Chapter 2
Environmental Risk Management Applications of ERA Acute

Abstract ERA Acute supports a variety of analyses, from simple screening studies based on oil spill statistics and potential impact areas to more in-depth impact and recovery calculations on species and habitats. The ERA Acute software tool has been built to enable and provide ease of use of the methodology and results. Visualizations of impact and risk areas can be made at several levels, from simulations and scenarios to whole cases. Results can have a monthly resolution to show variations throughout the year. This enables a wide range of decision-support from risk screening studies, impact assessments, risk quantification, risk management including effect of mitigating measures (NEBA/SIMA) evaluations to properly inform oil spill response planning. The methodology is suitable for global use and will be the recommended approach for oil spill risk assessments for offshore operators on the NCS.

Keywords Environmental risk management · Net Environmental Benefit Analysis · Spill Impact Mitigation Analysis · Environmental risk assessment · Environmental risk screening

2.1 Introduction

Environmental risk management in activities representing a possibility for oil spills is directly linked to ERA, since the ERM process utilizes the results and insights produced by an ERA (Venesjärvi 2016).

Quantitative ERAs are used to support decision makers in complying with regulations, e.g. for activity applications, planning processes and as input to oil spill response planning. This chapter provides an overview of risk management application areas with the newly developed ERA Acute methodology for acute oil spills (Libre et al. 2018; Stephansen et al. 2017a, b). Various endpoints and high degree of flexibility ensure many usage areas for ERA Acute. Environmental risk screenings may provide sufficient decision support in early stages of project development or concept selection and can be a viable endpoint in areas with restricted access to input data, whereas the most detailed assessment and results are found to be beneficial in several environmental risk management uses, e.g. ERA, impact assessment,

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NEBA/SIMA or as input to company-specific risk matrix rankings. In many areas the VEC data may be limited or less detailed, in which case ERA Acute provides a possibility to carry out more conservative calculations.

Impact and risk illustrations used herein are for illustration only and are made with the ERA Acute software.

2.2 ERA Acute Usage Areas

ERA Acute is an enhanced and globally applicable quantitative oil spill risk assessment methodology (meeting the guidelines set by IPIECA-IOGP 2013) and software tool, and is applicable for various risk assessment purposes, depending on user's need and data availability:

1. Risk screening
2. Input to concept selection/risk comparison
3. Environmental impact assessments
4. Site-specific decision making
5. Risk estimation and evaluation/risk ranking

Evaluation and prioritization or risk reducing measures; e.g. ERA Acute can provide quantitative input to NEBA/SIMA in order to inform oil spill response planning (IPIECA-API-IOGP 2017). Questions that can be answered using ERA Acute are:

- What is the possible impacted area of a spill scenario?
- What are the possible consequences to species and habitats in the various environmental compartments?
- Could there be a risk for adverse environmental effects?
- What is the probability for different consequences, i.e. what is the risk?
- Where will the highest impact be?
- In which areas to we need to prioritize oil spill response?
- How much do different mitigating measures reduce the impact or risk?

2.3 Environmental Risk Screening

The screening is the first phase in an ecological risk assessment, i.e. to decide on the distribution of stressors in the environment and the extent of contact where exposure could occur (US EPA 1998). ERA Acute is based on oil spill modelling of specific oil spill scenarios which make up a DSHA (see Sect. 1.5). Oil spill modelling enables researchers and others to estimate potential impact and utilize the results in ERAs, including cost-benefit and decision analyses (French McCay et al. 2004). This leads to informed decisions in strategic planning and/or operational management (Jakeman et al. 2006).

The output from stochastic oil drift modelling provides a statistical overview of oil spill trajectories and to what extent certain areas could be exposed to harmful oil. Without saying anything about the presence of sensitive resources or habitats, and just by analyzing the results from a high number of different oil spill trajectories, the screening process can highlight areas and periods of environmental concern in different environmental compartments. This is denoted level A.1 (see Sect. 1.3.3.1).

