Sediments and Dredging in the Baltic Sea Region Ports

Survey

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SUMMARY

Ports constitute a very important economic activity in the Baltic Sea Region (BSR). The amounts of goods and numbers of passengers are expected to increase significantly the upcoming years. Thus port infrastructure is needed to be maintained or developed including dredging and associated services. In order to get a broad view of the situations in the Baltic Sea ports for the upcoming 10 years, the PortInfrastructure (Port Infrastructure) Network and SMOCS (Sustainable Management of Contaminated Sediments) Network initiated this study. The project aimed to show future dredging operation and infrastructure development plans at the Baltic Sea ports to assess the requirements and challenges concerning the fulfilment of the plans. The survey was performed using a so called “Stakeholder Opinion Assessment” (SOA) with milestones such as: selection of ports, providing questionnaire and telephone interviewing, reporting and submission for comment and final reporting and dissemination. All in all 43 ports out of 125 in 8 countries around the Baltic Sea were contacted and 21 of them participated in the interview study covering 45 % of the total cargo handling volume.

Results show a majority of the ports plan to do dredging in next 1-5 or 6-10 years with the aim of maintaining or increasing the water depth, construction works or expansion of the port area. The fulfillment of all these plans depends on the financial situation. The respondents have presented different handling options of dredged sediments, which sea disposal of clean dredged sediments are frequently used. Some ports dispose dredged sediments in the landfills. Contaminated dredged sediments are occasionally used for construction purposes by the so-called stabilization and solidification technology. The study indicates that by making conservative assumptions, about 5-8 million m$^3$ of contaminated sediments could be expected to be dredged the upcoming years in 125 BSR ports. This is in conjunction with the expected amount of contaminated sediments to be dredged in Swedish ports as reported by SMOCS 2012. The following possibilities and challenges are proposed to be elaborated in the further:

- Permitting procedures; some ports have problem with getting permission according to the environmental legislations. In some cases this has caused delay in performance of their plans
- Investigating of sediments and contaminated sediments; according to the previous experience ports will obtain more amounts of contaminated sediments after they starts investigating more precisely.
- Technologies for management; the existing practices and technologies in some cases are needed to be assessed and improved sustainably
- Networking; although there is a high knowledge on many specific subjects in the ports, there seems to be a lack of an established forum for exchanging knowledge and experience, thus respondents expressed an interest to participate in knowledge exchange activities.

All in all, this study shows that the expected amounts of dredged sediments in the Baltic Sea are significant both to volume and cost. The cost for handling of the expected amount of contaminated sediments in confined disposal (upland) is more than 1000 million euro that is a significant amount. Therefore there is a need to utilize and develop technologies that can support management on land or into the sea. Besides, there is a need to establish a platform for exchanging experiences and knowledge.

Key words: Sediments, dredging, SMOCS, PortInfra, Stabilization/Solidification
ABBREVIATIONS

**SMOCS**- Sustainable Management of Contaminated Sediments

**PortInfra**- Port Infrastructure

**BSR**- Baltic Sea Region

**s/s**- Stabilization/Solidification

**SOA**- Stakeholder Opinion Assessment

**Mton**- Million ton
PREFACE

The project has aimed to assess the future dredging operation and infrastructure development plans at the Baltic Sea ports to assess the challenges and requirements concerning the fulfillment of the plans. It has been done within the framework of the project SMOCS and PortInfra Network initiated by the Swedish Geotechnical Institute and Luleå University of Technology in cooperation with the ports in the Baltic Sea Region. The project has been carried out through a so-called Stakeholder Opinion Assessment (SOA) methodology. This report contains a survey on Baltic Sea Ports that have been assessed in terms of future plans as well as challenges concerning sediments, contamination and handling of the dredged sediments.

I would like to express my sincere gratitude to my co-workers Åsa Erlandsson and Bo Svedberg who have guided me through the whole process of the survey.

Marjan Mousavi
November 2013
CONTENTS

1. Introduction .............................................................................................................. 7
  1.1 Background ........................................................................................................... 7
  1.2 Goal and scope of the project .............................................................................. 7
  1.3 Methodology and approach .................................................................................. 8
    1.3.1 Creating an inventory of the Baltic Sea ports to be interviewed .................. 8
    1.3.2 Creating the questionnaire .......................................................................... 10
    1.3.3 Telephone interviewing ................................................................................ 10

2. Literature review ..................................................................................................... 11
  2.1 Baltic Sea Region Ports ......................................................................................... 11
  2.2 Port authority ....................................................................................................... 11
  2.3 Baltic Ports Organization (BPO) ......................................................................... 11
  2.4 International Maritime Organization (IMO) ....................................................... 12
  2.5 SMOCS ................................................................................................................ 12
  2.6 PortInfra Network ............................................................................................... 13
  2.7 Inventory of Swedish ports on dredging and infrastructure development ....... 13
  2.8 Sediments and dredging ..................................................................................... 13
    2.8.1 The sedimentation process .......................................................................... 13
    2.8.2 Dredging ....................................................................................................... 14
    2.8.3 Handling options for dredged sediments .................................................... 14
    2.8.4 Stabilization/Solidification (s/s) technology ................................................. 14

3. Results and analysis ................................................................................................. 16
  3.1 Cargo handling volume ........................................................................................ 16
  3.2 Future plans for infrastructure development ....................................................... 16
  3.3 Future plans for dredging operations ................................................................... 17
  3.4 Sediments and contamination ............................................................................ 18
  3.5 Different handling alternatives of dredged sediments ....................................... 19
  3.6 Expanding the results to all BSR ports ............................................................... 20
  3.7 Contaminated sediments in the BSR ports ......................................................... 21
  3.8 Economics and handling options of BSR ports ................................................ 23

4. Discussion .................................................................................................................. 25
  4.1 Future plans in the BSR ports .............................................................................. 25
  4.2 Total amounts of contaminated dredged sediments in the BSR ports .............. 25
  4.3 Technology and economics ................................................................................. 26
  4.4 Permitting procedure for dredging and handling of the dredged sediments. .... 26
  4.5 Knowledge transfer ............................................................................................. 27
  4.6 Used methodology .............................................................................................. 27

5. Conclusion ............................................................................................................... 29
6. Reference ........................................................................................................................................... 30
Appendix .................................................................................................................................................. 31
  Appendix A- Baltic Port List 2006 ........................................................................................................... 31
  Appendix B. Questionnaire ......................................................................................................................... 35
  Appendix C- Port authority .......................................................................................................................... 37
  Appendix D- International Maritime Organization (IMO) ................................................................. 38
1. INTRODUCTION

1.1 Background

Ports play an important role in handling of goods and transportation of the passengers in the Baltic Sea Region. To maintain the function of a port and to face future challenges, such as heavier cargo and bigger boats, both maintenance and expanding actions are needed.

In 2005, 2009 and 2012 different surveys were done on Swedish ports with the main focus on dredging and infrastructure development plans. The results indicated that many ports were planning extensive infrastructure operations. The ports also highlighted issues related to dredging, sediment management and dimensions of port constructions. The Scandinavian project Stabcon, the EU-project SMOCS and the Port-Infra network were initiated to deal with issues related to port constructions and sediment handling. This was the basis for also exploring the Baltic Sea ports’ infrastructure plans and needs, focusing on dredging and sediment management.

1.2 Goal and scope of the project

The project aims to show future dredging operation and infrastructure development plans at the Baltic Sea ports in order to assess the challenges concerning sediments, handling of dredged sediments and fulfillment of all the plans.

An additional outcome is to introduce SMOCS guidelines and the PortInfra Network to participant organizations.

All these issues are explored within the next 1-5 and 6-10 years. Figure 1 shows 8 countries around the Baltic Sea which are included in this project.

![Figure 1- Red dots show 8 countries around the Baltic Sea that are included in the project.](image-url)
1.3 Methodology and approach

This project has been done within the framework of the project SMOCS and PortInfra Network initiated by the Swedish Geotechnical Institute and Luleå University of Technology. The methodologies used in this project are literature review and Stakeholder Opinion Assessment (SOA).

