IMPROVING OIL SPILL RESPONSE IN THE SOUTH BALTIC SEA REGION: BUILDING CAPACITY VIA AN INTERNATIONAL TABLE TOP EXERCISE

J. Larsson[1], D. Dalaklis[1], E. Bal Besikci[1,2], J.U. Schröder-Hinrichs[1]

[1]*World Maritime University (SWEDEN)*
[2]*Istanbul Technical University (TURKEY)*

Abstract

The IMO (International Maritime Organisation) allocates significant efforts through conventions and other interventions of a legal nature to regulate the operational environments and requirements of training for crew working on board ships, as well as for personnel working ashore; these efforts are having a positive effect and the level of safety in relation to shipping operations has increased overtime. Although the number of oil spills across the world has a decreasing trend, risks posed by oil spills still remain as major concerns for societies, around the world. These concerns arise from the possible damages to ecology and economy, as well as by considering the adverse impacts related to sociocultural and psycho-social aspects. A risk when oil spills doesn't occur that often and then do and becomes of international character, is that operational personnel might lack field experience and be less prepared. Recent major accidents, such as the "Prestige" and "Deepwater Horizon" have emphasized the importance of the associated response activities and training needs amongst operational personnel.

The South Baltic Oil Spill Response project (SBOIL) is a three year (2016-2019) European Union (EU) funded initiative, which is planned as a continuation of the BioBind project. Within the scope of that project, the BioBind system was established to ensure fast and effective oil spill response in any sea state condition by the use of a new more environmental friendly sorbent technique. The goals of the SBOIL are to enhance the existing response capacities using the BioBind system and to identify important gaps in international oil spill response by using a table top exercise training.

In November 2018, a Table Top Exercise (TTX) on testing a new oil spill response technique across borders was held in, Świnoujście, Poland. Under the framework of the SBOIL project, this international training exercise (in the form of a facilitated workshop) was organised in collaboration with the project partners from Sweden, Germany and Poland as well as local, regional and national stakeholders involved in oil spill preparedness and response from the various countries around the South Baltic Sea. The purpose of the training was to identify operational aspects of using new and so called "green technology" in oil spill response and to provid local authorities and national incident management centres with knowledge to address areas of oil spill response improvement. With this aim, an incident exercise scenario was used to test the compatibility of International/National/Regional plans, prove command and control procedures of a cross-border incident and identify-improve tactical decision-making processes. The analysis in hand presents the set-up of the TTX, as well as results and recommendations for the future. It also aims to highlight the training needs in cross-border collaboration and increase awareness regarding oil spills and their consequences. According to the results from the training, the use of the BioBind material is promising; the main challenge in relation to the use of this "new technology application" was the difficulty involved with waste management, mainly because of the current legislation in place within the participating countries. It also showed that without this kind of trainings, none of the gaps would have been discovered. The table top exercise was conducted through an action research approach.

Keywords: Oil Spill Response, Scenario training, South Baltic Sea Region, SBOIL Project, Table Top Exercise, Training.

1 INTRODUCTION

It is true that several types of maritime accidents are still taking place at a global scale, because of various reasons. In the contemporary world and no matter of the significant improvements in the technology applications supporting the conduct of navigation, maritime accidents are frequently recorded and marine ecosystems are being negatively influenced by them, considering that their vast majority is usually resulting into oil being spilled at sea. Clearly, the level of safety in relation to

shipping operations has significantly improved over time, under the intensive coordination efforts of the International Maritime Organisation (IMO). However, numerous maritime mishaps are still recorded today, with oil spills being their most often consequence; the fact that the volume of traffic at sea has steadily increased in order to support the expanded need for trade is complicating this situation even further [1]. Those maritime accidents previously pointed out, create a very negative impact on the communities who are heavily dependent on resources they obtain from coastal waters [2,3]. Dealing with the adverse consequences of these accidents usually requires significant amount of money and vast quantities of resources; for example, intensive and very time-consuming clean-up efforts are needed in order to minimise the damage towards the marine environment [4]. Oil spills pose a significant threat to the environment and society in all parts of the world and are still standing out today as a major concern [5]. Even with more robust legislation and an increased awareness to the related dangers/risks there is a rather high chance of major oil spills in areas where shipping, transfer of oil via pipelines and/or offshore oil and gas exploitation activities are conducted.

