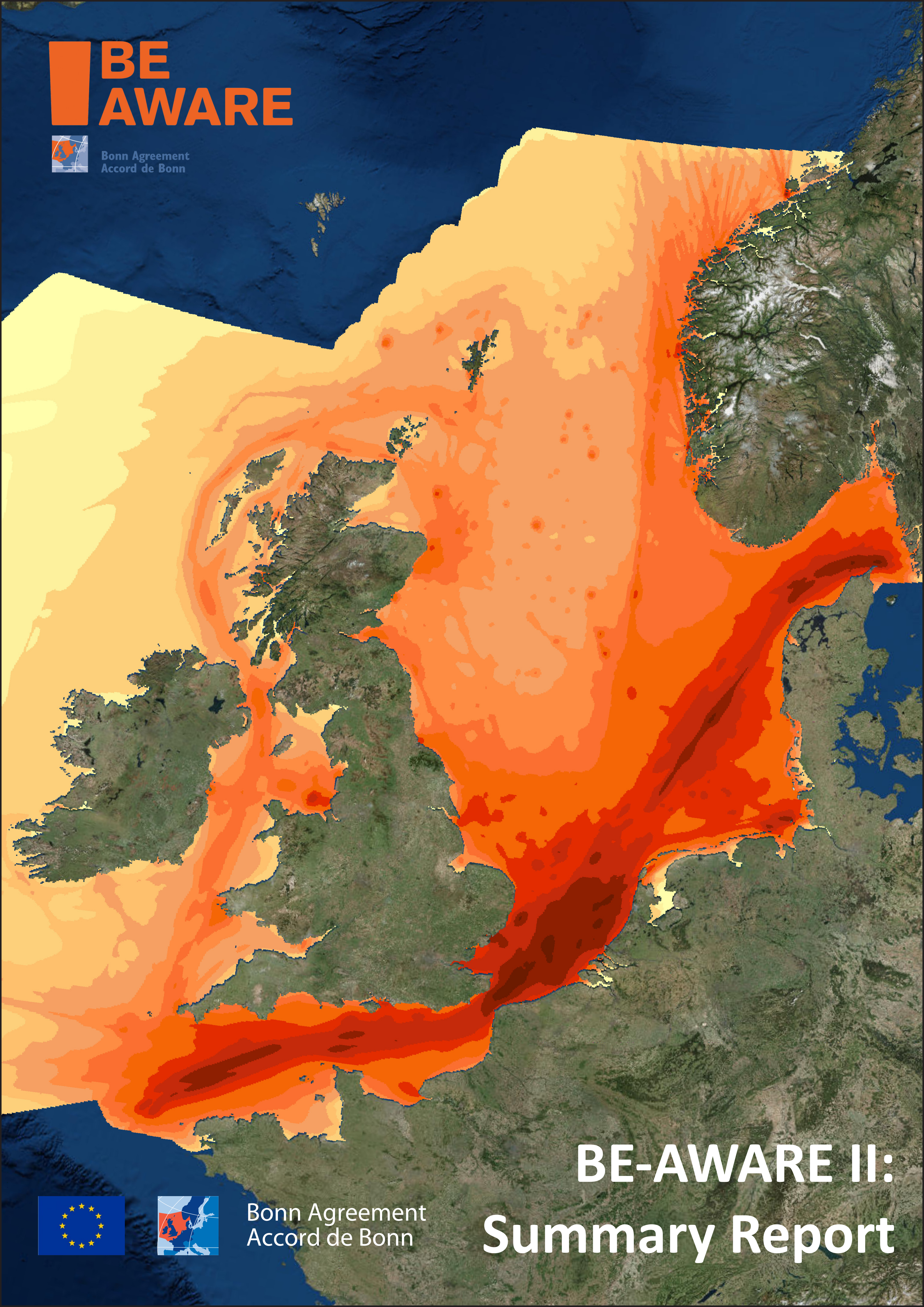

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BE-AWARE II: Summary Report

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The Greater North Sea and its wider approaches is one of the busiest and most highly used maritime areas in the world. With the ever-increasing competition for space comes an increased risk of accidents that could result in marine pollution.

Currently the area has no overall risk assessment for marine pollution; risk is mapped with a variety of national risk assessments which are undertaken with differing methodologies; thus reducing comparability.

The BE-AWARE project is therefore undertaking the first area-wide risk assessment of marine pollution using a common methodology that allows the risk to be mapped and compared under different scenarios.

The project outcomes will be subregional risk management conclusions, which will identify priority future risk reduction and response senarios for each sub region, oil impact and damage assessments and a region wide environmental and socioeconomic vulnerability analysis.

The project is a two year initiative (2013-2015), co-financed by the European Union (DG ECHO), with participation and support from the Bonn Agreement Secretariat, Belgium, Denmark, France, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom.

Contents

1. Introduction

The Greater North Sea and its wider approaches is one of the busiest and most highly used maritime areas in the world. Currently, the area has no overall risk assessment for marine pollution and risk is mapped with a variety of national risk assessments, which are undertaken with differing methodologies, thus reducing comparability.

In 2010, the Bonn Agreement contracting parties recognised the need for an area-wide risk assessment and the associated benefits (Bonn Agreement Dublin Declaration). The Bonn Contracting Parties, with project management by the Bonn Agreement Secretariat, undertook the BE-AWARE I and II projects, with part funding from the EU Civil Protection Mechanism.

The BE-AWARE I project (2012-2014), assessed the strategic risk of oil pollution both now (2011) and in the future (2020) and the likely size of any spills. However, in order to assess which methods and technologies would be most effective in reducing the risk of accidents and oil spills and in responding to oil pollution, further analyses were required.

BE-AWARE II models the outflow of oil from all the spills predicted in BE-AWARE I for ten different response or risk reducing scenarios, taking into consideration the hydrodynamics of the North Sea Region. The model is combined with an analysis of the environmental and socioeconomic sensitivity of the region to assess the effect of the different scenarios. Based upon this and the cost of implementing the measures, strategic risk management conclusions were developed for each of the 5 project sub-regions (Figure 1-1).

