CHEMSEA
CHEMICAL MUNITIONS SEARCH & ASSESSMENT

Baltic Sea Region Programme 2007-2013

Part-financed by the European Union (European Regional Development Fund)

Report of sampling cruise in area of chemical munitions dumpsite in Lithuanian economic zone

Vitalijus Malejevas
Galina Garnaga
Sabina Solovjova
Paulius Petrošius
Julija Fiodorova
Žydrūnė Lydeikaitė

aplinkos apsaugos agentūra

February 2014, Klaipėda

Contents

1. AIMS OF THE SEDIMENT SAMPLING

During World War II, in the Baltic Sea were dumped about 55 000 tons of Chemical Warfare Agents (hereinafter – CWA). The official dumping zones are Bornholm and Gotland deeps. There is reason to believe that the CWA is on the other seabed places. CWA metal sheaths corrode and contain substances which spread in the environment by undetermined intensity. Without knowing the extent of the risk, different activities on the seabed of the Baltic Sea (such as fishing trawlers or building hydraulic structures) can be dangerous.

From June of 2011 Lithuanian Environmental Protection Agency participate in international project CHEMSEA (Chemical munitions search & assessment), which is part - financed by European Union (European Regional Development Fund) Baltic Sea Region Programme 2007-2013.

Environmental Protection Agency (LEPA) Marine research department in April 26 – 29 of 2013 has accomplished an expedition to chemical munitions Gotland dumpsite, to the part which lies within Lithuanian exclusive economic zone, by R/V „Vėjūnas“. During expedition hydrological measurements were made, water, sediment and biological samples were taken.

2. VESSEL & EQUIPMENT

Research vessel – catamaran „Vėjūnas“ was built in the beginning of 2012 in Nasva shipyard in Estonia (Fig. 1). Modern, 24 meters length, small draft ship performs scientific tasks in the Baltic Sea and Curonian lagoon (Table 1).

Fig. 1. R/V „Vėjūnas“, Environmental Protection Agency Marine Research Department (photo: Baltic Workboats Shipyard)

Table 1. Specification of R/V „Vėjūnas“.

	R/V „Vėjūnas“
Year of construction	2012
Water capacity	424 m^3
Length	23,90 m
Width	8 m
Draft	1,30 m
Average speed	11 knots
Laboratories	2
Number of crew	5
Scientific group	6-12
Autonomy	3 days
Work area	Baltic Sea, Curonian Lagoon

„Vėjūnas“ is provided with newest scientific equipment: CTD, ADCP, single beam echosounder, side scan sonar and other equipment for water and sediment sampling.

CTD zonde measures water temperature, salinity, dissolved oxygen, pH in different water layers. ADCP measures current magnitude and direction in different water layers too.

Single beam echosounder is used for the depth measurements. For the bottom sediment samples and macrozoobenthos Van Veen grab sampler is used.

3. SAMPLING, METHODS AND RESULTS

Sediment sampling and measurements were made at 21 stations, 9 of them lies in Gotland deep chemical munitions dumpsite, 2 of them lies in Lithuanian EEZ and other 10 in Lithuanian waters (Figs. 2, 3, 4, 5, Table 2).