The literature review contains:

- Port organizations and cooperation and platform projects for the ports
- Sediments and dredging

Stakeholder Opinion Assessment (SOA) (Frostell, 2005) is briefly described as a combination of survey and in-depth interview. The SOA is performed to get a broad view of the ports’ dredging operations and infrastructure development situations. The SOA consists of the following phases:

1. Creating an inventory of the Baltic Sea ports to be interviewed
2. Creating a questionnaire containing less than 20 questions concerning ports’ future requirements and plans related to dredging and infrastructure development
3. Telephone interviewing for about 30 minutes with key players responsible at the BSR ports;
4. Compilation and analysis of the results of the survey
5. Sending the collected results to the respondent ports, so the stakeholders are able to express their comments and ideas and influence on the final report
6. Sharing the results and knowledge at the workshop/seminars where all the respondents will be invited to in spring/summer of 2014

Steps 1, 2, and 3 are described in detail as follows.

1.3.1 Creating an inventory of the Baltic Sea ports to be interviewed

Different parameters were taken into account in order to provide an inventory of the BSR ports. First the total number of the Baltic Sea ports was collected according to Baltic Port List 2006 (Saurama, et al., 2008) for each country included in this project, and sorted according to the total volume of cargo handling in ton (see Table a in Appendix A). Then an initial list of the ports that constitute 70 – 90 % of the total volume of cargo handling was created in each country. Top 20 ports around the Baltic Sea by the total cargo handling volume and total number of passengers were shown by Saurama, et al. (2008), so if the ports included in the initial list were among top 20 ports was taken into account (see Appendix A). Finally 21 ports have participated in the inventory of the Baltic Sea and interview study. Nevertheless, 43 ports around the Baltic Sea were got in contact. Table 1 shows all 43 contacted ports and 21 ports that participated in the interview study. Table 1 has been created according to Table a in Appendix A. In Table 1 [dk] stands for Denmark, [ee] for Estonia, [fi] for Finland, [de] for Germany, [lv] for Latvia, [lt] for Lithuania, [pl] for Poland and [ru] for Russia.
Table 1 - Baltic Sea ports, their cargo volume, contacted in the survey and responding in the inventory (source Saurama, et al., 2008).

<table>
<thead>
<tr>
<th>Port</th>
<th>Cargo handling volume (ton) in 2006</th>
<th>43 contacted ports in the survey</th>
<th>21 respondent ports in the inventory</th>
</tr>
</thead>
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<tr>
<td>Fredericia [dk]</td>
<td>16108000</td>
<td>X</td>
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<td>Aarhus [dk]</td>
<td>11913000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Statoil-haven [dk]</td>
<td>7573000</td>
<td>X</td>
<td></td>
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<tr>
<td>Copenhagen [dk]</td>
<td>6896000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rødy Færgehavn [dk]</td>
<td>5755000</td>
<td>X</td>
<td></td>
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<tr>
<td>Enstedværket [dk]</td>
<td>5734000</td>
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<td></td>
</tr>
<tr>
<td>Elsinore (Helsingør) [dk]</td>
<td>4442000</td>
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<td></td>
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<td>Kalundborg [dk]</td>
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<td></td>
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<td>Aalborg Portland [dk]</td>
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<td>Sillamäe [ee]</td>
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<td>Helsinki [fi]</td>
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<td>X</td>
<td>X</td>
</tr>
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<td>Kotka¹ [fi]</td>
<td>9 577 000</td>
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</tr>
<tr>
<td>Naantali [fi]</td>
<td>7 147 000</td>
<td>X</td>
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<tr>
<td>Rauma [fi]</td>
<td>6 595 000</td>
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<td>X</td>
</tr>
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<td>Raade [fi]</td>
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<tr>
<td>Pori [fi]</td>
<td>5 781 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Kokkola [fi]</td>
<td>5 323 000</td>
<td>X</td>
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<tr>
<td>Hamina¹ [fi]</td>
<td>5 181 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hanko [fi]</td>
<td>4 151 000</td>
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<td></td>
</tr>
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<td>Turku [fi]</td>
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<td>X</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Kemi [fi]</td>
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<td></td>
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<tr>
<td>Lübeck [de]</td>
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<td>X</td>
</tr>
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<td>Rostock [de]</td>
<td>19 058 000</td>
<td>X</td>
<td>X</td>
</tr>
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<td>Puttgarden/Fehmarn [de]</td>
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<td>X</td>
<td></td>
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<td>Wismar [de]</td>
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<td>X</td>
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<td>Kiel [de]</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sassnitz [de]</td>
<td>2 663 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ventspils [lv]</td>
<td>29 062 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Riga [lv]</td>
<td>25 358 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Liepaja [lv]</td>
<td>4 001 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Klaipeda [lt]</td>
<td>23 611 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gdansk [Pl]</td>
<td>24 207 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gdynia [Pl]</td>
<td>14 183 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Szczecin² [Pl]</td>
<td>9 965 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Swinoujscie² [Pl]</td>
<td>9 242 000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Primorsk [ru]</td>
<td>66 078 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>St. Petersburg [ru]</td>
<td>54 230 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Kaliningrad [ru]</td>
<td>15 225 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Vysotsk [ru]</td>
<td>13 811 000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ust-Luga [ru]</td>
<td>3 766 000</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

¹ The Port of Hamina and the Port of Kotka have lately merged together and since 1st of May 2011 they have been operating as the Port of HaminaKotka. So in this report, it has been mentioned as HaminaKotka Port.

² Port of Szczecin and port of Swinoujscie have one administration and in fact they are considered as one port, but the statistics can be presented separately. So in this report it has been mentioned as Szczecin-Swinoujscie Port.
According to Table a in Appendix A and Table 1, 21 ports included in the inventory account for 45% of the total cargo handled in all the ports located in the Baltic Sea Region. Figure 2 shows the contribution of the cargo handling volume in the ports included in the inventory in each country (according to Table a in Appendix A).

![Figure 2. The contribution of the cargo handling volume in the ports included in the inventory compared to the total volume in each country, (see Table a in Appendix A).](image)

1.3.2 Creating the questionnaire

The questionnaire contains ports’ future needs and plans linked to expansion in a regional level and dredging operations. Moreover, it covers the main issues that ports have concerning the objectives of SMOCS and PortInfra Network. The questionnaire was sent to the ports before telephone interviewing. It is found in Appendix B.

1.3.3 Telephone interviewing

The questions were answered orally on the phone by most of the ports included in the inventory, just a few of them answered by email. Telephone interviewing took about 30 minutes with the key players who were working mainly in environmental, infrastructure and technical departments with more than 11 years of experience. They did not need to report the exact data; estimation was enough for this purpose.
2. LITERATURE REVIEW
Some studies were undertaken in order to get an insight into the ports around the Baltic Sea Region in general, port authority, port organizations both in Baltic Sea and international levels, sedimentation process, dredging and aims and outputs of SMOCS project. They are found in detail in following sections.

2.1 Baltic Sea Region Ports
The Baltic Sea provides many services to its surrounding societies. The sea provides food, raw materials, energy and transport routes, as well as is a source of recreational values, cultural heritages, science and education. Unfortunately the Baltic Sea is one of the world’s most contaminated seas due to the inputs of chemicals, nutrients and human-induced ecosystem changes. Therefore, it is crucial to strike the balance and use the sea in a sustainable way, in order to safeguard a healthy Baltic Sea and prosperous region – not the least for the benefit of future generations.

The Baltic Sea borders to nine countries and over 200 ports are located around the Baltic Sea. When those ports that handle minimum of 50,000 tons of cargo annually, and where at least part of this cargo is international, are taken into account the number of ports reaches approximately to 190 (Rozmarynowska and Oldakowski, n.d.).

2.2 Port authority
Ports usually have a governing body referred to as the port authority, port management, or port administration. Port authority is used widely to indicate any of these three terms.

The term port authority has been defined in various ways. In 1977, a commission of the European Union (EU) defined a port authority as a state, municipal, public, or private body, which is largely responsible for the tasks of construction, administration and sometimes the operation of port facilities and, in certain circumstances, for security. This definition is sufficiently broad to accommodate the various port management models existing within the EU and elsewhere.

Ports authorities may be established at all levels of government: national, regional, provincial, or local. The most common form is a local port authority, an authority administering only one port area.

There are four different port management models: public service port, tool port, landlord port and private service port (PPIAF, 2013) (more detail can be found in Appendix C).

