Spring 2020

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Maritime Technology and Research

https://www.tci-thaijo.org/index.php/MTR

Research Article

Enhancing oil spill response capacities in the South Baltic Sea region via cross-border utilization of biodegradable oil binders

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Article information

Received: February 1, 2020
Revised: April 27, 2020
Accepted: April 30, 2020

Keywords
South Baltic region,
Oil spills,
Biodegradable oil binders,
Oil pollution

Abstract

Occurrences of oil spills are responsible for very significant environmental degradation; they are more likely to happen in areas with dense shipping traffic, or in the close vicinity of transport pipelines and/or other infrastructures used for production and processing purposes. Without international co-operation, individual countries often lack sufficient resources and assets to successfully respond to large-scale oil spill incidents. This can be related to the vast quantities of oil involved in those incidents, or the lack of necessary special equipment for dealing with the tasks at hand by the country under the need to respond. For the successful resolution of oil spill incidents, close and effective international co-operation- especially between neighboring countries that usually "share the burden" of oil pollution- is a vital necessity. On this basis, the South Baltic Oil (SBOIL) project aims to strengthen the existing oil spill response capacities in the South Baltic region, introducing a cross-border spill response tool based on the new 'green technology' of biodegradable oil binders (BioBinders). In order for this new concept to be implemented, it is necessary to examine the international and national regulations and guidelines with reference to sorbent use and the exchange of oil spill equipment in the area of interest, and also analyze the national oil spill contingency plans of the different countries involved in the project. After investigating the legal requirements for the utilization of BioBinders in the South Baltic region, the analysis at hand presents the outcomes of a Table Top Exercise that was based on a realistic oil spill scenario in the wider region. This exercise tested the compatibility of international/national/regional plans regarding the use of BioBinders and examined the topics of recovery and waste management, including alternative techniques available for oil spill response. The results suggest that the use of BioBinders is promising, and represents a response option to improve the existing oil spill response capacities in the South Baltic region; the main challenge lies with the difficulty in dealing with waste management, mainly because of the current legislation in place within the participating countries.

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1. Introduction

Oil spills pose a significant threat to the environment and society in all parts of the world. Large oil spills at sea have occurred since ships started to rely on oil as fuel (for needs of propulsion). Furthermore, the largest and most widely known spills, such as the Torrey Canyon, Exxon Valdez, and Prestige, came from oil tankers. Major oil spills are more likely to occur in areas with dense shipping traffic, or in the close vicinity of transport pipelines and/or other infrastructures used for production and processing purposes, despite the existence of strict regulation and increased awareness of the related dangers. Spills of petroleum oil have severe negative effects on the environment, smothering and poisoning flora and fauna (Dalaklis, 2017; Teal & Howarth, 1984). These effects may remain for several years, depending on the environment that has been impacted, the type and amount of oil, and prevailing weather conditions (O'Brien & Dixon, 1976). Oil spills can also have an impact on socioeconomic interests, such as fisheries, aquaculture, and tourism in the affected areas (Kirby & Law, 2010).

Minimizing the risk of oil spills and their negative impacts is a priority under the United Nations Sustainable Development Goals (SDGs), and especially SDG 14, concerning the conservation and sustainable use of the oceans, seas, and marine resources. In this direction, the South Baltic Oil Spill Response (SBOIL) project builds on the BioBind approach, focusing on the development of a fast and effective oil spill recovery system for coastal shallow water areas, even in adverse weather conditions (Dalaklis et al., 2019; Dalaklis et al., 2020). The BioBind concept is based on biodegradable wood-based oil binders, deployed by plane/helicopter, and removed by a specially designed net boom- a combination of fishery nets and conventional oil containment booms (**Figure 1**). The SBOIL project aims to take up this innovative green technology to strengthen existing cross-border spill response capacities in the South Baltic region, investigating the feasibility of using biodegradable binders to mitigate the consequences of spilled oil. Advantages of these products include their low production costs, small environmental impact, and potential use in adverse weather conditions and in shallow waters.

