BE AWARE

Bonn Agreement
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Technical sub-report 4: Risk management conclusions

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DOCUMENT TITLE: Risk Management Conclusions
TASK: Task I
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PUBLISHED ON: 10 November 2015

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Bonn Agreement
Accord de Bonn
Co-financed by the EU –
Civil Protection Financial Instrument

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 sub regional risk management conclusions, which will identify priority future risk reduction and response scenarios 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 present document describes the management implications of the BE-AWARE project. It builds upon the results of the activities described in the reports:

- Methodology Note (BE-AWARE, 2015b)
- Impact assessment report (BE-AWARE, 2015c).
- Joint environmental and socioeconomic sensitivity and vulnerability mapping (BE-AWARE, 2015d)
- The results are summarised in the Summary Report (BE-AWARE, 2015a)

This document gives an outline of the applied method for a common assessment of the effectiveness, costs and cost efficiency. The method was agreed upon by all project partners. The results for the different sub-regions are described and the implications for the Bonn Agreement area and also on the international level are given.

2. Methodology

2.1 Introduction

The applied methodology is based on the methods applied in the BRISK project, carried out in 2009-2012 for the Baltic Sea region (BRISK 2012). The management implications for the Bonn Agreement countries are based on the results of the present project. Since the project methodology has been discussed and agreed upon by all participating countries, the project provides decision- support based on a common and mutually accepted method.

The results of the present project provide support to decision-making at the managerial level of the authorities responsible for oil spill response in the Bonn Agreement area. The North Sea area is divided into five sub-regions where common measures for risk reduction and response actions are relevant in relation to the traffic, uses, vulnerability, etc. Within each of these sub-regions, the analysis is carried out and the effect of the selected scenarios is determined. The sub-regions are shown in Figure 2-1.

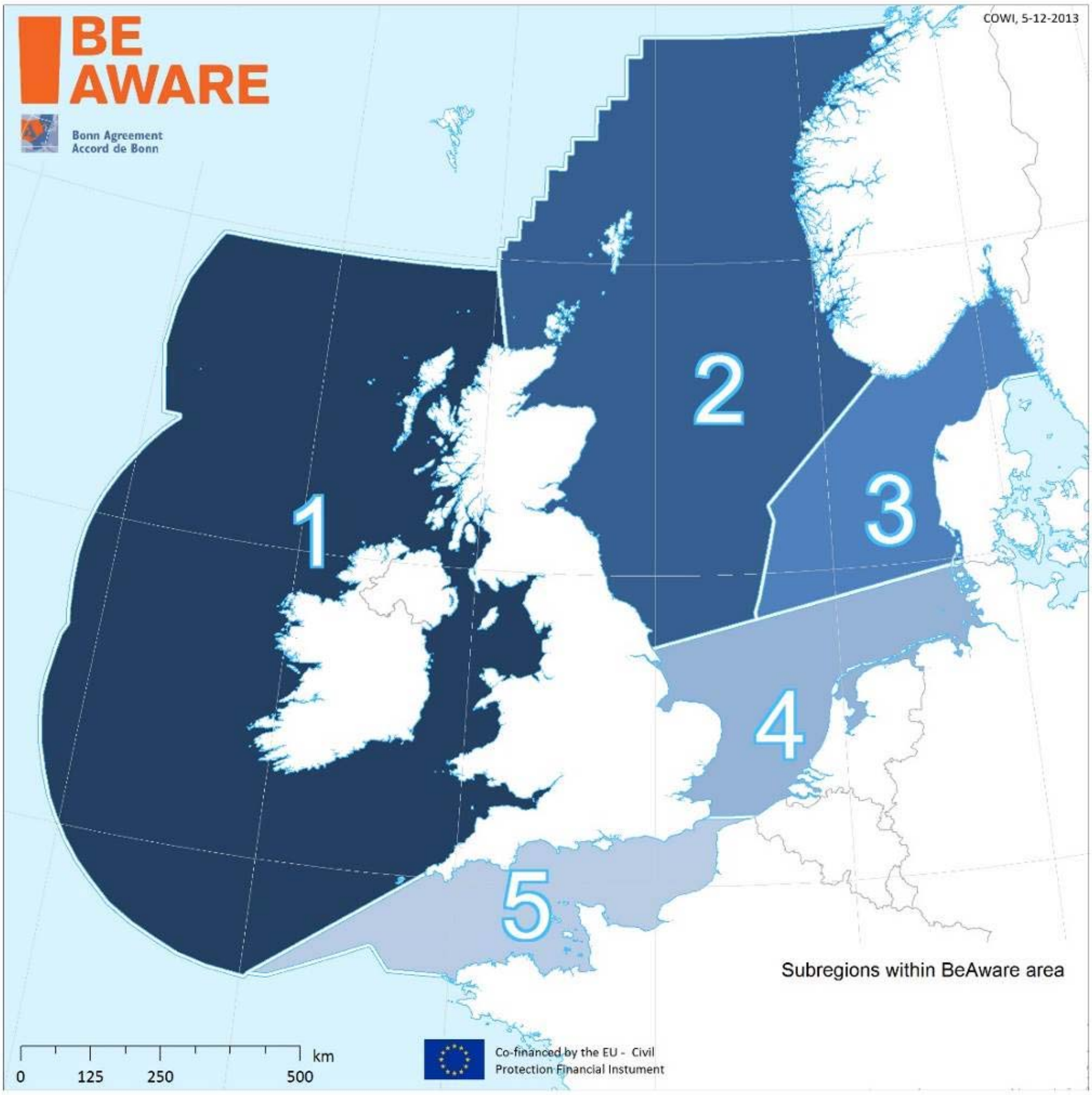

Figure 2-1 Map of the five sub-regions of the Bonn Agreement.

Within each of these sub-regions, the analysis was carried out, and the effect of the selected scenarios was determined.

The overall methodology is referred to in the document Method Note (BE-AWARE, 2015a). This document describes the method for how the information of ship positions (AIS-data), and the information on transported goods, was analysed to describe a traffic model. These results were applied in accident models, spill models, drift and fate models as well as models for response and dispersant use. Together with an analysis of the environmental and socioeconomic vulnerability towards oil on the sea surface and oil chemically dispersed in the water column, a damage assessment was carried out. Finally, the costs for the applied scenarios were estimated by the Project Partners. The costs comprise the initial investment costs, and the costs for running and maintaining the investments over their expected lifetime.

The concept for developing the final risk management conclusion is illustrated in the flow diagram in Figure 2-2.

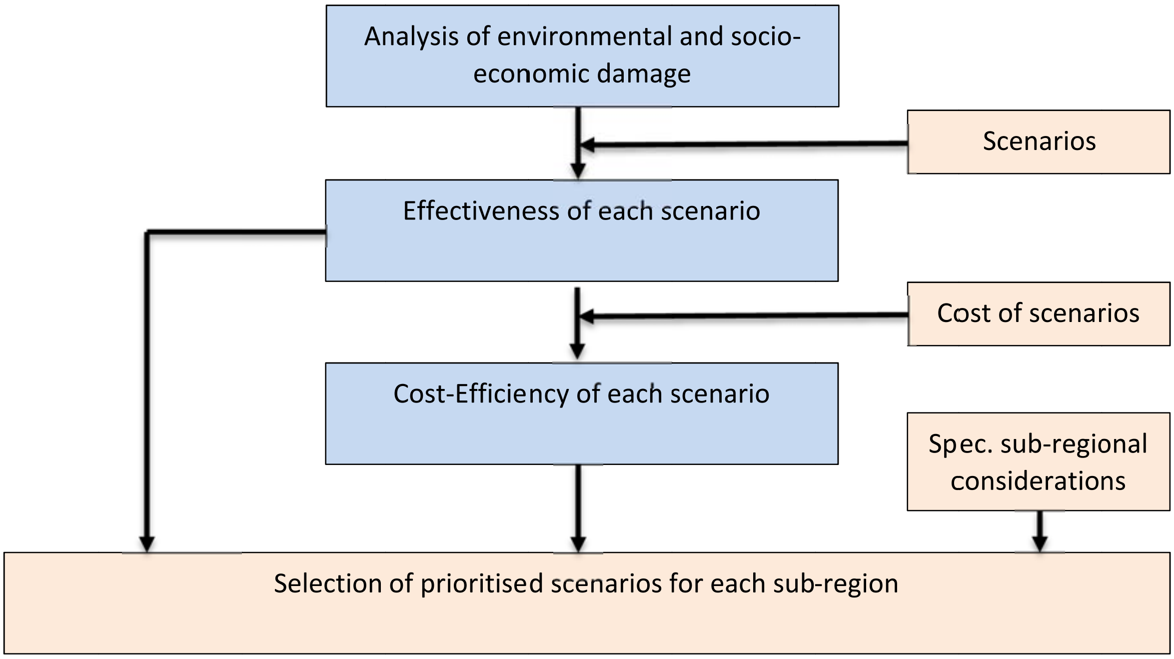

Figure 2-2 Flow diagram for concept for developing the risk management conclusions. The blue boxes represent technical analyses carried out by the consultant, the red boxes represent contributions from the Contracting Partners.

The results in chapter 3 are described according to the following main steps

- Effectiveness
- Cost-efficiency and
- Selection of prioritised scenarios.

2.2 Cost-efficiency analysis

The objective of the analysis was to investigate the consequences of different potential scenarios in the future, their effectiveness and cost-efficiency and on that basis evaluate the investigated scenarios.