The ERA Acute software tool can visualize important features from the oil spill modelling such as probabilities of oiling above an effect threshold value (i.e. surface oil film thickness or water column concentration), and statistical parameters such as minimum, mean and maximum values of oil volumes and concentrations in geographic areas. All oil spill parameters can be visualized in a map in an ERA Acute screening assessment. The risk screening can as such define the boundaries for further detailed impact and risk assessments, provide insight into the needs for further data gathering or inform concept selection in an early stage without extensive assessment approaches.

Assuming that certain species with specific oil spill sensitivities are present within the spilled area (Level A.1), the ERA Acute screening can also estimate the expected mortality of such a species in this area (Fig. 2.1, left). By adding information on the spatial-temporal distribution of the VEC in an area in the form of a data set of presence/non-presence, the first screening of probable impacts and impact areas can be further refined and examined (level A.2). The area of average potential mortality may for example be narrowed down to a particular seabird species/population in the breeding season within the breeding area (Fig. 2.1, right) (see Sect. 1.3.3.1).

In addition to the statistical results, visualization of single simulations is a possibility within the ERA Acute software tool. This is applicable for illustrating e.g. a

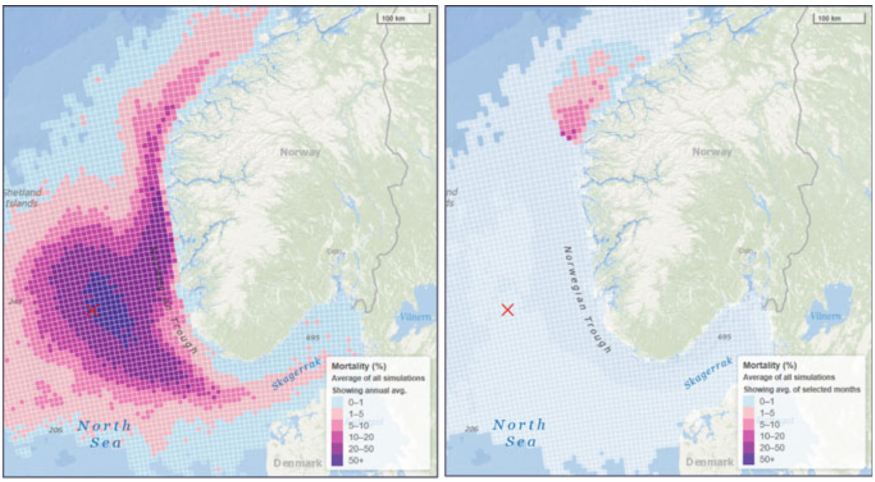

Fig. 2.1 Probable seabird impact (% mortality) in 10 × 10 km grid cells from stochastic oil spill simulations (left) and restricted to the breeding area of northern gannet in the breeding period (right)

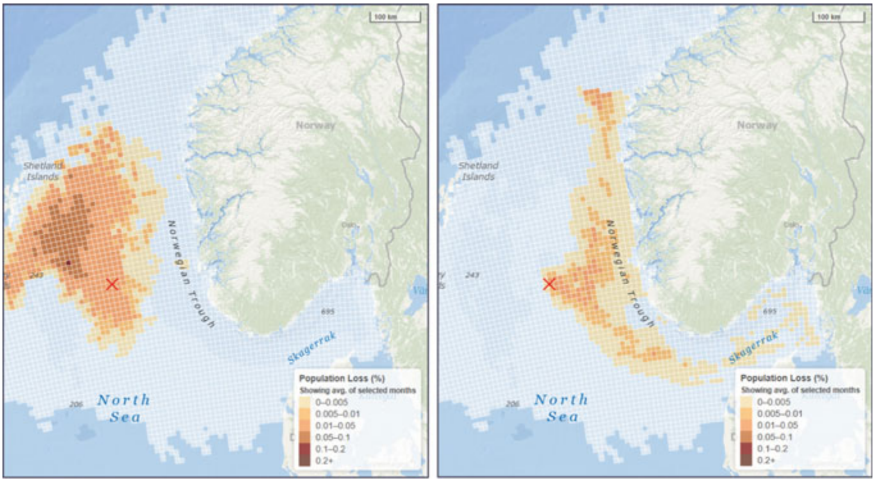

Fig. 2.2 Example of calculated mortality for a seabird from the simulation with the maximum (left) and minimum (right) impact potential on the sea surface from stochastic oil spill modelling in a North Sea scenario

percentile worst-case simulation in terms of shoreline volumes or drift time to shore, or a selected simulation with impact in certain areas of interest (Fig. 2.2).

