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Solutions for effective oil spill management in the south–eastern part of the Baltic Sea

Sergej Suzdalev, Saulius Gulbinskas, Vadim Sivkov, Tatiana Bukanova

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Abstract The Baltic Sea is facing exceptionally intensive marine traffic. Oil products in addition to other cargo types are being transported in this marine area. Therefore, the risk of potential oil pollution is very high. Although, the Baltic Sea has not experienced catastrophic oil spills, there have been spills causing serious environmental damage in the region. Construction of oil terminals and planned growth of Russian oil export through Baltic Sea ports along with the operation of large oil enterprises and oil drilling platforms make maritime safety a priority task for the Baltic Sea region. The publications collected in present *Baltica* Journal Special Issue set sights on the improvement of oil spill management in the South–Eastern Baltic Sea as well as stimulate the appearance of new transnational response agreements in the region.

Keywords • *oil spill* • *environment* • *sensitivity*

✉ *Sergej Suzdalev (sergej.suzdalev@jmtc.ku.lt), Saulius Gulbinskas, Klaipėda University Marine Science and Technology Centre, H. Manto 84, 92294 Klaipėda, Lithuania; Vadim Sivkov, Tatiana Bukanova, The Atlantic Branch of the P. P. Shirshov Institute of Oceanology of RAS, Prospekt Mira 1, 236022, Kaliningrad, Russian Federation*

INTRODUCTION

The problem of pollution of marine environment in the Baltic Sea is an important topic addressed in various strategic documents and agreements on the European Union and the Baltic Sea Region level (for example: EU Marine Strategy Framework Directive, European Union Strategy for the Baltic Sea Region, HELCOM Baltic Sea Action Plan). Marine litter, hazardous substances and oil pollution are among the main sources of oil contamination.

In 2012–2014, Klaipėda University (Lithuania) and the Atlantic Branch of the P. P. Shirshov Institute of Oceanology (Kaliningrad, Russia) have been granted by the NATO Science for Peace and Security Programme (SPS) in order to establish the cooperation on accidental oil spills and their impact on the marine environment in the south–eastern part of the Baltic Sea (Fig. 1).

The focus of the study chosen was to identify the most efficient measures and management tools for finding the best solutions for proper detection of oil spills in marine areas, forecasting their drift and dispersion, and to detect the most vulnerable ecosystems, which can suffer from accidental pollution. In particular, the statuses of different type of pollution (marine litter), oil hydrocarbons, aliphatic and polycyclic hydrocarbons were designated to be overviewed in the study (Balčiūnas, Blažauskas 2014; Suzdalev, Gulbinskas 2014; Nemirovskaya *et al*. 2014).

- Furthermore, the study aims to develop solutions for effective oil spill management in the south–eastern part of the Baltic Sea. The main scope and objectives of this initiative were:
- to develop preconditions for more accurate and reliable identification of oil spills and prediction of their drift trajectories in the open sea (Bulycheva *et al.* 2014);
- to develop solutions for the improvement of accuracy of existing oil drift modelling methods and exploring the potential of their possible application in shallow waters (Kileso *et al.* 2014);
- to prepare an integrated methodology for the analysis of near shore and beach sensitivity to potential oil spills (Blažauskas, Dorokhov 2014).

One of the tasks was strengthening of the scientific potential and technical capabilities of Russian partners. New quality data and adopted methodology has resulted in preparation of new map of marine habitats in the near shore of Kaliningrad marine area (Kocheshkova

