GRACE grant no 679266

Preliminary screening of design and data requirement

D5.1

WP5: Strategic Net Environmental Benefit Analysis

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Contents

Executive Summary

For inclusion of in situ burning, chemical dispersants and bioremediation in national oil spill contingency plans, a general context for particular areas / regions can be assessed in a strategic NEBA (sNEBA), which includes an analysis based on oil spill scenarios and published as well as expert knowledge on the environment in the area in question. The environmental knowledge included in the sNEBA, to achieve the overall environmental optimal oil spill combating strategy, is biodiversity (on sea surface, in sea and sea bed, and seasonality), biology, ecotoxicology of oil (naturally and chemically dispersed as well as oil burning residues). The sNEBA hence synthesizes complex knowledge for each of the spatial compartments; water column, sea surface, sea bed and coast, focusing on the key species / ecosystems characterizing these compartments and the potential impacts of oil spill, dispersed oil and oil burned on the sea surface.

Therefore, to achieve the platform that that best will manage the complex information of a sNEBA process and result in a transparent and user friendly output, several tool platforms have been evaluated for use for a sNEBA tool:

The tool platform designs assessed are:

- Interactive web based
- Decision tree
- Decision matrix
- Application for mobile and tablet
- Literature database
- Calculator

It was assessed that the interactive and computer/device based tool platforms will not be taken further due to high costs for development, operation and maintenance. It was considered, though, that interactive tools can be developed nationally on basis of the sNEBA tool developed within GRACE and national biological information as these platforms have the capacity to gather and present highly complex information.

The literature database is considered as a potential important base for a sNEBA tool.

The approaches of a matrix and a decision tree tool will be taken further into the decision process for a sNEBA tool platform. Both tool designs have proven to be useful in the process of the Store Hellefiskebanke sNEBA and for OSPAR HOCNF.

Foreword

As part of GRACE, WP5; Strategic Net Environmental Benefit Analysis (sNEBA), we will develop a sNEBA tool for decision-making on potential inclusion of in situ burning, chemical dispersants and bioremediation, in national oil spill response strategies and contingency planning.

This deliverable, D5.1; *Preliminary screening of design and data requirement*, concerns a preliminary screening of potential suitable tool designs for a sNEBA. A suite of existing tool platform designs will be screened and their potential suitability for the sNEBA concept will be assessed. The assessment also includes how to handle the data requirement. By a tool design/platform is meant the format for the analysis and information availability, e.g. interactive, decision tree / matrix etc. which is needed when complex information must be gathered in the analysis for selection of environmental optimal oil response technique(s).

1. Background

For minimization of the combined environmental impacts of both oil spill and oil spill response techniques, which include chemical dispersion of oil and *in situ* burning (burning of oil directly on the sea surface) an analysis must be performed to evaluate the environmental pros and cons of the different oil spill response techniques. This means that from an environmental point of view the selection of oil spill response technique(s) as part of an acute oil spill response strategy must be a balance between presence and sensitivity of organisms in the oil slick trajectory, both in the water column and on the sea surface as well as on the shoreline impacted by potential beaching oil.

However, for inclusion of in situ burning, chemical dispersants and bioremediation in national oil spill contingency plans, a general context for particular areas / regions can be assessed in a strategic NEBA (sNEBA), which includes an analysis based on oil spill scenarios and published as well as expert knowledge on the environment in the area in question. The environmental knowledge included in the sNEBA, to achieve the overall environmental optimal oil spill combating strategy, is biodiversity (on sea surface, in sea and sea bed, and seasonality), biology, ecotoxicology of oil (naturally and chemically dispersed as well as oil burning residues). The sNEBA hence synthesizes the knowledge for each of the spatial compartments; water column, sea surface, sea bed and coast, focusing on the key species / ecosystems characterizing these compartments and the potential impacts of oil spill, dispersed oil and oil burned on the sea surface. The general concept of a sNEBA is presented in Figure 1.1.

The sNEBA is hence a planning tool, and thus a desktop analysis finished in advance of a potential oil spill, for environmentally assessing and preparing of oil spill combating potential and strategy. The sNEBA, however, does not replace a NEBA in connection with an acute oil spill, but will constitute a decision-making tool on a scientific and operational basis that synthesizes available relevant knowledge and advance the qualified framework on which a national oil spill strategy can be based. The sNEBA result(s) can be used for establishment of cross-border and trans-boundary co-operation and agreements.

Several oil spill response tools and procedures for decision making on acute use of in situ burning and chemical dispersants as well as other operative decisions are available (see below). These tool platforms will be included in the assessment of the most suitable platform for the sNEBA tool.

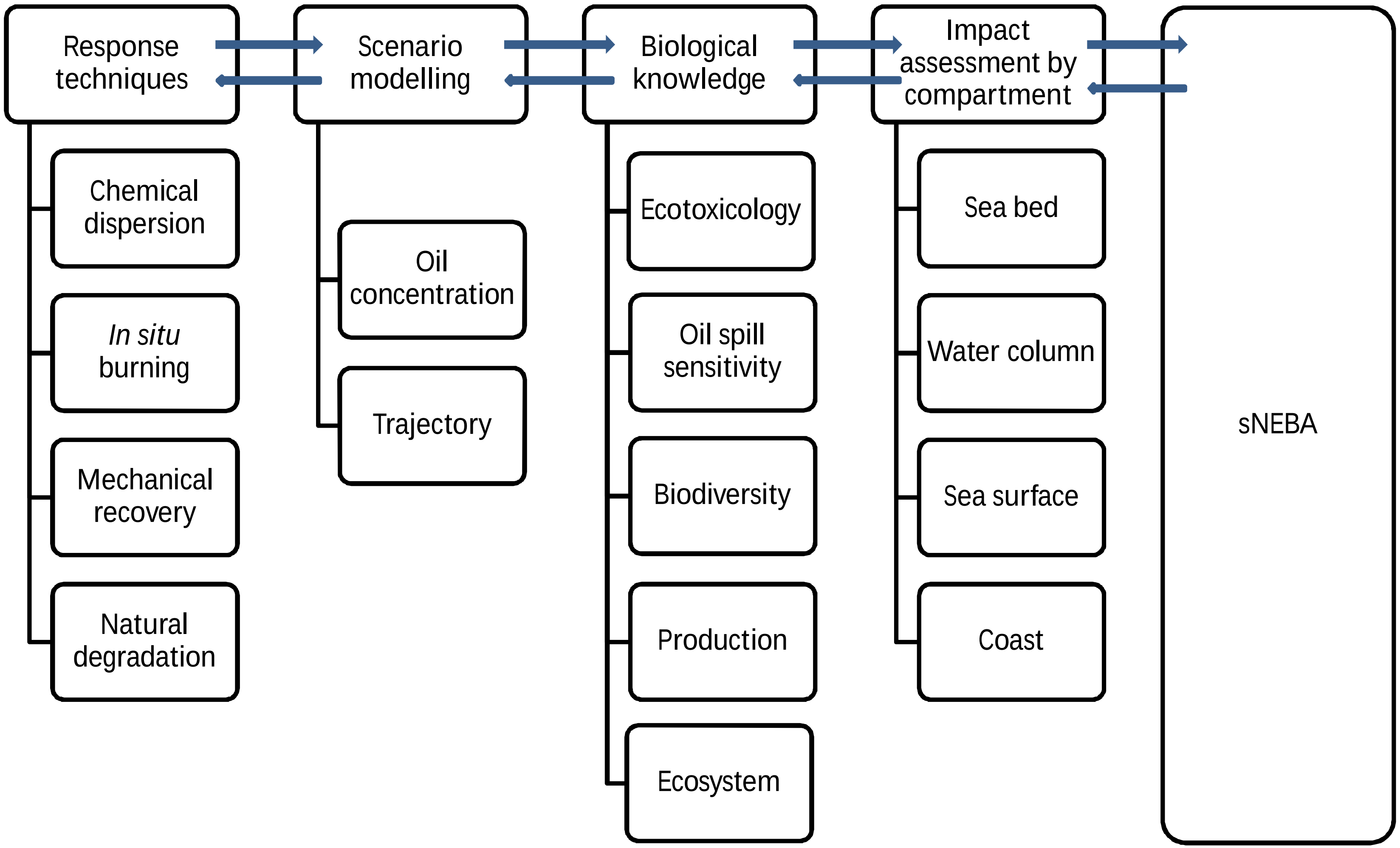


Figure 1.1. Frame work for the concept of a strategic net environmental benefit analysis (sNEBA).

