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Assessment of the sensitivity of sandy coasts of the south–eastern part of the Baltic to oil spills

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Abstract The sandy coasts of the south–eastern Baltic Sea are the unique landscape along the shores of Poland, Kaliningrad Oblast (Russia), Lithuania and Latvia. Flat sandy beaches, protective dune ridges and near shore sandy spits are very valuable and attractive resources for human recreation and valuable habitat for wildlife. Intensifying shipping, operation of oil terminals and offshore platforms poses a constant threat not only to coastal and socio–economic resources, but also to sensitive underwater landscapes of marine areas and vulnerable marine habitats. Analysis of environmental sensitivity proved to be an effective tool for national and regional oil spill response planning. However, in order to complete the precise evaluation of near shore and coastal zone sensitivity to possible oil spills there is a need to identify vulnerable coastal sectors and complete detailed mapping of underwater landscapes. This is achieved by developing an integrated methodology for analysis of valuable coastal zone sensitivity to potential oil spills.

Keywords • *oil spill* • *sandy coast* • *environmental sensitivity*

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INTRODUCTION

One of the strategic tasks of the NATO SPS Programme supported project "Development of solutions for effective oil spill management in South-Eastern Baltic" was preparation the common methodology of Lithuania and Russia for assessment of the sensitivity to an oil spills. Oil spills have deleterious effects on ecological and socio–economic assets in the coastal zones. Decision making during the response operations requires science-based prioritization of zones to be treated. In these circumstances, spatially explicit, impact assessment models, such as oil spill sensitivity mapping and integrated damage cost assessment are important tools to (1) address the complexity of impacts from oil spill on ecosystem services, (2) to support decision making for oil spill response planning and (3) stimulate the development of new management practices to be jointly accepted by EU and Russia.

The methodology has been prepared in order to assess the sensitivity of the Lithuanian coast to oil spills (Depellegrin *et al.* 2010). The GIS-based tool is based on the dataset representing four resource categories: marine biotopes, commercial fishery, seabird distribution, recreational areas. Further assessment was based on ecosystem service functioning. Different spilled oil scenarios were developed using the three-dimensional particle-tracking model *Seatrack Web*. Results indicated that the Lithuanian coast has two prioritization areas in case of oil spill: a 25 km long shoreline on the Curonian Spit and a 10 km long coastal strip on the mainland coast (Depellegrin, Blažauskas 2013).

The earlier studies (Depellegrin *et al.* 2010) identified that Lithuanian coastal section has two areas ranked as highly sensitive to potential oil spill. Those are a 28 km long coastal strip between Karklė and Šventoji settlements and 25 km of coastline from Nida to Juodkrantė small towns. This was determined by presence of important biological and socio–economic resources: *Furcellaria lumbricalis* algal beds, herring spawning grounds, important commercial fish stocks, bird wintering areas, the most important seaside resort of Palanga, diverse nature reserves protected under national and international agreements.

The estimated annual revenue from ecosystem services in Lithuanian coastal areas amounts to over €524 million/y (Depellegrin, Blažauskas 2013). Damage costs estimated for the impacted tourism sector ($DCI_{tourism}$) have been estimated to reach about €136 million/y. Deteriorated ecosystem functioning (DCI_{marine}) was evaluated to be slightly above €74 million/y, $DCI_{fishery}$ = €0.05 million/y, DCI_{birds} = €0.2 million/y. The model clearly identifies that the most valuable (highest) damage costs are typical for recreational areas if impacted by the oil spill. As a result, €22 to €27 million/y economic losses were registered within four km of coastline corresponding to Palanga resort. Such a value was calculated when damage to recreational facilities, sensitive algal beds, fishing grounds of regional importance and over 1300 impacted seabirds have been evaluated.

The proposed integrated approach should be applicable to every coastal zone and with any particle-tracking model. Kaliningrad Oblast coastal zone was the target area to prove the applicability of the tool and in order to harmonize the response activities between neighbouring countries. One of the main components determining the value of the particular coastal area is the seascape and/or the bottom habitats prevailing. High resolution and proper coverage data representing the morphology, sediment distribution and valuable marine biotopes along the near shore of Russian part of the Curonian Spit as well as along the main land of the Sambian Peninsula was missing.

Current study provides with common methodology for assessment of the sensitivity of the sandy coasts of the south–eastern part of the Baltic Sea. The study also presents the first attempt to evaluate the oil spill sensitivity of the coastal zone of Kaliningrad Oblast and Lithuania based on the coastal features and hydrodynamic regime of both regions. The additional research was made in order to assess and map marine biotopes using modern hydrographic equipment purchased in the framework of the implemented project. This is the first step towards development of biological resource sensitivity map – next step of integrated sensitivity mapping exercise.

The study area is extending in coastal zone of Lithuania and Russian Federation (Kaliningrad Oblast). The sandy cost and shallow near shore (up to 20 m water depth) of interest is divided into three main parts: northern part of Sambian Peninsula in the south, Curonian Spit in the central part, and mainland coast of Lithuania in the north (Fig. 1).