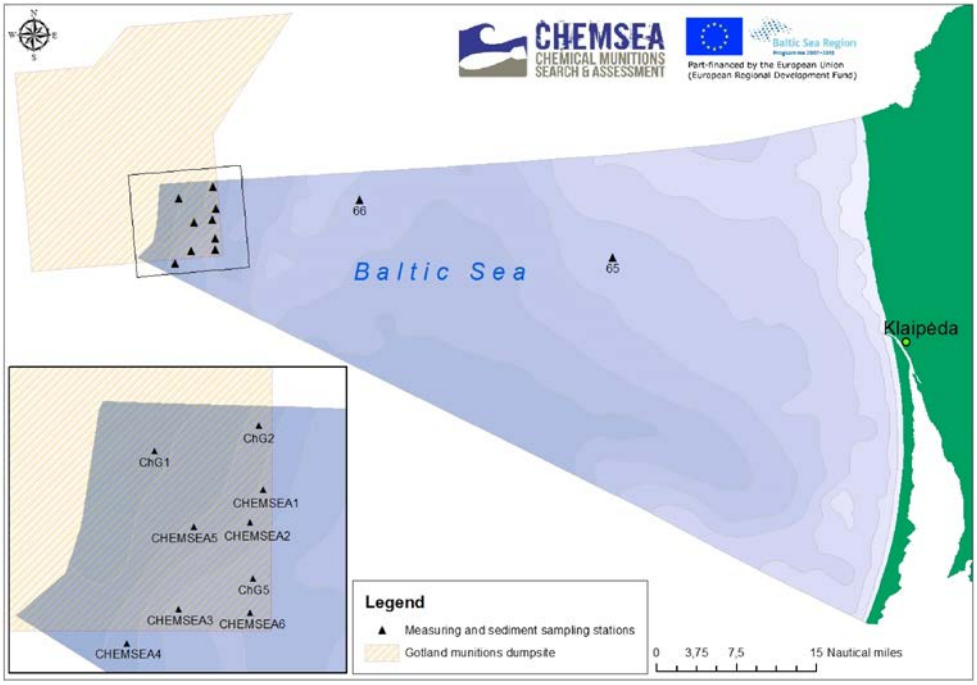

Fig. 2. Measuring and sediment sampling stations in Gotland deep

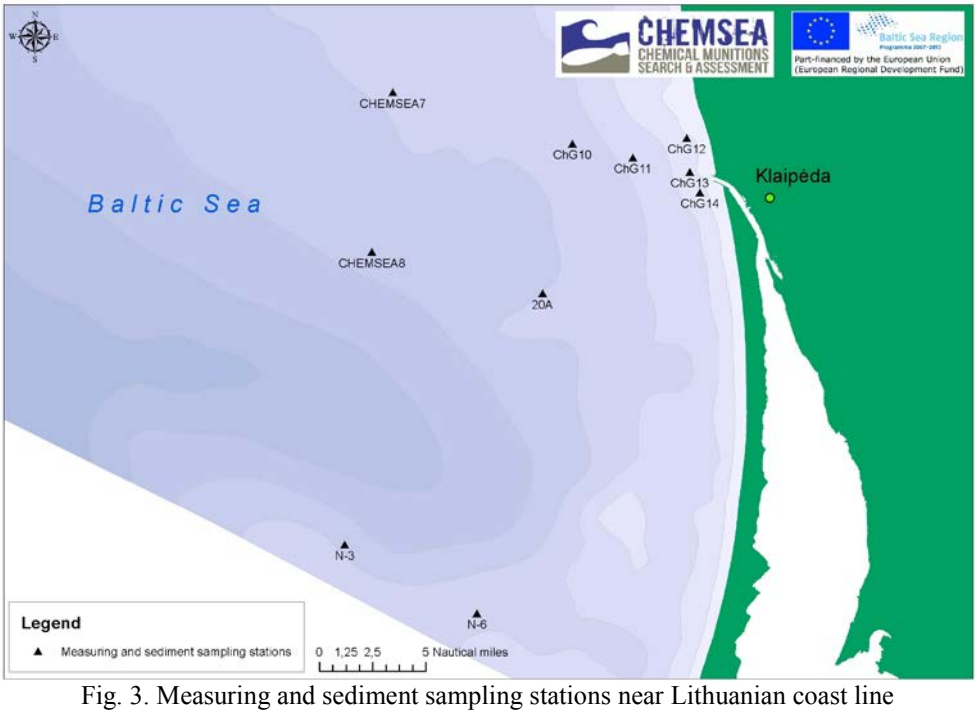

Fig. 3. Measuring and sediment sampling stations near Lithuanian coast line

Table 2. Coordinates of stations.