2.4 Damage and Risk Assessment

A complete damage assessment in ERA Acute is based on quantification of impact (e.g. population/habitat loss) and the duration of the impact until recovery (pre-spill conditions). The Resource Damage Factor (RDF) is calculated as the integral of the extent of impact and duration of impact until recovery. For damage assessments, the probability for different outcomes is calculated and can inform on the likely damage which is typically the case for environmental impact assessments.

The level of available or applicable temporal resolution of VEC data sets the frames for output resolution. For VEC data available as monthly distributions (e.g. seabirds, marine mammals), the impact and risk calculations can present impact levels and species at risk on a monthly basis. The example in Fig. 2.3 shows the monthly average population loss from a blowout scenario on 5 different seabird species. The results show high impact on northern gannet in the winter period from November to March and for northern fulmar in the autumn from August to October. Results as presented, will be of high value for risk management, e.g. if these were results from an analysis for an exploration drilling activity, they show that for these populations of seabirds, the potential impact is relatively low in the summer months. These results could be used further in an “ALARP assessment”, where e.g. the drilling period could be one element to assess.

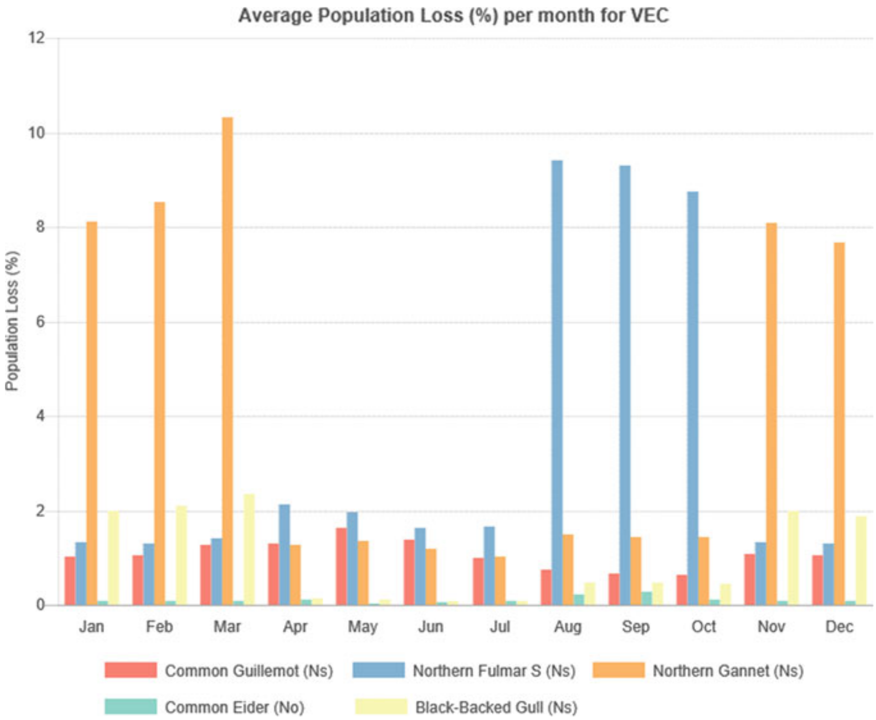

Fig. 2.3 Example on calculated monthly average population loss for 5 seabird species from a blowout spill scenario

As there is huge variation in spill trajectory and fate of the oil due to variations in wind and currents, as well as in the distribution of VECs, the different outcomes from each spill simulation can be categorized according to severity and then presented as probabilities for different impact/damage categories (Table 2.1). Such approaches are viewed beneficially for oil spill risk assessments where the extent of oil-induced damage may vary greatly (Hilborn 1996; Lecklin et al. 2011). The consequence probabilities can be presented as frequencies if multiplied with spill scenario frequency in line with ISO 17776:2016.

