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Report of the Working Group on Risks of Maritime Activities in the Baltic Sea (WGMABS)

6–10 November 2017

Helsinki, Finland

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Contents

Executive summary

The Working Group on Risks of Maritime Activities in the Baltic Sea (WGMABS) met in Helsinki, Finland, 6–10 November 2017. This was the third and last meeting of the working group and the objective was to review the recent work to understand what kind of scientific tools are available for maritime risk assessment and management. Moreover, there was a need to suggest the future activities of ICES, related to maritime risks and especially on oil spill risk analysis, which has been the main focus of WGMABS. There has been extensions of Bayesian approach, especially in engineering sciences, which has led to models that can be potentially integrated to such biological models which have been developed by Bayesian networks.

Also some novel scientific approaches like System-Theoretic Accident Model and Processes (STAMP) has been introduced. STAMP-Mar as the application of systems-theoretic approach to maritime domain - safety management of sustainable eco-socio-technical maritime transportation system, and the risk based maritime spatial planning (RBMSP). It considers safety an emergent property of the system, arising from the interaction of system components within a given environment. The Next Generation SmartResponse Web (NG-SRW) under development by BONUS STORMWINDS project was introduced as an online information management and exchange software platform enabling, maintaining and sharing the effective Common Situational Awareness (CSA) for maritime emergency management.

As a future perspectives it was suggested to continue activities to further develop the maritime domain related safety science including the Bayesian risk assessment methodologies, STAMP-Mar and RBMSP methodological approaches and the operational tools like NG SmartResponse Web. The WGMABS is focusing on: 1) integration of existing maritime transport and ecological risk models, with refinements and extensions; 2) maritime safety management harmonization across Baltic Sea Region; and 3) end-user needs, validation and usability of developed approaches.

As obviously in many ICES WG's, the contents of the work of WGMABS is very dependent on the project funding. Even though there would be important new topics for science in WGMABS, but these are not included to current or future projects, it is not possible to finalize such tasks. Currently all active members work in universities, which creates a risk for the continuation of the work, even though the research topic as such, is very important from the point of view of society, industry and ecosystem.

Especially the Bayesian network analysis has focused heavily on decision analysis. The basic research, like the impact of oil on survival or reproductivity of species has not been in the focus. Bayesian approach allows the use of meta-analysis to estimate the probability distributions of such estimates, which supports their use in e.g. populations models to estimate the population level impacts of oil spills. Another aspect, even though asked by many end users, is the development of software packages.

In 2017 meeting, WGMABS had a one-day meeting together with stalkeholders/ endusers of information. It consisted of seven presentations and of a 3-hours workshop which was focused on information needs of policy actions and the future research topics. During the meeting, WGMABS formulated possible research call texts.

1 Administrative details

Working Group name

Working Group on Risks of Maritime Activities in the Baltic Sea (WGMABS)

Year of Appointment within current cycle

2015

Reporting year within current cycle (1, 2 or 3)

3

Chair(s)

Sakari Kuikka, Finland

Robert Aps, Estonia

Meeting dates

6–10 November 2017

Meeting venue

Helsinki, Finland

2 Terms of Reference

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
A	Review the recent studies carried out for ecological risks of maritime activities and to plan ToRs for future group meetings	Maritime activities form a major risk for Baltic Sea nature. The WG will contribute to Integrated ecosystem assessments . Building a capacity to asses these risks is needed. This is needed to understand what type of literature is available for Baltic Sea modelling, and what kind of activities the WG agenda should include in near future.	6	3 years	Report of the scientififc activities by a review to scientists and managers, and plan the fure ToRs for the WG.
B	Review the science of maritime risk analysis in the Baltic Sea	This is needed to understand what kind of models are actively used in the risk analysis, and to see the future development needs.	13	year 1	Review paper