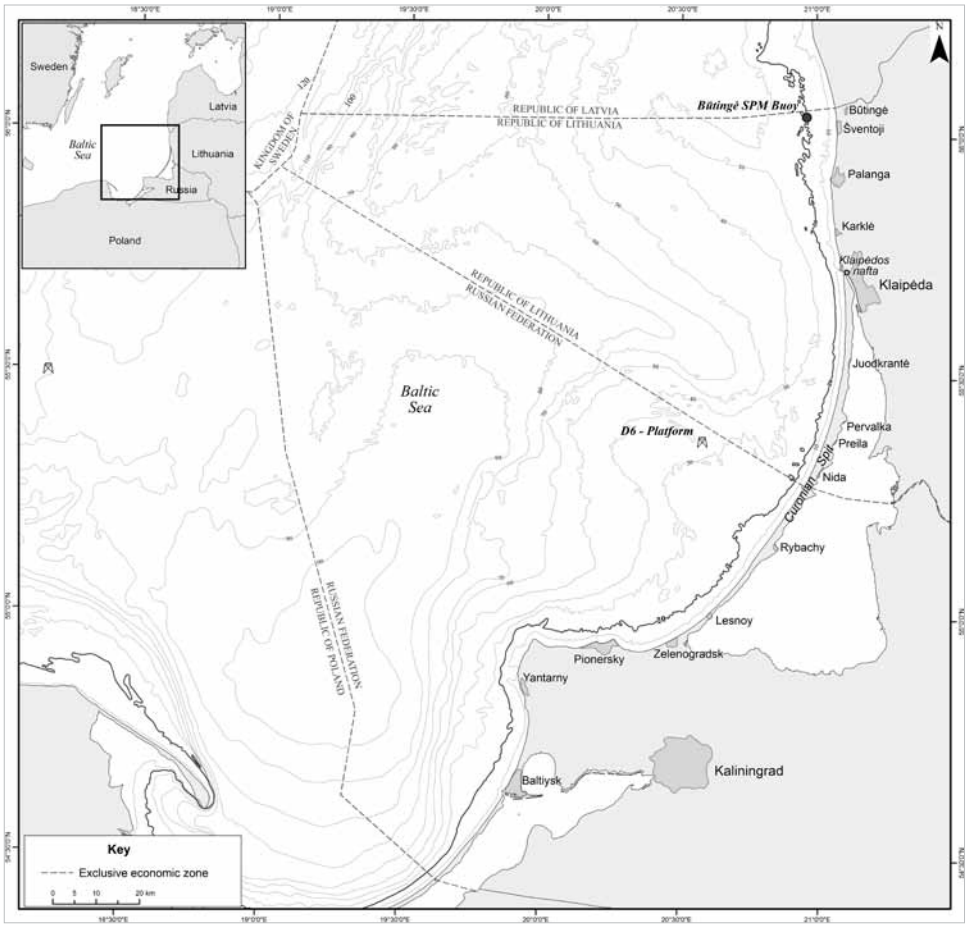

Fig. 1 Location map of studied area.

et al. 2014). The results have been integrated into the joint assessment and mapping of sensitivity of sandy coasts of the South–Eastern Baltic Sea.

Although, maritime safety and security are included in the priority list of major strategic documents of the Baltic Sea region, there is always a chance of accidental or illegal pollution. This is especially important nowadays when maritime economy is rapidly growing. Traditional sea uses are developing along with new activities that are looking for their place in the Baltic Sea area. An example of the effects of growing demand for the sea space on the marine areas of Lithuania is the recently developed comprehensive plan for future developments at sea including offshore renewables and the extraction of mineral resources (Milerienė *et al.* 2014). Traffic accidents and illegal discharges from ships may pose big ecological risks for the marine environment, thus co-actions to enhance maritime awareness and efficiency at sea seems to be the important challenge. The implementation of the strategic tasks combines wide range of initiatives, carried out in different parts of the Baltic Sea area.

SHIPPING AND OIL TRANSPORTATION

The traffic in the Baltic Sea is among the most intensive in the world. According to the data of the HELCOM AIS (Helsinki Commission Automatic Identification System) Expert Working Group there are about 2,000 ships in the Baltic marine area at any given moment, and each month around 3,500–5,000 ships operating in the waters of the Baltic Sea.

Both the numbers and the sizes of the ships have grown in recent years and this trend is expected to continue. Moreover, the Baltic Sea is actively used for the transportation of oil and other hazardous cargoes (11 % of the world's oil transportation), which has also tendency to grow (increase by 64 % is expected by 2020). The volume of oil being transported on the Baltic Sea has more than doubled during the last 10 years and today amounts to approximately 170 million tonnes a year. It has been estimated that the total volume of oil being transported in this region will increase by 40 % until 2015 (HELCOM 2009).

The size of the tankers is also expected to grow and tankers carrying 100,000–150,000 gross tonnes of oil will be seen more and more often in the Baltic Sea. In addition, the amount of oil turnover in the largest oil terminals surrounding the Baltic Sea has been growing each year. Due to the construction of Russian oil terminals, the export of Russian oil through the Baltic Sea ports reaches 111 million tonnes and is expected to reach 180 million tonnes in 2020. Klaipėda *(Klaipėdos naftos terminalas)* and Būtingė *(Būtingės naftos terminalas)* oil terminals located on the Lithuanian coast belong to the large oil import/export enterprises. During the last years the annual amount of transportation of oil products through those terminals has reached 16–18 million tonnes, making almost 10 % of total oil transportation in the Baltic Sea (Table 1).

