EcoSensitivity tool

User manual

Version 2.3

05.09.2026

Executive Summary

The EcoSensitivity tool is an advanced web-based decision support system designed to assess the environmental impacts of oil spills. The tool combines real-time data, advanced modeling algorithms, and simulation capabilities to predict oil spill dynamics, assess environmental impacts, and guide response actions, enhancing decision-making effectiveness.

Upon an actual grounding or ship collision, the tool utilizes the Accidental Damage and Spill Assessment Model (ADSAM) model to predict the volume of spills, leaks, or other unplanned releases of hazardous materials into the environment, considering the specific details of the accident and the ship involved. ADSAM supplies input for Seatrack Web simulations, which track oil spill scenarios using real-time, weather-driven 3D models. The simulation results are overlaid with data on sensitive ecosystems and shorelines, enabling the quantification and visualization of environmental risks. The PlanWise4Blue (PW4B) module enables cumulative impact assessments to be conducted either for the oil spill scenario solely or in combination with other environmental pressures, providing a holistic assessment to support more sustainable planning for oil risk mitigation and management. The EcoSensitivity tool enables highly detailed spatial predictions and assessments of oil spill progression in the marine environment, along with anticipated environmental impacts based on the best available knowledge. This integration, previously missing, is essential for more effective oil spill management and marine ecosystem protection.

The tool also sets a modelled spill against the ship traffic of the Baltic Sea. Traffic densities computed from AIS data by AISyRisk – the model in operational use by the Norwegian Coastal Administration and adapted to the Baltic Sea within the same OpenRisk II project – are held on a 10 km grid, one value per calendar month, so that the time vessels spend in the area a spill reaches is reported alongside the ecological consequences.

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1 Introduction to Blue Bio Sites portal and PlanWise4Blue tool

Blue Bio Sites portal is a web-based decision support platform designed to bridge the gap between science and decision-making in marine areas. Blue Bio Sites can be accessed at https://gis.sea.ee/bluebiosites/ (Figure 1). The portal was developed through close collaboration with managers, decision makers and stakeholders, combining different tools tailored to address various ecological and economic aspects relevant to spatial planning and sustainable marine development in the Baltic Sea region. It hosts the PlanWise4Blue (PW4B) tool, designed for data-driven analyses of cumulative environmental impact assessments.

The PW4B tool integrates the latest maps of nature assets and human pressures with science-based insights on how different human activities — and their resulting pressures — impact these assets, both individually and cumulatively. Using advanced algorithms, PW4B conducts detailed cumulative impact assessments, capturing the complex interactions between ecosystems and human activities. This complexity operates behind the scenes, allowing users to benefit from a user-friendly interface that makes sophisticated methods accessible regardless of technical expertise. PW4B translates complex model outputs into easy-to-understand formats, such as surface area or biomass changes in valuable natural assets, enabling diverse stakeholders to incorporate scientific insights into policy and decision-making processes effectively.

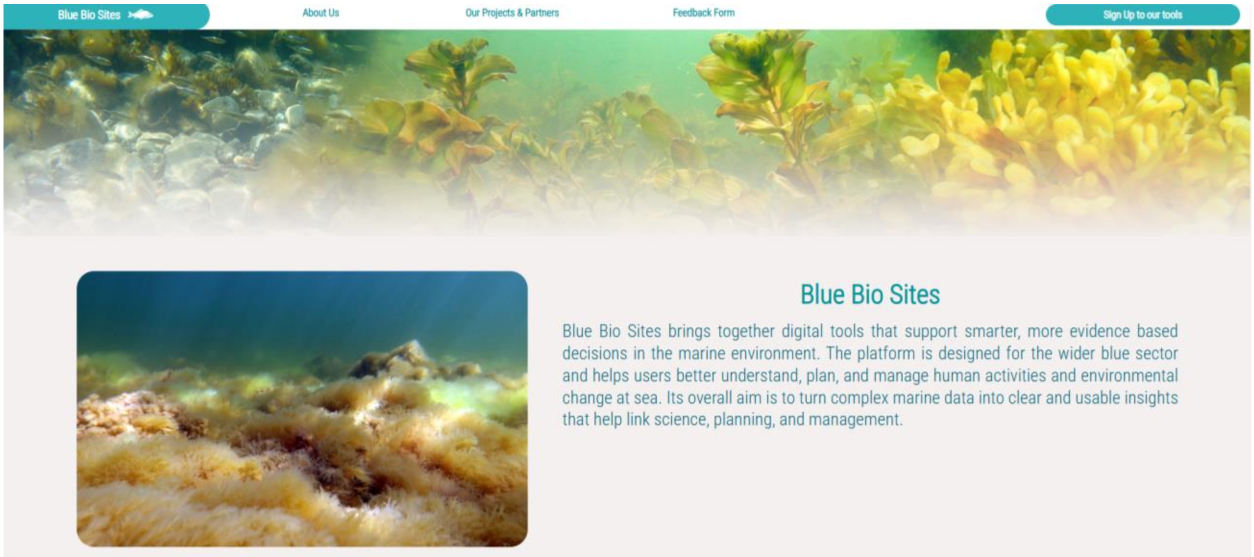


Figure 1. Front page view of the web-based decision support platform, Blue Bio Sites.

Modelled maps of nature assets. The PW4B tool provides the most up-to-date maps of various nature assets at a spatial resolution of 1 km^2. These modeled nature assets are based on the best available environmental data, both abiotic and biotic, sourced from national and regional monitoring and mapping programs conducted by research institutions, governmental, and international agencies. Additional data comes from European data infrastructure platforms (e.g., Copernicus) and scientific publications. This environmental information was integrated and analyzed using advanced machine learning algorithms (e.g., Boosted Regression Trees, Random Forests, Generalized Additive Models) to produce spatial predictions for specific nature values across areas of interest (for detailed modeling approaches, see Aps et al., 2018, and Torn et al., 2020). These nature asset maps are available under the “layers” tab in the PW4B tool.

Scenarios. Scenarios in the PW4B tool represent the spatial distribution of various human activities within a selected area of interest. These scenarios are used in cumulative impact assessments to quantify the effects of pressures from these activities on the natural assets in the region.

Assessing the cumulative effects of human activities on marine ecosystems. The cumulative effect assessment algorithm quantitatively evaluates both the individual and interactive impacts of human activities on nature assets. Unlike traditional expert-based assessments, the PW4B algorithm uses the best available scientific evidence, incorporating cause-effect relationships derived from scientific literature and relevant databases through systematic reviews and a meta-analytic approach. This enables a statistically robust assessment of cumulative human effects (Kotta et al., 2020; Vaher et al., 2022). The tool now includes oil spill footprints as a previously missing factor in assessing human pressures on nature assets, supported by co-funding from the Interreg Baltic Sea Region OpenRisk II project.

2 EcoSensitivity tool

The EcoSensitivity tool is a comprehensive suite of applications, tools, and models designed for streamlined information exchange during operational risk assessments of oil spills. Its primary goal is to enhance our ability to predict, analyze, and mitigate the environmental impacts of maritime oil-related accidents. Figure 2 illustrates the key components in the EcoSensitivity tool pipeline, with brief descriptions provided in the following subsections of the manual.

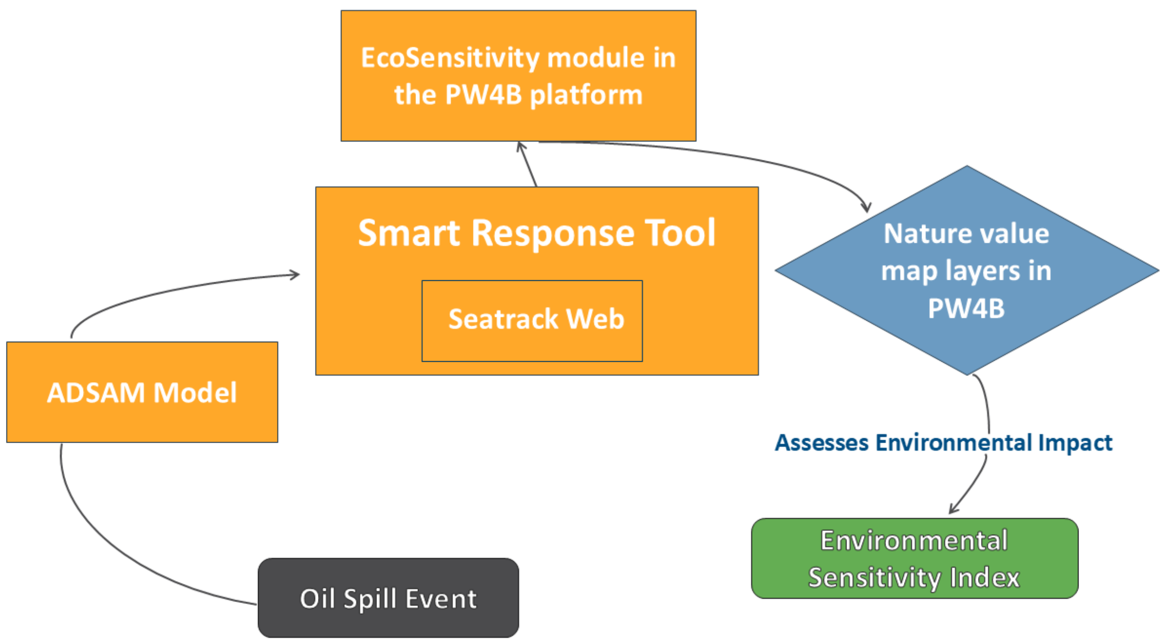


Figure 2. Data flow and analyses in the EcoSensitivity tool.

2.1 Accidental Damage and Spill Assessment Model (ADSAM)

The ADSAM model forecasts the quantity of accidental spills, leaks, or other unplanned hazardous material releases due to ship grounding and collisions (Tabri et al., 2018). This model aids in assessing incident severity, planning emergency responses, and mitigating potential environmental and public safety impacts.

Model application begins by defining the ship and the specific accident scenario. ADSAM is designed to function even with limited data, allowing simulations based solely on the ship's length (L) if that is the only available parameter. In such cases, the scenario is characterized by factors including ship size (a), penetration depth (δ), the initial point of contact between ship and ground (for grounding incidents), and the season of occurrence. Additional optional parameters can be specified, such as structural resistance, double-hull dimensions, loading conditions, cargo properties, tank arrangement, and ice conditions for winter simulations.

ADSAM also uses tanker data, including size and configuration details from AIS, to estimate the volume, timing, and duration of oil leakage based on rupture dimensions and load. This data is integrated with impact conditions like vessel speed and bottom profile to enhance the predictive accuracy of spill impact (Tabri et al., 2018).