Number	Station	Coordinates		Depth	Sampling date
		Longitude	Latitude		
1.	65	55°52,9'N	20°20,5'E	47	2013-04-26
2.	66	56°00,0'N	19°39,0'E	57	2013-04-26
3.	CHEMSEA1	56°00,0'N	19°14,9'E	87	2013-04-27
4.	ChG1	56°01,2'N	19°08,8'E	117	2013-04-27
5.	ChG2	56°02,1'N	19°14,6'E	106	2013-04-27
6.	CHEMSEA2	55°59,0'N	19°14,2'E	90	2013-04-27
7.	CHEMSEA5	55°58,8'N	19°11,1'E	101	2013-04-27
8.	ChG5	55°57,3'N	19°14,5'E	83	2013-04-27
9.	CHEMSEA3	55°56,2'N	19°10,4'E	85	2013-04-27
10.	CHEMSEA4	55°55,1'N	19°07,6'E	103	2013-04-27
11.	CHEMSEA6	55°56,2'N	19°14,4'E	78	2013-04-27
12.	ChG14	55°43,1'N	21°03,7'E	16	2013-08-21
13.	ChG13	55°44,1'N	21°03,0'E	15	2013-08-21
14.	ChG10	55°45,9'N	20°53,5'E	34	2013-08-21
15.	CHEMSEA7	55°49,0'N	20°39,0'E	40	2013-08-21
16.	CHEMSEA8	55°41,6'N	20°36,2'E	48	2013-08-21
17.	20A	55°39,0'N	20°50,0'E	43	2013-08-21
18.	N-6	55°24,3'N	20°42,4'E	36	2013-08-22
19.	N-3	55°28,0'N	20°32,0'E	42	2013-08-22
20.	ChG12	55°45,7'N	21°03,0'E	11	2013-11-22
21.	ChG11	55°45,0'N	20°58,4'E	27	2013-11-22

Fig. 4. Van Veen grab elevation (photo: G. Garnaga)

Fig. 5. Sediment sampling (photo: G. Garnaga)

3.1. Hydrological measurements

3.1.1. Thermocline

A thermocline is a thin but distinct layer in a large body of fluid in which temperature changes more rapidly with depth than it does in the layers above or below. In the ocean, the thermocline may be thought of as an invisible blanket which separates the upper mixed layer from the calm deep water below. Our Baltic Sea thermocline occurs only from 50 m depth.

In first station (65 station), which depth was just 42 meters, haven‘t seen any thermoclines. In the second station (66 station) just a beginning of thermocline formation was observed, this station depth was 54 meters. Other 9 stations had much bigger depth, so thermocline was observed very clearly. In all stations (except first two) thermoclines started in depth of 50 meters and temperature raised about +2˚C. Surface temperature was 2,8-3,2˚C, bottom temperature was 4,4-5,1˚C. The largest surface and bottom temperature difference was in station ChG1, even 2,3˚C, but that was due the fact that this station had biggest depth, 114,5 meters.

3.1.2. Halocline

In oceanography, a halocline is a subtype of chemocline caused by a strong, vertical salinity gradient within a body of water. Because salinity (in concert with temperature) affects the density of seawater, it can play a role in its vertical stratification. Increasing salinity by one kg/m^3 results in an increase of seawater density of around 0,7 kg/m^3. Our Baltic Sea halocline occurs only from 50 m depth.

First two stations (station 65 and 66) had no halocline, but other 9 stations had a highly visible halocline. In all stations surface salinity was 7,2-7,3 PSU. Bottom salinity was 9,4-11,4 PSU (not including stations 65 and 66). Thus, largest surface and bottom salinity difference was in station ChG1, even 4,2 PSU, because of biggest - 114,5 meters, depth. Halocline started in depth of 50 meters and from this depth salinity increased from 2,1 PSU to 4,2 PSU. Cause of the salt water at the bottom could have been inflow from the Atlantic Ocean.

3.1.3. Oxygen saturation

Oxygen saturation or dissolved oxygen (DO) is a relative measure of the amount of oxygen that is dissolved or carried in sea water. It can be measured with a dissolved oxygen probe such as oxygen or an optode in liquid media, usually water. The standard unit is milligrams per liter (mg/l).

Surface oxygen saturation in stations were 10,7-11,2 mg/l. First two stations had no big changes in water mass from surface to bottom, because of the small depth. Biggest oxygen saturation changes were in station ChG1. But in this station and in stations CHEMSEA 4, CHEMSEA 5, ChG2, were deformities of oxygen saturation in the water mass demersal, when oxygen saturation was falling and rising rapidly. This deformity is caused by inflow from the Atlantic Ocean. In the column of water, maximum values of dissolved oxygen was in station 65, in depths of 0,5 – 8,0, 9,0 and 11,5 meters and the value of maximum dissolved oxygen was even 11,3 mg/l. Lowest value of dissolved oxygen was in station ChG1, in depth of 102 meters and the value of lowest dissolved oxygen was just 1,1 mg/l.

