NEW TECHNICAL USES OF MARINE SPACE OF THE BALTIC SEA

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Abstract

The Baltic Sea area has already been intensively used by variety of maritime economic sectors such as marine transport, fishing, tourism, extraction of sand and gravel and oil and gas exploitation. This is also an area of relatively intense military penetration. In addition, this is a place of various other investments, e.g. coastal technical infrastructure (port and transhipment terminals constructions, as well as technical measures of the shoreline defence against transgression of the sea), electrical energy transmission systems (high voltage cables plus large scale electrodes) and natural gas transmission huge pipelines. Over the next decades, the use of the Baltic Sea will expand rapidly, particularly due to constructions of new coastal and offshore wind farms, electrical energy transfer network, further intensification of various forms of shipping, development and construction of new ports and terminals and installing new oil extraction platforms. Some of these activities influences natural spatial distribution of physical properties of the sea space (such as acoustic field, magnetic field, salinity distribution etc.) as well as disturb different natural processes (such as natural coastal dynamics, sedimentation, migration patterns of mobile species etc).

In order to present this problem, most important existing activities as well as the most recent large-scale constructions in the Baltic Sea are selected and presented in this study (with emphasis on the Polish Exclusive Economic Zone). Moreover most likely disturbances of natural distributions of physical properties of marine space are analyzed in light of the impact on the environment.

Keywords: *marine transport, large scale constructions, physical fields, marine environment protection*

1. Introduction

Observed in the last decades development of maritime technologies turn human attention to marine areas as a new “territory” for various technical investments. If the Baltic Sea is considered - it is an area suitable for introducing of industry for several reasons. First on all, it is area surrounded by 8 EU countries permanently developing technical and merchant cooperation resulting in growing competition for sea-space and in growing pressure on the Baltic ecosystem. Additionally, Baltic Sea is very shallow, is tectonically safe and distances between countries are relatively short.

Traditional uses of the sea have been limited to the sea trade and fishing in coastal and offshore areas and to construction of harbours, cargo terminals and urban agglomerations in the coastal areas. Relatively new uses of the sea include extraction of mineral resources, construction of traffic links (bridges, dams and tunnels), transmission of electricity, extraction and transporting of oil and gas (platforms and pipelines), construction of new oil terminals, modernization of port activities and setting wind farms for electricity production.

Maritime transport belongs to traditional uses of the sea and one can predict that establishing new technical construction will disturb marine traffic in various ways, not only as new fixed obstacles but also by natural physical field's modifications and introducing new energies.

Various problems should be overcome with spatial planning, just as is done on land areas. In the Baltic Sea spatial planning is only at the beginning stage. Some useful planning has been done for the Baltic drainage basin by regional organization for spatial planning and development called

"Vision & Strategies around the Baltic Sea" [1]. Worth noting is the ongoing EU INTERREG project on marine landscapes in the Baltic Sea [2]. However, the most important for the development of marine spatial planning is the recent HELCOM Baltic Sea Action Plan (BSAP) and its Recommendation on the Development of Broad-Scale Marine Spatial Planning Principles in the Baltic Sea Area [3] as well as the EU Maritime Directive on Integrated Maritime Policy for the European Union [4]. In Poland at present proposal for minister regulation for rules of preparation the marine spatial plan (MSP) is in faze of public consultations. Poland marine areas (Fig. 1), that is Exclusive Economic Zone, territorial waters and inner marine waters, cover about 23 200 km^2 which gives 7% in relation to whole (land + sea) Polish area.

