Development of nature-based solutions for marine oil spill response actions

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The objective of the GRACE Project is to explore the true environmental impacts and benefits of a suite of marine oil spill response technologies in the cold climate and ice-infested areas in the northern Atlantic Ocean and the Baltic Sea.

GRACE - Integrated oil spill response actions and environmental effects

www.grace-oil-project.eu
Oil spill response technologies

- mechanical collection in water and below ice,
- in situ burning,
- use of chemical dispersants,
- natural biodegradation and use of microbe additions
- and combinations of these;
Expected impacts

- Mitigate negative impacts of marine pollution on the marine environment, coastal economies and communities
- Better decision tools for oil spill response strategy in different cases
- Improve the integration between the scientific community and relevant government agencies charged with dealing with pollution, including cross-border and trans-boundary cooperation
- Better business potential for companies producing oil response equipment and monitoring services
- Increased public acceptance of off shore activities though a thorough environmental assessment of the environmental impacts of different response methods
Oil biodegradation and bioremediation

- The aim is to determine key bacterial species and metabolic pathways responsible for the degradation of different oil fractions in different compartments (aerobic and anaerobic water and sediments) of the Baltic Sea and the Northern Atlantic.
- We are assessing biodegradation rates of different oil fractions in seawater and sediments, and relate this data to environmental parameters and dispersant application.
- In order to maximize output from obtained data sets we apply integrative knowledge discovery from multiple omics sources.

Information about microbial community taxonomic composition and metabolic markers will be related to oil biodegradation kinetic parameters and oil remediation strategies using different modelling approaches.
Oil biodegradation in marine environment

Schematic representation of the environmental factors affecting oil biodegradation in the marine environment.
Experiments

Different steps of WAF (crude oil) and CE-WAF (crude oil and dispersant) preparations for the microcosm experiments. Picture A: shaking of WAF bottles. Pictures B and C: settling of WAF and CE-WAF before bottling. Picture D: filled microcosm bottles in shakers.
Biodegradation of petroleum hydrocarbon in seawater from Gulf of Bothnia amended with North Sea naphthenic crude oil and dispersant Finasol 51. *Oil removal value of 92 % was obtained in seawater at 5 °C.*
Natural removal of stranded oil on the coast in Arctic

Map of Greenland indicating all towns in Greenland including those (Nanortalik, Nuuk, Upernavik) where the experimental studies will take place nearby.
Oil removal from polluted sediments

- The electro kinetic treatment technology (EKO/GRID™)
- EKOGRID electro kinetic oxidation technology produces a weak electric field in a polluted area to amplify the remediation power of nature. It has proven to be an ecological, sustainable and cost-efficient way for cleaning and remediating the environment already in ten countries in five continents.
Example of the workflow

Locations of collecting the seawater in Svalbard

Microbial DNA sequencing

Bioinformatic analysis

Information about oil degrading microbial community
Relationships between different tasks

**Task 2.1** Oil biodegradation in seawater and impact of dispersants on oil biodegradation characteristics

**Task 2.2** Oil biodegradation is seawater-ice interface

**Task 2.3** Remediation of oil contaminated sediments using electrokinetic treatment

**Task 2.4** Effect-based assessment of biodegradation and remediation success

**Task 2.5** Omics data integration and meta-analysis

- qPCR
- Metagenomics

- Public domain omics data

**Task 3**

**WP4**

WP1, WP3, WP4, WP5
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IN SITU METHODS TO DETECT AND MONITOR OIL SPILLS ON-LINE IN THE BALTIC SEA
In-situ and on-line oil detection provide the following information

• Timely in situ detection of oil spills
• The location and spread of an oil spill over a larger area
• The thickness distribution of an oil spill to estimate the quantity of spilled oil
• A classification of the oil type in order to estimate environmental damage and to take appropriate response activities
• Timely information to assist in clean-up operations
Measurement principle: UV Fluorescence of oil compact and rugged sensors available
FerryBox system on M/S BALTIC QUEEN
Data management and visualisation via web-based user interface

http://on-line.msi.ttu.ee/GRACEferry/

In situ data with 1 minute interval, available on-line
Variability of oil compound PAH (in terms of carbazole) concentrations on Tallinn-Stockholm route, measured with UviLux UV-fluorometer (Chelsey Technology Group, UK)

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Thank you for your attention!

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Oil spills occur mainly on fairways, could be detected and monitored there.

Detected oil spills 1998-2004