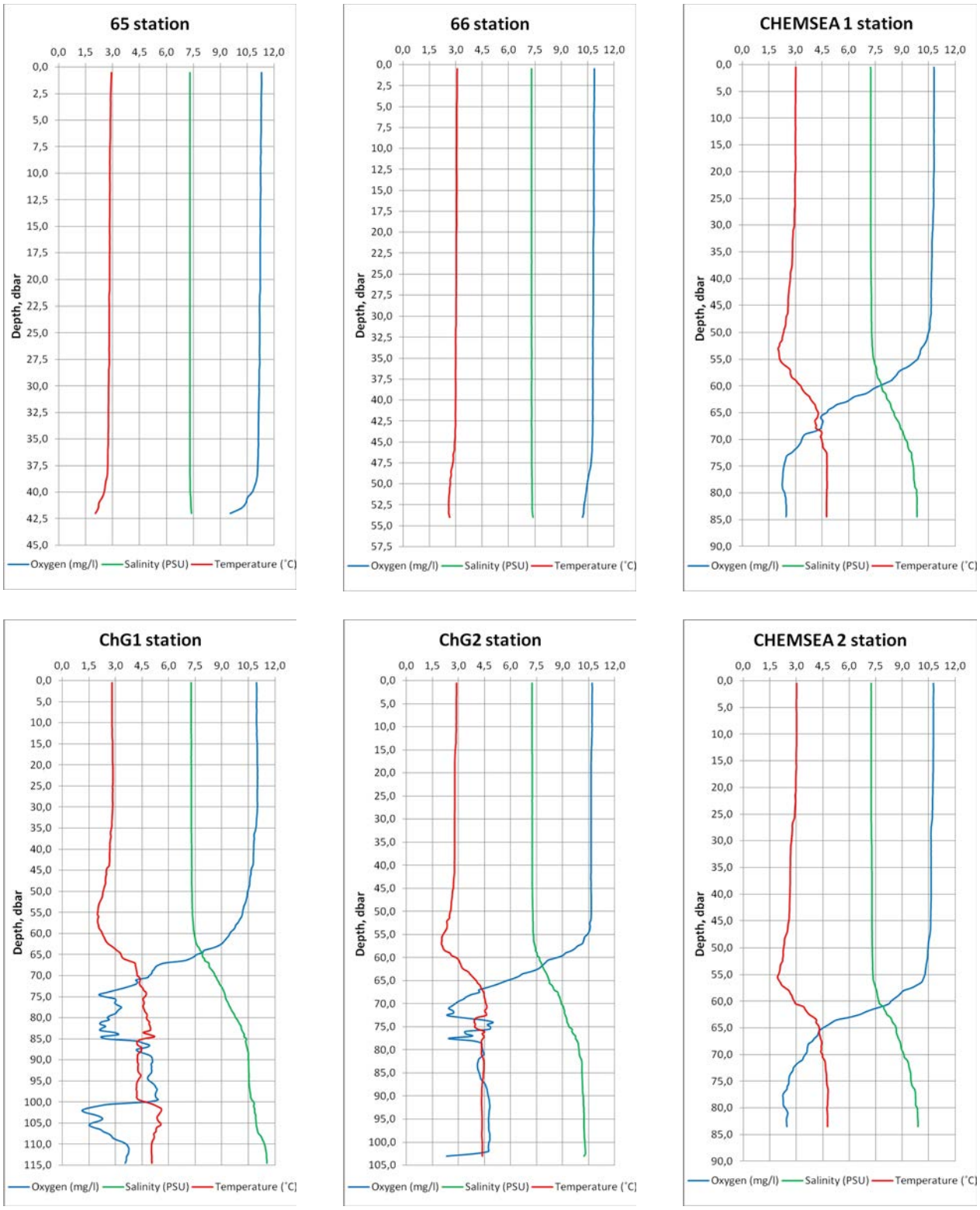

Fig. 6. Water temperature, salinity and dissolved oxygen results in the column of water (continuation in the next page)