Past accidents provide clear evidence that oil spills can be responsible for major pollution and very devastating consequences. For example, the “Exxon Valdez” grounding [6] or the “Heibei Spirit” collision [7] are two very indicative examples of such accidents. Following a major oil spill, recovery operations will create great financial expenditures in the short term [8]. Additionally, in the long run, those spills may have very adverse effects on the marine life and ecosystem [9] and they may even result into the complete break-down of the economic activities in the vicinity of the accident [10]. Apart from unnecessary expenses [11], there is also the issue of socio-cultural impacts and physiological stress for people involved [12]. For all those reasons, comprehensive administrative measures and regulations are set forth in advance, involving both strategic and operational precautions for pollution prevention and response. These precautions and planning factors are usually transnational in character and require political cooperation amongst the impacted countries and a common willingness to achieve the necessary level of environmental protection. One example of this kind of “legislative cooperation” is the Helsinki Convention for the Baltic Sea region [13]. The Baltic Sea (BS) is one of most ecologically affected seas in the world; furthermore, congested sea traffic is causing a great number of minor or major ship-sourced discharges every year. According to HELCOM’s 2006 yearly report, in the Baltic Sea, through a total of 5637 hours of surveillance flights, 224 illegal oil spills were observed in the year 2005 [14]. On the other hand, according to BRISK estimations, every four years an oil spill of 300 to 5000 tonnes is likely to occur, with another important estimation being that the expectancy of a possible major spill (5000 tonnes and more) is once in 26 years [15, 16].

As the amount of oil being transported within the sensitive SB is rather large, analysing the precautions taken for response and prevention measures by the surrounding countries for minimising the damage due to oil spill becomes an area of interest [17]. Although this region has not experienced a large number of oil spill incidents at sea (and by also factoring in the high level of regional coordination and frequent exercises), the countries of the Baltic seem to be well prepared for the specific type of incidents. However, the situation is not the same in relation to land based events/incidents. The fact that there is an extremely small number of oil incidents with origin (or very strong impact) in land has made local and regional authorities not well aware of the oil spill risks and unfamiliar with the methods to respond. This is why awareness raising is still an outstanding issue together with proposing training methods for realistic scenarios to form correct capabilities of response [18]. When examining the issue of oil spill response, it is also necessary to factor in that there is no single state having sufficient resources and equipment for responding towards a significant oil spill simply with its own capability. This is due to the fact that not all of the required special equipment is readily available in each and every country, since resources for the task at hand are usually limited.

The project SBOIL (South Baltic Oil spill response) is a three-year (2016-2019) European Union (EU) funded initiative designed as an enhancement and follow up of the BioBind project. This project aims to further promote the use of the so-called “BioBind system” to ensure fast and effective response for oil spills in all weather and sea conditions by following the scope and aims of its predecessor. The main goal of the SBOIL project is to further improve present response capacities by making use of the BioBind system and hence protect the SB region against all kinds of pollution including the ones sourcing from spills due to maritime accidents. The project has been focusing on examining how effective it is to use bio degradable binders for lessening the adverse consequences of an oil spill. Convenience in using those products lays in their low production costs and their versatility for usage in all weather conditions including shallow depths, as well as their low level environmental impacts. Advantages of these products are their low production costs, small environmental impact and potential for use in adverse weather conditions and in shallow waters. A full scale Table Top Exercise (TTX) was recently conducted within the framework of the SBOIL project. A TTX is very suitable in oil spill

disaster mitigation, including training in the associated response efforts. Focusing on operational aspects of “green technology” as a new approach for oil spill response was one of the main considerations of that exercise. The analysis at hand introduces the basics of how to set up a Table Top exercise in order to test an original technique for oil spill response across borders. It also presents the results of the exercise, as well as the recommendations and tools for anticipated future developments with respect to management of emergency response activities.