Table 2.1 Probability for different impact (population loss) categories for Atlantic puffin in the breeding season (May to August) based on stochastic oil drift simulations for a given spill scenario. Examples of categorization. The number of categories can vary

Population loss (%)	Category	Probability (%)	Frequency
<5	Minor	77.78	8.17E−5
5.0–10.0	Moderate	8.33	8.75E−6
10.0–20.0	Serious	4.41	4.63E−6
>20.0	Very serious	9.48	9.95E−6

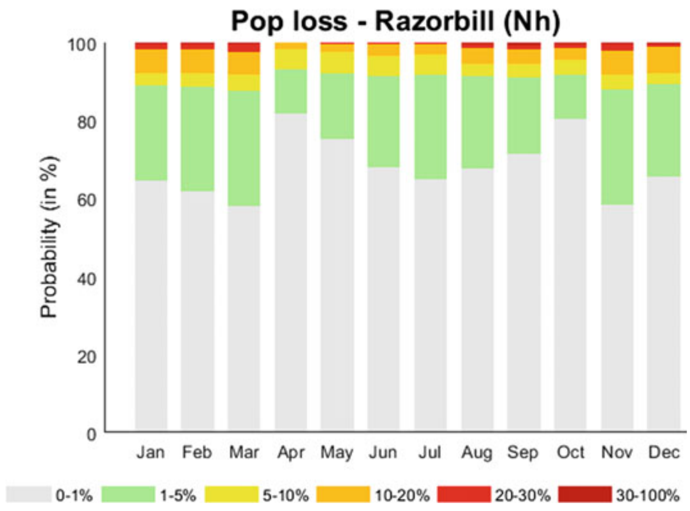

Fig. 2.4 Calculated monthly probabilities for various population losses (%) for razorbill for a spill scenario (with hundreds of spill simulations in each month)

Several endpoints can be used to categorize or classify the environmental damage in various seasons or months. This includes population loss on a species level for sea surface and water column species, impacted shoreline (in km) or seafloor (in km^2), recovery time (in years) or RDF (in population loss years or habitat impact years), see example in Fig. 2.4. Endpoints can be used separately or in combinations to categorize a damage, e.g. to calculate the combined probability for a shoreline impact above 50 km with habitat recovery time above 10 years.

In stochastic oil spill trajectory modelling, several oil spill scenarios can contribute to the overall risk for the planned activity. To identify the scenario(s) that contribute most to risk, ERA Acute can be used to compare the various impact and risk endpoints for each spill scenario separately in addition to a DSHA summary. This is illustrated in Fig. 2.5 where the calculated probability for different population losses for a seabird species is presented and compared for each spill scenario (each combination of spill rate and duration) in a topside blowout, this in order to inform about which scenarios that could have a substantial or possibly irreversible effect on the population. In the given example (Fig. 2.6), only blowouts with 60-days duration will have the possibility for population losses exceeding 30%, while the 2-day duration blowout scenario most probably would have a population loss below 1% even for a spill rate as high as 9000 m^3/d.

The example in Fig. 2.5 shows an outline of the drill down possibilities in the ERA Acute results. The impact from specific oil spill simulations (specific start dates) can also be selected and visualized in order to investigate specific situations and to further inform oil spill response planning and operations. Figure 2.6 (left) gives an example of the calculated impact (population loss) for northern gannet in the breeding season from a blowout spill scenario with a ranking of simulation results from highest to