The Sambian Peninsula is located between the Curonian and Vistula lagoons. Two clearly distinct seacoasts of the peninsula – the western and northern are intensively eroding nowadays (Burnashov *et al.* 2010). The study covers the northern part of the peninsula – eastern northward from the cape of Taran that is facing the most intensive erosion. Therefore, the cape is represented by a steep cliff and 5–10 m wide gravel beaches. Sand is nearly absent at the bottom slope (Boldyrev *et al.* 1992).

The Curonian Spit is a narrow, sandy peninsula of over 99 kilometres length, separating the Curonian Lagoon from the open Baltic Sea. The northern part of the spit (52 km) belongs to Lithuania, and the southern one (46 km) – to Russia. The Curonian Spit is separated from the mainland by the Klaipėda Strait, which serves as outlet for the Nemunas River and as gate for Klaipėda Port. The mainland coast of Lithuania extends over a length of 46 km, from Klaipėda Strait to the state border of the Latvian Republic. In order to collect the new data representing the composition of near shore bottom habitats and morphology near the coast of Russian part of the Curonian Spit three areas have been selected in front of coastal settlements of Lesnoy, Rybachiy and adjacent to the state boarder of Lithuania.

METHODOLOGY

Oil spill sensitivity mapping

The methodology provided bellow follows the main principles of sensitivity mapping for oil spill response developed jointly by the Global Oil and Gas Industry Association for Environmental and Social Issues (IPIECA), International Maritime Organization (IMO) and International Association of Oil & Gas Producers (OGP) in 2012. The simplified approach of mapping and identification the vulnerability of coastal assets is based on development of an integrated GIS database representing the main coastal components under the threat of possible oil spill. The oil spill sensitivity maps are integrated visualization of a different coastal components vulnerability to the oil spill. Those are being developed according to the adopted methodology for sensitivity assessment. Integrated oil spill sensitivity mapping is based on biological, socio–economic resources, presence and abundance of birds and intensity of commercial and recreational fishery. Sensitivity ranking is divided into four scales: low, medium, high and very high. The given rank depends on geological and geomorphological characteristics of the coastal zone (such as land inclination, substrate composition, degree of exposure to waves) the oil retention, natural clean up processes in the impacted area. The sensitivity mapping needs to follow certain steps:

- identification of important variables/assets to be involved in the evaluation of the vulnerability and sensitivity of the area;
- development of ranking scheme and sensitivity indexes according to the international standards;