Figure 1 BioBinders and their removal by specially designed net boom.
Source: Rostock University

The South Baltic Sea hosts rather dense shipping traffic, corresponding to both passenger and freight transport. This density poses great risks of maritime accidents, which can result in damage to the environment and injuries/loss of lives (Pelot & Plummer, 2010). Apart from the significant volume of crude oil transported in the area under discussion, ships' own bunkers pose an additional threat of potential oil spill. Nevertheless, despite being one of the busiest sea-transportation areas in the world, the Baltic Sea may still be considered one of the safest seas globally. This is the outcome of the regulations and response techniques already in place, as well as the various existing national and international contingency plans produced in advance to deal with possible emergency incidents (Zaucha, 2014). The main criteria for assessing the efficiency of the

present techniques for responding to oil spills are based, firstly, on the time required to reach the accident location and, secondly, on the meteorological and hydrodynamic conditions in the area. To lessen and overcome the existing limitations, new response techniques should be easily and rapidly deployable which not dependent on an individual country.

The SBOIL project aims to enhance the existing response capacities in the South Baltic region by utilising BioBind material and to improve the protection of the marine environment from all sources of pollution, including spills associated with maritime accidents. This new "green technology" is more environmentally friendly when compared to the standing practice of using chemicals to deal with oil pollution at sea; it can also contribute to the improvement and enhancement of cross-border oil spill response capacities. The main aim of this analysis is to increase awareness in relation to oil spill response measures in the South Baltic region. Additionally, it will discuss the outcomes of a Table Top Exercise, which was based on a realistic oil spill scenario and tested the preparedness and implementation of BioBinders as a response option to support existing oil spill response capacities in the area under discussion.

2. International regulations for sorbent use and exchange of oil spill equipment in the Baltic Sea region

In order to examine the feasibility of the utilisation of BioBind material in the South Baltic region, it is essential to investigate international law and guidelines with reference to sorbent use and the exchange of oil spill equipment in the area (Christodoulou et al., 2019). Regarding the general obligations under the United Nations Convention on the Law of the Sea (UNCLOS), the Baltic Sea States have given effect to the generally accepted international rules and standards to deal with pollution from vessels, including vessel-source oil pollution. Baltic Flag States and Baltic Coastal States are both empowered by UNCLOS to have in place pragmatic measures to minimize the threat posed by the discharge of oil, whether intentional or unintentional.

In particular, regarding the use of sorbents and the international exchange of oil spill equipment, the Shipboard Oil Pollution Emergency Plan (SOPEP) Guidelines, included in Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), briefly highlight that the master of the vessel should include in an incident assessment-report the need for the use of chemical dispersant or degreaser. Although there are no specific stipulations on the exchange of equipment, Article 6 of the International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC, 1990) requires the Baltic Sea States to co-operate through bilateral or multilateral agreements to establish pre-positioned oil spill response equipment. Moreover, the same article advises state parties to establish a mechanism to co-ordinate the response to an oil pollution incident with the capabilities to mobilize the necessary resources. For a better insight on the use of sorbents and the exchange of equipment, it is necessary to delve into the two relevant IMO guidelines, the 2016 Operational Guideline on the Use of Sorbents for Oil Spill Response and the 2016 Guidelines on International Offers of Assistance in Response to a Marine Oil Pollution Incident (IMO, 2016a; IMO, 2016b). Both Guidelines cover issues, such as preparation response plans, situation awareness, and response via sorbents; they also include relevant specifications with respect to equipment exchange as part of international offers of assistance and can act as instruction manuals for the Baltic Sea States.

Parallel to the international conventions and guidelines, there exist several multilateral agreements that endorse legislative and administrative co-operation in pollution response in the South Baltic region. With the Helsinki Convention (HELCOM) serving as a foundation of co-operation among the Baltic Sea States, the HELCOM Response Manual emphasizes the need for adequate equipment and trained personnel for response operation purposes, but there are no specific provisions on the usage of sorbents or the exchange of equipment (HELCOM, 1983). Similar traits are observed in the 1993 Copenhagen Agreement regarding co-operation for pollution control of the sea after contamination by oil or other harmful substances. However, this agreement furnishes only

a short provision on the exchange of equipment, which can be deemed as cursory and without any detailed advice on how the exchange procedure could be implemented (Nordic Council of Ministers for Education and Research, 1993).

Currently, the authorities of two South Baltic States (namely, Denmark and Poland) are authorized to use sorbents and dispersants in accordance with their national regulations and, as such, the usage of sorbents and dispersants is not prohibited. Moreover, the usage of chemical dissolvent is also permitted, but requires prior decision before application. For example, in Poland, the use of sorbents and chemical dissolvent requires a decision from the Polish Search and Rescue authorities. However, mechanical methods can be applied without any prior decision. In Denmark, chemical dispersants are allowed as a last resort following prior authorization from the Danish Environmental Protection Agency (EPA) (Christensen & Carpenter, 2015). With regard to Germany, dispersant application is currently prohibited 'within shallow coastal waters (less than 10 m deep) and in locations with limited water exchange' (Grote et al., 2018). Dispersants can only be used in a restricted manner in waters deeper than 20 m, and in an unrestricted manner in waters deeper than 20 m. In contrast, dispersant or sinking agents are not used in Sweden, where mechanical recovery methods are used during oil spill response operations (Chapman et al., 2007).