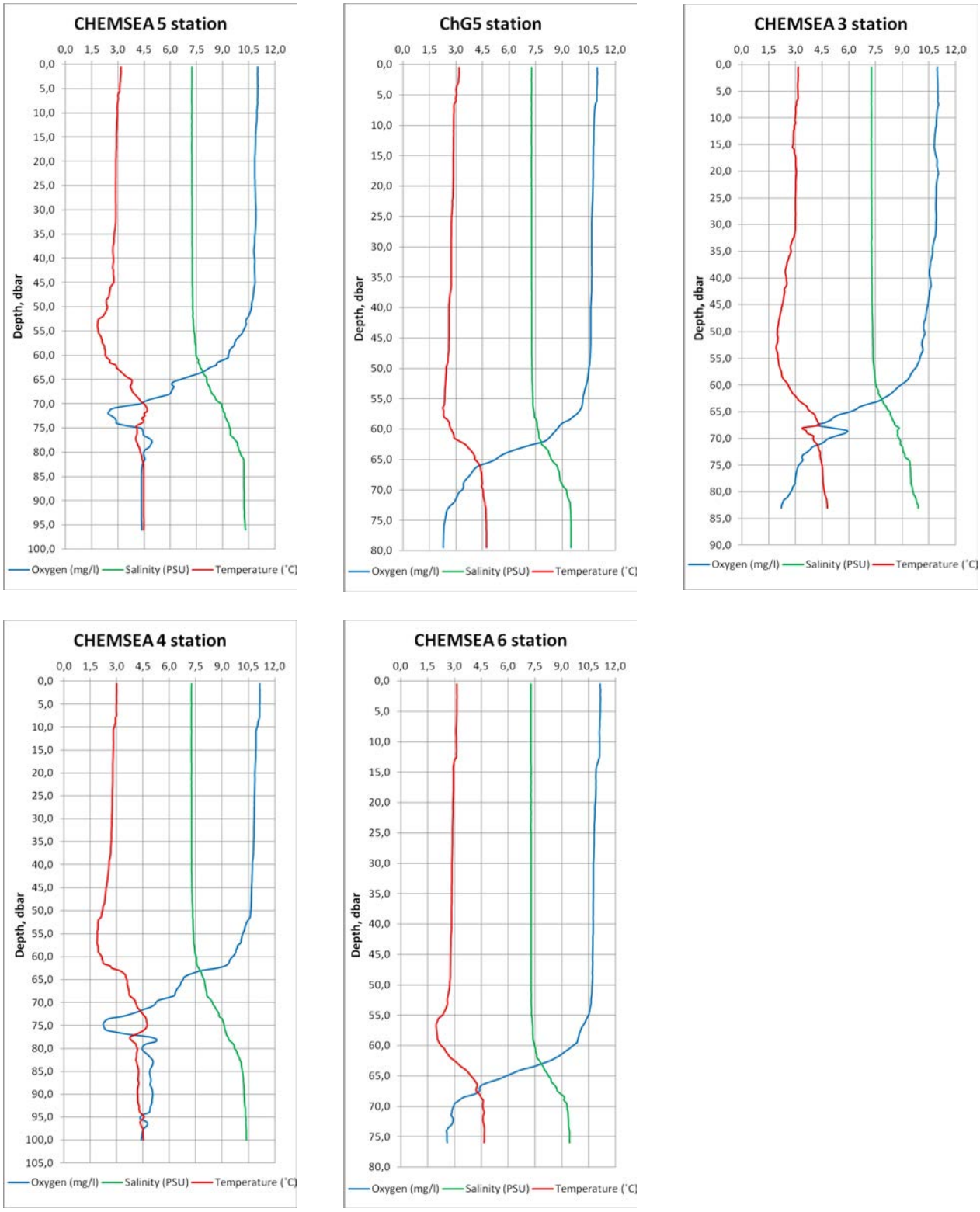

Fig. 6. Water temperature, salinity and dissolved oxygen results in the column of water

3.1.4. Current magnitudes and directions

In the first two stations (65 and 66) current magnitude in water column varied from 1 to 11 cm/s. Currents were directed to north-east (vary between 2 – 68°) in 65 station, hereupon in 66 station currents were directed to south-west (vary between 182 – 262°).