The idea behind analysing the efficiency of preparedness at the sub-regional basis is that this will help ensure there will be an adequate balance of resources among neighbouring countries, providing an optimised and coordinated response capacity in the Bonn Agreement area. Therefore, specific and concrete programmes, including a timetable for how to close identified gaps in capacity, can be prepared for each sub-region by the Contracting Parties in that sub-region.

The overall objective is to ensure timely and well-organised emergency response in such a way that environmental damage caused by accidents is minimised in a cost-effective manner. The cost-efficiency analysis will prepare an analytical background for investments in emergency and response resources. The background is provided to the project partners, as a tool to evaluate and select the scenarios that seem most viable, taking into account the country specific pre-conditions.

The analyses for the scenarios investigating additional response resource options are carried out in cooperation between national experts and an external consultant specialised within this field.

The effectiveness analysis compares the effectiveness of each scenario with regard to the reference scenario for 2020 (also called "do nothing new" or "maintain current level"). The effectiveness indicates how much the negative consequences are reduced in each scenario through:

- Reduction of spilt oil (in Tonnes/sub-region) due to the introduced measures in each scenario.
- Reduction of oil chemically dispersed in the water column (in Tonnes/sub-region) due to the introduced measures in each scenario.
- Reduction of oil washed on shore and smothering the coastline (in Tonnes/year/sub-region) for each scenario.
- Reduction of environmental damage (in Tonnes weighted/sub-region) for each scenario.

Figure 2-3 illustrates the effectiveness scaled to the same y-axis interval. It shows the effectiveness of damage reduction measured in terms of the above four parameters in order to illustrate the stability or sensitivity of the results. The damage reductions for the four parameters are scaled with arbitrary values to illustrate all results on the same graph; therefore the four parameters cannot be compared directly within each scenario.

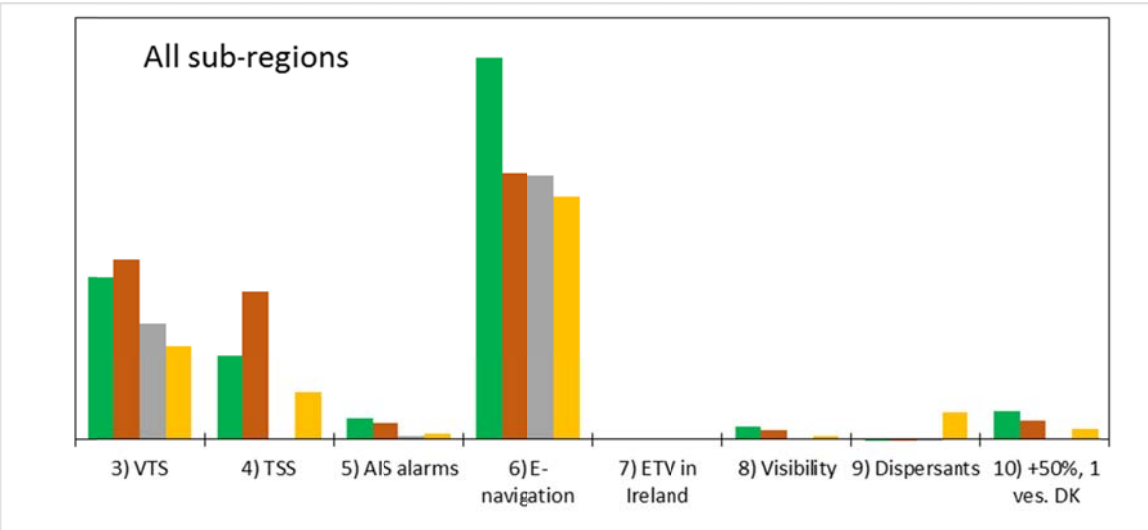

Figure 2-3: Effectiveness comparison: Illustration of the normalised damage for each scenario (all sub-regions).

The damage reduction for oil in water is negative in scenario 9 and hence excluded. The plot shows a similar distribution between the four parameters in the different scenarios, which demonstrates the relative stability of the results from scenario to scenario.

The analysis also provides the cost-efficiency of each scenario and compares them to the reference scenario. This is done by taking the cost for each scenario into account and provides the possibility of ranking the scenarios according to the benefit gained per invested Euro:

- Reduction of spilt oil per invested Euro (in Tonnes/Euro/sub-region) due to the introduced measures of each scenario.
- Reduction of oil chemically dispersed in the water column per invested Euro (in Tonnes/Euro/sub-region) due to the introduced measures of each scenario.

- Reduction of oil washed on shore per invested Euro (in Tonnes/year/Euro/sub-region) for each scenario.
- Reduction of environmental damage per invested Euro (in Tonnes weighted/Euro/sub-region) for each scenario.

The results of the cost-efficiency analysis are used in order to identify the most cost-efficient scenarios, and provide hence important analytical information for the management decisions on the development of the future emergency response.

2.3 Workshop

During the Risk Management Conclusions workshop in Copenhagen on 22 September 2015, the results of the analyses for efficiency and the cost-efficiency were 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 in order to decide on a prioritised list of scenarios that the sub-regional groups would promote in the future. The following chapter represents the outcome of the sub-regional working groups.

3. Results of cost-efficiency analysis

The results given below are based on the analytical results of effectiveness and cost-efficiency and are considered in the political and administrative context of each project partner. The prioritised list of scenarios given below represents the selection by the project partners within each sub-region.

Sub-region 1: UK and Ireland

Effectiveness

The effectiveness of the scenarios for sub-region 1 is illustrated in Figure 3-1.

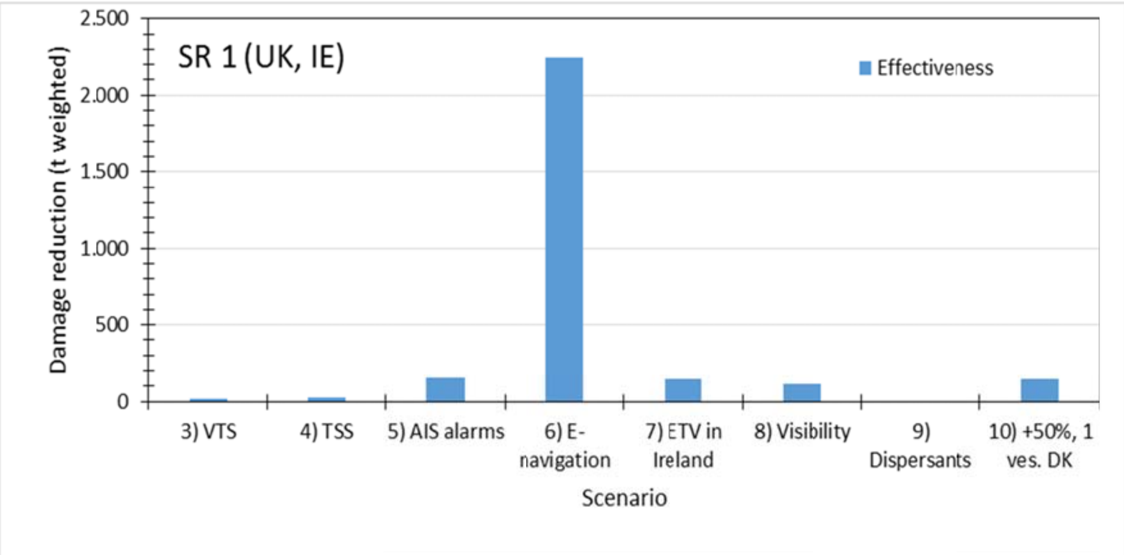

Figure 3-1 Sub-region 1: Effectiveness of reduction of environmental and socio-economic damage for each scenario.

It can be seen that the introduction of the measures included in the e-navigation scenario will provide the largest effect, given its impact on all shipping. Scenarios 5, 6, 8 and 10 will also provide significant benefits.

Cost-efficiency

In the next step, the costs for the scenarios are included in order to determine the cost-efficiency of the scenarios. Additional VTS areas and additional night detection/visibility equipment e.g. oil radar or IR cameras were not proposed for sub-region 1 and have therefore not been ranked.

Table 3-1 Sub-region 1: Ranking of scenarios based on cost-efficiency in reducing damage impact. The three scenarios with lowest ranking on "damage" are coloured.

Impact	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Oil on water	N/A	1	3	4	6	N/A	5	2
Oil in water	N/A	3	1	2	5	N/A	6	4
Oil on shore	N/A	1	3	4	6	N/A	5	2
Damage	N/A	3	1	4	5	N/A	6	2
Average	N/A	2,0	2,0	3,5	5,5	N/A	5,5	2,5

Prioritised scenarios

The project partners in sub-region 1, Ireland and the UK, broadly agree with the ranking in terms of cost-efficiency in relation to damage reduction, as outlined in Table 3-1. It is recognised that the two most effective scenarios based on cost effectiveness analysis (aimed at reducing damage impact), are AIS alarms on windfarms, 50% more equipment and TSS, as outlined in Table 3-1. Application of scenario 9 (dispersants only) provides negative damage reduction and is not included in the plot. When considering e-navigation, project partners had noted that the current IMO initiative was as yet incomplete with only four of the 20 planned outcomes currently going forward and no significant change anticipated over the next four years. This meant that while the analysis was attractive, the option was not implementable in the short term.

