

OpenRisk II Project Final Conference on Maritime Risk Management in the Baltic Sea Region

22.9.2026 Kristiansand, Norway

interreg-baltic.eu/project/openrisk-ii/



Welcoming Words from Norway

Hans-Petter Mortensholm

Director of Environmental Emergency Response in Norway
Norwegian Coastal Administration

OpenRisk II Project Final Conference on Maritime Risk Management in
the Baltic Sea Region | 22.9.2026 Kristiansand, Norway



Conference agenda

9:10-10:10 Setting the scene

10:10-10:40 Coffee Break

10:40-10:45 Introduction to workshop sessions

10:45-11:45 Workshop 1: AISyRisk and ice module

11:45-12:45 Lunch covered by organizers

12:45-13:45 Workshop 2: EcoSensitivity tool

13:45-14:30 Workshop 3: R-Mare matrix - Tool for enhanced overall risk management performance

14:30-14:45 Coffee Break

14:45-15:45 Future oriented session

15:45-16:00 Wrap-up of the day and the project

18:30 Conference Dinner covered by organizers



Setting the scene 09:10–10:10

- **OpenRisk II**
Hermann Backer Johnsen, Åbo Akademi University
- **Ice service in Norway - a practical perspective**
Geir Gjevang, Norwegian Coastal Administration
- **Digital tools for response - DIGIMARIS project**
Pentti Kujala, TalTech Estonian Maritime Academy
- **EMSA developments and risk-assessment needs**
Victor Diaz Seco, European Maritime Safety Agency



OpenRisk II

Background and overview

Hermann Backer Johnsen
Åbo Akademi University

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Maritime Risk Assessments

–an obligation for coastal states, not (just) for fun

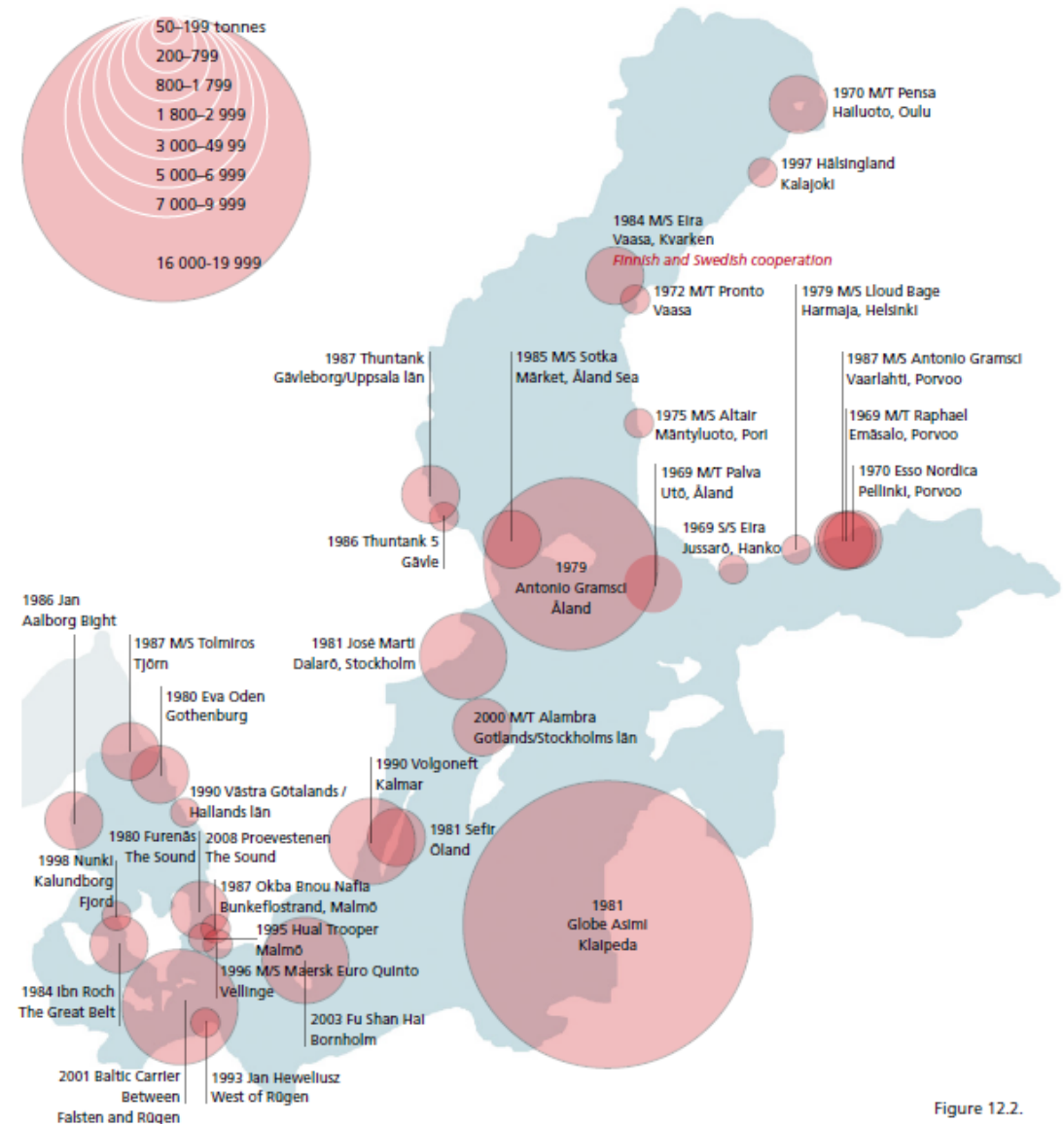
An example on fairways:

- Under SOLAS Chapter V, a coastal state's obligation to provide Aids to Navigation (AtoN) and Vessel Traffic Services (VTS) is linked to risk.
- AtoN and VTS must be provided as the volume of traffic or the degree of risk justifies.
- To prove justification, states are legally required to conduct formalized, data-driven risk assessments.
- Risk assessments should be carried out as agreed within IMO, including e.g. the Formal Safety Assessment (FSA) framework and the IALA toolbox
- The IMO Audits are ways to check that this is done as intended

It makes sense to share

In shared sea areas like the Baltic Sea
where distances between countries are short
it makes sense to

- share knowledge on risks
- take collective action to prevent accidents
- share the costs of response capacity



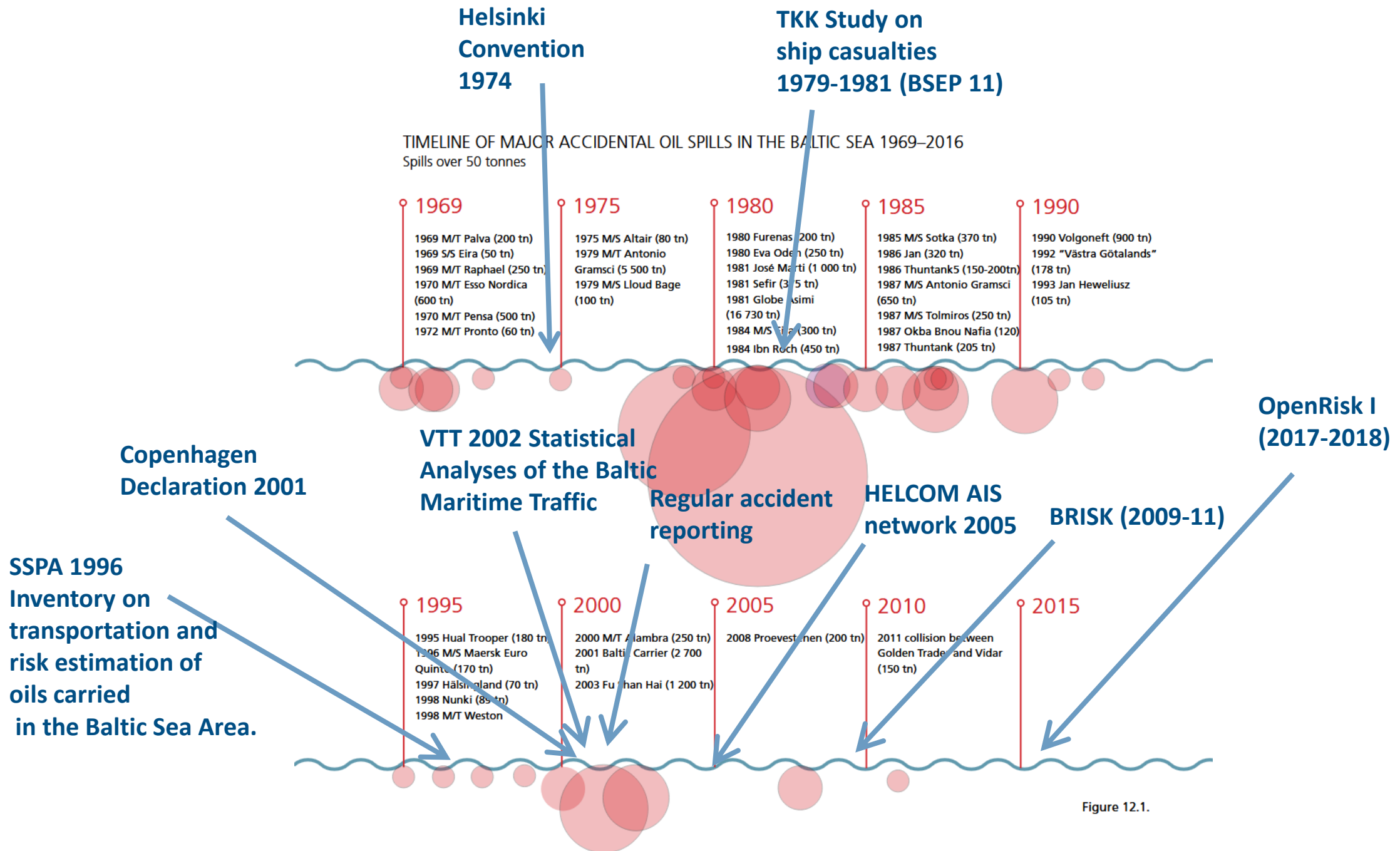


Figure 12.1.

BALTIC SEA ENVIRONMENT PROCEEDINGS

No. 11

STUDIES ON SHIP CASUALTIES IN THE BALTIC SEA 1979 — 1981

Helsinki University of Technology
Ship Hydrodynamics Laboratory
Otaniemi, Finland

P. Tuovinen, V. Kostilainen and A. Hämäläinen

TABLE 7. Number of casualties in different parts of the Baltic

	OIL DIS- CHARGE	FIRE	GROUND- ING	COL- LISION	RAMMING	FOUNDER- ING, LIST	WEATHER DAMAGE	ICE DAMAGE	Row Total
SOUND	0	2	39	10	8	2	0	0	60 12.7
GREAT BELT	0	0	27	4	5	0	0	0	36 7.6
FEHMARN & KIEL	1	1	5	10	47	1	0	0	65 13.8
KALMAR SOUND	0	0	9	1	3	0	0	0	13 2.8
OTHER PARTS	0	4	46	13	24	15	2	2	106 22.5
STOCKHOLM'S APPR	0	0	22	4	4	1	0	0	31 6.6
ÅLAND WITH SURR	0	0	18	6	5	2	0	1	32 6.8
GULF OF BOTHNIA	0	1	33	22	18	0	1	8	63 17.6
GULF OF FINLAND	0	0	21	11	6	2	0	5	45 9.6
Column Total	0.1	8 1.7	219 46.5	81 17.2	120 25.5	23 4.9	3 0.6	16 3.4	471 100.0

33

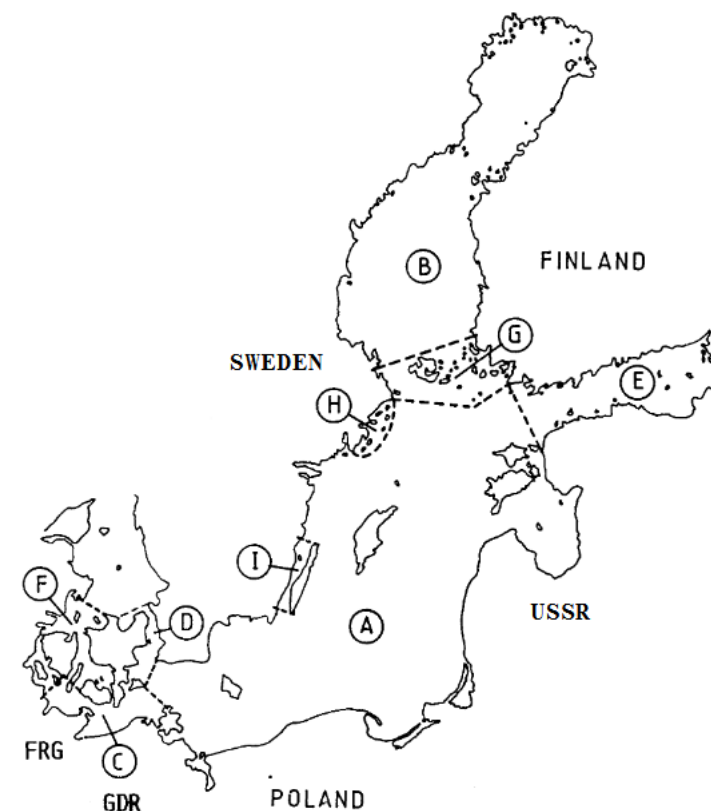
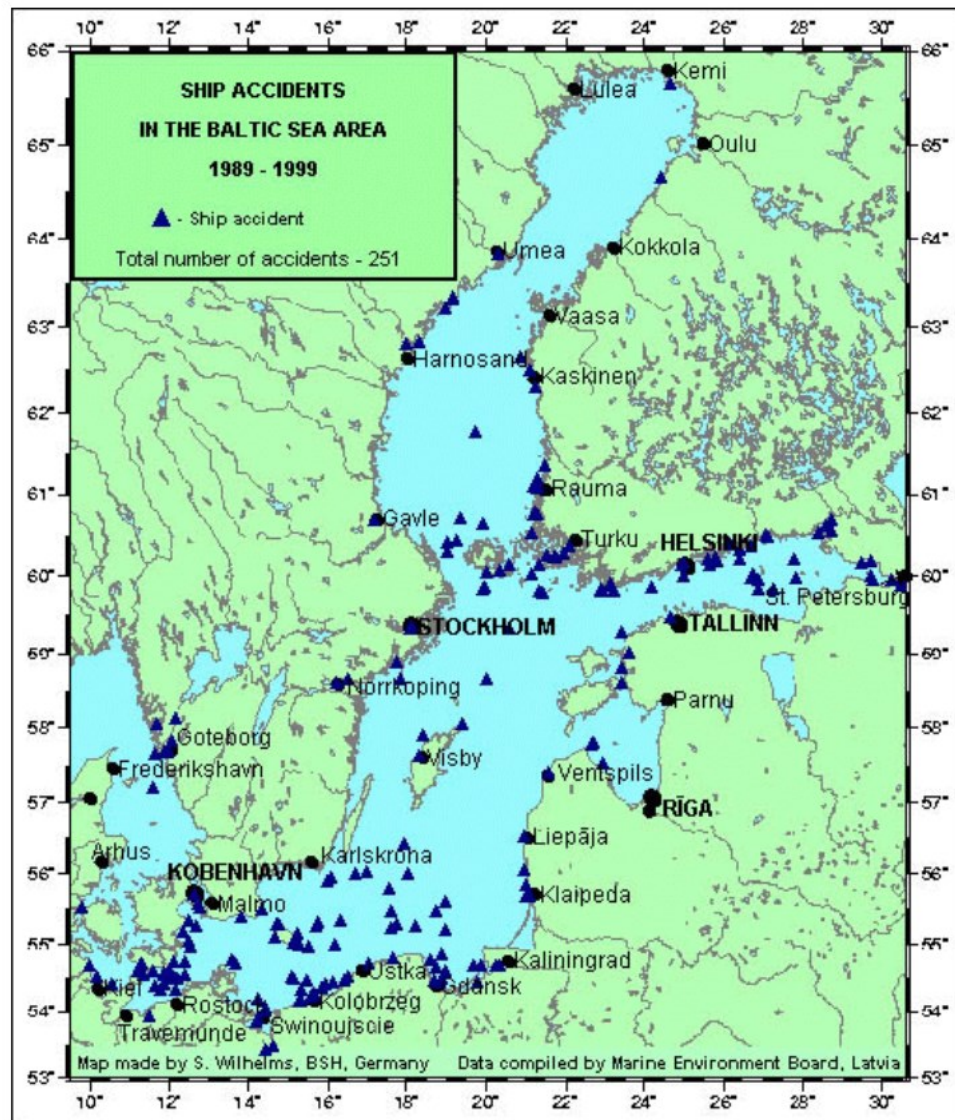
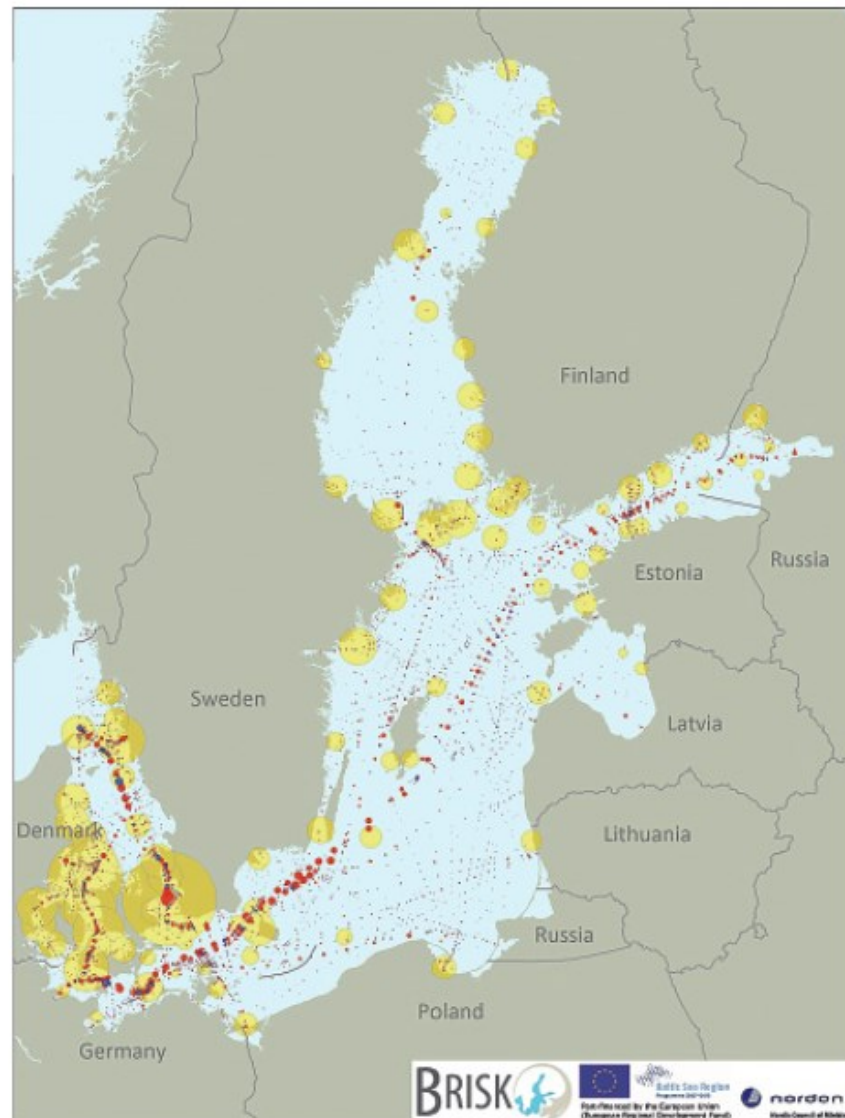


Fig.9. The Baltic Sea divided into 9 districts

Early HELCOM 2000s Accident compilations



HELCOM 2012 BRISK



The risk of collisions and groundings.

The size of the bubbles corresponds to the accident risk, i.e. the expected number of accidents per year.

