Spill response modelling based NEBA approach

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ABSTRACT

The aim of a NEBA (Net Environment Benefit Analysis) is to determine whether available oil spill response options offer relative environmental improvement over natural recovery. The modelling based NEBA approach evaluates environmental improvement over natural recovery in three compartments; sea surface, water column and shoreline. The method is developed with the aim of being transparent, and the results give clear visual understanding of the environmental consequences.

The analysis is based on results from statistical oil drift simulations with and without spill response options (chemical dispersion or mechanical recovery). ERA (Environmental Risk Analysis) methodology provides the relationship between oil contamination and expected impact. The impact areas are calculated for all response options and evaluated against the baseline (no response).
In addition, the species and habitats at highest risk within the impact area are selected for each compartment (sea surface, water column and shoreline). Consequence towards these risk indicators are calculated for each response option and again evaluated against the no response option. The evaluation is done with a scoring table for each environmental compartment, where the effect of the response options is scored against the no option. The sum of score results for each strategy option is the basis for the NEBA evaluation and the recommended response strategy option.

In addition, the ArcGIS software is used to visually illustrate expected impact and consequence within the spill area. Seasonal maps are created for all response options in order to give a visual expression of the effect of the response option. For a potential blowout, NEBA maps provides support in evaluating large-scale consequences of the response options and bridges the gap so often occurring between the ERA and the oil spill response analysis/planning.

INTRODUCTION

The aim of a NEBA (Net Environment Benefit Analysis) is to determine whether available oil spill response options offer relative environmental improvement over natural recovery. The following paper presents an outline of a modelling based NEBA approach.

Norwegian regulations set requirements to performing quantitative environmental risk assessments (ERA) related to both exploration drillings and for producing fields. In addition, an oil spill contingency analysis (OSCA) is the basis for an oil spill contingency plan that ensures appropriate response capacity and response time for the activity. The ERA methodology follows a

specific methodology (MIRA) established back in 1997 with the latest guideline revision from 2007 (OLF 2007). Section 19-6 in the Pollution regulation states that "*Dispersants or shoreline-cleaning agents shall be chosen to combat acute oil pollution when this method will give less overall damage to the environment than any other method. Assessments of potential environmental damage shall be documented*". The new OSCA guideline (NOROG 2013) has adapted this approach and recommends a net environmental benefit approach on various response options (chemical dispersion vs. mechanical recovery).

Spill modelling with response options has been an option in some oil spill models for some years and this is particular developed in the OSCAR (Oil Spill Contingency and Response) model from SINTEF, a state-of-the-art 3D particle model. OSCAR provides insight into hydrocarbon transport, fate and effects during a release and can simulate the results of different response strategies and techniques. Many of the modules in OSCAR have been developed through laboratory studies at SINTEF and field studies in temperate and Arctic areas. Key features include 3d- modelling of water column, representation of oil by 25 pseudo-components, extensive oil database with experimental weathering data, stochastic simulations and a near-field plume model for multi-phase deep and shallow water releases.

ENVIRONMENTAL IMPACT QUANTIFICATION

The endpoint of the ERA or oil spill risk assessment is typically the probability of a given environmental impact or consequence. In the MIRA methodology this is given as the probability for having a minor, moderate, considerable or serious environmental damage represented by species/habitats recovery times of less than 1 y, 1-3 yrs., 3-10 yrs. and more than 10 years respectively.

The quantification of impact for marine mammals and seabirds (sea surface impact) in the MIRA approach is done in a two-step approach:

1. Use of effect keys linking an oil volume in a defined 10x10 km grid cell towards mortality for seabirds/marine mammals in that grid cell. Different effect keys are used for different individual oil spill sensitivities for the various species.

Example of effect key for seabirds of various vulnerability towards oil spill (V1 = lowest, V3 = highest). Mortality in a 10x10 km grid cell is given as a function of an oil spill volume interval.

Impact factor – acute mortality	**Individual vulnerability of VEC seabirds**		
Oil quantity in a 10x10km square	**V1**	**V2**	**V3**
1-100 tonnes	5%	10%	20%
100-500 tonnes	10%	20%	40%
500-1 000 tonnes	20%	40%	60%
>1 000 tonnes	40%	60%	80%

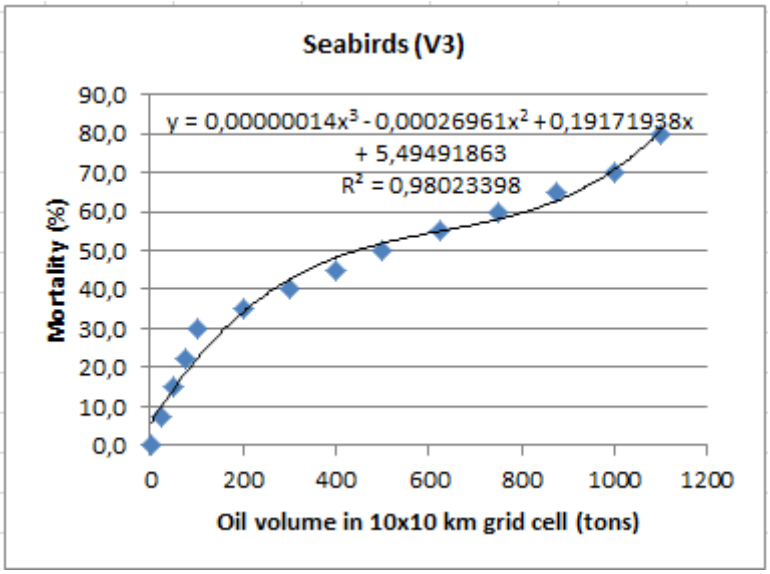
2. Summarize the total mortality over all affected grid cells in a spill simulation and then apply an damage key linking the overall population loss towards a probability for given recovery time based on the species populations status and recovery potential.