C	Plan the ToRs of future WG meetings	a) Science Requirements b) Potential future advice After the review, there is a need to plan future scientific activities of the WG. For example, it must be planned how the feedback is obtained from potential customers for scientific advice.		year 1	ToRs
D	Test the available risk models and operational sea dynamic models, including models that integrate major risks in the Baltic Sea	a) Science Requirements b) Potential future advice This is needed to get understanding of the current interface of models that are used in the operational risk management support. The integrated risk models and needed e.g. in spatial planning of Baltic Sea.	13,26	year 1 and 2	Part of the report or review paper
E	Review of existing databases and their applicability to the alternative model.	There is a ned to check the data avaibality for the current and potential future models.	13,26	year 2	WG report
F	Identification of the need of expert knowledge in the use of the models.	There is need to evaluate the needed use of expert knowledge to populate those part of models where there is no data.	13,26	year 2	WG report
G	Discussion with endusers on the applicability and relevancy of the models	Discussion with endusers is needed to understand the need for additional modelling tools.	13,26	year 2	WG report

3 Summary of Work plan

Year 1	Review the current science related to maritime activities in the Baltic Sea and to provide future ToRs.
Year 2	Test and report the available risk models and test them with stakeholders.
Year 3	Asses the possible needs for advice.

4 Summary of Achievements of the WG during 3-year term

The group has developed Bayesian modelling of oil spill risks. Most of the Bayesian applications have used Bayesian networks, which are effective in terms of calculus due to the fact that they apply mainly discrete probabilities. For example, models based on Markov Chain Monte Carlo simulations are time demanding and in this sense do not fit well to operational decision making in oil spills.

STAMP-Mar was adapted as a new application for systems-theoretic approach. It was applied to maritime domain - safety management of sustainable eco-socio-technical maritime transportation system in the Gulf of Finland. Moreover, also risk based maritime spatial planning (RBMSP) was applied. The Next Generation SmartResponse Web (NG-SRW) under development by BONUS STORMWINDS project was introduced as an online information management and exchange software platform enabling, maintaining and sharing the effective Common Situational Awareness (CSA) for maritime emergency management. List of publications relevant to WGMABS activities is given in Annex 2

5 Final report on ToRs, workplan and Science Implementation Plan

Progress by ToR

ToR a) Review the recent studies carried out for ecological risks of maritime activities and to plan ToRs for future group meetings

Since 2015, there are several maritime risk papers published for the Baltic Sea. Annex 2 includes the list of earlier papers (in WG meeting in 2016) and the recent papers published after the 2016 meeting. One of the aims has been achieved in the publications, i.e. that the engineering orientated papers and the biological papers apply to large extent the same methodology, i.e. Bayesian network models. This allow the linking of models together, making them more interdisciplinary than so far. This aspect must be included to future project proposals in order to take the next steps. WGMABS aims to apply such integrated models in the oil spill risk analysis.

In addition recent publications on the application of the System-Theoretic Accident Model and Processes (STAMP) approach to the maritime domain are added (Aps *et al.*, 2015; 2016; 2017), as well as papers producing the required evidence base for developing the risk models, methods for detecting possible near-miss ship collisions in the Northern Baltic sea, and a paper introducing a systematic method for defining key performance indicators in maritime safety management.

ToR b) Review the science of maritime risk analysis in the Baltic Sea

Writing of a review paper was started after the 2015 meeting. The paper has not been submitted yet. The manuscript includes e.g. following sections: maritime risk governance, modelling of oil spill risks in the Gulf of Finland, cost-benefit models, development of biodiversity-based utility functions, linking of experimental data and model outcomes: Bayesian techniques, existing data sets and possible new governance model for the Baltic Sea. It is based on the talks given in 2015 meeting and on existing published papers.

However, the majority of the topics of the review paper were also included in the book "The Gulf of Finland assessment", which was published 2016 (Finnish Environment Institute, 2016). Several WGMABS members participated in writing the book. The book includes a chapter on maritime traffic and its safety that contains separate sections related e.g. to the current and future characteristics of maritime traffic and oil transportation, maritime accidents and their causes, winter navigation risks, ecological consequences of oil spills, cost and benefits of oil spill combating, and the regional approach for maritime risk governance.