Ireland has prioritised 50 % additional response equipment and additional ETVs due to its exposure to cross-Atlantic traffic and a lack of national commercial capacity. Ireland's view was that sub-region 1 is at significant risk of receiving ships in distress from the eastern half of the northern Atlantic (e.g. "MSC Flaminia"). This traffic of high-risk ships was not included in the BE-AWARE analysis as traffic of particular high risk, as these ships are dealt with as "normal" ships in the AIS traffic analysis. Therefore, risk is expected to be higher and consequently, the actual demand for preparedness expected to be higher in this sub-region. The UK did not rank these priorities as highly on grounds of value for money, given it believed that adequate resources are in place commensurate with the agreed risk relevant for the UK sector of Sub-region 1. Furthermore UK believed that in the case of a major incident significant private sector resources already existed and were available.

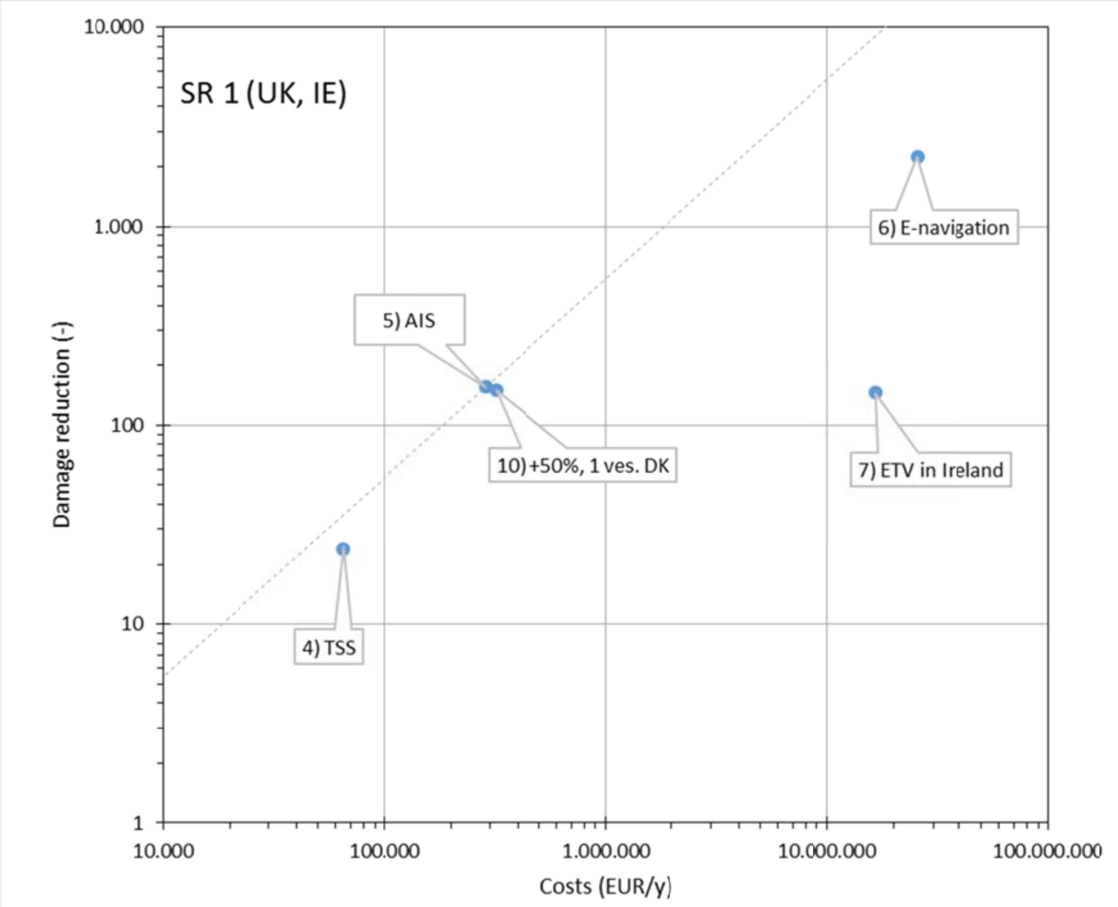

Figure 3-2 **Plot of cost effectiveness versus damage impact reduction. Note double logarithmic axes. The broken line indicates positions of equal and most optimal cost-efficiency ratio, the larger the distance to the line, the lower the benefit for each invested Euro.**

Thus, the priority ranking of the three significant scenarios between the Contracting Parties of sub-region 1 was agreed as:

1. AIS alarms/guard rings around wind turbine parks was identified by the UK as priority 1. New wind farms were clearly contributing new risks to navigation. This was in keeping with the high number of wind farms proposed for UK and Irish waters.
2. TSS extension beyond what was expected to be in place by 2020. The highest ranked scenarios for the sub-region were the TSS in Dublin Bay. While the UK considered the absence of TSS in some areas as a comparatively low risk, it was agreed that this scenario (particularly in the vicinity of wind farms) ranked second to AIS.
3. 50 % increase in counter pollution equipment. The UK considered its current counter pollution stockpile to be more than adequate (including both private and public sector equipment) for the eastern side of the Irish Sea. Ireland took the view that the national stockpiles (which are primarily public sector) were inadequate, and additional stockpiles

would be required in the event that there was a medium to major event on the western side of the Irish Sea. 50 % additional equipment[1] was ranked third for Sub-region 1.

The pure ETV scenario requested by Ireland was ranked lower compared to other options due to the high capital costs and annual costs of provisioning it. The ranking of this option did not, however, take into consideration other capabilities that Ireland may identify for a multi-purpose vessel (MPV) ETV. This may include oil recovery, hazardous and noxious substances incident response, on-scene coordination during a major maritime event, maritime safety enforcement, fishery enforcement, ship fire-fighting, chemical dispersants, coastal and other research and development, and as a diving and underwater remotely operated platform. The ranking would clearly be higher within an expanded Irish Coastal State requirement consideration.

Equipping response vessels with additional night detection/visibility equipment e.g. oil radar or IR cameras and VTS were agreed not to be applicable specifically to sub-region 1. However, it was noted that some benefit without cost could be derived from a neighbouring region's choice of such a scenario due to the risk of spread of oil spills from these regions.

The UK questioned the negative impact of dispersants in sub-region 1 and highlighted that risk assessments were done on a case-by-case basis; if dispersants were likely to cause environmental damage then the regulatory authorities would not allow their use in the first place. UK regulations on dispersant use ensure that dispersed oil does not reach sensitive resources and it should also be noted that Scenario 9 on dispersants models the use of dispersants only as a response strategy. It replaced the existing situation in the Bonn Agreement area where the recovery of oil was carried out primarily by dedicated oil recovery vessels. Further clarification on the UK view on the *dispersants only* scenario can be found in the BE-AWARE Method Note.

Ireland also has a policy of assessing each case on its merits prior to any use of dispersants. Permission is required from the Irish Coast Guard before any dispersants are discharged into the marine environment[2].

[1] Including a capacity to deploy response equipment on site

[2] Ireland does not have a national dispersant spraying plan. In the event that dispersant application was deemed appropriate then the activation of a MOU with an international contractor for direct spraying aircraft would take place

3.1 Sub-region 2: Norway and UK

Effectiveness

The effectiveness of the scenarios for sub-region 2 is illustrated in Figure 3-3.

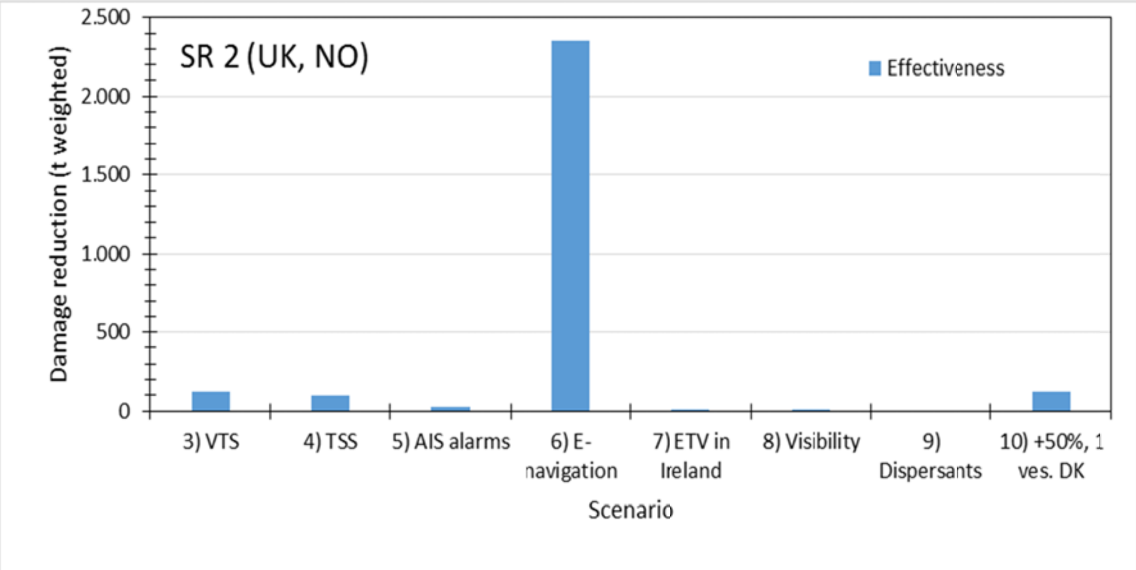

Figure 3-3 Sub-region 2: Effectiveness of reduction of environmental and socioeconomic damage for each scenario.

