Baltic Marine Environment Protection Commission

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EN DREDS 11-2021

Document title	Conversion factors in reporting
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Agenda Item	4 – Conversion factors
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Reference	

Background

EN DREDS 10-2020 (Outcome, para 3.3) discussed the differences in the conversion factors of wet volume to dry weight between HELCOM and OSPAR, as raised by Sweden. The Meeting invited Sweden to make a compilation of these national practices to be presented at the group's next meeting.

This document presents the compilation produced by Sweden.

Action requested

The Meeting will be invited to take note of this information and discuss the need for further steps.

Conversion factors in reporting

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Content

- Background
  - Conversion factors
  - Sweden
  - Helcom/Ospar
- Our interpretation of answers from different countries
  - Finland
  - Poland
  - Denmark
  - Spain
  - Germany
  - Default summary (matrix)
- Example calculation
- Suggestions on discussion topics

Background: Conversion factors

- The weight of the dredged material needs to be reported, but the volume is measured
- There are several parameters that determine the dry weight based on the volume:
  - Dry density
  - Particle size and soil type
  - Water content
  - Air content
- Dry matter content
  - Method 1: oven (**weigh the sample before and after**)
  - Method 2: freeze-drying
  - not necessarily representative for barge volume…
  - only measured when also assessing load of contaminants
- Grain size analysis
  - Uncommon practice (in Sweden)

Background: Sweden

- 13 different country administrative boards
- Started more systematic compilation of data in 2015.
- Data was incoherent, unclear what type of data was reported:
  - the barge volume?
  - permitted volume? (theoretical volume)
  - dry weight?
- 2017: Change in template to request reporting of ”raw data”
  - it is possible to update
  - more coherent and transparent
  - possible to compare
  - volume could also be useful information to have

Background: Sweden

- Material type often based on qualitative estimations:
  - photos
  - knowledge of the location
- Sweden therefore need to use some type of conversion factors
- Historically, knowledge about water content has not been used. However, this type of information is available in many cases.
- How could we use this information? We started to ask about the conversion factors in the templet.

Background: Helcom template

HELCOM estimates for conversions	**Column 1**	**Column 2**
Type of dredged Material	The wet weight in tons of 1 cubic meter **water-saturated sediment** (wet volume) Above water surface	The dry weight in tons of 1 cubic meter **sediment**
mud (containing organic matter)	1.2	0.3
postglacial clay, consolidated	1.5	0.6
glacial clay (boulder clay), consolidated	1.7	1.15
silt, soft and muddy	1.3	0.5
silt	1.6	1.1
sand	1.9	1.5
gravel/stone	2	1.8
till	2.2	2
general (when sediment type is unknown)	1.6	0.75

How should we interpret column 1 and 2?

Also, a third table in the templet

Conversion factors	
Type of sediment	***Density (dry sediment)***
Clay	0,6-1,15
Silt	0,5-1,1
Mud	0.3
Fine sand	1.3
Medium sand	1.4
Coarse sand	1.5
Very coarse sand	1.6
Gravel	1.8
Rock	2

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Background: Ospar vs Helcom example calculation

Helcom:

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B43 | =(B35*(100-B41)/100)*((0.6*B9)+(0.4*B8))

HELCOM estimates for conversions

	A	B
1	**Conversion factors**	
2	***Type of sediment***	***Density (dry sediment)***
3		
4	Clay	0.6-1.15
5	Silt	0.5-1.1
6	Mud	0.3
7	Fine sand	1.3
8	Medium sand	1.4
9	Coarse sand	1.5
10	Very coarse sand	1.6
11	Gravel	1.8
12	Rock	2
13		

Calculations

Dredged material (wet volume to dry weight)

Dry weight = ((Wet volume x (100 - % moisture) / 100) * density of material

Example: Convert 50000 m^3 of sediment (60% coarse sand, 40% medium sand - 45% moisture) to tonnes (dry weight)

Wet volume =	50000 m^3
% Gravel =	
% Coarse Sand =	60 %
% Med Sand =	40 %
% Fine Sand =	
% Silt =	
% Moisture	45 %
Dry weight =	=(B35*(100-B41)/100)*((0.6*B9)+(0.4*B8))

7. Conversion factors

Ospar:

Clipboard | Font | Alignment | Number

SUM | =(B21*(100-B27)/100)*((0.6*B8)+(0.4*B7))