2 SBOIL TABLE TOP EXERCISE: TESTING A NEW OIL SPILL RESPONSE TECHNIQUE ACROSS BORDERS

2.1 Exercise Scope & Methodology

A Table Top Exercise (TTX) within the SBOIL project was held in Świnoujście-Poland in November 2018. The event was attended by representatives from several pollution response organizations, maritime safety authorities, regional emergency response centres, marine risk consultancy companies, and certain people with an academic affiliation. Apart from people directly involved with the project (academics and researchers), 25 “guests” also took part in that exercise. As “BioBind” is a relatively new concept in the response portfolio of dealing with a surface oil spill at sea, it was identified that if the participating countries were not given crystal-clear guidance to what and how they were to mobilise during an oil spill response task, then they would only consider existing response options. Therefore, the ability to test the usefulness of BioBind as a complementary response choice would not be feasible without structuring the TTX as a “facilitated workshop”. The main objectives of the exercise were to:

- Test the compatibility of International Legislation/National Plans & Regional Plans from notification to material recovery and disposal.
- Prove Command & Control of a cross-border incident.
- Identify/Improve “Tactical” decision making – Examining potential use of the BioBind
- Pinpointing optimal actions and solutions
- Discuss and agree upon the “best course” of action (by using the concept of “time-outs”).

The table top exercise was conducted through an action research methodology and evaluated in a final report which will be included in a handbook (an outcome of the project in 2019).

2.2 Exercise Plan & Scenario

Prior to the participants working through a scenario-based setting, the issue of “Incident Preparedness” was extensively considered. The topic of “preparedness” was covered within the first objective, as prolonged discussions that took place considered how the notification process of the participant countries would fold out in the case of an incident involving multiple jurisdictions. This option provided a better understanding of each country’s emergency procedures and also the opportunity to identify the associated level of compatibility. The exercise scenario was based on two vessels colliding within Polish waters (a container vessel and a tanker), but rather close to the Exclusive Economic Zone (EEZ) of Germany. There were no casualties in terms of human life, but there was a significant spill of crude oil into the water and due to the prevailing winds and currents the oil was expected to be headed towards the German coast. This outcome was demonstrated by using a modelling software (Oilmap); it was also pointed out that any option of response should not be reliant solely on the modelling output, as any changes in the weather will also change the route/behaviour of the oil slick. The exercise was separated into the following different areas of operations: a) Offshore Operations – mobilisation, deployment & recovery and waste management; and b) Shoreline Operations – mobilisation, deployment & recovery and waste management. The participants examined in a sufficient level of detail all the necessary steps required to implement a response and to capture any actions that needed to be considered, discussed and resolved. Finally, a dedicated period of time was afforded to the participants to let them reflect on the use of BioBind and to suggest any other uses and applications that this advanced technology application may be of benefit other than just as a response to an offshore oil spill incident.

3 EXERCISE RESULTS AND DISCUSSIONS

3.1 Incident Preparedness

The participants were divided into two different groups in order to facilitate the necessary "role play" of the TTX. Both the groups agreed that they would use the IMO's Standard Notification Forms in order to inform the relevant stakeholders of an incident that took place in their waters. The POLREP form would be used by the "Competent Authority" involved to "inform" other countries on the details of the incident. This form can be separated, dependant on the incident, into a POLWARN (warning or threat of pollution), a POLINF (detailed supplementary information) and a POLFAC (Facilities – matters relating to assistance). The only differences to how these forms would be used is internally, as different countries have different Competent Authorities to manage the oil spill –depending on if it is an offshore response, a shoreline response, or an inland response case. There are also various other methods of dissemination of the incident information: either by phone to a dedicated number/position, by Fax (Russia), or by using the so-called "SafeSeaNet" under the auspices of the European Maritime Safety Authority (EMSA)[1].

