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Chemical Munitions Search & Assessment—An evaluation of the dumped munitions problem in the Baltic Sea

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ABSTRACT

Chemical Munitions Search & Assessment (CHEMSEA) project has performed studies on chemical weapon (CW) detection, sediment pollution and spreading as well as biological effects of chemical warfare agents (CWAs) dumped in the Baltic Sea. Results suggest that munitions containing CWAs are more scattered on the seafloor than suspected, and previously undocumented dumpsite was discovered in Gdansk Deep. Pollution of sediments with CWA degradation products was local and close to the detected objects; however the pollution range was larger than predicted with theoretical models. Bottom currents observed in the dumpsites were strong enough for sediment re-suspension, and contributed to the transport of polluted sediments. Diversity and density of the faunal communities were poor at the dumping sites in comparison to the reference area, although the direct effects of CWA on benthos organisms were difficult to determine due to hypoxic or even anoxic conditions near the bottom. Equally, the low oxygen might have affected the biological effects assessed in cod and caged blue mussels. Nonetheless, both species showed significantly elevated molecular and cellular level responses at contaminated sites compared to reference sites.

1. Introduction

Chemical weapons (CW) were produced in mass quantities during both World War (WW) I and II. However those made during WWII were never used in battle in the European theatre. Vast quantities of German chemical warfare agents (CWA) were captured by allied armies, and by decision of Potsdam conference their dumping at sea was commenced by allied military administrations.

By far, the largest part of these weapons was dumped in the Baltic Sea and Skagerrak Strait on the orders of the British, Russian and American occupation authorities (HELCOM, 1995). At least 170,000 t of CW was dumped in the Skagerrak, mainly in the Norwegian trench and in the eastern Skagerrak, off the Swedish coast. In most of the dumping operations in the Skagerrak, complete ships were sunk with their cargo (HELCOM, 1994, 1995). In the Baltic Sea, chemical weapons were stored in Wolgast, on the Baltic shore and transported

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from there to the main dumping sites located in Bornholm Basin and Gotland Deep. At least 50,000 t of CWs were dumped containing roughly 15,000 t of CWA. The most important dumpsites in the Baltic Sea are located near the island of Bornholm and in the Gotland basin (HELCOM, 1994). The largest dumping site is east of Bornholm with estimated 32,000 t of dumped CW. In most cases, the CW was thrown overboard, either loose (bombs, shells) or in containers, however several ships filled with CW were also sunk (HELCOM, 1994). In most cases dumped materials contained explosives (bursters for the CW) and conventional munitions (Andrulewicz, 1996). There are strong indications that part of the CW was thrown overboard during transport to the Baltic dumpsites; therefore the exact volume of the dumped CWs is not known (Andrulewicz, 1996; Schulz-Ohlberg et al., 2001).

Although not officially confirmed by archives, there are indications that the former German Democratic Republic (GDR) and the former Soviet Armies dumped CW in the Baltic Sea for many years after 1947 (dumping is believed to have continued into the 1980s). It is believed that the GDR dumped about 200 t of CW into the Baltic Sea in the 1950s. Dumpsites and transport routes are depicted in Fig. 1.

Today, the dumped CWs in the bottom of the Baltic Sea are in different stages of decomposition. Their metal shells are corroding and contents are leaking into the environment at a rate that cannot be estimated given present knowledge on the quality of material used to make them, posing a risk for the Baltic Sea ecosystem. In previous studies, several CWAs of major concern for biota, such as inorganic arsenic and organo-arsenic compounds, have been found in the sediments (Missiaen et al., 2006). Moreover, sea-bottom activities such as bottom trawling or constructions of pipelines and cables are increasingly claiming space within the contaminated areas. Growing fishery pressure and other activities such as the construction of the planned offshore wind farms will take place in the future.

The Chemical Munitions Search & Assessment (CHEMSEA) Project resulted from the need to describe in detail CW dump sites omitted or only partially included in previous investigations (Missiaen et al., 2006, 2010). CHEMSEA has the further goal to transform the scientific discoveries into tools that can be used by maritime administrators to manage risk.

