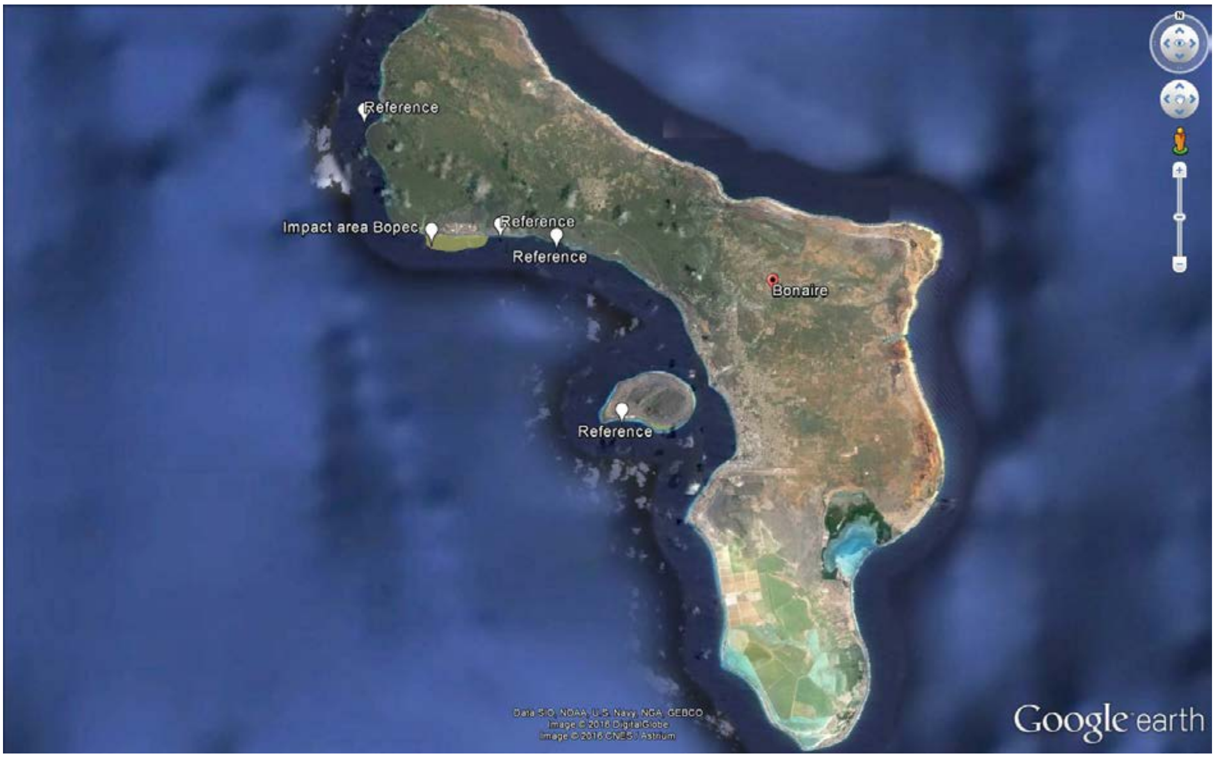

Figure 1 Reference areas and impact area (yellow) at Bopec, Bonaire

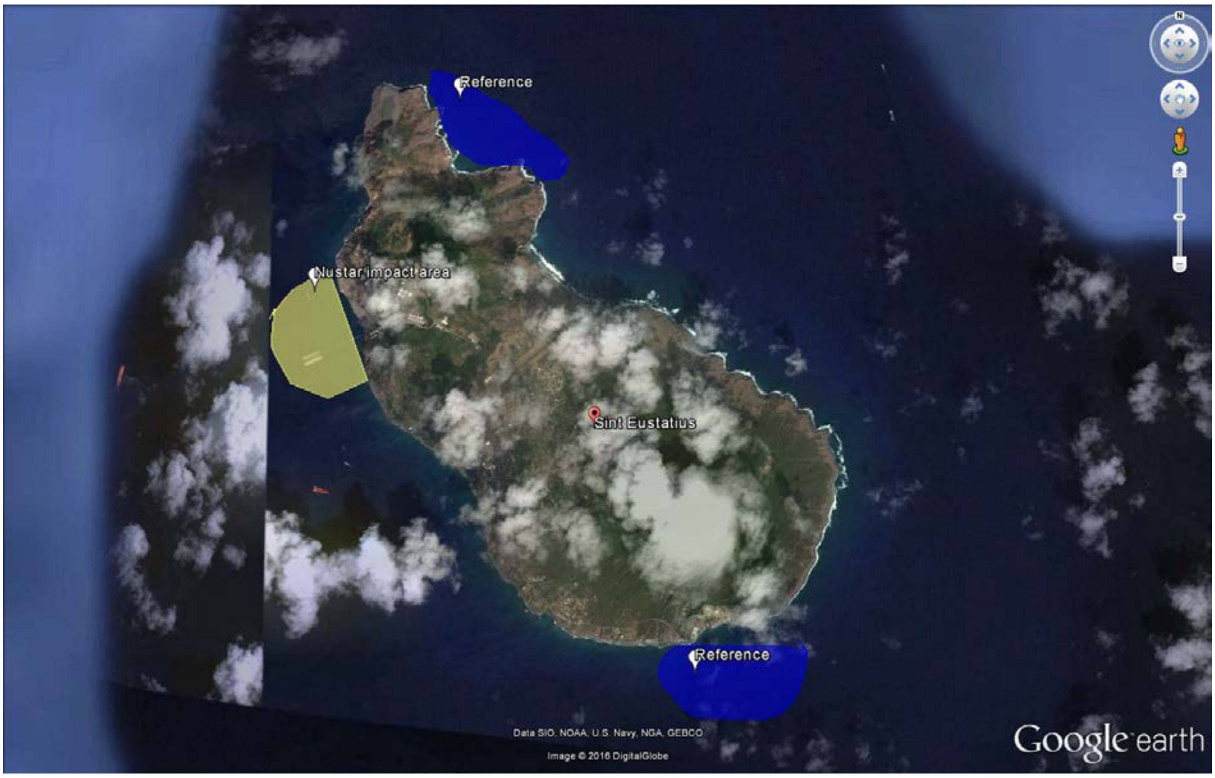

Figure 2 Reference areas (blue) and impact area (yellow) at Nustar, Sint Eustatius

6.4 Accident monitoring

During and after an oil spill, all biological descriptors should be monitored in addition to the monitoring requirement of the oil spill contingency plan (RWS, 2014).

In the case of an accident, polluted sites should be identified and monitored. In parallel, all baseline monitoring (including reference sites) should be continued. Due to wind and currents, there is a high likelihood that oil spilled at Nustar could float to the coast of Saba. Therefor it is necessary to check the coast of Saba as well after an oil spill at Nustar. Volume and type of oil, location of the incident, and weather conditions are most relevant to predict if, and where on Saba the oil will float to. The RPS- ASA model Oilmaps of *Applied Science Associates.Inc* is modified by Rijkswaterstaat for the Dutch Caribbean situation. The model is 27/4 applicable via the national coordination committee "*Milieu Incidenten Water"*(LCM)[2]. The model should in addition to its basic purpose[3] be used in order to select the proper monitoring sites, which should thereafter be confirmed in the field.

After the oil spill has been contained, baseline monitoring afterwards should be done immediately to investigate the consequences. In addition an increased frequency of baseline monitoring is advised for a limited period of time (e.g. 2-4 / year instead of 1/year, depending on the severity of the spill and the species or habitat impacted).

Relevant indicators are described in RWS (2014) and summarised in annex 1.

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[2] National Committee for Environmental Incidents in Water

[3] environmental advise for oil spill response, including oil spill modelling and short and long term effect predictions on the water column

In addition to the described monitoring in the oil spill contingency plan (RWS, 2014) (water, oil observations), record the number and location of dead birds, sea turtles and marine mammals at identified polluted sites.

6.5 Iterative process

The described scope and frequencies of monitoring should be further developed on the basis of this guideline. We recommend to evaluate the results after a few years and to adapt any relevant aspects based on experiences, results and possible upcoming parallel activities by the terminals or other parties (e.g. monitoring programs by others). As such this guideline and the monitoring program drafted by the terminals should be part of an iterative process led by the permitting authority (Figure 3) and should be made part of the permitting process.