The model also requires details about the type of oil spilled (e.g., light crude, heavy fuel oil) as different oils exhibit distinct environmental behaviors. Users can enter this information manually or select from a comprehensive database of real vessels. A similar option is available for ice conditions, where default values can be applied. Selecting a specific ship provides all necessary information for the next step in operational decision-making during oil spills caused by collisions. This data is then transmitted to the oil spill propagation model and environmental impact models, such as Seatrack Web (SMHI, 2012) and PlanWise4Blue (Kotta et al., 2020). These tools facilitate the evaluation of spill spread over time under real weather conditions and assess the environmental consequences of the spilled oil.

2.2 Seatrack Web

Seatrack Web (STW) is an advanced, fully operational web-based tool developed and maintained by the Swedish Meteorological and Hydrological Institute (SMHI) to track and predict the movement of oil spills and other pollutants in the Baltic Sea and parts of the North Sea. Using real-time weather data (Ambjörn et al., 2011), STW supports maritime safety and environmental protection efforts by assisting authorities and organizations in responding to maritime incidents. Developed in collaboration with SMHI and partner institutions in Denmark (FCOO), Germany (BSH), and Finland (FMI), the tool aids in formulating effective response strategies by supporting the planning of potential response actions (Fetissov et al., 2021).

STW uses sophisticated oceanographic and meteorological models, incorporating data on currents, wind, and other environmental factors to predict the drift and dispersion of substances in the water. For oil spill incidents, it characterizes the spill by type, estimated volume, and surrounding conditions, such as temperature, wind, and currents. The model simulates both the immediate impact of spills and long-term trajectories, allowing decision-makers to respond effectively. Additionally, STW offers backward simulation capabilities to help identify the original source of detected oil spills.

Widely used across the Baltic Sea region, STW provides critical support for emergency response, environmental monitoring, and planning, offering an accessible interface for users to input data, run simulations, and visualize results through detailed maps and reports. Furthermore, STW serves as the official drift prediction and historical analysis model for HELCOM, commonly used by national authorities and research organizations to simulate oil spill scenarios (HELCOM, 2020).

For the EcoSensitivity tool, oil weathering and transport data are derived from STW's Particle Dispersion Model (PADM), which uses a weather-driven 3D simulation (Ambjörn et al., 2011) and incorporates recent advancements in ice modeling (Arneborg et al., 2017; Lu et al., 2019). PADM, accessible through a web-based interface within EcoSensitivity, enables generated oil spill data to be further analyzed and integrated into the PlanWise4Blue tool for a comprehensive environmental impact assessment.

2.3 PW4B tool

PW4B evaluates the cumulative environmental impacts of various human activities on nature assets, allowing oil spill footprints to be included as a potential human pressure by integrating spill scenarios from the STW environment. When multiple scenarios are available, users can compare the impacts of different oil spill scenarios on nature assets, either as separate effects or combined with other human pressures in the region.

2.4 AISyRisk ship traffic

AISyRisk uses AIS data provided by the Norwegian Coastal Administration (Kystverket) to quantify shipping-related risk. It maps vessel traffic, accident probability, expected fatalities and spill risk on a monthly spatial grid, and is openly available for Norwegian waters at https://aisyrisk.no/.

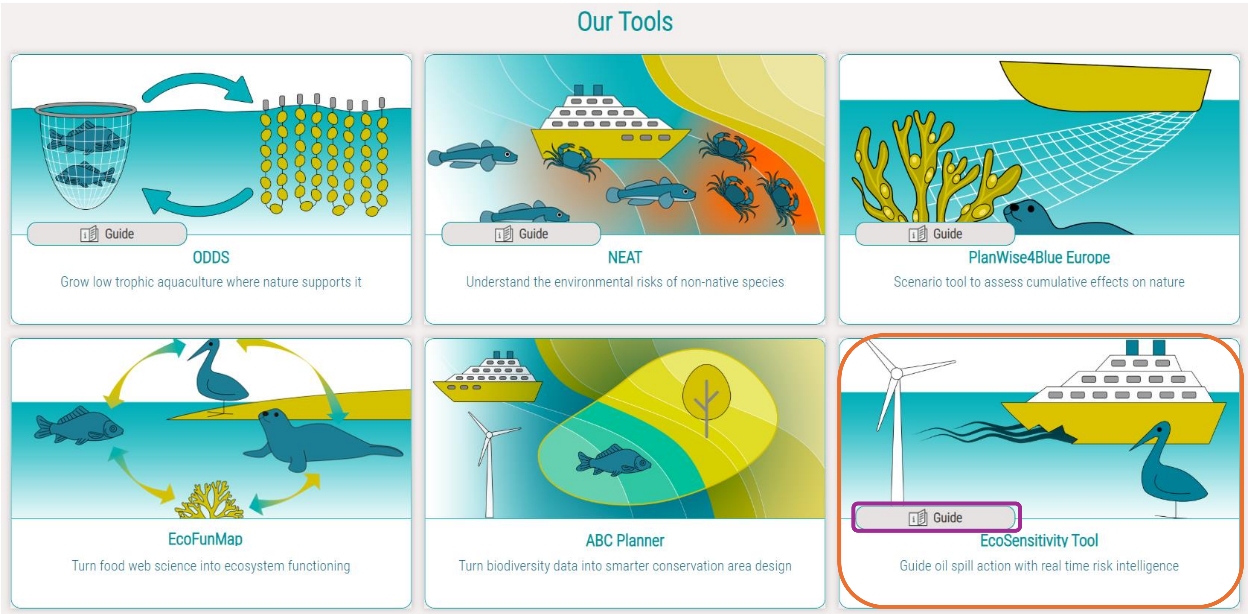
AISyRisk has been integrated with the regional service for assessing Baltic Sea ecosystem sensitivity to spills, which is what the EcoSensitivity tool provides. Together the tools link spatially explicit shipping and spill risk with ecosystem sensitivity, enabling a more integrated environmental risk assessment.

The Baltic result used here is the AISyRisk Baltic layer, which maps monthly vessel traffic as hours per 10 km grid cell across the whole Baltic Sea. In the EcoSensitivity tool it is a map layer with a time slider for choosing the month, and the same figures are intersected with a modelled oil spill footprint, so that the ship traffic under the spill is reported together with the biological sensitivity and the shore classes it affects (see 3.2.4).

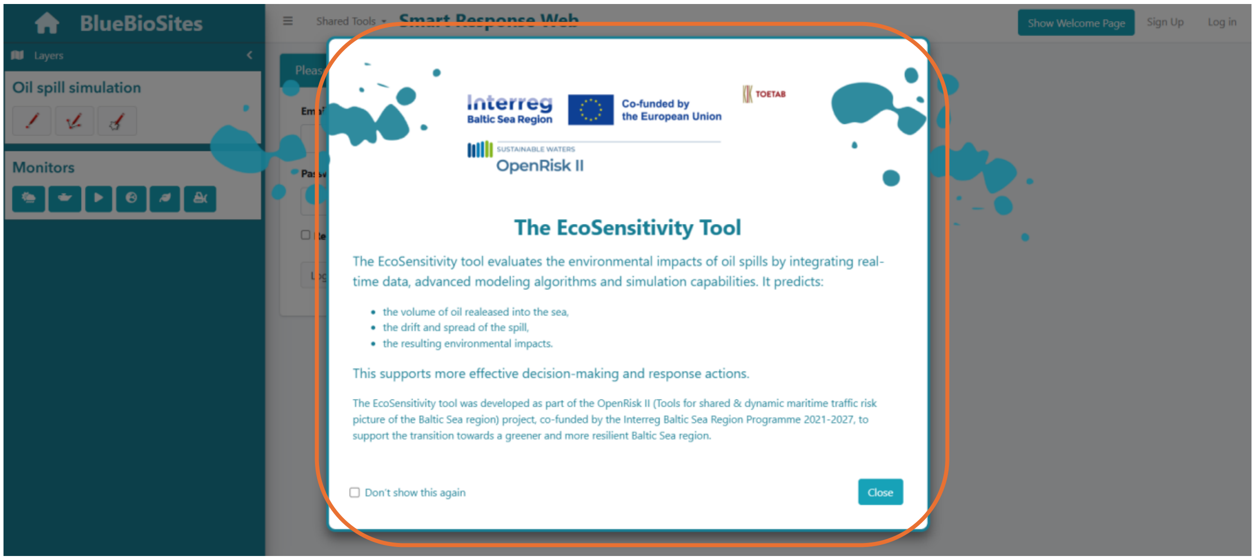
3 Step-by-step guidelines for using EcoSensitivity tool

1. User manual can be found under “Guide”.

2. Click on the box of the “EcoSensitivity tool”.



3. When EcoSensitivity tool is first opened, you can see a “welcome page”, where a short description of the tool is provided.

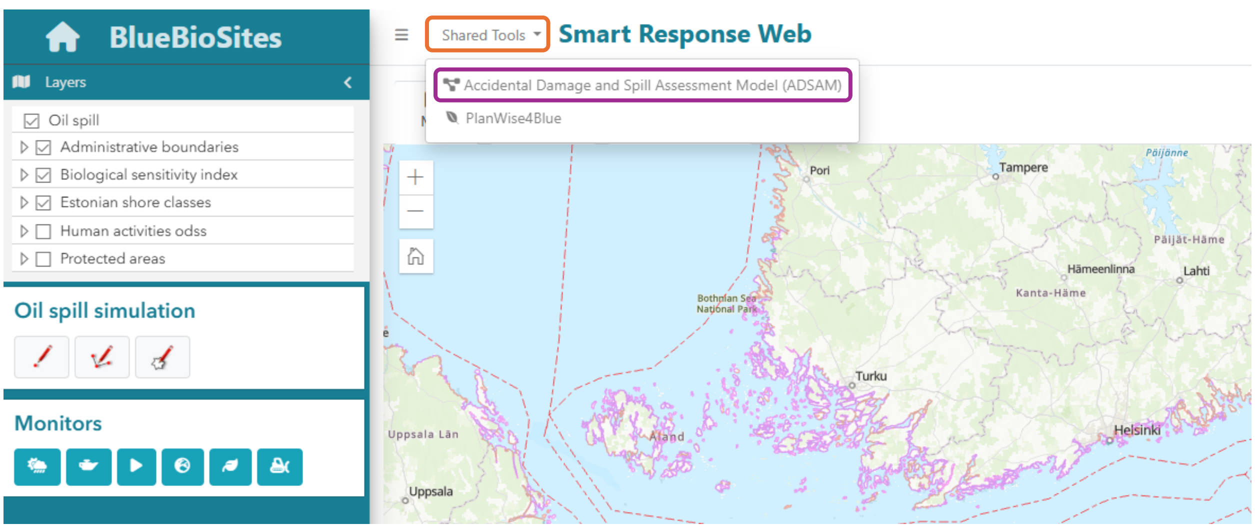


4. Before starting to use the tools, it is required to Log in and/or Sign Up an account. The „Sign Up“ and „Log in“ can be found from the upper right corner of the screen. For the registration of the account, only an email and a password are needed.