Table 1 Transportation of crude oil and oil products through the Lithuanian terminals.
Source: http://www.portofklaipeda.lt/uosto-statistika.

Year	The amount of loaded oil and oil products, t		
	Klaipėda	Būtingė	Total amount, t
2011	9 138 500	8 932 600	18 071 100
2012	8 259 200	8 519 300	16 778 500
2013	7 067 400	8 970 000	16 034 400

POLLUTION ACCIDENTS

Steadily increasing scale of oil transportation, handling at the oil terminals and oil exploration from at the offshore platforms in the Baltic Sea raises the risk of pollution accidents, which could have a devastating impact on the marine and coastal environment.

Shipping accidents including groundings and collisions occur every year in the Baltic Sea. The estimated number of annual shipping accidents in the Baltic Sea is 120–140 and according to the reports from the Contracting States 149 ship accidents occurred in the Baltic Sea area in 2012 (HELCOM 2012). It should be noted that only some of the incidents have so far resulted in serious pollution of the marine environment. In May 1969, the tanker *Palva* ran aground in the Kökär Archipelago in southwest Finland. In the accident, 120 to 150 tonnes of Russian crude oil was released into the sea, eventually spreading to cover an area of 200 square kilometres (Leppäkoski 1973). In February 1979, the tanker *Antonio Gramsci* grounded off the Latvian coast releasing 5,000 to 6,000 tonnes of crude oil into the sea. The oil drifted in the Baltic Sea for two to three months before reaching the Stockholm and Åland archipelagos. Due to the season, the weather conditions and favourable winds, a major oil disaster was avoided (Pfister 1980). About 16,000 tonnes of crude oil have been spilled near the Lithuanian coast in 1981. During the huge storm a 170-meter long and 19-thousand tonnes of capacity tanker *Globe Assimi* crashed at the northern breakwater of Klaipėda Port, polluting the port area and 50 km of Lithuanian seaside to the north. The vessel spilled 16,000 tonnes of crude oil which has polluted the beaches of intense recreational use. 0.5–1 m thick layer of oil has covered the 5–50 m stripe of the beach. 600,000 tonnes of crude oil and sand mixture were excavated and transported away from the recreational areas because of rescue operations (Pustelnikov, Nesterova 1984). The last major oil spill (more than 100 tonnes of oil) in the Baltic Sea happened in 2003 as a result of the bulk carrier *Fu Shan Hai* colliding with the container ship in Denmark (Brusendorff *et al*. 2012).

Several oil spills have been registered in the Būtingė terminal since 1999. The big accident occurred in 2005, when 59 tonnes of crude oil was spilled. Few other accidents have been reported in the response plan of Būtingė oil terminal (developed in 2009): in 1999 (3.4 tonnes), 2001 (48.2 and 3 tonnes), and in 2008 (6.5 tonnes).

Oil extraction at the offshore platforms is also a potential source of accidental oil spillages to the marine environment. The accidents can be related to operational spills and leaks; violation of oil transportation pipeline: inhibition during the anchorage, corrosion, fracture of joints (welding seams, flanges) as well as oil rig explosion. Operational spillages are usually not larger than several hundred kilograms. Violation of the pipeline can result in the leakage of up to 100 % of the three-phase (oil, gas and brine) outlet, which is located between the valves. Potentially, the largest oil spill during the oil rig explosion depends on the time needed for elimination of the consequences of the explosion.

The main threat of oil pollution in the south-eastern part of the Baltic Sea is oil extraction from Kravtsovskoye (D-6) oilfield located in the Kaliningrad EEZ (Russia). The Kravtsovskoye oil extraction platform is located 22.5 km from the Curonian Spit coast at the depths of 25–35 m. The estimated budget of the oil in the D-6 structure is 21.5 million tonnes. 14,300 barrels of crude oil are daily extracted and transported via a 47 km long underwater pipeline since June 2004 (Lukoil 2010). Lukoil Company is carrying the ecological monitoring in the marine and coastal areas adjacent to the platform. The monitoring also includes the remote control of the oil pollution based on the analysis of satellite radar images (RI). According to the monitoring results no oil spills originated from the offshore platform and the underwater pipeline have been detected so far (Lukoil 2012). Nevertheless, in the case of accidental oil spill from the D-6 oilfield the major damage would be caused to the Curonian Spit – UNESCO World Heritage site. Oil drift model developed using the *Seatrack Web* (by SMHI) estimates, that the probability that the oil spill drifts to the Lithuanian part of the Curonian Spit is 67 % (Kostianoy *et al.* 2006).