In Poland, there is an "Emergency Exchange System" that is designed to ensure that all the relevant-concerned authorities are immediately notified in the case of an oil spill incident (including for example entities responsible for Aerial Surveillance, EMSA's Satellite Surveillance, and Wildlife organisations). In Sweden, the competent authority to deal with an oil spill at sea (offshore response) is the Coast Guard; their on-duty personnel would have the responsibility to contact internal stakeholders of an incident. In Germany, the Havariekommando is taking the lead, through the Central Command for Maritime Emergencies (CCME)[2]. The CCME will inform both the offshore and inshore pollution response groups to deal with the incident by using pre-identified resources that they have available. Contingency plans are linked to the respective National Contingency Plan (NCP); the associated NCP's are based on the guidance provided via the HELCOM Plan. Other stakeholders' notification considerations that were discussed during the TTX included the potential of dealing with Contractors, Impacted (Local) Businesses, the Media, Pressure Groups and the General Public, as well as how each and every one of those previously pointed out actors could impact on how the response efforts should progressed. Although both the two group confirmed that all countries in the region have a dedicated media group that would deal with the necessary press releases, the appreciation of the opportunity to deal on their own with these additional stakeholders was welcomed.

3.2 BioBind as a Response Option

Having agreed upon the use of BioBind as an appropriate response option, the most suitable method of deploying those binders (mainly through consideration of the rather high quantity needed) was then addressed by the participants. In order to create a starting point for following discussions, the bio-binding material was considered as useful for offshore operations, with the issue of deployment by aircraft, helicopter and/or dedicated vessels subsequently examined in detail.

- Aircraft – both groups considered the quantities of BioBind required for a significant offshore response and the type of aircraft that may be available to deploy bio-binders onto an oil spill. It soon became apparent that storage, mobilisation of suitable assets and sufficient quantities of BioBind, along with aircrew availability that were already trained to fly at low levels/correctly deploy the material, were all posing significant challenges; lack of related legislation and complications in issuing of permits from multiple countries to allow this operation to proceed swiftly with deployment by air further inhibits this option.

[1] SafeSeaNet is a vessel traffic monitoring and information system, established in order to enhance maritime safety, port and maritime security, marine environment protection and efficiency of maritime traffic and maritime transport. It has been set up as a network for maritime data exchange, linking together maritime authorities from across Europe. It enables European Union Member States, Norway, and Iceland, to provide and receive information on ships, ship movements, and hazardous cargoes. The complete details can be found at: http://www.emsa.europa.eu/ssn-main.html, accessed December 2018.

[2] On January 1st, 2003 the Central Command for Maritime Emergencies (CCME) (in German: Havariekommando) commenced operations. The CCME is a joint institution of the German Federal Government and the Federal Coastal States. It was established to set up and carry out a mutual maritime emergency management in the North Sea and in the Baltic Sea. The complete details can be found at: https://www.havariekommando.de/EN/home/home-node.html, accessed December 2018.

- Helicopter – unlike the aircraft case in the south SB region, there are many types of helicopters that can be considered suitable to effectively deploy bio-binders. The material is delivered in 5m³ & 10m³ packages and this load are of a very appropriate size to be underslung from a helicopter. What isn't known at present is how the actual deployment method can be achieved as the operator would probably be needed to be in the helicopter, however, the potential to hover over a slick and release the BioBind directly onto the oiled surface makes this option quite efficient, especially when dealing with fragmented slicks.
- Vessels – these are readily available ships or medium size barges with tugs, pre-identified for response use. Unfortunately, there will be competing priorities between Offshore containment & recovery operations, BioBind deployment and Offshore BioBind recovery operations when using the available net booms. On the positive side, vessels have the ability to carry significant loads of bio-binders; however, at the time being the BioBind is deployed manually (time and effort intensive task), as the vessel moves through the oil slick. Furthermore, the bow wave will tend to move the slick away from the side of the vessel and the BioBind will need to be manually thrown further away than it was initially anticipated. A more suitable method of deploying the product over the sides of the vessel and directly onto the slick would improve efficiencies of this type of deployment; this is clearly an opportunity for future research.