2. Methods

Knowledge about available, relevant and suitable tool platforms for performing a sNEBA is obtained through:

1) Systematically search on the Internet (by use of popular search engines such as Google) where the terms used for the searching were found and based on expert knowledge within the area:

- Words / sentences of relevance for oil spill response tool platforms (NEBA; …; etc)
- Words / sentences of relevance for marine pollution tool platforms (OSPAR; HOCNF; …; etc.)
- Organisations which include oil spill response in their portfolio (CEDRE; ITOPF; IMO; EMSA; HELCOM; NOAA; EPA; WWF; etc.)

The search was completed by applying snowballing by evaluating the references/links obtained in the search for further relevant information not caught in the systematic searches).

2) Participation in meetings / activities with presentations of oil spill response tools including presentations of platforms:

- Oil in Ice / EPPR, Tromsø, November 2013
- IOGP Arctic Response Technology JIP
- EPPR, Copenhagen, October 2015
- ITOPF seminar, Copenhagen, September 2016
- EPPR, Copenhagen, December 2016

3) Reports and guidelines developed for the Greenland Government, e.g.:

- Wegeberg, S., Rigét, F., Gustavson, K. & Mosbech, A. 2016. Store Hellefiskebanke, Grønland. Miljøvurdering af oliespild samt potentialet for oliespildsbekæmpelse. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 98 s. – Videnskabelig rapport fra DCE - Nationalt Center for Miljø og Energi nr. 216 (Link)
- Wegeberg, S., Frit-Rasmussen, J. & Boertmann, D. 2017. Oil spill response in Greenland: Net Environmental Benefit Analysis, NEBA, and environmental monitoring. Aarhus University, DCE – Danish Centre for Environment and Energy, 92 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 221 (Link).

The tool platforms will be assessed with regard to their suitability for compiling complex information as well as their data requirement with respect to format/availability.

3. Results

From the above search and knowledge gathering, several tools/approaches for decision platform were identified as potential usable when a complex suite of information must be taken into consideration for the final decision on selection of oil spill response technique(s).

Below 6 general approaches on tool platforms are described and assessed for their suitability as platform for a sNEBA tool.

3.1 Interactive web based platforms

Examples and descriptions

- Arctic ERMA, NOAA, US (Link) (Figure 3.1a)
- WWF, Oil Spills in the Beaufort Sea (Link) (Figure 3.1b)

Arctic ERMA. The Environmental Response Management Application, ERMA is a web-based Geographic Information System (GIS) tool that assists both emergency responders and environmental resource managers in dealing with incidents that may adversely impact the environment. ERMA integrates and synthesizes various real-time and static datasets into a single interactive map, thus provides fast visualization of the situation and improves communication and coordination among responders and environmental stakeholders.

Oil Spills in the Beaufort Sea. Exploring the Risks. In 2012, WWF commissioned ASA Science to evaluate different types of oil spills most likely to occur in the Beaufort Sea. RSP ASA estimated the trajectory of future possible oil spills associated with increased ship traffic and offshore petroleum exploration and development in the Beaufort Sea.

Four types of oil spills were analyzed in the study:

- Shipping spill in the eastern region of the Beaufort Sea in the Amundsen Gulf
- Trans-boundary spill types (oil tankers or pipelines) in the waters crossing the Alaska/Canada border
- Shallow water blowout from an oil well close to shore on the Beaufort shelf, an area potentially subject to exploratory drilling
- Deep water blowout from an oil well on the Beaufort shelf break, an area potentially subject to exploratory drilling

Various scenarios were analyzed for each of the four types of oil spill resulting in a total of 22 scenarios of unique oil spills.

Pros and Cons of interactive web based platforms

Pros: Such platforms are able to manage comprehensive amounts of data in a visual format.

Cons: Strict requirements regarding format of data for GIS layers, which may exclude important information. In addition, modelling of oil slick trajectory must be performed, which will place severe demands to model development, data availability and computer power. Furthermore, we have been informed from the Danish representative of WWF that the experiences with the site and the operation expenses has led to the conclusion that WWF will not develop a similar site for five scenarios developed for the north eastern part of Baffin Bay.

Preliminary conclusion on suitability: Ideally a combination of GIS layers with relevant information including presence of sensitive species/areas with relevant oil spill trajectory scenarios would give most easy to access information. However, it is expensive to develop and maintain and keep updated. The expenses may lead to specific ownership, and the willingness and opportunities to share between nations may be limited by which the benefit of cross border decisions may be lost. Furthermore, information not convertible to GIS data such as important expert judgement will not be included.

3.2 Decision tree

Examples and descriptions

- NEBA tool development, CEDRE (Link) (Figure 3.2a, b)
- OSPAR (2010/4), HOCNF screening scheme (Link) (Figure 3.2c)

Centre of Documentation, Research and Experimentation on Accidental Water Pollution, CEDRE, is revising the IMO guidelines on dispersants which includes a Net Environmental Benefit Analysis and a decision making process for dispersant application developed as a decision tree. The process considerations were presented by Dr Francis Merlin, CEDRE, at the EPPR Oil in Ice Workshop in Tromsø, November 2013.

Harmonised pre-screening scheme for offshore chemicals. The OSPAR (Oslo Paris Convention) Hazardous Substances Strategy's objective is, with regard to hazardous substances, to prevent pollution of the OSPAR maritime area (North eastern Atlantic, Link) by continuously reducing discharges, emissions and losses of hazardous substances. For that a classification system for offshore substances has been developed with a screening test in OSPAR's Harmonised Offshore Chemicals Notification Format (HOCNF) system (OSPAR 2012/05 Link).

Pros and Cons of a decision tree

Pros: Yes/no principle makes the decision process relative simple.

Cons: As a sNEBA needs a comprehensive amount of information, the tree may, however, be very complex as well as answers, and hence selection of path/branch, will not be limited to yes or no, but rather an expert judgement.

Preliminary conclusion on suitability: Decision tree may be a good solution if the decision process is relatively simple with a limited set of information. However, if the information is complex this will require a very complex decision tree and hence may OVERSKYGGE the benefit from simplifying the process.

3.3 Decision matrix

Examples and descriptions

- Store Hellefiskebanke sNEBA, DCE/AU (Link) (Figure 3.3a)
- Beslutningsskjema for bruk av dispergeringsmidler, Norske Kystverket / KLIF (Figure 3.3b)

Store Hellefiskebanke sNEBA. Matrix for a sNEBA performed for Store Hellefiskebanke on the West coast of Greenland has been developed (Wegeberg et al. 2016). The matrix includes operations of dispersion, in situ burning and "doing nothing" – natural degradation, seasons, spatial compartments (sea surface, water column, sea bed and coast) with key ecosystem components/species as well as the assessment. The environmental benefit and consequences are assessed and indicated by +, ÷, ±. A final assessment is made based on the numbers of +, ÷ as well as an expert judgement.

Beslutningsskjema for bruk av dispergeringsmidler.This decision scheme regarding NEBA (for the use of chemical dispersants) is part of a desicion process which also includes an operative matrix. The key organisms (seabids, spawn) and key issues regarding water exchange (water depth, distance from land) are included and the environmental benefit and consequences are assessed and indicated by A, B, C. The final assessment is made on the numbers of A, B, and Cs.

Pros and Cons of a decision matrix

Pros: The matrix gives a convenient overview of information and does not but special restrictions on the data format.

Cons: The analysis will be based more on assessment/expert judgement than objective calculation based on binomial data sets.

Preliminary conclusion on suitability: The matrix gives a convenient overview of information and leaves room for assessment and expert judgement. Although the matrix does not give the opportunity for calculations, the use of indices may offer the opportunity for more exact results, which is preferred by some.