It can be seen that the introduction of all e-navigation measures included in the scenario would provide the largest benefit, given its impact on all shipping. Scenarios 3, 4 and 10 would also provide significant benefit.

Cost-efficiency

In the following paragraphs, the costs for the scenarios are included in order to determine the cost-efficiency of the scenarios.

E-navigation, AIS alarms around wind farms, TSS, improved night detection/visibility equipment and 50 % increase in mechanical response equipment are all measures that reduce the damage impact within BE-AWARE Sub region 2. There were no additional costs for VTS and no new ETV proposed for Region 2 so these scenarios have not been ranked.

Table 3-2 Sub-region 2: Ranking of the Scenarios in region 2 based on the cost efficiency in terms of damage impact reduction. The three scenarios with lowest ranking on "damage" are colored.

Impact	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Oil on water	N/A	1	3	2	N/A	4	5	6
Oil in water	N/A	4	2	3	N/A	1	6	5
Oil on shore	N/A	3	2	1	N/A	4	5	6
Damage	N/A	3	1	2	N/A	4	6	5
Average	N/A	2,8	2,0	2,0	N/A	3,3	5,5	5,5

The highest ranked scenarios in terms of cost-efficiency for reduction of socioeconomic and environmental damage, as outlined in Figure 3-4, are TSS, AIS alarms around wind farms and e-navigation. Norway already has TSS on its coast, which was included in scenario 1 (2011 conditions) and in the reference scenario 2 (2020). According to the analysis, this meant that the additional benefit for sub-region 2 from TSS comes from extending the TSS into the central North Sea. Application of scenario 9 (dispersants only) provided negative damage reduction and was not included in the plot.

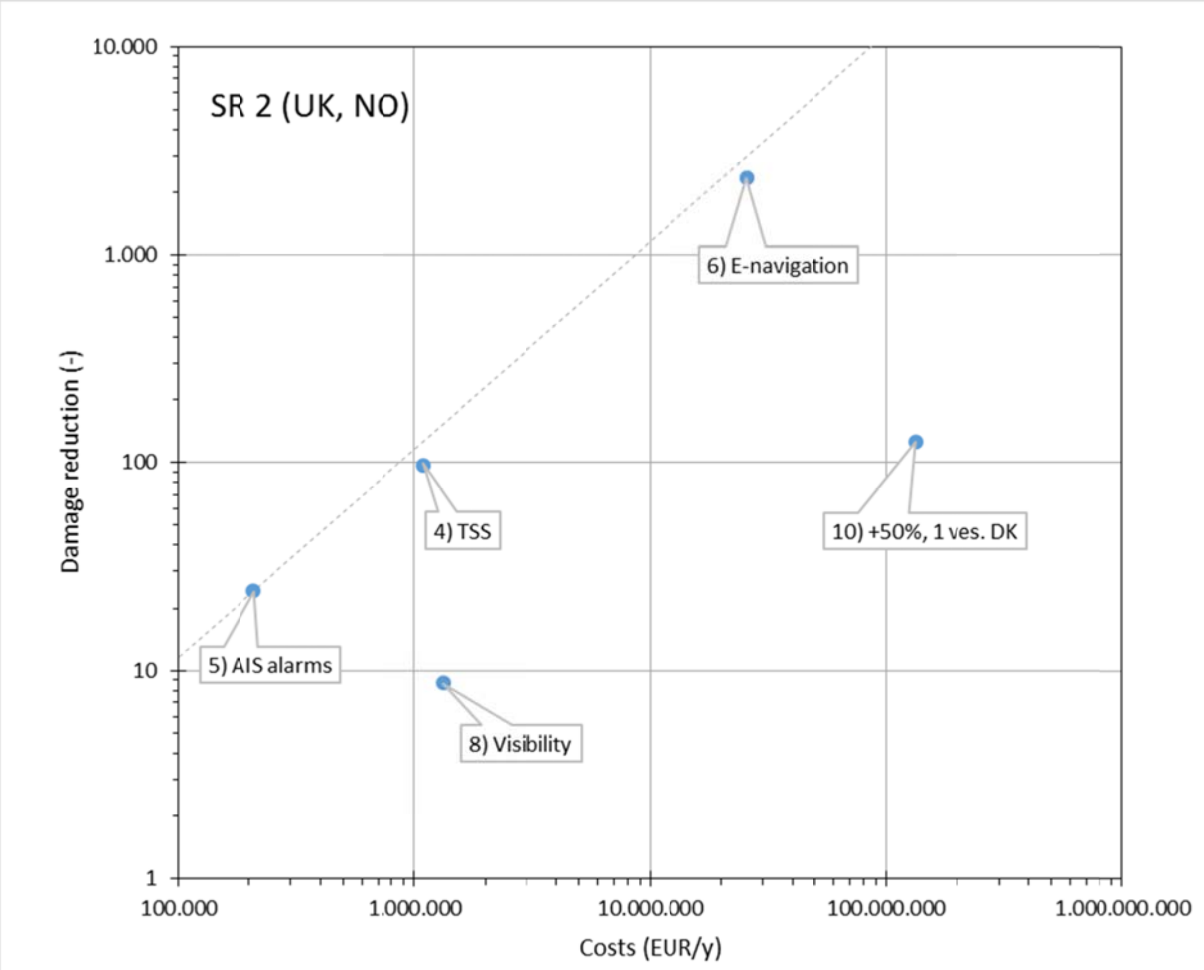

Figure 3-4 **Plot of damage reduction against cost effectiveness for the scenarios applicable to region 2. Note double logarithmic axes. The broken line indicates positions of equal and most optimal cost-efficiency ratio, the larger the distance to the line, the lower the benefit for each invested Euro.**

Prioritised scenarios

The project partners in sub-region 2, Norway and the UK, agreed with the ranking in terms of cost effectiveness in relation to damage reduction, as outlined in Table 3-2.

The main benefit for sub-region 2 from extending the TSS, as outlined in scenario 4, would be the addition of an improved ship reporting system for ships sailing between the different countries and regions within the Bonn Agreement area. The VTS centres could improve the reporting (for example, via SafeSeaNet) of ships with dangerous cargo or ships that pose other threats. In addition, the VTS would have as its main task to identify deviations, e.g. ships drifting or not following the TSS for other reasons. Deviations are more easily identified when ships are sailing according to TSS compared to free sailing. Early identification of deviations reduces the RMO-time (time for response, mobilization and operation) for tug assistance if a ship is in a critical situation when sailing according to a TSS. The probability of groundings is therefore considerably reduced. TSS would also reduce the probability for head on collisions significantly. The total effect of TSS and VTS considered together was therefore higher than the two measures considered separately.

The VTS NOR (Norwegian Oceanic Region) could easily extend its surveillance to the two additional TSS waypoints suggested in the Norwegian EEZ, ref. scenario 4. The TSS close to the north-western Jutland coast and the TSS in the middle of the North Sea could be supported by a VTS located in a country in sub region 3.

A fifty percent increase in mechanical response equipment (Scenario 10) was ranked lower because Norway already has a significant response capability, with many vessels with considerable oil spill response equipment installed. This equipment is placed on vessels with other responsibilities, e.g. the Coast Guard and offshore stand-by vessels. Further expansion of the oil response capabilities would require purpose-built vessels because most of the opportunities to join forces with other vessels were already utilised. This meant that it would be very expensive to increase the oil-spill response capabilities by 50 % in the Norwegian EEZ.

However, in the UK EEZ where oil response contingency was largely built on the use of chemical dispersants, the effect of a 50% increase of mechanical oil response equipment could be considerable under certain conditions; therefore this scenario was given a higher priority.

Partners shared a common understanding that e-navigation required further development before its effectiveness as a risk reducing measure for Sub-region 2 was clear. As in Region 1, the project partners had noted that the current IMO initiative was as yet incomplete with no significant change anticipated over the next four years. It was agreed to continue monitoring the further development of e-navigation.

In sub region 2, the emergency response to acute oil pollution relies largely on the use of dispersants. This is especially the case for the UK, while for the Norwegian contingency system, especially the offshore oil industry, this response measure cannot be totally ruled out. The decision on whether or not to use chemical dispersants is based on a net environmental benefit analysis carried out in every case. The UK position with respect to dispersants is described in more detail in the Method Note (BE-AWARE, 2015a).

The partners in sub-region 2 therefore prioritised the following scenarios:

1. TSS – the complete suggested TSS in the entire Bonn Agreement area, ref. scenario 4
2. 50 % increase in response equipment (see explanation above)
3. AIS alarms around windfarms – VTS will have a crucial role in the respective countries when it comes to this measure
4. Visibility – improved night detection night detection/visibility equipment e.g. oil radar or IR cameras.
5. Dispersants (see above).

3.2 Sub-region 3: Norway, Sweden, Denmark, Germany and the Netherlands

Effectiveness

The effectiveness of the scenarios for sub-region 3 is illustrated in Figure 3-5.