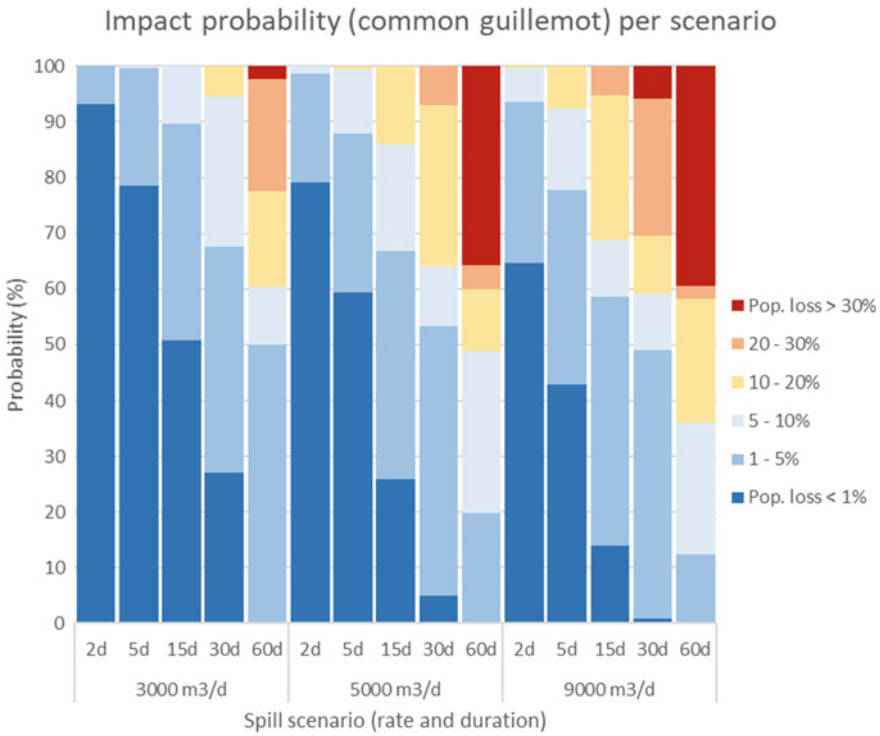

Fig. 2.5 Probability for various population losses for Common guillemot calculated for 15 different topside blowout scenarios (combinations of spill rate and duration)

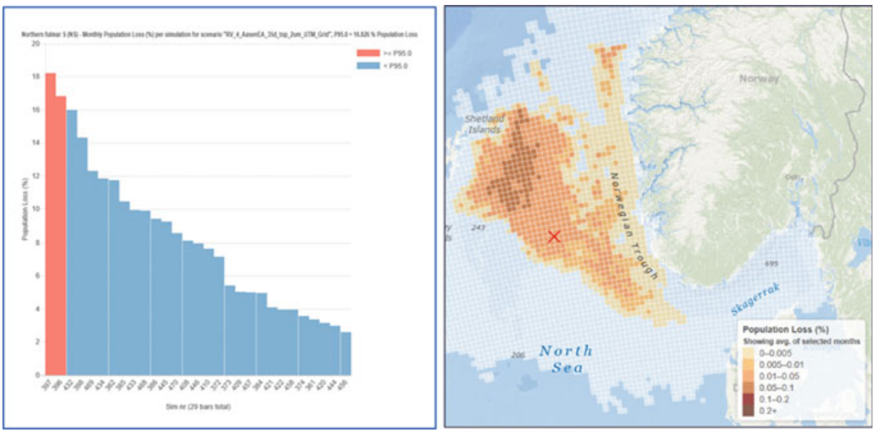

Fig. 2.6 Ranking of calculated population loss of northern gannet from highest impacting simulations (left figure). Shift between red and blue in the left figure indicates the 95-percentile level and the impact from this simulation is illustrated with calculated population loss per 10 × 10 km grid cell (right figure)

