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Non-navigational Uses of the Sea Space: The Baltic Sea case

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ABSTRACT: Some parts of the global ocean, apart from their traditional use (maritime transport, fishery, navy), becomes suitable for other technical activities and investments (e.g. gas and electricity transmission, wind farms, gas and oil extraction, gravel extraction, coastal protection). These activities interact with marine environment as well as can interfere with navigation. This paper presents relating to the Baltic Sea large scale technical activities as well as points up their possible individual environmental effects.

1 INTRODUCTION

Intensive navigation together with technical large scale objects located in the marine areas modify already existing natural physical fields and distributions of other physical, chemical or biological values in marine space. These modifications may affect aquatic organisms and as a further consequence negatively alter marine biocenosis. In some cases the seascape is radically modified. At the same time, individual types of technical activities can interfere one with each other.

Maritime management, including spatial planning [Hajduk 2009], should take into account possible modifications of the natural features of marine space. Additionally, there is the need of developing of appropriate standards for marine environmental impact assessments (just as on land areas at present).

In this paper examples of marine space disturbances caused by typical current non-navigational technical activities in these areas are described.

2 NON-NAVIGATIONAL TECHNICAL ACTIVITIES

2.1 *Wind energy conversion*

Marine shallow areas (up to depth of several dozen meters) appear suitable for installation numerous power stations for conversion wind energy into electricity. Present individual offshore wind turbine can generate electrical power up to 6 MW, which means that 100 windmills can produce energy comparatively to large power unit of classical electrical power plant. Rapid growing of electrical power production by offshore windmill generators is observed in EU countries. In the middle of 2013 total European offshore wind power production was 6,040 MW (EWEA 2013), whereas in 2020 is expected 150,000 MW (Tillessen 2010).

Also the Baltic Sea region is considered as an area of intensive production of electricity which is expressed in the Global Offshore Wind Farms Database available on the web (GOWFD 2013). In the Polish Exclusive Economic Zone to suitable areas for offshore wind farms belong slopes of Slupsk Bank (proper Slupsk Bank is restricted as the Protected

Area), Southern Middle Bank as well as Odra Bank. Coastal areas are protected as environmentally important, therefore cannot be consider as areas for technical use for now. There are several dozen applications (to the relevant authorities) for permission to build windmill farms in the Polish Marine Areas (Fig. 1).

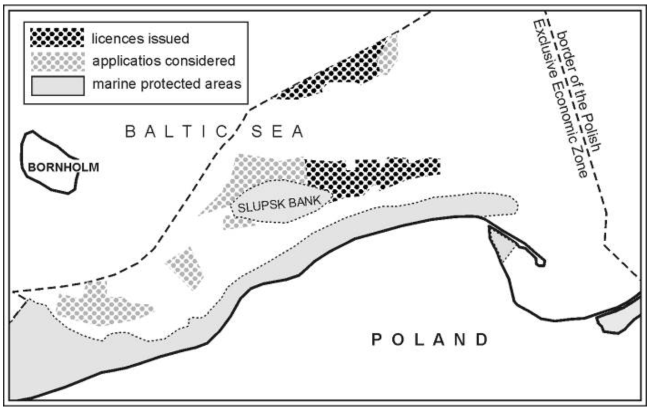

Figure 1. A part of the Baltic Sea - Polish Exclusive Economic Zone with areas planed for marine wind farms (updated May 2013 on the base of web [Ofshorepoland 2013].

One can point up various manifestations of maritime wind farms from the point of view of human activity in the sea areas (navigation, fishery, aviation, tourism, military, terrorist threat) and from the point of view of natural environment proper functioning (influence of noise, electromagnetic waves in air, magnetic field in the water masses). Additionally cable network between wind turbines and the land energetic system is substantial. Above mentioned noise (modification of natural underwater acoustic field) is expected during installation phase (mainly pile driving), in exploitation phase (interaction between wind and wings of rotor, work of the generators) and during removal phase (explosive materials use). For now there is no clear in what range wind farm space can be used for other human activities, for example for fishery.

2.2 *Underwater electricity transfer*

Marine water masses can be used as a medium transporting electrical energy. There are quite a few energy transfer systems installed in marine areas. If the Baltic Sea region is considered, since sixtieth of XX century several High Voltage Direct Current (HVDC) systems have been installed in which coastal electrodes introduce electrical current into water masses (Fig. 2). Apart electrodes, the single core cable operating with electrical potential of several hundreds of kilovolts in relation to surrounding water must be installed in the seabed.

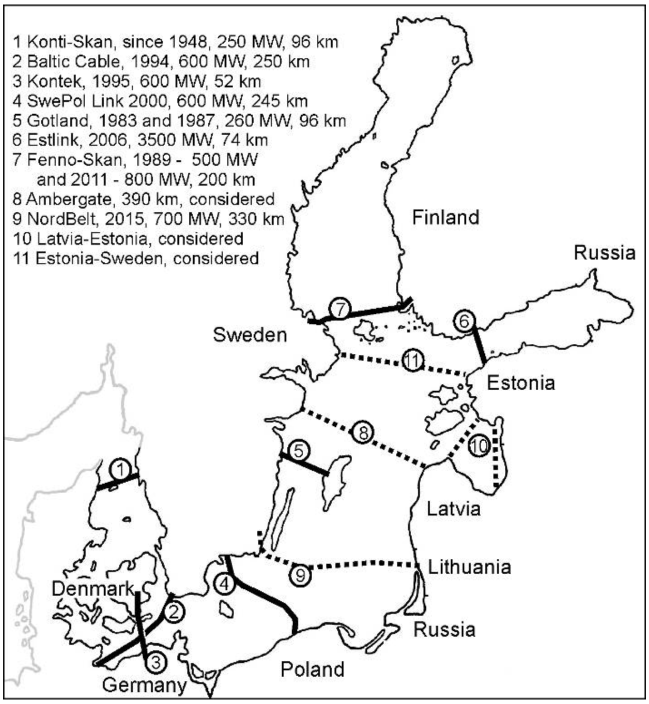

Figure 2. Present and planned High Voltage Direct Current (HVDC) electric power cables in the Baltic Sea (after dissipated sources).

Single HVDC system is able to transfer electricity up to 600 MW (Andrulewicz at al. 2003). After installation of planned wind farms (mentioned in section 2.1), probably numerous of HVDC systems will appear to transporting generated energy to the land electric grids. Furthermore trans-Baltic electric duct will operate using HVDC technique probably, despite the fact that world-electrical-grid operate with the alternating current (AC). DC energy transfer is due to possibilities of present technique economically better than traditional AC method (lower loss of energy along energetic line).

Recently installed HVDC systems (for example the *SwePol Link*), instead of electrodes, uses so called “return cable” (simply, electrodes are replaced by cable operating with low electrical potential).

2.3 *Oil and gas extraction*

“Offshore drilling, deep sea mining, oil platform, jack-up rig, drillship” – there are popular terms appearing in oil and gas production in marine areas. There are a lot of marine technical systems - floatable and fixed – which are in use for hydrocarbons extraction from deposits below the sea bottom (NOAA 2010).

Extraction devices are accompanied by ships, whose mission is supervision for safety, technical supply, collection and transport of excavated material. Brazilian coast, Gulf of Mexico, Norwegian Sea, North Sea, west coast of southern Africa - are areas of greatest production of crude oil, whereas northwest of Australia, Israel-Egypt coast, Venezuela coast, Brazil Coast and Norwegian Sea – areas of gas production. In the Baltic Sea only in the Polish and the Russian marine areas oil and gas are extracted. In the Polish part of the Baltic Sea the *Lotos* Corporation operates several dozen kilometers north of the

Rozewie Cape. Russian D6 oil deposit is located 22 km from the Curonian Shoal (Russian coast).

2.4 *Gas pipelines*

The seabed of above mentioned areas of hydrocarbons extraction is covered by dense pipeline grids.

Not only for hydrocarbons extracted in the sea areas must be transported though pipelines, because marine areas appears suitable for pipeline transport of hydrocarbons from land to land. The *NordStream* system may interfere with the shipping rout to the Swinoujscie/Szczecin Port in the case of necessity of deepening of the fairway (SSP 2010).

Figure 4 shows the route (more than 1000 km) of *NordStream* gas transporting system, together with pipeline connecting the oil/gas rig *Baltic Beta* with the Polish coast (to the power station in Wladysławowo).

2.5 *Traffic connections*

The world's longest marine traffic bridges are planned (2015) between Qatar and Bahrain (40 km) and between Hong Kong and China (50 km, with 5.5 km of submersed tunnel). In the Baltic region 4 long bridges exist: Oresund Bridge (7.85 km), Great Belt Bridge – Eastern (6.79 km), Great Belt – Western (6.61 km) and Oland Bridge (6.1 km). Oresund Bridge (Fig. 5) is connected with artificial island and underwater tunnel (Fig. 6).

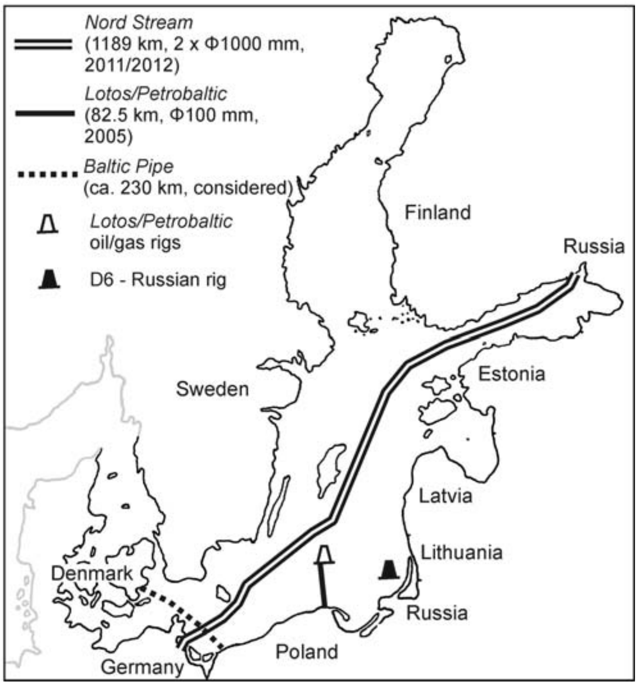

Figure 4. Present and considered gas pipelines in the Baltic Sea.

Interesting solution of the traffic connection through marine area is implemented in the Gulf of Finland so called Saint Petersburg Flood Prevention Facility Complex (former Leningrad Flood Barrier). Figure 7 shows the location of this construction, in which the tunnel beneath navigation canal is build. This navigation pass can be closed by the huge flood doors.

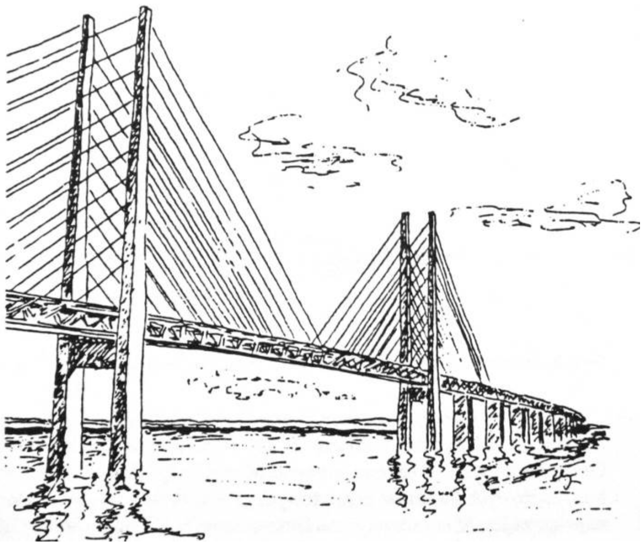

Figure 5. Oresund Bridge as seascape modifier (by the author).

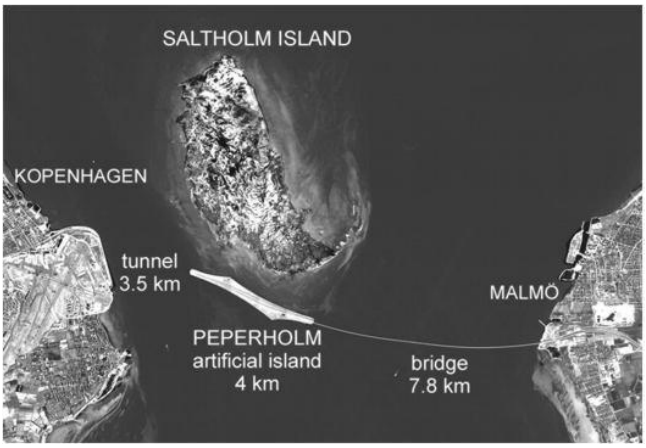

Figure 6. Components of the Oresund Connection.

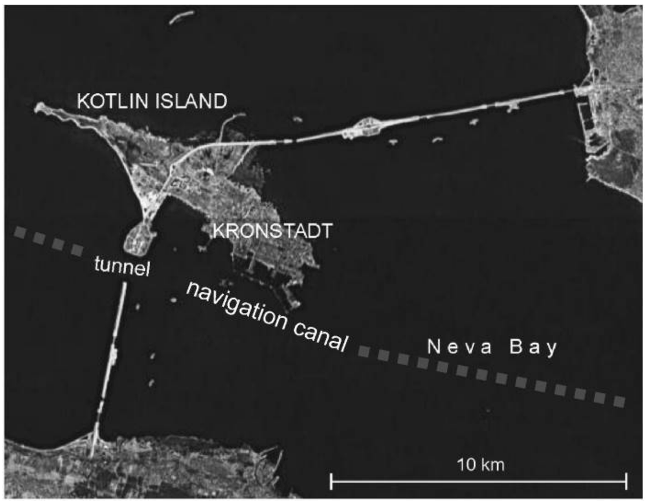

Figure 7. Saint Petersburg flood barrier.

2.6 *Coastal protection*

Encroachment of the sea into the land is a natural phenomenon in many points of the coastline in the world. Especially in the southern Baltic where land immerses itself successively even 0.2 mm/year (Uscinowicz 2011). The seashore is intensively defended in numerous places along the Polish coast. For example, in Jastrzebia Gora region (Figure 8), where gabion techniques is implemented, coastal protection cannot definitely stop the sea transgression – simply, coastal protection structures will sooner or later destroyed. Destroying processes of coastal structure can be weakened by detached breakwaters or underwater sills. Those underwater structures can be placed even several hundred meters from seashore line.

Figure 8. Example of poorly effective coastal protection: partly destroyed gabions at Jastrzebia Góra (photo by the author).

2.7 *Other technical activities*

Despite of above described human activities in the Polish marine areas, other than navigation and coastal structures for shipping, are gravel extraction (region of Slupsk Bank and Middle Southern Bank), undersea fiber-optics telecommunication cables, and military areas on the west of Ustka. Additionally, in the world scale, floating transloading terminals should also be classified as the place of technical activity influencing marine environment (CARGOTEC 2012).

3 DISCUSSION

3.1 *Navigational problems*

Marine technical investments are also discussed from point of view of navigation (Weintrit et al. 2012). It is expected that the competition for marine space will be observed in the future - especially for the ocean shelf and for shallow seas (for example the Baltic Sea). Anyway, at the present, also traditional users of the sea (navigation, fishery) are forced to search the space for them. Therefore closely delimited shipping routes are formed, with the land continuous navigational assistance. High developed current technologies allow reducing the risks caused by introduction of technical objects into marine areas. Only in emergency conditions - like sudden failure of equipment or extremely bad weather conditions - marine technical constructions can escalate serious hazards to navigation (Gucma 2009).

If the coastal technical defense measures are considered, only constructions put forward (several hundreds meters) into the sea (wave breakers) can endanger small vessels (tourist yachts, motorboats, fishing boats).

3.2 *Environmental concerns*

Any human activity in the sea areas impacts the natural environment. The issue of hazards from navigation is known for several dozen decades already - International Convention for the Prevention of Pollution from Ships (MARPOL) regulates problems connected with negative influence of maritime transport on environment. However, the other than navigation activities are poorly analyzed in relation to the safety of the sea. Some adverse or beneficial effects can be predicted before the construction of the particular installation. Unfortunately some of negative effect may be unpredictable for a given sea area. Therefore, a thorough study in the design phase, construction phase and in operation phase is needed.

Every type of technical construction has its own specific impact on environment. For example, if HVDC system is considered, the first problem in the projecting phase was the route of the system. A lot of discussions affected final decision (Fig. 9). Figure 10 shows principle of operation of typical marine HVDC whereas Figure 11 presents distribution of the magnetic induction (horizontal component) above the cables (in the *SwePol Link* case). Fish profile voltage in the vicinity of electrode is shown in Fig. 12. Some species of fish may be affected by electrical current in the vicinity of electrode.

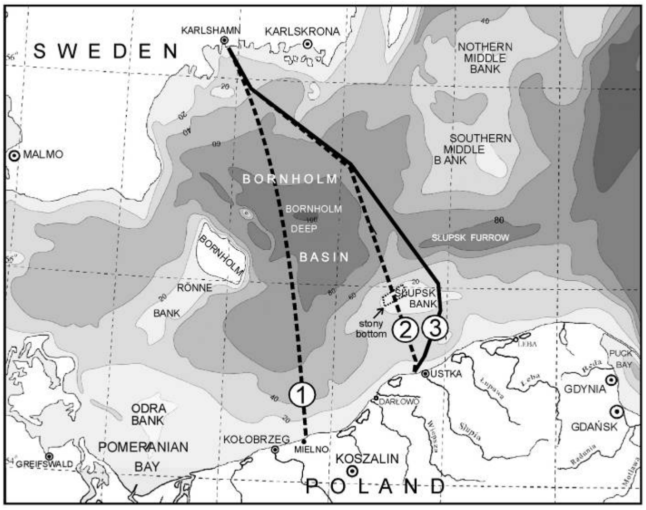

Figure 9. Evolution of projected route of the SwePol Link (Andrulewicz at al. 2003). The third is the final one – it bypasses chemical weapons deposits in the Bornholm Deep (1) and protected areas in the Slupsk Bank (2).

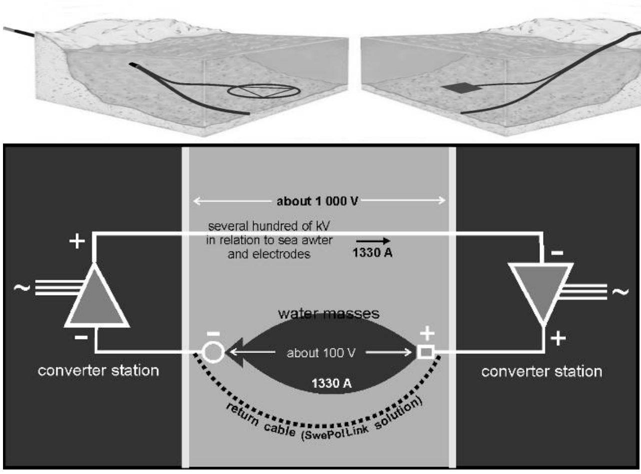

Figure 10. Scheme of submarine HVDC connection.

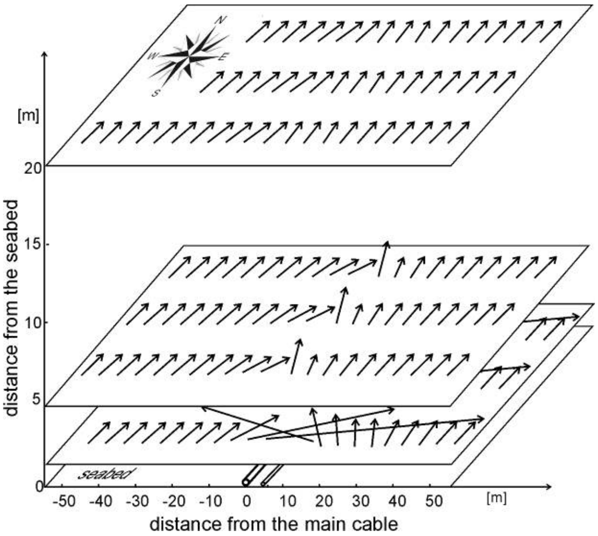

Figure 11. Distribution of magnetic induction above the HVDC cables (calculated by the author).

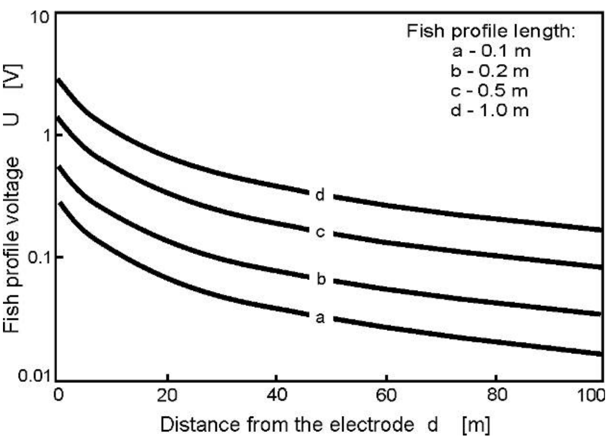

Figure 12. Fish profile voltage vs. distance from the electrode in the Baltic Sea waters (calculated by the author).

The question of environmental impact of marine technical construction has many aspects and requires more intensive study (Otremba & Andrulewicz 2007).

4 FINAL REMARKS

The time of new types of technical intensive activities at sea begins - above presented examples shows that the sea space is an attractive area for investments that have historically been implemented only on the land. Their interaction with navigation, fishery and natural environment is in intensive analyzing at present, therefore this study indicates limited number of problems only. One can indicate that there are also other types of problems associated with the introduction of large-scale technical structures into marine areas - for example financial compensation for lost fishing areas or elongated shipping routes or even limitation of the tourism industry.

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