3.3 Offshore Mobilisation Response Challenges

3.3.1 Poland

As BioBind is not a proven technology there was a reluctance from the people representing the country under discussion to use it as the option of choice. Poland has fairly robust and supported containment & recovery options already in place and the priority would be to use containment vessels for this rather than an untested method of response. It was suggested that if sufficient vessels were available on the scene, only then the people concerned would not be prudent to deploy both methods. However, there was clearly a reluctance, as the bio-binders are not integrated in the associated contingency plans and therefore not greatly favored as an option.

3.3.2 Germany

Germany appeared more open to the use of BioBind and not as restrictive in the use of materials that act as sorbents. However, as there is nothing in the German legislation that considers bio-binders as a response option, this method to respond would probably not be considered in the event of an incident. Another issue that was raised was the transfer of command when the incident "leaves" Polish waters and "enters" German waters. If Germany are to take the response lead, then a formal handover should take place. Ideally this should be in the "face-to-face" mode, but this may be totally impractical; therefore, a time and method for the transfer of command should be formally agreed by both parties to ensure that cross-border collaboration is effective and that the efficiency of resources are maximised (maybe even added as a dedicated annex to the existing National Plans).

3.3.3 Sweden

The Swedish Coast Guard has the authority to use (but limited knowledge of how) the BioBind and therefore it considers itself as unable to definitely confirm that they would be prepared to use the specific material as a suitable response option. Similarly, to Poland & Germany, there is a reluctance to heavily rely on the bio-binders as the quantities needed are not unknown with a fine level of detail. Additionally, they may need a change in legislation to prompt a change of attitudes before these countries exercise with bio-binders for offshore incidents.

3.4 Offshore Recovery and Waste Challenges

3.4.1 Poland

Poland has already pre-allocated vessels in the ports of Świnoujscie and Gdynia that would be immediately activated to respond among others (Navy and other Agencies); furthermore, vessels of opportunity could support the response efforts. For this scenario, the vessels would be the on-scene in six (6) hours, supported by vessels from Germany within twenty-four (24) hours; unfortunately, these are not very encouraging estimates. These vessels engaged in the response effort would concentrate on the primary method of recovery (Containment & Recovery) using the available vessel storage to contain the liquid waste. Therefore, they would not be tasked with operations involving the bio-binders

at all. Using the vessels of opportunity for deploying/recovering BioBind was also discussed; by factoring in the previous discussions that the use of bio-binders was an unproven option, this approach was completely dismissed by the Polish contingent. Subsequently, the discussion on dealing with waste was opened. Poland has legislation and facilities in place to deal with liquid waste, but very limited ability to deal with oiled solid waste. It appeared that this was the main driver to their reluctance to use BioBind as their perception is that its use would produce a vast quantity of hazardous waste with little ability to deal with it (except the "Landfill" option, which is not considered as very friendly towards the environment).

3.4.2 Germany

Vessels from German ports would support the operations and with the specific scenario setting the lead authority would pass from Polish authority to the German one during the second day (the oil moves out of Poland's EEZ after about 1.5 days). Germany would also use as their primary response method (Containment and Recovery) as it is tried and tested; furthermore, the use of BioBind is not integrated into their legislation as an option. German waste regulations are the same no matter if the waste is liquid or solid and Germany has many incineration plants that can be used to deal with the solid waste. This has also led into a discussion about "circular economies" and the use of oil impregnated bio-binders as "waste for energy production". If this approach wasn't an option of choice, a secondary use of oil impregnated BioBind could be explored as a topic of future research; this could help alleviate waste "costs" and make the use of bio-binders as more attainable for governments and pave the way to implement the technology application under discussion as an attractive option.

