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Protocols for studies on natural removal of stranded oil on the coast in Arctic climatic regimes

D 4.8

WP4 Combat of oil spill in coastal arctic water



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Executive Summary

The following report is a protocol for studies on natural removal of stranded oil on the coast in Arctic climatic regimes cover Task 4.3.1. The report includes experimental setup, study program and time schedule.

The aim of the present studies is to increase the knowledge base on the rate of natural removal and degradation of stranded oil on rocky surface in low arctic, middle arctic and high arctic climatic regime. Wind, ocean currents and waves can result in oil spill from ships and offshore activities reaching the coastline. In addition, risk for oiling the shoreline is high when fjords and bays are used as a safe haven for ships in distress. Rocky surfaces are a widespread coastal type in Greenland and other arctic areas. The self-cleaning potential is an essential factor in considering the shoreline clean-up strategy together with the potential adverse environmental impact of shore cleaning. Results of the study will support shoreline clean-up strategies in arctic waters.

At the selected locations for the study, tiles of granite, shale or similar material, comparable to the natural conditions will be treated with a homogenous layer of oil will be placed on ramps in the tidal zone. The tiles will be placed in different height levels of the tidal zone, and hence will be used to determine the natural removal of oil in this zone from seawater wash and natural degradation in correlation to different water covers and air exposure times. Furthermore, tiles will be placed above the high tide level where removal and degradation of oil in air only will be determined. Possible influence of sunlight (photooxidation) will be examined by monitoring removal/degradation of oil from tiles exposed and not exposed to sunlight by facing tiles upward and downward to the sun. The experiments will be conducted at three localities: the northernmost location will be near the Northwest Greenland town Upernavik (approx. 72° N), the mid location (approx. 64°N) will be placed outside of Nuuk, the Capital of Greenland, and the southern location will be placed near the town Nanortalik (approx. 60°N). The study will be conducted in the period June to September 2017 and reported in December 2017.

Introduction

Following deliverable D 4.8 Protocols for studies on natural removal of stranded oil on the coast in Arctic climatic regimes cover Task 4.3.1 Studies on natural removal of stranded oil on the coast in Arctic climatic regimes.

Wind, ocean currents and waves can result in oil spill from ships and offshore activities reaching the coastline. In addition, risk for oiling the shoreline is high when fjords and bays are used as a safe haven for ships in distress. Rocky surfaces are a widespread coastal type in Greenland and other arctic areas. The self-cleaning potential is an essential factor in considering the shoreline clean-up strategy together with the potential adverse environmental impact of shore cleaning.

Aim of the present studies is to increase the knowledge base on the rate of natural removal and degradation of stranded oil on rocky surface in low arctic, middle arctic and high arctic climatic regime. Results of the study will support shoreline clean-up strategies in arctic waters.

Approval for field test is given by the Greenland authorities in permit (Ministry of Nature, Environment and Energy, September 30, 2016.) Claims in the approval are mainly administrative and the implementation of the planned activities will and can be performed within the limits set out in the approval.

Study program

At the selected locations for the study, tiles of granite, shale or similar material, comparable to the natural conditions will be treated with a homogenous layer of oil will be placed on ramps in the tidal zone. The tiles will be placed in different height levels of the tidal zone, and hence will be used to determine the natural removal of oil in this zone from seawater wash and natural degradation in correlation to different water covers and air exposure times. Furthermore, tiles will be placed above the high tide level where removal and degradation of oil in air only will be determined. Possible influence of sunlight (photooxidation) will be examined by monitoring removal/degradation of oil from tiles exposed and not exposed to sunlight by facing tiles upward and downward to the sun.

At each location and site, study design will accommodate as much uniformity as possible with respect to coastal morphology to exclude local spatial variation. Therefore, the coastal slope, direction and substrate will be as comparable as possible for the three locations (see figure below).

Physical parameters will be obtained by local logging (temperature, wave action), from other sources such as the Danish Meteorological Institute (wind, visible light and UV radiation). The obtained physical data will also be compared to previous field studies. Based on data from the temperature loggers, water cover / air exposure time of the tiles at the different height levels on the coast will be estimated.

The experiments will be conducted at three localities: the northernmost location will be near the Northwest Greenland town Upernavik (approx. 72° N), the mid location (approx. 64°N) will be placed outside of Nuuk, the Capital of Greenland, and the southern location will be placed near the town Nanortalik (approx. 60°N). See locations on the map below.



Figure 1. Examples of the type and costal morphology of the locations used in the field experiment (photos: S. Wegeberg)



Figure 2. Map of Greenland indicating all towns in Greenland including those where the experimental studies will take place nearby. Please notice, from the south, Nanortalik, Nuuk and Upernavik.

Experimental setup

The tiles with added oil will be placed in different height levels in the tidal zone from right above the tidal zone and at 3-5 levels in the tidal zone depending on the local tidal amplitude and actual conditions. The height levels will refer to chart zero as to be able to calculate water and air exposure time as well as being comparable between locations.

The deployment and sampling will take place within the 2017 field season, from June to optimally September (depending on the freeze-up). The replicate number of deployed tiles will be sufficient for sampling weekly approx. 90 tiles at each location.

Approximately 2-3 mm thickness oil film will be applied on the tiles at initiation of the experiment. Two different oil types will be used for the study; a North Sea type crude oil and a heavy bunker fuel oil. The crude oil is expected to be a naphthenic crude oil, with a low pour point and the ability to form stable water in oil emulsions. The heavy bunker fuel oil to be used is expected to be an IFO180. IFO stands for intermediate fuel oil and refers to a mixture of gasoil and heavy fuel oil, having a viscosity of 180 centistoke at 50 °C. IFO180 is used as fuels in tankers and thereby representing an actual risk of spill in Greenland.

After sampling, the tiles will be placed in Rilsan-bags and glass container, stored at -20°C until transportation to the laboratories for further processing and analyses in Denmark. Oil on tiles will be extracted in laboratories using dichloromethane (DCM), and the amount of oil extracted from the tiles will be measured using UV fluorescence analysis as a proxy for oil and selected samples will be detailed characterized using GC-FID analysis. In addition, biofilm on the surface of tiles will be monitored by means of biomass of microalgae. Possibly the bacterial community in the biofilm on the tiles will be investigated by WP2.

Time schedule

Marts 2017:

Detailed planning and preparation of the study.

April 2017:

Shipment of equipment to the three locations in Greenland

June 2017:

Experimental start-up: Establishing of ramps and deployment of tiles added oil on locations in Greenland. Training of local contact person for sampling, monitoring and shipment of samples.

June – September 2017:

Sampling and monitoring by local contact person. One sampling per month.

October 2017:

Shipment of samples from Greenland to Denmark

Analysis of samples in laboratories in Denmark

December 2017:

Reporting of results