3.4 Application for mobile or tablet

Examples and descriptions

- SCATMAN (Link) (Figure 3.4a)
- Strandapp (Link) (Figure 3.4b)

SCATMANN. mobile application for field data input and management. Mobile applications can be used off-line when no data connection is available. Data is synchronized when the device is back online. The platform is an off-the-shelf tablet or smartphone with integrated camera and GPS. Application supports touch screen-based entering of data, such as surveyor or team member information, date, time, location, photos, video clips and survey specific information, which along with pictures and co-ordinates, can be sent via cellular phone network to SCATMAN Web Service for further processing. For instance, in a SCAT survey the following input are used: weather conditions, shore type and load-bearing characteristics, overall oiling, zone definition and surface oiling data, marine debris, natural resources and values, access data, shoreline usage. Users can also add additional observations and recommendations as they deem necessary for their survey.

Strandapp. Avinet, a Norwegian company, has developed this application for Kystverket, Norway, for coastal clean-up assessment based on open source-components. It is an android application, which combines actual position with a map of the coastline contours. When the clean-up personnel observe oil slicks, the geometry function can be activated in the app on the mobile or other tablets. This leads to a continuous logging of the GPS positions and the mapped geometry is combined with the coastline contour map. The information about the oil pollution is entered in an electronic template together with photos and video, which is coupled to the GPS data. All information is up-loaded to a server, which is available for coordinators of the clean-up task force. The app also works off-line, where all information is stored and put on hold until internet connection again is established.

Pros and Cons of an application for mobile or tablet

Pros: This is a convenient mobile platform for field actions.

Cons: Needs development and may be restricted in complexity due to the handy nature of the screen.

Preliminary conclusion on suitability: The restrictions in complexity may overrule the need for mobility in a sNEBA, as this is a planning tool and not designed for acute oil spill situations.

3.5 Literature database

Example and description

- JIP Arctic Response Technology; NEBA tool (Link) (Figure 3.5)

The literature database is developed as part of The Arctic Response Technology Joint Industry Project (JIP) and is an online, publically available database to aid Arctic oil spill decision-making. Intended as a one stop shop to identify information relevant to arctic oil spill response, the database is a volume of existing research on the environmental effects of oil and oil spill response techniques in the Arctic, compiled and reviewed in one place. The tool comprises a searchable report and literature database based on more than 960 literature references from investigations of arctic biology, the physical environment, oil fate and biodegradation, oil spill response, toxicology, population modelling and recovery, and Net Environmental Benefit Analyses.

Pros and Cons of a literature database

Pros: A comprehensive literature database may provide a significant tool for compiling existing data on specific subjects and can possess a substantial aid in building background knowledge for the environmental benefit analysis as long as the literature search is based on an objective search strategy to include all perspectives of sometimes contradicting results of the environmental benefit/consequence of a response technique.

Cons: A literature database needs constantly update to be a trusted resource, and not to provide misleading information if new knowledge is gained. Furthermore, as standing alone, it gives no option for combining knowledge in a structural and perhaps visual way, which may be useful for such a complex analysis.

Preliminary conclusion on suitability: A literature database will be extremely valuable for use as base for a sNEBA tool, and from where the necessary knowledge for assessing benefits and consequences of the different oil combat techniques can be consulted.

3.6 Calculator

Example and description

- Response Option Calculator ROC (Link) (Figure 3.6)

The Response Options Calculator (ROC) is designed to be accessed through your web browser, either locally on your computer or from this web site. ROC can be used to assess system performance involving mechanical recovery, dispersant application, and the burning of oil**.**

Pros and Cons of a calculator

Pros: It is simple, even for those who have no specific skills, to enter data for the calculator to give a result, which may not need any assessment or evaluation (although one should always question such results against common sense).

Cons: No data may lead to misleading results, e.g., positive result as no data will indicate otherwise. This phenomenon has been observed through other calculated risks and sensitivities related to oil spill. When the different result layers from different analysis have been combined, no data in predefined boxes may lead the final analysis presentation to be somewhat misleading.For example a positive result when actually the knowledge is absent.

Preliminary conclusion on suitability: A calculator is a branch of interactive tools, and hence needs development, but may not need that intensive management or update as the interactive tools consisting of data layers. Though, is should be updated according to new knowledge. However, the calculator is also at risk for simplifying the extremely complex process of assessing the overall environmental benefit of an oil spill response operation as no expert knowledge is possible to add.

4. Discussion and selection of most suitable sNEBA tool platforms

Interactive and computer/device based tool platforms are excluded as tools for the sNEBA solely by the reason that development of either an interactive web based platform with information/data layers, app or calculator are not within the economic frame of this project.

However, interactive tools may be developed nationally on basis of the sNEBA tool developed within GRACE and national biological information as these platforms have the capacity to gather and present highly complex information.

The literature database as a tool platform for sNEBA is excluded as it is assessed that it will not present the necessary data and information in a sufficiently illustrative way for a complex analysis such as sNEBA.

Hence, the following two approaches will be taken further into the decision process for a sNEBA tool platform: the matrix and the decision tree.

Both tool designs have proven to be useful in the process of the Store Hellefiskebanke sNEBA and for OSPAR HOCNF. When the sNEBA information is developed (Deliverable 5.2), it will be decided which tool platform that best will manage the complex information of a sNEBA process and result in a transparent and user friendly output.