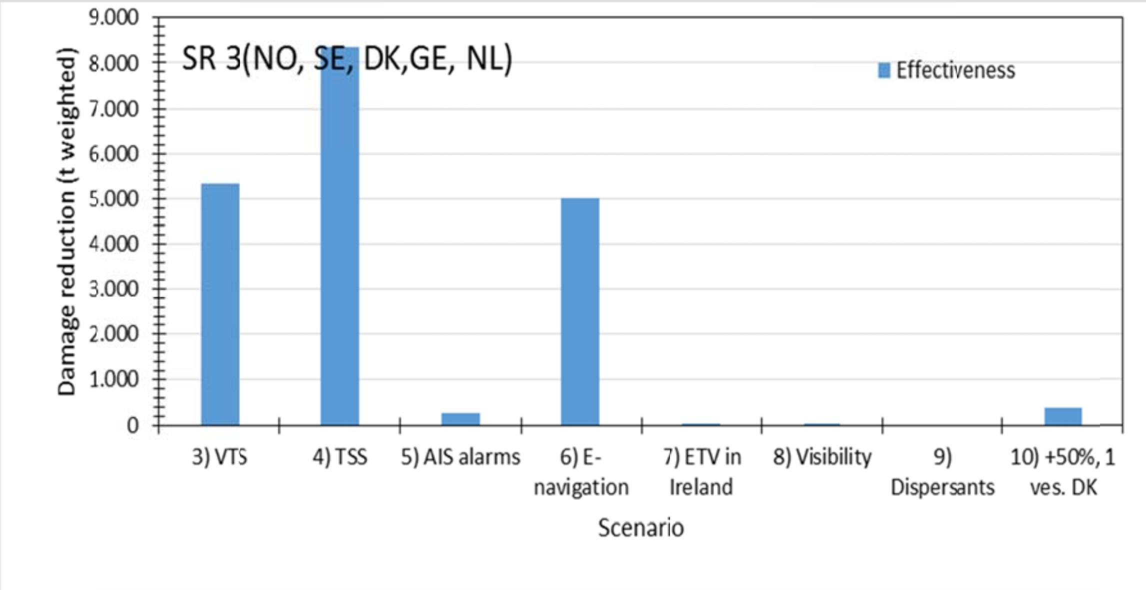

Figure 3-5 Sub-region 3: Effectiveness of reduction of environmental and socioeconomic damage for each scenario.

It was seen that the introduction of scenarios 3, 4 and 6 would provide the largest benefit. Scenario 5 and 10 will also provide significant benefit.

Cost-efficiency

In the following paragraphs, the costs for the scenarios are included in order to determine the cost-efficiency of the scenarios. The project partners of Sub-region 3 noted that the three most effective scenarios based on cost-efficiency analysis, aimed at reducing damage impact, were TSS, AIS alarms around wind farms and VTS respectively. As outlined in Table 3-3. Scenario 7 (ETV) was not ranked as there were no additional ETVs proposed. It is noted that all three measures were by nature risk reducing measures (RRM). The partners shared the common understanding of a close linkage between TSS and VTS establishment.

Table 3-3: Sub-region 3: Ranking of scenarios in sub-region 3 based on cost effectiveness in reducing damage impact. The three scenarios with lowest ranking on "damage" are colored.

Impact	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Oil on water	3	1	2	5	N/A	4	7	6
Oil in water	4	3	1	5	N/A	2	7	6
Oil on shore	3	1	4	5	N/A	6	2	7
Damage	3	1	2	4	N/A	5	7	6
Average	3,3	1,5	2,3	4,8	N/A	4,3	5,8	6,3

Prioritised scenarios

Thus, the priority between the project partners of Sub-region 3 is commonly agreed as:

1. TSS routes from the southwestern coast of Norway and the Skaw towards the Nord Friesland TSS, most likely to be based on virtual navigation marks as priority number one.
2. The TSS should be supported by a VTS close to the north-western Jutland coast as priority number two.
3. AIS on wind farms as priority number three.

Furthermore, the cost effectiveness of all scenarios that are presented in Figure 3-6 was noted. The application of scenario 9 (dispersants only) provided negative damage reduction and is not included in the plot. Partners shared a common understanding that e-navigation required further development before its effectiveness as a risk reducing measure for Sub-region 3 was clear and agreed to continue monitoring the further development of e-navigation.

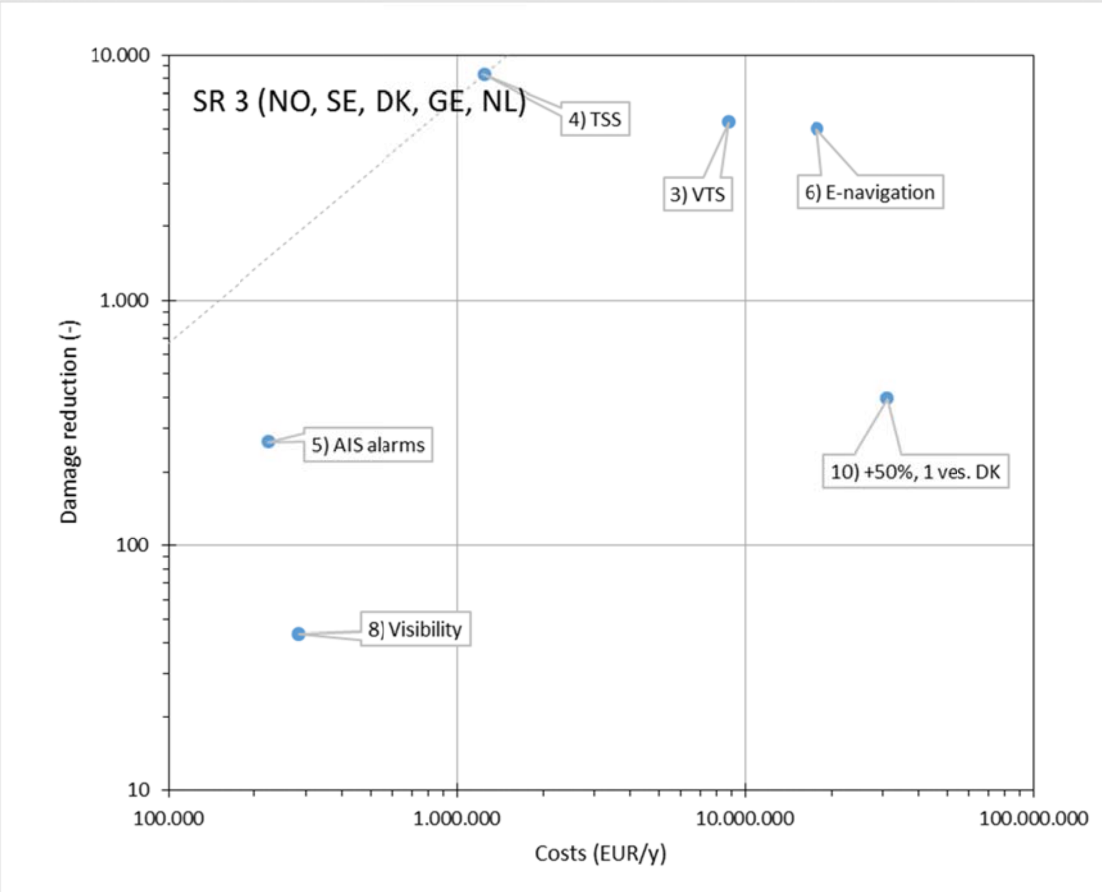

Figure 3-6: Plot of damage impact reduction against cost effectives for the scenarios applicable to region 3. Note double logarithmic axes. The broken line indicates positions of equal and most optimal cost-efficiency ratio, the larger the distance to the line, the lower the benefit for each invested Euro.

3.3 Sub-region 4: Germany, the Netherlands, Belgium, France, UK

Effectiveness

Sub-region 4 is a very high traffic area, which already has a high implementation of risk reducing and response measures. The effectiveness of the scenarios for sub-region 4 is illustrated in Figure 3-7.

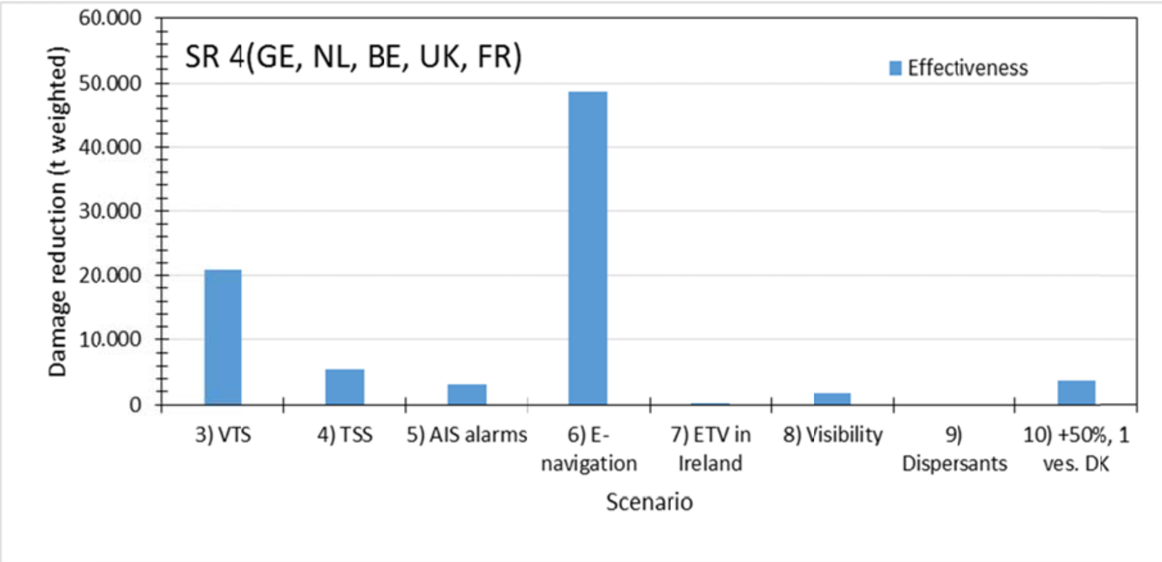

Figure 3-7 Sub-region 4: Effectiveness of reduction of environmental and socioeconomic damage for each scenario.