International regulations and guidelines concerning "exchange of equipment and co-operation" focus on the promotion of co-operation among states that are located in the same geographical region. This co-operation could be strengthened by co-operation-based exercises- a subject matter that was explicitly highlighted in the 2011 report titled BOILEX 2011 (Baltic Oil Spill Exercise, 2011). The report considers lessons learned from oil spill exercises held yearly in different parts of Sweden between 2008 and 2012, which in turn have provided valuable insight when developing the shoreline oil spill exercise titled "BOILEX". It is noteworthy that the aim and objective of BOILEX was to increase knowledge with regard to managing oil spills that affect the coastline in conjunction with achieving a well-functioning international cross-border co-operation in terms of management, assessment, and decision making in the preliminary stage of an oil spill.

The 2011 BOILEX report further notes that the "number of the stakeholders involved in a shoreline oil spill response is far larger than the ones operating at sea, which leads to a more complicated operation" and, therefore, international aid and assistance are required in the response process. As clearly indicated in that report, Baltic Sea States have "expressed uncertainty on how aid would be transferred", coupled with the fact that "nobody really knew how to help in a timely manner". The report further delves into very crucial matters, such as: a) the command system in place, including the use of appropriate technology; b) co-operation, including land-land co-operation, land-sea co-operation, and sea-sea co-operation; c) decision support tools with a special focus on the command system in Sweden; and, finally, d) drawbacks identified during the pre-exercise "Olivia". With reference to pre-exercise "Olivia", the evaluators note that "jurisdictions need to be outlined, where there is overlap, decisions must be made as to who has the lead", taking "international resources" into consideration. This consideration, according to the report, necessitates international co-operation on a cabinet/minister level that needs to be incorporated into the incident command structure. As such, the recommendations advanced by the report include, inter alia, cross-border exercises on a regular basis with different levels of management.

3. Oil spill contingency planning in the South Baltic Sea region

3.1 South Baltic Sea region- traffic and oil spills

The Baltic Sea, located in Northern Europe, is relatively shallow and is divided into several basins: Kattegat, Western Baltic, and the Sound in the West; the Baltic Proper in the South; the Gulf of Riga and Gulf of Finland in the East; and Bothnian Bay and the Bothnian Sea and Archipelago Sea in the North (HELCOM, 2017). It is one of the most heavily trafficked seas in the world, but in recent years has seen a slight decline in the number of ships (probably associated with the recent global financial crisis around the end of the previous decade). A total of 350,392 ships crossed the

fixed Automatic Identification System (AIS) lines in the Baltic Sea in 2013, a decrease from the 376,671 crossings in 2006 and the peak of 430,064 crossings in 2008 (HELCOM, 2014). During the same time, oil transport in the Gulf of Finland increased substantially, from 128 million tonnes in 2005 to 164 million tonnes in 2015, but with a slight decrease from the 2013 peak of 178 million tonnes.

Few oil spills have occurred in the Baltic Sea (Veiga & Wonham, 2002; Rambøll Barents, 2010). Most did not involve tankers, but cargo ships that spilled fuel oil. The largest oil spill in the Baltic Sea was the Globe Asimi, which spilled 16,000 tonnes in the port of Klaipeda in Lithuania in 1981. Nevertheless, increased shipping traffic creates an additional risk of collision and oil spills. This risk was mapped by the project Sub-regional risk of oil spill and hazardous substances in the Baltic Sea (BRISK). BRISK estimated that an oil spill between 300 and 5,000 tonnes will occur every four years, and an exceptionally large spill (5,000 tonnes and above) will occur every 26 years in the Baltic Sea region (BRISK, 2011).

3.2 Oil spill contingency planning in the South Baltic Sea region

In general, oil spills at sea are the responsibility of the respective national government that "controls" the specific sea area where the oil spill occurred. On land, it is often the local municipalities who are responsible for spills that impact their coastline. The national government most often assigns oil spill preparedness and response to an agency, such as the Coast Guard or Navy, and this agency is responsible for developing and maintaining a National Contingency Plan for oil spill response at sea. However, oil spill contingency planning responsibility differs among the South Baltic Sea countries, regions, and municipalities (**Table 1**) (Nilsson et al., 2018).