5. If you have entered the email and created a password, push “**Register**”

6. Click on the “Shared Tools” to change the tool.

7. Choose “Accidental Damage and Spill Assessment Model (ADSAM) at first.



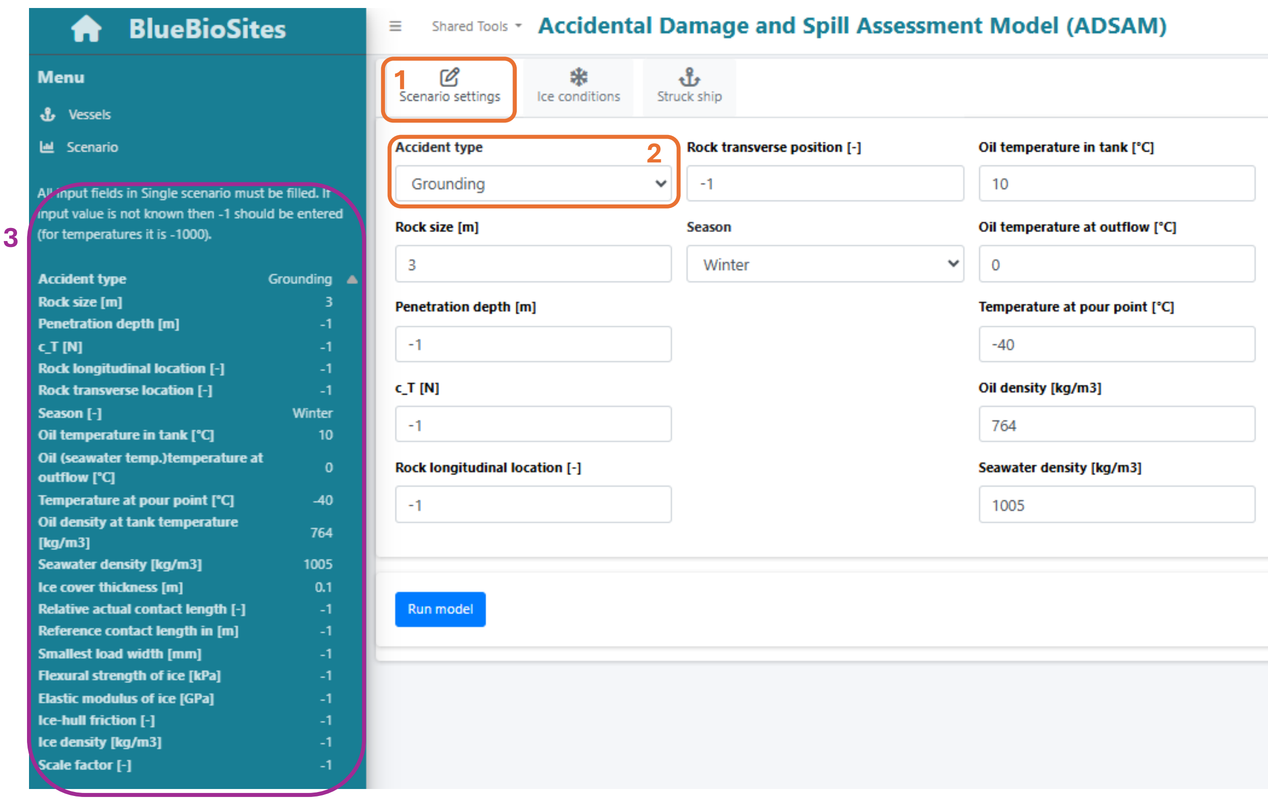
3.1 ADSAM

The ADSAM tool is designed and used when there is a grounding or collision of a vessel and inspectors need to estimate the potential damage, amount of oil (if) spilled into the sea and how fast it can happen.

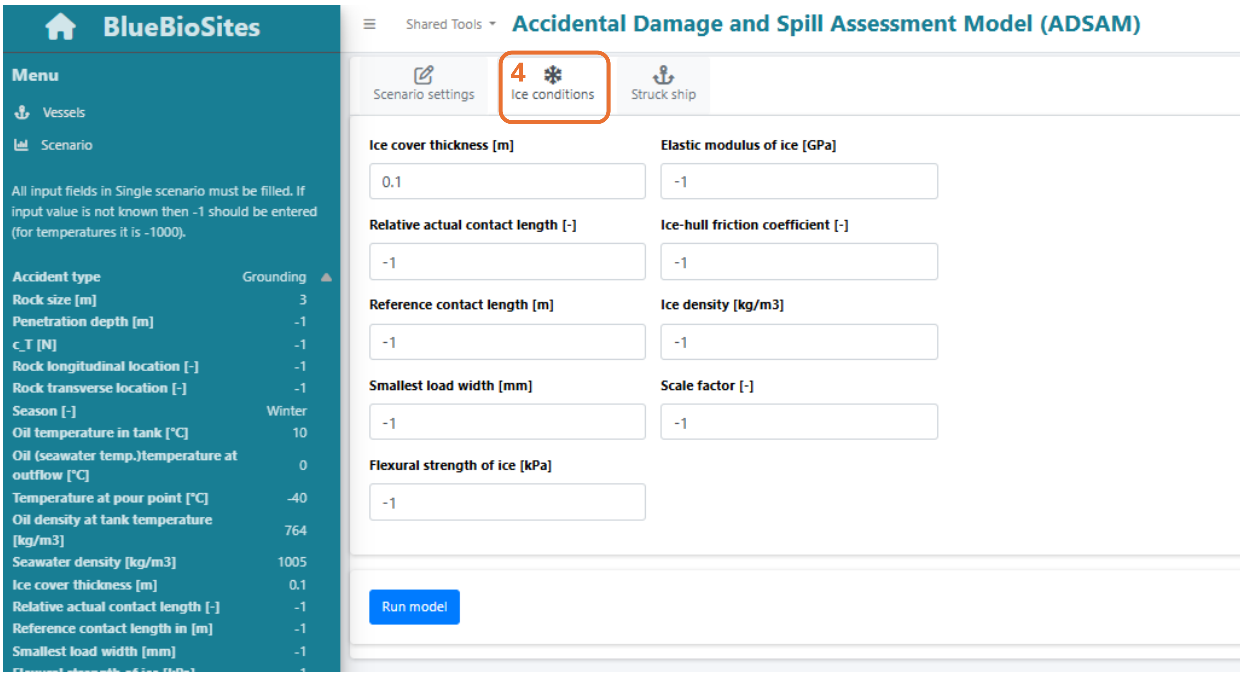
1. Start with “Scenario settings” tab.

2. Choose accident type► “Grounding“ or “Collision“

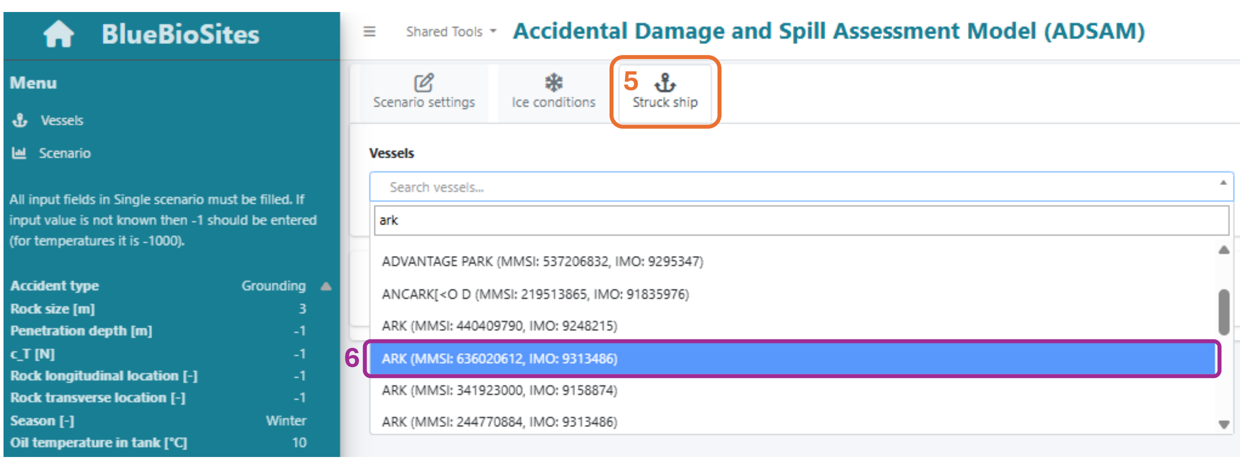
3. In the case of choosing “Grounding”, follow the instructions in the left panel and fill in the known information manually.



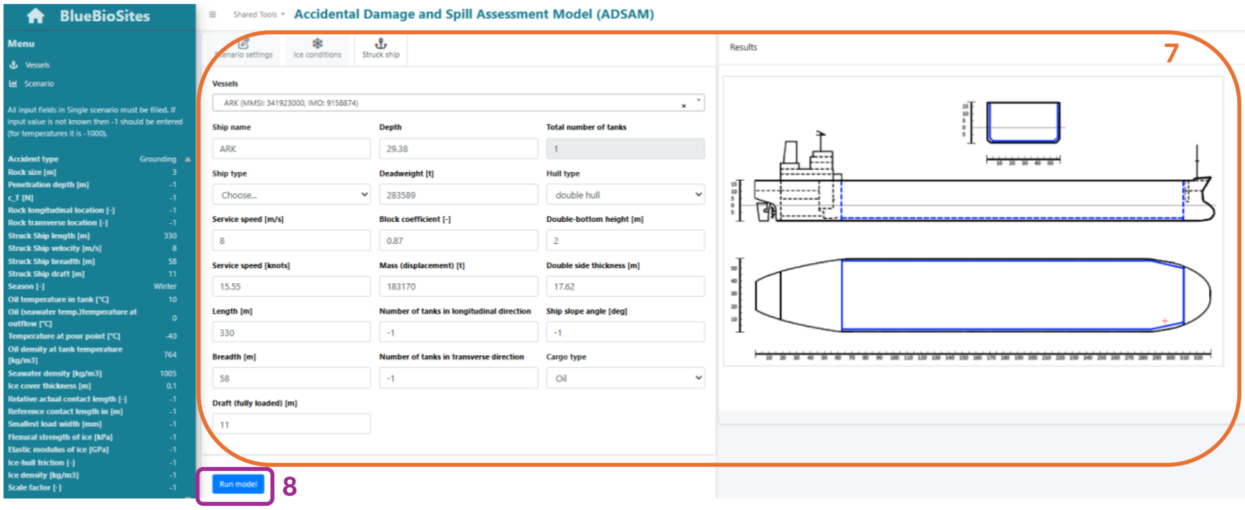
4. Click the tab “Ice conditions” and fill the knows information if needed. If not known keep value “-1” as for “Scenario settings tab.



5. To choose the grounded vessel from real database and fill the vessel related data fields automatically open “Stuck ship” tab and search the vessel from database based on the name of the vessel, MMSI or IMO code.



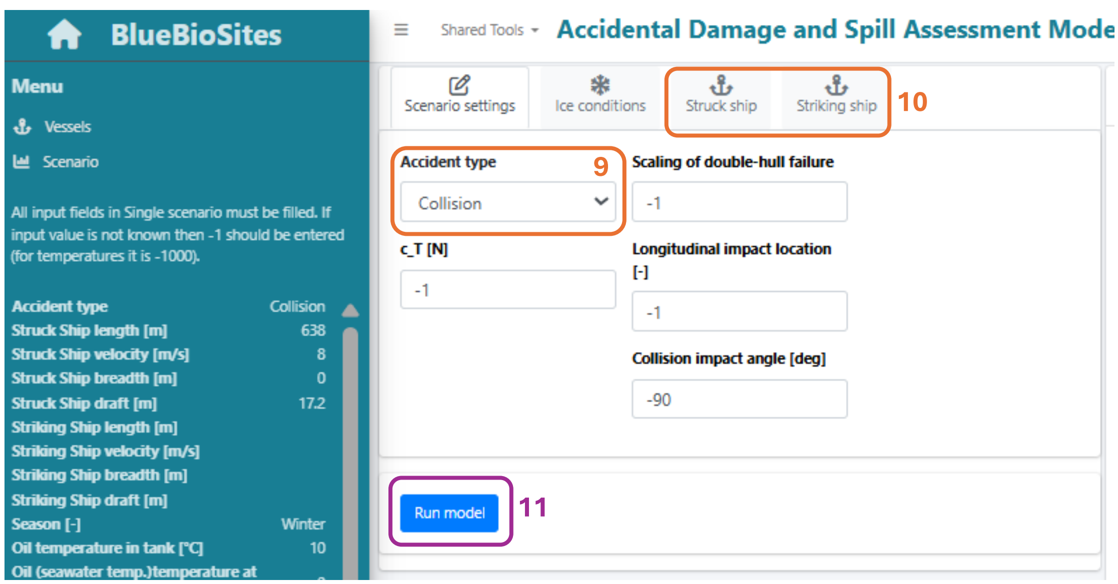
6. When the vessel is found from the database click on the row.



7. All the information about the chosen vessel can be viewed and edited if needed.

8. Push "Run model" if everything is ready.

9* In the case of a collision existing ships and vessels can be chosen from the large database to get all the needed input data automatically for two vessels collided ("Struck Ship" and "Striking Ship"). Choose "Collision" as he accident type.

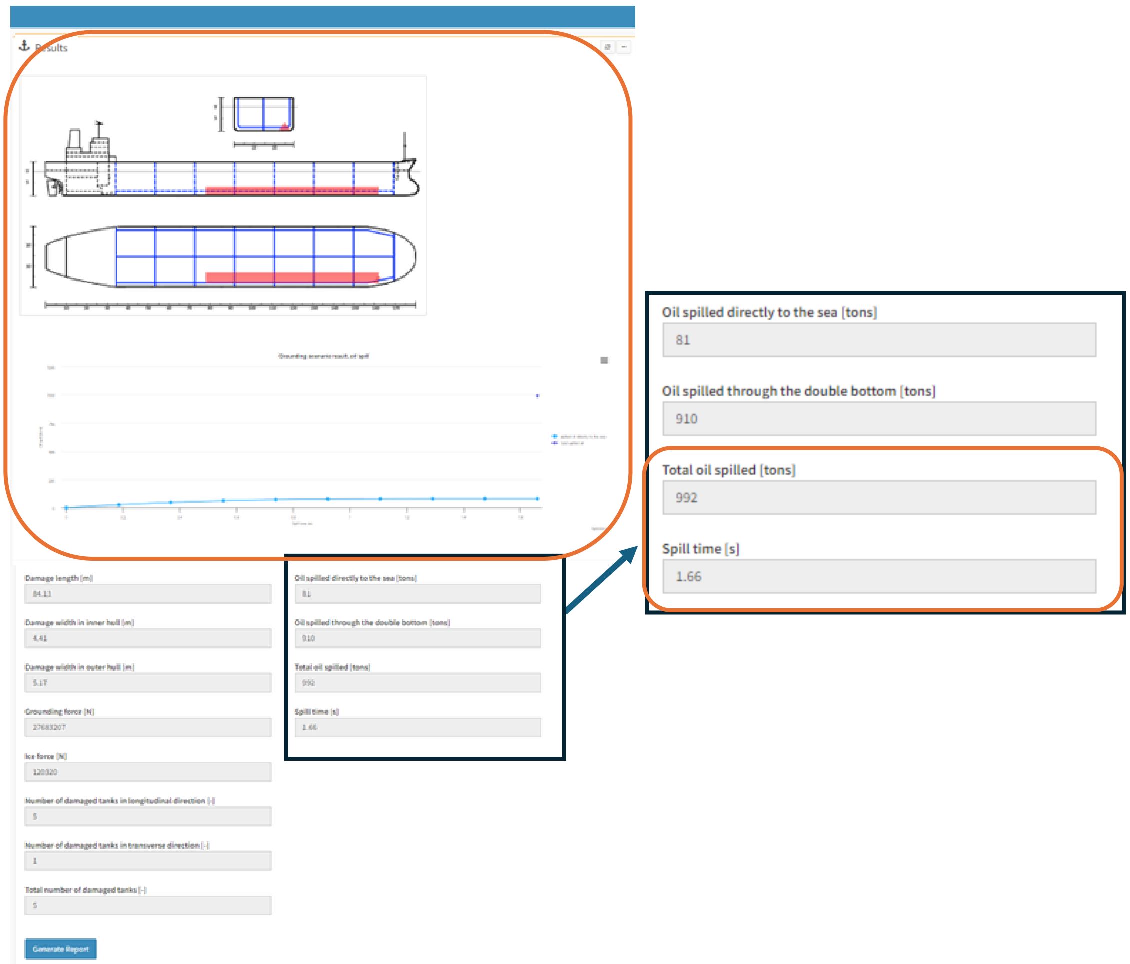


10*. When "Stuck ship" and "Striking ship" has been determined, both vessels information can be viewed.

11*. Push the button "Run Model"

Results: *Results of the model when choosing "Grounding" as type of accident at the beginning*

Results gives a blueprint of a damaged area and a graph of oil spill over time. From the "Results" tab see the values of "Total oil spilled (tons)" and "Spill time (s)". These two numbers are required for the subsequent steps in the Seatrack Web calculations (see the following paragraph).

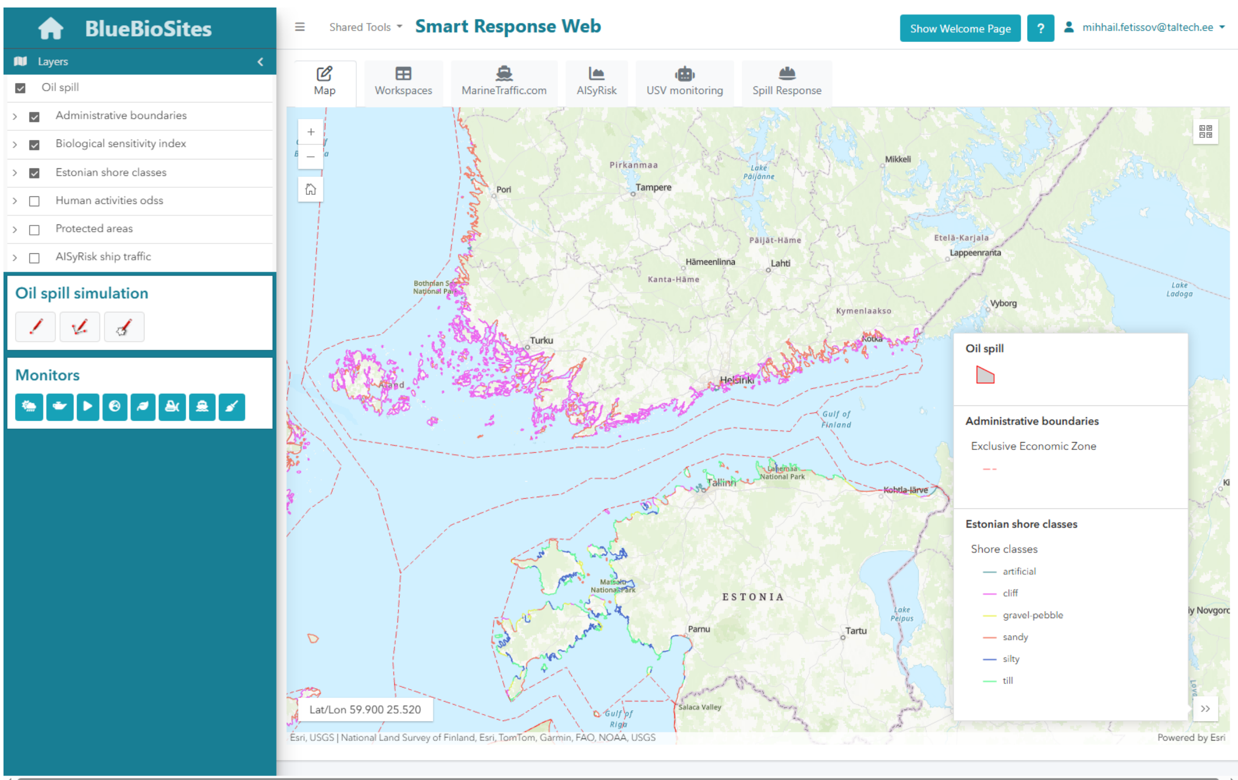


3.2 Smart Response Web and Seatrack Web

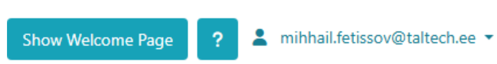
The Smart Response Web (SRW) tool runs the oil spill simulation in Seatrack Web and reports what the spill reaches. It is opened from the Shared Tools menu.

1. Choose the Smart Response Web Tool (SRW) from the Shared Tools menu.

2. The tool opens on the Map tab. The left sidebar holds the map layers, the drawing tools for the spill source under Oil spill simulation, and the buttons that open the result panels under Monitors. Above the map are the tabs Map, Workspaces and MarineTraffic.com, and the information pages AISyRisk, USV monitoring and Spill Response.



3. This manual is available at any time from the ? button in the top right corner, next to Show Welcome Page. It opens in a new browser tab.



4. From the left panel Oil spill simulation, the shape of the spill source is chosen from three options:

Point spill,

Line spill,
Spilled area.

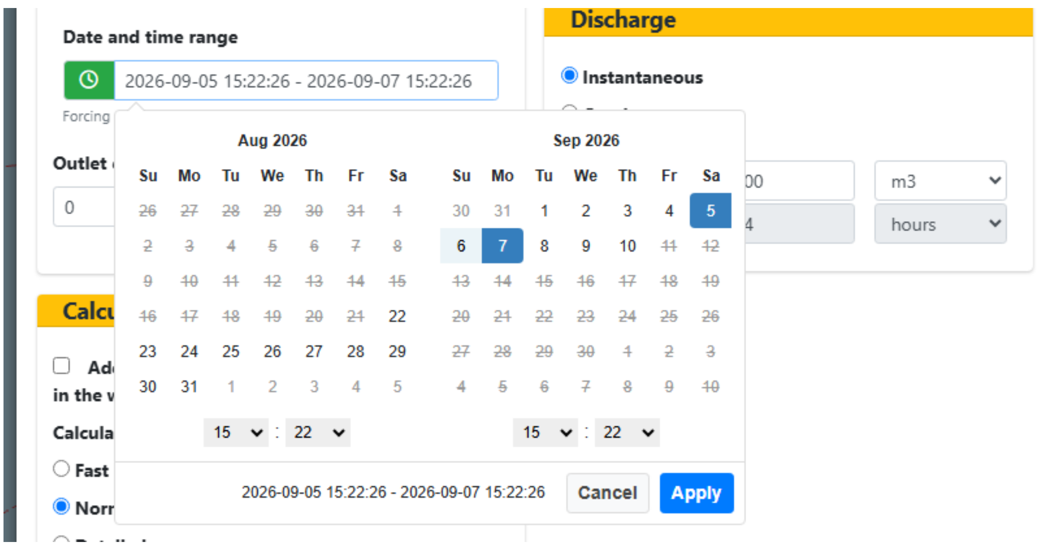
3.2.1 Tab “Map” – running a simulation

1. Click on the map and set the source of the oil spill. The SeaTrackWeb calculation parameters window opens. (NB! You need to be signed in.)

2. Select the workspace the case belongs to, or leave “new scene...” to have one created.

3. Choose whether the calculation runs forward or backward. If the depth of the oil spill outlet is known (m), it can be entered here.

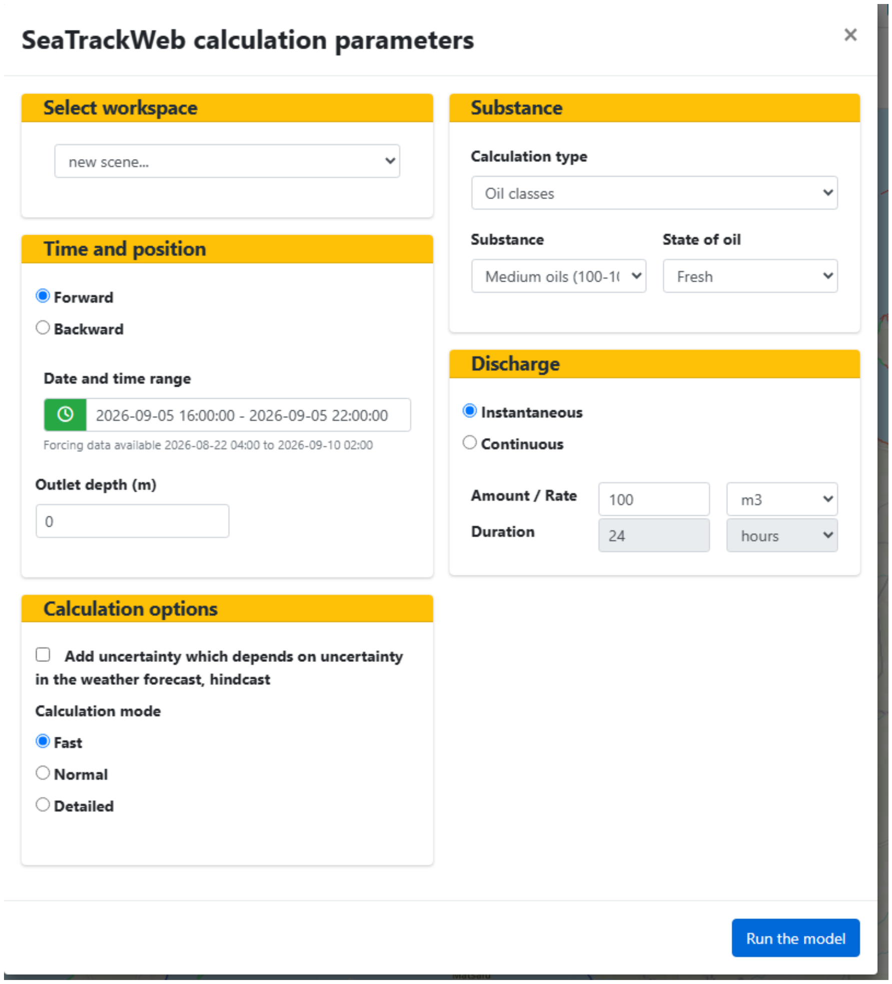
4. Set the date and time range. The period for which the model server holds forcing data is read live and printed under the field, and the calendar only offers dates inside it. A run outside the period is refused before anything is sent to the model, rather than failing later without explanation.



5. Under Calculation options, choose between fast, normal and detailed calculation according to the need, and whether the uncertainty of the weather forecast is added.

6. Under Substance, choose the type, class and state of the oil from the drop-down menus.

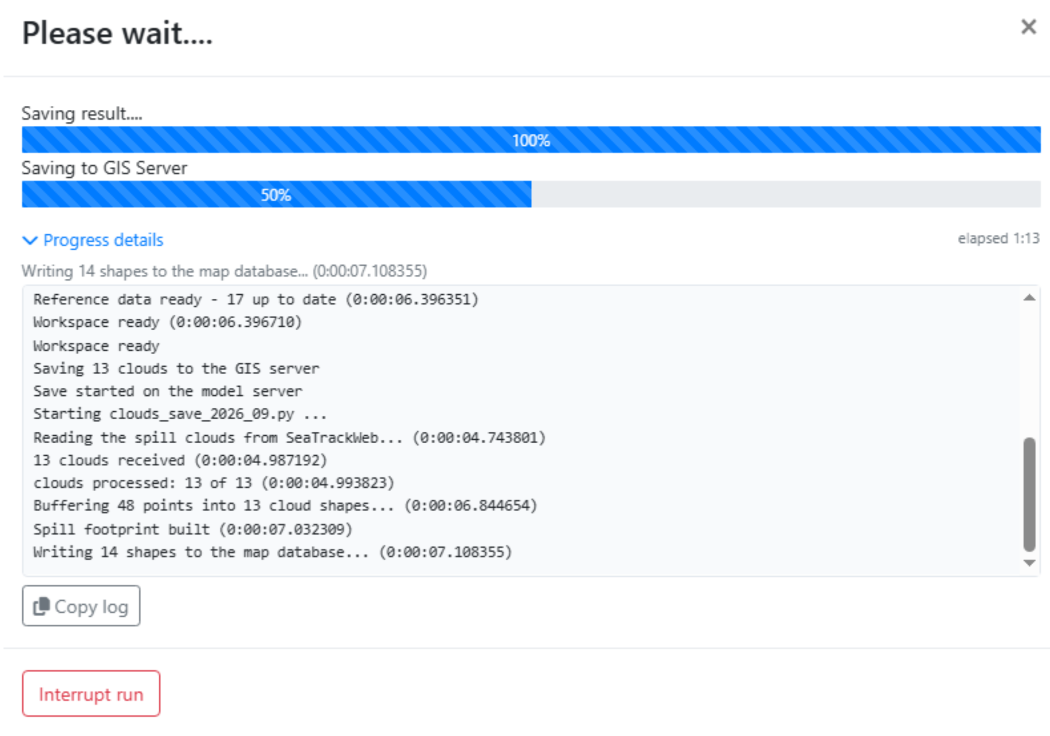
7. Under Discharge, enter the total spilled amount (Amount / Rate) and the spill time (Duration) from the ADSAM results – pay attention to the units – and choose whether the release is instantaneous or continuous.



8. Push Run the model. The progress window opens and stays in front of the application until the run is over, so that it cannot be dismissed by accident.

9. The upper bar counts the spill clouds the model produces – one for every 15 minutes of simulated time – and the lower one follows the saving of the result to the GIS server, which reads the clouds back from Seatrack Web, turns the particles of each one into a shape, builds the spill footprint from them and writes the whole set to the map database. Progress details lists every step in the order it happened, including the output of the scripts that run on the model server, and Copy log puts the whole list on the clipboard for a report.

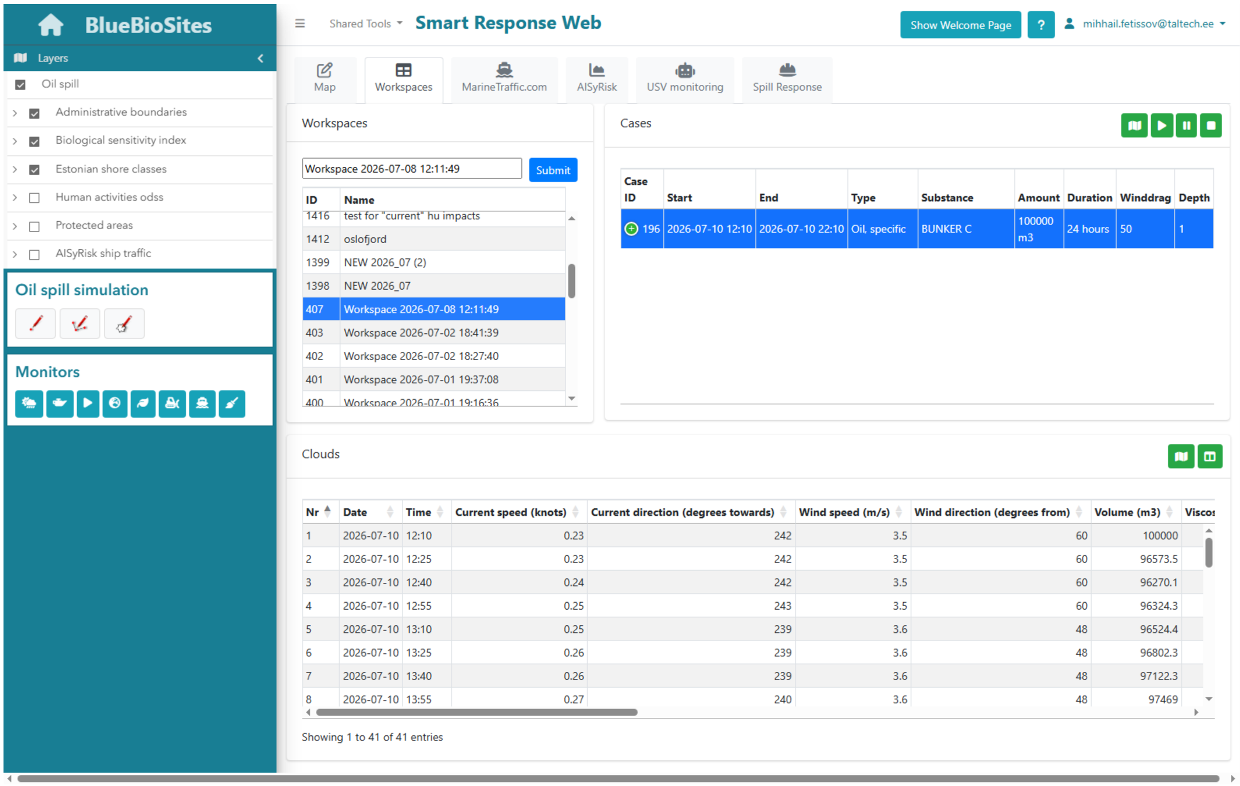
10. Interrupt run stops the run after a confirmation. The calculation already sent to Seatrack Web finishes there and only its result is discarded.



11. When the run has finished, the feed ends with “Clouds saved” and the window can be closed. The new case is listed under the Workspaces tab.

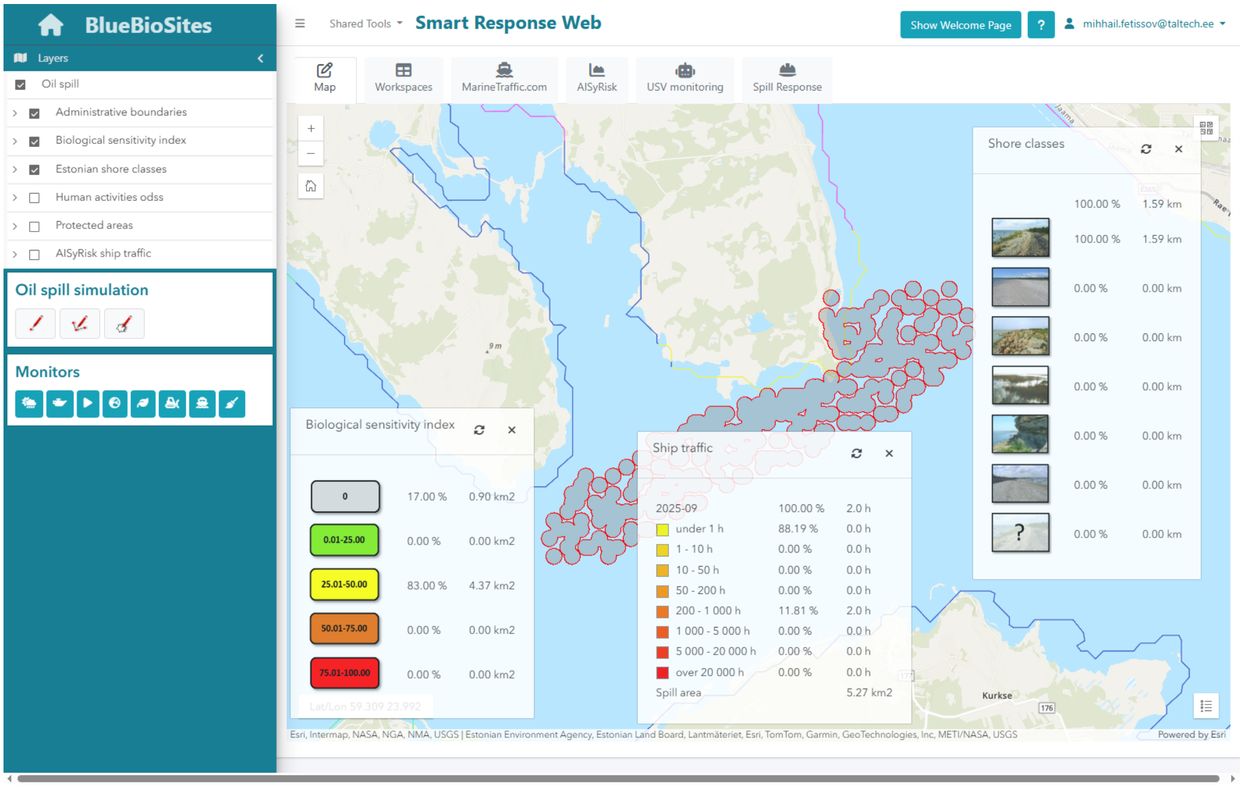
3.2.2 Tab “Workspaces”

1. A workspace can hold several cases, and each case holds the clouds the model produced for it. Selecting a workspace lists its cases; selecting a case lists its clouds, with the environment and the state of the oil at every step of the simulation.



2. The green buttons in the top right corner of the Cases panel act on the selected case: show the spill footprint on the map, play the case, pause it and stop it.

3. Show footprint on map switches to the Map tab, zooms to the spill and fills the result panels for it, so the consequences of the case can be read without running the queries by hand.



4. During the playback the movement of the oil spill is shown step by step. NB! The playback can be paused or stopped at any moment to read the weather information and the oil state for that step; the size of the step is set in the Playback panel.

5. At the end of the playback the maximum footprint of the oil spill is shown, which is the shape the queries below are measured against.

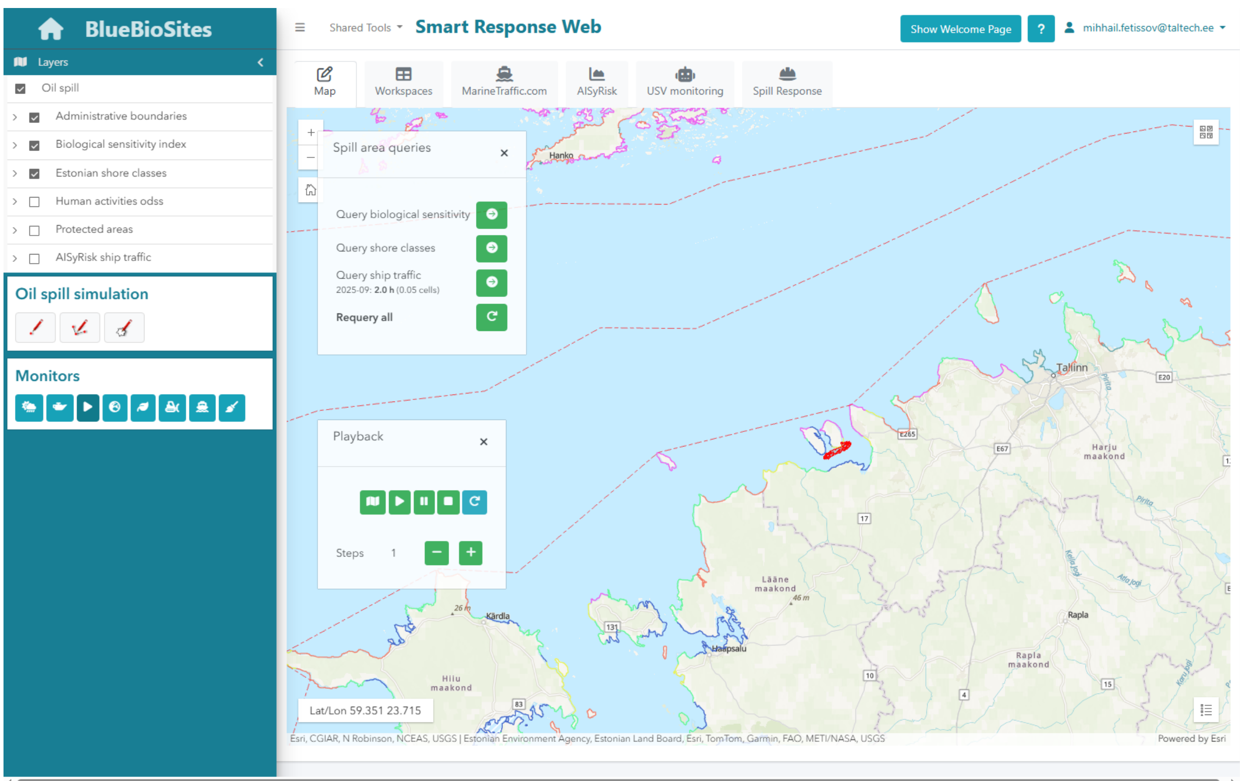
How the footprint is built. Seatrack Web reports the spill as particles, one set of them per cloud. When the result is saved, the particles of each cloud are thinned onto a regular grid and buffered into a single shape, and the footprint of the case is the union of those shapes over every cloud of the simulation.

The radius of that buffer is not a fixed distance. Seatrack Web models each particle as a disc whose area follows from the volume of oil the particle carries and the thickness of the slick, so the radius is worked out for every cloud separately from the volume, the viscosity and the number of particles the model reports for it. It grows as the oil spreads and weathers – for a 100 m^3 spill divided into a thousand particles it is well under a metre while the slick is still centimetres thick, and tens of metres once the oil has thinned. The thickness used is the terminal thickness of the oil, which makes each disc the largest area the oil in it could cover: the footprint is an upper bound on the area that can be affected, not a statement that every square metre inside it is oiled. Where the model does not report the numbers needed for a cloud, a fixed radius of 100 m is used for it instead.

3.2.3 Spill area queries

The Spill area queries panel, opened from the Monitors buttons in the left sidebar, measures what the spill footprint on the map reaches – the shape described at the end of 3.2.2, and with it the same upper-bound reading. It runs three queries, each of which answers into its own panel:

Query biological sensitivity – the area of each class of the biological sensitivity index under the footprint, as a share of the footprint and in km^2.
Query shore classes – the length of each shore class the footprint touches, as a share and in km.
Query ship traffic – the hours vessels spent in the area the footprint covers, split across the same classes as the ship traffic legend (see 3.2.4).



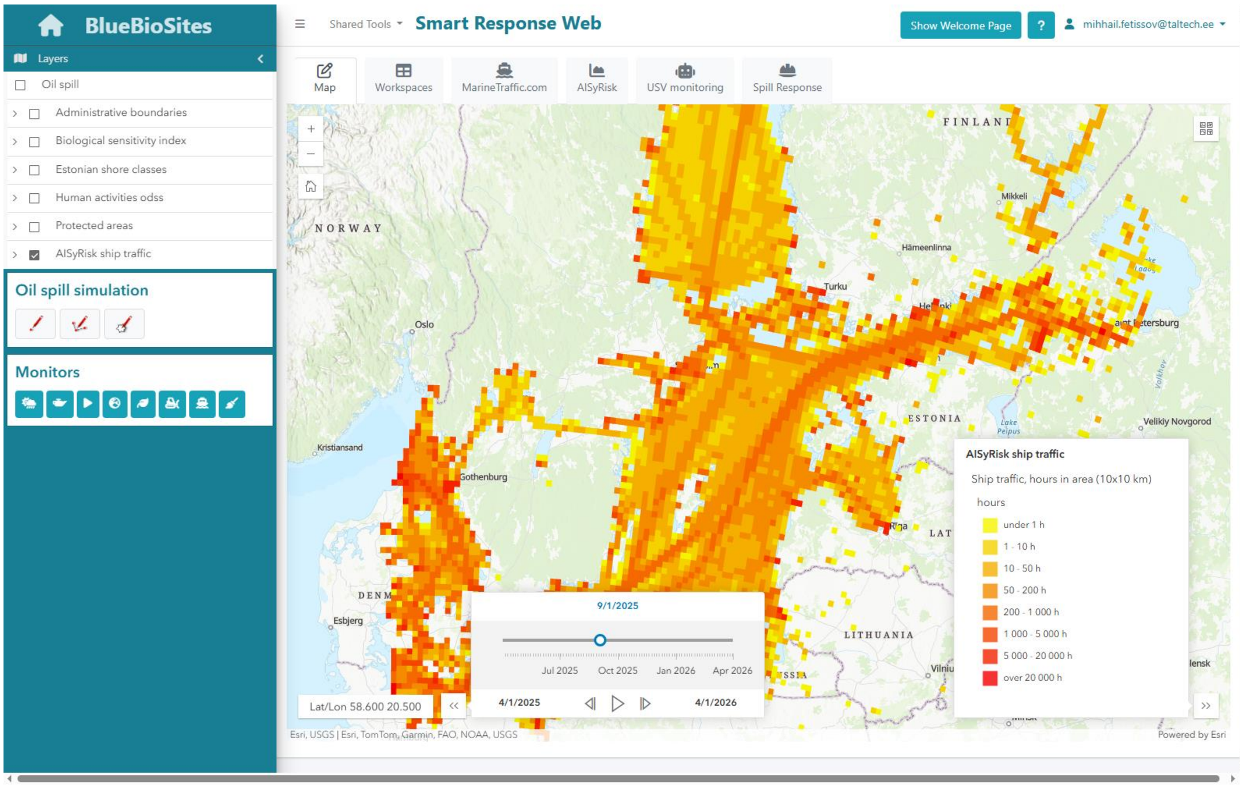
Requery all runs all three queries for whatever is on the map at that moment. Each result panel also carries its own refresh button in its title bar, so a single query can be repeated after the selection, the layer or the month has changed. A query that is still running shows a moving bar under the panel title.

The result panels can be dragged anywhere on the map and closed independently, and the Monitors buttons open them again.

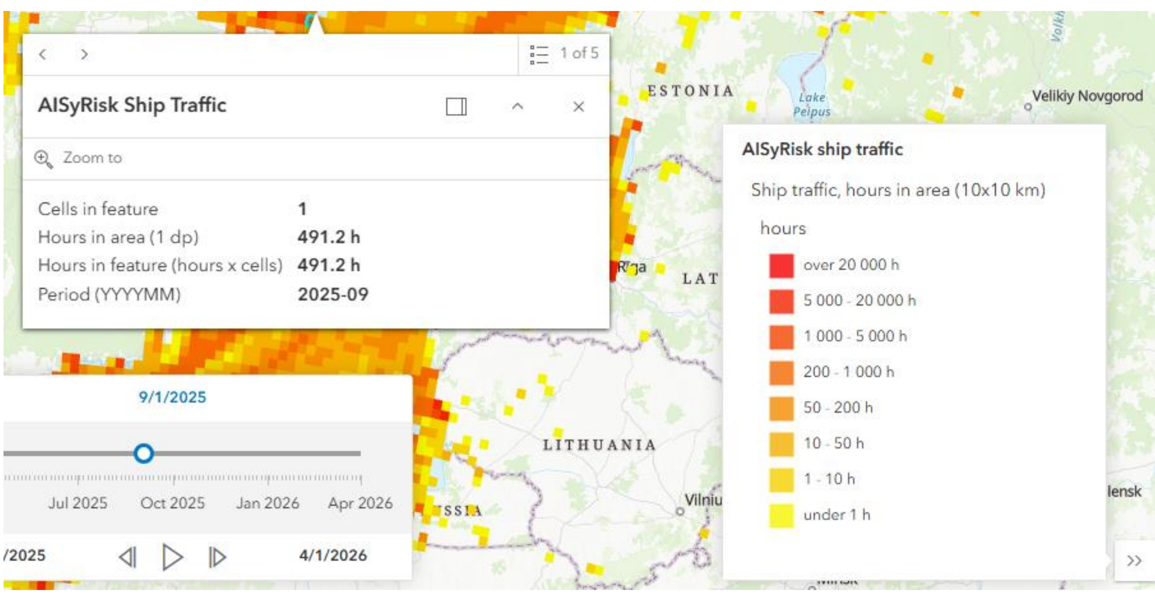
3.2.4 Ship traffic (AISyRisk)

1. Switch on AISyRisk ship traffic in the layer list. The layer shows the hours vessels spent in each 10 × 10 km cell of the Baltic Sea during one calendar month, in the eight classes of the legend.

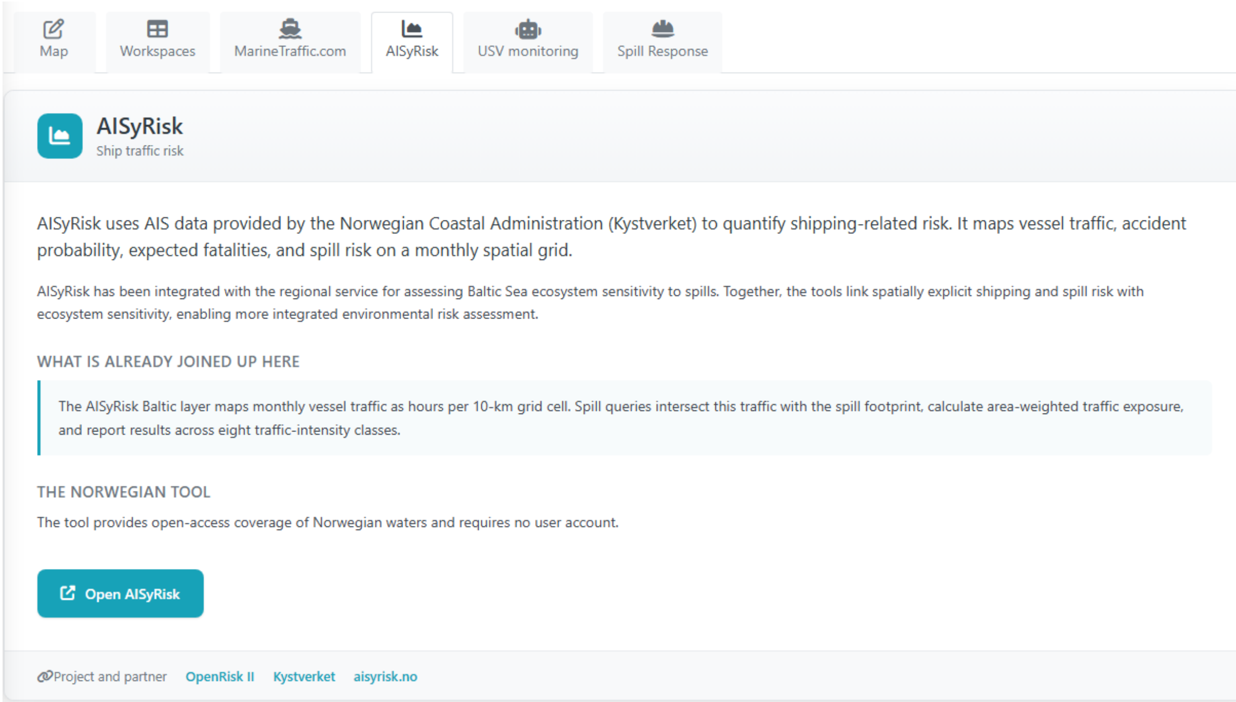
2. The time slider under the map chooses the month. Stepping it redraws every time-aware layer on the map, so the traffic picture and anything else driven by time stay on the same month.



3. Clicking a cell reports its values: the hours spent in the area, the period the value belongs to, and how many cells the clicked feature covers.



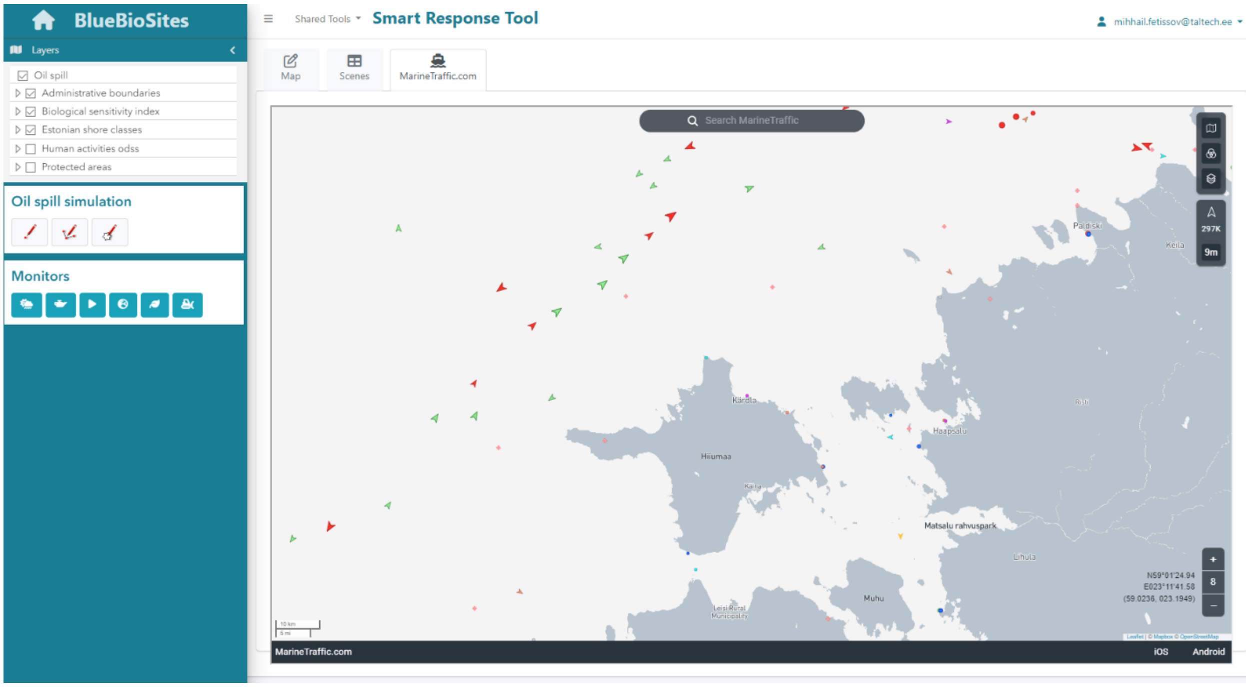
4. The AISyRisk tab describes how the two tools fit together and opens the Norwegian application, which covers Norwegian waters and needs no account.



5. The ship traffic under a modelled spill is reported by Query ship traffic in the Spill area queries panel (3.2.3). The hours are weighted by how much of each cell the footprint actually covers, and the panel names the month the figures come from. The traffic archive is a rolling window that ends some months before today, so a simulation run on current dates is compared against the nearest month the archive holds rather than against nothing.