3.4.3 Sweden

Sweden is to further investigate the hazardous waste regulations; participants in the TTX were not able to provide the necessary input in order to reach to a concrete conclusion.

3.5 Shoreline Mobilisation, Recovery & Waste Challenges

Dealing with a shoreline response added more challenges in the use of bio-binders, but not any additional challenges in dealing with the waste. In Poland the Municipalities, Fire Service and Maritime organizations have the responsibility to respond to a shoreline impact; in Germany, the Local Authorities have this responsibility and would use volunteers to support the clean-up. It was agreed that on a shoreline the most effective deployment of bio-binders would be by manually spreading on a shore prior to impact; recovery would be done by a vacuum system that would collect the impregnated BioBind into a collection net. Both groups agreed that using the BioBind material would indeed add significant volumes to the amount of waste, especially if the oil at this time is so weathered that instead of aiding the impact on the shore it just adds to the waste. This raised a very good question of viscosity of oil and the upper limit that the bio-binders cannot absorb the oil. This may be further work, but a clear understanding of the "window of opportunity" for the use of BioBind can effectively reduce the needless additional waste issue.

Another consideration that would be beneficial for cross border collaboration during a significant incident was the ability to transfer oiled waste cross border. This may be complicated to achieve, and legislation and agreements would need to be agreed between each country involved, but this may alleviate some of the waste issues and differences between countries. A final question was raised into whether the BioBind can be treated by "Bioremediation". As the binders are a natural product, if nutrients were added, would this "kick-start" the growth of microbes that would then 'eat' the oil? if this occurs, would the binders then be able to be disposed of by incineration without the added hydrocarbon emissions that causes regulatory issues? All these points previously raised should be considered as appropriate topics for future research.

3.6 Alternative Response Techniques

Both the two groups were also posed with a question about other uses of the bio-binders they would consider at about the end of the workshop (under the approach that they would have a greater understanding on the abilities of BioBind). After some deliberation several ideas were put forward, which include:

- Waste Water Treatment Plants – most plants have filtration systems that could be harmed if impacted with oil and hence have permanent booming in place; BioBinds could be a fast "First

Strike" capability to contain the oil within the binders before those recovery operations take then place.

- Port & Harbor incidents – within a port or harbor, many minor spills can become a common occurrence due to equipment failure or human error. If the bio-binders were used when the oil enters the water, even if it wasn't contained in containment booms the oil would migrate to a collection point where flotsam and jetsam congregate; if the oil is contained within the binders, it would not adhere or get mixed with the flotsam and jetsam increasing the contaminated waste.
- Inland Pipelines – a spill from a pipeline will pool in the local vicinity of the incident and if the substrate is permeable then begin to impregnate the soil. Using binders will substantially reduce the amount of oil entering the substrate, thus reducing the amount of soil that would need to be removed for disposal/bioremediation.
- Salt Marshes and Mangroves – both areas are very environmentally sensitive and response options are limited due to the diversity of the habitat and the need to carefully treat these types of shorelines. If binders were used on impacted areas, any free-floating oil will impregnate the binders and not the shorelines, thus reducing the overall damage.

4 CONCLUSIONS

The IMO allocates significant efforts through conventions and other interventions of a legal nature to regulate the operational environments and requirements of training for crew working on board ships, as well as for personnel working ashore [19]; these efforts are having a positive effect and the level of safety in relation to shipping operations has increased overtime. Although the number of oil spills across the world has a decreasing trend, risks posed by oil spills still remain as major concerns for societies, around the world. These concerns arise from the possible damages to ecology and economy, as well as by considering the adverse impacts related to sociocultural and psycho-social aspects. It is useful to point out here that on September 25, 2015, under the auspices of the United Nations (UN), countries adopted a set of goals "to end poverty, protect the planet, and ensure prosperity for all" as part of a new sustainable development agenda. The specific initiative is also more widely known under the title: "Transforming our world: the 2030 Agenda for Sustainable Development"; there are 17 Sustainable Development Goals (SDGs)[3] and minimising the risk of oil spills and their negative impacts is a priority under SDG 14, concerning the conservation and sustainable use of the oceans, seas and marine resources.