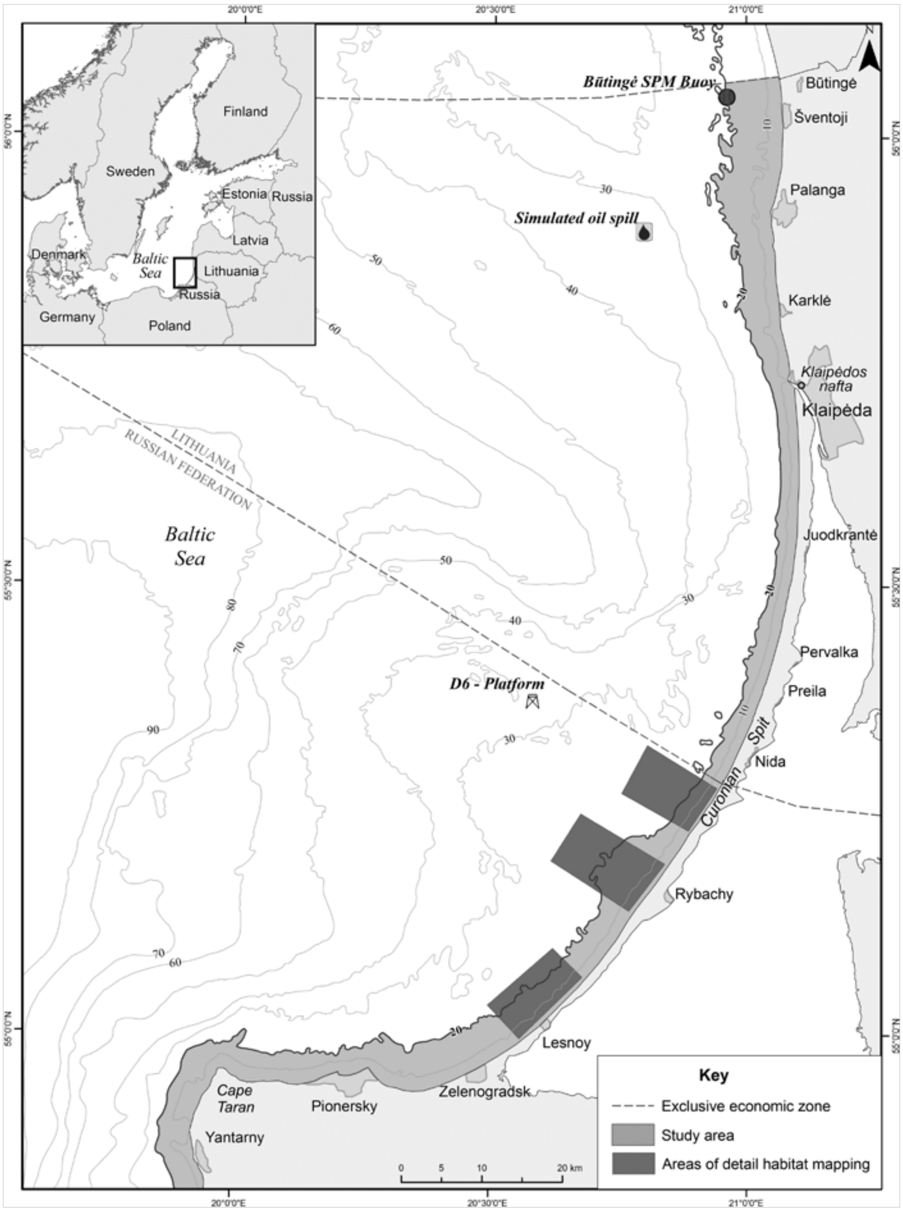

Fig. 1 Study area. Compiled by V. Jurkin, 2014.

- GIS modelling and mapping of the sensitive areas depending on the sensitivity level and character of the threat.

The main components of the integrated sensitivity mapping are physical, biological and socio–economic sensitivity.

The physical sensitivity index (I_{phy}) is designed to assess the potential impact of an oil spill on the self-cleaning capacity of a coastal segment. It is defined as the arithmetic sum of the following indexes:

- substrate type (I_{sub}): geomorphological features of the coastline (Lazauskienė, Vaitkus 1999; Depellegrin *et al.* 2010) according to NOAA (National Oceanic and Atmospheric Administration) guidelines;
- slope of the coast (I_{sh}): steepness of the coast defined according to NOAA guidelines (Hayes *et al.* 1992);
- geodynamic regime (I_{gr}): erosional, transitional and accumulative character of the coast (Lazauskienė, Vaitkus 1999; Depellegrin *et al.* 2010) introduced by the sediment budget of the coastline measured m³/10 year of sedimentation (Castanedo e*t al*. 2009; Pincinato *et al*. 2009):

$$I_{phy} = I_{sub} + I_{sh} + I_{gr} \quad (1)$$

The biological sensitivity index (I_{bio}) is designed to assess the environmental sensitivity associated to the oil spill. The basic indexes are defined as follows:

- biomass (I_{bm}) in g/m² of a specific benthic community;
- seabirds (I_{sb}) in individuals per square kilometre;
- functional role of the benthic community (I_{fun});
- potential exposure to pollutant (I_{exp}) according to weathering results provided by the oil spill scenarios modelled with SeaTrack Web.

$$I_{bio} = I_{bm} + I_{sb} + I_{fun} + I_{exp} \quad (2),$$

where I_{fun} is defined as the arithmetic sum of the functional components of a benthic community or of a single species defined according to references research and expert based judgement (Depellegrin, Blažauskas 2013; Olenin, Daunys 2004; Olenin, Ducrotoy 2006; Beaumont *et al*. 2007; Olenin 1990):

$$I_{fun} = F_{hab} + F_{brem} + F_{res} \quad (3).$$

where F_{hab} – habitat provided by benthic communities, F_{brem} – role of the benthic community in the removal or breakdown of xenic substances. Through either direct or indirect activity, marine organisms' store, bury transform of chemical substances and re-composition. F_{res} – resilience of the benthic community to the human perturbation and regeneration capacity.

I_{exp} is defined as the degree of exposure of a benthic community to the spilled oil. The index calculation is defined according to weathering result from a derived oil spill scenario with HIROMB and SeaTrack Web.

The index is designed and tested with SeaTrack Web (Depellegrin, Blažauskas 2013):

$$I_{exp} = OV_{ss} + OV_{sb} + OV_{wc} + OV_{sl} + OV_{ev} \quad (4),$$

where OV_{ss} – oil volume on sea surface, OV_{sb} – oil volume on sea bottom, OV_{wc} – oil volume dispersed in water column, OV_{sl} – oil volume on shoreline, OV_{ev} – oil volume evaporated. The sum of all OV's corresponds to the total amount of oil spilled applied in the scenario definition.

The socio–economic sensitivity index (I_{seco}) is designed to assess the socio–economic sensitivity associated to the oil spill affecting the coastal zone. It is defined according to the following indicators:

- recreational areas (I_{rec}) – presence or absence of recreational areas including access and points and facilities;
- legal status of conservation (I_s) of local (protected landscape, regional park), national (natural park) or international level such as Ramsar sites, European sites of interest for conservation, UNESCO World Heritage sites (Roberts, Crawford 2004);
- human settlements (I_{sett}) – number of inhabitants in a coastal settlement (Depellegrin *et al.* 2010). The identified coastal settlements for the sensitivity analysis are Rybachiy, Lesnoy and Morskoye for the Russian coastal segment and Pervalka, Preila, Juodkrantė, Nida, Šventoji and Palanga for the Lithuanian coastal segments.

$$I_{seco} = I_{rec} + I_s + I_{sett} \quad (5)$$

The integrated sensitivity index (I_{INT}) is defined as the arithmetic sum of the above-described indexes:

$$I_{INT} = I_{phy} + I_{bio} + I_{seco} \quad (6)$$

Input data required for the integrated oil spill sensitivity model is provided in the table below:

Integrated damage cost model

The oil spill damage cost evaluation is the result of integrative modelling of three-dimensional particle tracking against sensitivity and economic value of coastal assets (Depellegrin, Blažauskas 2013; Ambjörn 2007). Simulated oil spill scenarios were modelled for the Lithuanian mainland coast (see Fig. 1). Assumption is a homogeneous distribution of oil masses on the impact area and no rebound of the oil slick on the coast. Input variables were defined as follows:

- oil volume: (17,000 tons);
- oil type: medium – light – heavy;
- oil weathering processes: surface oil, oil on the shore, seabed, dispersed in water column, evaporation;
- hydro meteorological conditions: wind direction NW to SW, wind speed 6 m/s;
- current speed: 1 knot.

The damage cost index DCI, for a generic scenario *i*, is composed of an economic weighting factor (Wf), based on the relative annual economic productivity of marine and socio economic assets present in the coastal zone:

$$DCI_i = Wf_i \, SVM_i \, ODF_i \quad (7)$$

The oil mass distribution factor (ODF) is retrieved from Seatrack Web weathering module. A percentile value associates the distribution of oil masses at seabed (ODF_{seabed}), shoreline ($ODF_{shoreline}$), sea surface ($ODF_{surface}$), and dispersed ($ODF_{dispersed}$) and evaporated ($ODF_{evaporation}$) in water column to the spatial position of the resource.

The spill volume modifier (SVM) is an oil spill volume dependent value referenced to international oil spill clean-up studies (Etkin 2000).

The final output is a DCI matrix aggregates oil spill damage costs from tourism, marine, birds and commercial fishery relating to annual lost revenue from the service:

- $DCI_{tourism}$ is the number of trips not made by tourists to certain recreational areas;
- DCI_{marine} is the lost or deteriorated ecosystem functioning;
- DCI_{birds} economic efforts required to restore impacted seabird populations and
- $DCI_{fishery}$ is the lost revenue from fishing industry due to temporary closure of fishing grounds by authorities.

Mapping of the near shore seascapes

Surveying in the pilot areas (see Fig. 1) of Kaliningrad Oblast has been implemented. In order to provide high accuracy data on physical conditions of the near shore zone, a modern Hydrographic system for swath bathymetry and side scan imaging was purchased *(Teledyne Benthos C3D)*. The resolution of the 200 kHz multi-beam scanning device is five cm at maximum survey speed of eight knots. System is configured to work particularly at shallow depths (5–30 m water depth) – the most suitable tool for near shore mapping at high resolution and wide coverage (up to 200 m in width).

The mosaic from sonar images representing the acoustic photograph of the sea bottom was created using Hypack Side scan targeting and mosaicking tool. Additionally, Hypack *GEOCODER* application was launched for automatic classification of the bottom sediments in the preselected areas.

Table Input data for integrated oil spill sensitivity model. Compiled by D.Depellegrin, 2014.

Resources	Input	Name	Categories	Rank
Coastal	Physical sensitivity	I_{phy}		
	Substrate type	I_{sub}	Exposed, impermeable substrates: rocky cliffs; sedimentary scarps; artificial structures.	**1**
			Exposed, impermeable substrates: low-lying rocky shores and terraces	**1**
			Semi-permeable substrates, with low oil penetration /burial: beaches of medium to fine sand; sand spits and dune fields; sand scarps	**2**
			Medium permeable substrates, with moderate oil penetration / burial: exposed beaches of coarse sand or sheltered beaches of medium to fine sand.	**2**
			Medium to high permeable substrates, with high oil penetration / burial: sand of mixed composition/ shell hash beaches; irregular or vegetation covered platforms; interior part of fringing reefs.	**2**
			High permeable substrates: Shell / calcareous beaches; detrital beaches; beaches of talus; exposed riprap; porous terraces / platforms.	**2**
			Flat-lying, exposed permeable substrates: low-tide terraces. Exposed sand flats.	**3**
			Wetlands: Vegetated deltas and bars. Vegetated terraces and bars and river / lakes margins: marshes; mangroves.	**5**
	Slope of the coast	I_{sh}	Flat ($<5^{o}$)	**5**
			Moderate (30^{o} -5^{o})	**3**
			Steep ($>30^{o}$)	**2**
	Geodynamic regime	I_{gr}	Accumulative	**5**
			Transitional	**3**
			Erosional	**2**
Biological	Biological sensitivity	I_{bio}		
	Functioning of benthic communities	I_{fun}		
	1.Habitat function	F_{hab}	Presence or absence of the specific biological function for a given benthic community according to literature and expert based judgment:	**3**
	2.Bioremediation function	F_{brem}		**3**
	3.Resilience	F_{res}		**3**
	Biomass of benthic communities(g/m^2)	I_{bm}	High	**5**
			Moderate	**3**
			Low	**1**
	Wintering seabirds	I_{sb}	Presence	**5**
			Absence	**3**
Socio-economic	Socio–economic sensitivity	I_{soceco}		
	Recreational areas	I_{rec}	Presence	**5**
			Absence	**3**
	Status of conservation	I_{s}	International level	**5**
			National level	**4**
			Regional level	**3**
			No legal protection	**1**
	Settlements (number of inhabitants)	I_{sett}	>5000	**5**
			1000 - 5000	**4**
			500 - 1000	**3**
			< 500	**1**

Along with remotely acquired data, over 50 Van Veen samples have been taken from the selected polygons to provide information on lithological and biological composition of the bottom sediments. Collected datasets were used in order to get high-resolution data on the morphology, lithological composition and bottom habitats.