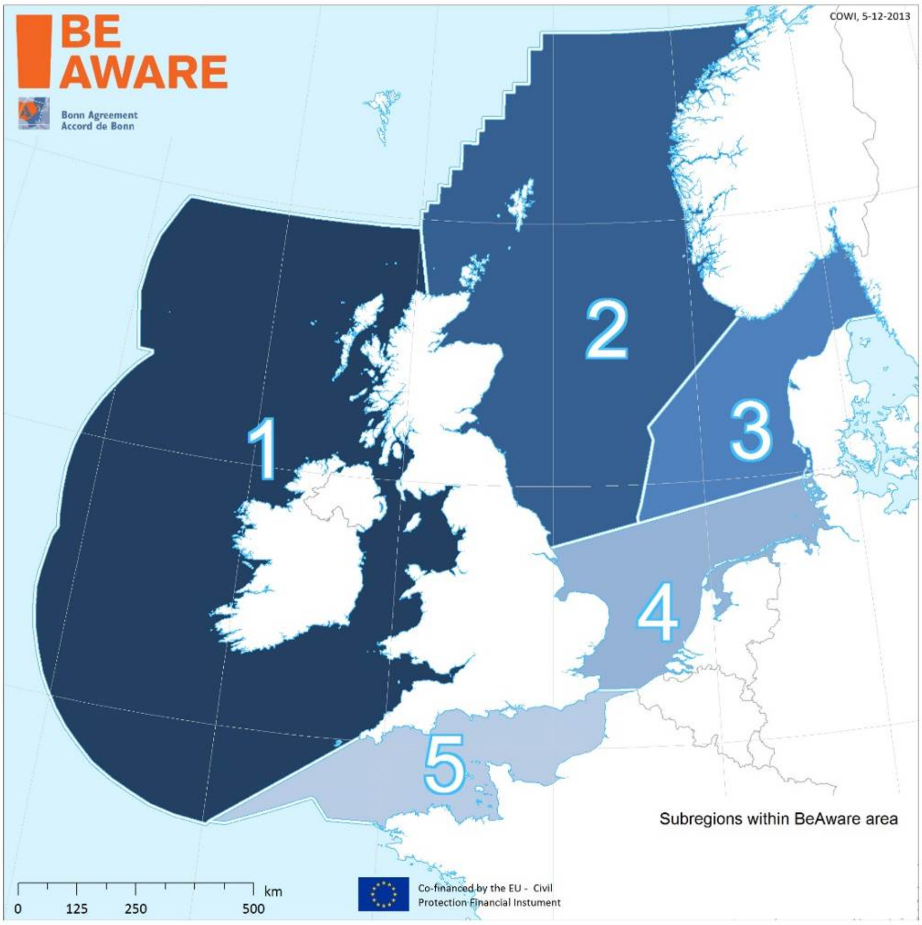

Figure 1-1 Sub-regional division of the Bonn Agreement area.

The project is a two year initiative (2012-2014), co-financed by the European Union, with participation and support from the Bonn Agreement Secretariat, Belgium, Denmark, France, Germany, Ireland, Norway, Sweden, The Netherlands and United Kingdom.

This document presents a summary of the findings from the project BE-AWARE II. References are made to the technical sub reports of the project, which comprise:

- Method Note, including the Data Request note. The latter outline the type and extent of data required for the project and the sources from where they were obtained. The method note documents the methodology of all project phases.
- Report on joint environmental and socioeconomic sensitivity and vulnerability mapping. This report documents the scientific basis of the sensitivity ranking of ecological and socioeconomic as well as the ranking itself. The resulting vulnerability mapping of the North Sea is also documented.
- Impact assessment report. This report documents the results of the oil drift model and the impact model, which models the outflow of oil from the spills predicted in BE-AWARE I for ten different response, or risk reducing scenarios.
- Risk management conclusions report. This report outlines the outcome of the assessment of the effectiveness and cost efficiency of the applied scenarios. It documents the risk management conclusions for each sub-region drawn by the contracting parties based on the assessment.

The summary report presents key findings and presents only selected data. For detailed studies, the reader is referred to the above technical sub reports.

2. Methodology

The applied methodology in BE-AWARE II has been commonly agreed by the project partners participating in the BE-AWARE project group, including the external consultants. The methodological principles are taken from the methodology of the BRISK project (BRISK, 2012) and adjusted to the specific conditions of the North Sea area (BE AWARE, 2015a). Adjustements included:

- Addition of more ecological and socioeconomic features
- Inclusion of vulnerability and impact modelling on water column
- Inclusion of offshore installations (oil platforms and wind farms)
- Tidal effects on oil spill drift
- Potential use of dispersants as a response measure
- Absence of sea ice

The methodology of the BE-AWARE II project deals with the strategic oil spill modelling and sensitivity analyses in the Bonn Agreement area. It builds upon the work done in the BE-AWARE I project. The main output of BEAWARE I was modelled spill frequencies and spill sizes of different oil types.

BE-AWARE II consists of the following work steps:

- A Project management and communication
- B Publicity

- C Methodology
- D Project resource database
- E Oil Spill / Response modelling
- F Environmental and Socioeconomic vulnerability
- G Project workshop
- H Area-wide risk assessment of impacts for the selected scenarios
- I Risk management conclusions
- J Project conference

Figure 2-1 gives an overview of the project phases, their dependence to each other and the connectivity to BE-AWARE I.

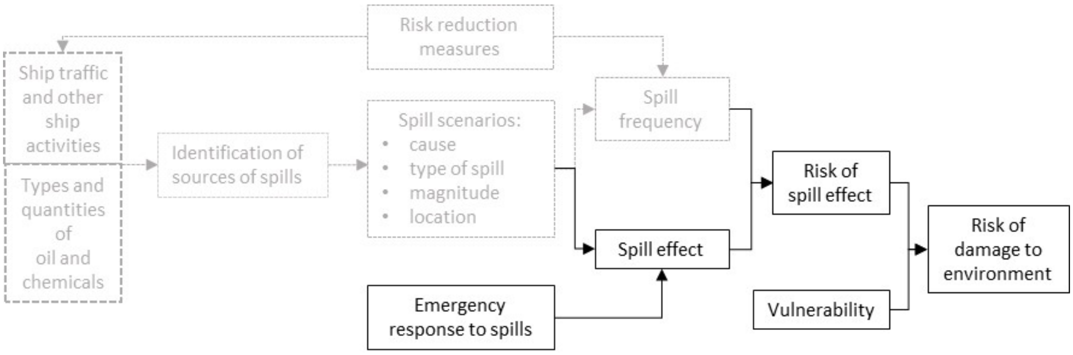

Figure 2-1 Flow of the risk assessment model (BE-AWARE II work steps are indicated in solid black, work steps of BE-AWARE I project are indicated in dashed gray).

The results from the system of models in the present project has been verified by state-of-the-art models and methods, where selected processes and cases were modelled independently. This include the following topics:

- Review of physical and oceanographic data in the area of the Bonn Agreement.
- 3D modelling study of the drift and fate of large oil spills in the seven project meteorological areas.
- A study to assess and validate the shape and size of potentially impacted areas.

The 3D modelling study was done by RBINS-MUMM, who was tasked to perform comparable simulations with its model OSERIT on the drift and fate of 10,000 m^3 of light crude oil released from seven predefined locations around the Greater North Sea and its wider approaches.

2.1 Impact

The modelling of the impact involves numerical modelling of the transport and dispersion of oil in the ocean while subject to changing characteristics, natural dispersion and degradation. The effect of the response measures (recovery or dispersants) to the spills are included in the model system.

In contrast to many traditional oil spill models that simulate the trajectory and the fate of a specific oil spill and are used for operational oil spill response, the present system of models is to be understood as a strategic model. The advantage of such model system is that it makes it possible to model a large number of scenarios, which is required for the overall risk assessment.

Separate modelling tools are established for two types of spills:

- Oil on the sea surface (oil on water surface)
- Oil dispersed into the water column (oil in water column)

The project area has been divided into a number of meteorological and hydrological areas within which the wind or current conditions are assumed uniform. Each area can be considered homogeneous and it must be different from its neighbour area. A 2x2 km grid has been applied throughout the North Sea for all impact modelling.