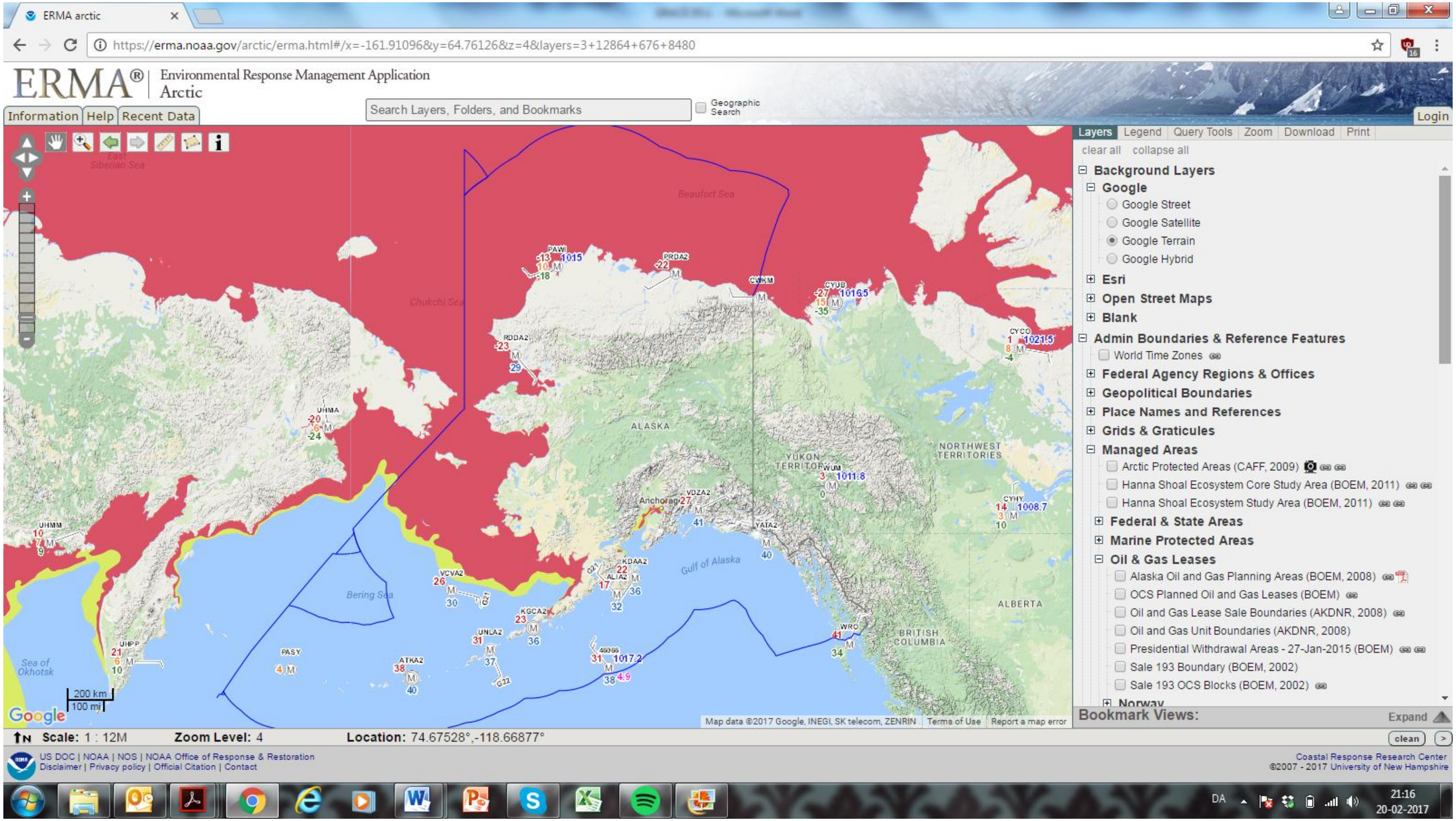


Figure 3.1a. Arctic Environmental Response Management Application, ERMA, for Alaska developed by US National Oceanic and Atmospheric Administration, NOAA (Link).

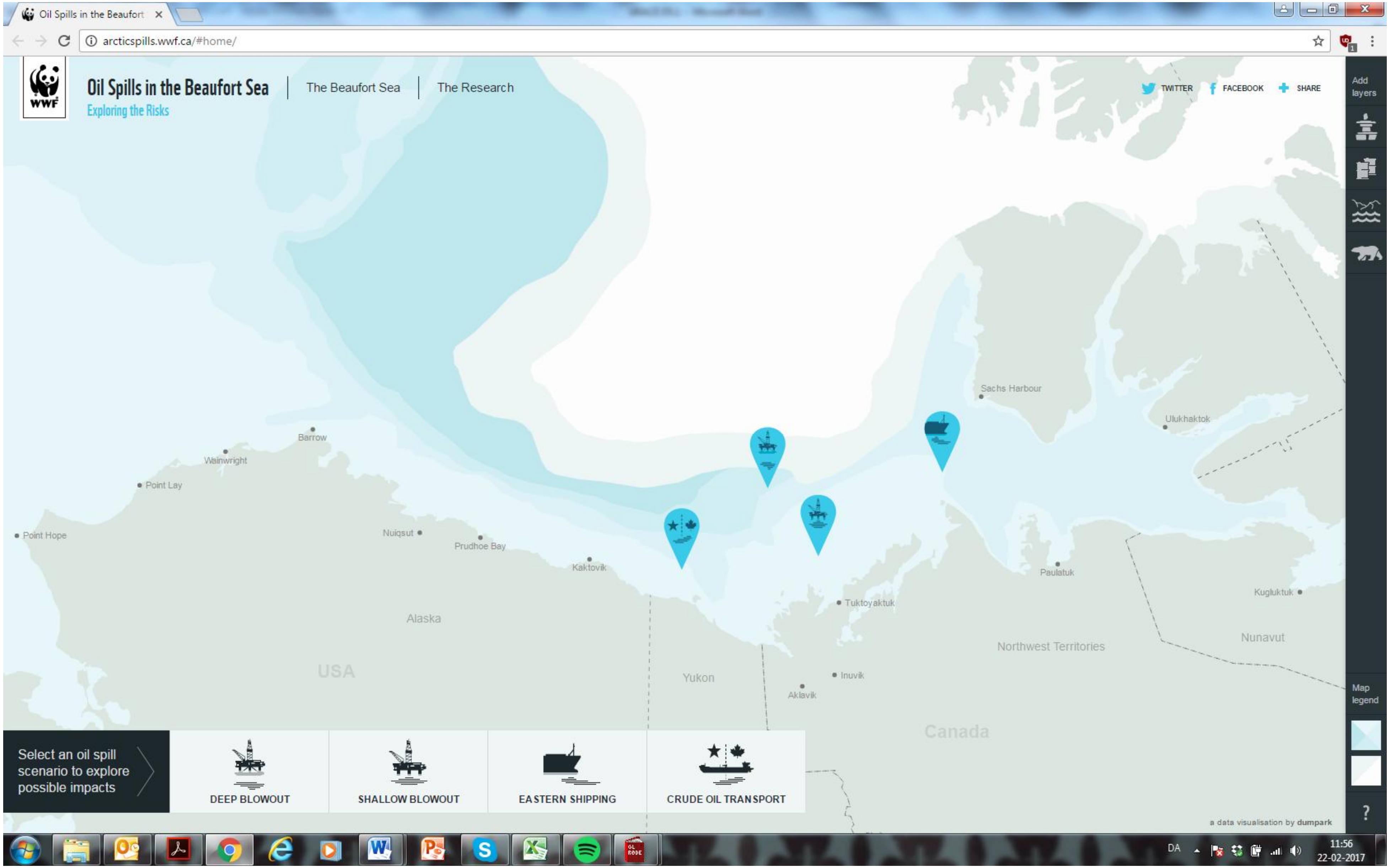


Figure 3.1b. Oil Spills in the Beaufort Sea. Trajectory scenarios developed by World Wildlife Foundation, WWF (link).