2.3 Baltic Ports Organization (BPO)
Baltic Ports Organization (BPO) is a networking organization for Baltic Sea ports and port operators. Forty or more of the most significant ports in the nine countries on all sides of the Baltic Sea are included in BPO. The organization was established October 10, 1991 in Copenhagen to facilitate co-operation between the ports and to take care of the possibilities for shipping in the Baltic Sea region. In other words, ports located in the area around the Baltic Sea are working together to improve the competitiveness of maritime transport in the Baltic region.

The main objective of BPO is to improve the competitiveness of maritime transport in the Baltic region by increasing the efficiency of ports, marketing the Baltic region as the strategic logistics center, improving the infrastructure within the ports and the connection to other modes.

Moreover, it aims to improve co-operation with the port users/operators, apply new technology in the port sector in order to improve the performance and the integration of ports into the transport chain, improve cost efficiency, good environmental behavior, organizational development, co-operation with authorities and interest groups. Table 2 shows ports around the Baltic Sea which are members of BPO (BPO, 2013).
### 2.4 International Maritime Organization (IMO)

It has always been recognized that the best way of improving safety at sea is by developing international regulations that are followed by all shipping nations and from the mid-19th century onwards a number of such agreements were adopted. Several countries proposed that a permanent international body should be established to promote maritime safety more efficiently. In 1948 an international conference in Geneva adopted a convention formally establishing IMO (the original name was the Inter-Governmental Maritime Consultative Organization, or IMCO, but the name was changed to IMO in 1982).

The International Maritime Organization (IMO) is a specialized agency of the United Nations which is responsible for measures to improve the safety and security of international shipping through cooperation and to prevent marine pollution from ships. It is also involved in legal matters, including liability and compensation issues and the facilitation of international maritime traffic. IMO also has an extensive technical cooperation program which concentrates on improving the ability of developing countries to help themselves.

IMO was established to adopt legislations. Governments are responsible for implementing legislations. When a government accepts an IMO convention it agrees to make it a part of its own national law and to enforce it just like other laws.

There are three different types of membership in IMO: member states, nongovernmental organizations (NGOs) and intergovernmental organizations (IGOs) (IMO, 2013), (more detail can be found in Appendix D).

### 2.5 SMOCS

Along the coastal area of the Baltic Sea, sediments are often contaminated with hazardous substances due to industrial activities, which have a serious impact to the environment. How to handle the contaminated sediments is the major problem.

In order to make dredging activities more sustainable and find joint solutions, a strong and durable cooperation between stakeholders, such as ports, maritime organizations, environmental authorities and construction industries is required. The European project SMOCS (Sustainable Management of Contaminated Sediments in Baltic Sea Region) was established in late 2009. It aims to find cheap additional methods to handle and treat contaminated sediments. SMOCS also aims to enlarge beneficial use of dredged materials as well as develop guidelines and tools to assess sustainability in decision making.
In the project SMOCS the advantage of sustainable handling of contaminated sediments is addressed with the overall aim to support sustainable actions all around the Baltic Sea. SMOCS is a complement to the HELCOM (see section 2.4.3.1) guidelines on sea disposal of dredged sediments. It has partners in Sweden, Finland, Poland, Lithuania and Germany. But the leader partner is Swedish Geotechnical Institute.

The main deliverables of SMOCS comprise a guideline, including tools for assessment of sustainability and decision support. It will especially address current and emerging technologies including verifications of these investigation and treatment technologies. The guideline will cover the whole process from planning to execution and control of treatment of dredged sediments (SMOCS, 2013).

### 2.6 PortInfra Network

The Project PortInfra is about infrastructure development in Ports in the Baltic Sea Regions. The aim is to support a sustainable development of port infrastructure as well as to increase knowledge transfer and cooperation within the BSR ports. The Project was presented at the GESeD congress in Caen, France, 10-12 April 2013. The partner countries involved in this project are Lithuania, Poland and Sweden (PortInfra, 2013).

### 2.7 Inventory of Swedish ports on dredging and infrastructure development

In 2005 and 2009 survey studies were done in Sweden to provide an inventory of the largest Swedish ports that required dredging.

In late 2009 the European project sustainable management of contaminated sediments (SMOCS) was established to develop more sustainable sediment management (e.g. dredging and handling of the dredged sediments) as well as guidelines and tools to assess sustainability in decision making.

Therefore ports found out, dumping the dredged materials into the sea was no longer viable and also they gained the knowledge of Stabilization/Solidification method for handling of the contaminated sediments.

Afterward in 2012, ports had problem with handling of the clean sediments, besides the problem with handling of the contaminated sediments. Therefore in 2012, an inventory of the Swedish ports was updated in order to specify ports’ dredging or infrastructure development requirements in future. The project was done by providing a questionnaire and telephone interviewing, which was called as Stakeholder Opinion Assessment (SOA). 31 Swedish ports were included in the inventory and interview study. The selection was based on the previous interview studies.

The questionnaire contained questions about the port operations, port facilities and dredging.

According to the results of the project done in 2012, the ports included in the inventory were interested in taking part in the survey. They had done more researches on contaminated sediments. So the amount of contaminated sediments was reported much more than what they had presented in previous surveys. Moreover, dredging and handling of the dredged sediments were still important issues at the ports.

### 2.8 Sediments and dredging

#### 2.8.1 The sedimentation process

Rivers and seas carry suspended sand and soil along with them as they flow toward the ocean. The higher the water velocity, the greater are the speed of the water, its energy and capacity to move soil, sand and even rocks. When the velocity of the water decreases, it loses energy and the non-floating materials drop to the bottom of the river channel. Materials that fall to the bottom of a liquid are called sediments.

There are different types of sediments clay, silt, sand, gravel, etc. As stream or river velocity slows, heavier materials, like sand and gravel, will settle out first. In still water, harbors and backwater areas silts and
clays will settle out. If enough sediments deposits to build a shallow spot on the river or ocean bottom, it forms shoals. A shoal in a navigation channel that causes the bottom to become shallower than is shown on nautical charts is a safety hazard. If a vessel grounds or strikes the shoal, the vessel and its content may be damaged. In serious situations, the environment can be damaged if the ship’s cargo is spilled into the waterway. Therefore, dredging of sediments is usually required.

2.8.2 Dredging
Under water excavation is called dredging. Dredging of sediments is sometimes required in order to maintain depth of the ports or excavate the contaminated sediments. In addition, dredging is essential to maintain navigation in ports and harbors as well as for the development of port facilities (Helsinki Commission, 2007).

There are different types of dredging with different purposes:

- a. Capital dredging – for navigation, to enlarge or deepen the existing channel and port areas or to create new ones;
- b. Maintenance dredging – to ensure that channels, berths or construction works are maintained at their designed dimensions. In addition to maintain the depth of the port;
- c. Clean-up dredging – deliberate removal of contaminated material from the marine environment for human health and environmental protection purposes.

There are different methods to handle dredged sediments, that in some cases beneficial use of dredged sediments is preferred rather than disposal. Using dredged sediments in road construction, using dewatered silt to cover disposal sites, filling harbor basins and mines etc. are some examples of beneficial use of dredged sediments.

2.8.3 Handling options for dredged sediments
There are different processes and locations to handle and manage the clean and contaminated dredged sediments. Generally handling option is a chain of different activities through dredging, transport, treatment and final location. The final location can be of beneficial type or disposal type.

Figure 3 shows different handling options for dredged sediments, both beneficial type and disposal type.

2.8.4 Stabilization/Solidification (s/s) technology
Locating contaminated sediments on landfills is very costly and disposal at sea is often not possible due to environmental restrictions. However emerging treatment technologies make it possible to consider beneficial use of contaminated sediments. One such method, Stabilization/Solidification, can improve technical
properties and reduce environmental impact thus enabling beneficial use of contaminated sediments as construction material saving cost and natural resources.

Stabilization/solidification (s/s) is a remediation technology that relies on the reaction between a binder and soil to reduce the mobility of contaminants.

The mixture of reagents and additives used for s/s technology is commonly referred to as the binder, and can range from a single reagent to a multi-component system. Hydraulic binders (e.g. cement) react with water to form solid materials and are the dominant binders in use.