The same drift and fate modelling is used for all 4 seasons. The modelling includes a description of the spreading of the oil on the water surface, the drift by current and wind, as well as the weathering of the oil. For light oil types, the weathering is simplified to describe only the evaporation, while for heavy oils the weathering is simplified to describe emulsification and the natural processes that reduce the amount of oil on the sea surface over time. For further details, please refer to Technical Sub Report 1: Methodology (BE AWARE, 2015a) and Sub Report 3: Impact analysis (BE AWARE, 2015d). As a result, the following is found:

- The amount of oil in each calculation cell on the seas surface as a function of time
- The amount of oil in each calculation cell in the water column as a function of time
- The total amount of oil washed ashore

Four different oil types are investigated in the study with varying physical and chemical properties:

- Gasoil (Diesel)
- Crude oil
- Fuel oil (Bunker)
- Gasoline (Benzin)

Modelling time was limited to stop the simulation when 5% of the oil was left on the sea surface. The rest of the oil is either weathered, washed ashore, drifted towards the North Atlantic, or removed by response action. Spreading of an oil spill on the sea surface was calculated based on the effects of gravity and viscosity in the first hours of a spill. Afterwards the hydraulic and oceanographic conditions determined the spreading process through differences in the surface currents. For more details, please refer to the Technical Sub Report 1: Method Note (BE AWARE, 2015a).

A feature of oil spill response in the North Sea region is the possibility of combatting oil spills with dispersants. The dispersants are typical applied from aircraft, although vessels also are able to be equipped with spray tools. The oil will not disappear but shift state and location from surface to water column. For example the impact on birds and on shorelines will be smaller, but impact is expected to be larger on pelagic species e.g. fish larvae. Dispersed oil will have a much larger surface for chemical reaction and the effect of the dispersant itself might be potentially harmful. An important characteristic of the dispersed oil is that it cannot be recovered by mechanical response means. Furthermore, the dispersed oil is less likely to reach the coastline and will stay in the water column until it is biologically degraded.

Oil on shore is summarised in the model for each sub-region. Once the oil touches a coastal cell in the model, the oil will "stick" to the coastal cell and the will be subtracted from the amount of oil on the sea surface and added to the amount washed ashore.

2.2 Vulnerability

During BE-AWARE I it was agreed that the vulnerability ranking should be based on a modification of the BRISK methodology (BE AWARE, 2015a). It is the overall objective of the environmental and socioeconomic vulnerability assessment to describe the vulnerability on a regional scale. Maps for the relevant environmental and socioeconomic parameters (such as e.g. migrating birds or tourism) are overlaid in a consistent and comparable way, providing a basis for comparison of vulnerability across country borders. The study is based on existing knowledge and GIS layer maps.

Accordingly, the ranking of the vulnerability of ecological and socioeconomic features to oil spills in the different regions of the BA area was carried out in the following distinct steps:

- Step 1: The identification of the most dominant ecological and socioeconomic features and establishment of BA area wide maps. The list of features comprises 9 species features, 23 habitats features, 4 protected area features and 17 socio-economic features. In all 53 features were taken into account.
- Step 2: Scores were allocated to each of the identified ecological and socioeconomic features during spring, summer autumn and winter for both surface oil spills and chemically dispersed spills. A weighting matrix was prepared that ties weights to different feature groups, such as species, habitats, protected areas and socioeconomy.
- Step 3: The preparation of integrated vulnerability maps based on maps of identified features, the vulnerability scores for each feature and the weighting matrix for specific groups of features.

Integrated vulnerability maps were prepared from a combination of the four series of seasonal vulnerability maps (habitats, species, protected areas and socioeconomic features). The resulting maps illustrate the spatial distribution of an index for vulnerability to oil on the sea surface and to chemically dispersed oil, see Figure 3-2 and Figure 3-3.

2.3 Damage

The environmental damage represents the combination of environmental vulnerability and impact of oil. The impact of oil is defined as the amount of oil that will be in a certain area. It is determined as follows:

a. Oil on shore determined as the mass of oil on the entire shoreline in a specific sub-region. This oil is not combined with any vulnerability, which instead is determined by the vulnerablility of the adjacent coastal cell the oil drifts through to reach the shore.

b. The impact of oil on the water surface calculated as mass (oil) per area water surface. This impact is combined with the vulnerability of the specific sea surface area.

c. For the impact of oil in the water column, the impact is determined equally, as mass (of oil) per area water column (horizontal area). This impact will be combined with the vulnerability of the specific water column.

In order to merge data sets of vulnerability with data sets of oil impact on a large regional scale, a series of transformations and normalisations must be carried out. The process is illustrated in Figure 2-2, and reference is given to the method note for details (BE-AWARE, 2015a).

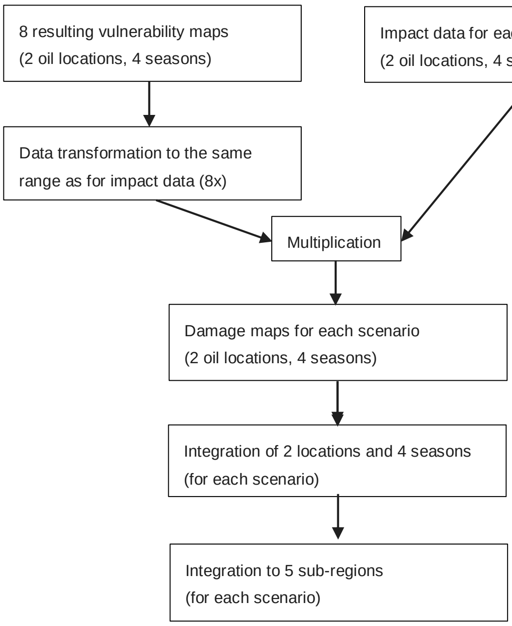

Figure 2-2 Schematic illustration of calculation of environmental damage (the "2 oil locations" refer to oil on surface and oil in water)

2.4 Risk management

The method of evaluating the model outputs is to describe all processes of relevance for the occurrence of spills and environmental damage. The processes are connected in a system of modules in order to facilitate that changed input parameters (different scenarios) will result in a measurable change for oil impact and damage to the environment.

2.4.1 Scenarios

At the BE-AWARE II Method seminar, 8-9 of April 2014 in Southampton, the process of selecting scenarios was initiated. All project partners participated at the meeting where the initial ideas for scenarios were discussed and non-viable scenarios were discarded.

After the Method Seminar a wider process was initiated that included a long list of scenarios. This long list was condensed to the short list presented below. For a full description of considered potential scenarios, reference is made to the Method Seminar Report (Bonn Agreement, 2014).

The different scenarios serve the purpose of identifying areas where improvements, such as implementation of safety measures or increase in recovery equipment, potentially could lead to a decrease in the risk of an oil spill or to limit the impact and the environmental damage. In order to be able to measure the effectiveness, the base scenarios, i.e. the current and future scenarios as described in BE-AWARE I, are used as reference. Besides two reference scenarios, the following scenarios were selected. The scenarios are listed in Table 2-1 below with a brief description and classification into the risk reduction or response measure class.