WGMABS group member Jimenez Madrid (Spain) proposed to take advantage of the information provided by techniques coming from dynamical systems theory, as the analysis of the dispersion and transport capacity by ocean currents are crucial to assess the potential risk of a pollutant, since spill monitoring needs the comprehension of pollutant evolution. Dynamical systems tools are powerful in this concern. They are able to locate both high and low dispersive regions. The former are related to "hyperbolic regions" which are related to filamentation processes. These regions act by elongating water masses in their neighbourhood along a direction and at the same time by compressing water masses along another direction. Uncertainties in ocean dispersion are due to the presence of "hyperbolic regions", i.e., in their neighbourhood fluid parcels placed very close each other may evolve in a quite different way, separating them at exponential rates. Another present feature in flows, contrary to what just described, is when water masses remain coherent and with almost no deformation. Oceanic eddies are an example of regions displaying such behaviour. They are able to maintain in their interior stable properties (like heat, salinity, etc.) for long periods of time. These regions are called "elliptic regions". Ocean transport is a combined action of both characteristics responsible for dispersion and bounding of water masses. The application of these ideas was showed with the oil spill produced by Oleg Naydenov vessel in Canary Islands on year 2015.

Application of the System-Theoretic Accident Model and Processes (STAMP) approach to the maritime domain considers safety an emergent property of the system, arising from the interaction of system components within a given environment (Leveson, 2011). Rather than focusing on particular errors or component failures as in traditional engineering risk analysis, STAMP focuses on safety constraints, hierarchical control structures (global to local regulatory levels of the maritime navigation and environment safety management system) and control loops. The basic concepts in STAMP are: 1) hierarchical regulatory levels; 2) constraints; and 3) control loops and process models. STAMP-Mar coverage is extended beyond the area of socio-technical systems safety into realm of safety of complex eco-socio-technical systems. At the operational level Regional Environmental Sensitivity Index (RESI) is used to integrate the ecosystem components and to add the environmental constraints to the STAMP-Mar safety control structure (Aps *et al.*, 2016).

Driven by social consciousness and strong political initiatives against climate change, renewable energy schemes have become increasingly common in recent years. The offshore renewables sector, in particular, has seen strong growth and development – best evidenced by the advances in efficiency, and the increase in the sizes and numbers, of offshore wind turbines (OWTs). To address the interaction between the offshore wind and maritime sectors, the current research focuses on the development of a novel concept – risk based maritime spatial planning (RBMSP). Currently, the RBMSP tool-kit consists

of three 'tools': 1) a harmonized, transparent framework for navigational risk assessment of vessels operating near offshore wind farms (OWFs), 2) a novel tool based on ship manoeuvring, that can provide decision support for a wide range of stakeholders, including wind farm planners and operational end users such as seafarers or VTS operators, and 3) a method of improving stakeholder communication and feedback through the use of simulators. These tools, while specifically designed to address OWF challenges, can also be adapted for other conflict resolutions as well.

It is important to show how the maritime safety science results are used to develop the oil spill response related operational tools like NG SmartResponse Web and risk based maritime spatial planning (RBMSP) being essentially a tool-kit consisting of various frameworks, models and methods that can augment traditional MSP approaches, and help decision makers optimize the use of sea space – dynamically.

The current WGMABS group has a strong experience in using Bayesian networks as a method for analysing risk and assessing the effect of different risk control options in managing risk. In earlier WGMABS meetings, it was agreed to link the models of the ecological effects of oil spills with models of the probability and consequences of maritime transportation accidents. The modelling of these systems relies on different types of evidence, stemming from different scientific traditions: evidence about the ecosystem is close akin to scientific methods in natural sciences, whereas maritime transportation accident models include elements of safety science and engineering sciences. Bayesian networks are known to be well-equipped to handle different types of evidence, and are considered a suitable methodological approach for interdisciplinary modelling. Hence, efforts were taken in the ecosystem models as well as in the maritime transportation accident models to utilize Bayesian networks as a modelling platform.

Several advances have been made in Bayesian maritime accident modelling, especially in winter conditions. Goerlandt *et al.* (2017a) describe an integrated approach for maritime oil spill risk management based on Bayesian network modelling and an uncertainty-based risk perspective. Several accident analyses and engineering model development have been performed to build evidence to feed into the Bayesian network. Goerlandt *et al.* (2017b) present an analysis of wintertime navigational accidents based on integrated data sources, where contextual factors (atmospheric and sea ice conditions, vessel characteristics, operation types,…) are linked to the accident types, providing insights in typical patterns of accident conditional in the Northern Baltic Sea in winter conditions. Kollo *et al.* (2017) present a new engineering outflow model for oil spills in wintertime conditions, based on hydraulic theory and accounting for temperature effects on viscosity. Arneborg *et al.* (2017) present an improved parameterization of the implementation of oil drift in sea ice conditions in SeaTrack Web, with an application to the oil spill of the Runner-4 accident. Goerlandt (2017) presents a Bayesian model for the probabilistic oil outflow for given damage scenarios, for tankers typically operating in the Northern Baltic Sea area. Lu *et al.* (2018) present a Bayesian model for the effectiveness of mechanical recovery of oil spills in ice conditions. These models include several nodes related to the oil spill size, extent of spread in the sea area, and the recovery effectiveness, which could be linked to ecosystem risk models developed by other researcher in the WGMABS. Some work on including risk control options to prevent collision and grounding accidents in Bayesian networks has also been performed, e.g. the work by Montewka *et al.* (2017), linking a number of global design factors in ship design with human performance and error mod-