The analysis in hand mainly provided brief background information on the SBOIL project, together with the details relating to the conduct of a Table Top Exercise examining the use of the bio-binders in the field. Furthermore, it provided certain recommendations for solving the difficulties pertaining to complex problems that governments and industry are facing and are inherent to oil spill response; it also highlighted in detail the logistical challenges during an oil spill incident. Participants in the exercise came with differing levels of knowledge and backgrounds: a) those that knew about the project and were aware of the capabilities of the bio-binders and b) those that didn't know as much, but knew duties and roles in an oil spill response. This led to good level of discussions and paved the way for an open dialogue between the groups which helped to ensure that the exercise objectives were fully met. It also helped to identify several areas that will need considerable effort to ensure the project continues to move forward. The main outcomes can be defined as:

- Aircraft deployment of BioBind is unlikely to happen – due to the lack of aircraft, lacking or conflicting regulations and other considerations this was felt by all parties that the effort to implement this as an option outweighs the benefits.
- Helicopter deployment of bio-binders would be more efficient and effective (especially on small slicks); especially the use on those hard to access areas where standard equipment is difficult to use is looking as rather promising.

[3] The 2030 Agenda for Sustainable Development, was adopted by all United Nations Member States; it provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its epicenter there are seventeen (17) Sustainable Development Goals (SDGs), which are an urgent call for action by all countries -developed and developing- in a global partnership. Each goal has specific targets to be achieved over a certain period of time, with more details being available at: http://www.un.org/sustainabledevelopment/sustainable-development-goals/, accessed November 2018.

- Vessel deployment is a far better option, however, until it is proven and fully integrated into the relevant contingency plans there will always be a reluctance to use the specific option over more conventional tried and tested methods.
- BioBind for offshore deployment will only be useful as a complementary response tool, as the resources required to contain the product in an oil spill incident would be hugely significant and difficult to recover in open, rough seas.
- Bio-binders were regarded as a useful option for Ports & 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.
- Waste management was BioBinds biggest disadvantage as, like all sorbents, its use is producing a vast amount of contaminated waste that has to be dealt with. If there are ways that waste can be reduced, reused or become part of the so-called “cyclic economy” and not become a financial burden to governments, then implementing this as a viable response option would be easier to be achieved and further promoted within the South Baltic Sea Region.

ACKNOWLEDGEMENTS

The work in the analysis at hand has been performed within the framework of the SBOIL project (South Baltic Oil spill response through clean-up with biogenic oil binders) (project number STHB.02.02.00-DE-0009/15). SBOIL is a three year (2016-2019) European Union’s (EU) project that has received funding from the EU South Baltic Programme.

REFERENCES

[1] Bi, H., Si, H., 2012. Dynamic risk assessment of oil spill scenario for Three Gorges Reservoir in China based on numerical simulation. Saf. Sci. 50, 1112–1118.

[2] Garcia Negro, M.C., Villasante, S., Carballo Penela, A., Rodriguez Rodriguez, R., 2009. Estimating the economic impact of the Prestige oil spill on the Death Coast (NW Spain) fisheries. Mar. Policy 33, 8–23.

[3] Miraglia, R.A., 2002. The cultural and behavioral impact of the Exxon Valdez oil spill on the native peoples of the Prince William Sound, Alaska. Spill Sci. Technol. Bull. 7, 75–87.