Table 2-1 Scenario overview.

Nr	Scenario Name	Scenario description	Measure class
1	Reference: 2011-situation	Base scenario for 2011 situation	-
2	Reference: 2020-situation	Base reference scenario for comparing scenarios 3-10	-

3	Vessel Traffic Services (VTS)	An evaluation of the effect of adding new and larger areas with VTS coverage	Risk reducing
4	Traffic Separation Schemes (TSS)	An evaluation of the effect of implementing new suggested TSS schemes	Risk reducing
5	AIS alarm (Wind turbines)	An evaluation of the effect of having an alarm system warning ships if on a potential collision course with wind turbines	Risk reducing
6	E-navigation	An evaluation of the effect of implementing generic risk reducing e-navigation technologies	Risk reducing
7	New Emergency Towing Vessel (ETV)	An evaluation of the effect on the regional scale of adding new ETV in the south of Ireland	Risk reducing / Response
8	Improved night detection capability	An evaluation of the effect of adding night recovery equipment to additional vessels	Response
9	Dispersants use only	An evaluation of a regional wide use of dispersants as the first and only reponse measure, under conditions where dispersion is possible	Response
10	50% increase in response equipment + one vessel	An evaluation of the effect of increasing the response equipment by 50% and adding one additional vessel at Danish westcoast	Response

There are five scenarios with risk reducing measures and three scenarios with oil-spill response mesures.

2.4.2 Cost-efficiency analyses of scenarios

The objective of the risk management analysis is to investigate the consequences of different future scenario swith respect to 1) their effectiveness and 2) their cost-efficiency.

The idea behind the cost-efficiency analysis, where the preparedness on an entire sub-region is assessed, is that there will be an adequate balance of resources among the neighbouring countries, providing an optimised and coordinated response capacity in the Bonn Agreement area.

Effectiveness

The analysis compares each scenario with the reference scenario for year 2020 (also called "business as usual" scenario). The effectiveness analysis indicates how much the environmental damage is reduced in each scenario.

Cost-efficiency

The cost-efficiency analysis compares the cost-efficiency of each scenario with the reference scenario. This is done by taking the damage reduction as well as the cost into account, and provides the possibility to rank the scenarios concerning how much damage reduction is gained per invested Euro.

Risk management conclusion

On a project workshop on September 22, 2015, in Copenhagen, the results of the analyses for effectiveness and the cost-efficiency where presented to the project partners. The project partners discussed these results in the sub-regional working groups and reviewed them in their own political and administrative context. The project partners then decided on a prioritised list of scenarios that the sub-regional groups would promote in the future.

3. Results

3.1 Impact / Oil Spill modelling

The oil impact distribution was one of the significant outcomes of the BE-AWARE project that allowed the contracting parties to see the most critical areas with respect to oil impact and on this basis enabled them to make decisions about the future focus of risk reducing measures and emergency response. For details please refer to the Technical Sub Report 3: Impact analysis (BE AWARE, 2015d).

In Figure 3-1 the oil impact distribution is shown for the base scenario in the year 2020. This scenario is used as reference scenario. The impact is given as g oil/km² and it expresses the amount of oil from accidental spills that on average is present on each km² of the North Sea. The average amount of oil includes contributions from all kinds of spills, including small spills that occur relatively often as well as large spills that occur relatively rare. In addition, different oil types and accident types are included. The map only shows impact of oil on the water surface. Dispersed oil and oil on shore are quantified for this scenario in Table 3-1 as the probability distribution of oil in the regional waters and on the coastline in the region.

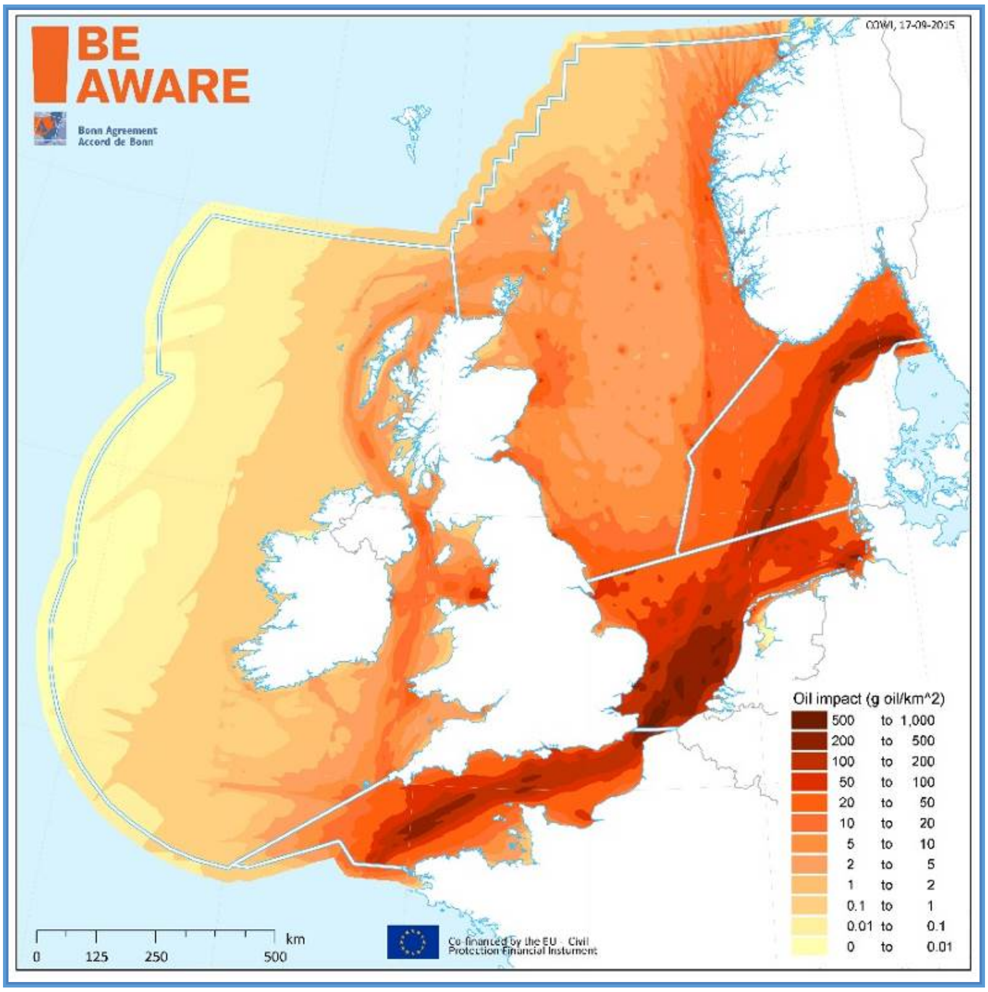

Figure 3-1 Base scenario 2020: Oil impact.