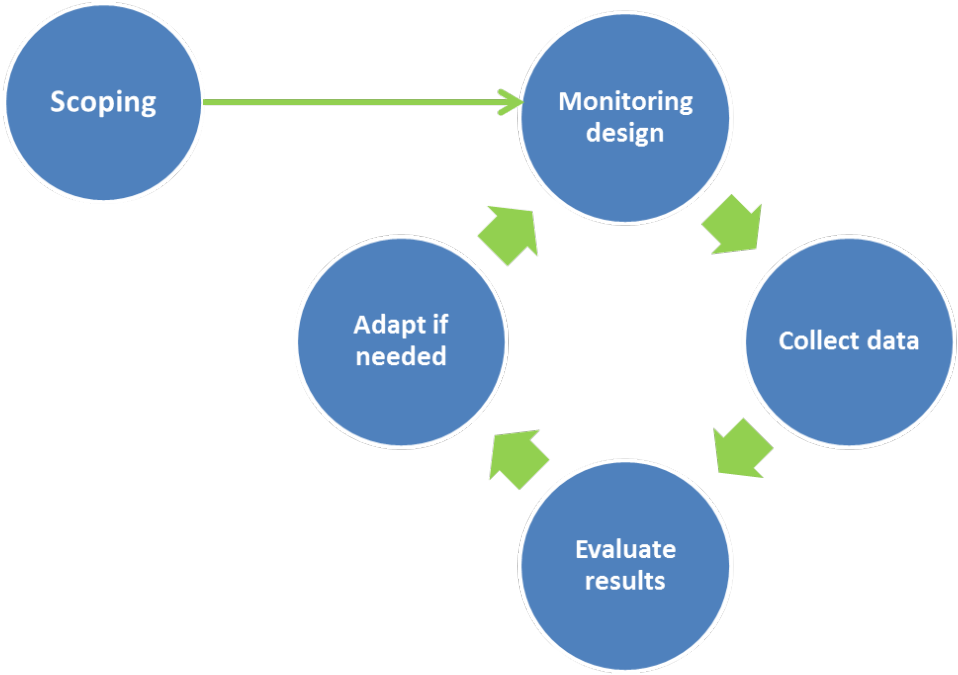

Figure 3 Iterative process

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

Furthermore, the chemical laboratory at IJmuiden has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation. The chemical laboratory at IJmuiden has thus demonstrated its ability to provide valid results according a technically competent manner and to work according to the ISO 17025 standard. The scope (L097) of de accredited analytical methods can be found at the website of the Council for Accreditation (www.rva.nl).

On the basis of this accreditation, the quality characteristic Q is awarded to the results of those components which are incorporated in the scope, provided they comply with all quality requirements. The quality characteristic Q is stated in the tables with the results. If, the quality characteristic Q is not mentioned, the reason why is explained.

The quality of the test methods is ensured in various ways. The accuracy of the analysis is regularly assessed by participation in inter-laboratory performance studies including those organized by QUASIMEME. If no inter-laboratory study is available, a second-level control is performed. In addition, a first-level control is performed for each series of measurements.
In addition to the line controls the following general quality controls are carried out:

- Blank research.
- Recovery.
- Internal standard
- Injection standard.
- Sensitivity.

The above controls are described in IMARES working instruction ISW 2.10.2.105. If desired, information regarding the performance characteristics of the analytical methods is available at the chemical laboratory at IJmuiden.

If the quality cannot be guaranteed, appropriate measures are taken.

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Justification

Report C056/16
Project Number: 4318100065

The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

Approved:` Dr. Dolfi Debrot
Senior researcher

Signature:

Date: June 2016

Approved: Dr. ir. T.P. Bult
MT Member

Signature:

Date: June 2016

ANNEX 1 Monitoring of oil spills

Following the Oil Spill Contingency Plan (RWS, 2014) several indicators are prescribed. At least the following indicators are proposed to include in both the baseline monitoring and accident monitoring.