DATA SET

The methodology of the integrated sensitivity mapping was prepared and tested using GIS–based database of the Environmental Management Atlas (Lazauskienė, Vaitkus 1999). Information on annual landings of eight major fish species was obtained from the Lithuanian Fishery Department in Klaipėda. Estimations on visitors to the recreational areas, average expenditures, and average length of stay were based on the EUROSION report (Povilanskas, Urbis, 2004), results of Interreg IIIB project Baltic Master (2007), yearbooks from the Lithuanian State Tourism Department (LSDT), and data sets obtained from the Lithuanian Department of Statistics (Lithuania Statistics 2011; LSDT 2007).

Physical sensitivity was assessed against three main parameters – slope of the coast, substrate lithology and coastline dynamics. Data was obtained from the atlas of geological and environmental geological maps of the Russian area of the Baltic Sea (VSEGEI 2010) and state of the coast of the south–eastern Baltic (Bagdanavičiūtė *et al.* 2008). The GIS data on seascapes for Kaliningrad Oblast was based on the use of available broad-scale geological, physical and hydrographical data with little or no biological information (Sivkov *et al*. 2013).

The datasets include information on seabed sediment types, light penetration, bottom temperature and salinity, ice cover. These layers were combined using the spatial analysis tool of the ArcGIS software. Five sediment types have been identified: 1) hard bottom, including sedimentary bedrock and bedrock covered with boulders; 2) hard bottom composite, including complex, patchy hard surface and coarse sand (sometimes also clay to boulders); 3) fine to coarse sand (with gravel exposures); 4) hard clay sometimes exposed or covered with a thin layer of sand or gravel; 5) mud. In order to differentiate light penetration conditions the euphotic and non-photic zones have been identified. Changes in salinity are reflected in four classes: 1) oligohaline I (< 5 psu); 2) oligohaline II (5–7.5 psu); 3) mesohaline I (7.5–11 psu); 4) mesohaline II (11–18 psu). Temperature variability is expressed in three classes: 1) upper variable (0–50 m); 2) intermediate weakly variable (50–65 m); 3) lower constantly cold (> 65 m).

Biological sensitivity was based on parameters indicating on quality and distribution of sea bottom habitats (Ezhova, Spirido 2007), wintering birds and related information on biomass at Kaliningrad Oblast near shore (Ezhova *et al.* 2013, Aleksandrov, Kudryavceva 2012; Ezhova, Volodina 2012).

RESULTS

Mapping of coastal resources present in Kaliningrad Oblast was done according to the jointly developed methodology of sensitivity to oil spill mapping and according to IPIECA (IPIECA/IMO/OGP, 2012) standards in terms of visualization and colour codes. The data available and coverage of scientific research is not the same across the border of two countries. The study presents first attempt to map the sensitivity of Kaliningrad Oblast and combine the results of former sensitivity mapping of Lithuanian coastal zone and current elaboration into the single integrated sensitivity map.

Physical sensitivity

The sensitivity of the coast is very much dependant on the physical character of the environment. According to the standard ESI shoreline classification (NOAA, 2002), shoreline of the Sambian Peninsula and adjacent Curonian Spit is unsheltered, facing highly dynamic wave regime and intensive alongshore sediment transport. The beaches are composed of fine and medium-grained sand mainly, but the near shore is much more lithologically diverse. The hard bottoms, clay outcrops and gravel fields present near the shore creates the specific conditions for local biotopes to establish. On the one hand, such geodynamic regime can favour the natural clean up and remediation processes (Castanedo *et al.* 2009), but on the other hand it can also foster the transportation of the spilled oil towards and along the shore (Adler, Inbar 2007).

The coast at the Sambian Peninsula and Curonian Spit is mainly flat. Although there are some parts of

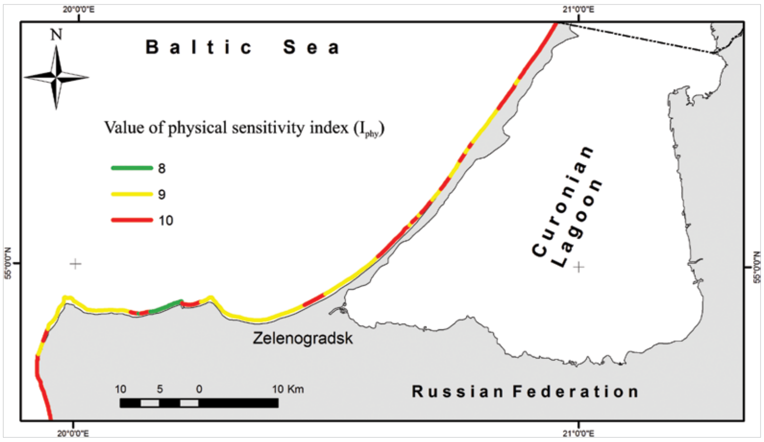

Fig. 2 Sensitivity ranking of coastal features in Kaliningrad Oblast. Compiled by N. Blažauskas, 2014.

intensive erosion and steep cliffs present, the sandy beaches are mainly flat with bigger or lower amount of gravel. The seawards projected peninsula is highly affected by erosion process and therefore is the natural source of the sediments. This fact also influences the sensitivity ranking (Fig. 2). Relatively highest ranks are attributed to the Curonian Spit and western part of the Sambian Peninsula.