- En-route collision
- Crossing collision
- Grounding

TIMELINE OF MAJOR ACCIDENTAL OIL SPILLS IN THE BALTIC SEA 1969–2016

Spills over 50 tonnes

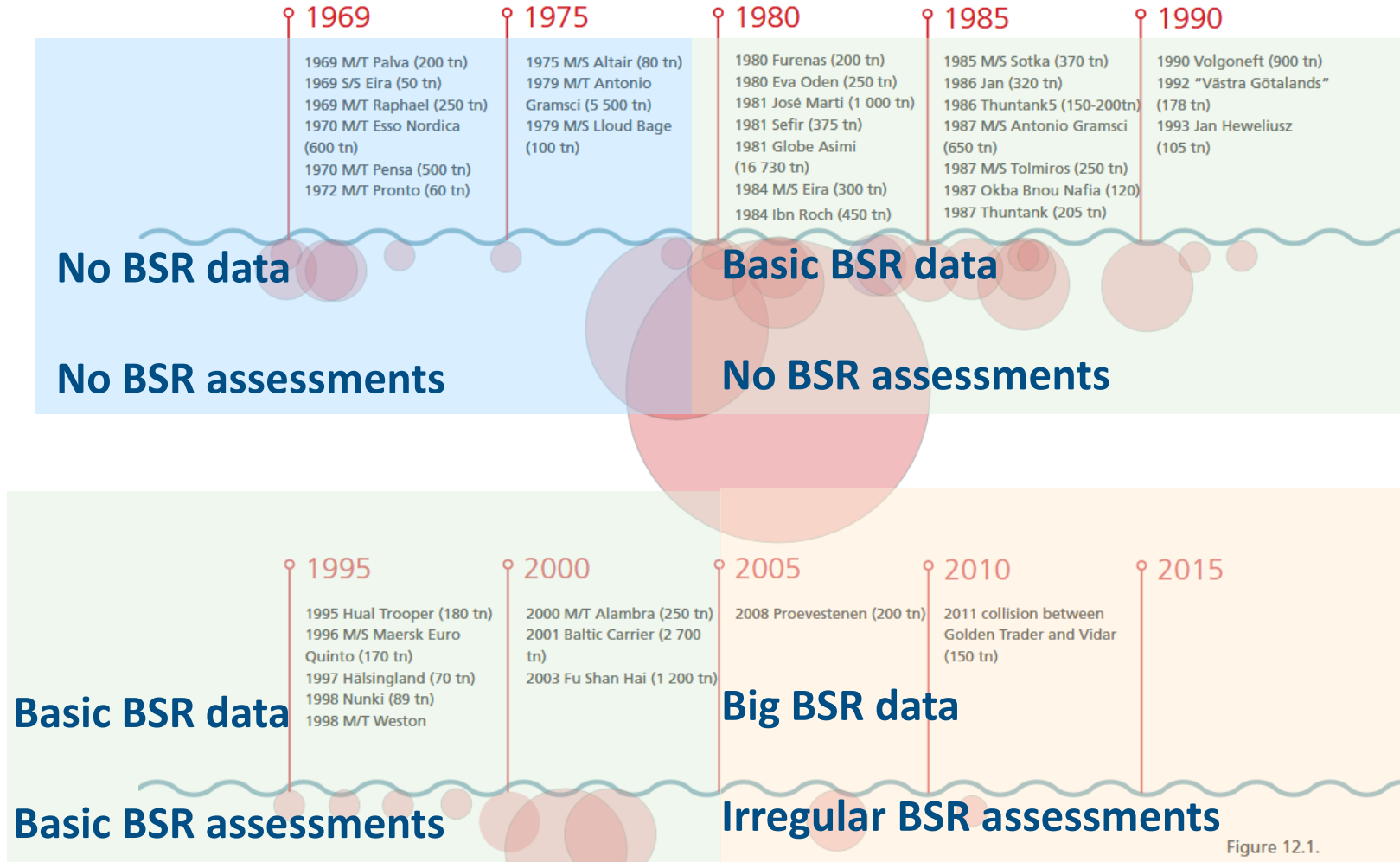


Figure 12.1.

Big BSR data

**Continuously updated
BSR assessments?**

**Proactive BSR Risk
Management?**

OpenRisk II

*Better Maritime Risk Management
for the Baltic Sea Region*



@ Mikko Törmanen

Interreg
Baltic Sea Region



Co-funded by
the European Union

SUSTAINABLE WATERS
OpenRisk II



Duration: November 2023 - October 2026

Funding: Co-funded by the EU Interreg BSR
programme 2021-27

Project consortium



UNIVERSITY
OF TARTU



GDAŃSK UNIVERSITY
OF TECHNOLOGY

TRAFICOM
Finnish Transport and Communications Agency



KYSTVERKET
NORWEGIAN COASTAL ADMINISTRATION



Aalto University



Åbo Akademi
University



UNIVERSITY OF HELSINKI

Three New Tools for Maritime Authorities to prevent and limit damage from accidents at sea

Improving organizational capacity to evaluate and enhance its risk management performance

Tools

R-Mare

Monitoring maritime
spill risks

Monitoring maritime
accident risks

Estimating ecological
damage of spills

AlSyRISK

EcoSensitivity tool

Measures

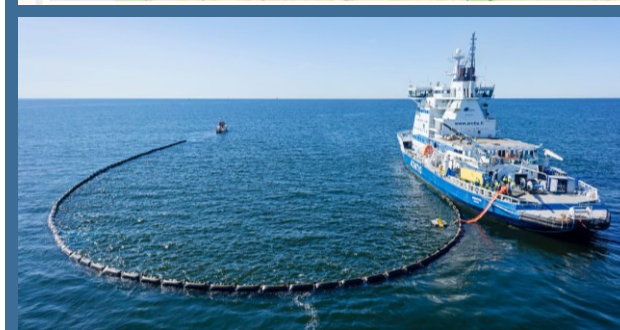
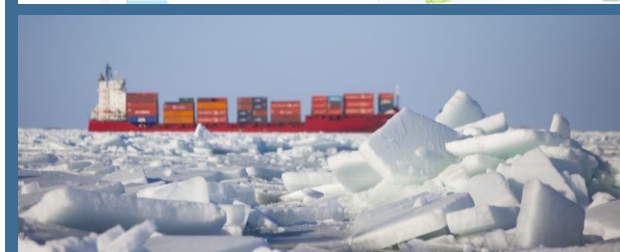
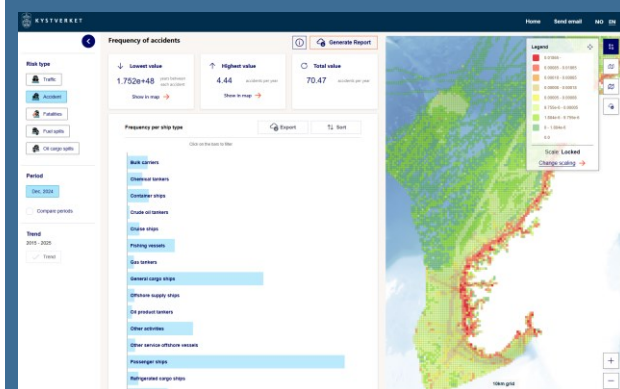
Improving
organizational
capacity to
manage risks

Estimating sufficiency
of response capacity

Improving safety
of navigation

Minimising
environmental harm
of spills by smart
response

**Improved Safety and Sustainability
in the Baltic Sea Region**





https://drive.google.com/drive/folders/1m_PJT2CrVMhgajCcERHWmRX76kQpSK_

Ice service in Norway - a practical perspective

Geir Gjevang

Norwegian Coastal Administration

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Digital tools for response - DIGMARIS project

Pentti Kujala

TalTech Estonian Maritime Academy

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EMSA developments and risk-assessment needs

Victor Diaz Seco

European Maritime Safety Agency

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Introduction to workshops session

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AlSyRisk Baltic

Jon Arve Røyset, Norwegian Coastal Administration

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KYSTVERKET
NORWEGIAN COASTAL ADMINISTRATION



**GDAŃSK UNIVERSITY
OF TECHNOLOGY**



Agenda

1. Presentation on the methodology and its anticipated use
2. Demo of the AISyRisk Baltic working version
3. Discussion on the potential of the tool for the Baltic Sea



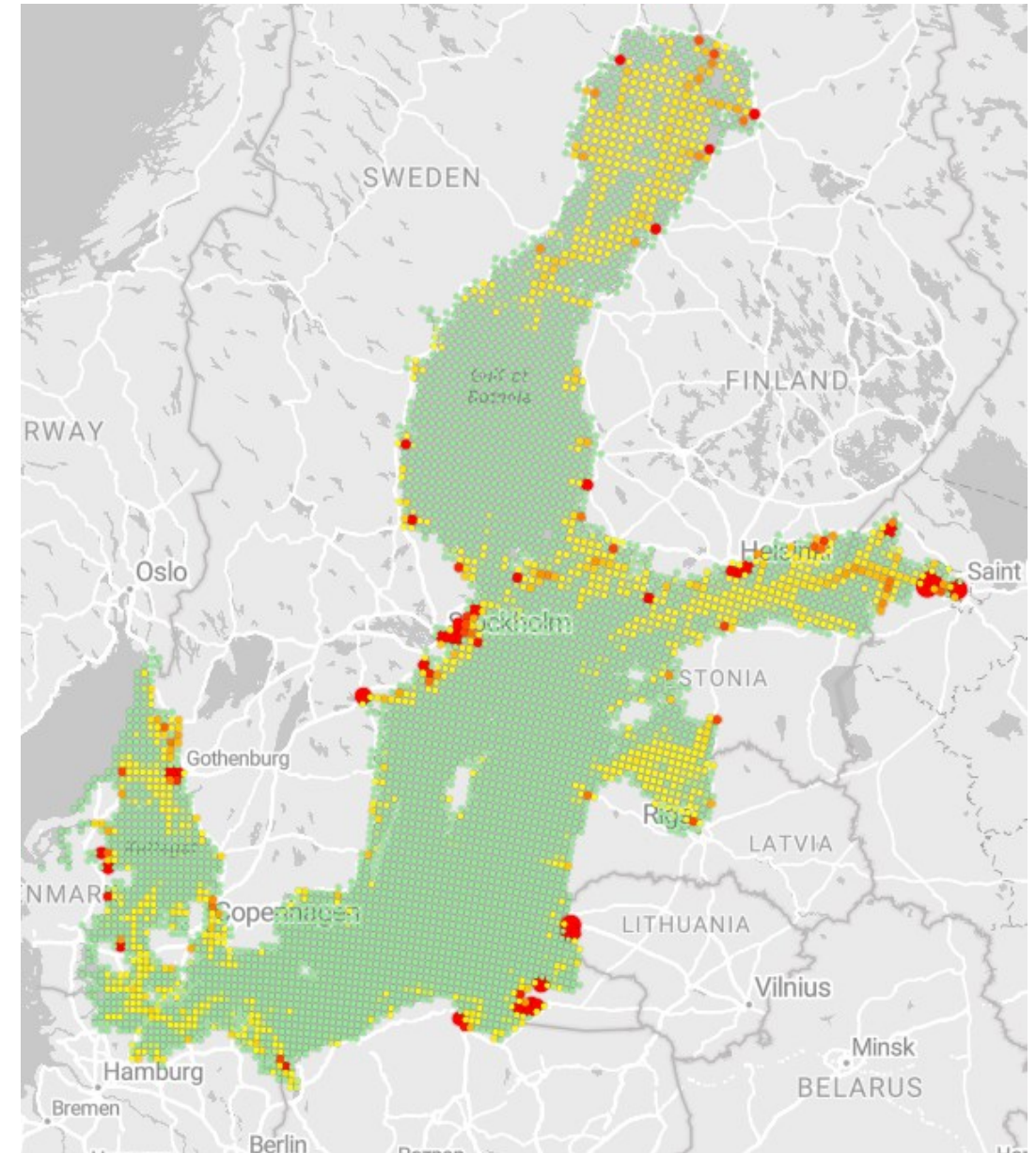
Background and objective

What is AISyRISK?

- AISyRISK is a method for automated estimation of risk. It is also a system for presenting the estimated risk in a dynamic and understandable way.

Why do we do it?

- **Objective:** The aim of the risk model is to assist the different users in their risk management activities related to maritime traffic.
 - Create an accurate and transparent system for monitoring trends related to frequency of accidents, including identifying high risk areas
 - In a uniform way enable the users to regularly deliver information about risk level trends for use in transport planning and risk planning processes, including risk planning processes on local and regional level



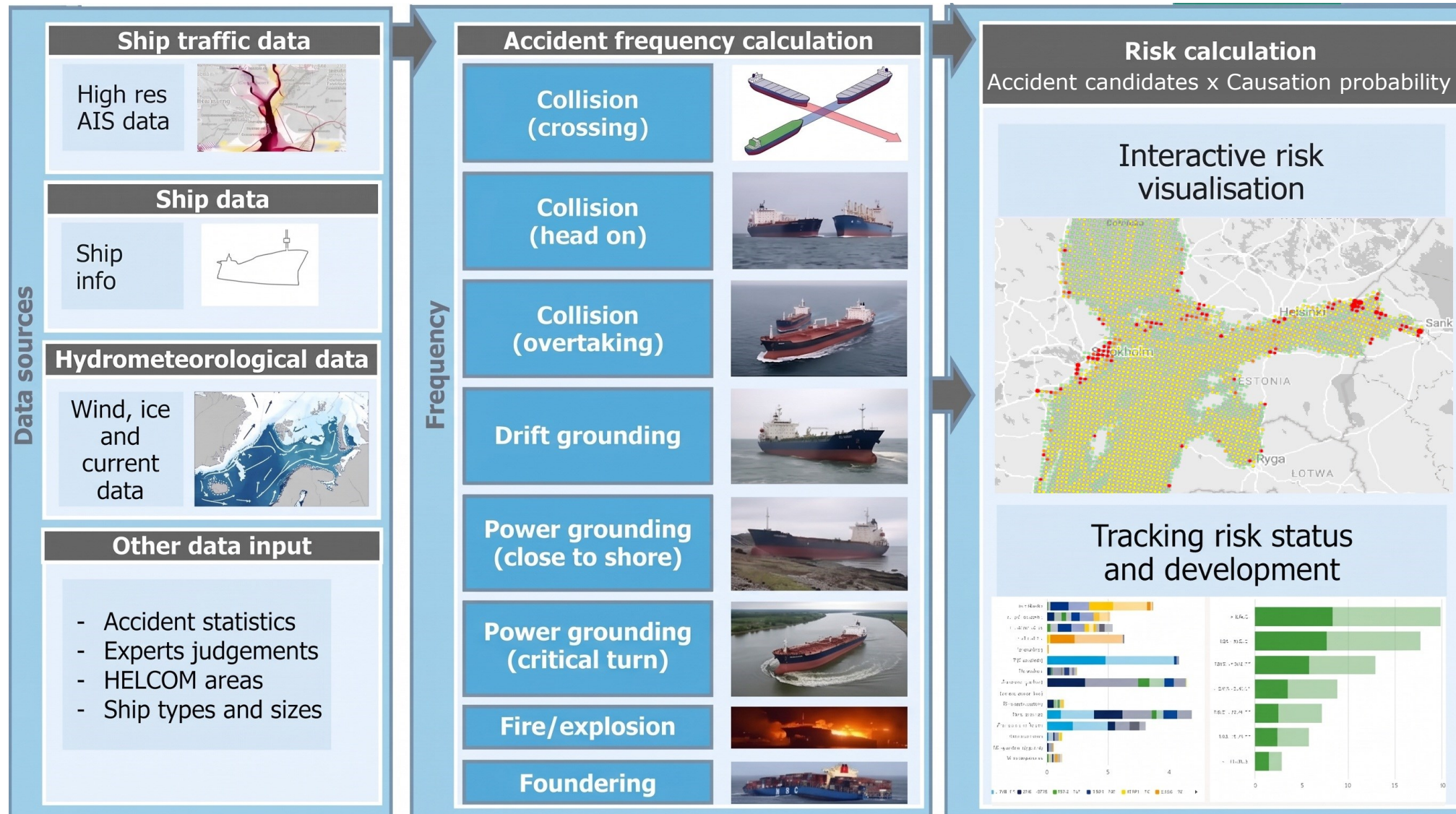
AISyRisk Baltic as a Strategic Decision Support Tool

- The AISyRisk including the new ice module is a strategic planning tool for use in:
 - Maritime administration, government, research and development
 - Maritime spatial planning
 - Oil spill contingency and response planning
 - Traffic regulation
 - Evaluating the need for new measures on macro level (high level).
 - Other tools like for example IWRAP is normally used to analyse on a smaller scale.

Strategy	Tactics
Planning	Doing
Large Scale	Smaller Scale
Why	How
Difficult to Copy	Easy to Copy
Long Time Frame	Short Time Frame

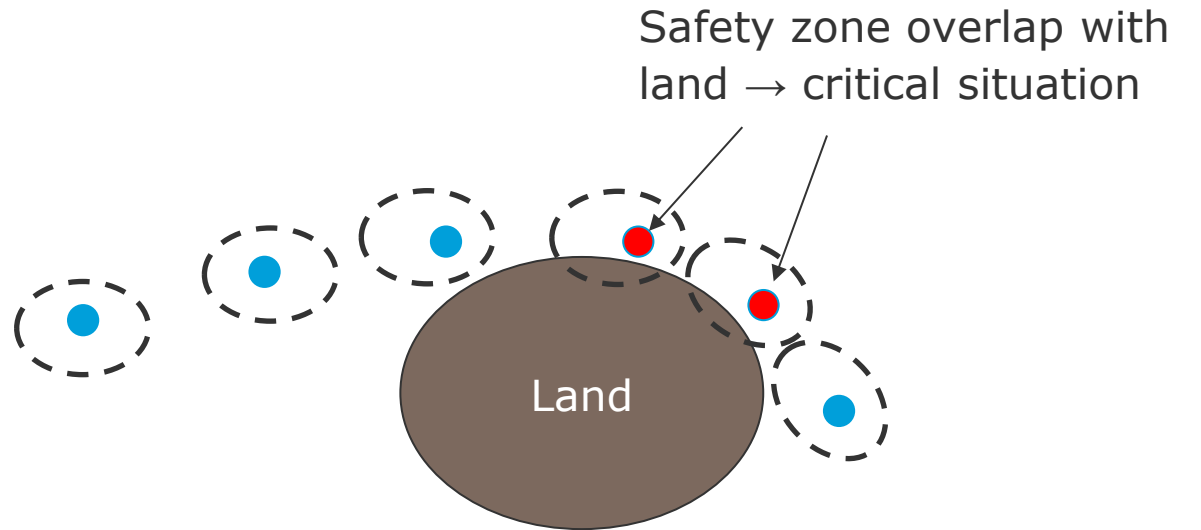
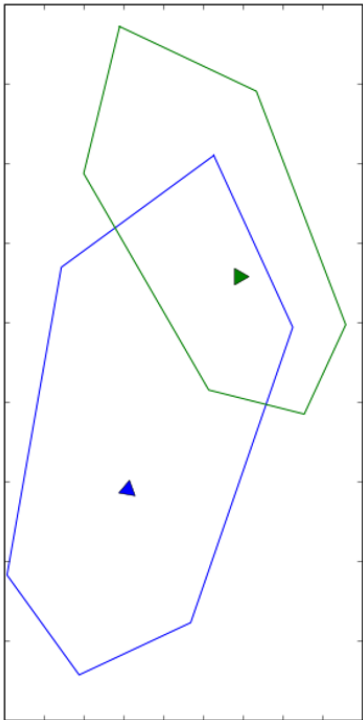
AISyRisk, including the new Ice module, is not a tool for operational voyager planning.

AISyRISK input data at present



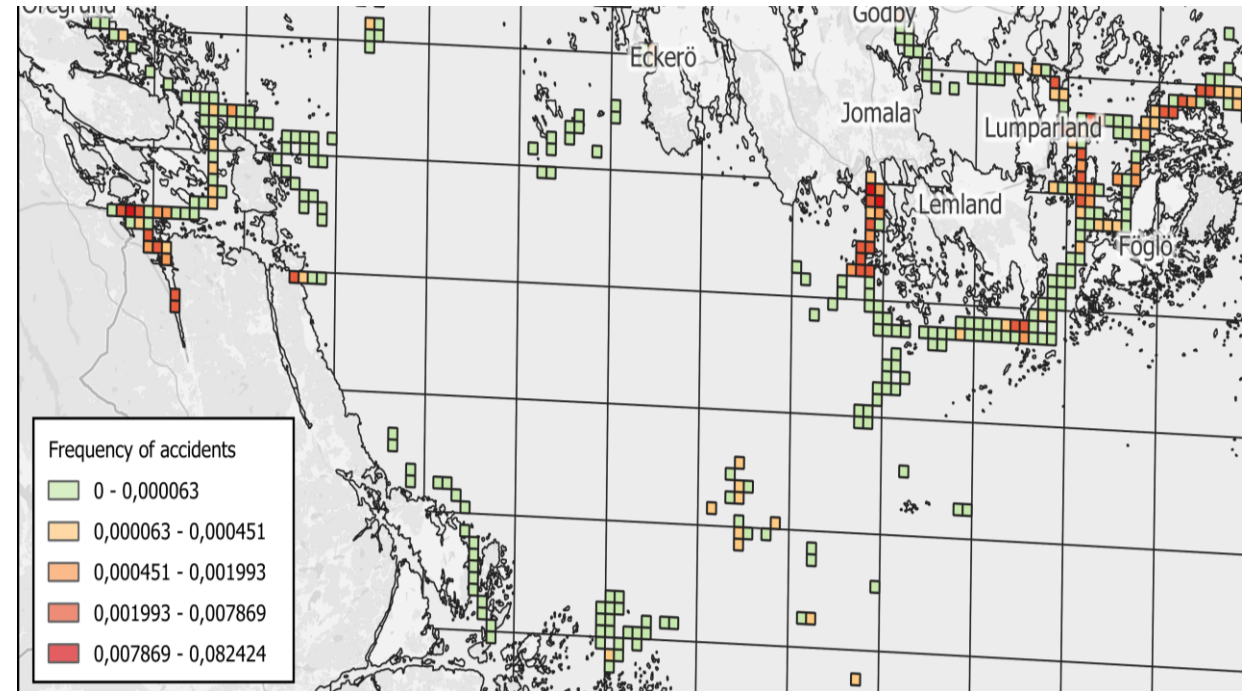
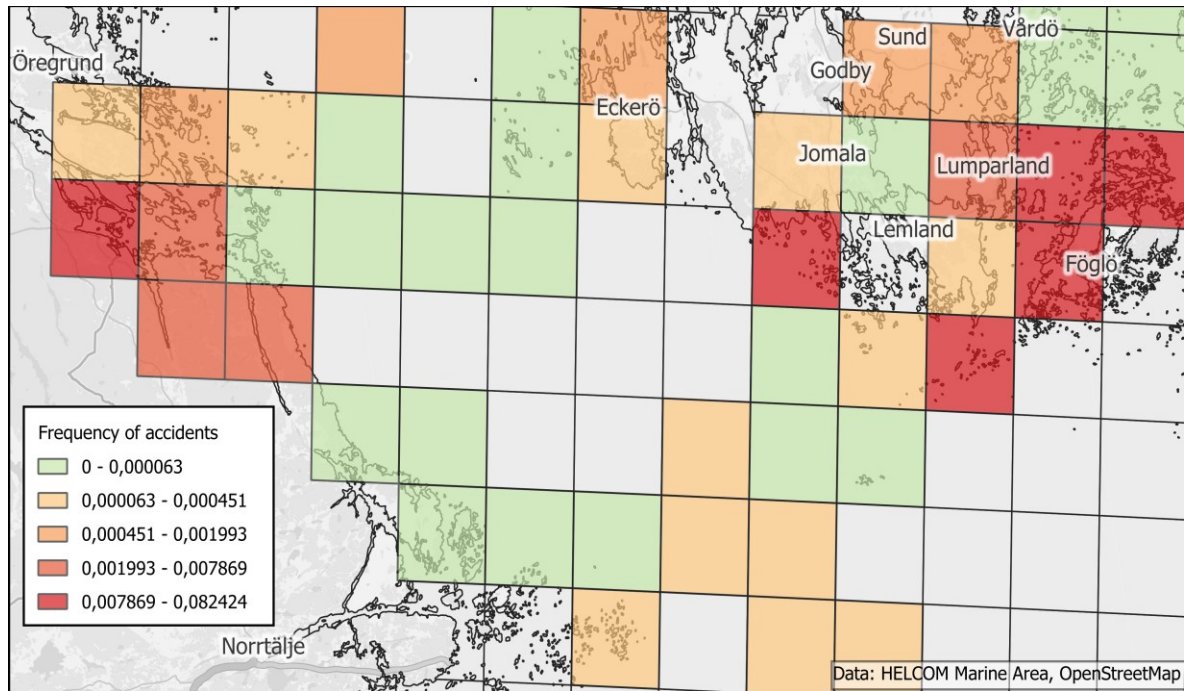
Powered grounding model and collision model

- Establishing a “safety zone” around each vessel
 - Checks for when the safety zone overlaps with land or too shallow water → critical situation.



$$\text{Accidents} = \text{Number of safety zone overlaps ("accident candidates")} \times \text{Causation Probability (P}_C\text{)}$$

Resolution of the frequency of accidents (10x10 km and 1x1 km)



Selected new information in AISyRisk after the ice module update

Area selection by country or HELCOM sub-area for a defined time period

General information

- Time sailed in open water (hours)
- Distance sailed in open water (nm)
- Number of unique vessels that sailed in open water in the selected period
- Frequency of accidents per ship type and size
- *Mean wind speed per month*
- *Median wind speed per month*

Data download will be configured as part of the final setup.

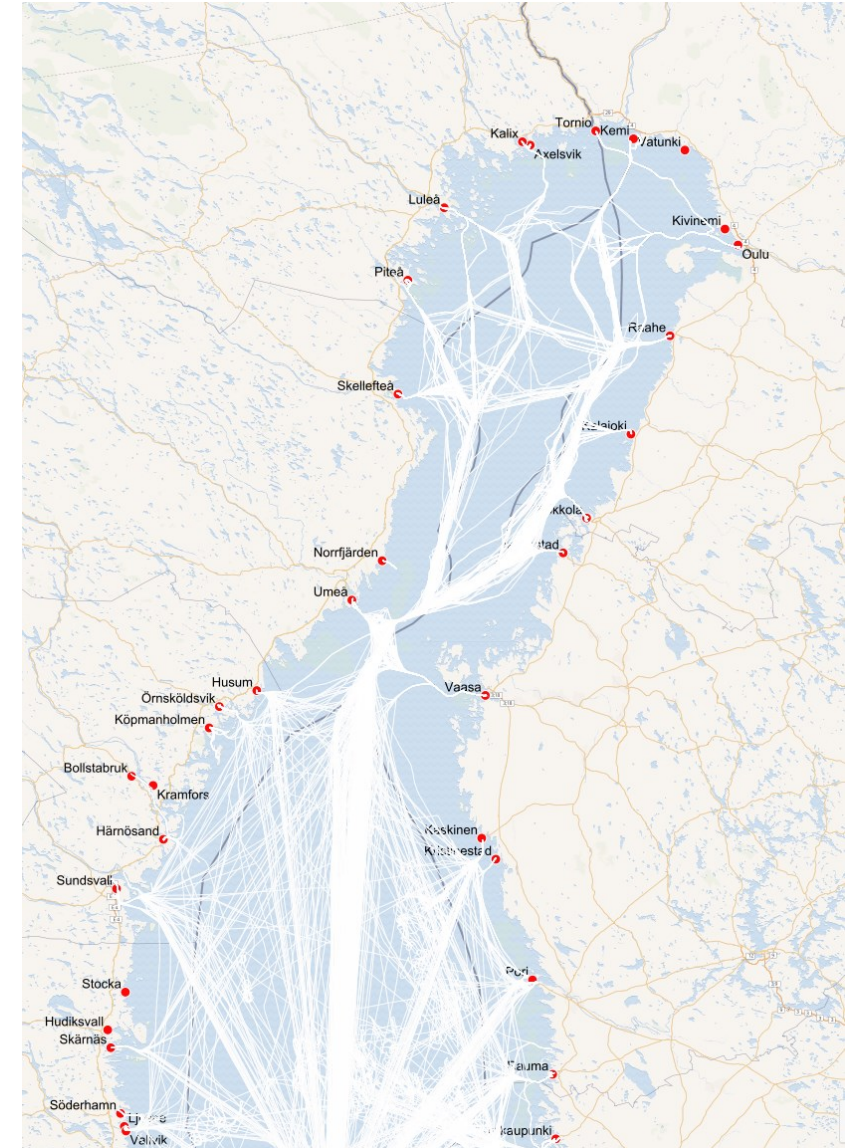
Ice related information

- Time sailed in ice (hours)
- Distance sailed in ice (nm)
- Number of unique vessels that sailed in ice in the selected period
- Frequency of accidents per ship type and size in ice
- Includes vessel ice-class data, enabling assessment of the share of ice-classed ships
- Mean ice concentration
- Mean ice thickness
- Minimum ice thickness per month
- Maximum ice thickness per month
- *Mean RIO score per month – from aggregation of Polaris from individual score per ship*

Processing Ice information



26 February 00:00



Ice module calculation

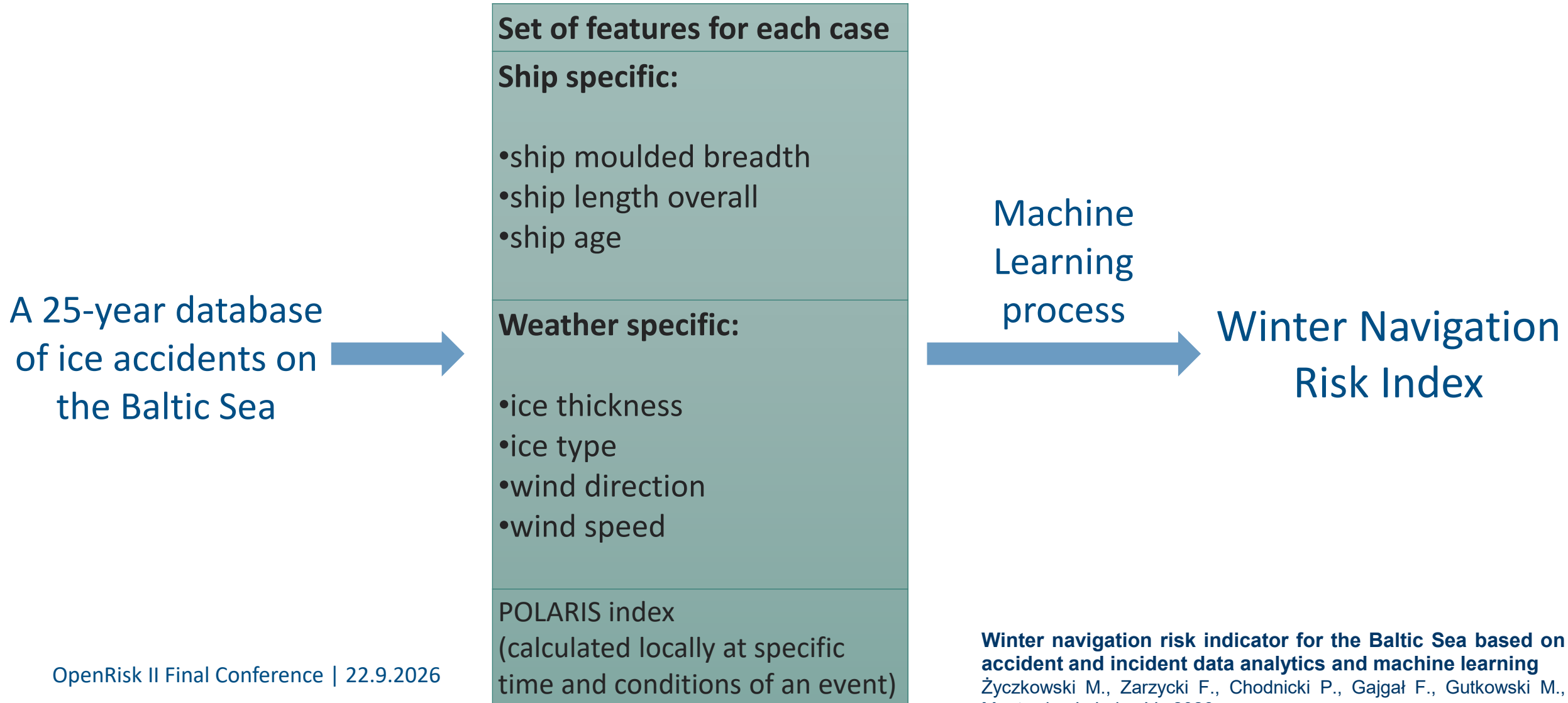
Risk index = $\frac{\text{Number of accidents}}{\text{Distance sailed}}$ * $(1 + \text{Additional Winter Navigation Risk Indicator} < 0,1 >)$

Risk multiplication factor for specific conditions

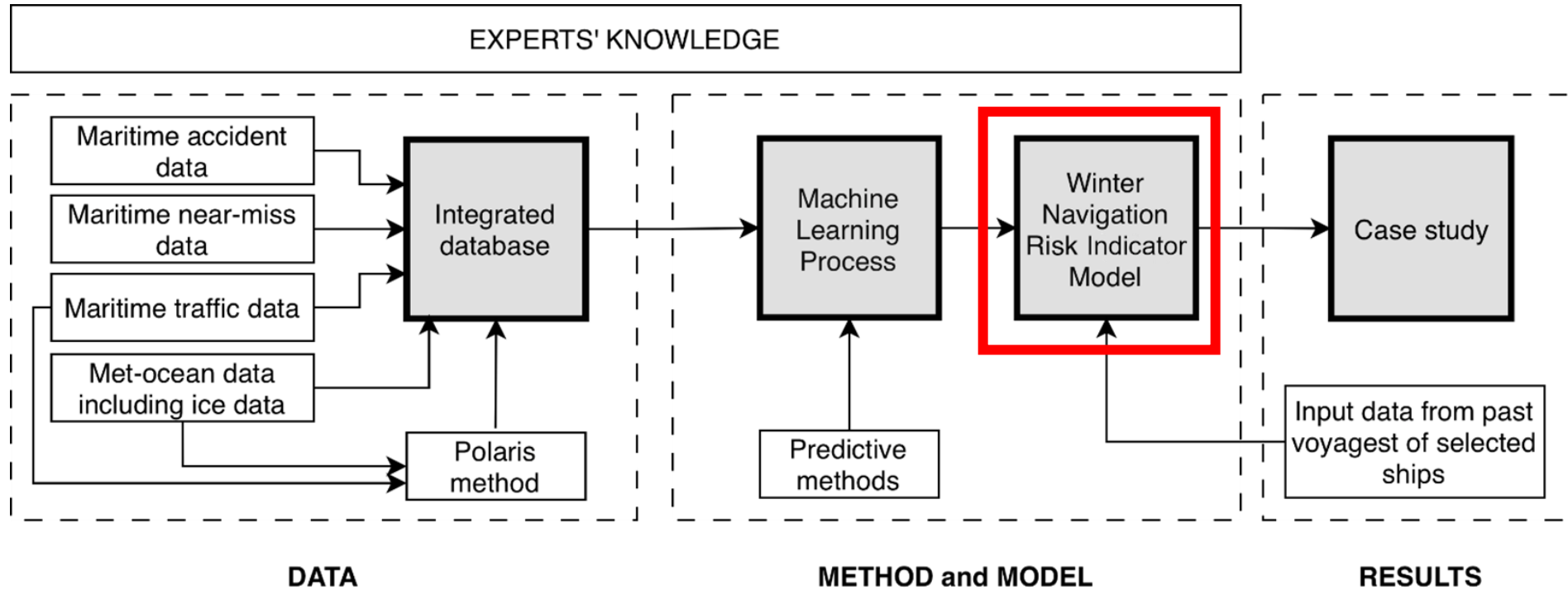
Statistical breakdown of accidents by vessel type, size, and distance sailed

0	The base accident frequency is multiplied with zero, i.e. this accident cannot happen when the given operation mode/condition is in effect. This is applied for traffic distribution (Ice & No accident analysis).
1	The base accident frequency is multiplied with one, i.e. the probability of the accident occurring is unchanged. No additional risk.
1.x	The resulting accident frequency is increased compared to the base accident frequency based on <i>Additional Winter Navigation Risk Index</i> .
x,yE-0z	Unique accident frequency (if possible in future).

Additional Winter Navigation Risk Indicator approach



Winter Navigation Risk Indicator interpretation



The output of the Machine Learning process is **Winter Navigation Risk Indicator (WiNRI)**:

- Continuous value in the range $[0, 1]$, representing the estimated level of risk of accident;
- A value of **1** represents the **highest** level of risk, while a value of **0** represents the **lowest**;
- Navigation outside the ice regime was assigned a value of 0 *a priori*.

The future for AISyRisk and AISyRiskBaltic?

Ongoing Development

- The NCA is modernizing AISyRisk and migrating the platform to a cloud-based infrastructure within the NCA domain.
- The ice module will be integrated and further enhanced for use along the Norwegian coast and around Svalbard.
- High-resolution AIS data for the entire Baltic Sea are now available through the HELCOM server, providing a strong foundation for continued AISyRisk Baltic operations.
 - One of the major success stories of the project has been securing access to and storage of high-resolution AIS data
 - To setup good download possibility of AISyRisk data is a requirement

Opportunities

- The NCA is prepared to operate AISyRiskBaltic beyond the project period, provided that participating states cover the costs associated with processing their national data.
- The methodology and ice module may provide a foundation for future circumpolar maritime risk assessments.

Improvements and knowledge gaps

- Consequence models for oil spills in ice-covered waters require further development
- Better calibration of the causation probabilities
- Handle AIS spoofing:
 - **Speed verification:** Calculates distance over time between consecutive data points.
 - **Anomalous jumps:** Flags vessels that instantly "teleport" across impossible distances.
 - **Performance limits:** Cross-references behaviors against the vessel type's maximum physical capabilities.
 - **Identity duplication:** Triggers alerts if the same MMSI number appears in two places at once for commercial vessels.
- Improving the python scripts for escort in ice

Future of the Baltic Sea region

Questions for the discussion

1. Once the end solution is set into production, will it add value for your organization?
2. Could you use AisyRisk Baltic in your organization? If, yes how?