Current magnitude and direction in the deeper stations differ more than in shallow stations (65 and 66). In surface water layer (extending between 0 – 10 m) prevail weak and mean velocity currents. Biggest current magnitude, in surface layer, was measured in CHEMSEA 5 station – 12 cm/s. Dominant current magnitude in all stations was 3 – 8 cm/s, currents were directed to north, except CHEMSEA 3, 4 and 6 stations there currents were directed to east-south (vary between 90 – 192°).

In water layer from 10 to 30 meters prevail 1 – 13 cm/s current magnitude. Current directions in this layer are related with surface, therefore dominates north direction, except CHEMSEA 3, 4 and 6 stations there currents were directed to east-south (vary between 90 – 192°).

The transitory (intermediate) dynamic zone (extending between 30 – 45 m) is characterized by vertical variations of currents. Current magnitude in this layer prevail 1 – 12 cm/s. Current directions in this layer change. Then on surface layer currents were directed to north, so now it turns to north-east side. In those stations were current directions were directed east-south, still keep the same direction (Fig. 7).

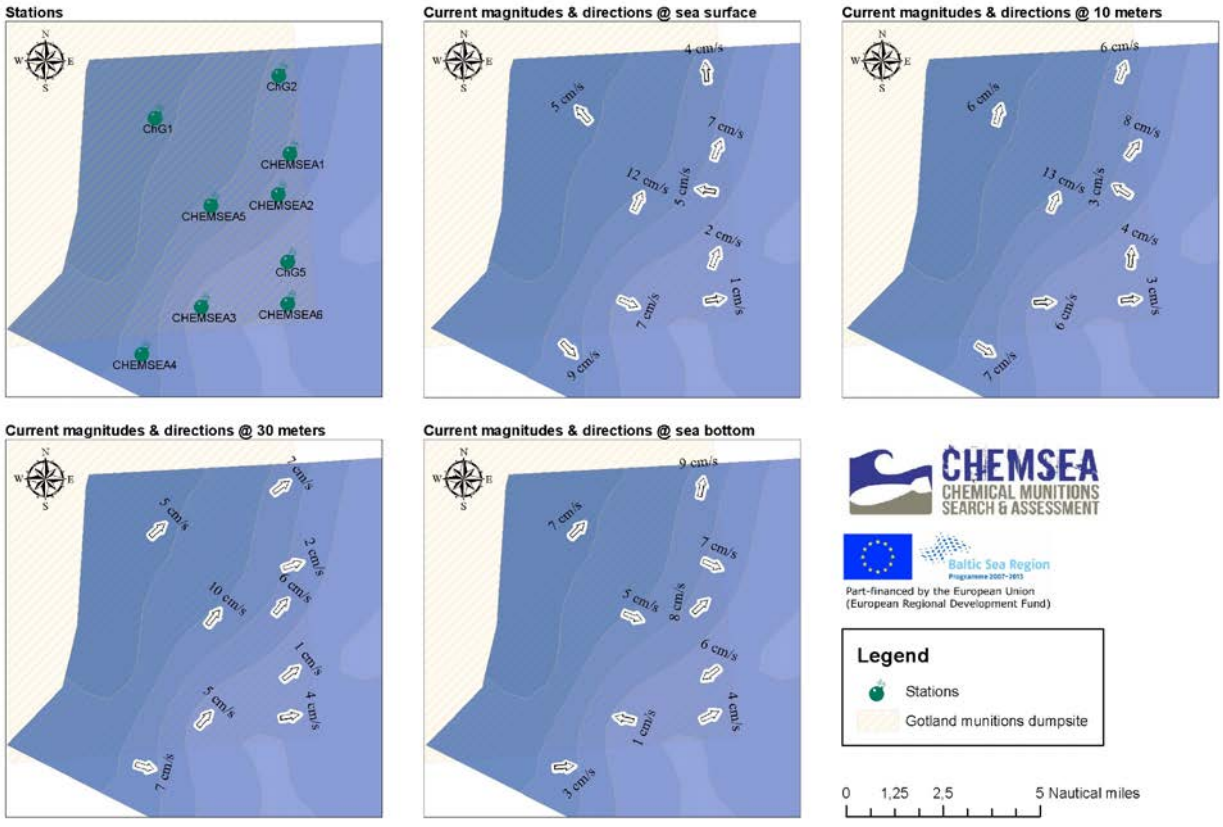

Fig. 7. Averaged current magnitudes and directions

3.2. Water and sediment sampling

Water samples were taken during CHEMSEA expedition in April 2013, were analysed later in laboratory for hydrogen sulphide determination, analysed by colorimetric method. The hydrogen sulphide was found in the sample taken from CHEMSEA3 station (E19°11,130'; N55°58,860') – 0,01 mg/l.

The sediment samples for arsenic and chemical warfare agents' analysis were collected during cruise of the scientific R/V "Vėjūnas" in April 2013 (Fig. 2). Sampling stations at the dumpsite were chosen near I class objects according to side scan sonar data obtained from screening the seabed by Swedish Maritime Administration (SMA). Sampling stations were also planned according to the results of previous research of the dumpsite in 2003.