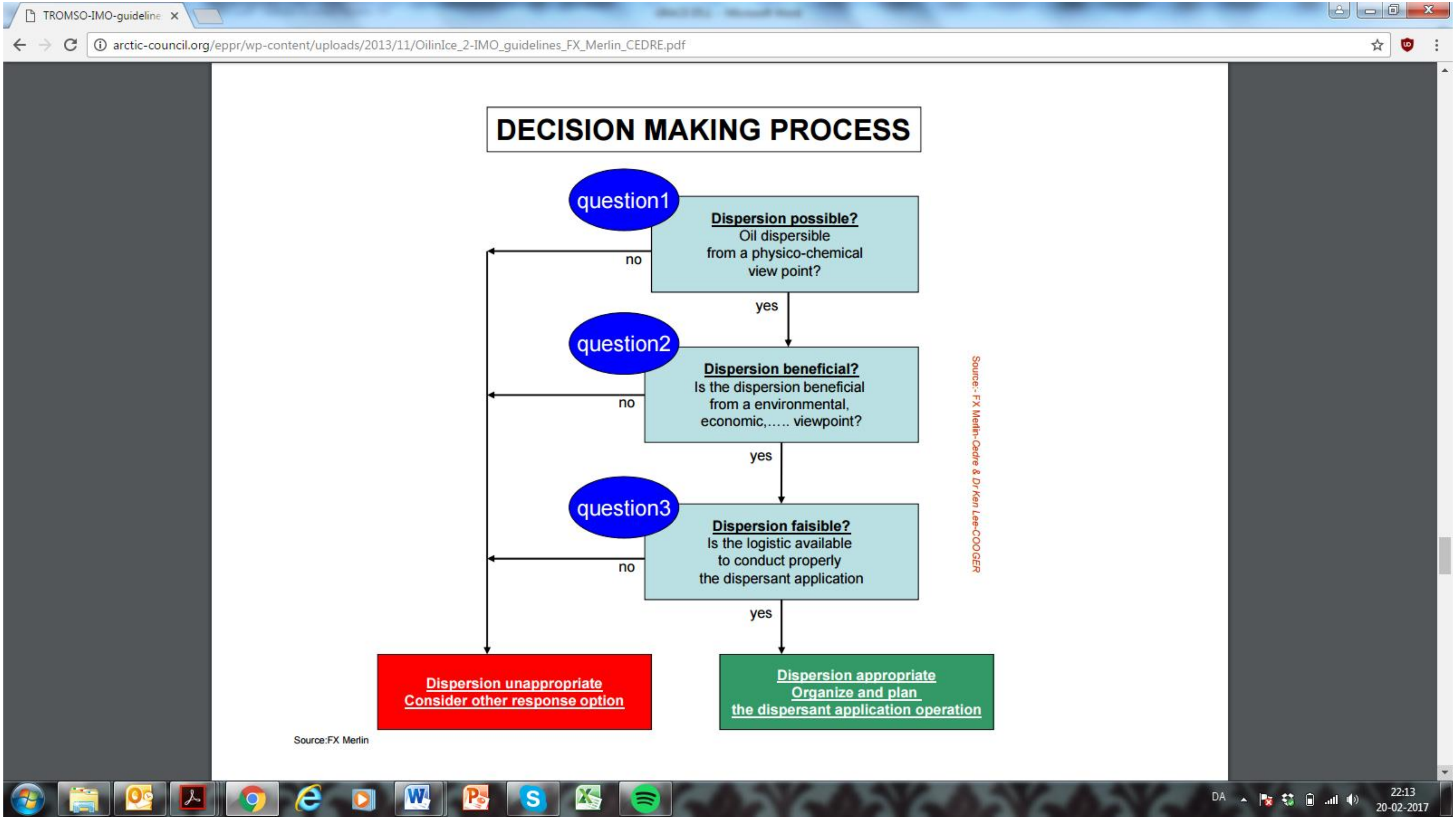


Figure 3.2a. Decision making process presented as a decision tree. Question 2 is the NEBA part which is broken up in more details in Figure 3.2b. Presentation at the EPPR workshop in Tromsø, Norway, 2013 by Dr Francis Merlin, CEDRE ([Link](#))

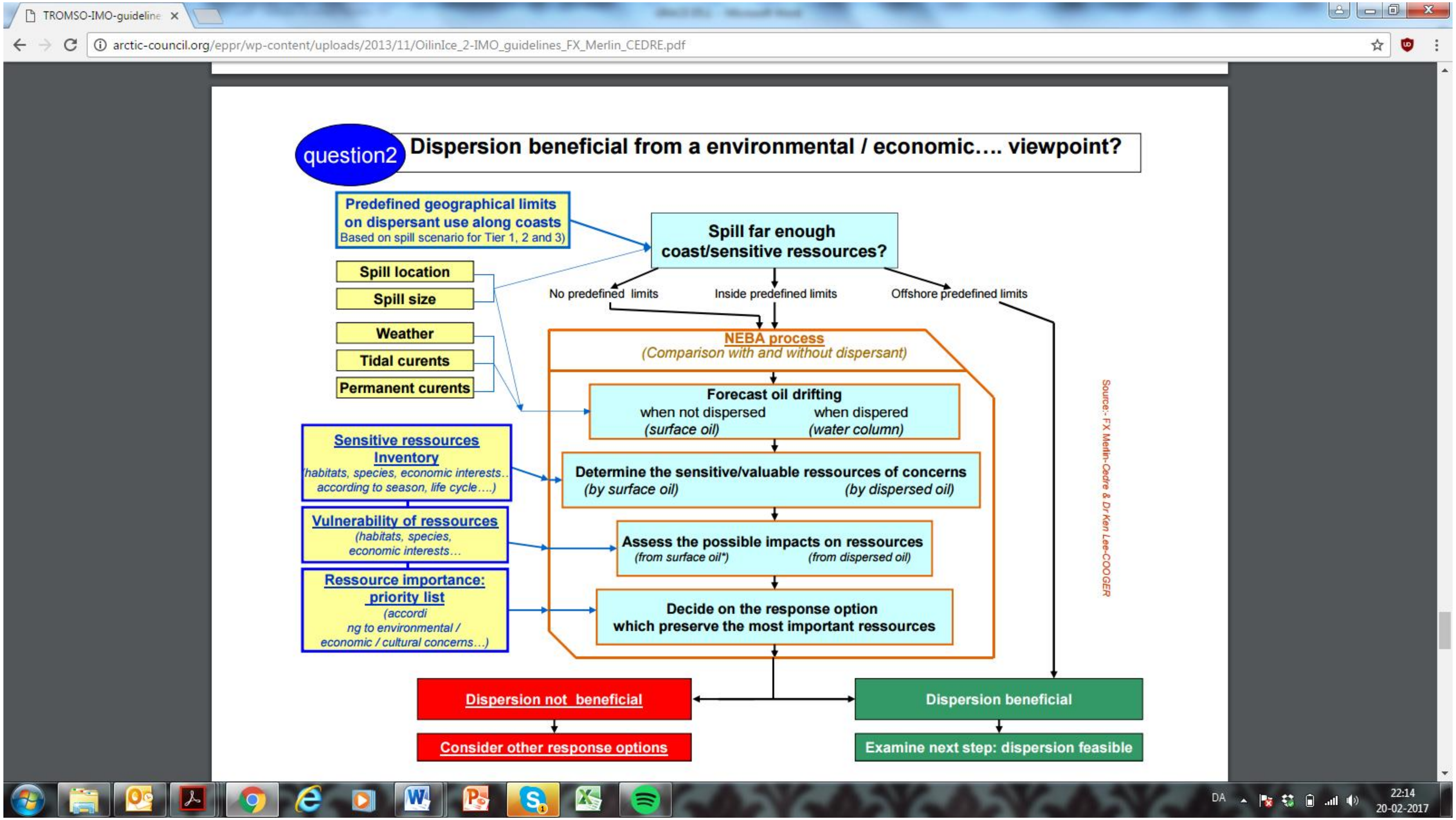
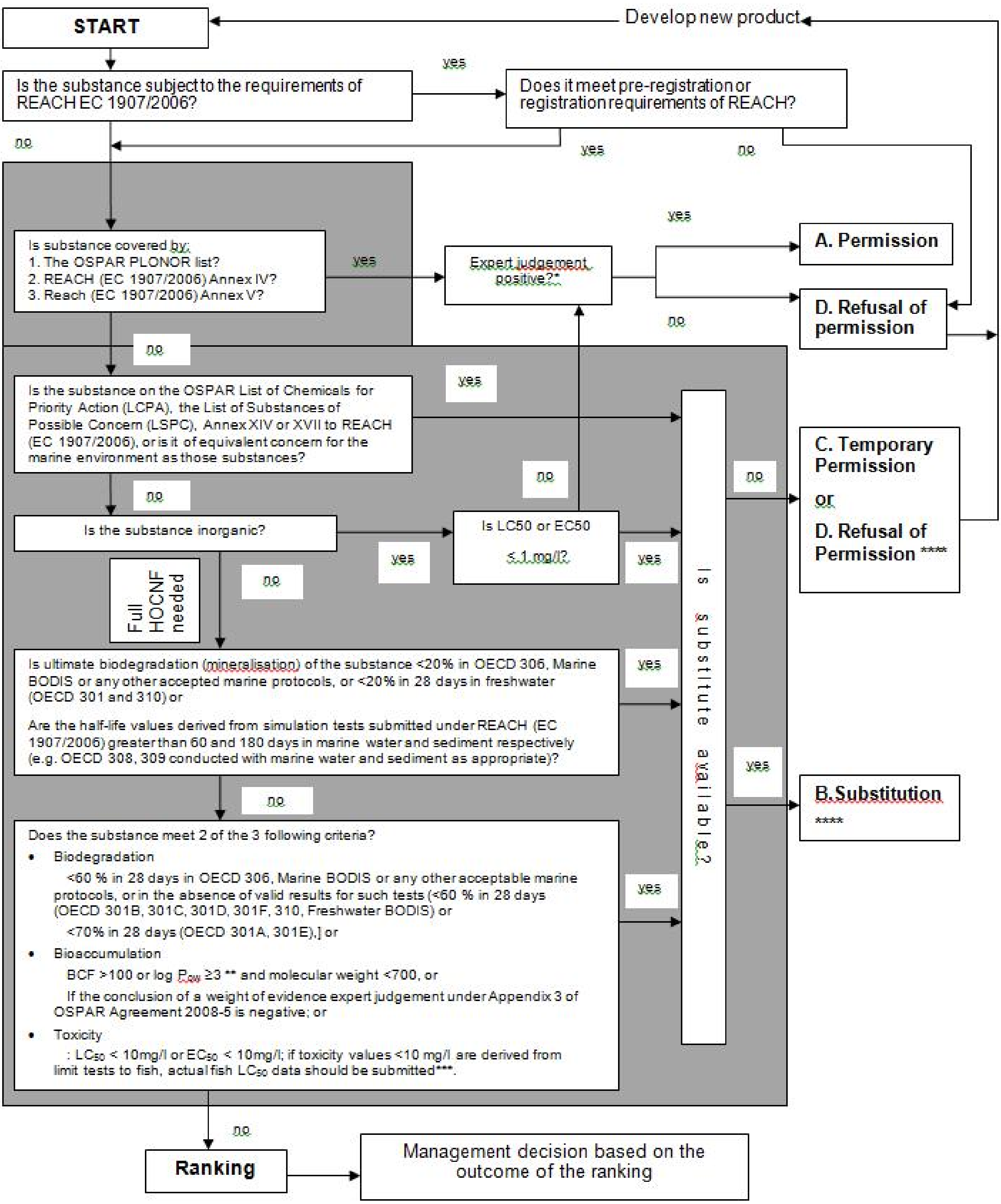