Table 1 National Contingency Plan status and main responsible organisations for oil spill response.

Country	National Contingency Plan	Authority responsible for NCP	Main responsible organisation at sea	Main responsible organisation on land	Main responsible organisation in ports
Denmark	Yes	Defence Command Denmark	Defence Command Denmark	Municipalities	Local councils
Germany	Yes	Central Command for Maritime Emergencies	Central Command for Maritime Emergencies	Regional Environmental Authorities	Operators
Lithuania	Yes	Ministry of Environmental Protection	Navy	Federal Rescue Service	Port authority
Poland	Yes	Maritime Search and Rescue	Maritime Search and Rescue	Ministry of Internal Affairs and Administration	Port authority
Russia	Yes	Ministry of Transport, Ministry of Natural Resources, and Ministry of Defence, Emergencies and Disaster Response	Marine Rescue Service	Ministry of Defence, Emergencies and Disaster Response	Operators
Sweden	Yes	Coast Guard	Coast Guard	Municipalities	Operators

Source: Nilsson et al. (2018)

Most countries cover only marine areas with their National Contingency Plans, and only a few countries include provisions and regulations for shoreline clean-up (Nilsson et al., 2018; Larsson et al., 2019). In most countries, there is a lack of proper instruction and knowledge on how a clean-up should be performed; familiarization with the relevant regulations is also rather limited. However, having a plan is not enough, as the plan itself is nothing more than words on paper. The foundation work, with consulting stakeholders, finding information, and prioritising sensitive areas, is crucial when developing a contingency plan. Most importantly, the plan needs to be tested through exercises. A lack of coordinated exercises onshore means that few municipalities or countries have a preparedness level on land as good as they have at sea in the South Baltic Sea region. Exercises raise awareness and "educate" civil servants on their roles and responsibilities during an oil spill response, making them familiar with response procedures. Consequently, regular and frequent exercises are necessary to raise awareness of oil spills and their potential impacts.

4. Experiences learned from Table Top Exercise

Apart from the Table Top Exercise analysed in this section, the feasibility of using BioBinders was tested in the northern part of the Polish Channel on 20 April 2018, and discussed during a national workshop arranged by the Maritime University of Szczecin, with the participation of the Polish SAR service, from 27-28 June 2018 in Swinoujscie and Szczecin. The main aim of the first practical exercises, in the use of a boom placed in a container, was to verify the possibilities of the use of BioBinders in real conditions. These exercises allowed the testing of the possibility of transferring the container with the boom to the SAR unit and using it in action, as well as testing the possibilities of the boom in sea conditions. During the workshop, experiences from the practical exercises were discussed among the participants, generating feedback from each country, and the co-operation of Polish services in the event of oil spillage was investigated.

4.1 Table Top Exercise setting

Within the framework of the SBOIL project, a Table Top Exercise was conducted by the World Maritime University (WMU), with the help of Oil Spill Response Ltd. (OSRL). The exercise was based on a realistic oil spill scenario in the South Baltic Sea region and tested the preparedness and implementation of BioBinders as a response option to support the existing oil spill response capacities in the area (Dalaklis et al., 2019). It took place on 8th November 2018 in Swinoujscie, Poland, and was attended by representatives from Poland, Germany, and Sweden. The objectives of the exercise were to:

- Learn, test, and train the mobilisation and management of the BioBind system in a transnational setting, in line with existing oil spill response co-operation arrangements.
- Test the compatibility between different oil spill contingency plans in the South Baltic at international, national, regional, and local levels.
- Enhance awareness and knowledge of oil spill response and contingency planning among key organisations involved in preparedness and response to oil spills.

This was achieved by separating the attendees into two groups and allowing them to work on a problem and solution 'facilitated' exercise. The exercise was based around a scenario and revolved around the logistical and procedural arrangements for the exchange of BioBind equipment across the project countries. The main target group(s) of the exercise were the organisations involved in the national oil spill response operations in these countries, specifically those that are responsible for requesting and accepting oil spill equipment from neighbouring countries.