For shoreline habitats there is a combined effect and damage key linking accumulated oil volumes in a shoreline grid cell towards a recovery time for that habitat based on its sensitivity towards oil.

For water column impact, this is typically calculated on the more sensitive fish eggs and larvae stages and seldom giving direct effects on adult fish. A dose-response function on total hydrocarbon concentration (THC) is used for the mortality on eggs/larvae starting at 100 pbb (no effect) ending at 1 ppb (100 % mortality).

In a stochastic run with hundreds of oil spill simulations, the effect area (step 1 above) can be visualized as either general effect area showing seabird mortality (valid for all species with a similar sensitivity) or as specific seabird mortality maps where the actual population loss in each grid cell is calculated (combines oil volumes with specific seabird resource distributions).

The proposed NEBA approach applies the oil spill statistics (average oil mass in a 10x10 km grid cell) and calculates the expected mortality based on this volume. This is done by a curve fitting of the existing effect keys in the MIRA method (se example below)



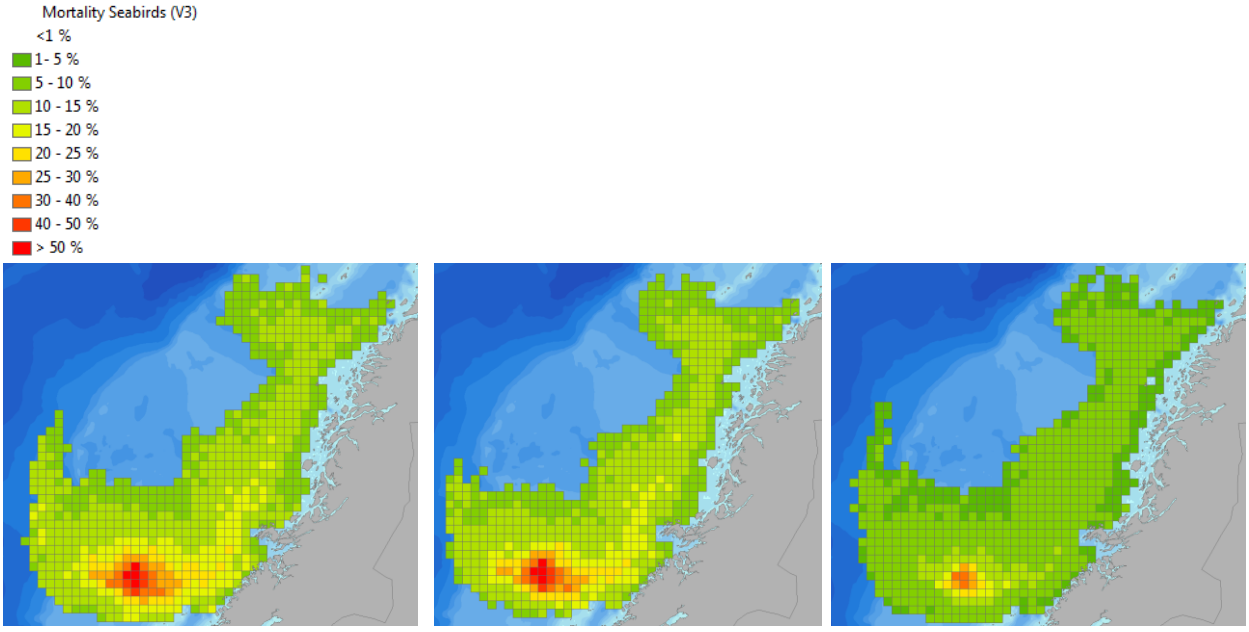
Example on curve fitting of effect key for seabirds with high individual mortality towards oil.

STOCHASTIC OIL SPILL MODELLING WITH RESPONSE OPTIONS

As oil spill modelling with various response options is a possibility with the OSCAR model, the output in terms of average oil volumes on the sea surface, total hydrocarbon concentrations (THC) in the water column and accumulated oil volumes on the shoreline will vary with the effect of the various spill response techniques modelled. Based on this modelling and for each response option, the effect area (mortality) for seabirds and marine mammals are calculated. In addition the specific impact on selected high risk species (actual population loss) can be estimated. Likewise, the effect area in the water column (mortality on eggs/larvae) can be calculated, while for the shoreline compartment, the recovery time for the various 10x10 km shoreline habitats is quantified.

NEBA EVALUATIONS

The actual NEBA evaluation consists of a scoring of the various response options against the no response option for the various environmental compartments. A certain reduction in the size of the effect area (on the sea surface) will give a positive NEBA score and a similar reduced recovery time in shoreline habitats will be reflected by a positive score. In the water column, an increase in effect area resulting from chemical dispersion of oil into the water column will give a negative NEBA score. The overall evaluation will then consider all environmental compartments and compare all which response option ends up with the highest positive NEBA score against the no option alternative.



Baseline (no response) *option 1: mechanical recovery* *option 2: chemical dispersion*

Example on NEBA maps showing the effect of two different response options modelled with OSCAR and statistically presented as mortality for sensitive seabirds in each 10x10 grid cell.

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