E-navigation and increased VTS were the most effective scenarios and dispersants were the least effective. 50% extra response equipment was not viable in this region due to the existing high level of response infrastructure.

Cost-efficiency

The highest ranked scenarios in cost-efficiency terms were AIS alarms, due to the large number of wind farms, extended night vision capability, and added TSS, as outlined in Table 3-4. Scenario 7 ETV was not ranked, as no additional ETVs were proposed in sub-region 4. The scenarios 4 (TSS) and scenario 6 (e-navigation) were found to be along the same cost efficiency line, as outlined in Figure 3-8. Therefore, these two scenarios were considered to be equally cost-efficient in this region. The application of scenario 9 (dispersants only) provided negative damage reduction and was not included in the plot.

Table 3-4: Sub-region 4: Ranking of scenarios based on cost-efficiency in reducing damage impact. The three scenarios with lowest ranking on "damage" are colored.

Impact	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Oil on water	4	3	1	5	N/A	2	7	6
Oil in water	2	5	1	3	N/A	4	7	6
Oil on shore	5	6	1	4	N/A	3	2	7
Damage	5	3	1	4	N/A	2	7	6
Average	4,0	4,3	1,0	4,0	N/A	2,8	5,8	6,3

The most cost-efficient scenarios for reduction of socioeconomic and environmental damage were AIS alarms around wind farms, enhanced visibility and TSS. E-navigation was in fourth position, with an insignificant distance to TSS in third position. It was recognised that the real pros and cons of e-navigation needed to be further clarified. The second most cost-efficient option was equipping response vessels with night detection/visibility equipment e.g. oil radar or IR cameras. Project Partners noted that a response operation continuing beyond 24 hours would also require more personnel on board the vessels.

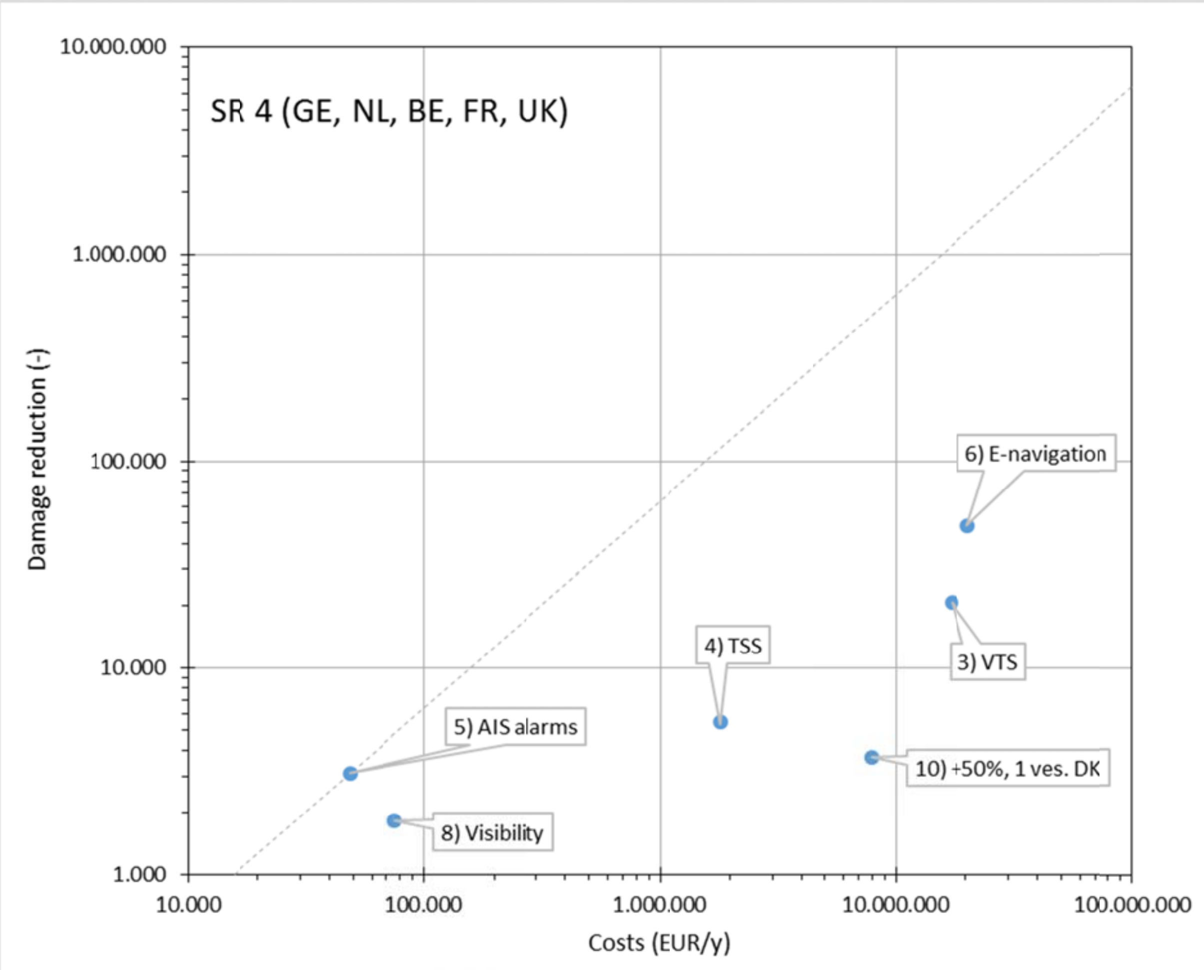

Figure 3-8: Plot of damage impact reduction against cost effectives for the scenarios applicable to region 4. Note double logarithmic axes. The broken line indicates positions of

equal and most optimal cost-efficiency ratio, the larger the distance to the line, the lower the benefit for each invested Euro.

Prioritised scenarios

The main benefit for sub-region 4 from extending the TSS, as outlined in scenario 4, would be the addition of an improved ship reporting system for ships sailing between the different counties and regions within the Bonn Agreement area. The VTS centres could improve the reporting of ships with dangerous cargo or ships that pose other threats, for example, via SafeSeaNet.

Further expansion of VTS requires action in IMO to give guidance to vessels outside the 12 mile zone. In addition, the VTS would have to identify deviations as its main task, e.g. ships drifting or not following the TSS for other reasons. Deviations are more easily identified when ships were sailing according to TSS compared to free sailing. Early identification of deviations reduces the RMO-time (time for response, mobilisation and operation) for tug assistance, if a ship is in a critical situation when sailing according to a TSS. TSS would also reduce the probability of head on collisions significantly. The total effect of TSS and VTS considered together was therefore higher than the two measures considered separately.

In sub-region 4, contingency response to acute oil pollution largely relies on the use of mechanical response. In the UK area, this is by dispersant use. The decision to use dispersants or not was based on a net environmental benefit analysis in every single case.

The project partners of sub-region 4 noted that the most effective scenarios based on cost effectiveness analysis (aimed at reducing damage impact) were:

- AIS alarms around wind farms – VTS would have a crucial role in the respective countries when it came to this measure.
- Night visibility capability on board response vessels.
- TSS – the complete TSS suggested in the entire Bonn Agreement area, ref. scenario 4.
- E-navigation (required further development before its effectiveness as a risk reducing measure for Sub-region 4 was clear).

3.4 Sub-region 5: UK and France

Effectiveness

The effectiveness of the scenarios for sub-region 5 is illustrated in Figure 3-9.

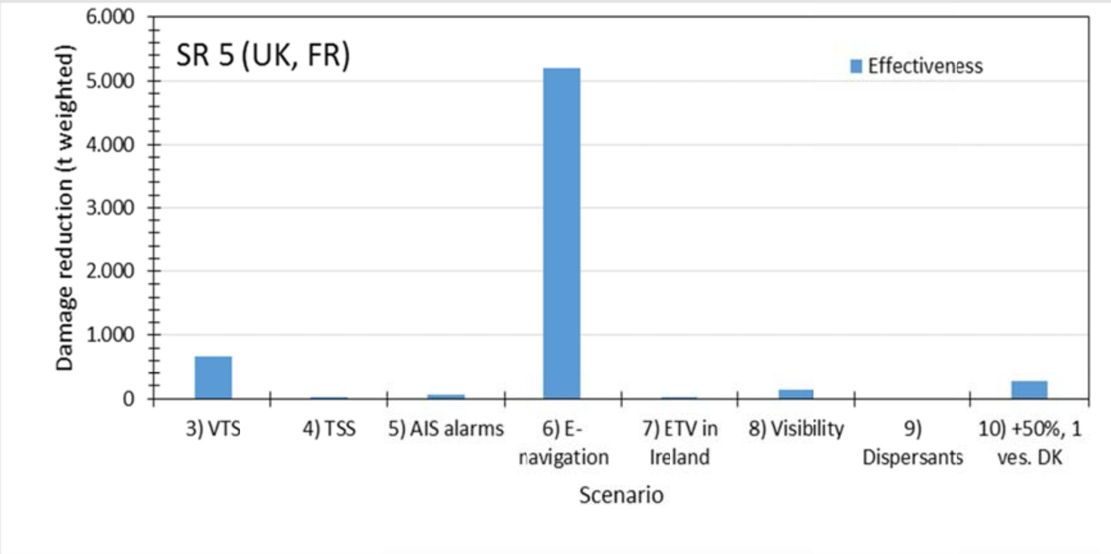

Figure 3-9 Sub-region 5: Effectiveness of reduction of environmental and socioeconomic damage for each scenario.