Project activities could be divided into several categories—development of new methods for object identification and analysis of CWA, survey of official and unofficial dumpsites, nature and extent of CWA contamination therein and ecological impact assessment. Survey performed in the project was aimed mainly at estimation of spatial distribution of CW related objects in the Gotland Deep dumpsite, verification of one of possible dumpsites from the 1950s in the Gdansk Deep, and search for objects resting in transport routes from Wolgast Harbor in Germany to Gotland Deep, in particularly hydro dynamically important area of Słupsk Furrow (Fig. 1).

Examination of the nature and extent of CWA contamination took into account previous findings, both in terms of degradation pathways and area in which leaking warfare agents can pollute sediments, in order to verify if observed objects are really chemical weapons, and to study the extent of sediment pollution. Ecological multidisciplinary impact assessment could be divided into the main three approaches. First one included the observation of near bottom currents and their potential to re-suspend the polluted sediments, which created a base for the model of CWA contaminated sediments spreading out of the dumpsites. The second one is the modeling of the bottom currents and scattering of the potential leakages. At the current state it is impossible to observe the bottom currents at any time and at any dumpsite. Hydrodynamical models are very powerful tool for investigating any sea part in any time (which is limited to external data, but in this case all data are available). In this case Parallel Ocean Program has been adopted and validated for the Baltic Sea area. All simulations were focused on the bottom currents and investigation of the bottom currents influence on the potential leakage. The third one was aimed at investigation of the bioavailability and the biological effects of CWAs in marine organisms, at all three major dumping sites.

2. Materials and methods

2.1. Survey

The CW deployment area in the Southern Gotland Basin (1700 km^2) and a smaller area in the Gulf of Gdansk (~100 km^2) were scanned with side—scan sonars and single and multibeam echosounders. Additionally, acoustical scanning was performed on more than 400 NM (nautical miles) transects along supposed transport routes of ships carrying loads of chemical munitions

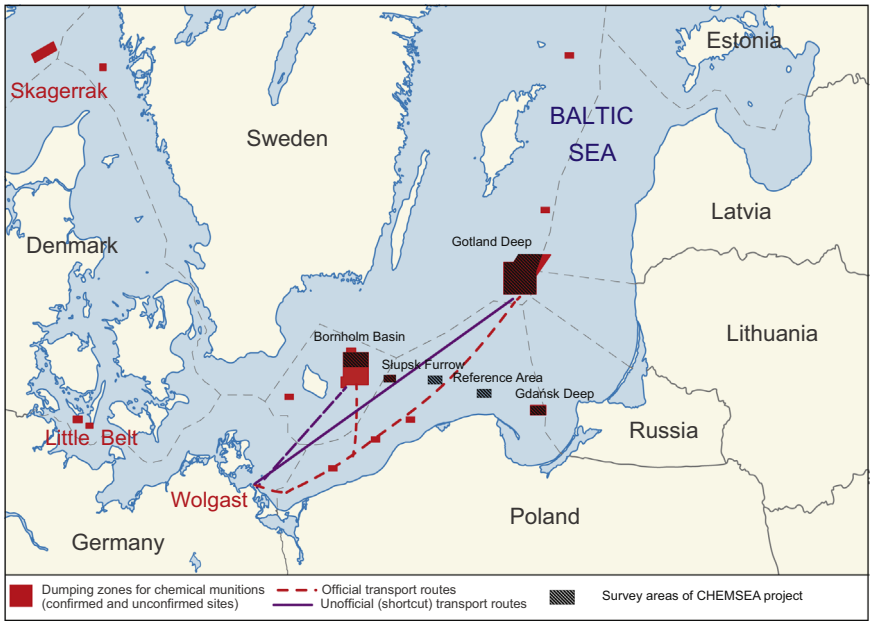

Fig. 1. Dumping sites of chemical munitions in the Baltic Sea.