	A	B	C
	mud (containing organic matter)	1.2	0.3
	postglacial clay, consolidated	1.5	0.6
	glacial clay (boulder clay), consolidated	1.7	1.15
	silt, soft and muddy	1.3	0.5
	silt	1.6	1.1
	sand	1.9	1.5
	gravel/stone	2	1.8
	till	2.2	2
	general (when sediment type is unknown)	1.6	0.75

Calculations

Dredged material (wet volume to dry weight)

Dry weight = ((Wet volume x (100 - % moisture) / 100) * density of material

Example: Convert 50000 m^3 of sediment (60% sand, 40% silt - 45% moisture) to tonnes (dry weight)

Wet volume =	50000 m^3
% Gravel =	
% Coarse Sand =	60 %
% Med Sand =	40 %
% Fine Sand =	
% Silt =	
% Moisture	45 %
Dry weight =	=(B21*(100-B27)/100)*((0.6*B8)+(0.4*B7))

Background: Helcom vs Ospar

	Column 1	Column 2
Type of dredged Material	The wet weight in tons of 1 cubic meter **water-saturated sediment** (wet volume) Above water surface	The dry weight in tons of 1 cubic meter **sediment**

Values in column 2 are almost same as the dry density

- My interpretation is that Ospar example calculations are closer to the truth.

$$\text{Wet weight} = \text{Wet volume} \cdot \text{conversion factor}_{\frac{\text{wet weight}}{wet\ volume}} \quad (1)$$

$$\text{Dry weight} = \text{Wet weight} \cdot \frac{100 - \%\ \text{water content of weight}}{100} \quad (2)$$

$$[1\ \&\ 2] \rightarrow \text{Dry weight} = \text{Wet volume} \cdot \text{conversion factor}_{\frac{\text{wet weight}}{wet\ volume}} \cdot \frac{100 - \%\ \text{water content of weight}}{100}$$

Helcom calculation use density for dry weight instead.

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Our interpretation of answers from different countries

Finland (April 2020)

- Also discussed this topic
- **Same conversion factors as Sweden**
- (Use the volume to dry weight conversion factors)
- One difference:

  - should be reported as “above surface” cubic meters, i.e. not including air, and not completely water saturated

*- The use of these conversion factors likely causes error in several cases, but at least it is **a systematic error**, and likely of similar magnitude in all cases.*

Poland (October 2020)

- Two different approaches:
  1. Maritime Office in Gdynia: *use the conversion factors from the HELCOM reporting template, for example for silt it was 1,1 and for coarse sand – 1,5* **(same as Sweden and Finland)**
  2. The Maritime Office in Szczecin*: use the actual data received from the laboratory. We are discussing this subject and will get to some conclusion soon.*

Denmark (April and October 2020)

- Has also discussed the conversion factors used and the comparability of data between the contracting parties.
- In cases where no sediment analysis have been made Denmark use a standard calculation from own template.
- Method developed by Aarhus University/ Copenhagen University and Nivas
- Templet and background information to time consuming to evaluate

Spain (April 2018)

- M=Cs * V * (Pa + Pf)/100

where M is Mass in tons; Cs is solids concentration; V is Volume in cubic meters; Pa sand percentage and Pf Silt percentage.

- In the case that the sediment characterization do not include **measurements of density** or solids concentration, for the estimation of this parameter, the guidelines include a second formula:
- Cs = (1.5*Pf + 1.7 Pa + 1.8 Pg)/100

where Pf, Pa and Pg are respectively the percentages of the fine, sand and gravel fractions.

Germany (April 2018 & October 2020)

- Several administrative authorities
- Ask for density and water content (%)
- Assume they often use one of the values also in the new reporting format:
  - silt with 1.2 kg/l
  - sand with 1.8 kg/l
  - mixture with 1.5 kg/l
  - default 50 % water content
- *"In the OSPAR-area the Federal Waterways and Shipping Administration provide their data about dredging with hopper dredger **in a database** where the amount is already given in dry weight tonnes."*

Summary of answers

- Seems like countries have discussed this topic. Three different ways of calculating dry weight was identified:
  1. Helcoms conversion factors for dry weight (Sweden, Finland, Gdynia).
  2. Own conversion factors (Spain, Germany, Denmark).
  3. Laboratory results from sample (Spain, Germany, Denmark, Szczecin).