Stabilization – involves the addition of reagents to the contaminated sediments to produce more chemically stable constituents; and solidification – involves the addition of reagents to the contaminated sediments to improve physical/dimensional stability to contain contaminants in a solid product and reduce access by external agents (e.g. air, rainfall) (Bone, et al., n.d.).
3. RESULTS AND ANALYSIS

In this chapter, results of the interview study including cargo handling volume at the ports, future plans for infrastructure development and dredging operations, sediments and contamination as well as handling methods of dredged sediments have been represented and analyzed.

3.1 Cargo handling volume

In order to get an overview of how large a port is, based on the total volume of cargo handling (ton/year) the following question was asked: How many tons of cargo are handled yearly?

Figure 4 shows the comparison between cargo handling volume in 2006 and that of in 2012 in the ports included in the inventory. (Note: the respondent ports presented the amount of cargo handling volume for the year 2012)

![Figure 4. The comparison between the total volume of cargo handling in 2006 (Saurama, et al., 2008) and that of in 2012 in 21 ports included in the inventory (Mton/year).](image)

In general the total amount of cargo handling volume has increased since 2006 in the ports included in the inventory by 10%. There has been a slight increase in cargo handling volume in most of the ports for different reasons, such as they have been developing their services all the time, improving new lines to other ports, etc. Whereas in a few ports cargo handling has decreased since 2006, mainly because of the economic crisis. Global financial problems have caused the import and export of the goods to decrease, which in turn have caused decreasing in cargo handling volume.

3.2 Future plans for infrastructure development

One of the main aims of this survey was to ask the ports included in the inventory if they had any future plans related to expansion of the port infrastructure in next 1-5 or 6-10 years. There are different purposes behind the expansion plan, such as building a new quay, increasing the cargo handling volume, expanding the port area, moving to the new location, changing the vessel type, etc. Figure 5 shows numbers of the ports that have different expansion plans in next 1-5 years and 6-10 years.
According to the interview study and Figure 5, most of the ports have different infrastructure development plans in next 1-5 years. As is obvious, most ports plan to build a new quay, increase the cargo handling volume and expand the port area.

While some of the ports have no expansion plans, due to the different reasons, such as no need of expansion, lack of enough space to expand, financial problems, not being sure about the future plans, etc. However, the fulfillment of all these plans mostly depends on the financial situations that will exist at the ports in the future.

According to the interview study, some ports have the same plans during the next 6-10 years as they do during the next 1-5 years, since some plans will continue till the next 10 years. Whereas there are more ports that have no expansion plans in next 6-10 years compared to the next 1-5 years (see Figure 5), the main reason can be being less sure about the situations that may exist at that time.

More than 50% of the ports included in the inventory, plan to expand both on land and in the sea in next 5 or 10 years. While about 40% of the ports plan to expand only in the sea and the rest plan to expand only on land.

### 3.3 Future plans for dredging operations

The other main purpose of this survey was to show ports’ dredging operation plans in next 1-5 or 6-10 years. Therefore the respondent ports were asked to present if they plan to do any types of dredging actions in the future, such as: capital dredging, maintenance dredging and clean-up dredging.

Figure 6 and Figure 7 show numbers of the ports that plan to do different types of dredging in next 1-5 or 6-10 years respectively.
According to the results of the interview study and Figure 6 and Figure 7, almost all the ports included in the inventory plan to do dredging actions in next 1-5 or 6-10 years. The requirements of the dredging actions are mainly connected to the infrastructure development plans that ports have in next 5 or 10 years. They usually need to do capital dredging since they plan to deepen the depth of the port or/and do construction works.

In addition, results show that maintenance dredging is performed in most ports regularly every few years to maintain the depth of the port. Ports do not have clean-up dredging plans so often.

As shown in Figure 6 and Figure 7, a few ports do not plan to do any types of dredging in next 5 or 10 years mainly because the depth of the ports is enough or they do not have proper financial situation.

### 3.4 Sediments and contamination

There are different types of sediments at the ports included in the inventory, such as silt, clay, sand, gravel, etc., but sediments are mainly the mixture of sand, clay and silt at the ports.
In addition, there are different types of contamination at the ports included in the inventory, which some of the ports are aware of and some are not. While there are some other ports that do not have any contaminated sediments. The respondent ports reported different types of contamination such as, TBT, dioxin, mercury, copper, zinc aromatic hydrocarbons, HOS etc.

Figure 8 shows proportion of the ports that presented the existence of contamination, no contamination or no answer.

![Figure 8 - The proportion of the ports that have knowledge on contamination situation at the ports in next 1-10 years](image)

Some of the interviewed ports did not have any quantitative information about the total dredged sediments or contaminated sediments. The ports usually do yearly research concerning sediments and contamination in sediments, therefore there may be some data, which they do not know yet.

As is obvious from Figure 8, 43% of the interview ports have to dredge contaminated sediments in next 1-10 years. The average amount of contaminated sediments is about 0.24 million m³.

### 3.5 Different handling alternatives of dredged sediments

Dredging and handling of the dredged sediments have impacts upon the environment. Therefore Sediment management generally requires permission, which needs to be founded on sound and reliable information of the handling option.

Dredged sediments are handled and managed differently at the ports based on the types of sediments and contamination.

Most of the ports included in the inventory dump clean dredged sediments into the sea. The other handling method that is quite common among the interviewed ports is disposal of the dredged sediments in the landfills. Ports mainly dispose the contaminated sediments in the landfills. Some ports bring the dredged sediments to the land for filling some parts of the land. They used dredged sediments in deeper layer and fill top of them with better building materials.

While other dispose the dredged sediments into the landfill in order to do construction on top of them. Dredged sediments need to be either treated or stabilized/solidified in order to be able to do construction on top of them.
Some ports use the dredged sediments as construction materials, whereas there are some ports that cannot use dredged materials as construction materials, since they are very organic and difficult to be compressed.

A few ports stabilize dredged sediments by cement or other similar materials in order to use the sediments beneficially.

### 3.6 Expanding the results to all BSR ports

According to Baltic Port List 2006 (Saurama, et al., 2008), 43 ports were selected mostly among the largest ports to be contacted. They accounted for 90% of the total cargo handled in BSR ports in 8 countries around the Baltic Sea in 2006. 21 ports included in the inventory and interview study covered 45% of the total. As shown in Figure 9 and Figure 10, the distribution of the cargo handling volume in 20 ports included in the inventory is from more than 2.6 Mton to 41 Mton, with the total amount of about 273 Mton and average of 12 Mton. Just one of the ports included in the inventory has less than 2.6 Mton of cargo handling. The remainder contacted ports (22 ports) have also more than 2.6 Mton of cargo handling, with almost the same total amount of cargo handling volume as the ports included in the inventory, 277 Mton, and exactly the same average amounts of cargo handling volume, 12 Mton. Therefore it can be assumed that the results of the interview can be generalized about almost all these 22 ports. Consequently, it is expected that most of these ports have different future plans regarding developing their port infrastructure and increasing the economic activities. Thus they may have to prepare the conditions to fulfill their plans.

If it is assumed that at least half of these 22 ports have any of the mentioned expansion plans (building the new quay, increasing the cargo handling volume, expanding the port area, etc.) in the future, it is expected that about 24 ports out of 43 ports may have different expansion plans in total. Moreover, if it is assumed that more than half of the aforementioned 22 ports plan to do any types of dredging actions in the future, in total about 30 ports out of 43 ports may plan to do dredging operations.

Besides these 43 ports, there are 80 ports left that are small based on the amount of cargo handling volume. As shown in Figure 9, the distribution of the cargo handling volume in these 80 ports is from 0.06 Mton to less than 2.6 Mton. The total amount of cargo handling in 125 BSR ports is 607 Mton that of this 10% is handled in these ports (see Table a in Appendix A). Accordingly, it is much trickier for these ports to make an assumption related to their development plans in the future, because they might have or not have been developed since 2006. One of the ports included in the inventory had less than 2.6 Mton of cargo handling volume in 2006 (see figure 9), but since 2006 the cargo handling volume has increased considerably in this port. If assumption for the future plans of these 80 ports is made according to this one small port included in the inventory, it is possible that at least one fourth of the ports have been increasing cargo handling since 2006. Consequently, expansions or dredging operations has been already performed or will be performed in the future. Therefore, there may be a large amount of sediments to be handled and managed at these ports.

Figure 9 shows the distribution of the cargo handling volume in the ports included in the inventory compared to that of in the rest of the Baltic Sea ports. In addition Figure 10 shows the total cargo handling volume in the interviewed and non-interviewed ports.