Figure 3.2b. Net benefit analysis for environment and economics presented as a decision tree. The tree may get quite complicated if the yellow boxes leading to light blue boxes are broken up into key organisms / ecosystem components. Presentation at the EPPR workshop in Tromsø, Norway, 2013 by Dr Francis Merlin, CEDRE (Link).



*In accordance with the precautionary principle, expert judgement on a PLONOR/Annex IV/Annex V substance should take into account sensitive areas, where the discharge of certain amounts of the substance may have unacceptable effects on the receiving environment, or any relevant

**The figure ≥3 means the result of an OECD 107 test or the highest reported log P_{ow} from the range of values in an OECD 117 test.

*** For further guidance on fish toxicity testing, please refer to OSPAR Guidelines for Completing the HOCNF

****CHARM may be used as a decision supporting tool + expert judgement

Figure 3.2c. OSPAR HOCFN screening scheme for offshore chemicals (Link).

Method	Season	Sea surface		Water column (0-50m)		Sea bed (0-50m)		Coast		Total assessment
Dispersion	Spring	Seabirds Walrus	+	Spring bloom of plankton, including fish larvae Bowhead whale, other whales	÷	Benthos, in particular bivalves	÷	Intertidal zone Kelp forest	+	÷ Despite the benefit for organisms on sea surface and the coastal ecosystems, it is assessed that the effect in the water column, and hence on the food web and risk of cascade effects, exceeds the potential positive environmental effect during most of the year
	Summer	Seabirds	+	Plankton Fish, sandeel	÷					
	Autumn	Seabirds	+	Plankton Fish, sandeel	÷					
	winter	Seabirds Walrus	+	Plankton Fish, sandeel	+					
ISB	Spring	Seabirds Walrus	±	Spring bloom of plankton, including fish larvae Bowhead whale, other whales	±	Benthos, in particular bivalves	±	Intertidal zone Kelp forest	+	± It is predominantly assessed that the method will give an overall positive environmental effect, however, with reservations on still unknown environmental side effects of burning residues and soot
	Summer	Seabirds	±	Plankton Fish, sandeel	±					
	Autumn	Seabirds	±	Plankton Fish, sandeel	±					
	Winter	Seabirds Walrus	±	Fish, sandeel	±					
Natural degradation	Spring	Seabirds Walrus	÷	Spring bloom of plankton, including fish larvae Bowhead whale, other whales	±	Benthos, in particular bivalves	+	Intertidal zone Kelp forest	÷	÷ As natural dispersion of oil in the water column and hence potential effects on organisms on the sea surceace and in the water column as well as the risk of the oil beaching, it is assessed that the risk of not being able to repond to an oil spill may result in negative environmental effects
	Summer	Seabirds	÷	Plankton Fish, sandeel	±					
	Autumn	Seabirds	÷	Plankton Fish, sandeel	±					
	Winter	Seabirds Walrus	÷	Fish, sandeel	±					

Figure 3.3a. Matrix for a sNEBA performed for Store Hellefiskebanke on the West coast of Greenland. The matrix includes operations of dispersion, in situburning and “doing nothing” – natural degradation, seasons, spatial compartments (sea surface, water column, sea bed and coast) with key ecosystem components/species as well as the assessment. Adopted from Wegeberg et al. 2016.

KLIMA- OG FORURENSNINGS- DIREKTORATET

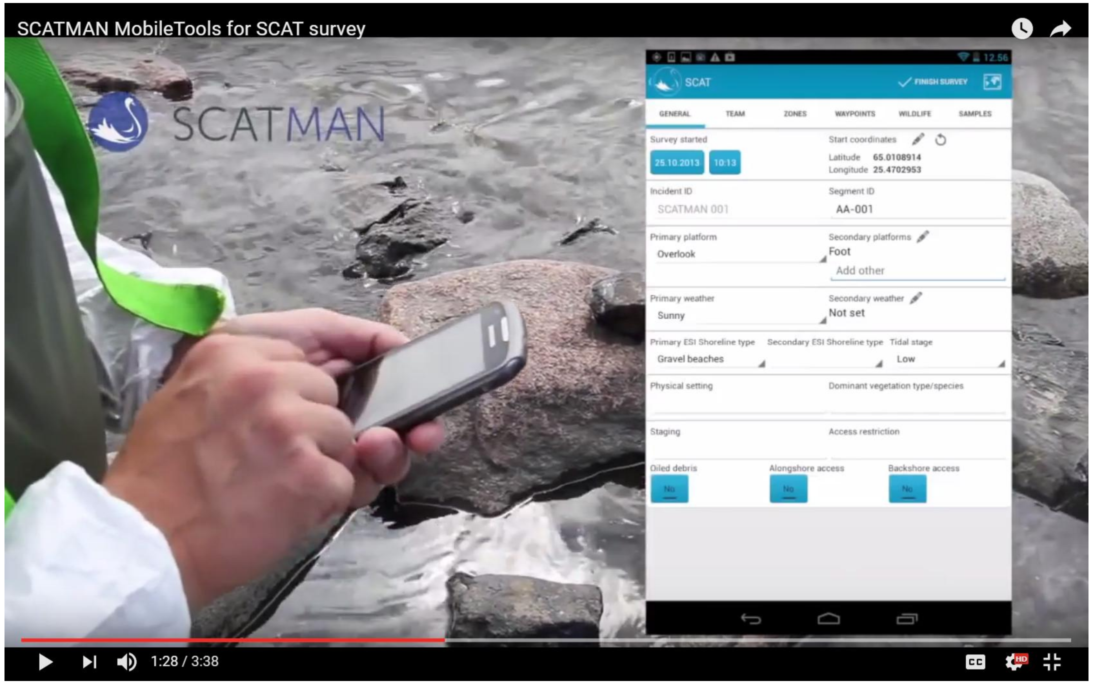
Beslutningsskjema for bruk av dispergeringsmidler

KYSTVERKET

I	**Gir dispergering totalt sett mindre miljøskade i forhold til ingen tiltak eller mekanisk opptak?** *Fyll ut pkt 1 – 4 før pkt I besvares, sett kryss*	**JA**	**NEI**
II	**Er de operative betingelsene for gjennomføring av en dispergeringsaksjon oppfylt?** *Fyll ut pkt 5 – 12 før pkt II besvares, sett kryss*	**JA**	**NEI**