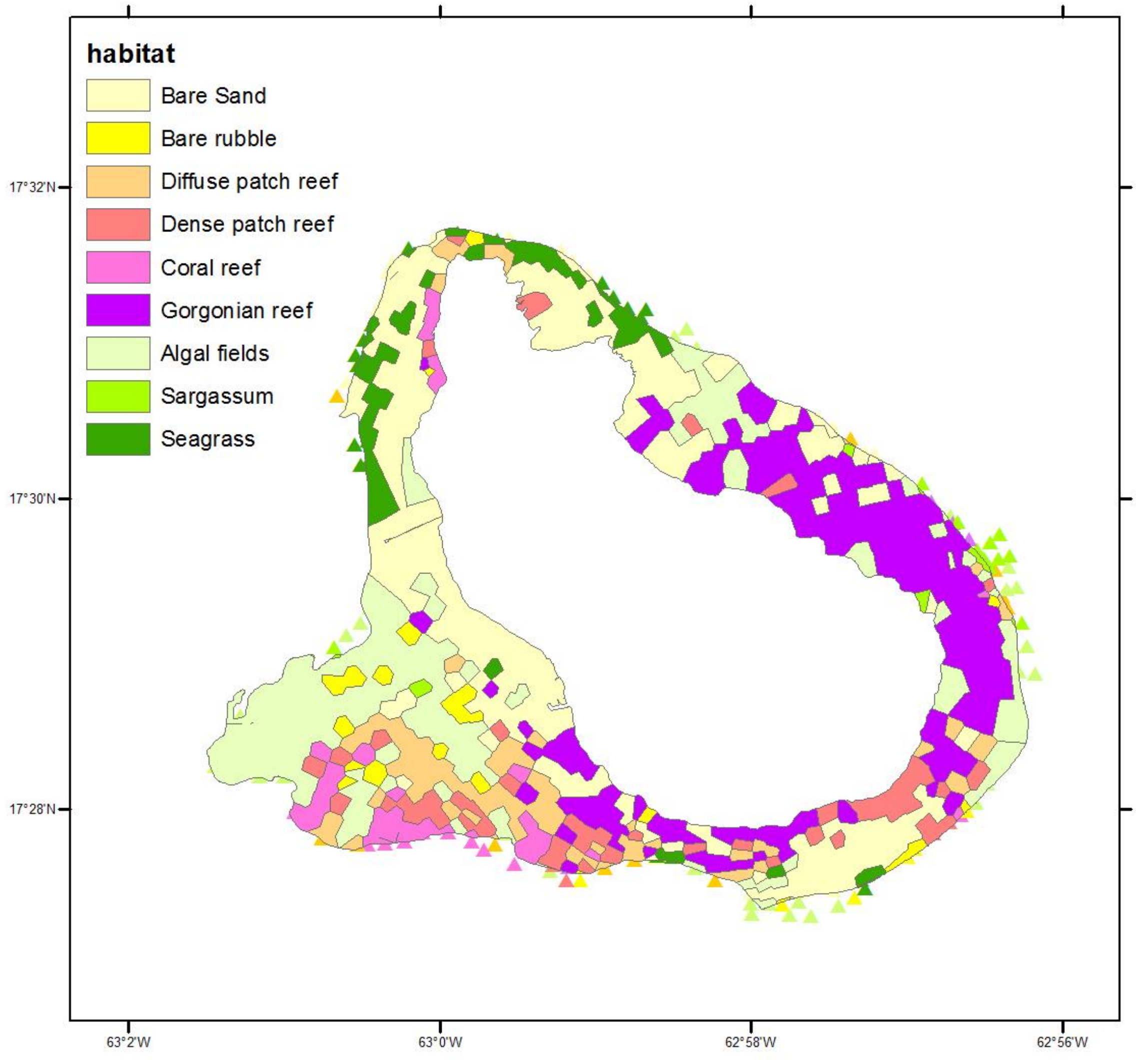
The Bonn Agreement Oil Appearance Code can be utilised to estimate the spill volume from a visual assessment of oil on the sea surface. A maximum and minimum volume estimate can be calculated where Bonn colour codes are utilised in order to allow a suitable assessment of potential pollution in the sea.

Colour code / Appearance	Example	Layer Thickness/Description (ìm)	Litres (L)/km^2
1. Sheen (silvery/grey) Appearance is due to their thickness.		0.04 to 0.30 Very thin films of oil that reflect the incoming light slightly better than the surrounding water.	40 - 300
2. Rainbow Rainbow oil appearance is independent of oil type.		0.30 to 5.0 Oil films with thicknesses near the wavelength of different coloured light exhibit the most distinct rainbow effect.	300 - 5,000
3. Metallic The appearance of the oil in this class is oil type dependent.		5.0 to 50 Metallic will appear as a quite homogeneous colour that can be either blue, brown, purple or another colour.	5000 - 50,000
4. Discontinuous true colour The broken nature of the colour is due to thinner areas within the slick.		50 to 200 For oil slicks thicker than 50 µm the true colour will gradually dominate the colour that is observed.	50,000 - 200,000
5. Continuous true colour Homogenous colour can be observed with no discontinuity as described in Code 4.		200 to > 200 The true colour of the specific oil is the dominant effect in this category. This category is strongly oil type dependent.	200,000 - >200,000

After and during a spill:
Oil sampling is a fundamental step in spill assessment and is the first step in the process of obtaining information about the spill and its consequences. Sampling can be carried out onshore from oiled sediment and effected mammals and seabirds (correct procedures must be followed when handling live animals). Also offshore onboard vessels and from aircraft or helicopters using sampling buoys. Samples of floating or stranded oil are taken for qualitative purposes to confirm the source of the oil. If the oil type is unknown, the oil must be tested and verified to help determine specific response details.
There a number of different methods to collect oil samples depending on the type of spill encountered. The Bonn Agreement, Volume 3, Chapter 32: The Guidelines for the Exchange of Oil Samples/Results between countries, and on Oil Spill identification, describes in full the different sampling equipment and techniques to successfully collect viable oil samples (Ref: Bonn Agreement Oil Spill Sampling Guidelines)

Description	Indication of Minimum Required Quantity (per sample)
Pure oil source sample	30 - 50 millilitres
Contaminated oil (e.g. emulsified oil, oil from the sea or shore, sandy tarball)	10 - 20 grams
Debris with oil, stained sand	Sufficient quantity that the oil content is approximately 10 milligrams
Oiled feather	5 - 10 feathers depending on quantity of oil
Fish, shellfish (flesh and organs)	Mulitple individuals of the same species totalling 30 grams
Water sample with visible oil	1 litre
Water sample with no visible oil	3 - 5 litres

ANNEX 2 Habitat map Sint Eustatius



Reference; Debrot et al., 2013