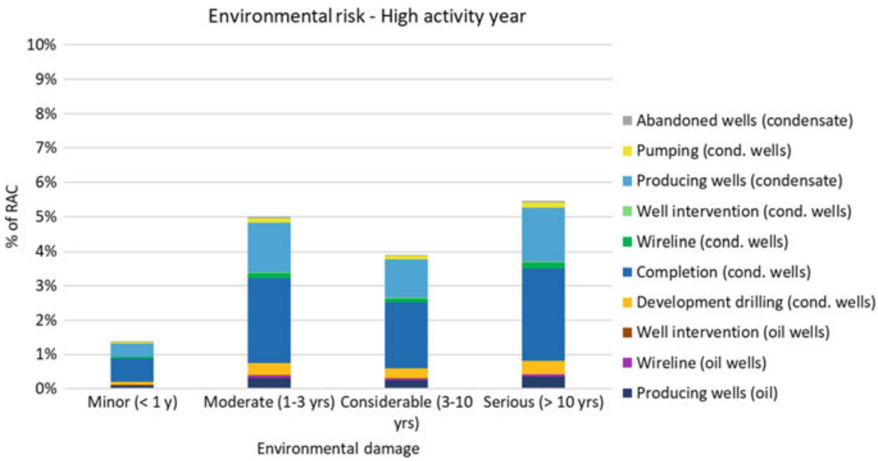

Fig. 2.7 Environmental risk overview for various activities from a producing oil field in a high activity year with several well operations and development drillings. Here, an example measured against the operator's own Risk Tolerance Criteria (RTC) and categorization

lowest impact (left to right), and a map showing the impact in grid cells from the 95-percentile worst-case simulation (Fig. 2.6, right).

An oil-producing installation case can have several DSHAs (i.e. a blowout, a process leakage, a pipeline spill etc.) and each DSHA can consist of several spill scenarios (i.e. a blowout can have different spill rates and durations with different probabilities). Therefore, the risk results can be aggregated on the DSHA and case level, with possibilities to look at specific contributions and details from the underlying spill scenarios (Fig. 2.7). This will give valuable information towards the understanding of risk-contributing activities and towards the planning of field activities.

Once the risk has been established, the primary objective is to evaluate the risk level and to communicate activity or scenario risk to stakeholders and decision-makers in a logical and understandable way. ERAs are carried out with the purpose to assess and ensure acceptable environmental risk for oil and gas offshore operations. To ensure this, the risk level can be evaluated against risk tolerance criteria (RTC), and/or properly informed decisions (e.g. using the ALARP principle) can be made regarding the implementation of risk reducing measures to achieve a tolerable risk level (IPIECA-IOGP 2013).

ERA Acute provides the necessary input to a traditional risk matrix by giving the probabilities for different operator-defined damage categories (Fig. 2.8). In the risk matrix, risk tolerance criteria define the threshold for a tolerable likelihood of an environmental damage (EPA 2007; NORSOK Z-013 2001). Alternatively, risk can be presented as a percentage of a certain RTC for different species or habitats, where values above 100% represent risk level exceeding the RTC (NOROG 2007).