The results presented in Table 3-1 were used as a benchmark in the analysis, and other scenarios were measured against this. The oil amounts were a result of all sizes of oil spills and thereby the variations in the underlying return periods were very large. This means that the impact came from both frequent small spills and from very large and very infrequent spills.

Table 3-1 Oil impact in the sub-regions – Base case

Base Scenario	**Sub-region 1**	**Sub-region 2**	**Sub-region 3**	**Sub-region 4**	**Sub-region 5**
Oil on coast [t]	39	140	70	160	78
Oil on water [t/y]	1.3	3.2	8.3	15	7.7
Dispersed oil in water [t/y]	0.2	0.4	0.0	1.4	1.5

3.2 Vulnerability

The mapping of vulnerability produced a series of maps of the location of ecological and socioeconomic features. The subsequent sensitivity ranking and merging of maps gave the integrated combined vulnerability maps with the selected weighting ratio of habitat, species, protected areas and socioeconomic features.

For specific maps of the location of features and tables of ranking scores with underlying scientific rationale, please refer to the Technical Sub Report 2: Environmental and socioeconomic vulnerability mapping (BE-AWARE, 2015b). On the BE-AWARE web site (http://www.bonnagreement.org/be-aware/ii), interactive versions of the vulnerability maps will be made available and can be used to assess local variations in locations and vulnerability.

Figure 3-2 shows the combined seasonal vulnerability to undispersed oil spills and Figure 3-3 shows the combined seasonal vulnerability to dispersed oil spills.

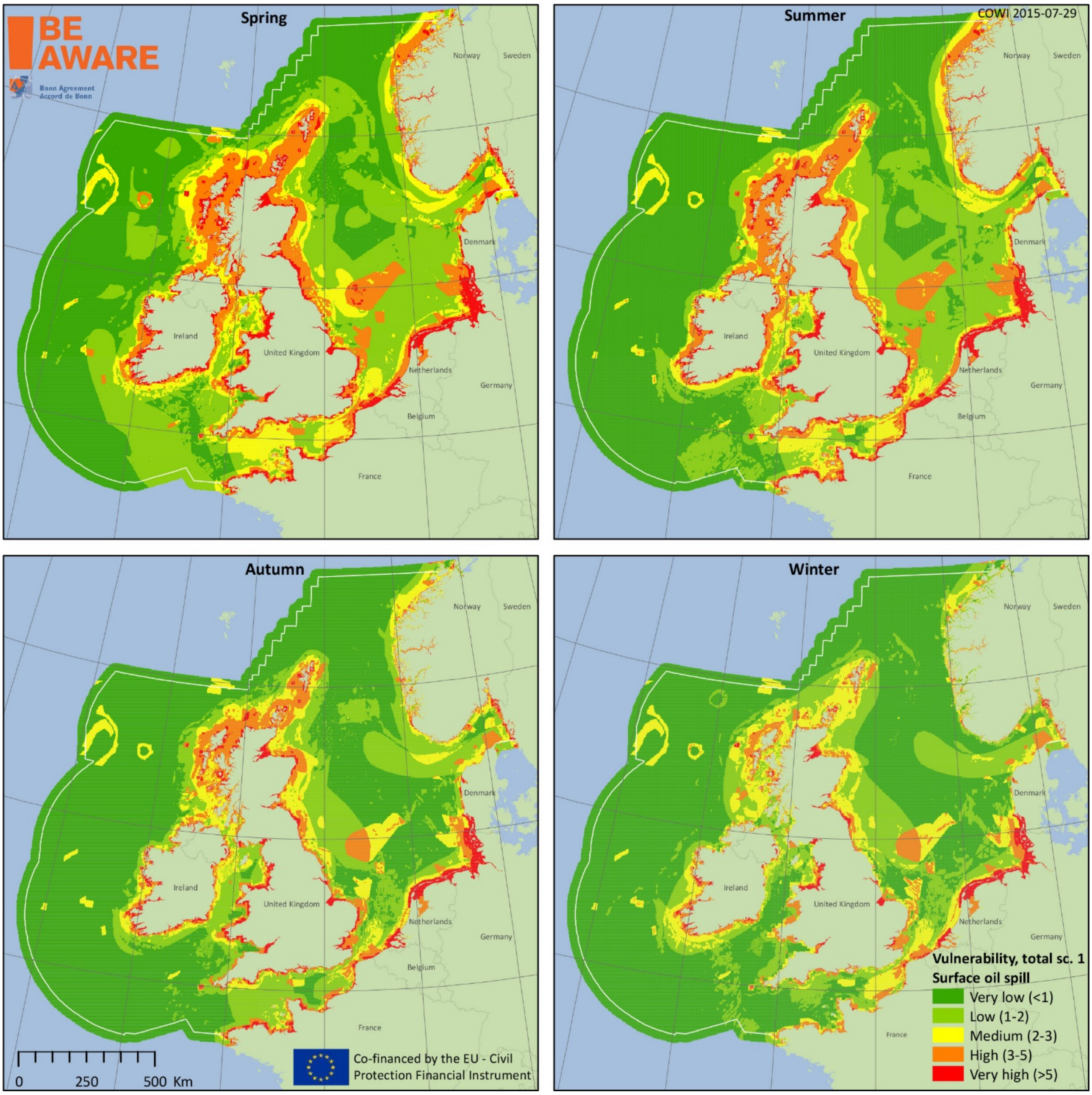

Figure 3-2 Combined seasonal vulnerability to <u>undispersed</u> oil spill.