els to the occurrence of collisions and groundings. Thus, the work of WGMABS shows good promise to link models across disciplines to develop integrated risk models linking the traffic system, accident occurrence and consequences, and ecosystem impacts.

ToR c) Plan the ToRs of future WG meetings

The work of WGMABS has focused on the Baltic Sea, and there to Gulf of Finland. This is natural in the sense that, on the other hand high accident risks, and on the other hand very detailed data sets of e.g. threatened species have enabled detailed risk analysis. However, there is a need to learn from the applied methodology of other sea areas, and to include scientists from other fields than engineering and biology.

The issue of testing the available risk models and operational sea dynamic models, including models that integrate major risks in the Baltic Sea was discussed. The WGMABS meeting was informed that HELCOM led OpenRisk project is developing ISO 31000 Standard based risk assessment and management process for European Pollution Prevention and Response authorities. The risk assessment part is divided into three different stages: risk identification, risk analysis and risk evaluation. The project provides and explores tools to cover each of these stages. In addition, it develops framework and procedure for risk management.

The risk assessment tools and process for risk management will be tested in the Baltic Sea and HELCOM during the OpenRisk project.

WG agreed, that in order to be able to expand the oil risk related work to new areas, there should be 2 – 3 chairs (Baltic Sea, Atlantic, Mediterranean).

ToR e) Review of existing databases and their applicability to the alternative models

During the WGMABS meeting, the different national and international databases on i) marine and coastal ecosystem, ii) maritime traffic and safety, and iii) weather and climate were reviewed and their application to models discussed. Based on the discussion, a database of relevant information was compiled. In addition, the missing data sources were recognized, and related to that, the accessibility to ship inspection report program databases was discussed. Future needs of ecological data were also assessed.

It was concluded that relevant information and knowledge about marine ecosystem and maritime traffic need to be collected and analyzed in advance, and then taken into account for the adequate ecosystem-based maritime risk management. The existing data must be integrated into problem-adapted frameworks, such as Bayesian oil spill risk assessments. The WGMABS decided to include this discussion to the planned two scientific review articles.

In the meetings of 2016 and 2017, several existing and unfinished models (SpillMod, NEMO, MOMBA) and tools (SeaTrack Web, Boris 2, Smart Response Web, Short-Term Risk assessment) for maritime risk assessment and management have been presented. Here, the term “model” is used when referring to a single model, whereas “tool” is a user interface / modelling platform, consisting of e.g. database, map layers and models.The group concluded that there is a high number of different types of models and tools that are used or can be used to provide information for the assessments on the maritime risks of the Baltic Sea. Roughly speaking, these can be divided to two main groups: a) models

and tools for risk assessment and strategic planning of risk management, and b) tools for operational risk management in accident situations.

The group stated that to be able to test and compare the existing models and tools, a common task and aim to be tested, should be defined. On the other hand, most of the models and tools are created for different needs and to answer different questions. Typically, single models have been validated to the extent possible, and the results published in scientific articles. The end-user value of the developed tools and models was considered very important by the whole group. Common testing and evaluation could thus be built on the concepts based on this (see section **ToR Descriptor G** below).

ToR f) Identification of the need of expert knowledge in the use of the models

The role of experts was seen important as they can offer relevant information for risk assessments. Structured expert judgement can be integrated into modelling approaches to improve predictions. This is an important resource that may even provide completely new information for a particular case, especially if no relevant published data can be found. Experts have achieved high knowledge on a particular subject through their work and life experiences, and are defined by their qualifications, track record and professional status. Further, expert-informed modelling can contribute to bridging the gap between researchers and decision-makers.