(Note: Port of Hamina and Kotka operated separately according to Baltic Port List 2006 (see Table 1), but now they are operating together as port of HaminaKotka. In addition, port of Szczecin and port of Swinoujscie have one administration and in fact they are considered as one port, Szczecin-Swinoujscie Port, but the statistics can be presented separately. Consequently, interviewed ports has been considered as 21 instead of 23 ports.).
Figure 9- The distribution of the cargo handling volume in the ports included in and excluded from the inventory according to Baltic Port List 2006, (Saurama, et al., 2008)

Figure 10- The total volume of cargo handling in the interviewed and non-interviewed ports according to Baltic Sea ports 2006, (Saurama, et al., 2008)

3.7 Contaminated sediments in the BSR ports

43% of the ports included in the inventory reported the existence of contaminated sediments in next 1-5 or 6-10 years. 33% of the ports reported no amounts of contaminated sediments, and the rest was not
sure about the existence or nonexistence of the contaminated sediments (see section 3.4). The average amount of contaminated sediments in the interviewed ports in next 1-10 years is about 0.24 million m³.

Accordingly, in this section three different methods have been proposed to estimate the total amount of contaminated sediments in 125 BSR ports in next 1-10 years (see Figure 11). They are also discussed in detail as follows.

**Estimation 1**

Total contaminated dredged sediments in 43% of 43 BSR ports (with >2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.24 million m³

Total contaminated dredged sediments in 10% of 80 BSR ports (with <2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.024 million m³

**Estimation 2**

Total contaminated dredged sediments in 67% of 43 BSR ports (with >2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.24 million m³

Total contaminated dredged sediments in 15% of 80 BSR ports (with <2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.024 million m³

**Estimation 3** (The same pattern as the inventory of the Swedish ports)

Total contaminated dredged sediments in 62% of 43 BSR ports (with >2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.2 million m³

Total contaminated dredged sediments in 30% of 80 BSR ports (with <2.6 Mton of cargo)
Average amount of contaminated sediments is equal to 0.1 million m³

Figure 11: Three proposed methods of estimating the total contaminated sediments in the BSR ports in next 1-10 years

**Estimation 1**

According to what has been discussed in section 3.6, 22 non-interview ports are similar to the ports included in the inventory in terms of the total, distribution and average of the cargo handling volume. Therefore, it can be assumed that these 22 large ports may have to dredge some amounts of contaminated sediments in next 1-10 years. If it is assumed that 43% of these 22 ports have to dredge the same average amount of contaminated sediments in next 1-10 years, in total about 4.4 million m³ of contaminated sediments will be dredged in 43 Baltic Sea ports (with > 2.6 Mton of cargo). Furthermore, if it is assumed that just 10% of 80 small ports have to dredge 10% of the mentioned average amount of contaminated sediments, about 0.2 million m³ contaminated sediment should be dredged in these ports. Consequently, about 5 million m³ of the contaminated sediments is expected to be dredged and handled in the BSR ports.

**Estimation 2**

According to the Swedish survey experiences, as soon as the ports started investigation about the sediments and contamination, they found out there were much more amounts of contaminated sediments than what had been reported in 2005 and 2009 for the coming years.

Accordingly, in this project it can be assumed that more ports have to dredge contaminated sediments in the future than what has been reported. Therefore it is expected that 67% of the interviewed ports have to dredge the contaminated sediments, if it is assumed that all 24% of the ports have contamination in the sediments. Besides, if the same assumption is applied to 22 ports, the total amount of contaminated
dredged sediments that should be dredged in 43 ports will increase to about 7 million m$^3$. If in this case it is also assumed that the numbers of the small ports that have to dredge the contaminated sediments increase by 5%, the total amount of dredged contaminated sediments in these ports will rise to 0.3 million m$^3$. Therefore the total amount of contaminated sediments in the BSR ports is calculated 7.3 million m$^3$.

Estimation 3

The inventory of the Swedish ports in 2012 contained 30 ports, of which 13 ports had more than 2.6 Mton of cargo handling volume and 17 had less than 2.6 Mton of cargo handling volume.

62% of 13 Swedish ports have to dredge the average amount of 0.2 million m$^3$ of contaminated sediments in the future, almost the same as the average amount in the current inventory. Accordingly, if it is assumed that 62% of 43 BSR ports have to dredge contaminated sediments in the future, the total amount of contaminated sediments in these ports will increase to 5.3 million m$^3$.

Besides, 30% of 17 Swedish ports have to dredge the average amount of 0.1 million m$^3$ of contaminated sediments in the future. If this result is generalized about 80 BSR ports, the amount of contamination in these ports will increase to 2.4 million m$^3$. Consequently, the total amount of contaminated sediments in the BSR ports is calculated about 8 million m$^3$.

According to the analysis, there will be a large amount of contaminated sediments in the BSR ports in 1-10 years that should be handled in both sustainable and beneficial ways. In addition, a great deal of money is expected to be financed for handling and management of the contaminated sediments. Therefore selection of the beneficial handling alternatives with less financial requirement is preferred.

3.8 Economics and handling options of dredged sediments

It is of importance to take into account the cost of different handling options. The cost varies in different handling alternatives and sometimes there is a significant difference between the costs. However, it is important to consider that in some cases different handling alternatives are not easily comparable. This is because of sea disposal, confined disposal upland and near sure are some methods of getting rid of dredged sediments, while land reclamation is beneficial use of the dredged sediments as construction materials. Ports that are planning to expand the port area can decrease the use of other construction materials by using dredged sediment as construction materials. The cost of using dredged sediments as construction materials is included in the cost of handling of the dredged sediments.

Figure 12 has been created according to Stabcon guidelines (Stabcon, 2011), which shows cost for handling of the average estimated amounts of contaminated sediments (6.7 million m$^3$) in 125 BSR ports where different handling options are used.

According to the Stabcon guidelines, the costs for different handling alternatives per cubic meter are as follows: confined disposal (upland) 150-200 euro/m$^3$, confined disposal (near shore) 10-50 euro/m$^3$, land reclamation (s/s) 10-15 euro/m$^3$ and confined sea disposal 2.5-5 euro/m$^3$.

In order to get an insight into different handling options see Figure 13. According to Figure 13 a handling option can be either of beneficial type or of disposal type.
Figure 12. The expected amount of money for handling of average amount of contaminated dredged sediments in 125 BSR ports in different methods (Stabcon, 2011). (See Figure 13 to get an insight into different alternatives)

Figure 13. Different possibilities for handling of dredged sediments, either the beneficial use or disposal of the dredged sediments (Figure 13 is based on the image supplied by Oakajee Port and Rail Pty Ltd)
4. DISCUSSION

In this chapter results of the interviewing and assumptions have been discussed in detail in order to draw conclusion and propose future works.

The project has aimed to show future dredging operation and infrastructure development plans at the Baltic Sea ports in order to assess the requirements and challenges concerning the fulfillment of the plans. The BSR ports located in 8 countries around the Baltic Sea namely Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Russia have been considered.

The project has been carried out within the framework of the project SMOCS and PortInfra Network. It has been done through a so-called “Stakeholder Opinion Assessment” (SOA). The SOA methodology is a combination of the questionnaire and in-depth interview. The ports included in the inventory gave interviews via telephone. Questions have been asked about the ports’ future plans with the main focuses on sediments, dredging, handling of the dredged sediments and port infrastructure development.

43 Baltic Sea ports were contacted and 21 of them participated in the interview study. The ports were mainly selected due to their size, based on amount of cargo handling. 90% of the total volume of cargo is handled in the 43 contacted ports The source for creating the inventory of the BSR ports was Baltic Port List 2006 (Saurama, et al., 2008), (see Table a in Appendix A).

4.1 Future plans in the BSR ports

A majority of the interviewed ports have different expansion plans in next 1-5 or 6-10 years. They mainly plan to build a new quay, increase the cargo handling volume or expand the port area. In addition almost all the ports have plan to do different types of dredging in the future to deepen or maintain the depth of the port or/ and do construction works. They usually plan to do capital dredging with the aim of construction works, while they do maintenance dredging regularly every few year to maintain the depth or design of the port. However, financial situation is one of the main issues that may affect the performance of the future plans at the ports.