4.2 Exercise scope and scenario

The original scope of the exercise was to test the participating countries' collaboration in mobilising and responding to an offshore oil spill incident within the Exclusive Economic Zone

(EEZ) of one country that then migrates across to another EEZ of an adjoining country. As BioBind is a new response option for mitigating a surface oil spill at sea, if the participating countries were not given guidance as to what and how they were to mobilise, then they would likely only consider conventional response options, and the ability to test the usefulness of BioBind as a complementary response option would not be proven. Therefore, the concept of a "facilitated" Table Top Exercise was decided, with the intention of focusing on the use of BioBinders as complementary to the primary response options, and considering the process of mobilisation, deployment, recovery, and waste management.

The participants were divided into two groups; this was to allow them to 'mix' and use their experience to work through the exercise and reach agreements based on their knowledge of each country's legislation and procedures. The two groups arranged themselves with the Polish contingent at one table and the German/Swedish contingent at the other. However, this did not hinder the collaborative approach of the exercise.

The exercise scenario was based on two vessels colliding within Polish waters (a container vessel and a tanker), close to the EEZ of Germany (**Figure 2**). There were no casualties, but a significant loss of crude oil into the water was reported.

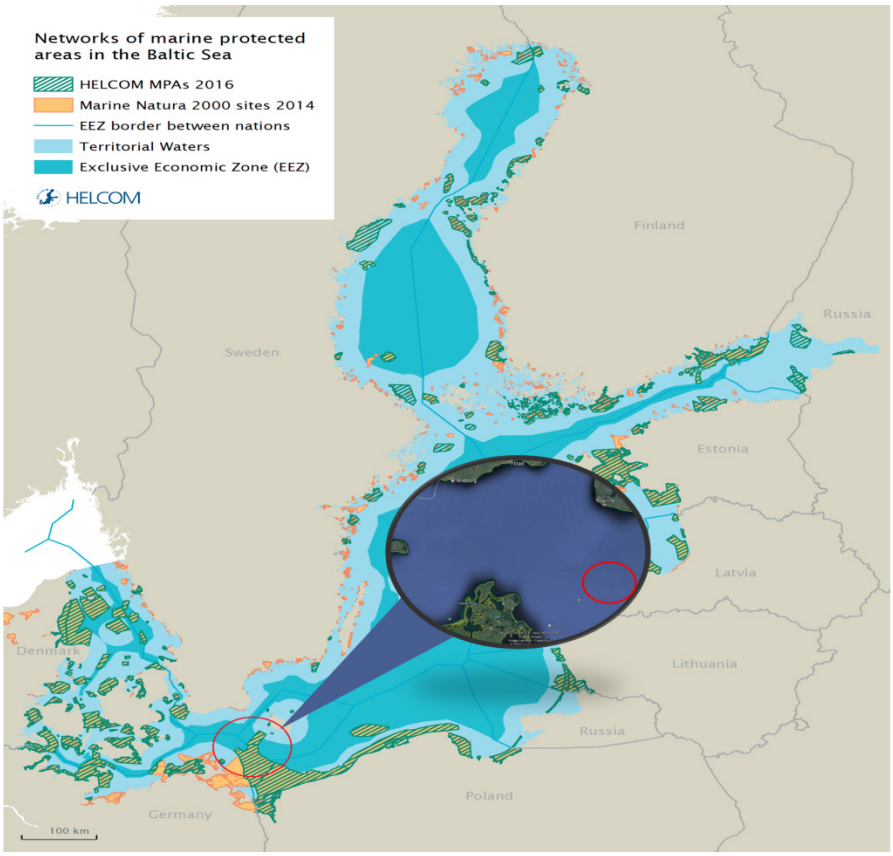

Figure 2 Incident site with likely impacted coasts of Poland, Germany, and Sweden, depending on prevailing conditions.
Source: Oil Spill Response Ltd. (OSRL)

For this exercise, the prevailing winds and currents meant that the oil was heading towards the German coast. This was proven by using an appropriate oil spill modelling software (Oilmap). However, it was pointed out that any tactical response should not be reliant on modelling alone, as any changes in the weather would change the fate of the oil slick (**Figure 3**).

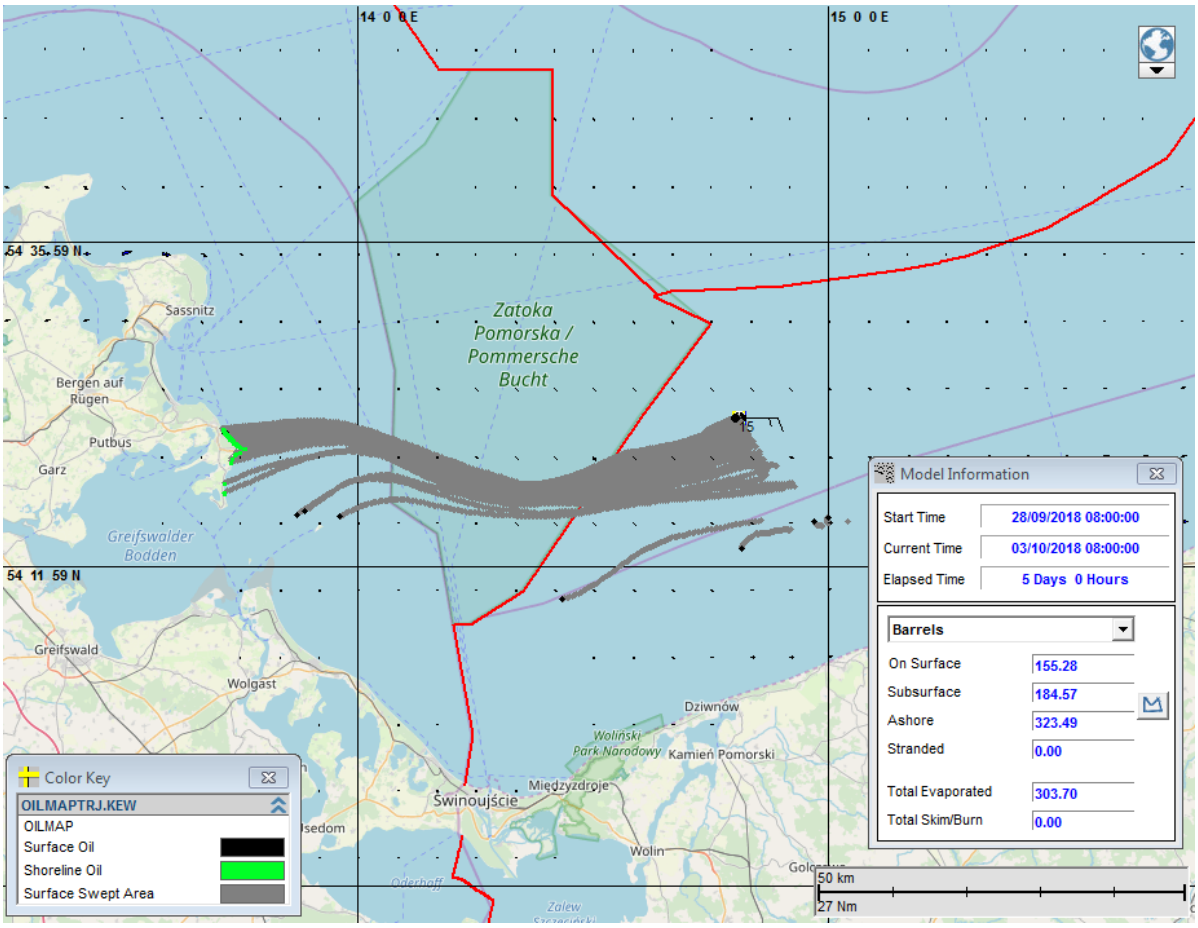

Figure 3 Prevailing weather conditions and modelling results if conditions remained constant. Source: Oil Spill Response Ltd. (OSRL)

An initial response assessment of the incident was worked through, as this is an important part of understanding the scale and complexity of the incident. Suggestions for gathering further information on the magnitude of the incident, the hazard and safety concerns, and initial priorities were discussed by the groups, including aerial surveillance and satellite surveillance, together with the information that could be obtained by personnel at the incident site.

When the response strategies and tactics were covered, the assumption that the groups would only consider the tactical operations that they were familiar with was proved correct. Aerial delivery of BioBinders was ruled out, and Offshore Containment and Recovery were the preferred offshore response options for this incident. However, the objectives of this exercise meant that the facilitators asked the groups to consider BioBinders as the primary offshore and shoreline response to this scenario and to plan the mobilisation and operations for their use. As a complementary response option, BioBinders could be used in conjunction with other response options; therefore, the use of simultaneous operations (SIMOPS) was introduced as a method to manage multiple operations in response to the same incident (**Figure 4**).