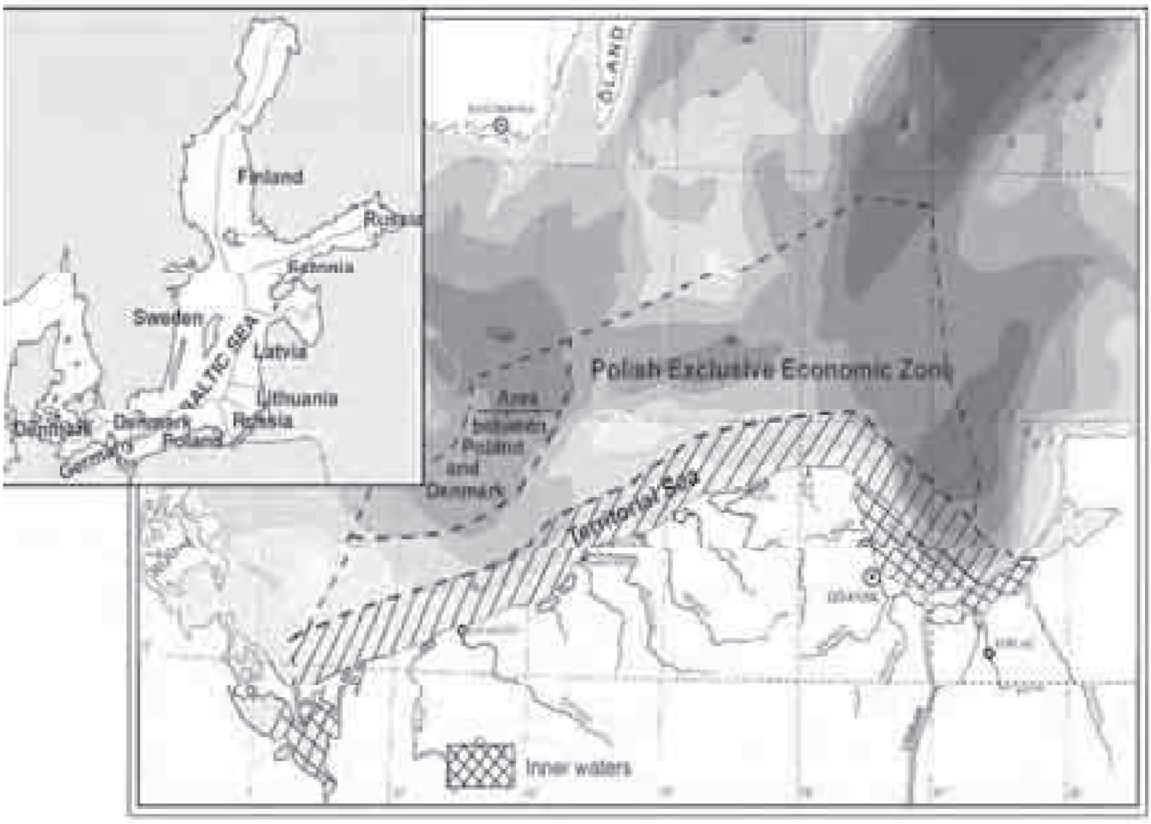

Fig. 1. Polish marine areas

New uses of the sea area result not only in new difficulties for marine transport but also produce hazards for marine environment [5] and as consequence for food resources and recreation values.

2. Existing technical activities in the Baltic Sea

The following large-scale installations or constructions are settled in the Baltic Sea:

- several number of bridges – for example communication bridge "Öresund Link" – the longest bridge in the Baltic Sea (combined with tunnel and artificial island),
- seven electrical energy transmission systems (High Voltage Direct Current - HVDC). Some of them are also connecting different countries. The most recent cable connections "Baltic Cable" and "SwePol Link" belong to the longest cable connections in the world,
- four oil extraction platforms: three Polish and one Russian,
- numerous ports, oil terminals and peers,
- many coastal defence barriers (sea walls) and beach nourishment activities (mostly in the southern part of the Baltic Sea).

2.1. Large scale communication bridges in the Baltic Sea

The most significant environmental problems during bridges construction are related to remobilizing of sediments and reduction of water exchange. After construction, vertical structures serve as a hard base for development of fouling communities ("reef effect").

Öland Bridge:

Inaugurated in 1972, is the road bridge connecting Swedish mainland (Kalmar) and island Öland. It is over 6000 m long, supported on 156 pillars, and has a characteristic hump - created to provide a vertical clearance of 36 m for shipping.

Öresund Link:

This impressive traffic link connecting Copenhagen and Malmö (Fig. 2) was opened in 2000. Before construction the project went through the large number of corrections proposed by experts representing marine and environmental sciences. The original proposal of the bridge crossing the Saltholm Island (bird sanctuary) was criticized and the investors decided to build an artificial island, known as the "Peperholm" (Fig. 2). As proposed by the hydrodynamic experts, the compensate trenches were dug in the seabed to prevent the obstruction of water exchange between the North Sea and the Baltic Sea through the Öresund Straight.

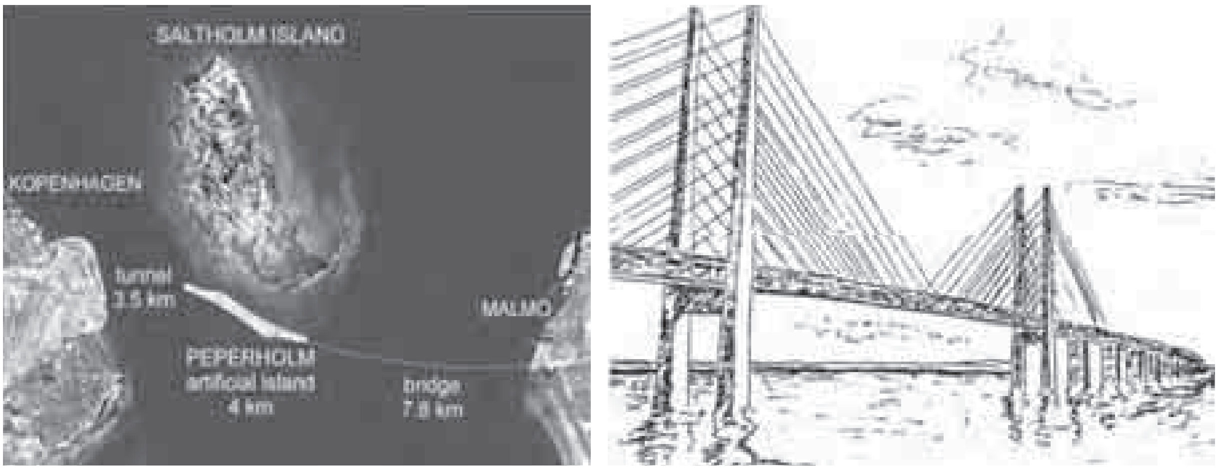

Fig. 2. "Oresund Link" connecting Denmark and Sweden (left) and effects in new seascape (right)

Great Belt Fixed Link:

The fixed link between Danish islands of Zealand (Korsør) and Funen (Nyborg) across the Great Belt (opened in 1997/98). It consists of a road (suspended) bridge and railway tunnel between the island Zeland and the islet Sprogø.

2.2. Power cables

The transmission of electrical energy through underwater high voltage direct current lines (HVDC) may cause several ecological effects. These include mechanical damage to bottom (during cable layering), the chemical effects related to the release of electrolysis products (particularly toxic chlorine on anode) and the influence of physical fields (particularly electromagnetic) on macrofauna and migrating fish.

The present Baltic Sea cable network consists of seven power transmission lines (Fig. 3, left) One of the first cables in the world was *Gotland*, which connects the Swedish mainland with the Swedish island of Gotland. The *Baltic Cable* installation, which runs from Herrenwyk (Sweden) and Lübeck (Germany), is the longest power transmission cable in the world (250 km). The older cables, e.g. *Gotland* and *Konti-Scan*, are systematically being replaced by new ones laid along the same routes.

SwePol Link

An underwater cable system (245 km long) for electricity transfer, using direct current (HVDC) of high voltage (600 megawatts), was built between Sweden and Poland in 1999-2000.

Fig. 3. High voltage electric power cables in the Baltic Sea (left), changes of SwePol Link routs due to protests of local communities and nature conservation issues (route No.1- original proposal: one cable and two electrodes, route No. 2 – second proposal: main and return cable replacing electrodes, route No. 3 - adopted solution: cable route avoiding stony reefs of the Slupsk Bank (right)

The studies conducted prior to cable installation (1999) and one year following construction (2000) demonstrated that there had been no visible permanent changes to the surface of the sea bottom. The cable itself was buried in the soft bottom, and only on the hard stony and boulder bottom in the eastern part of the Slupsk Bank did the cable appear in some places on the surface of the bottom. Studies of macrozoobenthos indicated that one year after construction there were no obvious changes in macrozoobenthos species composition (which could be related to bottom disturbance caused by cable construction) [6].

There is a concern that the magnetic field around HVDC cables may affect fish migration because some fish may use the geomagnetic field for orientation. However, some research projects have not produced definitive results. No negative effects on fish stocks or fishing have been reported in connection with the FennoSkan cable between Sweden and Finland. The same also applies to the Gotland cable line. In case of SwePol Link, the modification of the magnetic field within a few meters from the cable line was significant; however, at a distance of more than ten meters changes in the magnetic field did not exceed the value of natural changes in the earth’s magnetic field.

2.3. Oil and gas exploitation rigs

Oil and gas in the Baltic Sea are extracted in the Polish exclusive economical zone (EEZ) and most recently in the Russian (Kaliningrad) EEZ (Fig. 3). Polish oil company, which was setup in 1990.

At present exploration and exploitation of oil and gas deposits are performed with three drilling platforms: *Petrobaltic*, *Baltic Beta* and *PG-1*. In 2006 new platform (*D-6*) in Russian sector of Kaliningrad Region has started oil extraction.

Until now there was no significant oil pollution reported related to oil extraction.

2.4. Barriers against flood and coastal erosion

This kind of constructions usually involves massive dredging (physically affecting benthic organisms) as well as disruption of coastal dynamics. Coastal barriers and beach nourishment usually drastically change coastal landscape and living conditions in the construction area (Fig. 4).

Scale of environmental effects of these constructions will depend on hydrological features of the construction area.

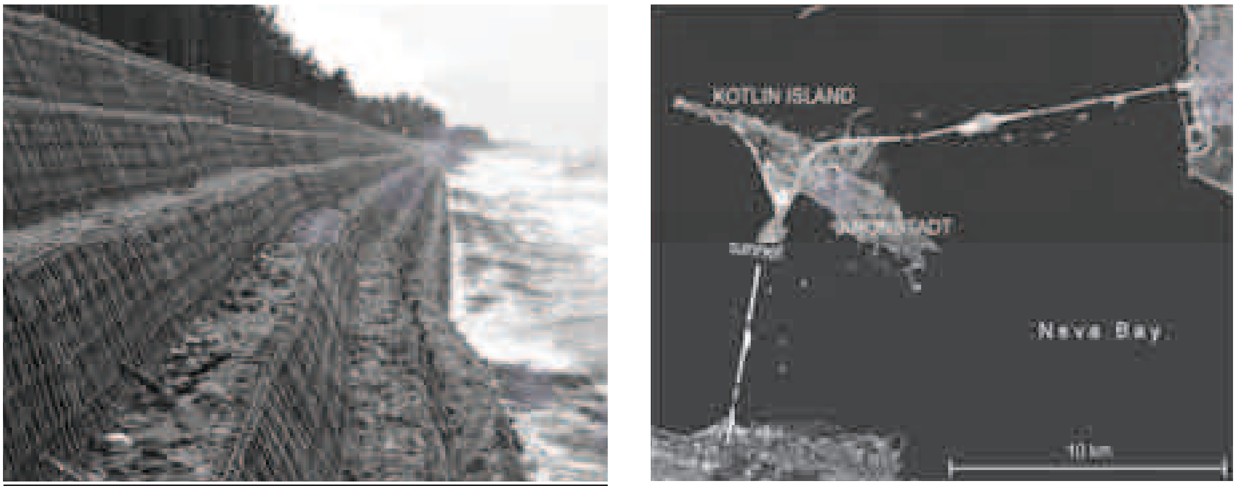

Fig. 4. Large scale coastal protection of the cliff-coast in Poland (left), the St. Petersburg (Russia) combined communication connection and flood barrier (right)

The "Leningrad Dam" (in Russian: "*Leningradskaya Damba*") – is the name of the dam construction which was in use in the eighties of the last century. The current name is the "*Petersburg flood barrier*" or the "*Saint Petersburg Flood Prevention Facility Complex*". Due to degradation of the environment of the Neva Bay and the lack of funds, the construction of flood barrier was stopped in 1988-2003. In 2010 this traffic system was put into operation. The barrier complex measures 25.4 km (22.2 km over the water area and the remaining part is the road through the Kotlin Island (Fig. 4, right).

2.5 Huge pipeline

The controversial NordStream gas transmission line links Russia and Germany. In fact, it is going to consist of two large diameters (1220 mm) and extremely long (1200 km) gas pipelines joined together. The Nord Stream pipeline has a very high (yearly) transmission capacity – up to 55 billion cubic meters. The pipeline enter the sea in the Gulf of Finland and then to go along the Baltic Sea from Russian EEZ through Finnish, Swedish, Danish to German EEZs (Fig. 5).

3. Planned installations in the Baltic Sea

At present we note a number of projects for the development of new installations:

- numerous wind power farms,
- second large gas pipelines (NordStream),
- large development programs for ports and cargo terminals.

3.1. Wind power farms

A few wind power farms already operate along the Danish and German coasts, many are planned (Fig. 5 right). Despite the fact that wind power farms are not a source of chemical or biological pollution, they remain controversial. They may pose many other environmental effects: the possibility of bird collisions, emission of noise and vibration (both to atmosphere and water), possible disruption of fish migration and fish spawning periods, creation of electromagnetic fields, changing conditions on sea bad, alterations of sea currents. In coastal areas, they will changes of natural landscape to “industrial landscape” and therefore they may be a serious concern for local communities. However, until now these are theoretical considerations. We still do not know how fish and mammals will react on noise, vibrations and electromagnetic fields. For sure, wind power farms will change original landscape/seascape to a new - industrialized landscape type, a landscape which might not be liked.

Wind power farms will also add hard substrata to the sea. Development of sessile colonies may create a suitable habitat for some invertebrates and may attract some fish species (“reef effect”). As a result, wind power farms may enhance biodiversity within the given area.