EcoSensitivity tool session

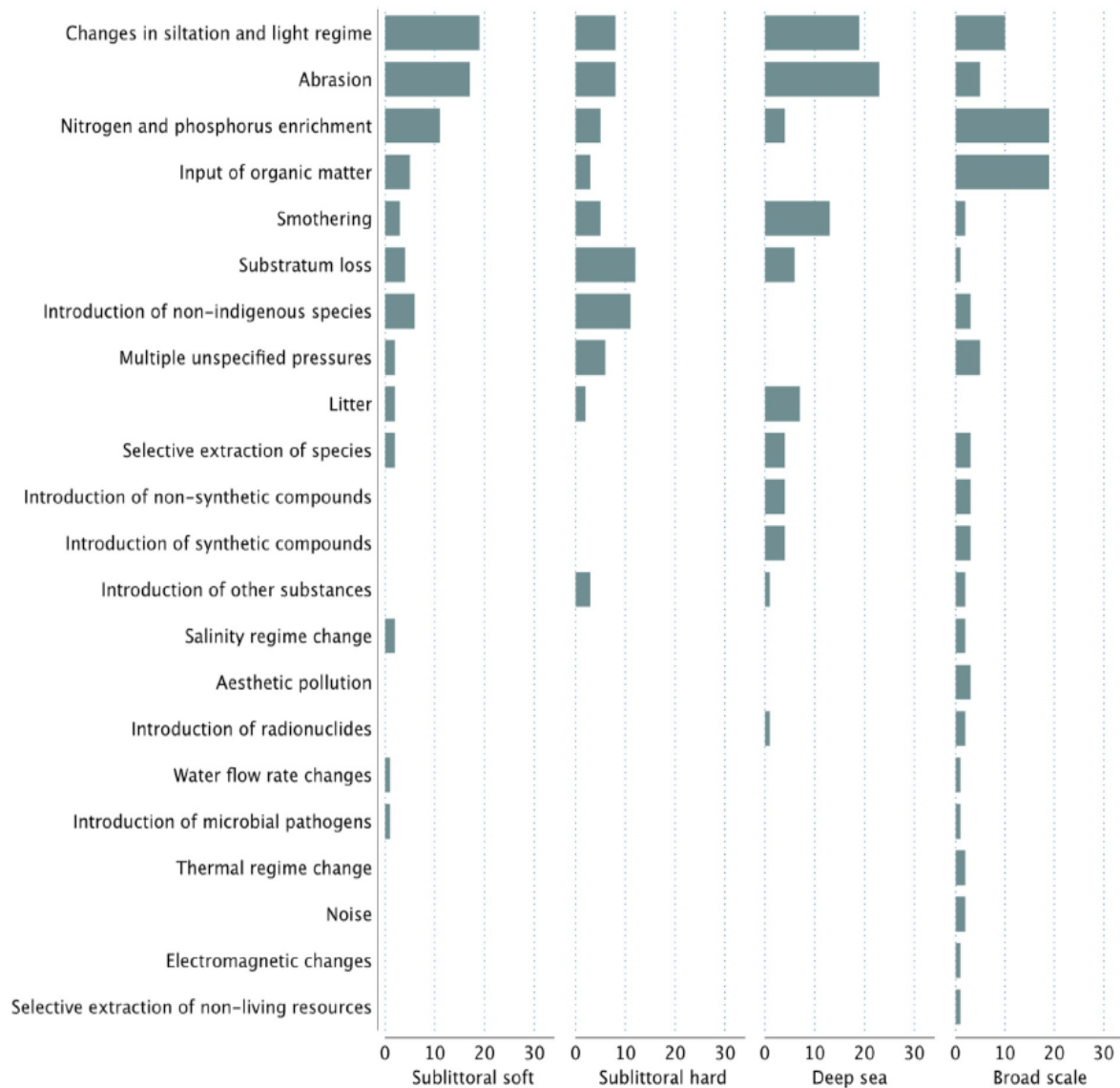
Jonne Kotta and Mihhail Fetissov,
University of Tartu

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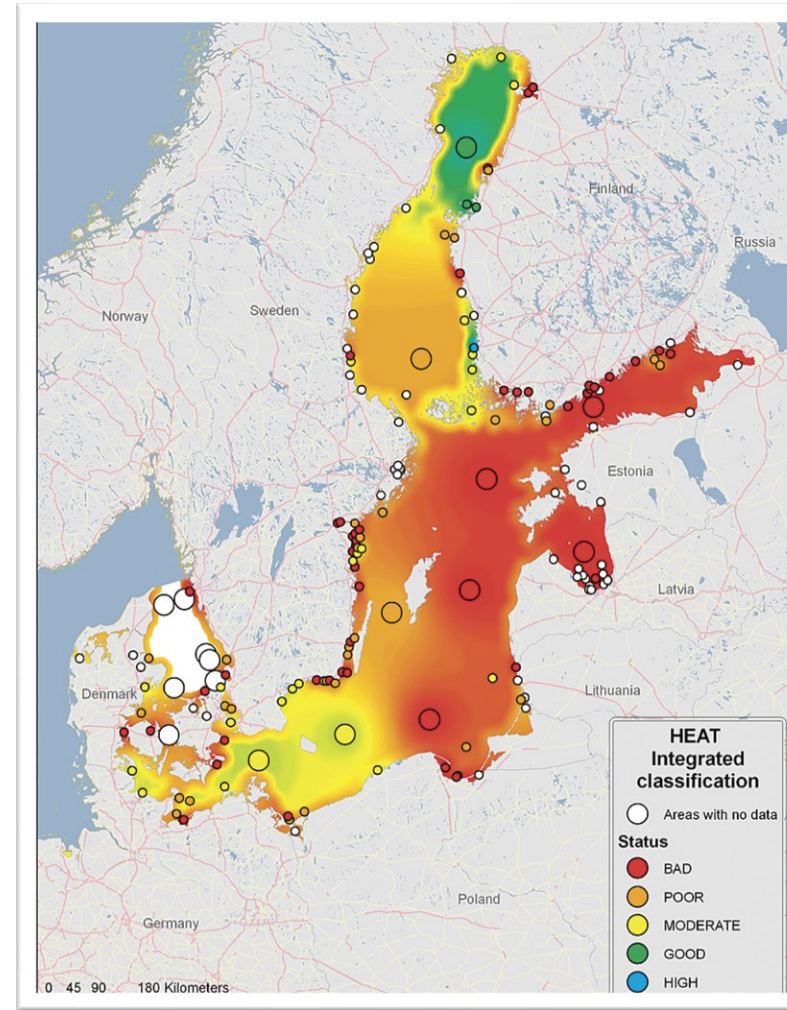
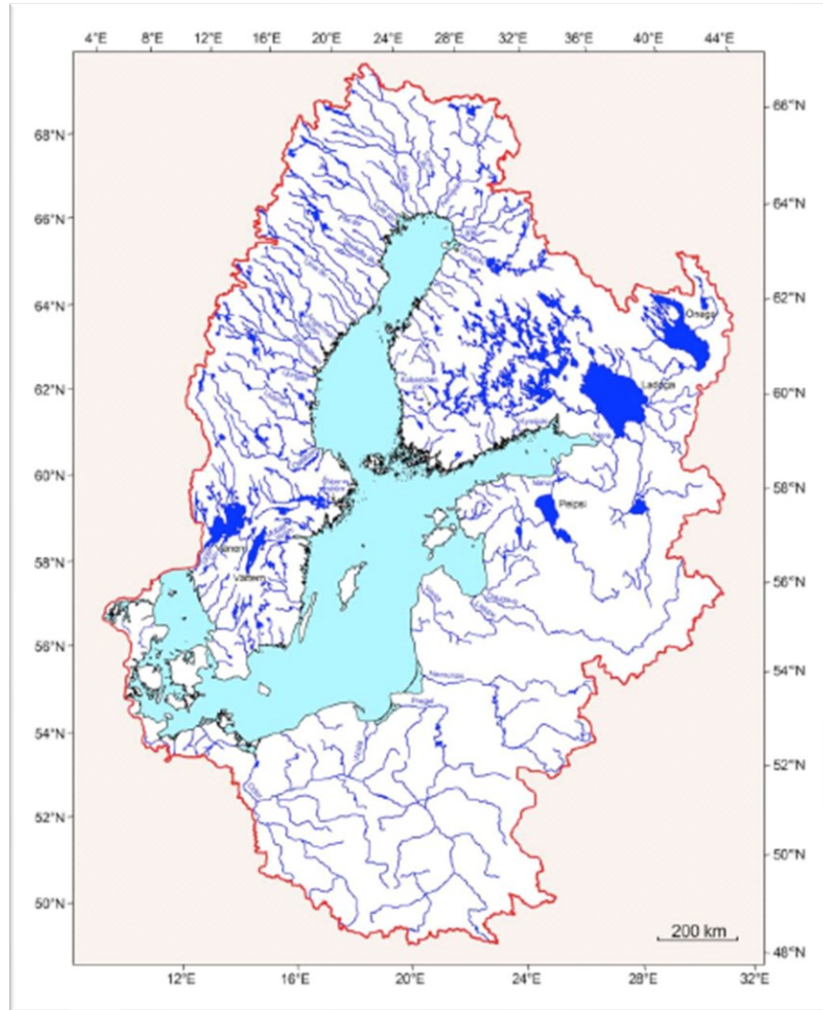


HUMAN ACTIVITIES HAVE IMPACTS

Human induced pressures become more intense and diverse and result in the loss of habitats



Baltic Sea is a transboundary ecosystem with large watershed area





HELCOM Baltic Sea action plan (BSAP) environmental targets

Eutrophication

Baltic Sea unaffected by eutrophication

- Clear water
- Natural level of algal blooms
- Natural distribution and occurrence of plants and animals
- Natural oxygen levels

Hazardous substances

Baltic Sea undisturbed by hazardous substances

- Concentrations of hazardous substances close to natural levels
- All fish are safe to eat
- Healthy wildlife
- Radioactivity at the pre-Chernobyl level

But how?



Biodiversity

Favourable status of Baltic Sea biodiversity

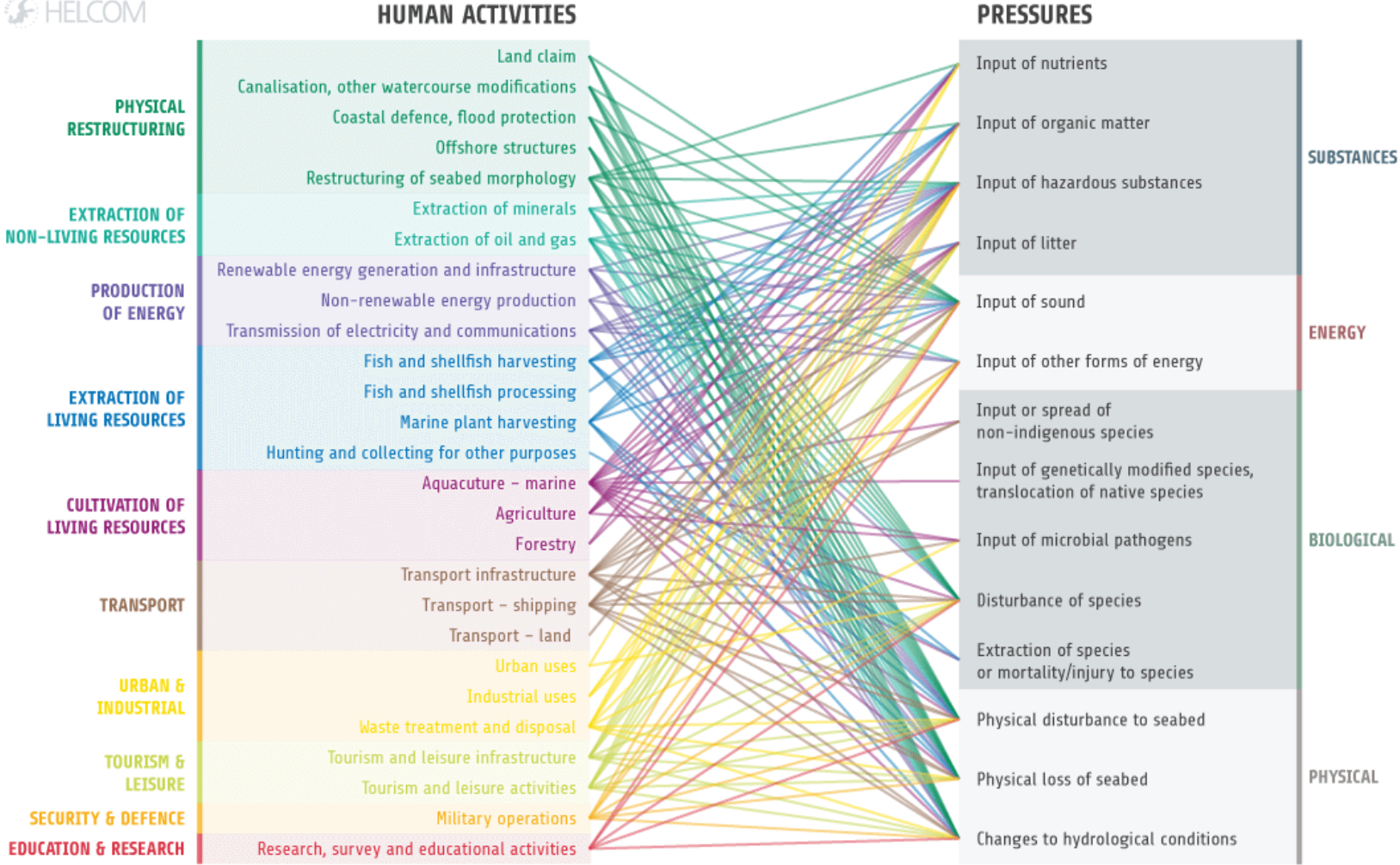
- Natural marine and coastal landscapes
- Thriving and balanced communities of plants and animals
- Viable populations of species

Maritime activities

Environmentally friendly maritime activities

- Enforcement of international regulations – no illegal discharges
- Safe maritime traffic without accidental pollution
- Efficient emergency and response capabilities
- Minimum sewage pollution from ships
- No introductions of alien species from ships
- Minimum air pollution from ships
- Zero discharges from offshore platforms
- Minimum threats from offshore installations

Complex system: human activities and related pressures in the Baltic Sea



Complex ecosystems with multiple feedback loops

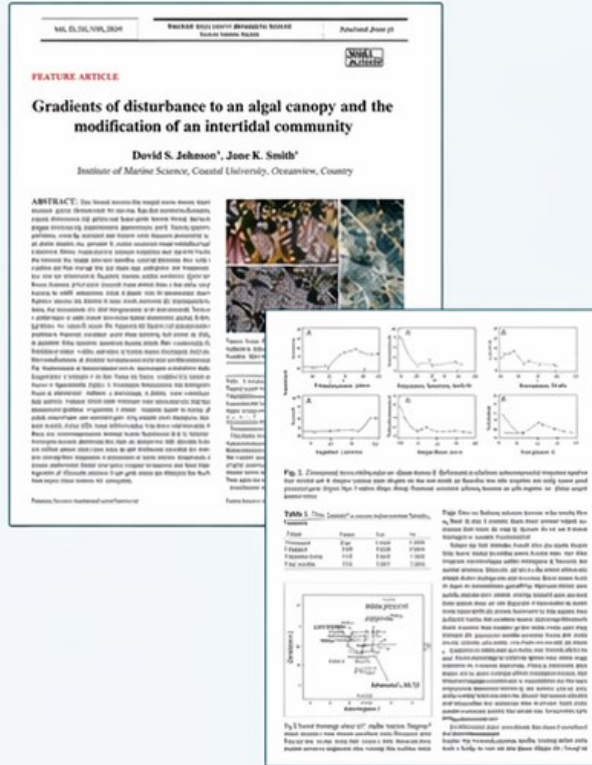


The connection between science and policy remains weak and fragmented

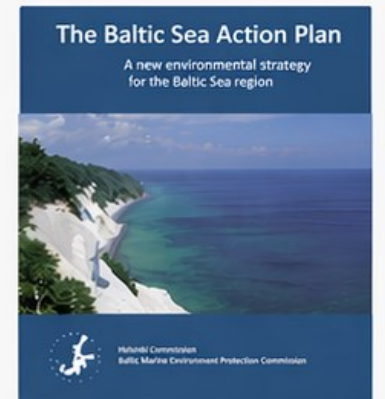
Marine ecosystem functioning and service delivery arise from many components and processes acting at the same time. Understanding this complexity *requires data- and analysis-demanding approaches*.



Data collection

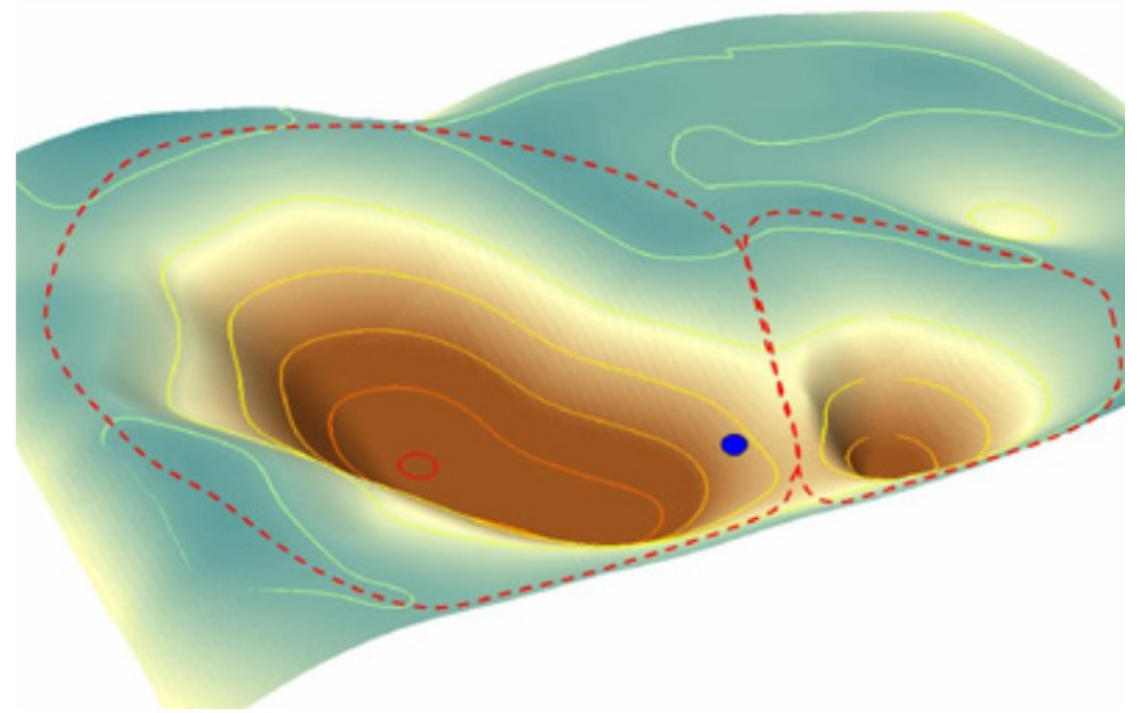
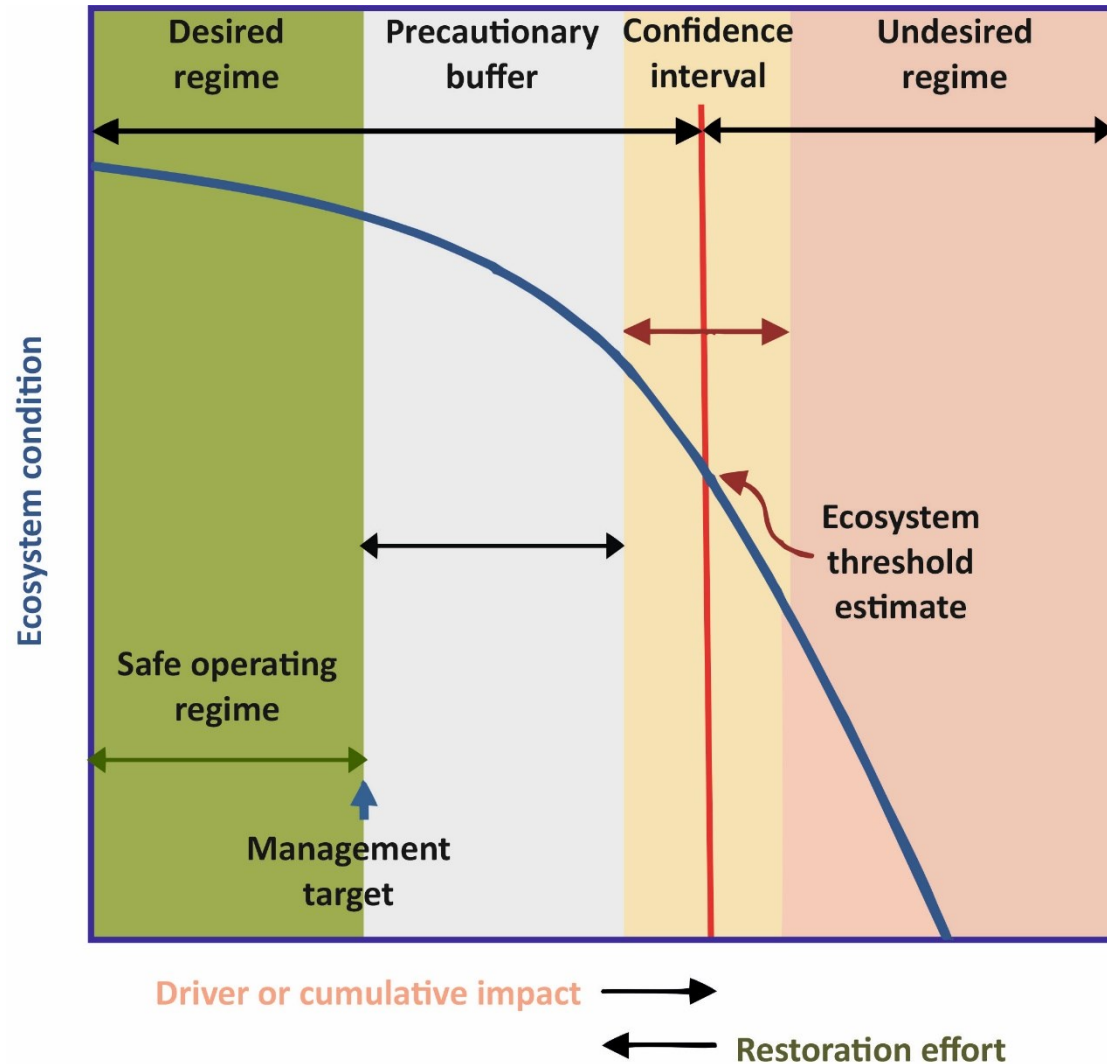


Scientific knowledge



Policy and management outputs

Ecological digital twin: Management model



A transition from current management to true ecosystem-based management

Ecological digital twin: Decision Support Tools

Blue Bio Sites 

About Us

Our Projects & Partners

Feedback Form

Sign Up to our tools



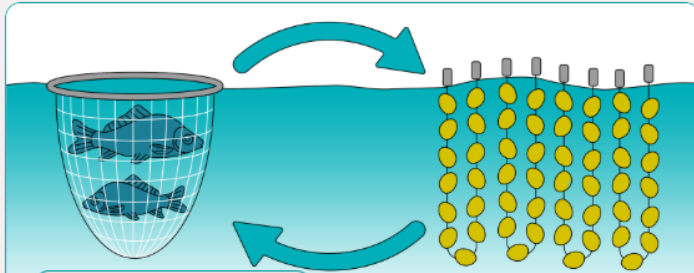
Blue Bio Sites

Blue Bio Sites brings together digital tools that support smarter, more evidence based decisions in the marine environment. The platform is designed for the wider blue sector and helps users better understand, plan, and manage human activities and environmental change at sea. Its overall aim is to turn complex marine data into clear and usable insights that help link science, planning, and management.