INITIATIVES TO IMPROVE SAFETY OF MARINE ENVIRONMENT

There are number of initiatives (EU co-financed projects) known to date which are/were focused on the improvement of maritime safety and mitigation of environmental impact caused by accidental oil spills. First to be mentioned - *Baltic Master* project was launched in 2005 in order to increase the influence and preparedness of regional governments and local authorities on the matters related to the maritime safety. The project indicated the most sensitive parts of coastal area of the Curonian Spit; determined the migration routes, speed and degree of the potential oil spill; assessed the threats to the main summer resorts'; evaluated the impact to living quality and economic consequences. The project has developed the strategy for oil spill prevention and elimination of oil spill consequences as well as proposed a loss compensation mechanism.

A follow-up project (*Baltic Master II*) was initiated in 2007 with the overall aim to improve the on-land response capacity to oil spills in the

Baltic Sea as well as to enhance the prevention of pollution from maritime transport. *Baltic Master II* has conducted a study aiming at identifying the costs associated with a spill of 10,000 tonnes of oil in a three case studies (two from Sweden and one from Poland). Four different oil contingency plans of those regions have been updated. In addition, a guideline for regional response organizations has been produced for Saaremaa County, Estonia. The Environmental Atlas (a digital web based GIS-tool) has been developed and updated for both Sweden and Poland. The Maritime University of Szczecin has developed an online tool with integrated models for dynamic risk management.

The importance of accidental oil pollution from shipping was also recognized by HELCOM, which had patronage the initiative lead by Danish Admiral Fleet – *Sub-regional Risk of Spill of Oil and Hazardous Substances in the Baltic Sea.* A project known under the acronym *BRISK* started in 2009 and was implemented by all countries of the Baltic Sea. The overall aim of the project was to increase the preparedness to respond to major spills of oil and hazardous substances from shipping and enhance sub-regional co-operation. The project provided first overall risk assessment of pollution caused by shipping accidents covering the whole Baltic Sea area. The gaps in existing emergency and response resources were identified, pre-investment plans for filling the identified gaps were developed and sub-regional agreements between neighboring countries for joint response operations were prepared. Additionally a common methodology to map the environmental sensitivity to oil spill was developed.

The negative effect of oil spills on particular species of the Gulf of Finland and the Archipelago Sea were addressed by the *OILRISK* project - *Applications of Ecological Knowledge in Managing Oil Spill Risk* which started in late 2009. This was the one of the rare attempts to evaluate the value of damage to specific endangered species. The project has been investigating the possibilities to minimize the harmful effects to the environment by the means of offshore and onshore oil combating. This has resulted in a web based decision support system *(OILRISK Web)* dedicated to oil spill response planning in the Gulf of Finland. The tool which uses so called *Bayesian decision ranking module* supports contingency planning, environmental risk assessment and facilitates the decision making when responding to the oil spill effects. Furthermore, the developed tool enables to integrate the particle Tracking model Seatrack Web (SMHI) and serves as platform for real-time information sharing during environmental crisis by state authorities and non-governmental organizations.

Complementary action focusing on negative environmental and socio-economic impacts in the Central Baltic Sea area of an oil spill accident was *ENSACO* project titled *Environment and Safety Management Cooperation on Shoreline Oil Spill Response*. The main objectives of the project included: development of the efficient operative management tools (electronic management mappings and cooperation agreements); development of oiled wildlife response preparedness and a protocol for oiled wildlife response in the Central Baltic Sea.

Oil transportation and related risks to the marine environment in the areas of less attention in the Baltic Sea was addressed also in the *MIMIC* project titled *Minimizing risks of maritime oil transport by holistic safety strategies*. The project focused on the maritime safety and security problems in the Gulf of Finland, integrating the knowledge from earlier projects and new information on the less studied aspects of accidents. One of the main objectives was to study and compare the effect of different management actions to avoid accidents, giving insight to the cost-effectiveness of these measures. One of the main project deliverables is a probabilistic and systematic model estimating the costs of clean-up operations for the Gulf of Finland (Montewka *et al.* 2013).