Another related issue that came up in several contexts during the meeting was the need for including the views, values and systemic understanding of the stakeholders to the risk analyses. Stakeholder involvement is needed to define the collective objectives of the risk management, e.g. the tolerable or/and acceptable risk levels in different cases. As stakeholders are those parties/persons, who experience the harm related to the activity (such as the losses following a potential oil accident), they should be listened when the level of harm is defined. In practice this can mean mapping their values and weighing related to e.g. divergent ecosystem services or the existence of threatened species *per se*. It is important to note that in some cases the stakeholders are also the best experts of their own operational environment, and thus can provide valuable information for the risk assessment, concerning the functioning of the system analyzed.

New and innovative methods regarding the expert elicitation and stakeholder involvement were discussed in the meeting. Different methods for content analysis on written text (e.g. transcribed interviews and written query responses) were suggested, including visualisation of the framing and structure of an individual's thinking by using concept maps, and the use of compiling statistics on the terms used. The importance of recognizing the semantic meaning of the terminology (i.e. acknowledging the context in which certain word is used) was highlighted though. Machine-learned Bayesian Networks were presented as one potential method to analyze multiple choice question -based query data, acknowledging the full profile of the respondents and the interlinkages between their responses to different questions. This method could provide interesting insights to stakeholder profiling and to mutual weighing / scoring of divergent aspects when defining the objectives of risk management (directly relating to the decision making criteria to be used in the decision analysis tools).

ToR g) Discussion with end-users

WGMABS had a very successful end user day on the 9th November. The presentations and the time schedule of the day are below. The scientific conclusions include the following:

- the biological knowledge in HELCOM risk analysis could be improved by better data;
- there is a need to model the effectiveness of Baltic Sea oil combatting fleets by agent based simulation models;
- instead of using words in risk classification, it would be beneficial to aim to use numbers which allow more effective further use of the information;
- the role of biological information in ranking of oil combatting decisions could be improved;
- the nature values may play an important role in deciding to which safety harbor a leaking vessel is taken;
- there should be more precise objectives in that legislation where the actions of oil combatting are defined;
- the definition of sustainable use of Arctic resources is a difficult task;
- the academic research was considered to be important when deciding about activities in Arctic area;
- it is already implemented, that vessels which have risk decreasing tools have lower insurance fees than other vessels;
- the Helsinki City Rescue Center has well adapted the way how location of threatened species is taken into account when deciding the location of oil booms;
- in the presentation of Gard insurance company, it was declared that the cleaning costs are paid up to 1 billion USD;
- it is very important to define by scientific tools before any accident, how clean is clean, i.e. to say how long the cleaning much continue before the biological impact is acceptable. This has a very big impact on the cleaning costs and therefore on possible costs to be paid by an insurance company. This reflects to insurance fees that must be paid by vessels;
- it may also be possible that the insurance fee is to be defined online, depending on the type of ecosystem where the vessel is located.

It was jointly concluded that science has an important role in creating the maximum interest to avoid large-scale oil spills both in Baltic Sea and in the Arctic area. However, this requires interdisciplinary science that can integrate engineering, biological, economic, social and legal questions and knowledge. It is not easy to find such funding agencies that can support so large programs.

Program of the end user day

9.00 - 9.10	Sakari Kuikka: Wellcome and the aims of the day
9.10 - 9.30	Valtteri Laine, HELCOM: Helcom activities and OPEN RISK project
9.30 - 9.50	Jarmo Häkkinen, Finnish Coast Guard: Leading in MRO (mass rescue operation) at SEA
9.50 - 10.10	Henna Malinen, SYKE: BORIS system as an operational and strategic tool in oil combating decision making
10.10 - 10.30	Anita Mäkinen,Trafi: Private - public partnership in Arctic risk governance
10.30 - 10.50	Health break
10.50 - 11.10	Marjukka Porvari, John Nurminen Foundation: Experiences of John Nurminen Foundation in oil tanker risk governance
11.10 - 11.30	Ville Estlander, Helsinki City Rescue Department: Using knowledge in oil combating decision making
11.30 - 11.50	Roberto Lencioni, Gard Ltd: P&I-insurance cover and P&I-insurer's role in oil spill prevention, handling and compensation
11.50 - 12.10	Sakari Kuikka, WGMABS chair:Response to talks - does current science support actions of stakeholders?