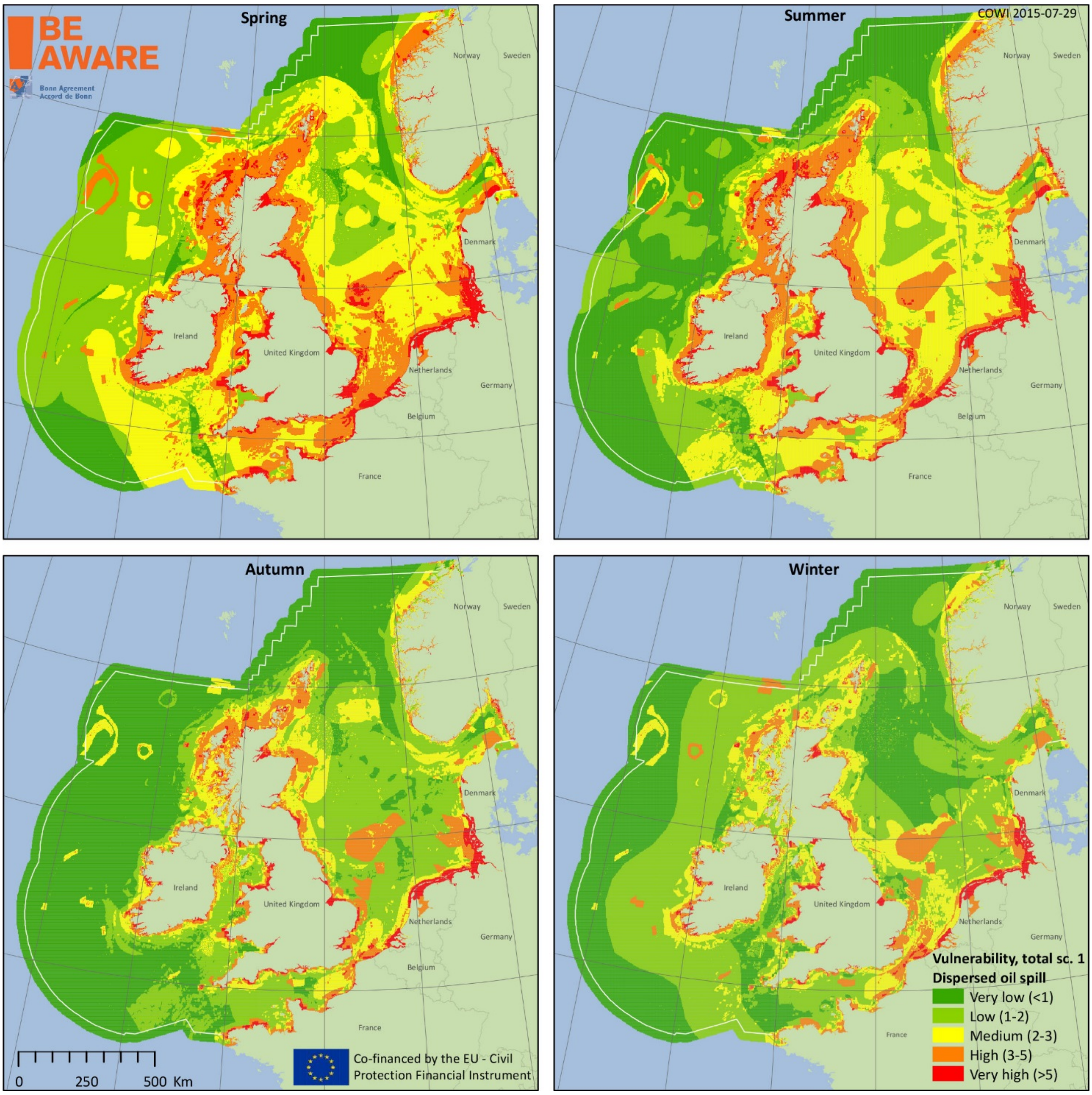

Figure 3-3 Combined seasonal vulnerability to <u>dispersed</u> oil spill.

3.3 Damage

By combining the oil impact maps with the environmental and socio-economical vulnerability maps, the environmental and socio-economic damage is calculated, i.e. the damage that the oil impact cause in the specific area. Due to the diverse vulnerabilities seen in the Bonn Agreement area, the damage maps are somewhat different from the oil impact maps. The damage maps enable the contracting parties to evaluate a current response based on one parameter (damage) that includes a wide range of features. By introducing the single parameter damage approach, the results of the impact analysis become clear, unambiguous and directly comparable, For details please refer to the Technical Sub Report 3: Impact analysis (BE-AWARE, 2015d). The approach makes it possible to carry the damage results further in the analysis and base the risk management conclusions and the cost-efficiency analysis on them. The incorporated damage map for all 4 seasons for the base case can be seen in Figure 3-4. The damage map in Figure 3-4 corresponds to the impact map in Figure 3-1.

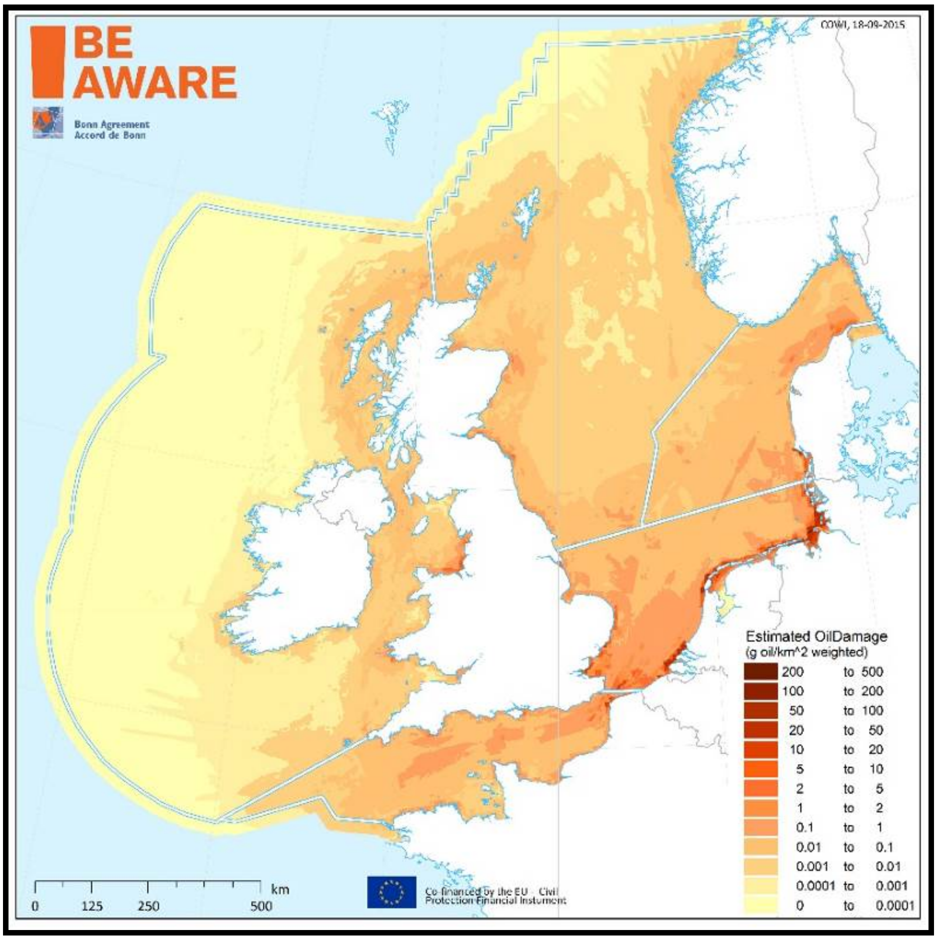

Figure 3-4 Base scenario 2020: Oil damage

The clear differences between Figure 3-1 and Figure 3-4 indicates the large variations found in the Bonn Agreement area within the environmental and socioeconomical vulnerability. Less vulnerable areas, e.g. far from shore, typically get less damage relative to the oil impact, and highly vulnerable areas such as the Wadden Sea shows more damage relative to the oil impact. In Table 3-2 below, the damage index integrated within each sub-region is shown.

Table 3-2 Damage index in the sub-regions – Base case

Base Scenario	Sub-region 1	Sub-region 2	Sub-region 3	Sub-region 4	Sub-region 5
Damage index [Non-dimensional]	8,969	9,393	20,068	194,383	20,781

The summation of damage in region 1 and 2 are comparable in size. The summation of damage in region 3 and 5 are also comparable but twice the size of region 1 and 2. Region 4 is the high-risk area with a damage index approximately 10 times higher than the results from region 3 or 5.