Some other initiatives can also be named as relevant. Those are: the *SAFGOF* project (*Evaluation of traffic increase in the Gulf of Finland 2007–2015 and the effect of the increase on the environment and traffic chain activities*) dealing with safety of the marine traffic in the Gulf of Finland including the detailed accident statistics during the period from 1997 to 2006 and further analysis of ship collision risks by theoretical modelling (Kujala *et al*. 2009); the *OILECO* project (*Integrating ecological values in the decision making process on oil spill combating in the Gulf of Finland*) providing with dynamic mapping application for comparing the ecological value of the shoreline of the Gulf of Finland and guiding towards the proper arrangement of oil booms after an oil spill accident (Kokkonen *et al.* 2010); and state of the art for oil spill detection in the world oceans was prepared in frame of *OCEANIDES* initiative (*Harmonised monitoring, reporting and assessment of illegal marine oil discharges*) along with further suggestions for further research with respect to oil spill detection systems were elaborated (Brekke, Solberg 2005).

Most of the initiatives mentioned above address the effectiveness of response operations and other operational procedures when the pollution has already occurred. When seeking to reduce the risk of extreme situations and their possible impacts on the Baltic Sea ecosystems it is also important to develop innovative methods and solutions for proper identification of oil spills in marine areas, forecasting of their drift and dispersion as well as identification of most vulnerable values, which can suffer most from accidental pollution. This can be achieved by close

cooperation among scientific communities involving also relevant stakeholder groups (shipping operators, oil companies, environmental authorities).

INTERNATIONAL COOPERATION

In the Baltic Sea region, several bilateral agreements and international conventions exist to strengthen the cross border cooperation in the case of an oil spill. In order to be able to assess differences in motivation and capability to additionally improve maritime environmental safety in the Baltic Sea, it is necessary to go beyond unanimous agreements at the regional level as required by HELCOM. Helsinki Commission since the establishment in 1974 has been heavily engaged in how to reduce environmental hazards from oil spills. There are three key recommendations addressing the response oriented international cooperation prepared by HELCOM: 31E/6 „Integrated wildlife response planning in the Baltic Sea area", 33/2 "Co-operation in response to spillages of oil and other harmful substances on the shore" and 28E/12 "Strengthening of sub-regional co-operation in response field". Along with recommendations HELCOM is coordinating practical exercises (so called HELCOM Balex Delta) held annually by the Navies and Coast Guards of different countries on combatting oil - multiple joint response operations. However, in similarity with many other international environmental agreements and conventions, a considerable implementation gap exists (Hassler 2010).

It is extremely important to strengthen cooperation between Russia and neighbouring countries and particularly Lithuania as Russia is extracting oil offshore close to the Curonian Spit. The recommendations for monitoring of ecological impacts of an oil rig (at D-6) in operation have been developed by a joined (Lithuanian and Russian) group of experts. In 2007, the joint Lithuanian–Russian Commission for collaboration in environmental protection issues recommended to establish a proper notification and response practice between the countries; to jointly plan the response operations and trainings; agree on measures for oil type and origin identification; agree on damage compensation principles and procedure; harmonize the criterions on environmental sensitivity of the sea and shore; exchange of satellite monitoring data; continue modelling of oil drift and others. In order to implement the proposed recommendations, the bilateral agreement between Lithuania and Russia was signed in October 2009. Additionally, the same year, Lithuania, Poland and Russia signed an agreement for joint response to accidental oil spilling and every second year the countries are organizing bilateral and trilateral trainings. However, there are a number of questions relevant for the operational activities if an accident takes place. The most important unsolved issues are operational notifications and requesting for assistance; identification of the oil slick; principles and procedure of damage compensation.

CONCLUSIONS

The compensation mechanism of damage to the environment caused by oil exploration at sea is not regulated on international level and has instead to be tackled bilaterally. Most important is a common understanding of the objects of negotiations, *i.e.* – what is considered as pollution and damage? A joint methodology for oil spill identification (satellite and *in situ*), sensitivity mapping, and oil drift modelling is the subject for joint agreements and a nowadays topic. Lack of joint agreements and common understanding leads the situation, where the operator of the oil platform is not allocating sufficient funds for insurance and proper precautionary measures. In addition, scale of the damage remains unclear and therefore compensation might be inadequate. Moreover, uncertainty with regard to the compensation of the response operation might lead to the situation when parties are delaying the rescue procedures and therefore environmental damage may dramatically increase.

The focus of this project was to identify the most efficient measures and management tools for finding the best possible solutions for proper detection of oil spills in marine areas that should contribute to the improvement of oil spill management, safety and security of the Baltic Sea.

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