Kriterium		Grunnlag for vurdering	Nytteverdi - velg A_X, B_X eller C_X for hvert kriterium	Utdypende opplysninger er gitt i den vedlagte veiledningen. I kommentarfeltet nedenfor kan de vurderinger som ligger til grunn for valg av nytteverdi under hvert kriterium noteres.
		A – Dispergering gir meget stor nytte **B – Dispergering gir nytte / begrenset nytte. Nærmere vurdering bør foretas av fagekspertise** **C – Dispergering bør ikke brukes** **Ved kun avkrysning i A eller B er dispergering egnet (Dispergering ikke egnet dersom C er krysset av)**		
Vurdering av miljøskade / - eksponering (pkt. 1- 4):				
1	**Levetid på sjøen**	A: Levetid på sjøen > 1 døgn B: Levetid på sjøen: < 1 døgn C: Levetid på sjøen: < 3 t		**Kommentar:**
2	**Naturressurser i mulige drivbaner**	A: Mye sjøfugl eller prioriterte strandlokaliteter og lite egg og larver (gyteprodukter) i vannsøylen B: Mye sjøfugl og gyteprodukter tilstede samtidig C: Høy tetthet av gyteprodukter, lite sjøfugl		**Kommentar:**
3	**Dybde og avstand til land**	A Dybde > 20 m og avstand til land > 200m B_1: Dybde < 20 m og avstand til land > 200m B_2: Kriterier i A og B_1 er ikke oppfylt, men særlige grunner tilsier dispergering (f.eks sjøfugl eller vind-/strømretning) C: Kriterier i A, B_1 og B_2 ikke oppfylt		**Kommentar:**
4	**Mulighet for stranding ved dispergering**	A: Stranding av overflateolje / emulsjon kan forhindres B_1: Stranding av overflateolje / emulsjon vesentlig redusert B_2: Behandlet olje kan strande mot middel-/ høy-energi strand C: Behandlet olje strander mot lav-energi /sand-strand		**Kommentar:**

Figure 3.3b. Decision scheme for use of dispersants. Adopted from Norwegian Coastal Administration and Norwegian Environment Agency (in Norwegian).



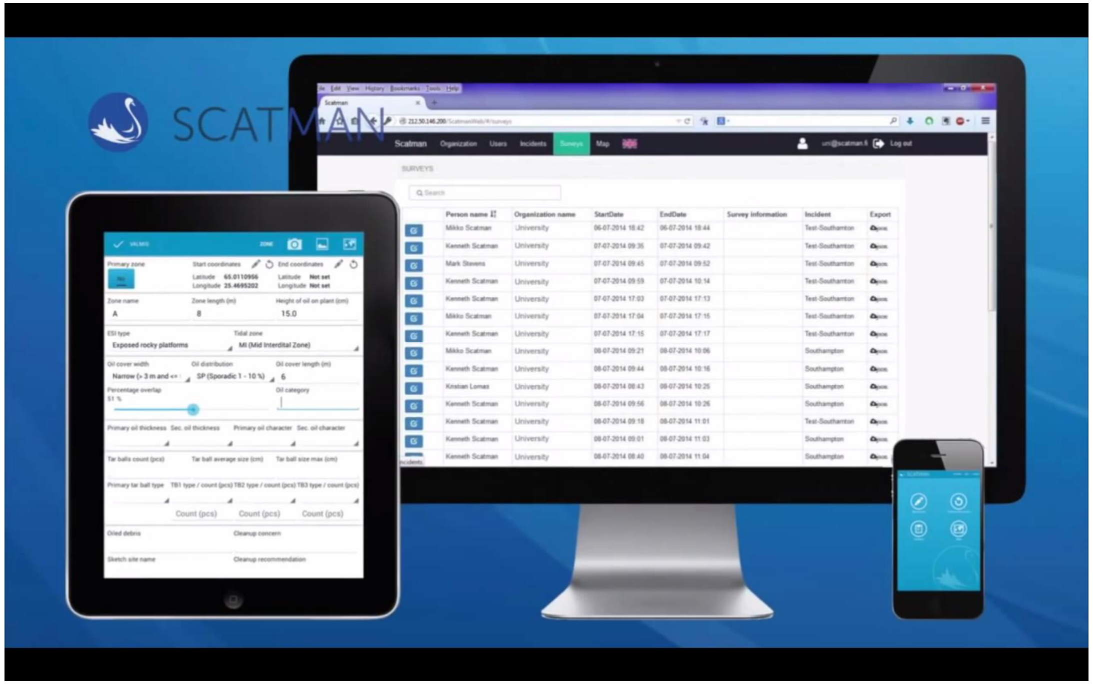


Figure 3.4a. SCATMAN, app developed for Shoreline Cleanup Assessment Technique (SCAT) by Finish LAMOR ([Link](#))

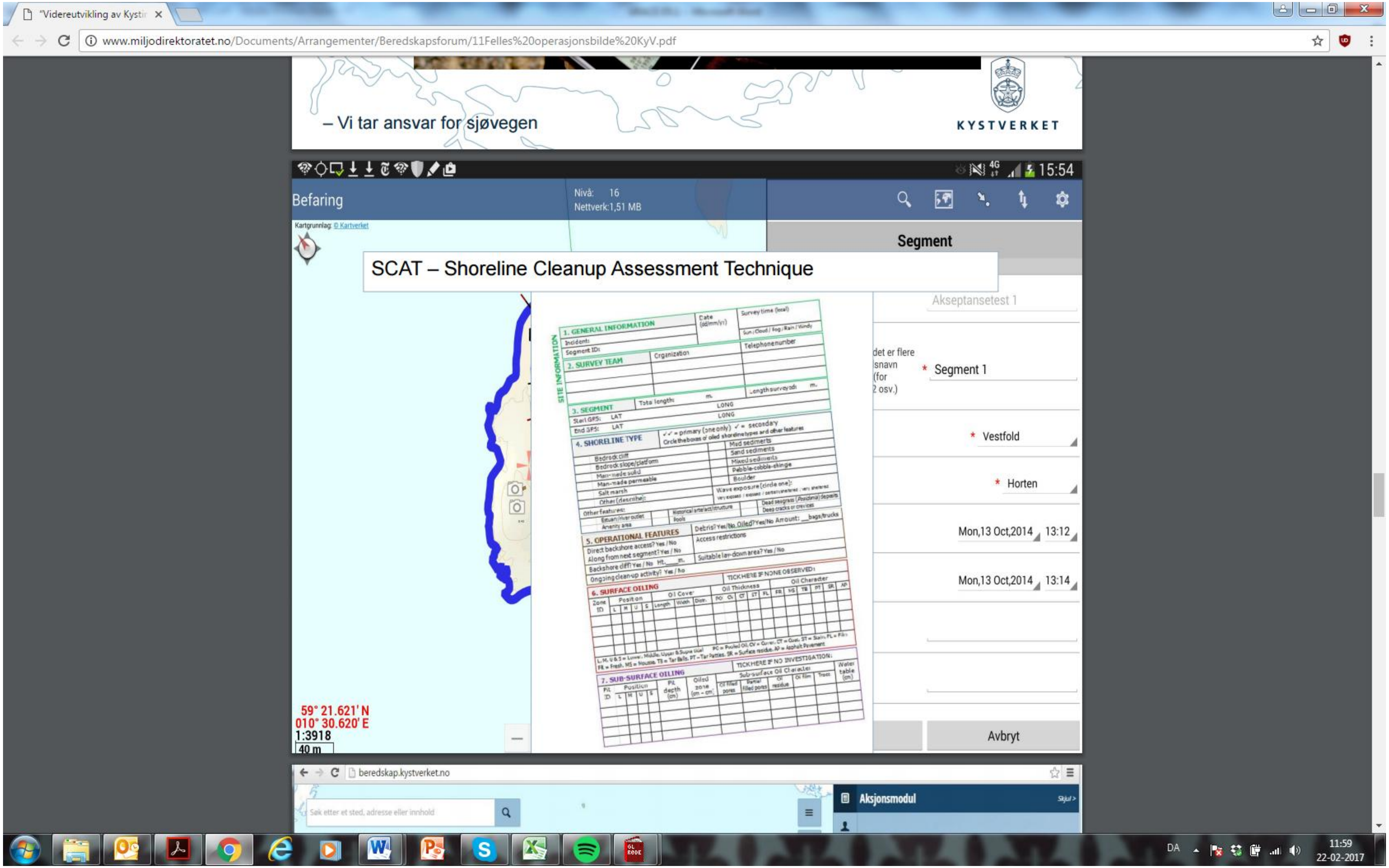


Figure 3.4b. Strandapp developed by Norwegian Coastal Administration for Shoreline Cleanup Assessment Technique (SCAT). Presented at EPPR meeting in Copenhagen, November 2016 (Link).

