Residual Armaments Relics - results from the Bornholm dumpsite

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After WW1 & WW2 large amounts of conventional and chemical weapons were dumped in European seas: over 80 known sites
Munition dumpsites in the Baltic Sea & Skagerrak

Skagerrak (D & E) over 170,000 tons conventional + chemical > 36 ships were sunk

Little Belt (C) over 5,000 tons chemical weapons 2 ships were sunk, later recovered

Gotland (A) over 2,000 tons (?) chemical weapons no ships were sunk
Munition dumpsite east of Bornholm

- Main dumping in 1947
- Additional in 1952-1965
- Water depth 70 to 96 m
- > 32,000 tons of CW
- > 11,000 tons toxic agents
- Mainly mustard gas and Arsenic
What was dumped and how?

Mostly shells, mines, bombs

Also drums and containers

In total > 500,000 objects

Most of the munition was thrown overboard
Either loose or packed in wooden crates

Aerial mustard gas bomb type KC 250
No official records of scuttled munition ships in 1947
In 1962 one barge filled with CW was sunk (Operation “Hanno”)
Fishing incidents near the Bornholm dumpsite

In 1947–1948 bomb casings and barrels washed ashore

From 1948-1992: >200 injured fishermen reported in DK

In 2002: 8 incidents in DK, all involve mustard gas bombs

Baltic fisherman with mustard gas injury
Caught munition near the Bornholm dumpsite

Since 1992: most bombs caught are empty or heavily corroded mustard gas bombs

Also lumps of mustard gas are often caught in fishing nets

Picture: Bornholms Marinedistrikt

Bursting charge found in mustard gas lump

Picture: Bornholms Marinedistrikt
Geophysical investigations: MERCW Project

Modelling of Environmental Risk related to sea-dumped Chemical Weapons

*Acoustic survey*  
*Magnetic survey*  
*ROV video survey*

**OBJECTIVES**

- Internal structure of the dumpsite
- Possible natural hazards
- Detection of dumped weapons
- Detection of shipwrecks
Magnetic and acoustic investigations

After Missiaen & Feller 2008
Detection of scattered objects (1)
Magnetic evidence

Magnetic maps

Two small areas of ±1 km² were surveyed in high detail

Large difference in objects density: heterogeneous distribution
Detection of scattered objects (2)
Acoustic evidence

All objects are buried less than 1.5 m below the seafloor

Large objects > 2 m
Drums & containers?

Small objects < 2 m
Shells and bombs?

Missiaen & Feller 2008
Possible natural hazards

Sediment and water locally pushed up due to overpressure
Only observed in south of extended dumpsite area
Minor hazard – possible spreading of leaking toxic compounds
Shipwrecks at the Bornholm dumpsite (1)

Four shipwrecks identified in primary dumpsite
Wrecks are partly buried in soft sediments
It is not certain if the wrecks contain any CW
Shipwrecks at the Bornholm dumpsite (2)

ROV video image

Corroded missile found on the deck of one wreck

Side-scan sonar image

Some wrecks seem heavily destroyed
No actual chemical warfare agents (CWA) were detected

Only degradation products were detected, mostly in sediment

Arsenic contamination widespread in dumpsite area (50 samples)

Contamination near wrecks may not originate from wrecks
Sampling and chemical analysis (2)
(work in progress)

Yet only 1 sample shows contamination with mustard gas – WHY?

Mustard gas lumps have solidified over time and are not easily soluble

63% of all dumped toxic compounds is mustard gas

Recent catches by fishermen all involve mustard gas
Conclusions regarding detection

The detection of dumped warfare is possible using state-of-the-art acoustic and magnetic methods.

All of the detected munition is completely buried below the sea bed.

Four shipwrecks were detected at the dumpsite; most likely they do not contain CW.

The distribution of dumped warfare is very heterogeneous and most likely spreads beyond the dumpsite area.
Conclusions regarding possible risks (preliminary)

Arsenic contamination was measured in entire dumpsite area but is observed only in the sediments, not in the sea water.

Mustard gas contamination is barely measured; this is due to solidification of the lumps.

Fluid expulsion in the shallow sediments may form a minor hazard related to toxic migration.

Many factors remain unknown, e.g. corrosion state of buried munition and ecotoxicological properties. Also only a small portion of the dumpsite was investigated.

More interdisciplinary research is needed for a correct risk analysis.