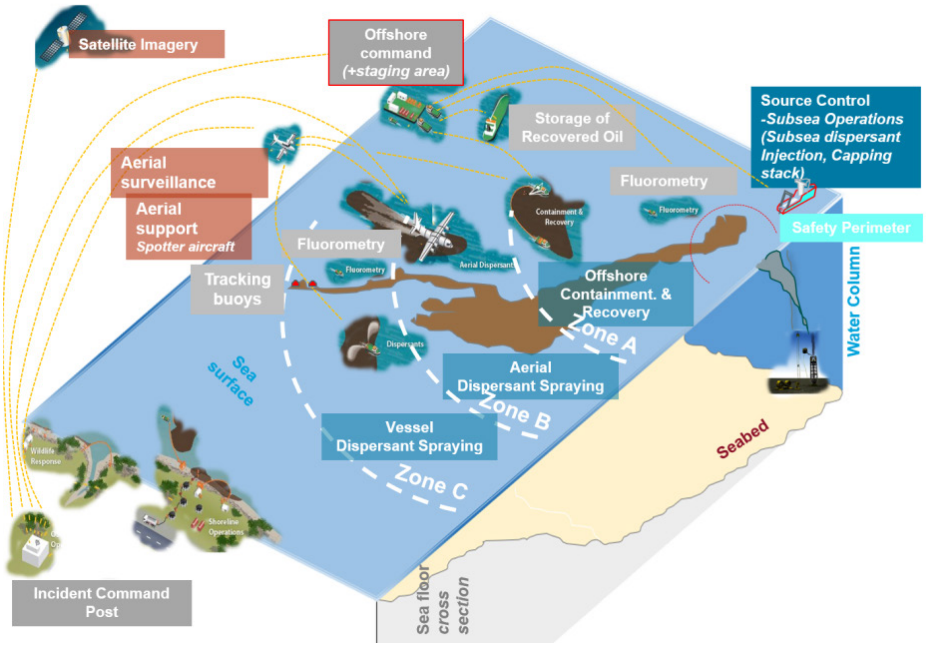

Figure 4 Managing multiple operations without confliction.
Source: Oil Spill Response Ltd. (OSRL)

4.3 Main outcomes from the Table Top Exercise

The Table Top Exercise focused on an in-depth examination of the operational aspects of using BioBinds as a response option and, in doing so, was always likely to raise more questions than provide adequate answers, especially considering preparedness for a new technology. However, raising questions at every step in the mobilisation, deployment, and recovery led the project into specific areas that require further consideration for the next stage of the program.

The exercise participants from Germany, Poland, and Sweden came with different levels of knowledge and backgrounds. Some knew about the project and were aware of the capabilities of BioBinders, while others knew less about the technology but knew what their roles would be in a response. This led to varied and good discussions, along with open dialogue between the groups, which helped to ensure that the exercise objectives were met. It also helped to identify several areas that will require considerable effort to ensure the project continues to move forward. The main outcomes of the Table Top Exercise can be defined as:

- Although the opinions of the participants were relatively negative, *BioBinders should remain an option due to their ability to retain oil without leaching*. For this response option to move forward as a technique, and for governments to believe this method is viable, there is further work to be done. Sorbents do not have a great reputation, as the perception is that dealing with the oiled waste is more problematic and costly than using conventional methods of clean-up.
- *Fixed-wing aircraft deployment of BioBinders is unlikely to happen* due to the lack of aircraft, regulations, and other considerations. It was felt by all parties that the effort required to implement this as an option outweighed the benefits.
- *Helicopter deployment of BioBinders would be more efficient and effective (especially on small slicks) and for use in hard-to-access areas* where standard equipment is difficult to use. This may be a far more efficient use of BioBinders offshore and may gain more traction with governmental implementation. Helicopters are more readily available; they can treat smaller slicks (targeted deployment), do not use existing response resources, can be used closer to shore, and are not hindered by sea depth. Therefore, they can be deployed just prior to shoreline impact, minimising shoreline contamination.

- Vessel deployment is a far better option; however, until it is tested and integrated into contingency plans, there will always be a reluctance to use this over conventional tried and tested methods. As containment and recovery is, at present, the primary offshore response option in the Baltic region, there would be a reluctance to use vessels for an unproven technology. Therefore, sourcing additional vessels and using them for deployment and recovery near-shore would not diminish offshore operations, but add a complementary response, using the 'cone of response' concept.
- *Waste was BioBind's biggest disadvantage*. Like all sorbents, it produces a vast amount of contaminated waste that must be disposed of.
- *Ways that waste can be reduced, reused, or become part of the circular economy need to be addressed* so it does not become a burden to governments. Options for reuse of oiled binders can be examined and, once an option is defined, an agreement in principle can be sought. At this point, implementing BioBinders can become a viable response option, which would be easier to pass through legislation and gain approval within the South Baltic Sea Region.
- *Biobinders were regarded as a useful option for ports and harbours, shallow and sheltered waters, and shorelines prior to impact if the oil is still of a low enough viscosity for the binders to be used.*
- *BioBinders are a 'loose' sorbent* (i.e., not confined like a sorbent boom or pad) that contains oil without leaching. This material has the ability to be deployed very quickly, without the need for immediate containment, as the oiled binders will not cause any additional contamination to non-oiled surrounding areas.