The introduction of E-Navigation and VTS would provide the largest benefit. Improved night detection capability and 50% increase in equipment would also reduce damage from oil spills in the region.

Cost-efficiency

In the following paragraphs, the costs for the scenarios are included in order to determine the cost-efficiency of the scenarios. Table 3-5 highlights that the most cost-effective scenarios, based on cost effectiveness analysis, aimed at reducing damage impact were AIS alarms around wind farms, improved night detection capability and 50% increase in response equipment.

Table 3-5: Sub-region 5: Ranking of the scenarios in region 5 based on the cost efficiency in terms of damage impact reduction. There were no TSS or new ETVs proposed for Region 5 so these scenarios have not been ranked. The three scenarios with lowest ranking on "damage" are colored.

Impact	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Oil on water	5	N/A	2	4	N/A	1	6	3
Oil in water	3	N/A	1	2	N/A	4	6	5
Oil on shore	4	N/A	2	6	N/A	3	1	5
Damage	4	N/A	1	5	N/A	2	6	3
Average	4,0	N/A	1,5	4,3	N/A	2,5	4,8	4,0

Prioritised scenarios

The partners in Sub-region 5 - France and the UK, broadly agreed with the ranking as outlined in Figure 3-10. The application of scenario 9 (dispersants only) provided negative damage reduction and was not included in the plot.

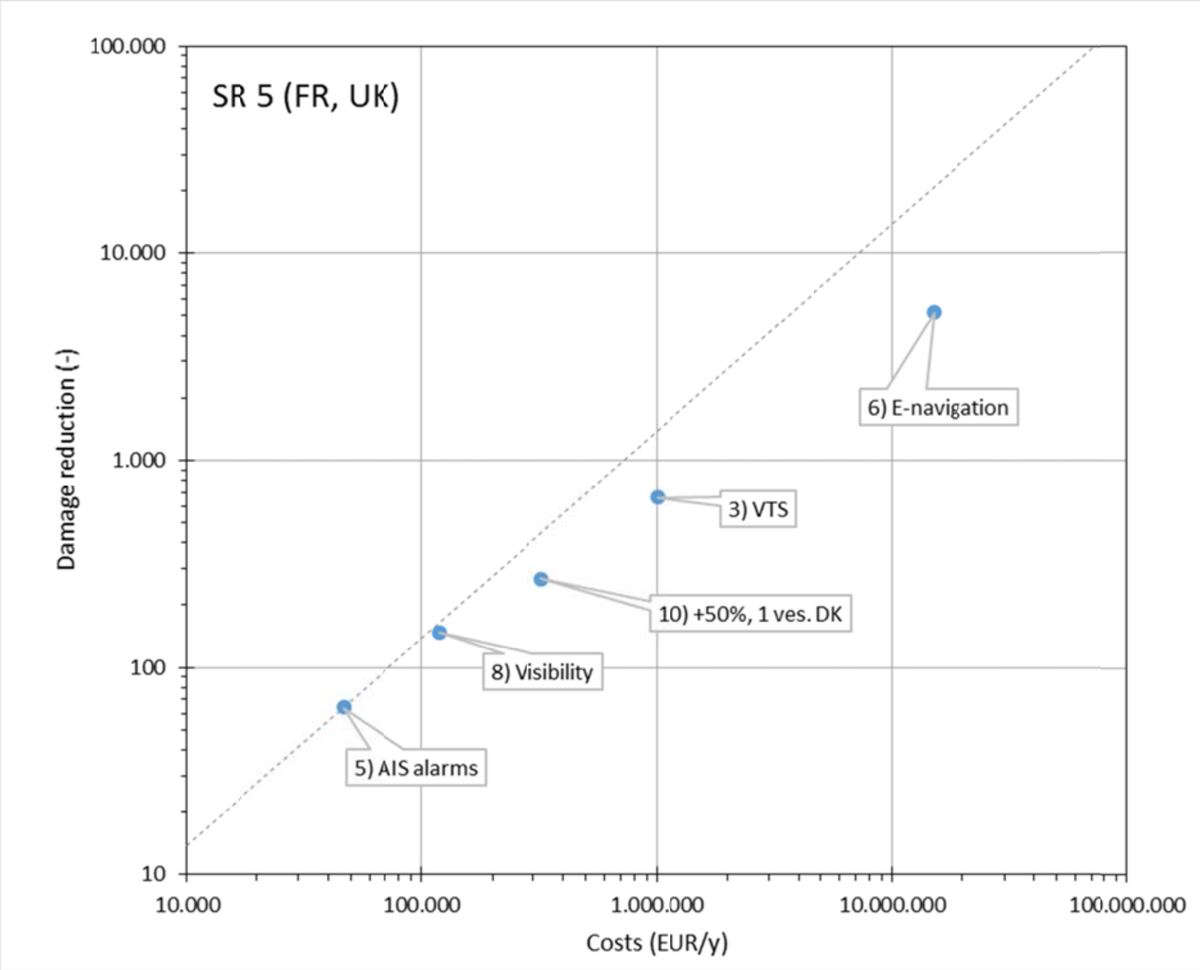

Figure 3-10 Plot of damage impact reduction against cost effectiveness for the scenarios applicable to region 5. Note double logarithmic axes. The broken line indicates positions of equal and most optimal cost-efficiency ratio, the larger the distance to the line, the lower the benefit for each invested Euro.

Scenario 10 (50% increase in counter pollution equipment) was ranked at third position, however the UK considered their current counter pollution stockpile to be more than adequate (given that it included both private resources, which were outside the scope of the project, and public sector equipment). France shared this opinion that the stockpiles of counter pollution equipment were appropriate to the threats. In addition, new multi-purpose response vessels would arrive in the Channel before 2020 to replace old vessels. Therefore, this scenario had not been prioritised for sub-region 5.

The UK and France also questioned the negative impact of dispersants in sub-region 5 and highlighted that if dispersants were likely to cause environmental damage then the regulatory authorities would not allow their use in the first place. Furthermore, the decision to use dispersants was based on a net environmental benefit analysis in every single case. Further clarification of the UK view on the dispersants only scenario could be found in the BE-AWARE Method Note (BE AWARE, 2015b).

Partners shared a common understanding, that e-navigation required further development before its effectiveness as a risk reducing measure for sub-region 5 was clear. As in Region 1, the project partners had noted that the current IMO initiative was as yet incomplete with no significant change anticipated over the next 4 years. Therefore, it was agreed to continue monitoring the further development of e-navigation.

In general, all scenarios in region 5 were placed within the same cost efficiency range, as outlined in Figure 3-10. Therefore, no scenario was particularly predominant for this region.

The partners in sub region 5 therefore prioritised the following scenarios:

1 AIS alarms/guard rings around wind farms, new wind farms were clearly new contributing risks to navigation.

2 Visibility – improved night detection night detection/visibility equipment e.g. oil radar or IR cameras. While the UK had no oil recovery vessels it was recognised that in the event of a major spill then at sea recovery would be a key response and the ability to recover 24/7 would enhance that response. Night detection could be of use for monitoring of dispersant application, French ETVs were fitted for spraying dispersants with a permanent storage of about 50 Tonnes on board each vessel. Night detection radar could be an enhancement in this field.

3 VTS.

4 E-navigation.

4. Risk management conclusions

4.1 Report findings and conclusions

Summarising the results of the different sub-regions, the scenarios that are prioritised based on their respective effectiveness, their cost-efficiency and the specific conditions valid in each sub-region are given in Table 4-1.

Table 4-1: Summary of the prioritised scenarios for each sub-region and for all sub-regions (the entire model area). The number in the table gives the priority rank, e.g. 1 means the most preferred.

	3) VTS	4) TSS	5) AIS alarms	6) E-navigation	7) ETV in Ireland	8) Visibility	9) Dispersants	10) +50%, 1 ves. DK
Sub-region 1		**2**	**1**					**3**
Sub-region 2		**1**	**3**			**4**	**5**	**2**
Sub-region 3	**2**	**1**	**3**					
Sub-region 4		**1**	**2**	**4**		**3**		
Sub-region 5	**3**		**1**	**4**		**2**		

The data in Table 4-1 indicates that in general, the three highest prioritised scenarios are TSS, and AIS alarms, with the two scenarios VTS and 50% more capacities sharing third priority.

However, some measures do affect several sub-regions, therefore it may be of interest to the adjacent countries to "join forces" on scenarios that will be of particular benefit when introduced in parallel in several sub-regions. Therefore, the cost-efficiency plots for all scenarios and for all sub-regions are given in Figure 4-1 below.