Type of dredged Material	Column 1 - Used in Ospar example calculation	Column 2 - Sweden, Finland, Gdynia (not including water content)	Dry weight (Helcom example calculation exc. water content)	The dry weight in tons of 1 cubic meter barge volume - Germany default
mud (containing organic matter)	1.2	0.3	0.3	-
postglacial clay, consolidated	1.5	0.6	0.6-1.15	-
glacial clay (boulder clay), consolidated	1.7	1.15		-
silt, soft and muddy	1.3	0.5	0.5-1.1	0.65
silt	1.6	1.1		
sand	1.9	1.5	1.2-1.6	0.9
gravel/stone	2	1.8	1.8	-
till	2.2	2	-	-
general/mix (when sediment type is unknown)	1.6	0.75	-	0.75

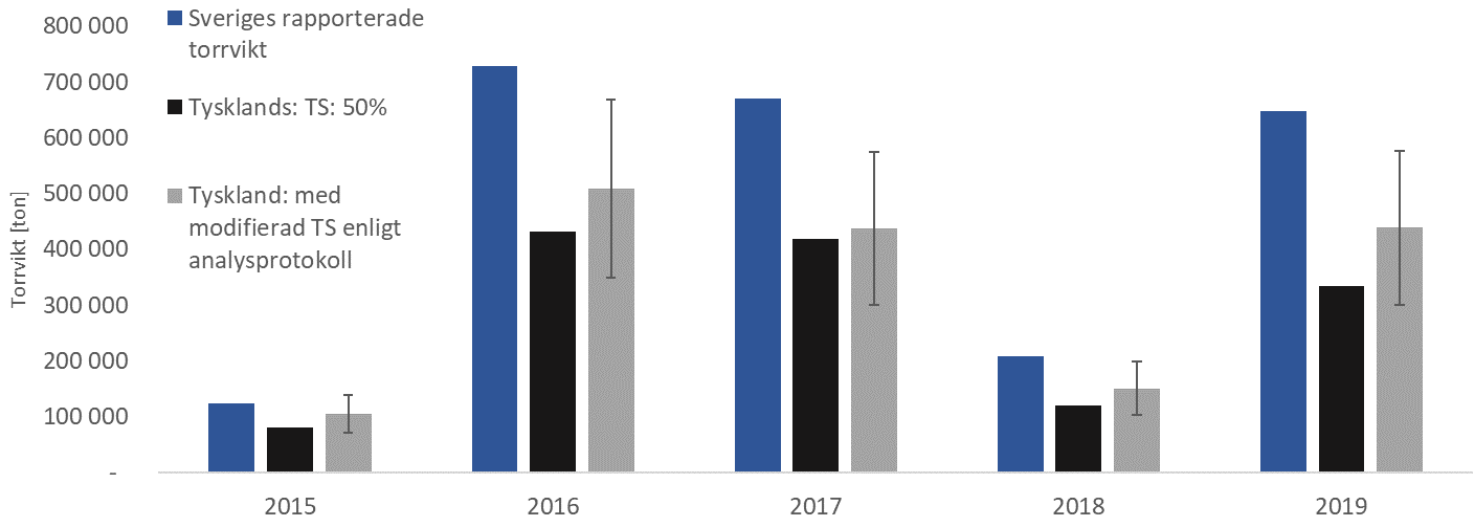
Example calculation

Table showing average and median water content for some dredging projects carried out in Sweden

Category	"Mud"/-clay/silt	Unknown/ mixture	Sand/lime-stone	Total
Dry weight [%] average	54	44	68	57
Std [%]	13	12	11	16
Dry weight [%] median	57	43	68	57
Count [#]	11	16	21	57

1. What would happen if Sweden would use the default used in Germany instead?
2. What would happen if Sweden used average water content values instead of 50%?

Example calculation results



Swedish reported dry-weight calculated with the dry weight conversion factors (blue),
Sweden's dumped masses calculated using Germany´s default value of 50% watercontent instead (black)
And Swedish dumped masses calculated using Germanys default conversion factors (grey).

Impacts

- The results indicate a significant difference
- The conversion methods and therefore the reported amounts are not directly comparable
- Contaminant loads are directly correlated with weight, implying that this data is just as incomparable as the data on amount of dredged material
- Estimated amounts of dumped material under-/overestimated
- Ospar and Helcom guidelines/templates not coherent
- Volume data (or "raw data") and with it the ability to recalculate amounts is lost/not reported

Disscussion

- Is it better to have default values which are based on typical conversions for barge volumes and theoretical volumes? e.g. not entirely water saturated and with some over volume included.
- Is it wrong to use the conversion factors the way Sweden, Finland and Gdynia do?
- Is it common that laboratories also report density of sample?
- Why don´t we also report volume (or "raw data")?
- Should the Ospar and Helcom templates be coherent?