3.2.5 Tab “Marine traffic”

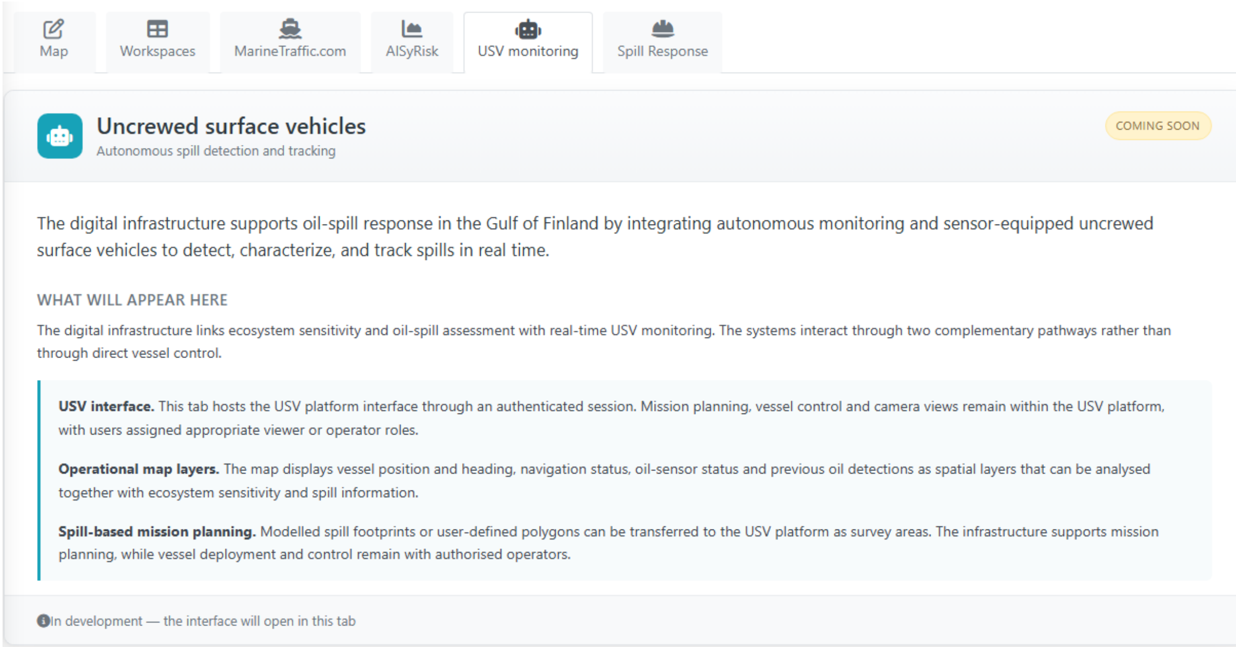
1. The MarineTraffic.com tab shows the sea in real time with AIS target tracking, for the area the map is looking at. The view is embedded from marinetraffic.com and depends on that service.



3.2.6 Tabs “USV monitoring” and “Spill Response”

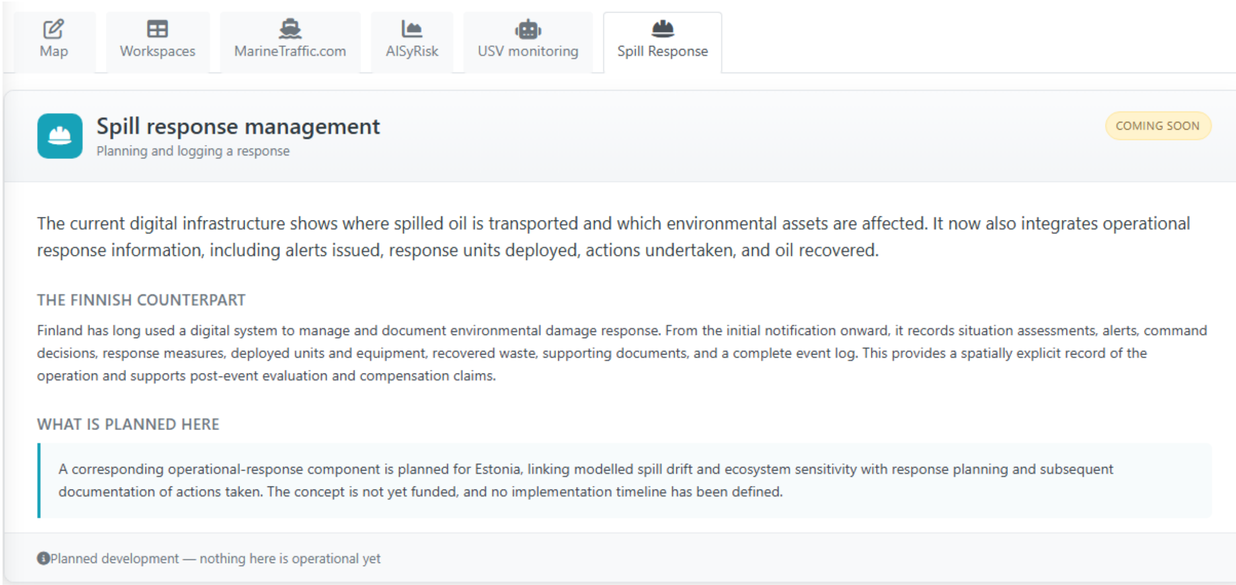
The last two tabs describe work that is planned rather than operational, and both are marked “coming soon”. They are there so that the direction the tool is taking is visible from inside it.

1. USV monitoring – uncrewed surface vehicles. Autonomous monitoring and sensor-equipped uncrewed surface vehicles are to be used to detect, characterise and track a spill in real time. The tab will host the interface of the USV platform in an authenticated session, and the map will carry the position and heading of the vessel, its navigation status, the status of the oil sensor and earlier oil detections as layers that can be read together with the ecosystem sensitivity and spill information. A modelled spill footprint, or a polygon drawn by the user, can be passed to the USV platform as a survey area: the infrastructure supports mission planning, while deploying and controlling the vessel stays with authorised operators.



2. Spill Response – spill response management. What the tool shows today is where the spilled oil is transported and which environmental assets are affected; the part still to come is the operation itself – the alerts issued, the response units deployed, the actions undertaken and the oil recovered.

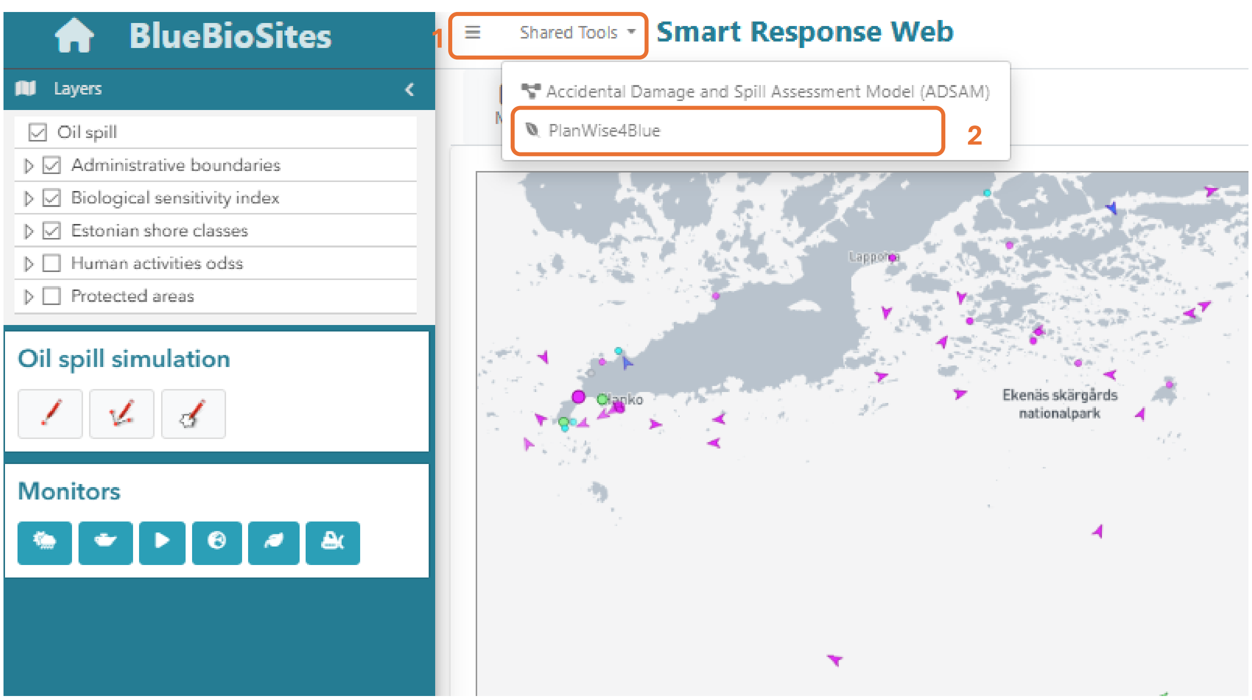
3. Finland has long used a digital system to manage and document environmental damage response. From the initial notification onwards it records situation assessments, alerts, command decisions, response measures, deployed units and equipment, recovered waste, supporting documents and a complete event log, which gives a spatially explicit record of the operation and supports post-event evaluation and compensation claims. A corresponding component is planned for Estonia, linking modelled spill drift and ecosystem sensitivity with response planning and with the documentation of the actions taken. The concept is not yet funded and no implementation timeline has been defined.



3.3 PW4B portal

1. PW4B portal view under 'Shared Tools,' where detailed environmental effects of oil spills can be quantified.

2. For cumulative effects assessment, select the PlanWise4Blue (PW4B) tool. The manual for the PW4B Europe tool can be found at https://gis.sea.ee/bluebiosites/?page=PW4B-Guide.



4 Knowledge gaps

Ultra-low Sulphur fuel oils (ULSFOs) are marine fuels with a sulfur content of 0.10% or less, developed in response to stringent international regulations aimed at reducing sulfur oxide emissions from ships. These fuels are increasingly used in Emission Control Areas (ECAs) to comply with the International Maritime Organization (IMO) regulations, which came into force in 2020. While ULSFOs help in lowering air pollution, there is a growing concern about their impact on marine ecosystems, particularly during accidental spills. The specific environmental behavior of ULSFOs, including their biodegradability and toxicity, is not yet fully understood (IMO, 2020; Turner and Lewis, 2020; Smith, 2021). This represents a significant knowledge gap that requires further research to assess their potential long-term effects on marine life and habitats. In addition, ammonia and other new fuel types lack the data. Despite these constraints, the current application marks a significant achievement in unifying sophisticated models of ship accidents, oil spread, and resulting environmental effects into a fast and easy-to-use web application, enhancing the efficiency of response actions. When new models for ULSFO spread become available, they can be seamlessly integrated to further improve application performance for these fuel types.

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