Biological sensitivity

The assessment of the sea bottom habitats sensitivity to oil spill was based on the expert choice decision (Kocheshkova *et al.* 2014). Vulnerability of the benthic communities is determined by the prevailing biological resources such algal beds (*Furcellaria lumbricalis*), spawning grounds, bird wintering areas and major benthic communities such as *Macoma balthica* (on soft bottom) and *Mytilus edulis* (on stony bottom). In order to have comparable data sets, an attempt to develop an integrated habitat map for Lithuania and Kaliningrad Oblast was made (Fig. 3).

The highest diversity of valuable species was identified near and along the near shore of Curonian Spit, where the extensive fields of boulders with pebbles and former lagoon silts/clays are exposed. The highest biomass of investigated algal beds (*Furcellaria lumbricalis*) was identified in front of the Cape Taran – the seaward projected part of the Sambian Peninsula. The overall sensitivity of the biological resources (Fig. 4) integrates also the abundance and distribution of wintering birds. The most important habitat for wintering and migrating are the areas near Zelenogradsk and close to the border with Lithuania. The dominant waterbird species are the velvet scoter (*Melanitta fusca*), long-tailed ducks (*Clangulas hyemalis*), whooper swan (*Cygnus Cygnus*) and herring gull (*Larus argentatus*).

Socio–economic sensitivity

Population of coastal communities, established public beaches and other recreational facilities, management of natural assets under protection, those are the available parameters allowing evaluation of sensitivity of the coastal zone from the socio–economic perspective (Fig. 5). Zelenogradsk, Pioniersky and Yantarny are the main settlements (with population over 5000 inhabitants each) to be impacted by the

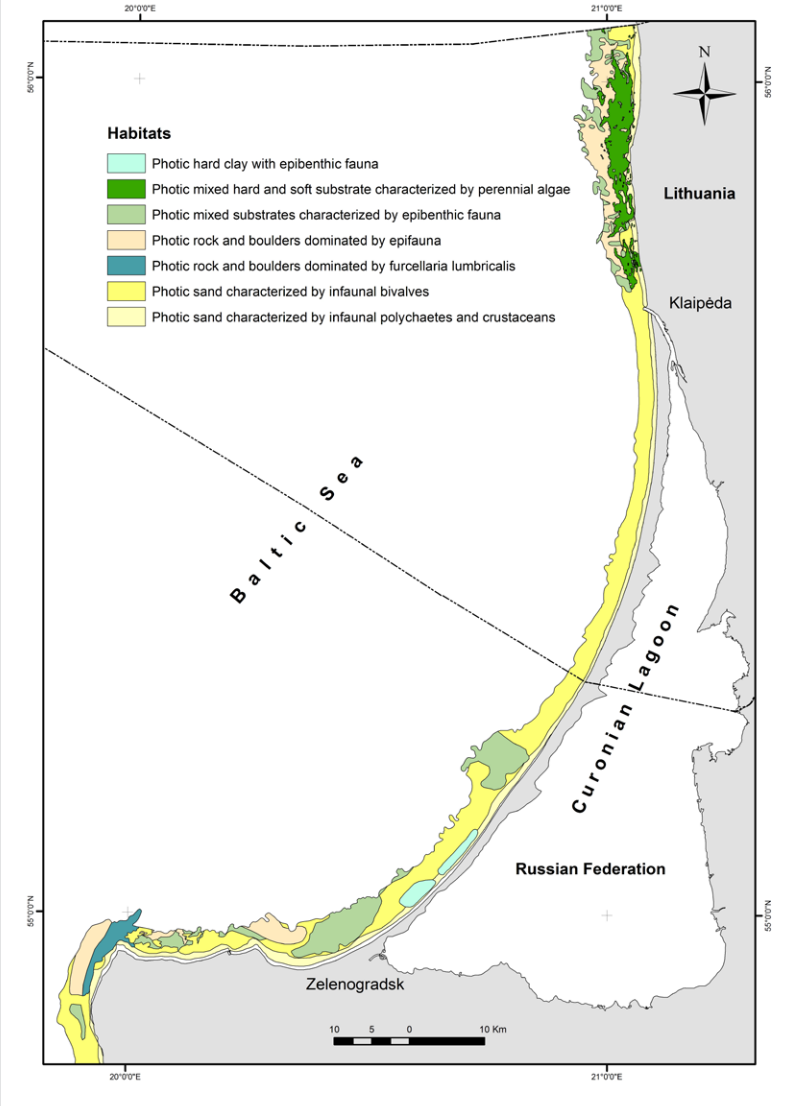

Fig. 3 Sea bottom habitats and coastline dynamics. Compiled by N. Blažauskas, 2014.