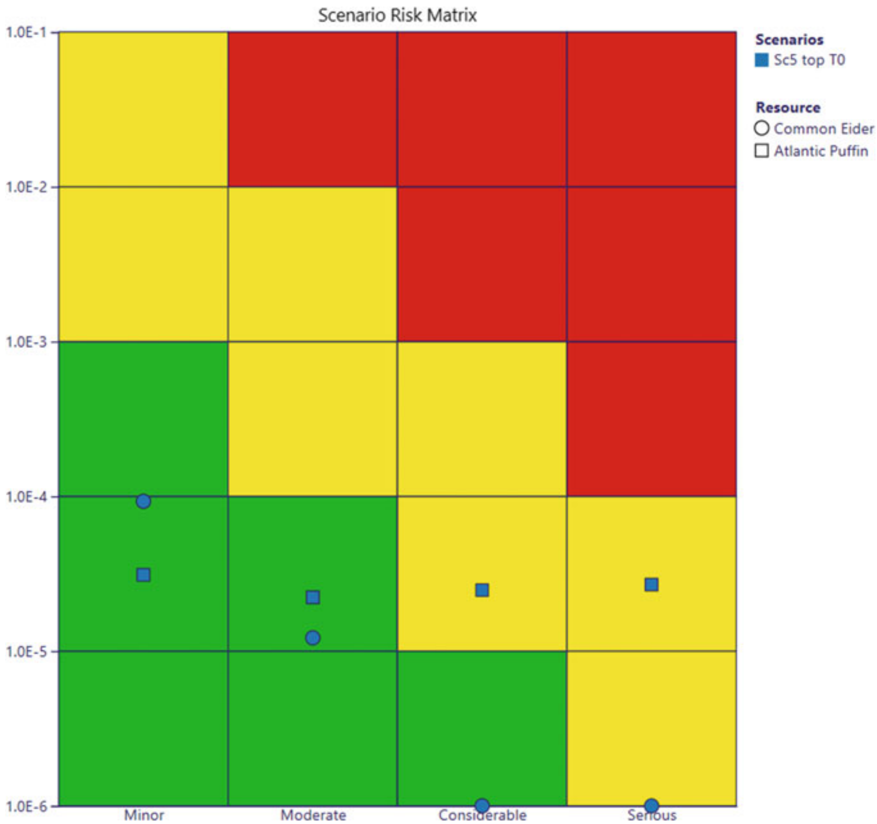

Fig. 2.8 Example of risk results for two seabird species from a spill scenario plotted in a risk matrix where the size of damage (x-axis) is categorized from RDF values and spill frequency (y-axis). Risk tolerance criteria has been set to the different damage categories and frequencies (red = intolerable risk; yellow = ALARP level; green = acceptable risk)

2.5 Risk Mitigation and Net Environmental Benefit Assessments

Identification of possible risk reducing measures is typically performed as a part of the risk assessment process (Wenning et al. 2018; Bock et al. 2018). The quantitative ERA Acute approach is suited for evaluating and visualizing probability and consequence reducing measures to reduce risk, e.g. recalculation of risk when a risk reducing measure changes the spill scenarios. The probability of a scenario can be reduced, or the oil spill response may change the actual spill scenario's fate and trajectory. As such, the method can be used for quantitative input to NEBA/SIMA (IPIECA-API-IOGP 2017). Revised oil spill scenarios or probability distributions can be entered in the model and the re-calculated environmental risk levels can be easily compared to the original output, to evaluate the effect of the mitigating measures (see example

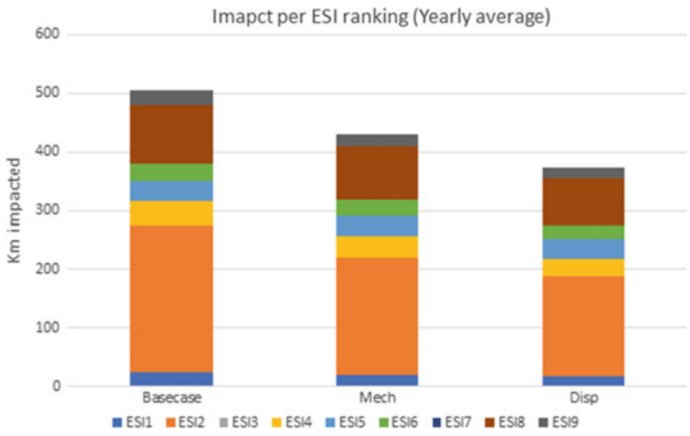

Fig. 2.9 Comparison of shoreline impact (km) from a blowout scenario with and without spill response options. Basecase = no response; Mech = surface mechanical response; Disp = surface chemical dispersion

in Fig. 2.9). The foundation principle that ERA Acute uses continuous impact and damage algorithms, means it is well-suited to reflect even minor changes in spill scenarios or resources distribution as a change in impact and risk.

In the ERA Acute software tool, a separate comparison module enables the user to compare oil spill trajectory, impact and risk data from different scenarios or calculations in a straightforward manner. This can be performed as compartment or resource impact and risk summaries but also plotted as impact maps. This is important in balancing the trade-offs by weighing and comparing the range of benefits and drawbacks associated with each response option (IPIECA-API-IOGP 2017).

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