<https://gis.sea.ee/bluebiosites/>

Ecological digital twin: Decision Support Tools

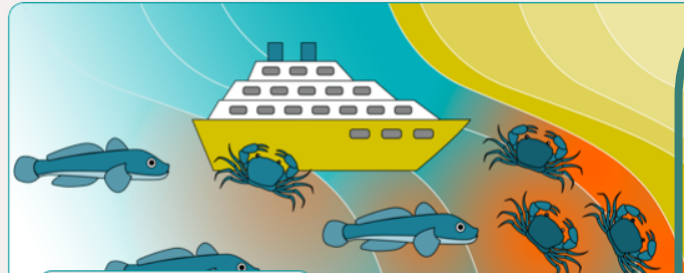
Our Tools



 Guide

ODDS

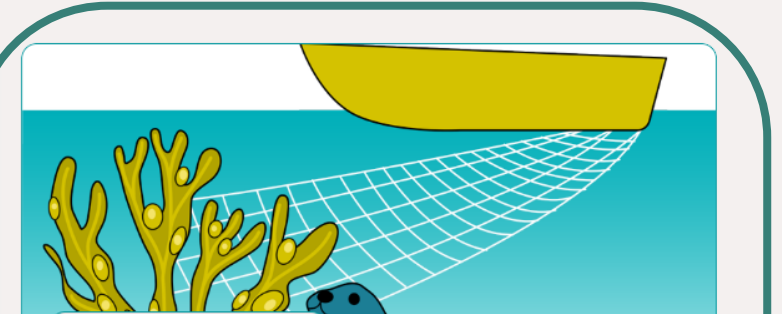
Grow low trophic aquaculture where nature supports it



 Guide

NEAT

Understand the environmental risks of non-native species



 Guide

PlanWise4Blue Europe

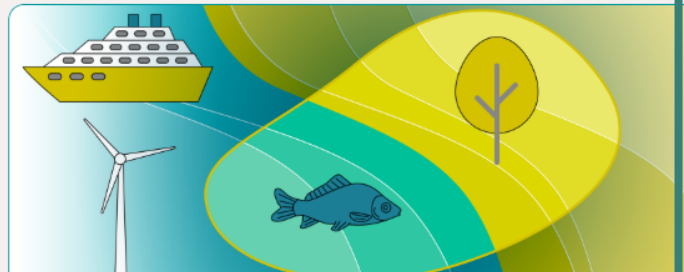
Scenario tool to assess cumulative effects on nature



EcoFunMap

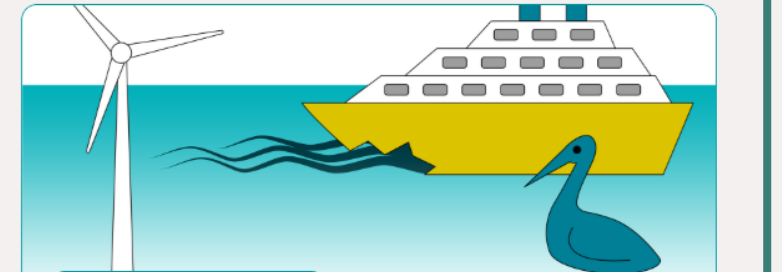
Turn food web science into ecosystem functioning





ABC Planner

Turn biodiversity data into smarter conservation area design



 Guide

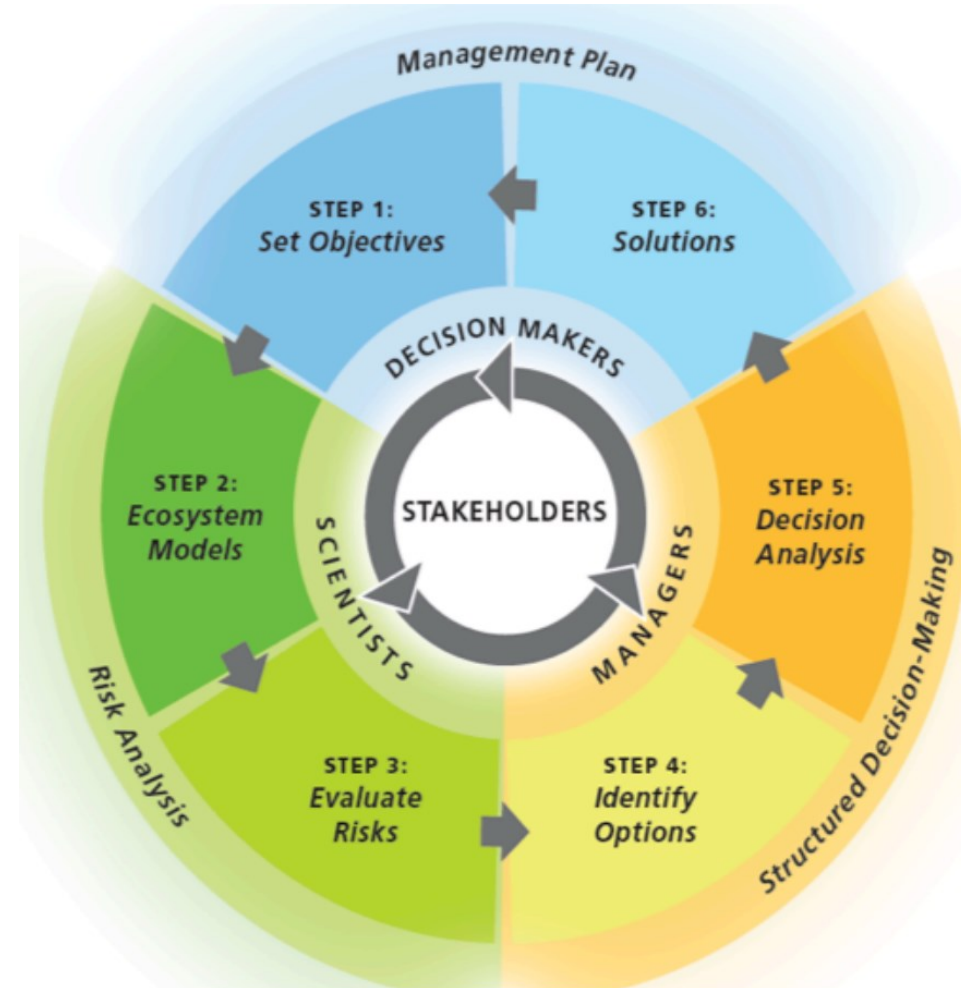
EcoSensitivity Tool

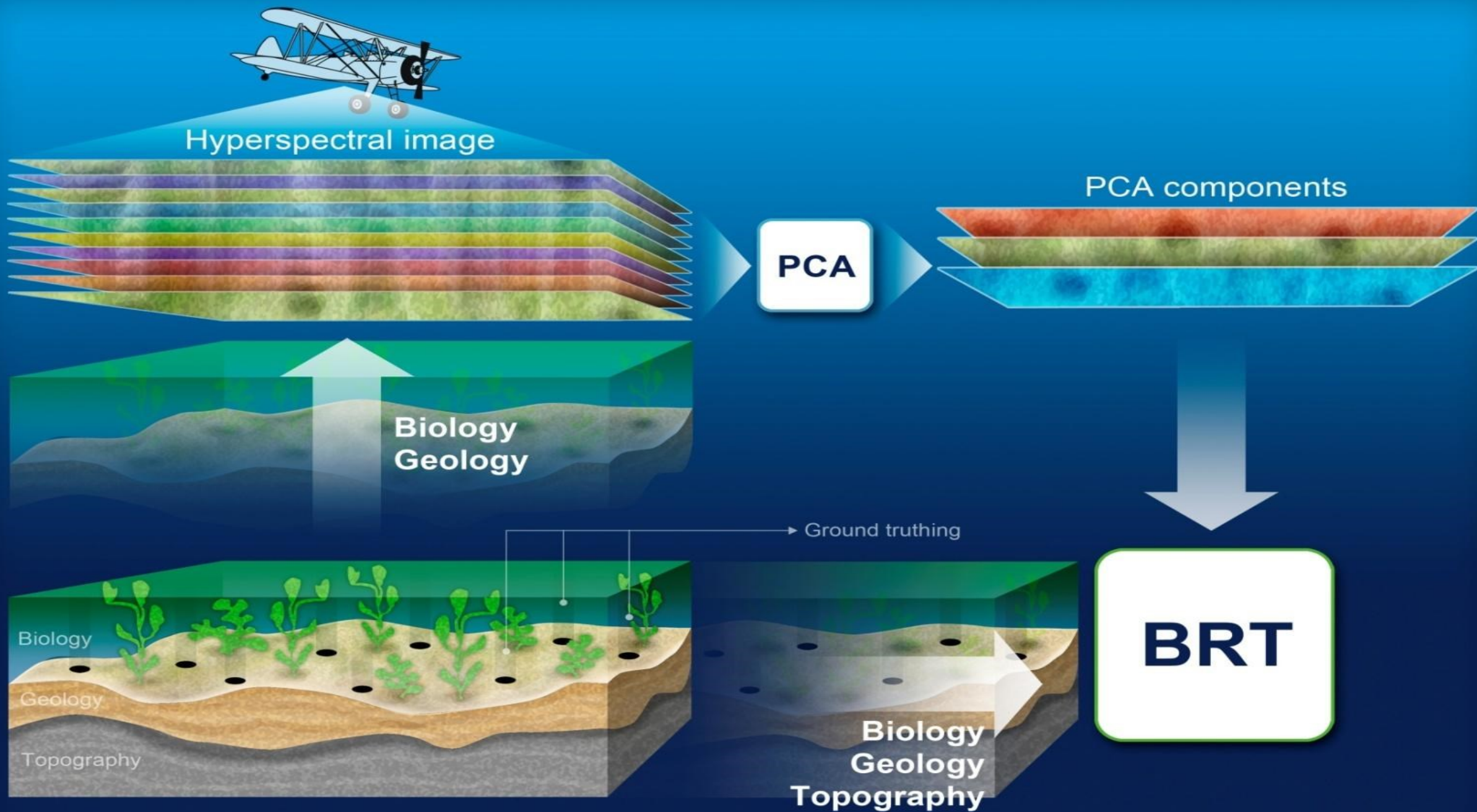
Guide oil spill action with real time risk intelligence

<https://gis.sea.ee/bluebiosites/>

Assessing cumulative impacts → informing management →
→ data and knowledge driven environmental decisions

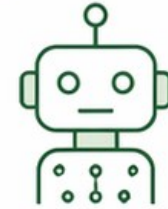
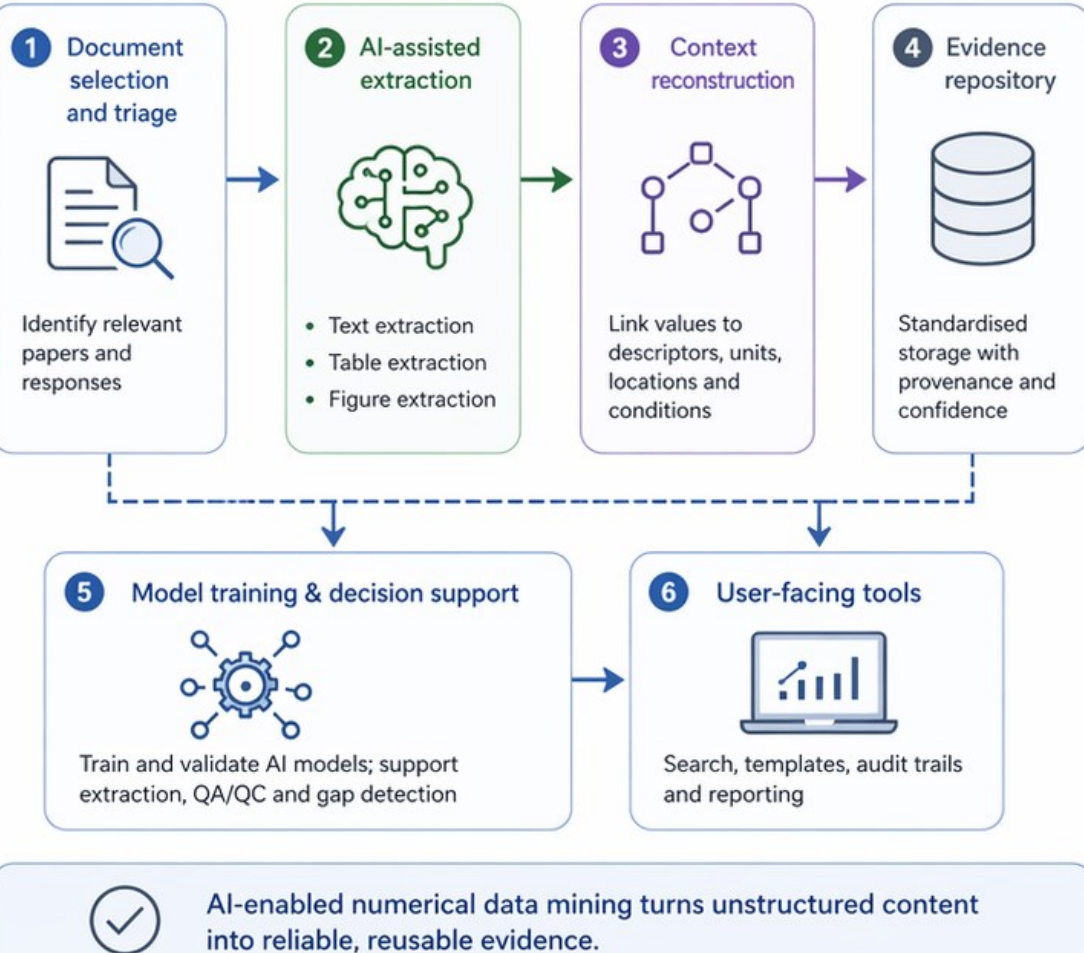
Cumulative impacts: Impacts on the environment that result from pressures of several human activities acting together, as caused by past, present or any possible foreseeable future actions





Overcoming the challenges of knowledge scarcity and quality

Context-aware numerical evidence extraction workflow



AI-based numerical data mining algorithm

Continuously learns and improves from feedback and new data



Structured knowledge base



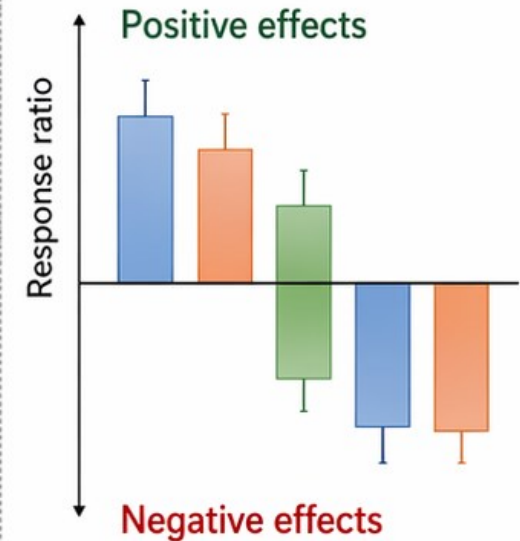
- ✓ Standardised
- ✓ Traceable
- ✓ Quality-assessed
- ✓ Continuously updated



Used to parameterize CEA models



Reliable parameters for cumulative effects and carrying capacity assessment models and scenarios



Draw your area of interest (geographic extent)

 **BlueBioSites**

 Input Layers

 Cumulative Effects Assessment

 Workspaces

 Layers

PERMAGOV seminar

☒ Scenario Extent

☒ Conservation areas - Europe

☒ Conservation features and measures - Estonia

☒ Human activities

☒ Administrative boundaries

Shared tools ▾ **PlanWise4Blue Europe** jonne.kotta@ut.ee ▾

 Model settings

 **Extent** success

 Human pressures not ready

 Nature values not ready

 Results Map not ready

 Results Tables not ready

Draw extent of the study area  

Apply extent

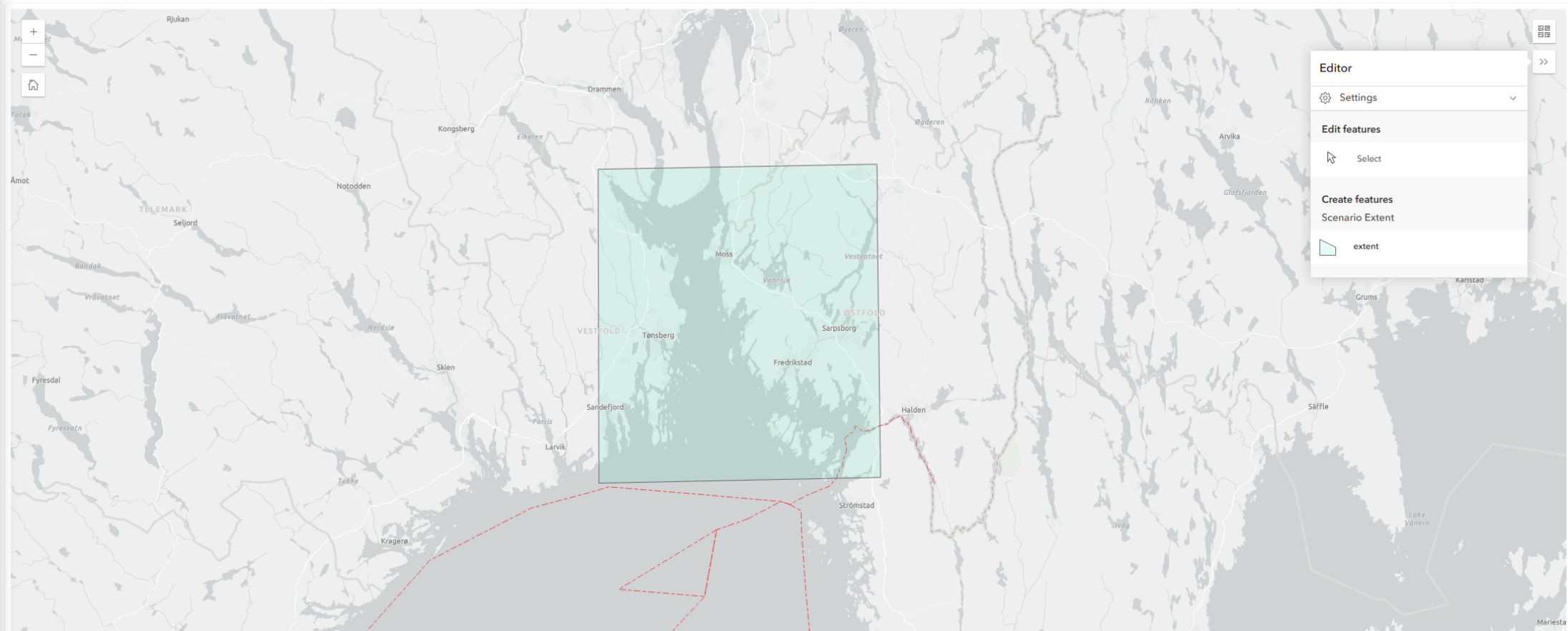
Copy extent from PW4B workspace

Human impact calculation

 **Finish** saved

 **Copy Extent**

 **Run model** not ready



Select human activities, choose the baseline and future scenario(s), and modify their intensity and/or spatial extent

BlueBioSites

Input Layers

Cumulative Effects Assessment

Workspaces

Layers

PERMAGOV seminar

Scenario Extent

PlanWise4Blue Europe

Model settings

Extent

Human pressures

Nature values

Results Map

Results Tables

Manage Human Pressures in the workspace

Available human pressures

Nutrient load

Wastewater discharge outlet

Contaminants release

Microplastics release

Marine littering

Major oil accident

Extraction of oil and gas

Dredging and dumping areas

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Human pressures in workspace

Nutrient load

Sea temperature

Intensity

1

Assessment scenario

Scenario A total load

Reference scenario

Baseline scenarium total load

Current

Baseline scenarium agriculture

Baseline scenarium municipal

Baseline scenarium total load

Scenario A agriculture

Scenario A municipal

Scenario A total load

Scenario B agriculture

Scenario B municipal

Scenario B total load

Copy existing

Edit/Create

Build combinations

Human impact calculation

Run model

Map

Select nature assets from different categories, such as habitats and species, and run the cumulative effect assessment

BlueBioSites

Input Layers

Cumulative Effects Assessment

Workspaces

Layers

PERMAGOV seminar

Scenario Extent

Nature Values - Europe

Shared tools

PlanWise4Blue Europe

Success Success Success not ready not ready

Model settings Extent Human pressures Nature values Results Map Results Tables

Manage Nature values in the workspace "PERMAGOV seminar"

Search available nature values...