Referring to **ToR D** section above, the group stated that there is a need to focus on the end-user perspective in testing and evaluating different types of models and tools. This could be based on frameworks like ISO standards, User quality, and Knowledge broker concept (see below).

Diverse groups of potential end-users for these models or the information that they can provide, were discussed. The end-user groups that were mentioned are:

- Marine planners
- Authorities
- Decision-makers
- Ship owners
- Ports
- Oil companies
- Common public
- Science community
- NGOs (e.g. WWF)
- P&I clubs

- Forums
- Consumers
- IMO
- HELCOM
- ICES

It was stated that different end-user groups have very different knowledge needs, in terms of scope, timing and accessibility (i.e. the form of presentation and channel of delivery). The evaluation of the end-user quality of the tools and models should be thus done user-group -specifically.

The 'quality in use' framework (Bevan 1997) enables combining a product-oriented view of *quality* with a user-oriented view of *usability* in the evaluation of models/tools. The approach, based on ISO 9241-11 standards for quality and usability, is developed for software quality evaluation (Bevan 1997). It facilitates analyzing 'quality in use' in a structured way by exploring model development, model as such, and the user's view of quality separately. 'Quality in use' is seen as dependent on the external quality of a model, which further depends on the model's internal quality. Therefore, to achieve or improve 'quality in use', measures are required at all three levels. ISO/IEC 9126 attributes combine external and internal aspect to model quality in terms of functionality, reliability, usability, efficiency, maintainability and portability.

It must be remembered that quality is not an absolute property but depends on the context of use. The measure of 'quality in use' evaluates the extent to which a tool meets the needs of specified users to achieve specified goals in a specified context. Thus, it represents the user's view of model quality, evaluated in terms of the result of using the model, rather than the properties of the model itself. In addition, 'quality in use' depends on the type of the user (e.g. person using the tool, person maintaining the tool). Evaluating 'quality in use' requires decomposing usability into measurable and verifiable attributes, such as effectiveness, efficiency, and satisfaction. There are several methods for measuring 'quality in use' (Isaias and Issa 2015, Brooke 1996).

It was concluded, that conducting a more systematic evaluation of the 'quality in use' of the models and tools requires defining: 1) the models to be evaluated, 2) the intended users/end-users of the models, 3) problems that the end users want to solve by using the tools/models, and related goals, 4) the context in which the tools/models are used.

The so called Knowledge Broker -concept was introduced (https://prezi.com/x9seckfmbzuj/2015-brussels_knowledge-brokers/). The approach pays attention on the *know - do gap* between knowledge producers and end users. The group agreed that the utilization of risk models, databases, decision support models and other scientific products can be streamlined by combining them to a stream of knowledge e.g. by means of integrated modelling and tool development. In some cases, however, it is not likely that the end users will use the models or tools by themselves. Thus, there is a clear need for players who would be specialized in facilitating and supporting the exchange and utilization of knowledge between scientists and end-users, providing it in timely, relevant and accessible format, thus maximizing the societal utility of the science. This will further strengthen the evidence-based management culture.

Science Highlights

There has been a major step forward in developing models that are based on Bayesian network methodology. As this has been done in dozens of biological models, it is high time to integrate the biological assessments with models that assess accident risks for oil tankers and potential of different technical solutions to reduce risks

This is a reasonable job but requires additional funding. As Bayesian networks allow calculus from effects to the causes and from causes to effects, it is possible to first define a biologically acceptable risk and then calculate backwards what the achievement of this value requires from technical solutions.

6 Cooperation

The WGIAB co-chair, Laura Uusitalo, participated in the WGMABS 2015 meeting part-time.

This group applies Bayesian networks, and the overall risk from all sources should be estimated, not only from fishing, eutrophication or oil spills. Therefore, co-operation is justified in future. There has been no co-operation with advisory structures or other IGOs. The end user day created opportunities for a continued co-operation.

7 Other business

Possible needs for advice and the potential role of future oil spill relate WG

The need for systematic advice and the possibility to provide such advice was discussed. It is obvious that this could be done for the Gulf of Finland by the current WG members, but not really for other areas in the Baltic Sea. There is a recent publication (Haapasaari *et al.* 2015) which suggests establishing a regional risk governance framework for managing the oil spill risks in the Gulf of Finland. The overall value of the oil transportation through the Gulf of Finland is very high, and the potential impacts on ecosystem are enormous. From this perspective, such a framework would be well justified, but this likely needs interests from industry.