As it has been already mentioned in section 3.6, it is expected that most of the large BSR ports (with more than 2.6 Mton of cargo handling) may have different expansion plans in the future. Therefore, they may require preparing the condition for the infrastructure development plans. Accordingly, it is assumed that a majority of the large ports probably require to do any types of dredging actions.

It is much trickier to make an assumption about future plans in small BSR ports (with less than 2.6 Mton of cargo handling volume). However it is expected that some of the small ports may have different expansion plans mostly increasing the cargo handling volume. In order to meet their goal, these ports may require to maintain or develop the port, thus they may require to do either capital dredging or maintenance dredging.

Consequently, it is expected that a large amount of clean and contaminated sediments are required to be dredged and handled in the future in the Baltic Sea ports.

4.2 Total amounts of contaminated dredged sediments in the BSR ports

Three different methods have been proposed to estimate conservatively the total amount of contaminated dredged sediments in the BSR ports. It is estimated that at least 5-8 million m³ (5 000 000 – 8 000 000 m³) of contaminated sediments will be dredged and handled in 125 BSR ports for the upcoming years. However, it is expected that more amounts of contaminated sediments will be obtained as soon as the ports start investigating more precisely. This expectation is based on the previous surveys in Sweden that as soon as the ports started investigation, they found out there were much more amounts of contaminated sediments than what they had been reported before.
All in all, as soon as the ports start doing more in-depth investigation, more amounts of contaminated sediments in the ports are expected as well as numbers of the ports that have contaminated sediments are expected to increase.

4.3 Technology and economics

In theory, there are several possibilities for locating the dredged sediments. But in practice, the existing legislations and framework will restrict the possible actions. The alternatives for location can be either of a beneficial type or of a disposal type. Therefore the ports can make decision how to handle the dredged sediments according to the purposes that they are looking for as well as the quality of the sediments.

The ports included in the inventory apply different methods for handling of the dredged sediments, such as sea disposal, landfill disposal, land reclamation, etc. They mostly dump clean dredged sediments into the sea. Sea disposal could be the cheapest method if the sediments are clean and the ports are allowed to dump the dredged materials into the sea. However, dumping into the sea might not be a preferred handling alternative in all the ports, because of the probable long distances that ships have to travel to reach the dumping areas. Transportation is one of the important factors that should be taken into account in order to mitigate the environmental effects of the dredging and handling of the dredged sediments.

The other common handling method among the ports included in the inventory is landfill disposal of the dredged sediments. This method could be considered as beneficial use of contaminated dredged sediments, if dredged sediments are used as construction materials upon the landfills in order to build on top of them. But this may require treatment of the dredged sediments before using in construction as well as other construction materials. Consequently this upgrading of the material properties could become very costly. In addition distance to the landfills is needed to be considered, since that can affect the environment significantly.

One of the treatment methods that can be used for the landfill disposal is Stabilization/Solidification method in order to improve technical properties and reduce the environmental impacts. Thus the contaminated dredged sediments can be used as construction material on a landfill. However, emerging treatment technologies such as Stabilization/Solidification makes it possible to consider and increase the beneficial use of the contaminated dredged sediments. In other words, s/s technology can be used to treat and upgrade the contaminated dredged sediments to be used in several civil engineering applications such as: land reclamation, port facilities, embankment and dikes, bricks for construction purposes, etc. Among interviewed ports, a few ports stabilize contaminated dredged sediments by using binders such as cement or other similar materials. However, the beneficial use of the dredged sediments is usually preferred and profitable.

As it has been mentioned before, disposal of the contaminated sediments is very costly especially the confined disposal (upland) method, it is more than 1000 million euro. Therefore it is important for the ports and authorities to consider handling practices, which can reduce the cost to society, port owners and environment.

4.4 Permitting procedure for dredging and handling of the dredged sediments

One of the main issues among the interviewed ports is permitting process for dredging and handling of the dredged sediments according to the environmental legislations. As the number of the ports planning to be developed is increasing, the need for dredging is increasing as well. Therefore, as time passes legislations are becoming more and more intense, so getting permission will become more difficult. In some cases the permitting procedure also causes delay in the implementation of the plans.

Interpretation of legal requirements seems to be different between the Baltic Sea countries. To our knowledge this is mainly due to the local or national differences. The international legislation is governing
in all countries, legislation and conventions such as London protocol, Helsinki convention and Helcom guidelines are all providing a basic framework. The situation with long permitting procedures is an unhappy situation that actually can be considered important for both ports and authorities to derive and agree upon further. On the other hand, there are some ports that are not accustomed to the new policies, legislations and practices yet that in some cases it is the same situation for the authorities also. All in all, the Baltic Sea Region is very valuable resource and estuary that is needed to be handled carefully and wisely in the future. Therefore that is why it is very necessary to find consensus and a main line for permitting procedures and corresponding requirements in all BSR countries.

4.5 Knowledge transfer
The majority of the contacted ports found the survey very important and interesting to be evaluated. On the other hand some of the ports did not have time to take part in the survey.

Some of the interviewed ports have some challenges with handling of the contaminated dredged sediments in the future. They are looking for other handling alternatives if dumping into the sea is not proper or sediments are not suitable for filling the lands. Therefore they were interested to know how SMOCS and PortInfra Network could help them with these issues. In fact SMOCS has developed guidelines for management of contaminated sediments; including sustainability assessment practices and decision support regarding the handling alternatives as well as treatment technologies (see www.smocs.eu).

However, in some cases workshop or seminars are required to help having the complete understanding of the guidelines for those who have expertise in other different areas. All in all, a great impression has been got from the ports that there is a big interest in participating in the knowledge transfer and exchange that such activities are needed in near future.

4.6 Used methodology
The project aimed to show the future dredging and infrastructure development plans at the Baltic Sea ports to assess the challenges and requirements related to performance of the plans. Therefore it was needed to contact the ports directly to compile the required information. The question is that if the SOA methodology was the best option doing this project and if other methods could have been applied to meet the project goals better.

There are different methods of doing a survey. By doing the interviewing in person instead of telephoning would have probably resulted in more detailed information and a better understanding of the specific ports’ situation and needs. Interviewing in person would cost more per interviewed person.

Another method that could have been used is conventional written survey, which a survey is sent via email and answered in text. This method would have saved a lot of time but probably resulted in fewer respondents and fewer details about the ports’ plans and needs.

The SOA methodology made it possible to discuss questions with the key players directly on the phone, which has provided much clearer view of the situations than the conventional written survey would have done. Moreover, the key players felt more comfortable to talk about their issues and plans rather than to write. Some respondents chose to answer in written text due to the lack of time or language barriers. The respondents represented ports from all countries around Baltic Sea (except Sweden).

The discussion with the key players responsible at the ports has provided a broad view of the situation at the Baltic Sea ports. Therefore in this case the SOA methodology was a good option to meet the goals.

All in all, although the chosen method has been more time and resource consuming than the conventional written survey, it has provided valuable results and contacts that cost more. It took about 5 months to contact all 43 ports and interview with 21 ports included in the inventory as well as collect the results.
Therefore, it is estimated to take more than 1 year to go through all the BSR ports in Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Russia.

To sum up, the advantages of this method outweigh the disadvantages.
5. CONCLUSION

This study shows that a large quantity of clean and contaminated sediments are expected to be managed in the Baltic Sea Ports for the upcoming years. At least 5-8 million m³ of contaminated sediments are estimated to be dredged and handled in the BSR ports, if assumptions are made conservatively. Traditional handling options such as disposal at land or into the sea are likely to be very costly. The cost for handling of the estimated amount of contaminated sediments in confined disposal (upland) is more than 1000 million euro. It is therefore of utmost importance that key stakeholders, ports, construction industry and environmental authorities cooperate to improve existing solutions as well as introduce new technologies and best practices.

Key challenges and opportunities that are needed to be considered and future elaborated are for instance:

1. As time passes legislations are becoming more and more intense, so getting permission for dumping into the sea will become more difficult;

2. Thus, sustainable handling methods and treatment technologies that make it possible to consider the beneficial use of the contaminated sediments are needed to be developed and increase in the ports.

3. According to the previous surveys, it is expected that more amounts of contamination in sediments will be obtained as soon as the ports start investigating more precisely.