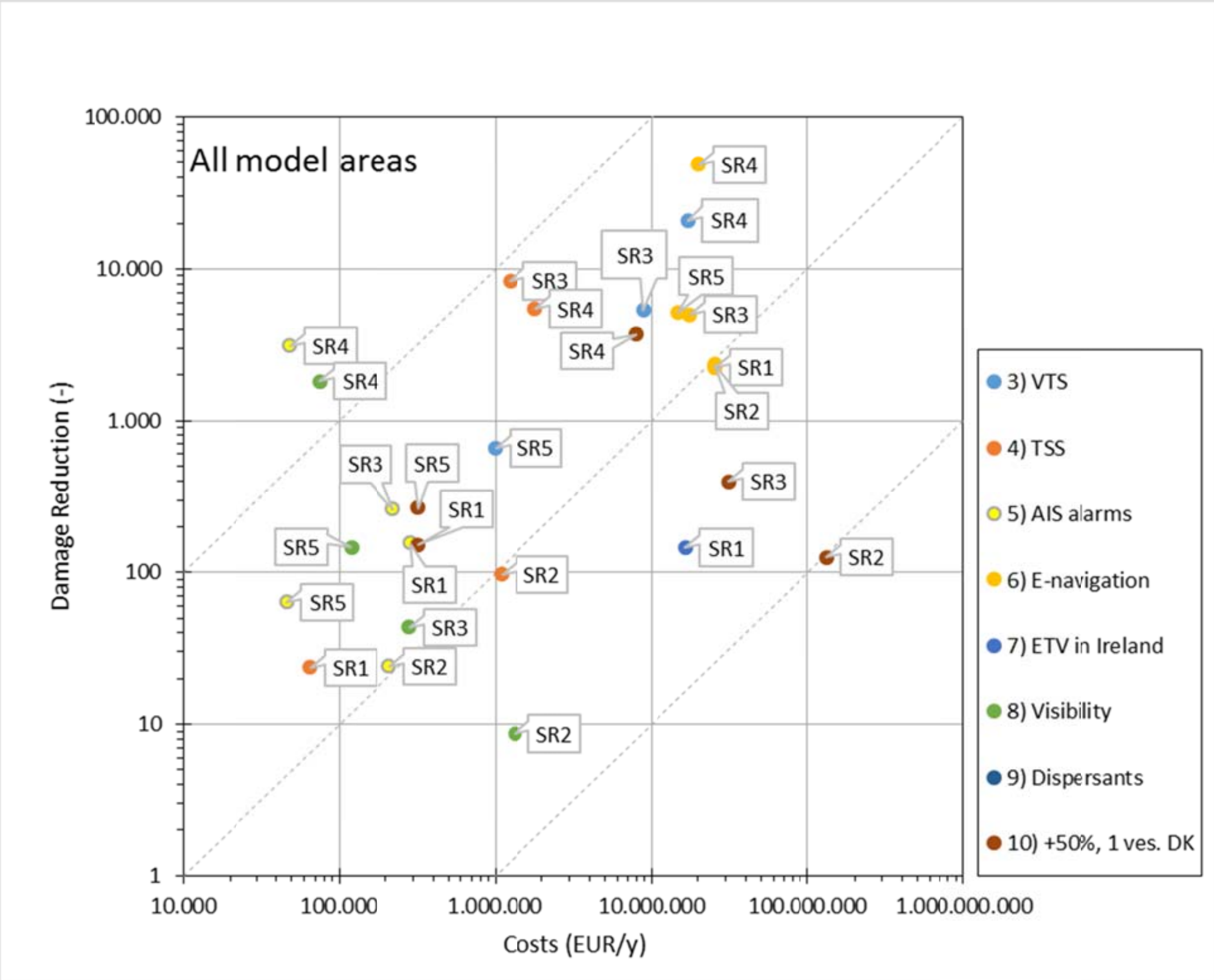

Figure 4-1: **Plot of damage impact reduction against cost-efficiency for all scenarios and all sub-regions. Note double logarithmic axes. Application of scenario 9 (dispersants only) provides negative damage reduction and is not included in the plot.**

Figure 4-1 provides the option to identify scenarios of similar high cost-efficiency in neighbouring sub-regions. Such scenarios are TSS (Scenario 7) and VTS (Scenario 4) between Skaw and the Channel, affecting sub-regions 2, 3 and 4. The cost-efficiencies for these two selected scenarios are given in Figure 4-2 below.

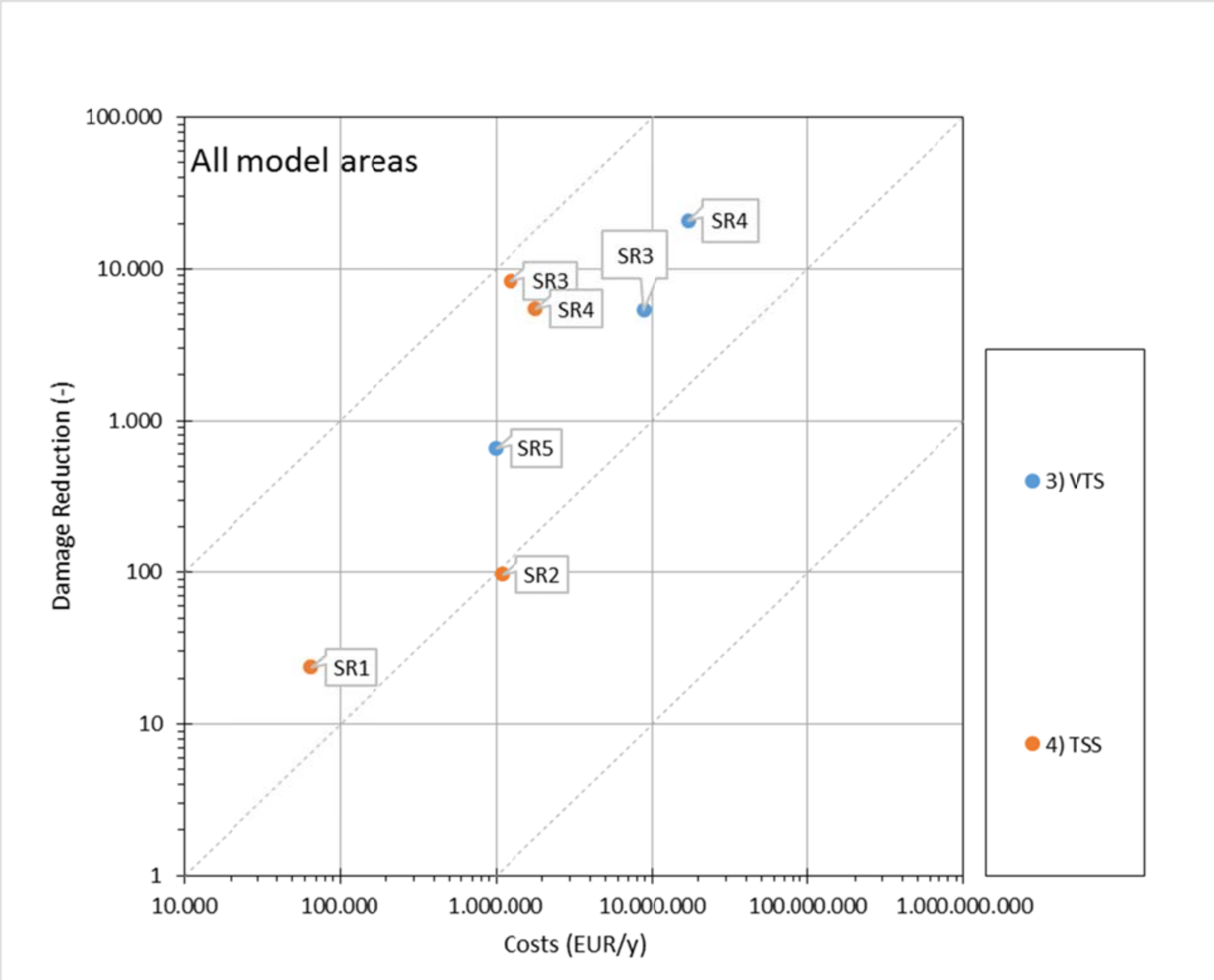

Figure 4-2 **Cost-efficiency plot for scenario 3) VTS and scenario 4) TSS. Scenarios for sub-regions 3 and 4 indicate a cluster of particularly high cost-efficiency.**

The scenarios for sub-regions 3 and 4 form a cluster with a particularly high cost-efficiency. The sub-regions 1, 2 and 5 do not show a similar high cost-efficiency. This indicates that a particularly high cost-efficiency could be achieved when regions 2, 3 and 4 co-operate on the joint establishment of TSS and VTS.

4.2 Future use of results from the report

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

- International level:
  The contracting parties organised through the Bonn Agreement Secretariat now have analytical arguments to jointly promote global risk reduction measures such as e.g. E-Navigation in the relevant fora.
- North Sea:
  Specific measures such as VTS and TSS from Skagerrak to the English Channel could be promoted with the competent national and international authorities in order to achieve a joint and synergistic benefit.
- Sub-regional level:
  For each sub-region, the Project Partners have selected the specific scenarios that were found to be most viable for their specific sub-region and that could be considered for the future development of national preparedness and sub-regional co-operation.

5. References

BE AWARE, 2015a. Summary Report. BE-AWARE II project.

BE AWARE, 2015b. Technical Sub Report 1: Methodology note. BE-AWARE II project.

BE AWARE, 2015c. Technical Sub Report 3: Impact assessment. BE-AWARE II project.

BE AWARE, 2015d. Technical Sub Report 2: Environmental and socioeconomic sensitivity and vulnerability mapping. BE-AWARE II project.

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