[4] Montewka, J., Weckström, M., Kujala, P., 2013. A probabilistic model estimating oil spill clean-up costs – a case study for the Gulf of Finland. Mar. Pollut. Bull. 76, 61–71. http://dx.doi.org/10.1016/j.marpolbul.2013.09.031

[5] ITOPF, International Tanker Owners Pollution Federation Limited. London, United Kingdom. Available on line on<⟨http://www.itopf.com/fileadmin/data/Photos/Statistics/Oil_Spill_Stats_2017_web.pdf⟩>.

[6] NTSB, 1990. Marine Accident Report. Grounding of the U.S. Tankship Exxon Valdez on Bligh Reef, Prince William Sound Near Valdez, Alaska. March 24, 1989. National Transportation Safety Board PB90-916405. NTSB/MAR-90/04.

[7] MAISSPB, 2008. Report of Investigation Into the Collision Between the Hong Kong Registered Ship “Heibei Spirit” and Korean Crane Barge “Samsung No. 1” on 7 December 2007. The Hong Kong Special Administrative Region Marine Department Marine Accident Investigation Section.

[8] Montewka, J., Weckström, M., Kujala, P., 2013. A probabilistic model estimating oil spill clean-up costs – a case study for the Gulf of Finland. Mar. Pollut. Bull. 76 (1–2), 61–71.

[9] Lecklin, T., Ryömä, R., Kuikka, S., 2011. A Bayesian network for analyzing biological acute and long-term impacts of an oil spill in the Gulf of Finland. Mar. Pollut. Bull. 62 (12), 2822–2835.

[10] García Negro, M.C., Villasante, S., Carballo Penela, A., Rodríguez Rodríguez, G., 2009. Estimating the economic impact of the Prestige oil spill on the Death Coast (NW Spain) fisheries. Mar. Policy 33, 8–23.

[11] Ventikos, N.P., Sotiropoulos, F.S., 2014. Disutility analysis of oil spills: graph and trends. Mar. Pollut. Bull. 81, 116–123.

[12] Gill, D.A., Ritchie, L.A., Picou, J.S., 2016. Sociocultural and psychosocial impacts of the exxon valdez oil spill: twenty-four years of research in Cordova, Alaska. Ext. Ind. Soc. 3, 1105–1116.

[13] HELCOM, 2008. Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992, as Amended. Helsinki Commission – Baltic Marine Environment Protection Commission.

[14] HELCOM, 2006. HELCOM achieves a 50% reduction in illegal oil discharges in the Baltic. HELCOM Information Service.

[15] BRISK. (2011). Risk of spills of oil and hazardous substances. Retrieved April 24, 2012, from http://www.brisk.helcom.fi/risk_analysis/spills/en_GB/spills/

[16] COWI. (2011). Risk Model Result Report (No. 3.2.2, 1st ed.). BRISK (pp. 1–113). Kongens Lyngby: BRISK.

[17] H.Nilsson, D. Dalaklis, J.Larsson, J. Palsson, 2018. Maritime Education and Training Activities: Improving Oil Spill Response in the South Baltic Sea Region, 12th International Technology, Education and Development Conference (International Academy of Technology, Education and Development (IATED), Valencia, Spain, 5-7 March 2018. DOI: 10.21125/inted.2018.0418

[18] D.Dalaklis, J. Larsson, H. Nilsson, J. Palsson, 2018. Training in Oil Spill Response: Improving Oil Spill Response in the South Baltıc Sea Region via Table-Top Exercises, OceansTrends2018 Scientific Seminar, Malmö, Sweden, 29-30 August 2018. DOI: 10.13140/RG.2.2.11477.88802

[19] Dalaklis, D., Safety and Security in Shipping Operations, (Eds) Visvikis I. and Panayides P., Shipping Operations Management. WMU Studies in Maritime Affairs, vol 4. Springer, Cham. Pp. 197-213. DOI: 10.1007/978-3-319-62365-8_9