4. The last but not least, although there is a high knowledge on many specific subjects in the ports, however there seems to be a lack of an established forum for exchanging knowledge and experience. Therefore the respondents expressed an interest to participate in knowledge exchange activities. SMOCS guidelines and PortInfra network are some such networks that by knowledge and experience transferring can help the ports with some issues such as handling and management of the contaminated sediments.
6. REFERENCE


Frostell, B., 2005. HOST WP1, User needs analysis – Sub project Stockholm – Initial market inventory and identification of HOST services to study – Result from Stakeholder Group Interviews


## Appendix A - Baltic Port List 2006

Table a- Baltic Port List 2006 in 8 countries included in this project (Saurama, et al., 2008). Ports marked with a cross are included in the inventory and interview study.

<table>
<thead>
<tr>
<th>Country</th>
<th>Port</th>
<th>Total volume of cargo handling (ton) in 2006</th>
<th>Interviewed ports</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Fredericia</td>
<td>16108000</td>
<td></td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>Aarhus</td>
<td>11913000</td>
<td>X</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>Statoil-havnen</td>
<td>7573000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Copenhagen</td>
<td>6896000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rødby Færgehavn</td>
<td>5755000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enstedværket</td>
<td>5734000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elsinore (Helsingør)</td>
<td>4442000</td>
<td></td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
<tr>
<td></td>
<td>Kalundborg</td>
<td>3833000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aalborg</td>
<td>3126000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frederikshavn</td>
<td>3089000</td>
<td></td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
<tr>
<td></td>
<td>Aalborg Portland</td>
<td>3088000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Odense</td>
<td>2289000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asnæsværket</td>
<td>2057000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aabenraa</td>
<td>1721000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gedser</td>
<td>1714000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rønne</td>
<td>1565000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Studstrupværket</td>
<td>1437000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Randers</td>
<td>1244000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Koge</td>
<td>1243000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kolding</td>
<td>1175000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stigsnæsværket</td>
<td>1166000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grenaa</td>
<td>1078000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vejle</td>
<td>1060000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nordjyllandsværket</td>
<td>981000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stålvalseværket</td>
<td>900000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avedøreværket</td>
<td>830000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horsens</td>
<td>602 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nyborg</td>
<td>577 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Næstved</td>
<td>449 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nakskov</td>
<td>436 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nykøbing Falster</td>
<td>374 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Korsør</td>
<td>327 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hundested</td>
<td>278 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Skagen</td>
<td>266 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dansk Salt</td>
<td>204 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Holbæk</td>
<td>180 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Sediments and Dredging in the Baltic Sea Region Ports – Survey

- **Bandholm-Maribo**: 163,000
- **Stubbekebing**: 160,000
- **Vordingborg**: 149,000
- **Faxe**: 148,000
- **Svendborg**: 140,000
- **Hobro**: 127,000
- **Rødby**: 114,000
- **Assens**: 70,000
- **Sønderborg**: 69,000
- **Rudkøbing**: 66,000
- **Kongsdal**: 65,000
- **Aeroskøbing**: 62,000
- **Skaerbaekvaerket**: 54,000

**Estonia**
- **Tallinn**: 41,084,000
- **Vene Balti**: 2,064,000
- **Miiduranna**: 1,734,000
- **Pärnu**: 1,357,000
- **Kunda**: 1,156,000
- **Sillamäe**: 473,000

**Finland**
- **Kilpilahti (Sköldvik)**: 19,739,000
- **Helsinki**: 11,728,000
- **Kotka**: 9,577,000
- **Naantali**: 7,147,000
- **Rauma**: 6,595,000
- **Raahe**: 6,089,000
- **Pori**: 5,781,000
- **Kokkola**: 5,323,000
- **Hamina**: 5,181,000
- **Hanko**: 4,151,000
- **Turku**: 3,926,000
- **Oulu**: 2,993,000
- **Kemi**: 2,710,000
- **Kaskinen**: 1,920,000
- **Tornio**: 1,894,000
- **Inkoo**: 1,891,000
- **Pietarsaari**: 1,541,000
- **Uusikaupunki**: 1,489,000
- **Koverhar**: 1,412,000
- **Vaasa**: 1,398,000
- **Lovisa**: 1,106,000
- **Parainen**: 1,047,000
- **Kantvik**: 778,000

---

*One of the 20 biggest ports (volume of cargo)*
*One of the 20 biggest ports (volume of cargo and number of passengers)*
*SMOCS partner*
### Sediments and Dredging in the Baltic Sea Region Ports – Survey

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kristinankaupunki</td>
<td>551 000</td>
<td></td>
</tr>
<tr>
<td>Taalintehdas</td>
<td>296 000</td>
<td></td>
</tr>
<tr>
<td>Rahja</td>
<td>288 000</td>
<td></td>
</tr>
<tr>
<td>Lappohja</td>
<td>279 000</td>
<td></td>
</tr>
<tr>
<td>Vessö</td>
<td>229 000</td>
<td></td>
</tr>
<tr>
<td>Förby</td>
<td>184 000</td>
<td></td>
</tr>
<tr>
<td>Kemiö</td>
<td>174 000</td>
<td></td>
</tr>
<tr>
<td>Pohjankuru</td>
<td>153 000</td>
<td></td>
</tr>
<tr>
<td>Eurajoki</td>
<td>149 000</td>
<td></td>
</tr>
<tr>
<td>Tolkkinen</td>
<td>106 000</td>
<td></td>
</tr>
<tr>
<td>Mariehamn</td>
<td>85 000</td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
</tbody>
</table>

**Germany**

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lübeck</td>
<td>21 056 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td>Rostock</td>
<td>19 058 000</td>
<td>One of the 20 biggest ports (volume of cargo and number of passengers)</td>
</tr>
<tr>
<td>Puttgarden/Fehmarn</td>
<td>3 965 000</td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
<tr>
<td>Wismar</td>
<td>3 848 000</td>
<td></td>
</tr>
<tr>
<td>Kiel</td>
<td>3 047 000</td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
<tr>
<td>Sassnitz</td>
<td>2 663 000</td>
<td></td>
</tr>
<tr>
<td>Stralsund</td>
<td>854 000</td>
<td></td>
</tr>
<tr>
<td>Flensburg</td>
<td>496 000</td>
<td></td>
</tr>
<tr>
<td>Lubmin-Virow</td>
<td>405 000</td>
<td></td>
</tr>
<tr>
<td>Wolgast</td>
<td>380 000</td>
<td></td>
</tr>
<tr>
<td>Rendsburg</td>
<td>302 000</td>
<td></td>
</tr>
<tr>
<td>Greifswald, Landkreis</td>
<td>258 000</td>
<td></td>
</tr>
<tr>
<td>Berndshof</td>
<td>190 000</td>
<td></td>
</tr>
<tr>
<td>Neustadt/Holstein</td>
<td>97 000</td>
<td></td>
</tr>
<tr>
<td>Heiligenhafen</td>
<td>68 000</td>
<td></td>
</tr>
<tr>
<td>Burgstaaken/Fehmarn</td>
<td>59 000</td>
<td></td>
</tr>
</tbody>
</table>

**Latvia**

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventspils</td>
<td>29 062 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td>Riga</td>
<td>25 358 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td>Liepaja</td>
<td>4 001 000</td>
<td></td>
</tr>
<tr>
<td>Skulte</td>
<td>392 000</td>
<td></td>
</tr>
<tr>
<td>Salacgriva</td>
<td>389 000</td>
<td></td>
</tr>
<tr>
<td>Mersrags</td>
<td>278 000</td>
<td></td>
</tr>
</tbody>
</table>

**Lithuania**

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klaipeda</td>
<td>23 611 000</td>
<td>One of the 20 biggest ports (volume of cargo) – SMOCS partner</td>
</tr>
</tbody>
</table>

**Poland**

<table>
<thead>
<tr>
<th>Location</th>
<th>Population</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gdansk</td>
<td>24 207 000</td>
<td>One of the 20 biggest ports (volume of cargo) – SMOCS partner</td>
</tr>
<tr>
<td>Gdynia</td>
<td>14 183 000</td>
<td>One of the 20 biggest ports (volume of cargo) – SMOCS partner</td>
</tr>
<tr>
<td>Szczecin'</td>
<td>9 965 000</td>
<td>One of the 20 biggest ports (volume of cargo) – SMOCS partner</td>
</tr>
<tr>
<td>Swinoujscie'</td>
<td>9 242 000</td>
<td>One of the 20 biggest ports (number of passengers)</td>
</tr>
<tr>
<td>Police</td>
<td>2 446 000</td>
<td></td>
</tr>
<tr>
<td>Kolobrzeg</td>
<td>158 000</td>
<td></td>
</tr>
</tbody>
</table>
### Sediments and Dredging in the Baltic Sea Region Ports – Survey