4. Risk Management Conclusions

4.1 Effectiveness

A number of scenarios were modelled to test the effect various risk reducing measures and oil spill response measures in relation to the base case scenario. The comparison parameters are oil impact (on the surface as well as on the water column), amount of oil on shore and environmental and socio-economic damage. These results were fed into the risk management conclusions report where the effect and the cost are gathered and recommendations on possible future measures are given. For an overview of the scenarios, please see section 2.4.1.

The results are summed per sub-region in order to make it possible to conclude on the effectiveness in the different regions. This is essential to reflect the effect of the individual scenarios as the regions are different with respect to traffic, vulnerability and response equipment. The results in terms of oil impact are listed in the following tables. The effect of E-navigation in all regions was conservatively set to 25 %. The rationale behind stems from previously reported estimates of a risk reduction factor on all maritime accidents between 8 and 17% for individual e-navigation options.

Table 4-1 Effect of the scenario on the amount of oil in water compared to the base case

Oil on water – effect					
Scenario	Sub-region 1	Sub-region 2	Sub-region 3	Sub-region 4	Sub-region 5
3) VTS	-0.2%	-3.1%	-31%	-22%	-0.9%
4) TSS	-0.3%	-5.2%	-52%	-3.1%	0.0%
5) AIS Alarm	-0.8%	-0.2%	-1%	-2.8%	-0.3%
6) E-navigation	-25%	-25%	-25%	-25%	-25%
7) ETV in Ireland	-1.8%	0.0%	0.0%	0.0%	-0.0%
8) Night vision	-0.7%	-0.1%	-0.4%	-1.1%	-1.3%
9) Dispersants	-1.0%	-0.1%	3.7%	6.4%	3.0%
10) +50% resp.	-1.2%	-1.2%	-1.7%	-2.0%	-1.8%

Table 4-2 Effect of the scenario on the amount of oil on the coast compared to the base case

Oil on coast – effect					
Scenario	Sub-region 1	Sub-region 2	Sub-region 3	Sub-region 4	Sub-region 5
VTS	-0.3%	-0.6%	-28%	-15%	-3.4%
TSS	-0.4%	-0.2%	-31%	-1.0%	-0.0%
AIS Alarm	-0.3%	-0.1%	-0.5%	-1.2%	-0.6%
E-navigation	-25%	-25%	-25%	-25%	-25%
ETV in Ireland	-2.1%	0.0%	0.0%	0.0%	0.0%
Night vision	-0.9%	-0.1%	-0.1%	-0.5%	-0.5%
Dispersants	-0.6%	-0.0%	-5.8%	-3.9%	-3.7%
+50% resp.	-1.1%	-1.2%	-1.1%	-1.2%	-0.8%

Table 4-3 Effect on dispersed oil in the water column compared to the base case

Dispersed oil in water column - effect					
Scenario	Sub-region 1	Sub-region 2	Sub-region 3	Sub-region 4	Sub-region 5

VTS	0.0%	-0.1%	-20%	-28%	-0.7%
TSS	0.0%	0.0%	0.0%	0.0%	0.0%
AIS Alarm	-0.6%	-0.2%	-0.1%	-0.7%	-0.1%
E-navigation	-25%	-25%	-25%	-25%	-25%
ETV in Ireland	-0.1%	0.0%	0.0%	0.0%	0.0%
Night vision	0.0%	0.0%	0.0%	0.0%	0.0%
Dispersants	44%	60%	N/A*	290%	120%
+50% resp.	0.0%	0.0%	0.0%	0.0%	0.0%

* Since no dispersant are applied in Region 3 in the base scenario, it is not possible to calculate the relative effect of applying dispersant.

Furthermore, the impact on the damage by including both the environmental and socio-economical features is given in Table 4-4.

Table 4-4 Effect of the scenario on the damage in the region compared to the base case

Damage effect					
Scenario	Sub-region 1	Sub-region 2	Sub-region 3	Sub-region 4	Sub-region 5
VTS	-0.2%	-1.3%	-27%	-11%	-3.2%
TSS	-0.3%	-1.0%	-42%	-2.8%	-0.0%
AIS Alarm	-1.7%	-0.3%	-1.3%	-1.6%	-0.3%
E-navigation	-25%	-25%	-25%	-25%	-25%
ETV in Ireland	-1.6%	0.0%	0.0%	0.0%	-0.0%
Night vision	-1.3%	-0.1%	-0.2%	-0.9%	-0.7%
Dispersants	1.5%	3.1%	33%	15%	27%
+50% resp.	-1.7%	-1.3%	-2.0%	-1.9%	-1.3%

Large variations on the effectiveness of the different scenarios are seen in the various regions. Some of the scenarios are primarily introduced in one or two regions, hence the effect elsewhere is very limited as this is only caused by the difference in the amount of oil drifting into the region. Other scenarios are more generic and linked to the intensity of the traffic, such as VTS and TSS scenarios where great variation is introduced from variable traffic intensity.

4.2 Cost-efficiency analysis

Project partners has decided upon a prioritisation based on cost-efficiency analysis for each subregion. The analysis provided output as shown in Figure 4-1 below, which shows damage impact reduction against cost effectiveness for all scenarios and all sub-regions on a log scale. Therefore scenarios range from the most damage reducing/least costly in the top left to least damage reducing/most expensive in the bottom right. Application of scenario 9 (dispersants only) provided negative damage reduction and is not included in the plot.