Some work going on in the Mediterranean and Arctic areas

In the third meeting, Dr, Assistant professor Jarno Vanhatalo gave a talk about CEARC-TIC project, which focuses on the Arctic area. There are Finnish, Norwegian, Canadian and German partners. Project is coordinated by prof. Pentti Kujala, Aalto University, Finland.

In the last years, the following two projects funded by Med Programme improved the maritime safety in the Mediterranean area: The TOSCA (Tracking Oil Spills and Coastal Awareness network, http://www.tosca-med.eu/) project, cofinanced by the European Regional Development fund (Med Programme), aims to improve the quality, speed and effectiveness of decision-making process in case of marine accidents in the Mediterranean concerning oil spill pollution and search and rescue (SAR) operations. TOSCA project had three main objectives: 1) Develop a sustainable scientific monitoring and forecasting

system; 2) Create a support tool for decision-making process in case of maritime accidents; and 3) Elaborate a common management on oil spill and SAR operations. THE MESESS-4MS (Mediterranean Decision Support System for Marine Safety, http://www.medess4ms.eu/) was dedicated to the strengthening of maritime safety by mitigating the risks and impacts associated to oil spills in the Mediterranean area. MEDESS-4MS aims to deliver an integrated operational multimodel oil spill system in the Mediterranean by gathering and analysing met-ocean data as well as data related to ship traffic, ship operations and sensitivity mapping. This data will be provided to well established oil spill monitoring and forecasting systems, thus, providing an invaluable tool regarding the early detection and efficient control of the oil spill at early stages. Therefore, MEDESS-4MS aims to offer a comprehensive and integrated multi-model approach regarding our response to oil spills at sea; an approach that takes into account all three important aspects related to marine pollution, that is, Prevention, Detection and Control.

Need to cover new geographical areas

There is an obvious need to expand the geographical area of the WG to new areas. There is a need to learn more effectively from the experiences of the other areas, where both the management decisions, scientific traditions and the sensitivity of the ecosystem to oil are different compared to Baltic Sea.

The WG is of the opinion, that most of the oil spill related assessment issues are of cross disciplinary nature. There is a need to get members from economic, social and engineering sciences. Moreover, the demanding calculus requires scientists from statistics and computer science. The interests of these scientists must be increased by ICES delegates and other active experts in the domain.

The WG agrees, that also in the future, the working group must have close relationships to the end users of the information. This ensures that among all possible oil related research topics, the closeby research activities are focused on areas that are important for the actual management. This covers both private, NGO and governmental decision making,

Risk governance and communication

Risk communication needs further attention, especially in terms of identifying obstacles for integrating scientific knowledge and assessments in decision-making. Numerous assessments and frameworks are being developed, but often the concern is that they are not used in practice. Defining the role of science in risk governance together with end-users and stakeholders is thus needed. WGMABS members do not really have such skills, even though they have provided probabilistic risk estimates nor for decades. Risk communication is not very actively studied area of science among institutes and universities working under ICES umbrella.

Furthermore, the bottlenecks of risk communications, i.e. challenges of risk communications and improvement suggestions should also be identified. Given the varying information needs of the end-users, more attention to the information channels and how the information should be communicated is needed. Even very skilfully derived risk estimates are of no practical use, if they cannot be understood by the end-users.

Potential new topics for oil spill related research

Despite the extensive amount of research conducted in the previous years, it is evident that there are still important knowledge gaps that need to be addressed in the future.

For instance, we still lack knowledge of possible long-term ecological effects of oil spills in the Baltic Sea environment. The topic can be addressed to some extent by modelling, yet e.g. mesocosm experiments dealing with the disappearance of the most oil-sensitive organisms would be beneficial in understanding the impacts of oil spills in the brackish-water Baltic environment.

Further, although e.g. BRISK project (http://www.brisk.helcom.fi/) has produced environmental sensitivity maps related to oil spills that cover the whole Baltic Sea, it is evident that these maps have too coarse resolution to be used in operational oil combating. Coastal countries, in turn, usually have their own sensitivity maps, which can be based on very different ecological attributes. This can be problematic in regional co-operation, if management actions need to be agreed jointly without having a common database on which the decisions can be based. Hence, more emphasis needs to be paid on developing common approaches e.g. to sensitivity of ecosystems in a regional context.