Sediment samples for arsenic and chemical warfare agents were collected using Van – Veen grab sampler (75 kg, with a sampling area of 0.1 m^2). Sediments from the top 3-5 cm thickness were sub-sampled and frozen immediately onboard (about -20°C). Every sediment sample was checked using portable ChemPro100i detector for the presence of chemical warfare agents (CWA) and other hazardous substances (Fig. 4). In April 2013 sediments for arsenic analysis were sampled at 11 stations (all except ChG1). Sediment samples for chemical warfare agent's analysis were taken at 6 stations: ChG2, CHEMSEA1, CHEMSEA2, CHEMSEA3, CHEMSEA4 and CHEMSEA5.

Later in August and November 2013 more sediment samples were taken for arsenic analysis (Fig.3). The aim of the sampling was - to search unofficial chemical munitions dumping sites in the Lithuanian waters. 10 sediment samples for arsenic analysis were taken during this cruise.

3.3. Macrozoobenthos sampling

Total 23 samples of the macrozoobenthos were taken during the expedition on April 26 – 27 of 2013.

Ship-board routines SAMPLING, SIEVING and FIXATION of the macrozoobenthos samples were done according LST EN ISO 9391:2000; Manual for Marine Monitoring in the COMBINE Programme of HELCOM. Annex C-8. Soft bottom macrozoobenthos.

- **SAMPLING** – Van-Veen grab (75 kg, 0.1 m^2);
- **SIEVING** – sieve 0,5 x 0,5 mm mesh size;
- **FIXATION** – 4 % formaldehyde solution (1 part 40% formaldehyde solution and 9 parts water).

Table 3. Results of macrozoobenthos sampling

Station	Depth, m	Sampler Nb.	Sediment
65	47	1	very fine sand (95 %), detritus (5 %)
		2	
		3	
66	55	1	black mud (100 %)
		2	
CHEMSEA1	87	1	black mud (80 %), gravel (20 %), smell H_2S
		2	
		3	
ChG2	106	1	clay (80 %), mud (20 %), orange colored interlayer
		2	clay (40 %), mud (60 %), smell H_2S
CHEMSEA2	90	1	gravel (100 %), smell H_2S
		2	black mud (50 %), medium sand (50 %), smell H_2S
		3	black mud (80 %), medium sand (20 %), smell H_2S
CHEMSEA5	101	1	clay (95 %), mud (5 %)
		2	black mud (90 %), gravel (10 %), smell H_2S
ChG5	83	1	black mud (90 %), gravel (10 %), smell H_2S
CHEMSEA3	85	1	coarse sand (80 %), gravel (20 %)
		2	black mud (100 %), smell H_2S
		3	black mud (80 %), gravel (20 %), smell H_2S
CHEMSEA4	103	1	clay (40 %), black mud (60 %), smell H_2S
		2	
		3	
CHEMSEA6	78	1	clay (50 %), mud (40 %), gravel (10 %)