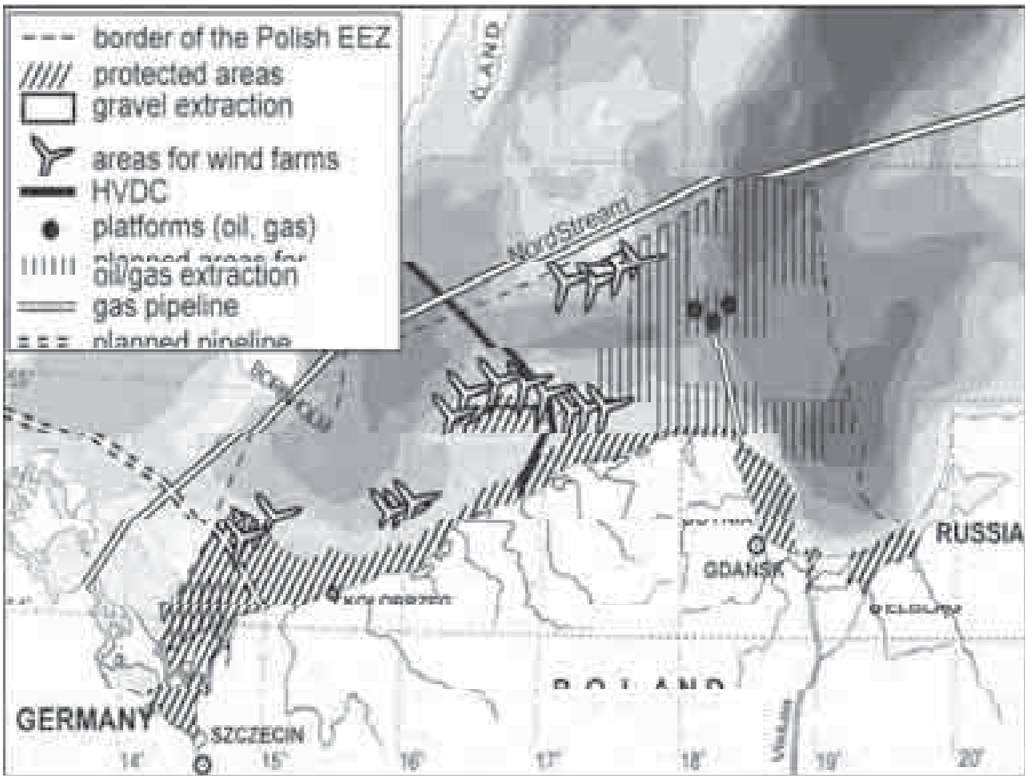

Fig. 5. „Competition for marine territories“ for new technical uses in combination with protected marine areas in the Polish Exclusive Economical Zone

Until now, wind power farms have been in use for a relatively short period of time, therefore, there is not sufficient empirical evidence on the impacts of wind energy farms on the marine environment. Hence, present environmental impact assessments (EIA) for the Baltic Sea wind power farms are mostly based on the theoretical considerations.

3.2. Large pipelines

The pipeline network on the seabed of the North Sea and the Norwegian Sea is dense and has been operating for several decades. A variety of companies exploit/own them. The technical supervision in these seas is well managed and very advanced, as oppose to the Baltic Sea where there is no experience.

As mentioned in the introduction, two large pipelines are planned in the Baltic Sea, namely:

The “Baltic Pipe” to connect Polish and Western Europe pipeline network,

Second line of the “Nord Stream pipeline” to connect Russian gas extraction areas with the German gas system.

The “Baltic Pipe”, is scheduled to connect the Polish and Danish shorelines, a distance of ca. 230 km. A steel pipe with external diameter of 672 mm is planned to be the core of the construction. To compensate buoyancy forces, the concrete cover is going to be layered on the pipe, so a real size will be greater. Currently, the construction schedule, as well as detailed route and technical solution is unknown.

4. Pressures from construction works and large-scale installations

Environmental effects related to introduction of new installations in the sea can be divided into two, types of impacts, namely:
– impacts during the construction phase,
– impacts during the operational phase.

Introducing of new installations usually involves mechanical stress on the sea bottom, creation of new physical fields, mobilizing of deposited nutrients and chemical contaminants, partitioning of habitats, disruption of coastal dynamics (currents and sediment transport) and others.

There are some specific environmental problems related to the Baltic Sea. This is a danger which may appear from dumped chemical munition and a danger of disruption of water exchange between the Baltic and the North Sea (in case of constructions at the Danish Sounds). New constructions may introduce new types of impacts, particularly in case of introducing new physical fields (acoustic, electrical and magnetic ones). Effects of this fields or disruption of existing and natural fields on marine organisms are largely unknown.

Unfortunately, the present knowledge about the Baltic ecosystem in relation to the needs of the new technical installations is insufficient. There is not adequate habitat mapping and habitat classification. In many cases, there is lack of relevant knowledge on the effects of the

5. Conclusions

Density of large technical installations in the Baltic Sea will rapidly grow in the near future. This will rise new environmental concerns, competition for sea-space and new conflicts. Under these circumstances there is raising need for marine spatial planning.

Some existing large scale technical installations in the Baltic Sea (e.g. “Öresund Bridge”, “Baltic Cable” and “SwePol Link”) have already been operating for several years, and they have not shown negative environmental effects. This result was achieved thanks to the careful planning, well prepared and transparent process of EIA and readiness of investors for necessary changes prior to original plans. However, the growing number of new installations rise a serious concern about environmental effects.

In the Baltic Sea, we already face conflicts between different proposals for large scale constructions and nature conservation plans as well as between large-scale constructions and traditional uses of the sea (transport, fishery, tourism, military). These conflicting interests particularly appear in coastal areas (already used for fishing and recreation) and shallow banks (already used or proposed for extraction of mineral resources). These areas are also suitable for setting large wind farms. At the some time these areas are recognized as valuable nature conservation sites and proposed as protected areas (Fig. 5). It is not clear how these conflicting proposals will be solved by decision-makers.

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