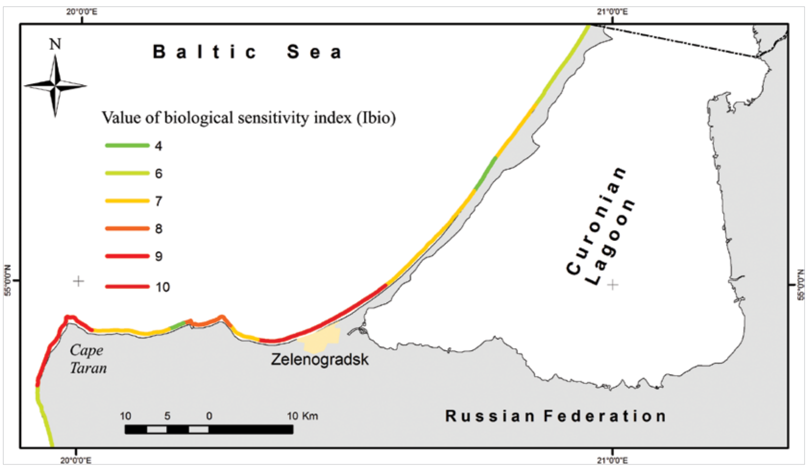

Fig. 4 Sensitivity ranking of biological resources in Kaliningrad Oblast. Compiled by N. Blažauskas, 2014.

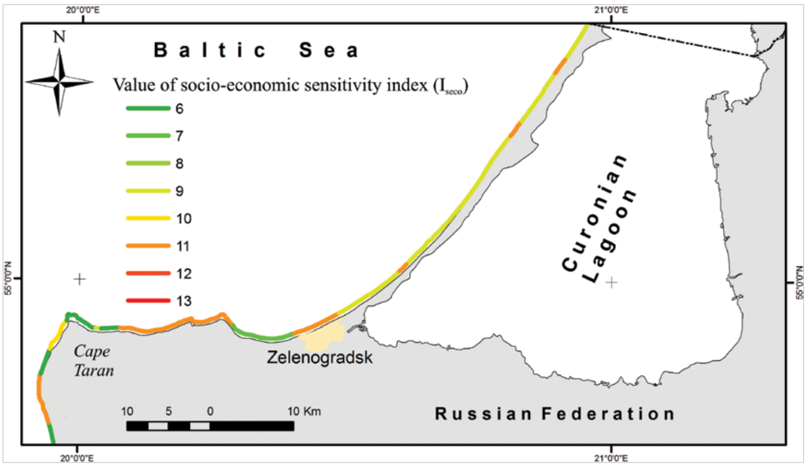

Fig. 5 Sensitivity ranking of socio-economic assets in Kaliningrad Oblast. Compiled by N. Blažauskas, 2014.

consequences of the oil spill in front of the coasts of Kaliningrad Oblast. There are number of smaller villages located at the coast. Those do also have significant importance for developing recreational potential of the region. The officially established recreational areas are tightly connected to populated areas, but wild beaching is not less attractive for the tourists visiting the seaside at the main coast and also in the spit. The only designated protected area is the Curonian Spit – the UNESCO World Heritage site.

Integrated sensitivity

The integrated sensitivity map was developed in order to integrate sensitivity ranking of all three assessed coastal resources into a single comprehensive map and to extend the existing sensitivity map developed for Lithuania (Fig. 6). In general, the sensitivity of the Curonian Spit can be considered as high. The most sensitive (very highly sensitive) site is the coastal area adjacent to Nida – main summer resort on the Curonian Spit. The high sensitivity is determined by important biotope complexes, cod fish stocks, water birds density and existing recreational areas.

It is worth to mention, that although the identified sensitivity is somehow similar on the Curonian Spit, the sensitivity values achieved for the mainland coast are obviously less extreme. The result is influenced by existence/absence of protected areas at the coast. Main parts of Lithuanian mainland coast (apart of small strips north from the Klaipėda Port entrance and near the state border with Latvia) are under national or European level nature protection. Additionally, the coasts of Kaliningrad Oblast are more affected by intensive erosion caused by stormy events, wave regime and alongshore currents. Therefore, the self-cleaning capacity of this part of the Baltics is somehow higher than in Lithuania.

The developed assessment should not be recognized as a finalized one. The result of the integrated map is very much dependant on the parameters used and datasets available. Nevertheless, if applied in the same manner and using the same methodology, even such elaboration may serve as a comprehensive tool allowing prioritization and optimization of rescue operations. While targeting to the relatively most valuable/sensitive areas the damage and the restoration costs might be considerably minimized.