The successful implementation of BioBinds as a response option for the abatement of oil spills in the South Baltic Sea region is based on effective co-operation among states that are geographically located in the same region. As highlighted by this Table Top Exercise, this co-operation could be strengthened by co-operation-based exercises, like the one analysed in the BOILEX 2011 report. The shoreline oil spill exercise titled "BOILEX" was based on oil spill exercises held yearly in different parts of Sweden between 2008 and 2012, and aimed at increasing knowledge with regard to managing oil spills that affect the coastline, in conjunction with and achieving a well-functioning international cross-border co-operation in terms of management, assessment, and decision making in the preliminary stage of an oil spill. During the BOILEX exercise, it was identified that "a shoreline oil spill response is a complicated operation" that requires international aid and assistance, with Baltic Sea States "expressing uncertainty on how aid would be transferred in a timely manner". Other crucial matters identified included: a) a command system including technology; b) co-operation including land-land co-operation, land-sea co-operation, and sea-sea co-operation; c) decision support tools with a special focus on the command system in Sweden; and, finally, d) drawbacks identified during the pre-exercise "Olivia". The pre-exercise "Olivia" also highlighted the need to 'divide' jurisdictions among authorities, to avoid overlapping responsibilities, and the necessity to incorporate 'international co-operation' in the incident command structure. The implementation of cross-border exercises, like the Table Top Exercise analysed in this paper, on a regular basis is crucial for the mobilisation of 'international resources' in the mitigation of the consequences of oil spills.

5. Conclusions

The main outcomes of the table top exercise are consistent with previous studies suggesting that traditional recovery methods, like Offshore Containment and Recovery, remain the preferred offshore response options for an oil spill incident. BioBinders, though, could be used as a complementary offshore and shoreline response in conjunction with other response options, especially in Ports and Harbours, shallow and sheltered waters and shorelines prior to impact if the oil is still of a low enough viscosity for the binders to be used. Another significant finding of this research is related to the fact that the existence of a plan is not enough, but the relevant authorities

need to regularly test this plan to ensure the mobilisation and operational employment of BioBinders.

Throughout the exercise, the feasibility of using BioBinders as a response option for the mitigation of the consequences of spilled oil was investigated, including the logistical and procedural arrangements for the exchange of BioBind equipment across the project countries. The mobilisation and management of the BioBind system in a transnational setting and the compatibility between different oil spill contingency plans in the South Baltic, at international, national, regional, and local levels, were tested.

The consensus from the participants was that BioBinders is a very interesting concept, but it would be very difficult to implement, partly due to the required amount of binders to absorb a large volume of oil, which would increase the waste volume, and partly due to the ability to source suitable aircraft at short notice to deploy the BioBinders. Despite the identified challenges, the participants became more open to ideas on how to use BioBinders and explored opportunities for their use. If these challenges, which are not insurmountable, could be alleviated, and the issues that were raised solved, then the implementation of BioBinders in the Baltic Sea region could become an additional 'response tool' in the toolbox of the organisations involved in the national oil spill response operations of these countries. The use of BioBinders remains a realistic option due to the ability of the binders to retain oil without leaching. Although offshore containment and recovery remain the preferred offshore response options for an oil spill incident, BioBinders could be used as a complementary offshore and shoreline response in conjunction with other response options, if the relevant authorities are willing to prepare a plan for their mobilisation and operational employment.

Acknowledgements

The current research was conducted under the South Baltic Oil spill response (SBOIL) project, co-funded by the European Union's (EU) South Baltic Program. The views herein are solely of the authors and do not represent the views of the United Nations/World Maritime University or any other organization with a similar scope. Preliminary results of this work have been presented at the 12th and 13rd International Technology, Education and Development (IATED) Conferences. The authors are grateful to two anonymous referees for very helpful feedback on an earlier version of the paper.

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