Habitats (31)

EUNIS Habitat Classification (31)

Species (17)

Fish (1)

Invertebrates (3)

Mammals (2)

>

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Nature values in workspace

Circularlittoral rock, area

Circularlittoral sand, area

Infralittoral rock, area

Infralittoral sand, area

Alaria esculenta, index 0...1

Ascophyllum nodosum, index 0...1

Laminaria digitata, index 0...1

Laminaria hyperborea, index 0...1

Save the list

Human impact calculation

Run model

Explore the results map to compare baseline and scenario values and identify increases or decreases



BlueBioSites



Input Layers



Cumulative Effects Assessment



Workspaces



Layers

WS3 scenario B wt climate vs baseline



Left side map

Comparison: Bentic Habitats HIJL / init value ↔ Bentic Habitats HIJL / end value

Layer value ranges: auto.

Scenario Extent



Bentic Habitats HIJL

Kelp forest

init value

	0.98 - 1.00
	0.96 - 0.98
	0.95 - 0.96
	0.93 - 0.95
	0.91 - 0.93
	others

PlanWise4Blue Europe

oslofjord@sea.ee

Model settings Extent success Human pressures success Nature values success Results Map success Results Tables success

Comparison layers for "WS3 scenario B wt climate vs baseline"

Lat/Lon 59.553 11.059

Lat/Lon 59.151 10.267

Explore the tabular view to see effects across all included nature assets

BlueBioSites

Input Layers

Cumulative Effects Assessment

Workspaces

Layers

Enter new workspace name... +

Workspace	Timestamp
PERMAGOV seminar	03.09.2026 17:43:13

Shared tools PlanWise4Blue Europe

Model settings

Extent SUCCESS

Human pressures SUCCESS

Nature values SUCCESS

Results Map SUCCESS

Results Tables SUCCESS

Summary table

Negative Contribution

Positive Contribution

Distribution of losses

Copy CSV EXCEL

General				Current baseline		CEA scenario		Change from current baseline		
Nature value	Region	Area of overall extent (km ²)	Area with no data for the nature value within the extent (km ²)	Nature value area (km ²)	Total biomass or abundance (kg or ind)	Nature value area (km ²)	Total biomass or abundance (kg or ind)	Change in nature value area (km ²)	Overall nature value area affected (km ²)	Change in total biomass or abundance (kg or individuals)
Alaria esculenta, index 0...1	atlantic	1535.67	0.46	0	0	0	0	0	8.77	0
Ascophyllum nodosum, index 0...1	atlantic	1535.67	0.46	102.47	0	102.47	0	0	49.06	0
Laminaria digitata, index 0...1	atlantic	1535.67	0.46	299.93	0	296.57	0	-3.36	239.74	0
Laminaria hyperborea, index 0...1	atlantic	1535.67	0.46	231.94	0	216.75	0	-15.19	347.94	0
Saccharina latissima, index 0...1	atlantic	1535.67	0.46	363.88	0	363.61	0	-0.27	273.87	0
MB1: Infralittoral rock, area	atlantic	1535.67	0	454.93	0	454.93	0	0	95.87	0
MB5: Infralittoral sand, area	atlantic	1535.67	0	16.11	0	16.11	0	0	2.86	0
MC1: Circalittoral rock, area	atlantic	1535.67	0	375.99	0	375.99	0	0	105.17	0
MC5: Circalittoral sand, area	atlantic	1535.67	0	34.43	0	34.43	0	0	3.2	0

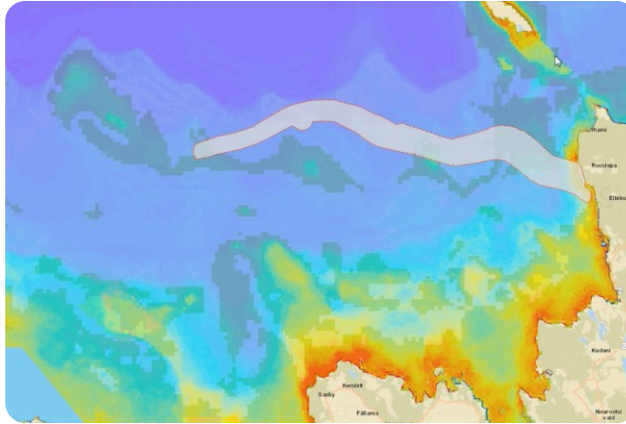
Oil spill impacts are event-specific

1 The spill



Location, oil type
and spill volume

2 The exposure



Environmental conditions
shape where oil travels

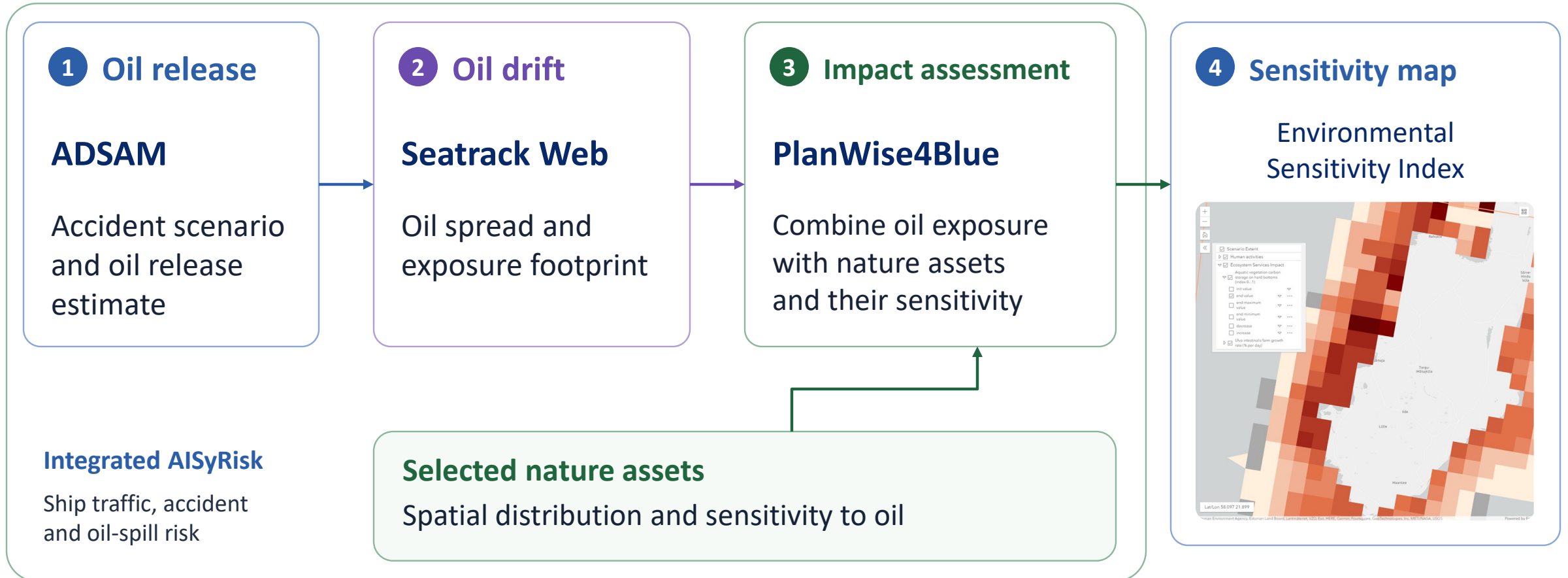
3 The ecosystem



Impacts depend on the
assets exposed and
their sensitivity to oil

Rapid response must address immediate damage and longer-term ecological effects.

EcoSensitivity: how the assessment works



Supports response priorities and longer-term restoration planning

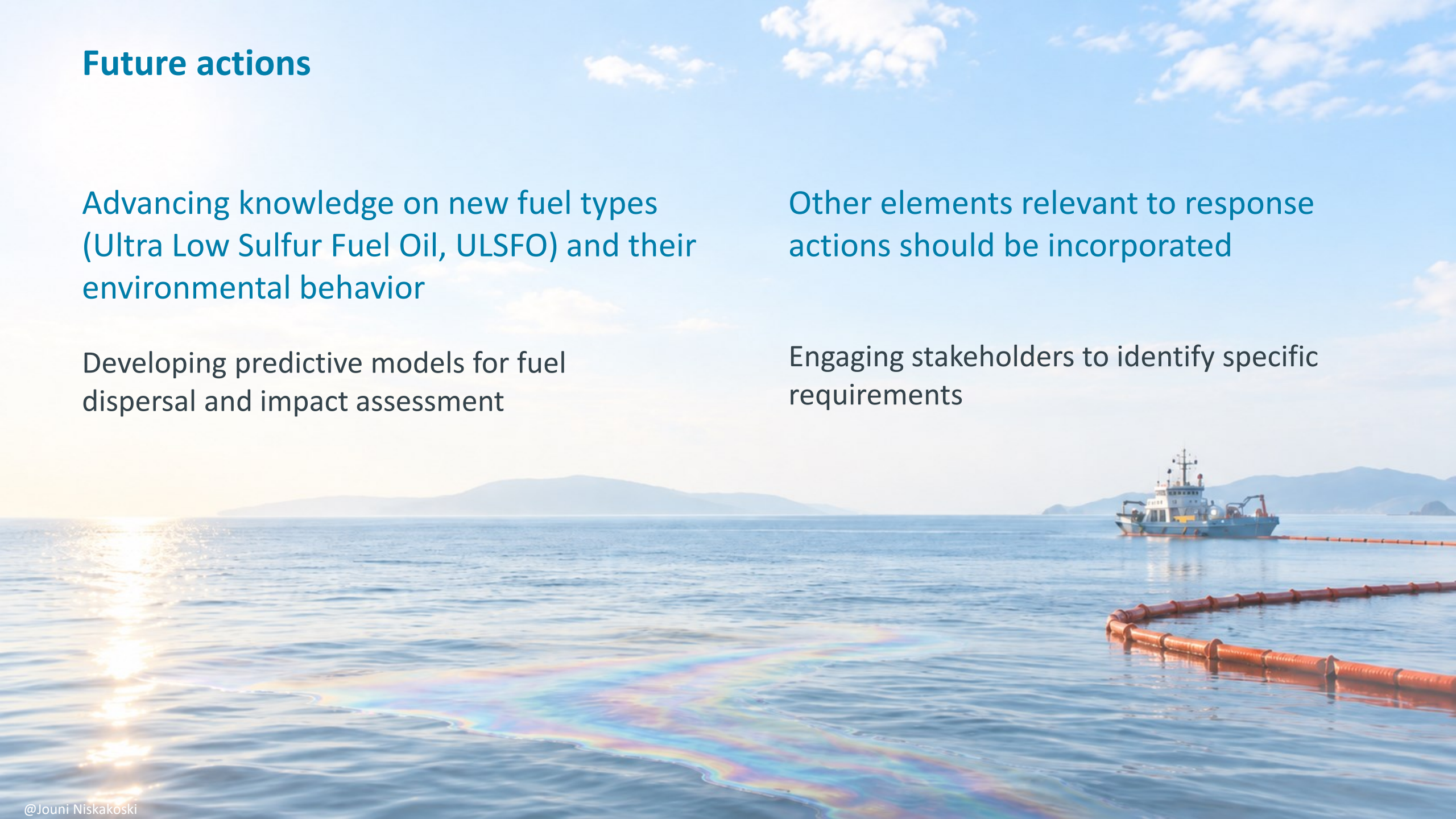
Future actions

Advancing knowledge on new fuel types (Ultra Low Sulfur Fuel Oil, ULSFO) and their environmental behavior

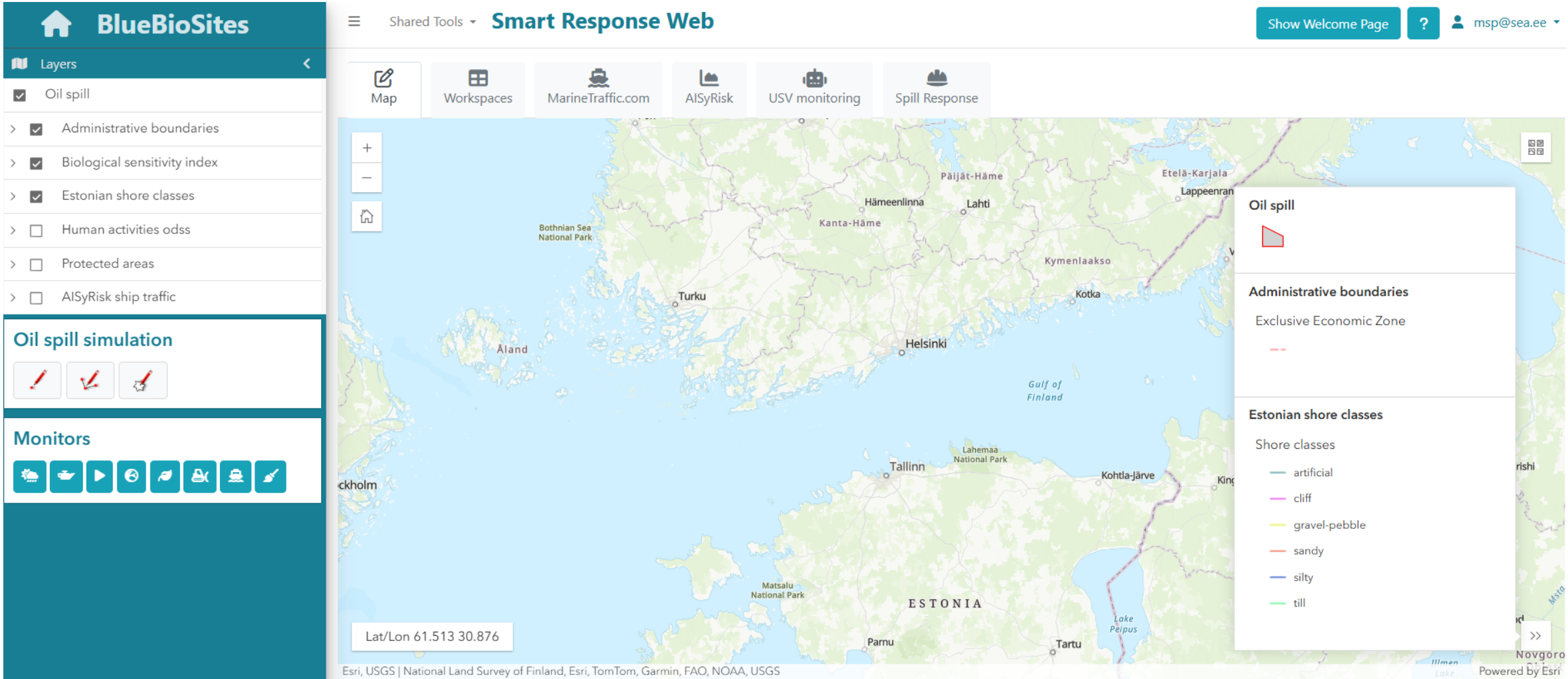
Developing predictive models for fuel dispersal and impact assessment

Other elements relevant to response actions should be incorporated

Engaging stakeholders to identify specific requirements



Tool demonstration



Exploring methodological approaches to policy effectiveness and information integration using Bayesian Networks

Jaana Haavisto, University of Helsinki

OpenRisk II Project Final Conference on Maritime Risk Management in the Baltic Sea Region | 22.9.2026 Kristiansand, Norway

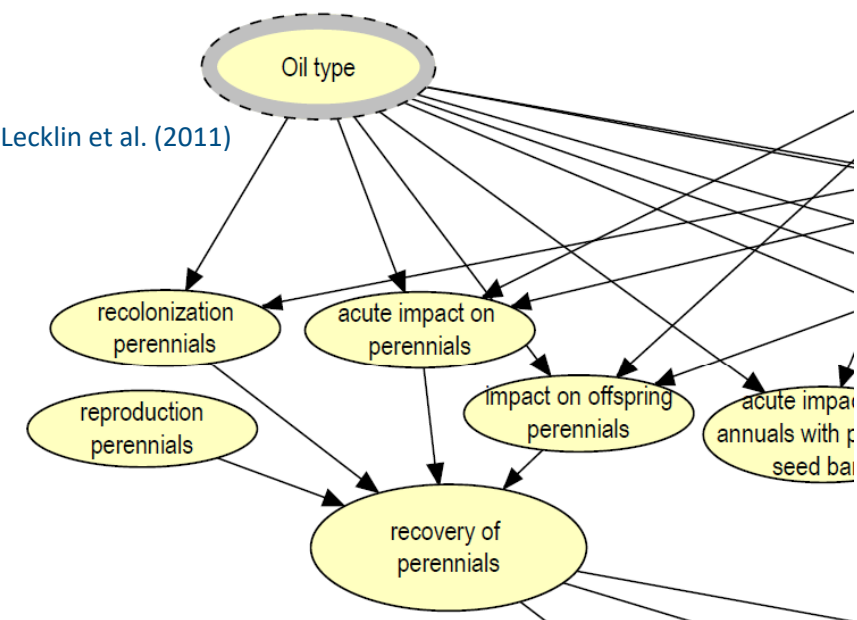


Introduction

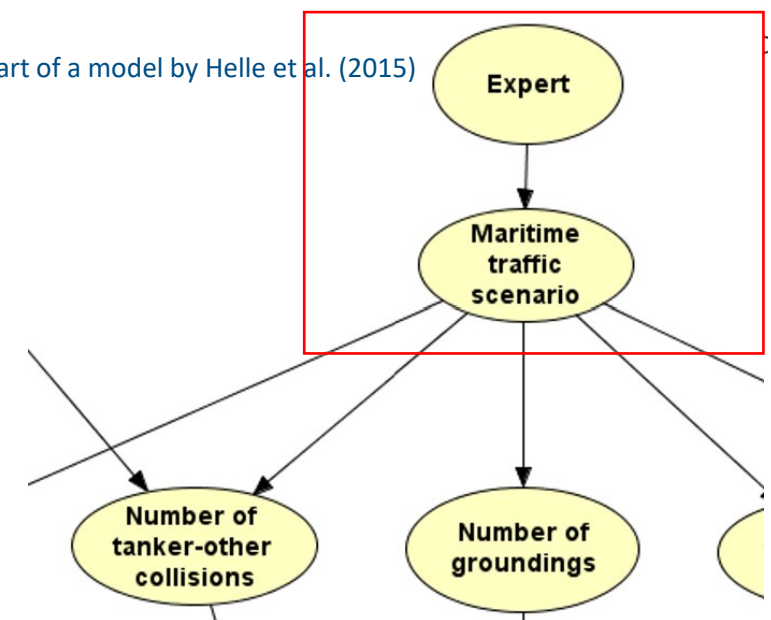
Bayesian Networks

- Graphical probabilistic networks used for decision support
- Also known as information or belief networks, as they represent the current understanding of systems and the causal relationships in the system
- Utilize information from multiple different sources, e.g., existing data, simulations or expert elicitation
- Serve as a useful tool for the exploration of future systemic changes, e.g., Helle et al. (2015) included expert knowledge on possible future changes in maritime traffic in the Gulf of Finland