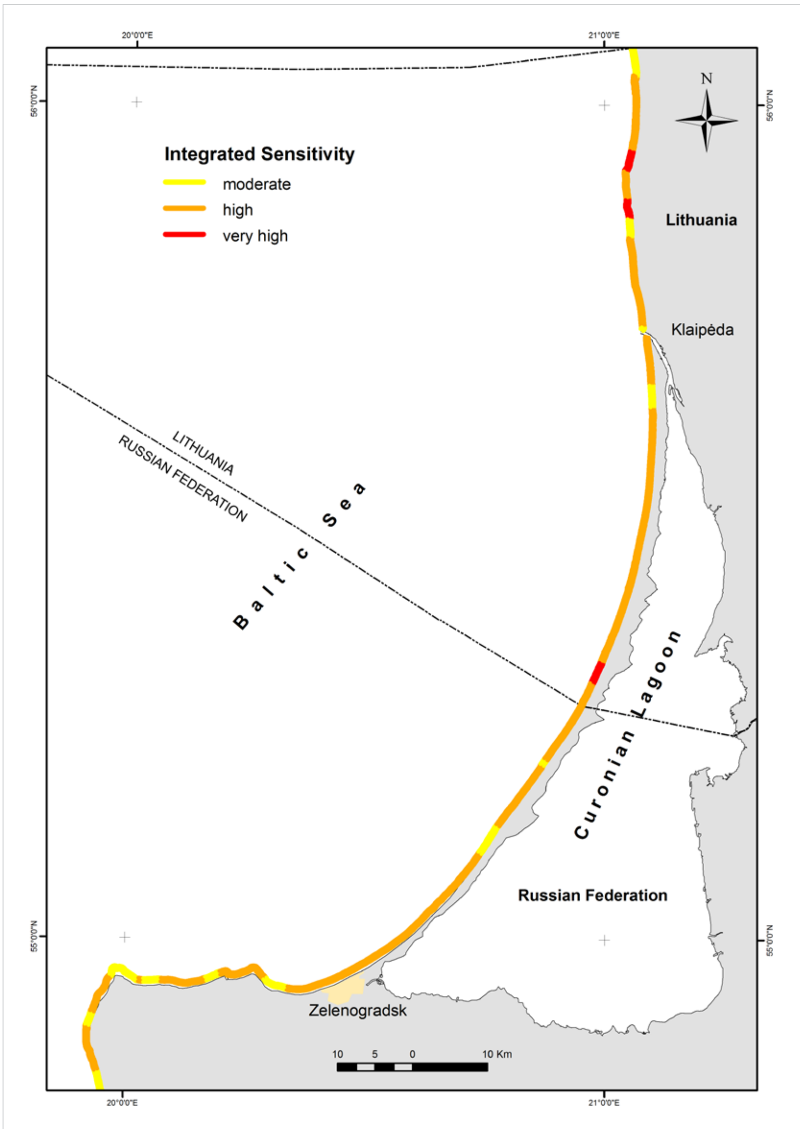

Fig. 6 Integrated sensitivity of the study area. Compiled by N. Blažauskas, 2014.

DISCUSSION

Sensitivity mapping and in particular using environmental sensitivity index (ESI) is already widely accepted approach (USA, Ukraine, South Africa, Caribbean Sea, Israel, Egypt) also being used as a basic information for other types of assessment (i.e. damage cost modelling). Furthermore, compared to other approaches it has a fast and less data intensive computing and thirdly it is based on knowledge of long lasting scientific background. In the Baltic Sea region, ESI mapping has been applied in Poland, Lithuania, Sweden and Saint Petersburg. Only Sweden has a stated operational use of its sensitivity maps by municipal rescue services for local contingency planning and response. All other sensitivity-mapping approaches have no operational use (f.e. in Poland), are in certain progress or have no implementation at all (i.e. presented Lithuanian approach).

In general, economic impact assessment methods have weak application within the Baltic Sea region. A major reason seems to be the methodology for assessment. Usually it lacks in internationally agreed methodological guidelines and economic evaluation techniques. Although there is general agreement on the definitions, the ranking systems within each case study seems to diverge in favour of a country specific, relativistic, ranking scheme. This is not a purely methodological issue, but is very much influenced by the social-institutional, environmental and economic perception of the problem.

The study presents the attempt to harmonize, or at least to introduce the common methodology for assessment the sensitivity of ecologically linked environment that has been divided by the geopolitical boarders of Lithuania and Russia. The main aim is to facilitate the sensitivity mapping and decision-support systems seem in order to foster operational use within national or regional oil spill contingency plans suggesting an increased involvement of science in policy on this topic and an increased awareness of the problem and its potential environmental and socio-economic consequences.

CONCLUSIONS

Evaluation of the coastal zone sensitivity to the potential oil spill and estimation of possible damage is very important information influencing rescue and management operations. The proposed integrated approach is easily applicable to neighbouring countries with similar natural conditions and existing assets. Knowledge and methodology developed for assessment of the sensitivity to oil spill in Lithuanian coastal areas was applied for coastal zone of Kaliningrad Oblast. Common sensitivity map of coastal features has been developed.

New data of valuable near shore habitats have been collected and used for comprehensive mapping of the biological sensitivity of the Kaliningrad Oblast of Russian Federation. Proven applicability of the tool and new datasets allowed providing with first attempt of integrated sensitivity mapping. The result might serve as the main, scientifically grounded information in order to facilitate the national response operations as well as harmonize the response activities between neighbouring countries.

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