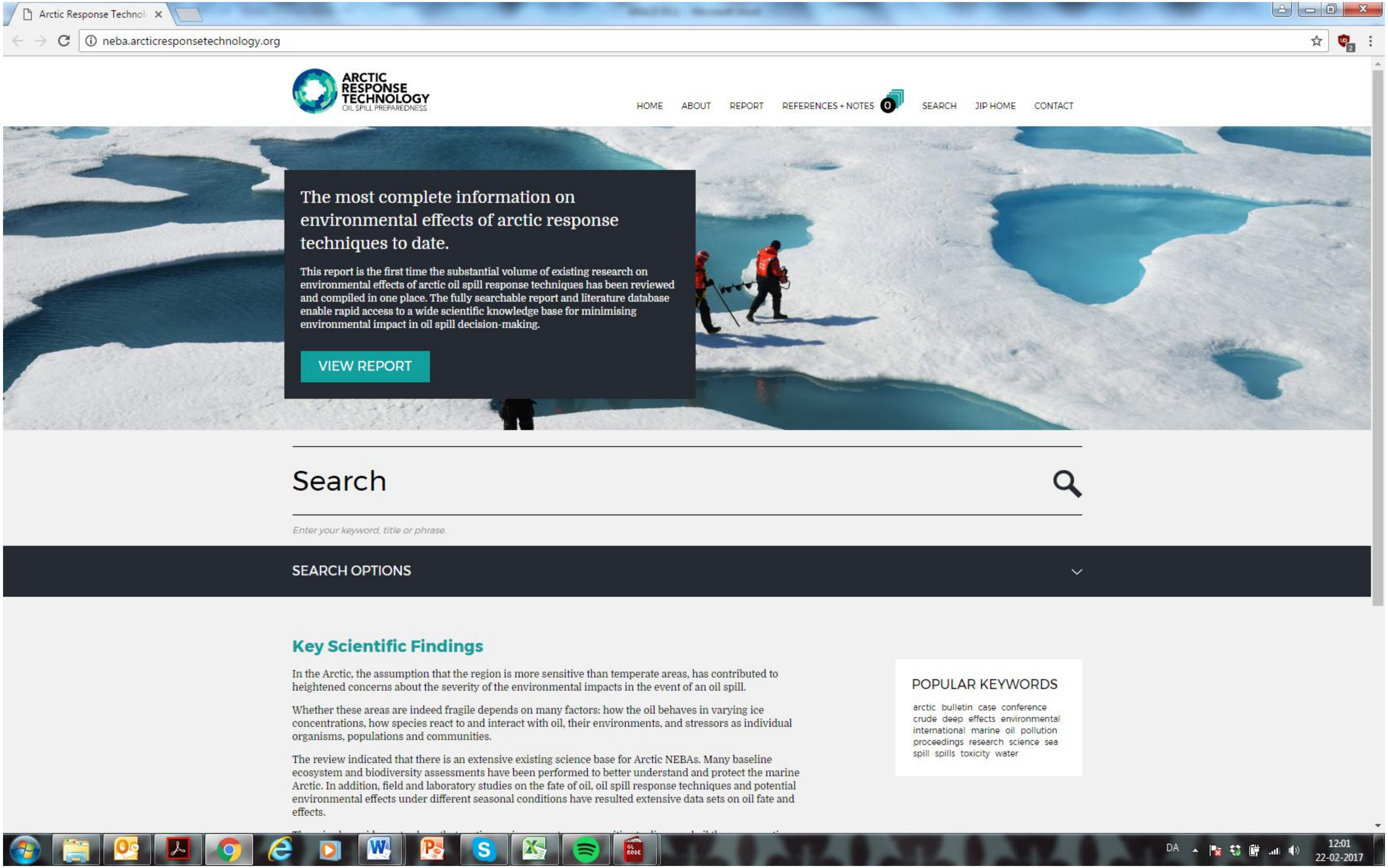


Figure 3.5. Joint Industry Project: Arctic Response Technology. Oil Spill Preparedness, launched a NEBA tool; a searchable literature database (Link).

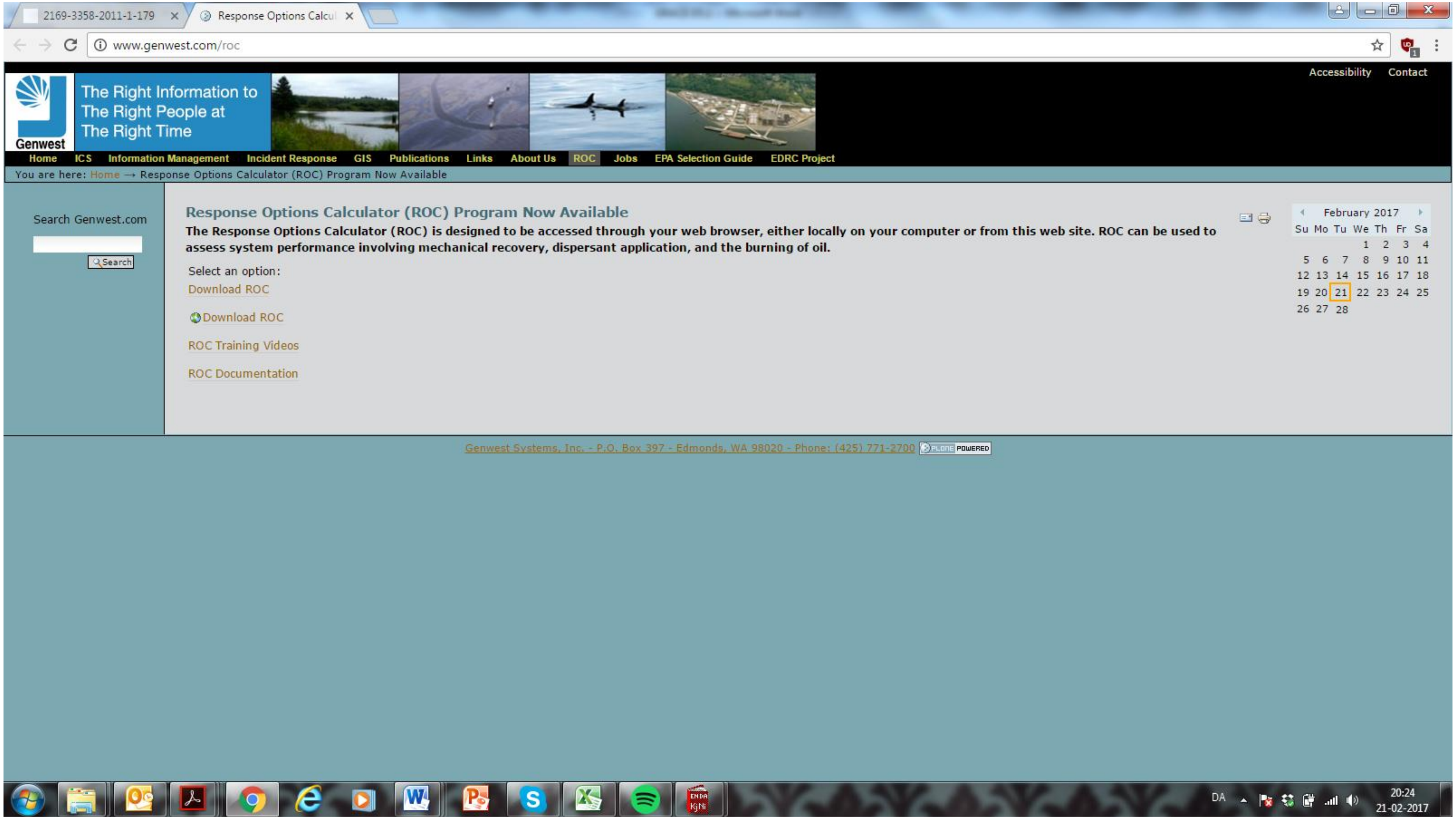


Figure 3.6. Response Option Calculator (ROC) site, from where the program can be downloaded, however, which was not possible on the day tried ([Link](#))