[1] Part of a model by Lecklin et al. (2011)



[2] Part of a model by Helle et al. (2015)

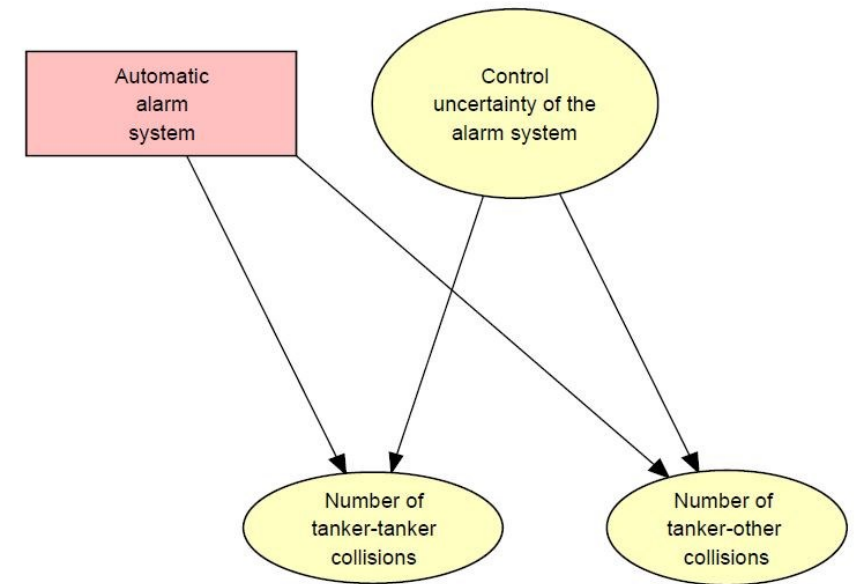
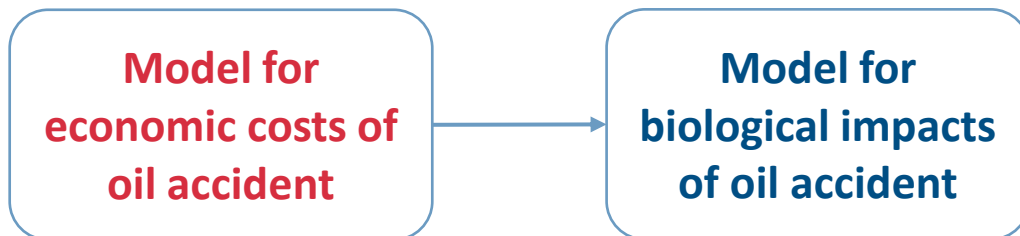


Introduction

UH work during the project

Focus on new methodological approaches to evaluate

1. **policy effectiveness uncertainty**, i.e., how uncertain policy outcomes impact the system, which in our example focuses on oil spill risks and related economic and biological consequences
2. **integration of existing Bayesian networks**, i.e., how separately developed networks can be integrated into one for more holistic decision support



Related to questions for decision making processes:

How should we prepare for policy outcomes that

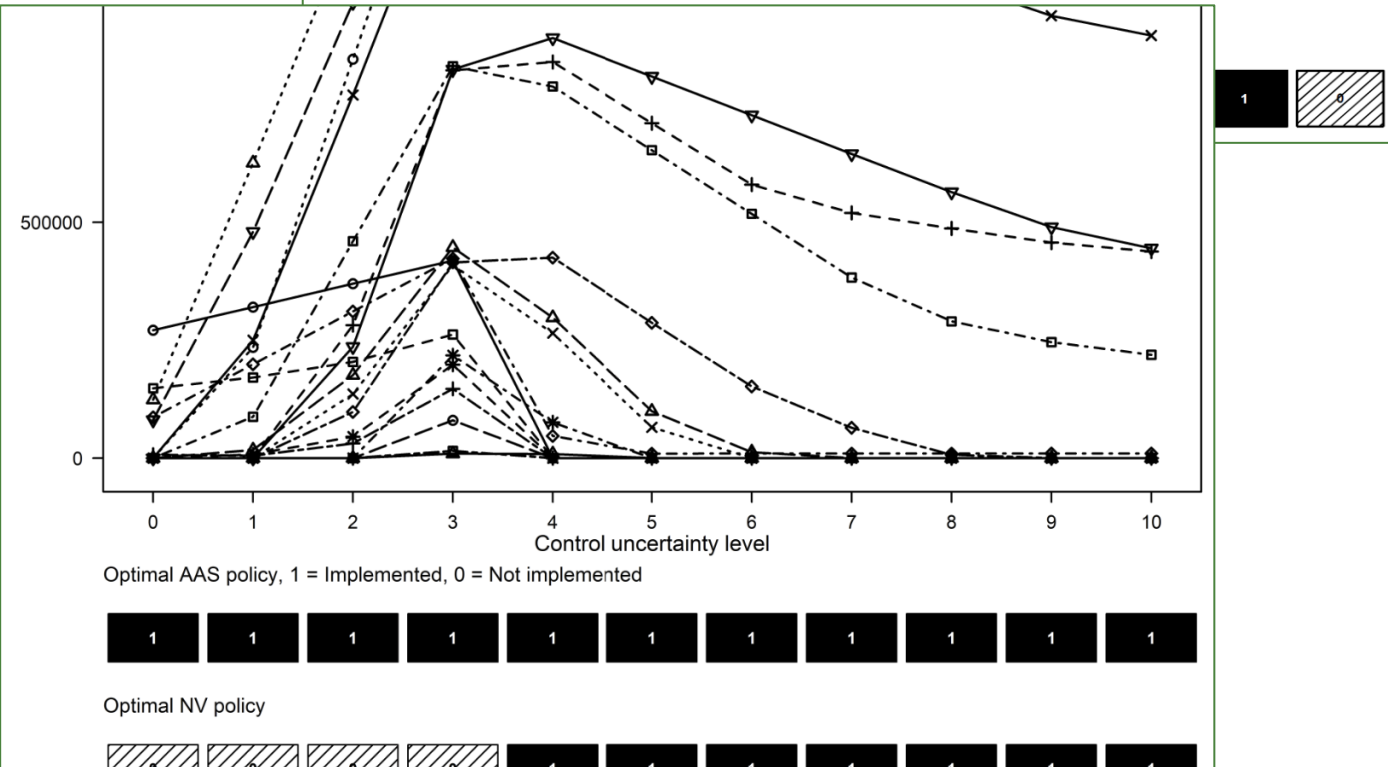
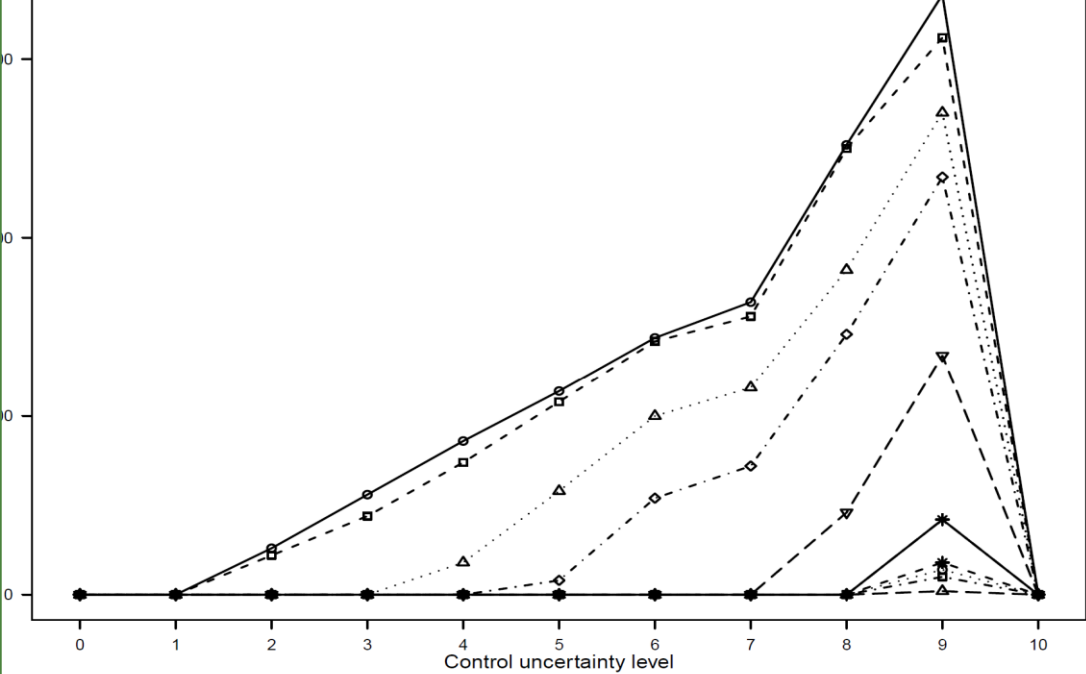
1. are not as effective as initially believed,
2. Or how can we utilize existing probabilistic information more efficiently.

Results

Policy effectiveness had a connection with the benefit of additional information about the system.

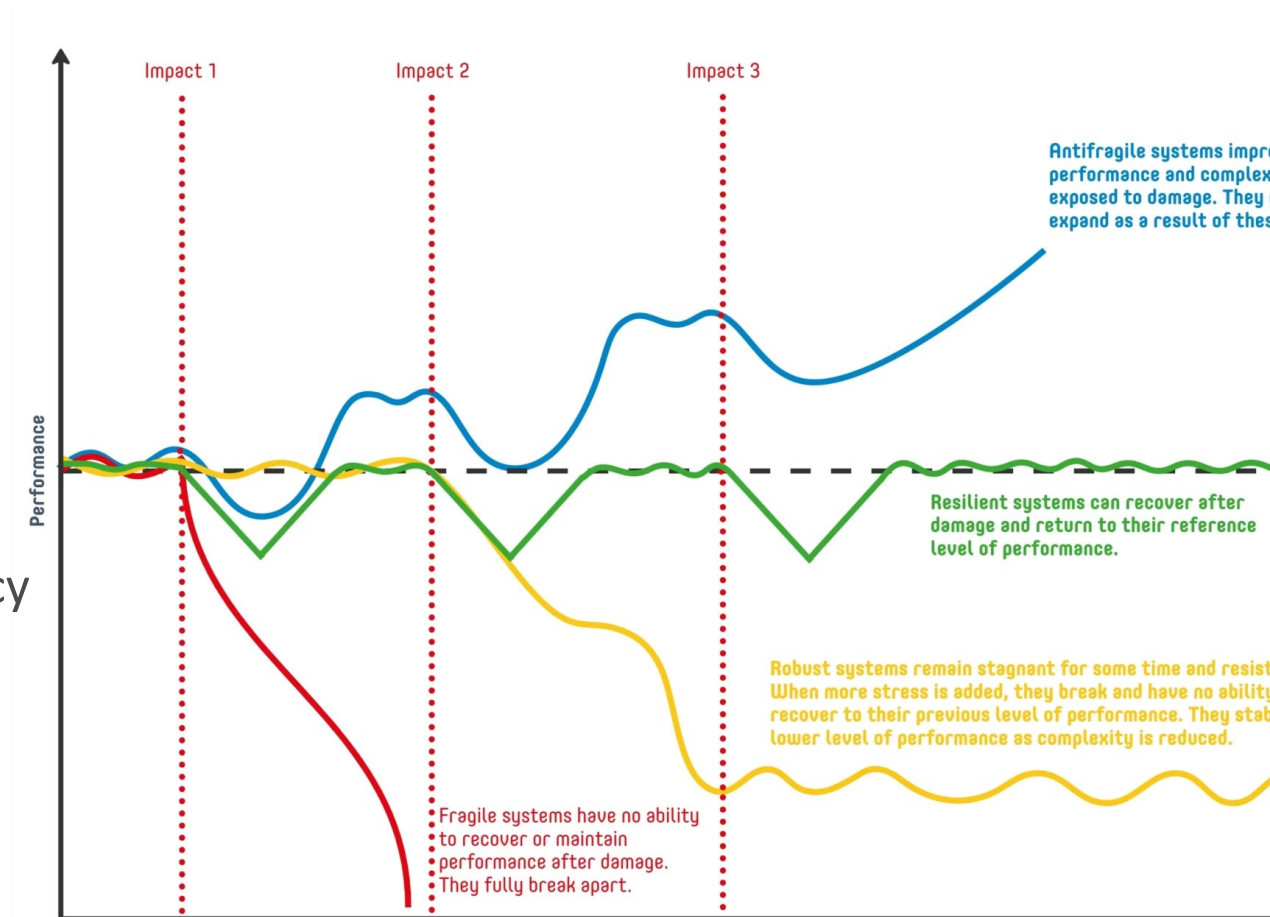
When policy effectiveness decreased, supporting information about the system became more beneficial.

If a supporting policy was available, it became optimal to implement for more uncertain levels of policy effectiveness.



Recommendations

- Evaluation of policy effectiveness, or systemic changes that can impact it, should be conducted during policy evaluations.
- Expert elicitation can be used in those instances, where no existing information about the effectiveness is available.
 - What changes in the system could impact current or planned policy?
 - How strong this change would impact policy effectiveness?
- **Building resilience:** understanding the impact of future changes on the effectiveness of current or planned policies can help to ensure system resilience, i.e., under disturbance, we still have ways to manipulate the system.



[3] From blog by Datentreiber (2024)

Conclusions

These approaches were not the focal point in the newly developed tools, but they are also important questions for decision making perspective.

Frameworks for evaluation of policy effectiveness and the integration procedure of existing Bayesian networks are now under publishing process.

In the future we aim to strengthen these concepts further and explore stakeholder experiences in, for example,

1. the evaluation process of policy effectiveness or uncertainties in planned interventions,
2. the benefit of information integration using existing Bayesian Networks.



Discussion and feedback



<https://forms.cloud.microsoft/e/c3HwuC1axk>

Screen.io participation tool

We will use Screen.io during the next workshop and the future-oriented session to collect your views and ideas.

traficom.screen.io/or2



R-Mare matrix – Tool for enhanced overall risk management performance

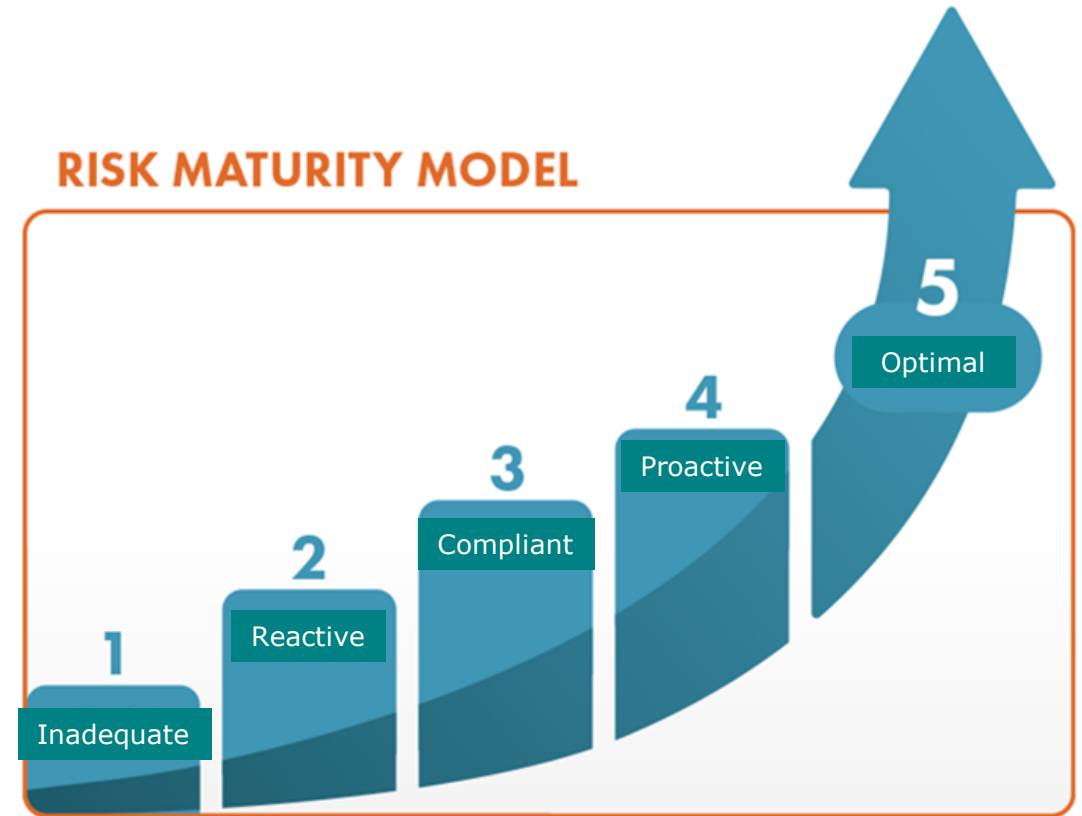
Dr. Valtteri Laine, Traficom

OpenRisk II Final Conference
22.9.2026 Kristiansand, Norway



Risk maturity models

- Risk maturity models are conceptual models that an organization can use to evaluate and improve its ability to manage risks.
- The models have proven to be useful to evaluate organization's current level of maturity, identify realistic targets for improvement, and produce action plans for developing or enhancing its risk capacity.



R-Mare matrix model elements

L-1. Inadequate. There is no risk management framework in place or established processes to carry out risk assessments. The decisions on corrective actions are made on an ad hoc basis, without sufficient knowledge or consulting with stakeholders. The risk and crisis communication are poor and focus on hiding mistakes and blaming others. The Flag State is on the Black list or a corresponding rank in the international Port State Control system. The general performance of the administration is below the legal minimum.

A-2. Leadership and commitment

Top management should ensure that risk management is integrated into all activities of the maritime administration, while considering also the ethical, national, and economic aspects of shipping.

L-1/A-2

Leadership and commitment - inadequate

Top management is not showing interest in risk management and has only a limited knowledge of this area. They are not trusted among the staff and stakeholders, and set a bad example for everyone.