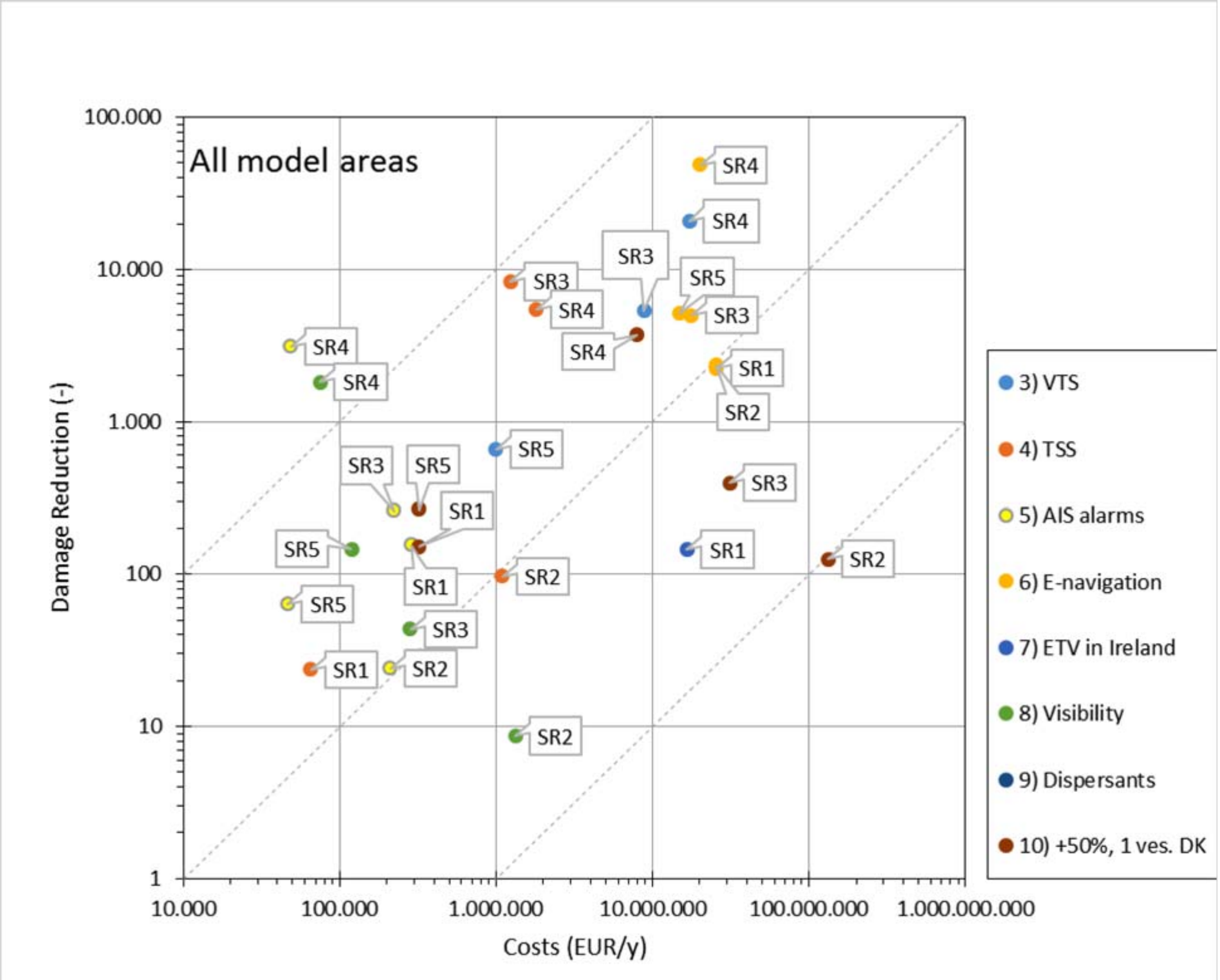

Figure 4-1 **Plot of damage impact reduction against cost effectives for all scenarios and all sub-regions. Note double logarithmic axes.**

4.3 Risk Management Conclusions

The key outcome of the project is risk management conclusions specific to each sub-region that will guide future development of risk reduction and response measures in that region. The risk management conclusions are based on the analytical results for effectiveness and cost-efficiency and are considered in the political and administrative context of each sub region. The prioritised list of scenarios given below, represent the selection of the project partners within each sub-region. For further elaboration of the rationale behind the prioritisations by the individual sub-regions, please refer to the Technical Sub Report 4: Risk Management Conclusions (BE-AWARE, 2015c).

The main conclusions of the cost-efficiency analysis are the selected and prioritised scenarios for each sub-region, summarised in Table 4-5 below:

Table 4-5 **List of scenarios prioritised by the project partners within each sub-region based on the results of the project analysis.**

	1. Priority	**2. Priority**	**3. Priority**	**4. Priority**	**5. Priority**
Sub-region 1	5) AIS alarm	4) TSS	10) +50%	7) ETV Ireland	
Sub-region 2	4) TSS	10) +50%	5) AIS alarm	8) Visibility	9) Dispersants

Sub-region 3	4) TSS	3) VTS	5) AIS alarms		
Sub-region 4	4) TSS	5) AIS alarms	8) Visibility	6) E-navigation	
Sub-region 5	5) AIS alarms	8) Visibility	10) +50%		

It can be seen that different sub-regions have different priority, even though the same method was applied. The sub-regions with relatively little traffic (sub-regions 1, 2 and 5) have response scenarios on a high priority, whereas the sub-regions with relative heavy ship traffic (sub-regions 3 and 4) prioritise risk reduction scenarios.

The three highest prioritised scenarios are AIS alarms, TSS and increased visibility options, when the cost-efficiency criterion is applied. Even though E-navigation in general resulted in high damage reductions (see Figure 4-1), it was not prioritised by contracting partners because of its early state of development and high costs.

The scenario 9 "dispersant-only" came out with negative effects on the environmental and socio-economic sensitivity in all sub-regions. The main reasons for that are two-fold: 1) In the project modelling and vulnerability analysis, chemically dispersed oil transfer negative effects into the water column from the water surface. This means for instance, that sea birds are much less impacted, whereas other sensitive features such as fish stocks in the water column are more heavily impacted. 2) In the scenario, collection of spilled oil is not possible after spraying dispersants and in many sub-regions oil this means a dramatic reduction in mechanical recovery of oil in comparison with the reference scenario.

Some measures do affect several sub-regions, and it may be of interest to the adjacent countries to join forces on such scenarios as they will be of particular benefit when introduced in several sub-regions. Such measures are the scenarios 3 (TSS) and 4 (VTS), which are applied on the main traffic route between Skaw and the English Channel. That will have a cost effective impact on sub-regions 2, 3 and 4. This indicates that particular benefit can be expected should regions 3 and 4 co-operate on a joint establishment of TSS and VTS.

4.4 Future use of report results

Overall, the project provides results to the project partners on three different levels:

- International:
    - The contracting parties organised through the Bonn Agreement Secretariat now has new analytical arguments to jointly promote global risk reduction measures, such as E-navigation in the relevant fora.
- North Sea:
    - In the North Sea area, specific measures, for instance VTS and TSS from Skagerrak to the English Channel, could be promoted jointly in order to achieve a synergistic benefit.
- Sub-regional:
    - For each sub-region, Project Partners have selected specific scenarios that are found to be most viable for their specific sub-region and which can be considered for the future development of the national preparedness and sub-regional co-operation, see Table 4-5.

5. Follow up of BE-AWARE results

A key objective of the BE-AWARE project is to ensure that the results and conclusions are implemented within the Greater North Sea and its wider approaches. As all project partners are also Contracting Parties to the Bonn Agreement, the implementation of the results were discussed by the 2015 meeting of the Agreement. The meeting agreed to draft an implementation plan for the BE-AWARE Risk Management Conclusions, which would be agreed in 2016.

The Implementation plan will be integrated into the Bonn Agreement Action Plan for 2016-2019, for actions which are within the Agreement's remit, i.e. oil pollution response measures. For other actions these will be raised in a coordinated manner within the appropriate competent authorities, however this is dependant upon regional cooperation outside the Bonn Agreement as it does not have competence over risk reduction measures. Finally the results of both BE-AWARE I and II, as well as there implementation, will be reviewed at the next Bonn Agreement Ministerial Meeting in 2019.

6. References

BE AWARE, 2015a	Technical Sub Report 1: Method Note.
BE AWARE, 2015b	Technical Sub Report 2: Environmental and socioeconomic vulnerability
BE AWARE, 2015c	Technical Sub Report 4: Risk Management Conclusions
BE AWARE, 2015d	Technical Sub Report 3: Impact Analysis
Bonn Agreement, 2014	Report of the BE-AWARE II Method Seminar.
BRISK, 2012	http://www.brisk.helcom.fi/publications/en_GB/publications/