In recent years, a few studies have been published that have modeled ecological impacts of oil spills in the Baltic Sea (e.g. Lecklin *et al.* 2011, Helle *et al.* 2011). Further, Helle *et al.* (2015) applied an estimate of "environmental losses" of oil spills in their analysis, which was based on the results of a contingent valuation study (Ahtiainen 2007). However, there is a need to study the impacts of oil spills e.g. on ecosystem services, if we aim at understanding the overall costs of oil spills. This understanding is essential e.g. when conducting cost-benefit analysis related to maritime safety, as underestimating the potential benefits (i.e. avoided environmental losses and other costs) may distort our conclusions about the utility of studied management actions. (However, it is also important to notice that the environment has also intrinsic value, which cannot be expressed in monetary terms.

8 Summary of Working Group self-evaluation and conclusions

WGMABS has achieved basically almost all of its original aims. The interaction with stakeholders was not as extensive as originally planned, in the Helsinki meeting 2018 there were stakeholders only from Finland. It seems obvious, that the fact that there has not been recent oil spill accidents in the Baltic Sea area, decreases the need to focus on the issues what WGMABS has been dealing with. It is obvious, however, that science needs to prepare for such an accident, so that it is clear what is modelled, surveyed, analyzed, estimated, and publicly informed. Society may not realize this, and scientists must be active to keep such analysis on the agenda of funding organizations. For example, the EU Horizon 2020 does not really include oil spill related research topics.

Annex 1: List of participants

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Annex 2: Publications

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Annex 3: Recommendations

1) WGMABS states that there is a need to apply Bayesian risk and stock assessment models to any data poor or high uncertainty cases. This need is obvious in oil spill impact analysis, where learning between accidents is highly important to support the interests of various stakeholders.

2) The view of WGMABS is that the applied decision analysis problems include information from social, economic, biological and engineering sciences. ICES must be more active to make these professionals more interested about ICES activities.

3) WGMABS recommends that the methodological development inside ICES must be made as open as possible. It is obvious, that many WG's share same type of methodological challenges.

4) WGMABS suggests, that ICES should have a theme session on: "Cross Disciplinary analysis of oil spill risks"

5) WGMABS suggests, that oil and shipping industry would be more active in formulating their information needs related to decisions that they make.

Annex 4: WGMABS self-evaluation

1) Name: Working Group on Risks of Maritime Activities in the Baltic Sea (WGMABS)

2) Year of appointment: 2015

3) Chairs: Sakari Kuikka, Finland, and Robert Aps, Estonia

4) Helsinki, Finland 2015: 16 participants
Copenhagen, Denmark: 12 participants
Helsinki, Finland: 13 participants

Self-evaluation is carried out for each ToR:

a) Review the recent studies carried out for ecological risks of maritime activities and to plan ToRs for 2017 WG meetings

This was carried out well. Review followed all steps forward.

b) Review the science of maritime risk analysis in the Baltic Sea

A review paper was written and published as part of a book focusing on Gulf of Finland.

c) Plan the ToRs of future WG meetings

The ToRs were planned in a satisfactory manner and end result was that ToRs were achieved.

d) Test the available risk models and operational sea dynamic models, including models that integrate major risks in the Baltic Sea

WG failed in here, no major tests were carried out. This would have required considerable research budget to be able to do properly.

e) Review of existing databases and their applicability to the alternative model

These were well reviewed and the list is in Annex 3.

f) Identification of the need of expert knowledge in the use of the models

This was covered well and reported in this report.

g) Discussion with end-users on the applicability and relevancy of the models

This was changed to be a discussion on the future research needs. This discussion was very good and gave several important research ideas for WGMABS members. Also end users were happy about the information provided in presentations.

Publications can be found in Annex 2. Advice was given in the format of some presentations and a newspaper article. Advice was that there is no reason in Finland to invest more money in oil combatting fleet, better use for economic resources is to focus them on preventive actions. WGMABS has no future plans as such, it suggest that a new WG will

be established, focusing on oil spill risks. This would cover oil transportation and oil drilling. This is a relatively new area for ICES, its economic value is huge.