RISK MANAGEMENT ATTRIBUTE	RISK MATURITY LEVEL				
	Inadequate	Reactive	Compliant	Proactive	Optimal
1. Ethics and integrity	L1/A1	L2/A1	L3/A1	L4/A1	L5/A1
2. Leadership and commitment	L1/A2	L2/A2	L3/A2	L4/A2	L5/A2
3. Design	L1/A3	L2/A3	L3/A3	L4/A3	L5/A3
4. Integration	L1/A4	L2/A4	L3/A4	L4/A4	L5/A4
5. Resources	L1/A5	L2/A5	L3/A5	L4/A5	L5/A5
6. Communication and consultation	L1/A6	L2/A6	L3/A6	L4/A6	L5/A6
7. Continuous improvement	L1/A7	L2/A7	L3/A7	L4/A7	L5/A7
8. Risk terminology	L1/A8	L2/A8	L3/A8	L4/A8	L5/A8
9. Definition of context	L1/A9	L2/A9	L3/A9	L4/A9	L5/A9
10. Data and information	L1/A10	L2/A10	L3/A10	L4/A10	L5/A10
11. Tools and techniques	L1/A11	L2/A11	L3/A11	L4/A11	L5/A11
12. Hazard identification	L1/A12	L2/A12	L3/A12	L4/A12	L5/A12
13. Risk analysis and evaluation	L1/A13	L2/A13	L3/A13	L4/A13	L5/A13
14. Risk control measures	L1/A14	L2/A14	L3/A14	L4/A14	L5/A14
15. Cost-benefit assessment	L1/A15	L2/A15	L3/A15	L4/A15	L5/A15
16. Recommendations	L1/A16	L2/A16	L3/A16	L4/A16	L5/A16
17. Decision-making	L1/A17	L2/A17	L3/A17	L4/A17	L5/A17
SCORE					

Use of R-Mare matrix

RISK MANAGEMENT ATTRIBUTE	RISK MATURITY LEVEL				
	Inadequate	Reactive	Compliant	Proactive	Optimal
1. Ethics and integrity	L1/A1	L2/A1	L3/A1	L4/A1	L5/A1
2. Leadership and commitment	L1/A2	L2/A2	L3/A2	L4/A2	L5/A2
3. Design	L1/A3	L2/A3	L3/A3	L4/A3	L5/A3
4. Integration	L1/A4	L2/A4	L3/A4	L4/A4	L5/A4
5. Resources	L1/A5	L2/A5	L3/A5	L4/A5	L5/A5
6. Communication and consultation	L1/A6	L2/A6	L3/A6	L4/A6	L5/A6
7. Continuous improvement	L1/A7	L2/A7	L3/A7	L4/A7	L5/A7
8. Risk terminology	L1/A8	L2/A8	L3/A8	L4/A8	L5/A8
9. Definition of context	L1/A9	L2/A9	L3/A9	L4/A9	L5/A9
10. Data and information	L1/A10	L2/A10	L3/A10	L4/A10	L5/A10
11. Tools and techniques	L1/A11	L2/A11	L3/A11	L4/A11	L5/A11
12. Hazard identification	L1/A12	L2/A12	L3/A12	L4/A12	L5/A12
13. Risk analysis and evaluation	L1/A13	L2/A13	L3/A13	L4/A13	L5/A13
14. Risk control measures	L1/A14	L2/A14	L3/A14	L4/A14	L5/A14
15. Cost-benefit assessment	L1/A15	L2/A15	L3/A15	L4/A15	L5/A15
16. Recommendations	L1/A16	L2/A16	L3/A16	L4/A16	L5/A16
17. Decision-making	L1/A17	L2/A17	L3/A17	L4/A17	L5/A17
SCORE					

Reliability of R-Mare matrix

Internal consistency reliability test results

Round	α value	Ω value	Interpretation
1	0.93	0.92	<i>Almost perfect</i>
95% CI	0.85 - 0.97	0.87 - 0.98	
2	0.96	0.96	<i>Almost perfect</i>
95% CI	0.92 - 0.98	0.93 - 0.96	

Inter-rater reliability test results

Round	ICC (3, k)	Interpretation
1	0.73	<i>Moderate</i>
95% CI	0.51 - 0.89	
2	0.75	<i>Moderate/Good</i>
95% CI	0.53 - 0.89	

N = 16

Scientific publications

WMU Journal of Maritime Affairs
<https://doi.org/10.1007/s13437-023-00328-z>



ARTICLE

Risk maturity model for the maritime authorities: a Delphi study to design the R-Mare matrix model

Valtteri Laine¹  · Osiris Valdez-Banda¹ · Floris Goerlandt²

Received: 23 August 2023 / Accepted: 3 December 2023
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Abstract

Maritime authorities have the administrative responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution caused by ships. This responsibility involves various tasks that can be supported through effective risk management, but currently, there are no models available to evaluate its level of maturity in maritime administrations. To fill this gap and respond to the needs identified by maritime authorities, this article introduces a new risk maturity model called the R-Mare matrix. This model is built on recent scientific knowledge in the field of risk management, and it has been designed in close cooperation with end-users and maritime risk management experts using the Delphi methodology. As a result of this process, the article provides a qualitative risk maturity matrix specifically tailored to support the self-evaluation of maritime authorities. The matrix consists of 17 state-of-the-art risk management attributes, a five-step risk maturity scale, and associated risk maturity grid descriptions. These elements can be used to evaluate the current risk management performance of maritime authorities, identify areas for improvement, and develop a plan to achieve a higher level of maturity. Overall, the R-Mare matrix model represents an important step forward in this field while laying the foundation for further development.

Keywords Maritime safety · Maritime sustainability · Maritime administration · Risk management · Risk maturity · Risk maturity model matrix

<https://doi.org/10.1007/s13437-023-00328-z>

WMU Journal of Maritime Affairs
<https://doi.org/10.1007/s13437-025-00389-2>



ARTICLE

Risk maturity model for maritime authorities: testing the internal consistency and inter-rater reliability of the R-Mare matrix

Valtteri Laine¹  · Luana Almeida² · Mirka Laurila-Pant³ · Floris Goerlandt⁴ · Osiris Valdez Banda¹

Received: 17 September 2024 / Accepted: 14 September 2025
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Abstract

The R-Mare matrix is the first risk maturity model developed for maritime authorities. Its main purpose is to support the authorities in self-evaluating their current risk management performance and in steering that performance toward higher levels. To gain insight into the model's usability in practical applications, the aim of this study is to test the reliability of its measurements in real-world settings and identify areas for improvement. The empirical testing is conducted within maritime administration in the Baltic Sea region and involves two rounds of semi-structured interviews with 16 panelists. During these interviews, the panelists employ the R-Mare matrix model to provide individual ratings of their administration's risk management performance and justify their expert judgments. To achieve a comprehensive understanding of the model's reliability, the collected data is analyzed using internal consistency reliability and inter-rater reliability tests. For the former, statistical quantifications are performed using Cronbach's Alpha and McDonald's Omega coefficients, while for the latter, the Intraclass Correlation Coefficient is employed. These tests are conducted separately for the results of both interview rounds to further address the model's temporal stability. The findings indicate a high degree of internal consistency reliability, and at least a moderate degree of inter-rater reliability for the model's measurements. These further highlight areas for improvement in the model and assist in developing strategies to enhance its reliability. Consequently, the results provide evidence of the reliability of the R-Mare matrix model's measurements, while supporting its deployment in the maritime administrations of the Baltic Sea region and beyond.

Keywords Maritime safety · Maritime sustainability · Maritime administration · Risk management · Risk maturity model · Model reliability

<https://doi.org/10.1007/s13437-025-00389-2>

R-Mare matrix application

BLUEBIOSITES

Menu

Welcome page

R-Mare matrix model

Export data

1. Risk Management Attributes

2. R-Mare matrix - model

3. Personal and Community Risk Analysis

SPECIFY RISK MATURITY LEVEL FOR EACH RISK MANAGEMENT ATTRIBUTE

Risk Management Attribute	Risk Maturity Level
Design	proactive
Integration	compliant
Resources	compliant
Communication and consultation	reactive
Continuous improvement	proactive
Risk terminology	compliant
Definition of context	proactive
Data and information	reactive
Tools and techniques	proactive
Hazard identification	compliant
Risk analysis and evaluation	proactive
Risk control measures	compliant
Cost-benefit assessment	compliant
Recommendations	proactive
Decision-making	compliant

inadequate

reactive

compliant

proactive

optimal

not selected

There is a basic process for risk-based decision-making, but the means for validation and continuous improvement are missing. Top management decisionmaking on risk control measures focuses on compliance with legal requirements.

Comment

Here you can write comments and notes concerning your expert judgement.

Export To PDF

Export To Word

Output of model

● Risk Maturity Level

Sign up

Sign in

gis.sea.ee/r-mare

OpenRisk II Final Conference - 22.9.2026

Applying R-Mare matrix in practice





Test yourself

Risk attributes in practice

1. Leadership and commitment
2. Data and information

Exercise 1: Leadership and commitment

- The top management should ensure that risk management is integrated into all activities of the maritime administration, while considering also the ethical, national, and economic aspects of shipping
- They should allocate adequate resources for this purpose and establish robust communication channels with internal stakeholders (e.g., ministry and sister organizations) and external stakeholders (e.g., private sector and intergovernmental bodies)
- They should focus on creating safe working conditions and an environment of trust for the administration and its stakeholders
- They should demonstrate willingness and commitment to continuously improve the risk management performance of the administration in both the short and long term

Exercise 1: Leadership and commitment

1. **Inadequate:** Top management is not showing interest in risk management and has only a limited knowledge of this area. They are not trusted among the staff and stakeholders, and set a bad example for everyone.
2. **Reactive:** Top management is showing interest in risk management after an undesirable event such as a maritime accident leading to e.g. acute environmental damage. They react to the identified problems rather than trying to prevent them.
3. **Compliant:** Top management aims to ensure that the risk management considers and meets all legal requirements. They supervise that all mandatory tasks are conducted and aim to provide necessary resources for this purpose.
4. **Proactive:** Top management aims to ensure that the risk management is integrated across the administration and considers its internal changes. They supervise that standard procedures are in place for e.g. continuous improvement and risk acceptability.
5. **Optimal:** Top management aims to ensure that in the risk management, the ethical and financial aspects are balanced in optimal way. They motivate staff through visible endorsement, create an environment of trust and set a good example for everyone.

Exercise 2: Data and information

- The maritime administration should have a systematic and documented process to collect the best achievable data and information for its risk assessment, including both quantitative and qualitative sources
- The process should include incentives for stakeholders to share their sources and means to follow relevant scientific research and global megatrends
- The process should provide criteria to ensure the usefulness of data and information, while considering the scope of risk assessment and available resources for data analytics
- The process should address the sensitivity of the data and information due to privacy concerns and account the limitations and uncertainties

Exercise 2: Data and information

1. **Inadequate:** There is no processes or interest in the maritime administration to collect risk-related data and information. The data is either missing or completely useless.
2. **Reactive:** There is an undeveloped process to collect risk-related data and information focusing on historic accidents. The data is submitted to compulsory databases, such as GISIS and EMCIP, before external audits or due to demands.
3. **Compliant:** There is a basic process to collect risk-related data and information and receive them from the stakeholders. The focus of the process is on data collection, rather than on using it effectively in the risk assessments.
4. **Proactive:** There is a systematic process to collect risk-related data and information, which involves a wide range of stakeholders. The data is used effectively in the risk assessments, while also considering its quality and bias aspects.
5. **Optimal:** There is an optimized process to obtain and provide useful risk-related data and information for the risk management. The data collection is extended to also cover scientific research of the risk field, global megatrends and futurology as needed.



Final discussion

The potential of the R-Mare tool

Your reflections on R-Mare matrix

- Could you use the tool in your organization?
- How would you use it?
- What could be the benefits from using it?
- Is there a need for training?
- Is there a lack of skills related to risk management in general?

Thank you for your interest!



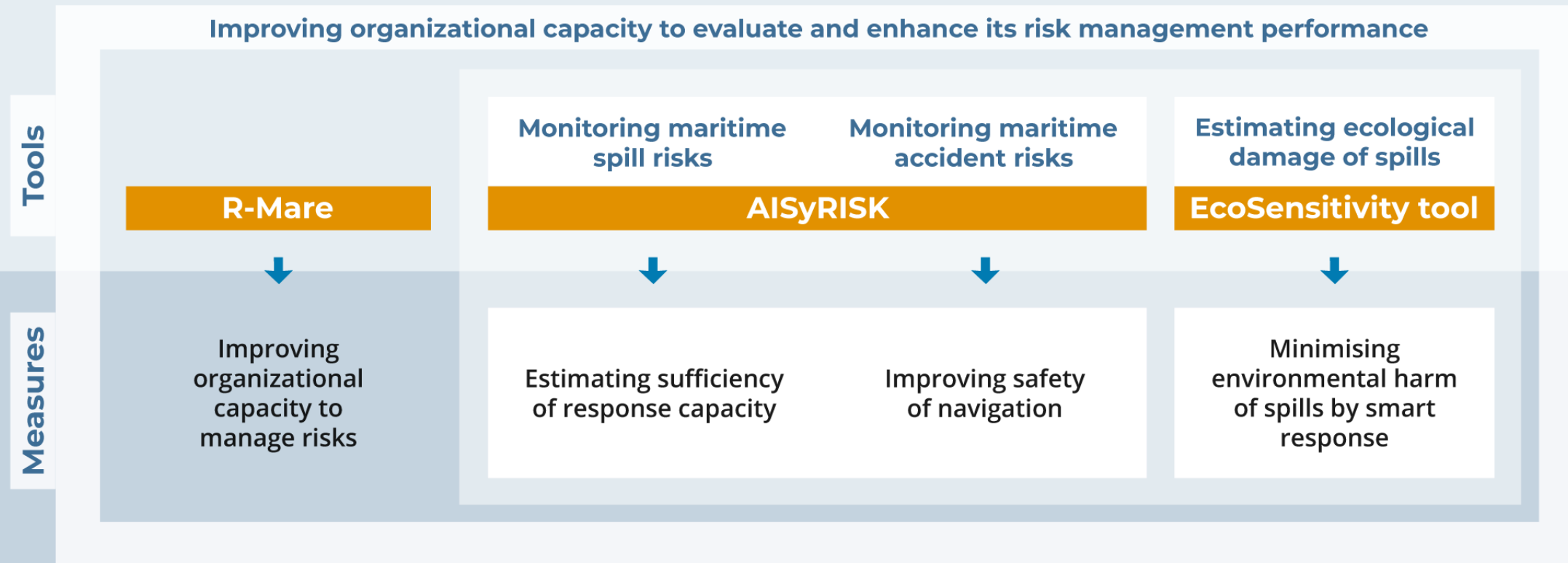
Valtteri Laine
valtteri.laine@traficom.fi

Future Oriented Session

OpenRisk II Project Final Conference on Maritime Risk Management in
the Baltic Sea Region | 22.9.2026 Kristiansand, Norway



Three New Tools for Maritime Authorities to prevent and limit damage from accidents at sea



**Improved Safety and Sustainability
in the Baltic Sea Region**

Interreg
Baltic Sea Region



Co-funded by
the European Union



SUSTAINABLE WATERS

OpenRisk II

Goal of the session

To discuss the future of maritime risk management in the Baltic Sea Region and beyond

Five guiding topics with opening comments from experts

1. How can the Baltic Sea Region become a leading region for maritime safety and security?
2. Increasing the uptake of risk management tools
3. Beyond the Baltic Sea
4. From Research to Practice
5. What do we need to do next?

How can the Baltic Sea Region become a leading region for maritime safety and security?

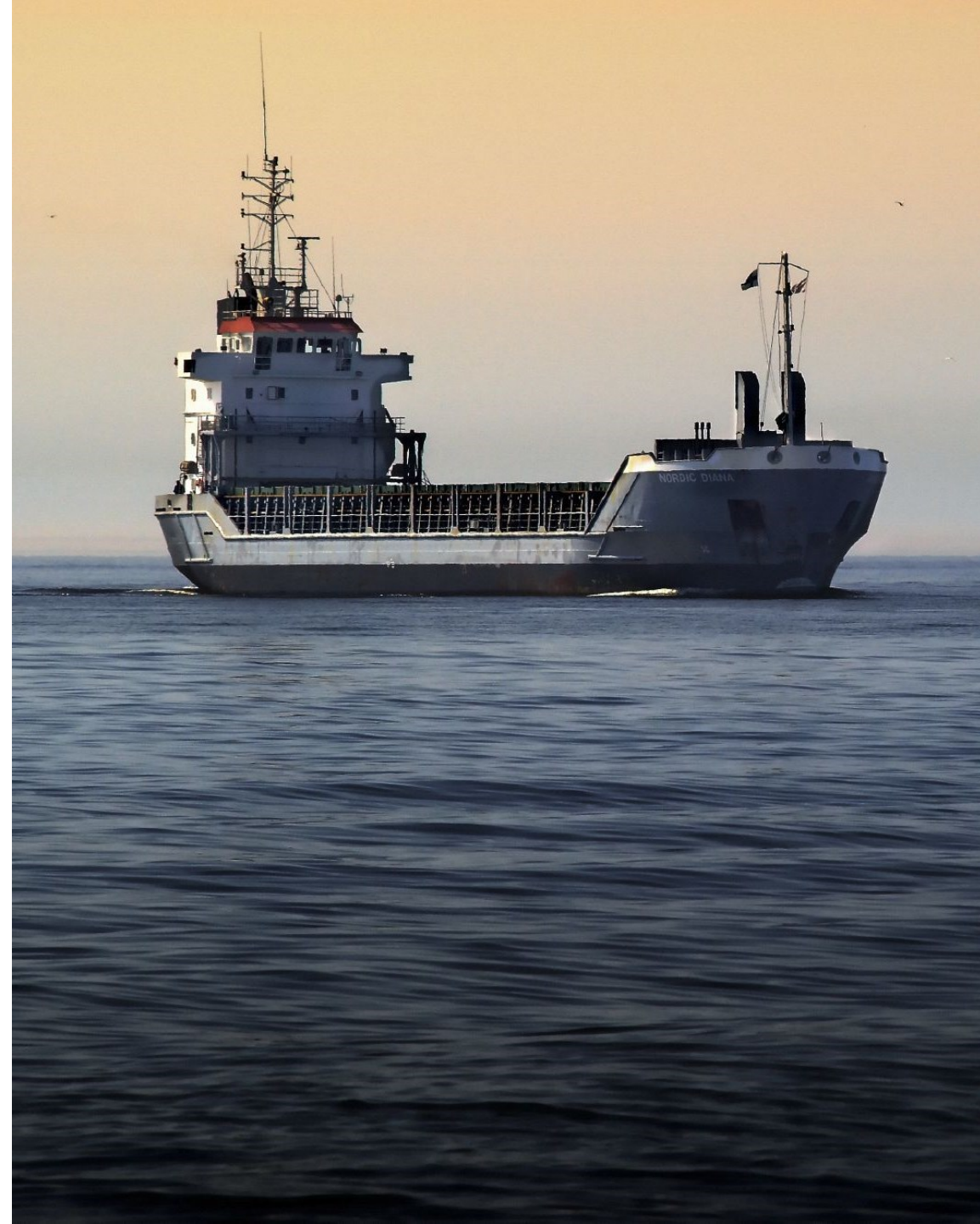
Collaboration is a key part of all EUSBSR Policy Area Safe objectives: what kind of cooperation is still needed?

Especially from the perspective of maritime risk management tools and existing frameworks?

Will Norway, as the newest full member of the EU Strategy for the Baltic Sea Region, bring something new to the table?

Comments from EUSBSR PA Safe Coordinator Seppo Mäkinen, Traficom

OpenRisk II Final Conference | 22.9.2026





Increasing the uptake of risk management tools

How do we expand the tools' user base in the Baltic Sea Region: how can the potential benefits be realized?

How do we get the national authorities engaged?

What kind of future development of the tools is needed?

Comment from Henrik Ringbom, Åbo Akademi University

Beyond the Baltic Sea

Should we aim to share the tools beyond the Baltic Sea, and what would need to happen for this to become a reality?

What about Arctic collaboration?

Comments from Jon Arve Røyset, Norwegian Coastal Administration



Why a Circumpolar Risk Assessment Has Not Become Reality Yet?

The challenges

- A circumpolar risk assessment remains an objective within the Arctic Council framework.
- Geopolitical tensions limit regional cooperation and data sharing, particularly challenging as Russia accounts for about 50% of the Arctic coastline.
- The Arctic is warming four times faster than the global average, reducing the predictive value of historical baseline data.
- Variations in chart quality, data availability and reporting practices continue to present challenges.
- Until recently, no automated ice-risk assessment capability comparable to the OpenRisk II Ice Module was available.

The way forward

- The OpenRisk II Ice Module demonstrates a scalable methodology that could support future circumpolar maritime risk assessments.
- By integrating automated calculations, the methodology reduces dependence on fragmented national datasets and manual analyses.
- Will a circumpolar risk assessment become a reality?
 - Not in the near future I'm afraid because it is other priorities in the work plan:
 - Arctic connect (New ASTD initiative)
 - AMSA 2 (very large new project)





From Research to Practice

How can research be turned into decision-ready information for maritime risk management?

Where can research-based digital tools create the greatest practical benefits for authorities and companies?

What are the main barriers to uptake?

Comments from Jonne Kotta (University of Tartu) and Osiris Valdez Banda (Aalto University)

What do we need to do next?

What kind of collaboration and/or projects are needed?

Are there some key obstacles that we need to overcome?

Some reflections from Hermann Backer
Johnsen, Åbo Akademi University



Wrap-up of the day

OpenRisk II Project Final Conference on Maritime Risk Management in
the Baltic Sea Region | 22.9.2026 Kristiansand, Norway



Wrap-up of the Day & OpenRisk II

Thank you to all speakers, partners and participants!

Shared expertise across countries and organisations

Next steps

Continued use, development and wider uptake of the tools

OpenRisk II will close at the end of **October 2026**.

All project outputs and links to the tools will remain available on the **OpenRisk II website**.



Wrap-up of the Day & OpenRisk II

Meet us next at the Arctic Circle Assembly 2026

Where: Reykjavík, Iceland

When: 8–10 October 2026

Session:

Can the Baltic Inspire the Arctic? New Tools for Maritime Risk



Thank You!

Thank you for joining us today.

After the conference

You are welcome to explore the **Kunstsilo exhibitions** (Museum closes 17:00)

Conference Dinner

18:30 at Kunstsilo Brasserie. Dinner is covered by the project.

We look forward to seeing you there!