<table>
<thead>
<tr>
<th>Country</th>
<th>Port</th>
<th>Volume (TEU)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>Primorsk</td>
<td>66 078 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>St. Petersburg</td>
<td>54 230 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>Kaliningrad</td>
<td>15 225 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>Vysotsk</td>
<td>13 811 000</td>
<td>One of the 20 biggest ports (volume of cargo)</td>
</tr>
<tr>
<td></td>
<td>Ust-Luga</td>
<td>3 766 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vyborg</td>
<td>1 253 000</td>
<td></td>
</tr>
</tbody>
</table>

1. The Port of Hamina and the Port of Kotka have lately merged together and since 1st of May 2011 they have been operating as the Port of HaminaKotka. So in this report, it has been mentioned as HaminaKotka Port.
2. Port of Szczecin and port of Swinoujscie have one administration and in fact they are considered as one port, but the statistics can be presented separately. So in this report it has been mentioned as Szczecin-Swinoujscie Port.
Appendix B. Questionnaire

Introduction

This survey has been done within the framework of the SMOCS Network 2013-2017 as a follow-up of the EU-project SMOCS and is led by the Swedish Geotechnical Institute and Luleå University of Technology. The project involves ports and universities in several countries around the Baltic Sea with the main issues of dredging and sediment management. SMOCS project has produced a guideline on sustainable management of contaminated sediments according to the objectives of SMOCS Network 2013-2017. The objectives include mainly improving infrastructure, sediment management and water sewage management.

This survey aims to get an overview of the port’s future needs and plans linked to maintenance / expansion in a regional level and dredging operations. About 30-40 ports around Baltic Sea will be included in the survey. The survey is sent in advance and answered orally by phone. You do not need to report the exact numbers; estimation is enough for this purpose. You will receive the collected results of the interview and also be invited to a workshop in the winter of 2013/2014. The results will be presented officially, but no information from individual ports will be released.

A. About the person is interviewed

A1. What are you working with?

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Technical</th>
<th>Economics</th>
<th>Infrastructure</th>
<th>Environment</th>
<th>Others</th>
</tr>
</thead>
</table>

A2. How long have you been working?

<table>
<thead>
<tr>
<th>0-5 years</th>
<th>6-10 years</th>
<th>11-15 years</th>
<th>16-20 years</th>
<th>More than 21 years</th>
</tr>
</thead>
</table>

B. Harbor and goods

B1. How many tons of cargo are handled yearly? (ton/year) ........................................
B2. How many ships arriving annually? .................................................................

C. Future plans for infrastructure

C1. Do you have any plans for expansion?

<table>
<thead>
<tr>
<th>In 1-5 years</th>
<th>In 6-10 years</th>
</tr>
</thead>
</table>

C2. What is the type of expansion?

<table>
<thead>
<tr>
<th>New quay</th>
<th>Increasing the cargo handling volume</th>
<th>Expanded port area or move to new location</th>
<th>Changing the vessel types</th>
<th>Others</th>
</tr>
</thead>
</table>

C3. Will you expand on land or in the sea? ........................................
D. Future plans for dredging

D1. Do you have any plans for dredging? If yes, what is the purpose of dredging? (You may choose more than one answer.)

In 1-5 years:

<table>
<thead>
<tr>
<th>Capital dredging (1)</th>
<th>Maintenance dredging (2)</th>
<th>Clean-up dredging (3)</th>
<th>others</th>
</tr>
</thead>
</table>

In 6-10 years:

<table>
<thead>
<tr>
<th>Capital dredging (1)</th>
<th>Maintenance dredging (2)</th>
<th>Clean-up dredging (3)</th>
<th>others</th>
</tr>
</thead>
</table>

[1] Capital dredging – for navigation, to enlarge or deepen the existing fairway and port areas or to create new ones;

[2] Maintenance dredging – to ensure that fairways, berth or construction works are maintained at their designed dimensions. In addition to maintain the depth of the port;


D2. How much is needed to be dredged, total amount and contaminated amount?

<table>
<thead>
<tr>
<th>Total (m³)</th>
<th>In 1-5 years</th>
<th>In 6-10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Of which is contaminated (m³)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D3. What are the types of contamination? ..........................................

D4. What type of sediments exists in the port? Specify if there is a mixture of two or more.

<table>
<thead>
<tr>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
<th>Gravel</th>
</tr>
</thead>
</table>

D5. How do you plan to handle the dredged sediments? Do you have a permit? ..........................

D6. Have you ever heard about Stabilization/Solidification technology or used this technology for handling the dredge sediments?

E. Knowledge need

The SMOCS Network 2013-2017 project collects actors working with port issues in different countries around the Baltic Sea. The network Port Infra, aims to increase knowledge transfer and cooperation within BSR ports on three key topics; Sediments and land reclamation, Quay structures and pavements and Sewage water management.

-Given this, do you have any specific question/issue that in your point of view is particularly important to work with and take into account? Or anything else you want to add.

1. .................................................................

2. .................................................................

3. .................................................................

Hope to see you at workshop!

Good Luck and Thank you!

PortInfra / SMOCS Network 2013-2017
Appendix C- Port authority

Public Service Port
Public service ports have a predominantly public character. The number of service ports is declining. Many former service ports are in transition toward a landlord port structure. However some ports in developing countries are still managed according to the service model. Under it, the port authority offers the complete range of services required for the functioning of the seaport system. The port owns, maintains, and operates every available asset (fixed and mobile), and cargo handling activities are executed by labor employed directly by the port authority. Service ports are usually controlled by (or even part of) the ministry of transport (or communications) and the chairman (or director general) is a civil servant appointed by, or directly reporting to, the minister concerned.

Tool Port
In the tool port model, the port authority owns, develops, and maintains the port infrastructure as well as the superstructure, including cargo handling equipment such as quay cranes and forklift trucks. Port authority staff usually operates all equipment owned by the port authority. Other cargo handling on board vessels as well as on the apron and on the quay is usually carried out by private cargo handling firms contracted by the shipping agents or other principals licensed by the port authority.

Landlord Port
The landlord port is characterized by its mixed public-private orientation. Under this model, the port authority acts as regulatory body and as landlord, while port operations (especially cargo handling) are carried out by private companies.

Today, the landlord port is the dominant port model in larger and medium sized ports. In the landlord port model, infrastructure is leased to private operating companies or to industries such as refineries, tank terminals, and chemical plants.

Private Service Ports
Private Service Ports are few in number. In fully privatized ports, port land is privately owned, unlike the situation in other port management models. This requires the transfer of ownership of such land from the public to the private sector. In addition, along with the sale of port land to private interests, some governments may simultaneously transfer the regulatory functions to private successor companies.
Appendix D- International Maritime Organization (IMO)

Member states
IMO currently has 170 member states. IMO’s governing body is the Assembly which is made up of all 170 Member States and meets normally once every two year. Among the countries member in IMO, nine countries around the Baltic Sea are member of IMO too.

Non-Governmental international Organizations (NGOs)
There are different NGOs which have been granted consultative status with IMO.

Intergovernmental Organizations (IGOs)
There are different intergovernmental organizations which have concluded agreements of co-operation with IMO. Among all the intergovernmental organizations in IMO, HELCOM is one of the members.

Baltic Marine Environment Protection Commission (HELCOM)
The Helsinki Commission (HELCOM) is an intergovernmental organization of the nine Baltic Sea coastal countries, the EU Commission and a number of observer organizations (maritime industry, environmental NGOs, other stakeholders). It works to protect the marine environment of the Baltic Sea from all sources of pollutions.

The organization has a permanent secretariat in Helsinki, Finland. This kind of holistic co operations and projects are often necessary to get together knowledge about complex legislations (water, waterways, soil and waste) as well as reducing dredging and handling costs.

HELCOM’s vision for the future is a healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities.