Theme 2: Hazardous substances

This is a deliverable from the BalticBOOST project that was coordinated by HELCOM and co-financed by the European Union in 2015-2016 as part of the programme DG ENV/MSFD Action Plans/2016.

WP 2.1 Deliverable 1: Development of a tool for assessment of hazardous substances

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1. Development of a hazardous substances assessment tool (CHASE)

The HELCOM BalticBOOST project has further developed the hazardous substances status assessment tool (CHASE) that will be used in the upcoming 'State of the Baltic Sea report' that is produced by the HELCOM HOLAS II project. The assessment of hazardous substance in HOLAS II will be based on the HELCOM core hazardous substance indicators. The development of the tool has been guided through two HELCOM workshops with participation of experts from the HELCOM Contracting Parties, the HOLAS II core team and the State and Conservation Working Group. The recommended application of the tool in HELCOM was based on a set of test cases that was carried out in BalticBOOST WP 2.1. The tool as presented in this report was approved for use in HOLAS II by HELCOM HOD 51-2016.

The tool has been coded in R-script to enable an operationalization of the HELCOM hazardous substances assessment system. Adjustments have also been made to the categories and integration rules applied in the tool.

CHASE as R-code available in GitHUB: https://github.com/NIVA-Denmark/CHASE

CHASE for test use in ShinyApps: https://niva.shinyapps.io/CHASE_R/

1.1 Background on the development of the structure of the tool

The HELCOM Hazardous Substances Status Assessment Tool (CHASE) is a multi-metric indicator-based tool originally developed for the first HELCOM integrated thematic assessment of hazardous substances in the Baltic Sea (HELCOM 2010a). The first version of the tool (CHASE 1.0) produced an integrated assessment and classification of hazardous substances status, grouping indicators according to the four ecological objectives which defined the strategic goal for hazardous substances segment in the HELCOM Baltic Sea Action Plan:

- Concentrations of hazardous substances close to natural levels
- All fish safe to eat
- Healthy wildlife
- Radioactivity (radionuclides) at pre-Chernobyl level

Further development of the tool by the HARMONY project resulted in an updated version (CHASE 2.0) which is described in a peer-reviewed article by Andersen *et al* (2016)[1]. This version of the tool aggregates indicators in groups according to matrix:

- Water
- Biota
- Sediment
- Biological effects

These early versions of the tool are both implemented in Microsoft Excel. The user is required to type indicator information into a customized spreadsheet. Spreadsheet formulas and scripts then perform the calculations necessary to make the status assessments.

The current version of the CHASE tool has been developed by the HELCOM BalticBOOST project (WP 2.1) to be used in the 'State of the Baltic Sea' report (HOLAS II). In HOLAS II the tool will only use HELCOM core indicators as a basis for the integration. The CHASE retains the main principals of the HARMONY version.

[1]Andersen, J.H., Murray, C., Larsen, M.M. et al. Environ Monit Assess (2016) 188: 115. doi:10.1007/s10661-016-5121-x

However, based on agreement by STATE & CONSERVATION 5-2016 (outcome paragraph 4J.75), CHASE has been developed so that the integration is only carried out between the "concentration" category;

- Water
- Biota
- Sediment

Through the work carried out in the BalticBOOST project, CHASE has been coded in R, a free statistical software[2]. The CHASE R code is freely available at GitHub, an online open-source repository and version-control system for software codes. This represents an operationalization of the HELCOM hazardous substances assessment system compared to previous versions only available in excel.

Since programming in R may not be familiar to all users, the CHASE tool has also been made available online for testing at ShinyApps, a public and free web interface for R programs. The CHASE Shiny App[3] is simply a website where input in the form of a text file containing indicator data is uploaded and then the CHASE status assessment is calculated. This functionality allows users who are not familiar with R to test the tool using either their own data or with the test datafile provided for download from the same website.

Figure 1. The Shiny App web interface for the R version of CHASE tool.

1.2 Assessment structure

Figure 2 shows the structure of the CHASE tool. The flow of information follows the calculation steps outlined in Section 1.3. (1) Status and corresponding threshold values are used to calculate Contamination Ratios (CR), (2) CR values within each Category are aggregated to give a Contamination Score (CS) (3), the Contamination score is used to determine the Category Status, and (4) The overall status for the assessment unit is given by the Category having the worst status.

[2] https://www.r-project.org/
[3] https://niva.shinyapps.io/CHASE_R/

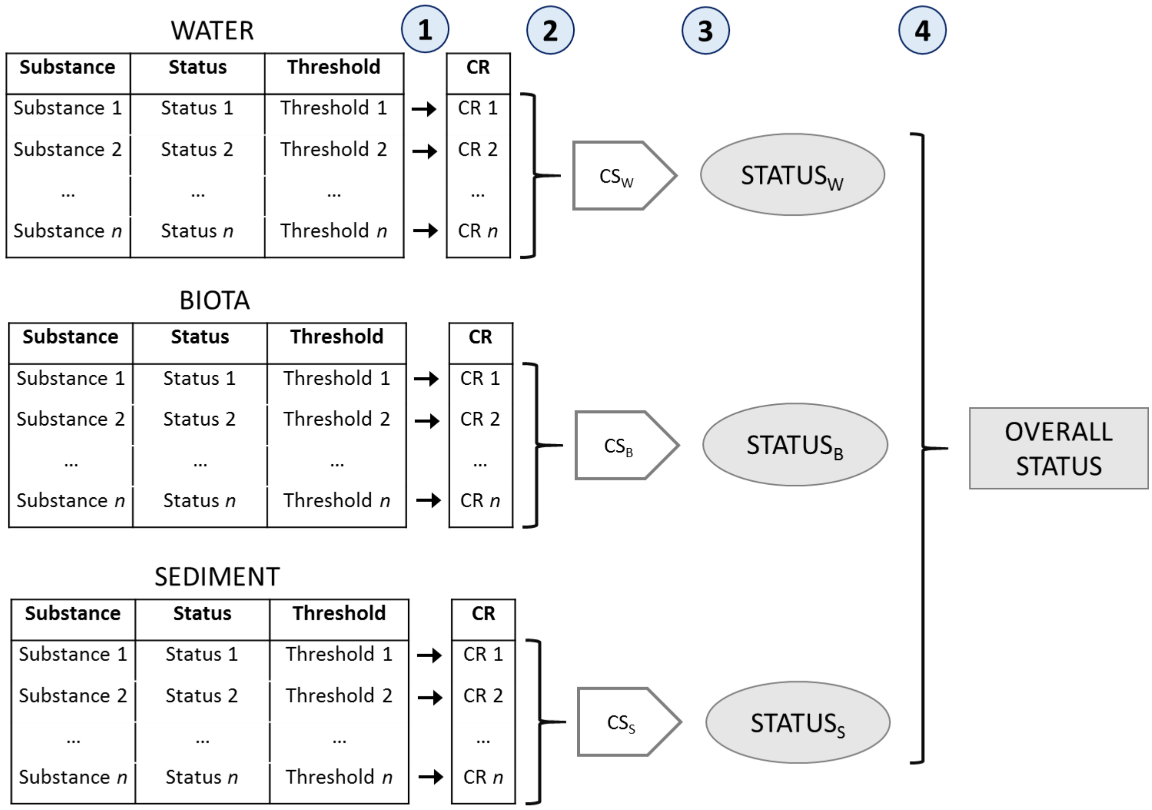


Figure 2. Structure and flow of information in the CHASE Tool. The numbers in blue circles correspond to the calculations steps described in Section 1.3.

1.3 Methodology of CHASE

The CHASE tool produces an assessment of "Chemical Status" by nesting substances/indicators in 3 categories (CI: water; CII: sediments; CIII: biota)

For each assessment unit, the assessment and classification is a simple 4 step procedure:

• **Step 1** – For each substance/indicator, a Contamination Ratio is calculated as the ratio of the monitored value of the indicator to the threshold value.

$$CR = \frac{C_{mon}}{C_{Threshold}}$$

It can be seen that where an indicator value exceeds the threshold, the resulting Contamination Ratio will be greater than 1.0 and if the indicator value is below the threshold, the Contamination Ratio will be less than 1.0.

NOTE: An indicator whose value increases with worsening Chemical status is said to have a positive (+) response, whilst an indicator whose value decreases with worsening chemical status has a negative (-) response. For all hazardous substances, any increase in concentration is associated with worsening status and their responses are thus positive.

• **Step 2** - For each category (I-III), a Contamination Score (CS) is calculated (C1: CSW; CII: CSS; and CIII: CSB):

$$\mathrm{CS} = \frac{1}{\sqrt{n}} \sum_{i=0}^{n} \mathrm{CR}_i$$

As Andersen *et al* (2016) explain and was shown by the test cases, the CHASE aggregation method is robust towards the “dilution effect” which describes the situation in which several low-scoring indicators can mask the effect of one or a few indicators having a high Contamination Ratio.

• **Step 3** – For each of the categories I-III, if the aggregated Contamination Score is less than 1.0, the status is determined to be good, otherwise it is not good. The classes good and not good are subdivided into, respectively, 2 and 3 sub-classes, according to the value of the aggregated Contamination Score, as shown in Table 1. The sub-classes allow giving a visual representation of ‘distance to target’ that can help to e.g. distinguish an area with a very high contamination score from an area with a score closer to 1.

Table 1. Category Status Classes (2-Class and 5-Class divisions) determined by the Contamination Score (CS).

CS ≤1.0	CS ≤0.5	Good
	0.5 < CS ≤1.0	Good
CS >1.0	1.0 < CS ≤5.0	Not good
	5.0 < CS ≤10.0	Not good
	CS >10.0	Not good

• **Step 4** – The overall assessment classification is determined by the “One-out-all-out” method. That is, the worst-scoring Category of the three Categories I, II, III determines the overall status. The score the category received is retained to indicate how far from 1 the overall assessment is, thus a visual ‘distance to target’ representation is also possible for the overall assessment result.

1.4 Output structure

The R-script generates two sets of tabular output. In the Shiny app, these results are visible in tabs on the website. The R-script run locally in an R-environment generates text files containing the same information.

1.4.1 Indicator Contamination Ratios

The first tabular output from the tool reproduces the input data with indicator status values and corresponding threshold values, listed by assessment unit. Additional columns show the resulting Contamination Ratio calculated for each indicator, as well as the Contamination Score for the ‘Assessment Unit’-’Category’ combination to which the indicator belongs.

This first tabular result showing individual Contamination Ratios and used in conjunction with the second set of results helps the user identify which individual indicators could have contributed to the overall result for an assessment unit.

1.4.2 Category Contamination Scores

The second tabular output lists the results by Assessment unit. Table 2 shows an example of these results. For each assessment unit, the contaminations scores within each Category and the Overall Assessment results are displayed. A separate column is included in the table for each of the three Categories, showing the calculated Contamination Score for each Category within an assessment unit.

If no indicators representing one of the categories were used in any of the assessment units, then the corresponding column will not be displayed in the results tables. In our example, this is the case for the Water Category which is thus excluded from the results (**Table 2**).

The column "Worst" shows the name of the Category having the worst (greatest) contamination score. This score determines the Overall Status for the assessment unit which is also included in the set of results.

Table 2. Example of CHASE output, for an assessment using indicators only for the Biota and Sediment Categories.

Waterbody	Biota	Sediment	Worst	Contamination Score	Status
1	16.60		Biota	16.60	Not good
2	11.68	4.37	Biota	11.68	Not good
3	22.22	2.64	Biota	22.22	Not good
4		3.22	Sediment	3.22	Not good
5	7.31		Biota	7.31	Not good
6	6.46	9.63	Sediment	9.63	Not good
7		0.23	Sediment	0.23	Good
8	13.38		Biota	13.38	Not good
9	5.59		Biota	5.59	Not good

1.4.3. Category Confidence Scores

In addition to the primary assessment results, CHASE also generates Confidence results (Table 3). For further information on the confidence scoring, see section 2.2.

Table 3. Example of CHASE Confidence results.

Waterbody	Biota	Sediment	Confidence	Class
1	0.74		0.74	II
2	0.92	0.79	0.86	I
3	0.77	0.78	0.77	I
4		0.73	0.73	II
5	0.81		0.81	I
6	0.83	0.86	0.85	I
7		0.83	0.83	I
8	0.81		0.81	I
9	0.83		0.83	I

1.5 Testing the tool

The development of the CHASE tool through the HELCOM BalticBOOST project has included testing the tool so that different outputs have been produced. The test outputs have been used as decision support material for the HELCOM community when considering the development proposals of the project. The test results have thus supported the finalization of the development of the tool to be aligned with the HOLAS II assessment needs.

In summary, the results of tests cases show that the overall assessment outcome tends to be similar when either the OOAO or the CHASE integration is used, whereas the test output tends to differ more significantly when different sets of indicators are used as input.

Test cases have been prepared for offshore areas, and also for several coastal areas in order to explore differences in the overall outcome between the CHASE method and the application of the one-out-all-out (OOAO) method between indicators as applied in the EU Water Framework Directive (WFD). The tests have also explored the effect on the overall output of including different sets of indicators, namely 'only HELCOM core indicators', 'core indicators, HBC, DDE and Cu', 'all available data' (i.e. any available data, whether core indicator related or other) and the effect of including and excluding the HELCOM core indicator on radionuclides. An overview of the tests presented in Table 4.

Table 4. Overview of test cases for the CHASE tool carried out in the BalticBOOST project as decision support material for finalizing the tool development.

Test area		Test cases			
		CHASE integration vs. OOAO for all available substance	CHASE integration vs. OOAO for core indicators only	CHASE integration for core indicators + HCB, DDE, Cu	CHASE integration including and excluding radionuclides
Offshore assessment units	Kiel Bay		X		X
	Arkona Basin		X		X
	Eastern Gotland Basin		X		X
Coastal assessment units	Estonia	X	X	X	
	Germany	X			
	Poland	X			
	Denmark		X		

1.5.1 Offshore assessment units: Kiel Bay, Arkona Basin, Eastern Gotland Basin

Test case areas are examined using data extracted from COMBINE in August 2016. For the offshore test case areas, only substances included among the core indicators are included in the testing (cf. approach 4 as described in BaltiBOOST HZ WS 2-2015 meeting document 1). The areas Kiel Bay, Arkona Basin and East Gotland Basis were selected as test case areas based on the availability of data, and their different geographical features. The BalticBOOST project originally proposed the use of another set of offshore assessment units for the test areas, however when the data extraction was made it was noted that insufficient data was available in these areas to produce relevant examples as a decision basis in HELCOM.

For the selected case study areas, there were no data available for biological effects. Therefore it was not possible to calculate results for that category, and consecutively explore the effects of switching the category on and off.

1.5.1.1 Description of the test case areas

Kiel Bay is located in the south-western part of the Baltic Sea, between Schleswig-Holstein and Denmark. The water is brackish as in the rest of the Baltic Sea. The bay is relatively shallow, with depth on 20-30 meters.

The Arkona Basin is located in the Baltic Sea south of Sweden, north of Germany and with its eastern and western borders flanked by Bornholm and Zealand. The catchment area of Arkona Basin is Poland, Sweden, Germany, Czech Republic and Denmark.

The Eastern Gotland Basin is in the Baltic Sea stretching from Poland in South northwards between the western coast of Lithuania and Latvia and the western coast of Gotland Island. Within this basin is the Gotland Deep, an anoxic basin 249 meters deep. The catchment area of the Eastern Gotland Basin is constituted by seven different countries (Poland, Belarus, Lithuania, Russia, Ukraine, Slovak Republic and Sweden).

1.5.1.2 Results of applying OOAO method

The results of applying the OOAO method at the indicator level are shown in Figure 3. In all three areas, there is at least one of the indicators for which the observed value exceeds the threshold. All areas show therefore 'not good' status.

Figure 3. Open sea test case areas. From left to right, 004 (Kiel Bay), 006 (Arkona Basin) and 009 (East Gotland Basin). The figure shows results applying an OOAO assessment method for the core indicators. The red colour indicates that all 3 areas have 'not good' status.

1.5.1.3 Results of applying the CHASE method

Applying the CHASE method, a status is calculated for each of the categories. Applying OOAO between the categories (Biota, Sediment, Water) gives the overall CHASE status for the assessment unit in question.

The results of the three case studies show that the poorest status is seen in the Biota category and that these determine the overall status (Figure 4).

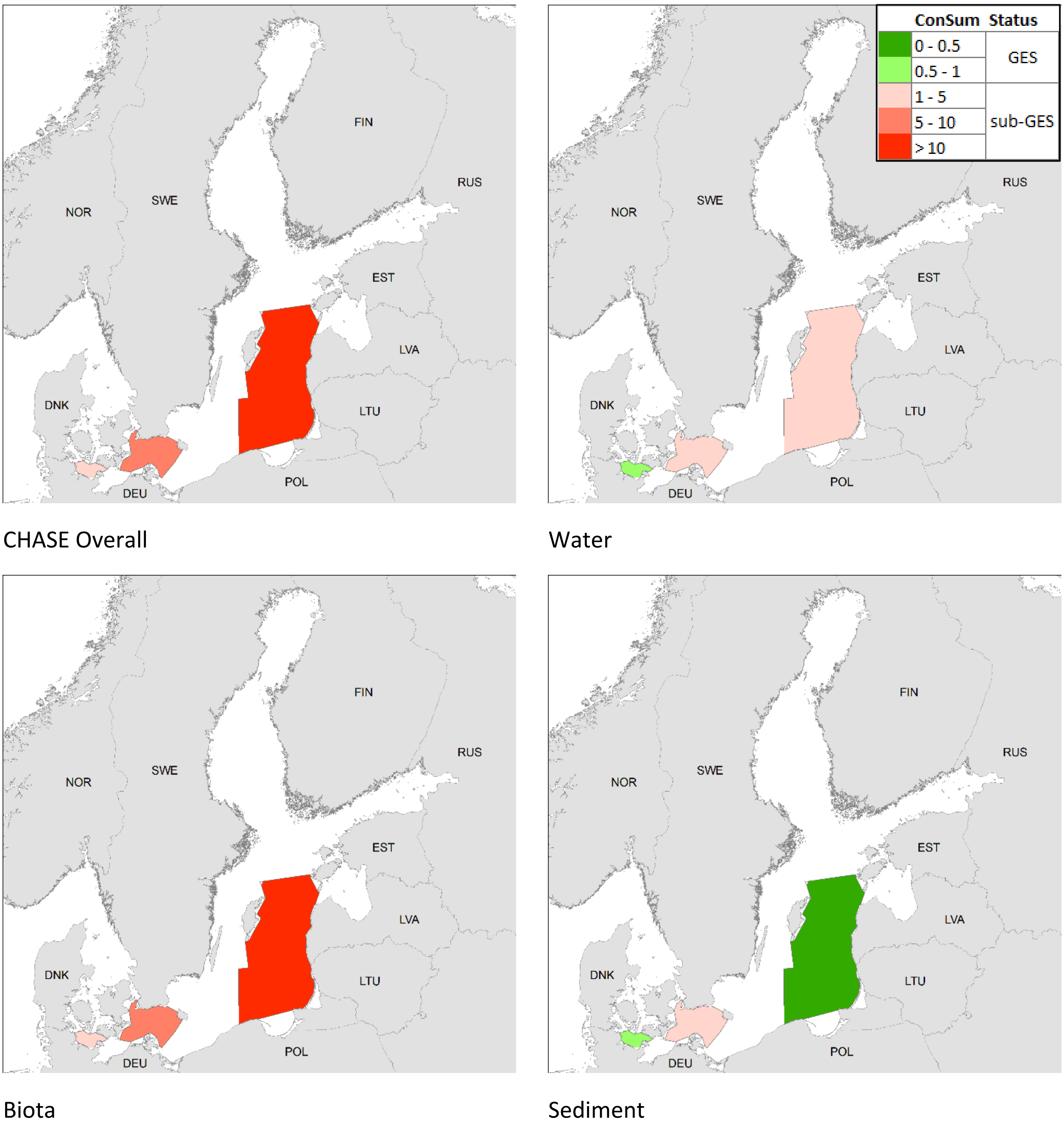


Figure 4. Open sea areas tested from left to right, 004 (Kiel Bay), 006 (Arkona Basin) and 009 (East Gotland Basin). Showing results of CHASE assessments per category and the overall CHASE assessment including the final OOAO step. As no bio-effect data were available in the extracted data, no assessment results are shown for that category. The colours indicate the distance from good chemical status on a 5-step scale.

HOLAS II 5-2016 requested BalticBOOST WP 2.1 to test the CHASE approach with and without the radioactive substances to explore the effect on the assessment output. Table 5 shows that the effect in general seems negligible. In one case, SEA-006 water, the status assessment changes from not good to good when radionuclides are excluded. However it should be noted that only 3 respectively 2 indicators were available for use in each case.

Table 5. Results by category (Biota, Sediment, Water) for the selected Open Sea Areas, showing effect of including or excluding radionuclide indicators.

		Incl. Radionuclide indicators			Excl. Radionuclide indicators		
Waterbody	**category**	**Ind. Count**	**CHASE Result**	**CHASE Status**	**Ind. Count**	**CHASE Result**	**CHASE Status**
SEA-004	Biota	4	1.47	Not good	2	1.34	Not good
SEA-004	Water	3	0.89	Good	2	0.11	Good
SEA-004	Sediment	5	0.69	Good	5	0.69	Good
SEA-006	Biota	15	4.58	Not good	12	4.35	Not good
SEA-006	Water	3	1.23	Not good	2	0.24	Good
SEA-006	Sediment	5	1.20	Not good	5	1.20	Not good
SEA-009	Biota	9	6.99	Not good	7	6.90	Not good
SEA-009	Water	3	1.98	Not good	2	1.02	Not good
SEA-009	Sediment	4	0.14	Good	4	0.14	Good

The final CHASE integration applies a OOAO between the four categories determining the overall status assessment for the assessment unit. Table 6 shows that for all the three test case areas the final status assessment is sub-GES, both when the CHASE approach is used and when an OOAO between individual substances is used. The CHASE approach however allows for inclusion of some additional information on the distance from the threshold.

Table 6. Results by test case assessment unit showing overall status using both CHASE and OOAO (One-out all-out) between substances.

Waterbody	Biota	Water	Sediment	Worst	CHASE Result	CHASE Status	Status OOAO
SEA-004	1.47	0.89	0.69	Biota	1.47	Not good	Not good
SEA-006	4.58	1.23	1.20	Biota	4.58	Not good	Not good
SEA-009	6.99	1.98	0.14	Biota	6.99	Not good	Not good

1.5.2 Coastal assessment units: Estonia, Germany, Poland, Denmark

1.5.2.1 Estonia

1.5.2.1.1 Description of the test case area

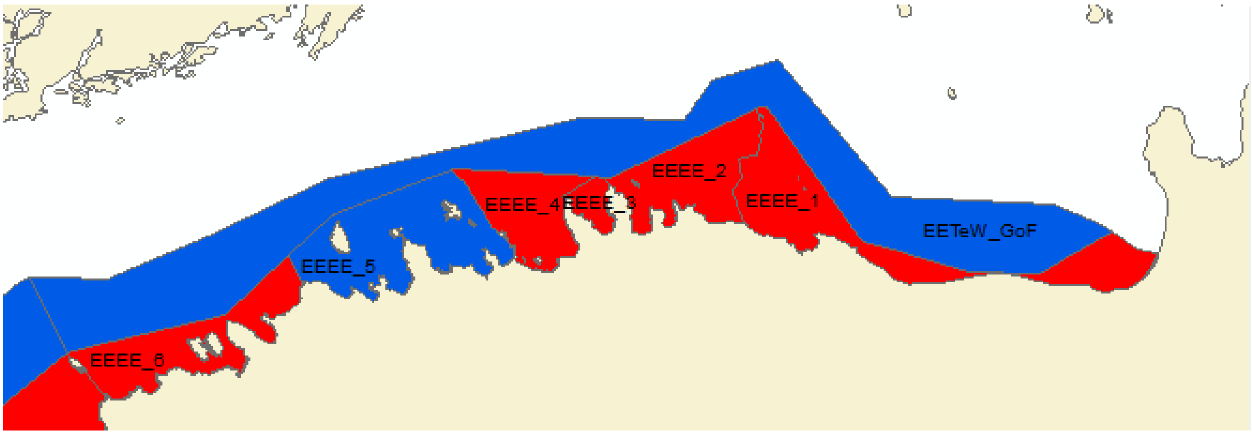
The Gulf of Finland is the most eastern part of the Baltic Sea, located between Finland, Russia and Estonia. It is relatively shallow, and has a low salinity (2-6‰) due to the influx of freshwater from the Neva River. At the eastern end, the Gulf ends in Neva Bay and at the western end, it merges with the Baltic Sea. The Narva-Kunda Bay, Hara Bay, Kolga Bay and Muuga-Tallinna-Kakumäe Bay are all water bodies at the Northern coast of Estonia, With Narva-Kunda and Muuga-Tallinna-Kakumäe Bay as the most eastern and western coastal Estonian water bodies, respectively.

1.5.2.1.2 WFD chemical status (OOAO) assessment results compared to CHASE integration

The data set is made up of the provided assessment details in the HELCOM data call for WFD second cycle assessments. This small data set is good for the purposes of this test as it contains a limited number of waterbodies allowing for a clear comparison between the waterbodies and different outputs.

The BalticBOOST WP 2.1 made a test with the Estonian Gulf of Finland assessment results, using CHASE to explore how the integration method affects the assessment outcome compared to the WFD assessment results where the OOAO method is applied. The background to the test approaches is outlined in the workshop BalticBOOST HZ WS 2-2016 meeting document 1.

The 'approach 3' is a CHASE integration of "all substances" available, exemplified by the results under the heading 'CHASE assessment'. "All substances" in this test case means all the substances used by Estonia in their WFD chemical status assessment.



Waterbody ID	Waterbody name	WFD Chemical Status	CHASE of all substances included in WFD assessment 'cf. approach 3'	
			ConSum	Status
EEEE_1	Coastal water of Narva-Kunda Bay	Failed	1.97	Not good
EEEE_3	Coastal water of Hara Bay	Failed	1.87	Not good
EEEE_4	Coastal water of Kolga Bay	Failed	1.33	Not good
EEEE_5	Coastal water of Muuga-Tallinna-Kakumäe Bay	Good	0.87	Good
EETeW_GoF	Territorial waters of Estonia (Gulf of Finland)	Good	0.81	Good

Figure 5. Results for CHASE tool applied to Estonian assessment details of chemical status, columns show the WFD assessment based on the OOAO approach between substances and the CHASE aggregated approach for the same substances.

In addition to applying the CHASE calculations to the same set of indicators which were used to assess the WFD Chemical status, two further calculations. The 'approach 4' is a CHASE integration of only agreed HELCOM core indicators, exemplified by results under the heading 'CHASE core assessment'. In addition to core indicators, Contracting Parties have indicated that three substances (HCB, DDT and Cu) could be included in the assessments, exemplified by results under the heading 'CHASE core + 3 assessment' (Figure 5). Table **7** compares the number of indicators in each of the sets and the corresponding status results of the three tested approaches. The test can be carried out using the ShinyApp application (Figure 6).

Table 7. Results for CHASE tool applied to different sets of Estonian chemical status indicators.

Waterbody	CHASE assessment 'cf approach 3'			CHASE core assessment 'cf. approach 4'			CHASE core + 3 assessment		
	Count	ConSum	Status	Count	ConSum	Status	Count	ConSum	Status

EEEE_1	34	1.97	sub-GES	12	2.83	sub-GES	17	0.84	GES
EEEE_3	8	1.87	sub-GES	3	2.85	sub-GES	5	2.21	sub-GES
EEEE_4	8	1.33	sub-GES	3	1.91	sub-GES	5	1.49	sub-GES
EEEE_5	38	0.87	GES	12	1.07	sub-GES	16	0.6	GES
EETeW_GoF	8	0.81	GES	3	1.07	sub-GES	5	0.83	GES

Figure 6. It is possible to consider the results more closely in the 'ShinyApp' web application illustrated by this screen shot.

It should be noted that the provided example result using the CHASE integration shows how the method affects the assessment output and are not intended as proposals for final assessment outputs. For example, it could be noted that for the sake of demonstration, anthracene and fluoranthene are included in the example where only core indicators are include, although the Estonian measurements are in the water matrix and the secondary GES boundary agreed for the substances is defined for biota and sediment measurements.

1.5.2.1.3 Conclusion regarding the Estonian coastal test case

Applying the CHASE tool to the Estonian assessment results in an outcome comparable with the national WFD chemical status assessment when the same substances are included in the analyses(Annex 2 Figure 3). In both assessments only the waterbodies EEEE_5 and EETeW_GoF achieve a good status.

When the 'CHASE assessment' (approach 3 -all available substances) is compared to the 'CHASE core assessment' (approach 4' - only the HELCOM core indicators) the result differs for some of the waterbodies (Annex 2 Table 3). The result also differs when the three additional substances are included in addition to the core indicators (Annex 2 Table 3). An overall conclusion based on the test case is that the selection of indicators or substances to include in the integration affects the assessment outcome.

Thus, based on the Estonian test case, it would seem that when the same substances are included in an OOAO between substances or a CHASE integration (Annex 2 Figure 3) the result does not differ significantly, however when different substances are included in the CHASE integration (Annex 2 Table 3) the results differ.

1.5.2.2. Germany

1.5.2.2.1 Description of the test case area

The assessment units of in the Schleswig-Holstein are Eckernfoerder Bucht, Flensburg Innenfoerde, Kieler Aussenfoerde, Kuestenmeer Schlei/Trave and Mittlere Shclei. Eckernförde Bay is a fjord in Schleswig-Holstein a part of the Baltic Sea and Kieler Bay. It is 17 km long. Flensburg Fjord, is the westernmost inlet of the Baltic Sea and is located between Denmark and Germany. The inner part of the fjord is 2-3 km wide. The entire fjord is 50 km long with a maximum of 19 meter. Saline water enters the inner fjord, across Holnis Sill, creating a pycnocline between the salty bottom water and the less salty top water. The Kiel Fjord is 17 km long, and is an inlet of the Baltic sea. At its outer part, it merges into the Kiel Bay. The Schlei / Trave waterbody encompasses the waters in the eastern part of Schleswig-Holstein from the German-Danish border and is a part of the Baltic Sea. The Schlei is a 43 km long and 3.4 km narrow inlet of the Baltic Sea. The water in Schlei is brackish with decreasing salinity from the outer to the inner part of the inlet.

1.5.2.2.2 WFD chemical status (OOAO) assessment results compared to CHASE integration

A test dataset delivered by Germany with concentrations of substances measured in sediment and seawater was used to produce the assessment outputs below, comparing OOAO by substance with the CHASE methodology for the assessment units of Schleswig-Holstein.

The overall assessment results are in general similar when the OOAO or the CHASE approach is applied, however the Kieler Aussenfoerde is classified as achieving good chemical status when the OOAO approach is applied and to be at sub-GES when the CHASE is applied, and vice versa the Mittlere Schlei is classified as not achieving the threshold value when OOAO is applied but to reach the threshold value when CHASE is applied (Table 8).

Table 8. Result table for the German test case for six assessment units in Schleswig-Holstein applying the WFD approach of one-out-all-out (OOAO) or the CHASE integration.

	OOAO		CHASE	
Waterbody	**ConScore**	**Status**	**ConSum**	**Status**
Eckernfoerder Bucht, Rand	0.50	Good	0.36	Good
Eckernfoerder Bucht, Tiefe	0.34	Good	0.56	Good
Flensburg Innenfoerde	1.65	Good	2.72	Not good
Kieler Aussenfoerde	0.71	Good	1.03	Not good
Kuestenmeer Schlei/Trave	0.50	Good	0.45	Good
Mittlere Schlei	1.10	Not good	0.83	Good

Data Results

	Waterbody	water	sediment	Worst	ConSum	Status
1	Eckernfoerder Bucht, Rand	0.36		water	0.36	High
2	Eckernfoerder Bucht, Tiefe		0.56	sediment	0.56	Good
3	Flensburg Innenfoerde	0.37	2.72	sediment	2.72	Moderate
4	Kieler Aussenfoerde	0.36	1.03	sediment	1.03	Moderate
5	Kuestenmeer Schlei/Trave	0.37	0.45	sediment	0.45	High
6	Mittlere Schlei	0.41	0.83	sediment	0.83	Good

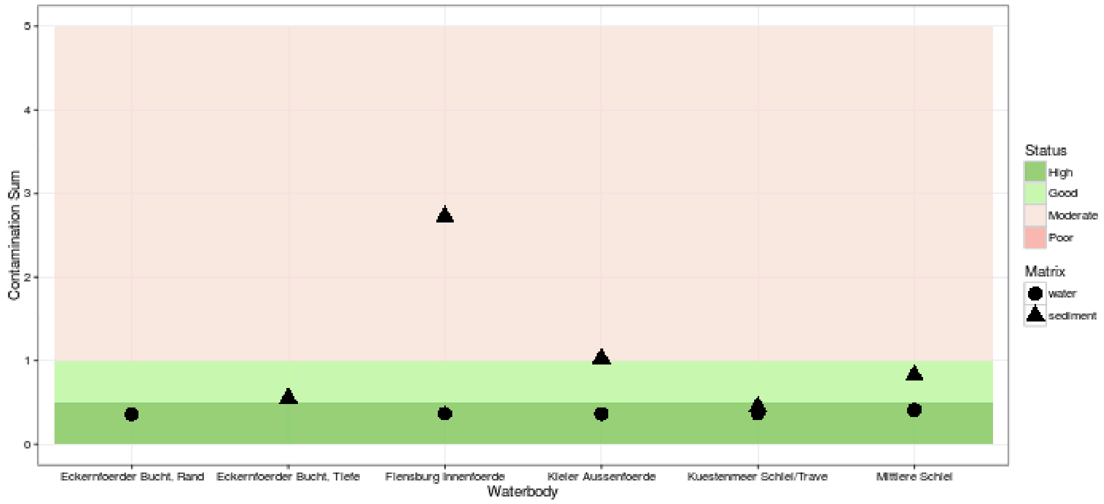


Figure 7. The German test case are displayed as a screen shot of the Shiny App.

The German results for the six assessment units generally display similar status classes for the two assessed categories, water and sediment, however a significantly more contaminated status is reflected for sediment in Flensburg Innenfoerde than in water (Figure 7).

There is a good agreement between the CHASE results and the results of the OOAO method in 4 out of 6 waterbodies. In Kieler Aussenfoerde, none of the individual substances exceed their threshold values. However, three substances in the sediment phase have concentrations close to or exceeding 70% of the threshold value. This is just sufficient for the aggregated CHASE Contamination Sum to exceed 1.0, giving a "Not good" status overall.

In Mittlere Schlei, the reverse is seen: that is, CHASE gives a "Good" status where the status according to the OOAO method is "Not good". The overall status is determined by the sediment phase. Here, the concentration of 1 of 14 measured substances exceeded its threshold value by approximately 10%. All other concentrations were less than 50% of the threshold value, 10 of them below 20%. In such a case, the CHASE method returns a "Good" status even though one of the individual substances does have a concentration just exceeding its threshold.

1.5.2.3 Poland

1.5.2.3.1 Description of the test case area

The assessment units of the coastal parts of Poland, is manly located around Gdańsk Bay and the Oder Lagoon. Gdańsk Bay is a bay at the south-eastern part of the Baltic Sea. The maximum depth of Gdańsk Bay is 120 meter and has a salinity on 7 ‰. The Bay is enclosed by the shores of both Poland (Gdańsk Pomerania) and Russia (Kaliningrad Oblast). The Oder Lagoon is in the south-eastern parts of the Baltic Sea, along the coast of Germany and Poland. The Lagoon consist of smaller water bodies/assessment units. The

Oder River discharge into the Lagoon together with other minor rivers. The lagoon is relatively shallow, having an average water depth on 4 meter and maximum depth on 9 meter. It has a low salinity between 0.5 and 2 ‰.

1.5.2.3.2 WFD chemical status (OOAO) assessment results compared to CHASE integration

The CHASE methodology was applied to the Polish test dataset for the chemical status for the second cycle of the WFD. This dataset included only substance concentrations measured in seawater, thus no comparison of differences between categories was possible.

All Polish assessment units were assessed to fail good chemical status when applying the OOAO approach of the WFD, and when the CHASE assessment was applied three assessment units were assessed to achieve good chemical status (Table 9 and Figure 8).

This case study actually demonstrates the robustness of the CHASE method towards the dilution effect. In this example, there are many waterbodies having a great number of indicators, of which only a few exceeded the threshold value. CHASE still gives an overall “not-good” status in most cases. In only three waterbodies can one see a status from CHASE which is “good” where the OOAO method results in “not good”.

The worst contamination which “slips through the net” when applying the CHASE method is the case of Jaroslawiec Sarbinowo (row 2 in Table 9) where only 1 single substance out of 50 measured has a concentration exceeding threshold value. Despite CHASE’s robustness, in this case there are 46 of 50 substances where concentrations are less than 20% of the threshold value or lower and thus the CHASE aggregation method does not record an overall “not-good” status.

Table 9. Polish test case of applying the one-out-all-out (OOAO) approach as in the WFD compared to the CHASE approach.

Waterbody	OOAO		CHASE	
	ConScore	Status	ConSum	Status
Dziwna-Swina	5.50	Not good	1.57	Not good
Jaroslawiec_Sarbinowo	1.65	Not good	0.80	Good
JastrzebiaGora-Rowy	1.75	Not good	1.17	Not good
MierzejaWislana	2.50	Not good	2.20	Not good
PolwysepHel	1.88	Not good	1.11	Not good
Rowy-JaroslawiecWschod	2.50	Not good	1.92	Not good
Sarbinowo-Dziwna	1.12	Not good	0.74	Good
UjscieSwiny	3.14	Not good	1.2	Not good
UjscieWislyPrzekop	2.50	Not good	2.05	Not good
Wladyslawowo-JastrzebiaGora	1.88	Not good	1.34	Not good
ZalewKamienski	1.17	Not good	1.00	Good
ZalewPucki	2.67	Not good	2.31	Not good
ZalewSzczecinski	6.32	Not good	2.06	Not good
ZalewWislany	25.06	Not good	4.59	Not good
ZatokaGdanskaWewnetrzna	2.50	Not good	2.16	Not good
ZatokaPuckaZewnetrzna	2.50	Not good	2.22	Not good

Data Results

	Waterbody	water	Worst	ConSum	Status
1	Dziwna-Swina	1.57	water	1.57	Moderate
2	Jaroslawiec_Sarbinowo	0.80	water	0.80	Good
3	JastrzebiaGora-Rowy	1.17	water	1.17	Moderate
4	MierzejaWislana	2.20	water	2.20	Moderate
5	PolwysepHel	1.11	water	1.11	Moderate
6	Rowy-JaroslawiecWschod	1.92	water	1.92	Moderate
7	Sarbinowo-Dziwna	0.74	water	0.74	Good
8	UjscieSwiny	1.20	water	1.20	Moderate
9	UjscieWislyPrzekop	2.05	water	2.05	Moderate
10	Wladyslawowo-JastrzebiaGora	1.34	water	1.34	Moderate
11	ZalewKamienski	1.00	water	1.00	Good
12	ZalewPucki	2.31	water	2.31	Moderate
13	ZalewSzczecinski	2.06	water	2.06	Moderate
14	ZalewWislany	4.59	water	4.59	Moderate
15	ZatokaGdanskaWewnetrzna	2.16	water	2.16	Moderate
16	ZatokaPuckaZewnetrzna	2.22	water	2.22	Moderate

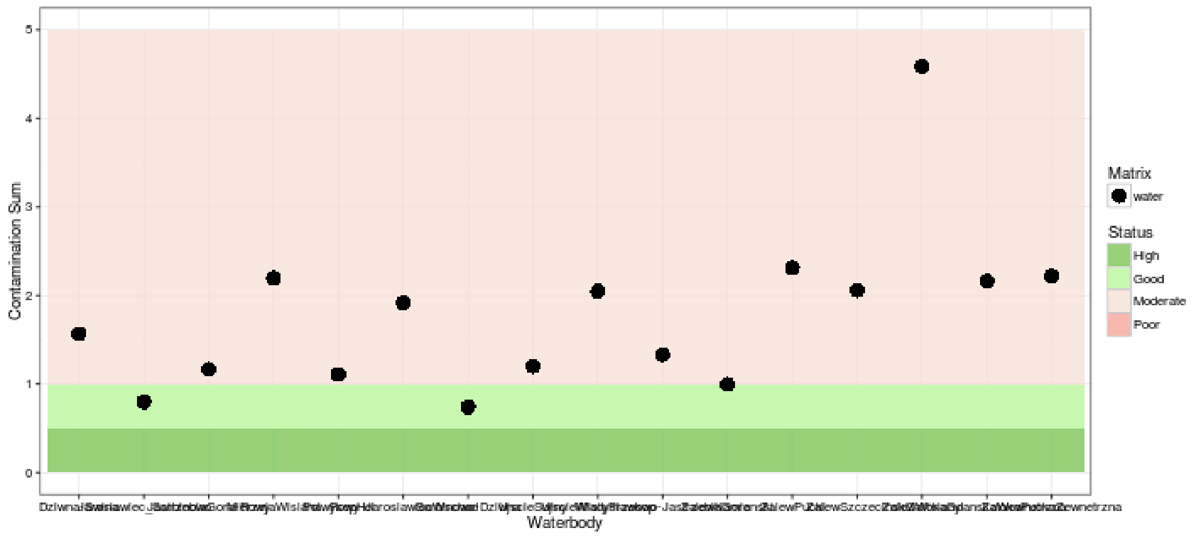


Figure 8. Polish test cases shown as a screen shot from the Shiny App.

1.5.2.4 Denmark

1.5.2.4.1 Description of the test case area

The assessment units for the Danish case study are widely distributed in the Danish Waters. The Danish coastal waters are constituted of the Sound, located between Zealand and Sweden, the Great Belt, located between Zealand and Funen, the Little Belt, located between Funen and Jutland. The assessment units are mainly found in small inlets, bights and fjords of these three waters. The Danish waters are in connection to the Baltic Sea and water discharge from the Baltic Sea through the three straits to the Skagerrak and North Sea. Therefore, the Danish waters are brackish however, due to the connection to the North Sea, it has a higher salinity than the rest of the Baltic Sea.

Data were downloaded from:

http://dome.ices.dk/views/ContaminantsBiota.aspx

http://dome.ices.dk/views/ContaminantsSediment.aspx

Table 10.Results for test when applying the CHASE integration vs one-out-all-out (OOAO) for HELCOM core indicators in Danish waters.

Assessment unit	Biota	Sediment		Worst	CHASE	OOAO	Indicator with worst status
Roskilde Fjord, ydre	96,50	0,66		Biota	96,50	302,69	PFOS, Fish (µg/kg WW)
Roskilde Fjord, indre	3,89	1,99		Biota	3,89	3,78	Pb, Fish (µg/kg DW)
Nordlige Øresund	135,16	0,88		Biota	135,16	259,34	PFOS, Fish (µg/kg WW)
Øresund, 12 sm		0,29		Sediment	0,29	0,37	Anthracene, Sediment (µg/kg DW)
Korsør Nor		1,16		Sediment	1,16	1,48	Anthracene, Sediment (µg/kg DW)
Isefjord, ydre	20,25			Biota	20,25	49,65	PBDEs, Shellfish (µg/kg WW)
Skælskør Fjord og Nor	0,81	3,17		Sediment	3,17	4,25	Anthracene, Sediment (µg/kg DW)
Musholm Bugt, indre	4,62	0,07		Biota	4,62	5,76	PBDEs, Shellfish (µg/kg WW)
Kalundborg Fjord	3,31			Biota	3,31	4,00	PBDEs, Shellfish (µg/kg WW)
Karrebæk Fjord	104,73	2,62		Biota	104,73	329,99	PFOS, Fish (µg/kg WW)
Avnø Fjord	1,57			Biota	1,57	1,72	Hg, Shellfish (µg/kg WW)
Guldborgsund	3,54	0,11		Biota	3,54	5,35	PBDEs, Shellfish (µg/kg WW)
Østersøen	77,37	0,88		Biota	77,37	116,98	PFOS, Fish (µg/kg WW)
Præstø Fjord	1,95	0,20		Biota	1,95	2,20	PBDEs, Shellfish (µg/kg WW)
Stege Bugt	3,41	3,84		Sediment	3,84	5,21	Anthracene, Sediment (µg/kg DW)
Stege Nor		6,49		Sediment	6,49	10,05	Anthracene, Sediment (µg/kg DW)
Bornholm, 12 sm	2,42			Biota	2,42	3,54	Cd, Shellfish (µg/kg DW)
Lillestrand	2,03	0,05		Biota	2,03	2,29	PBDEs, Shellfish (µg/kg WW)
Nakkebølle Fjord	121,07			Biota	121,07	401,52	PFOS, Fish (µg/kg WW)
Kløven		1,07		Sediment	1,07	1,09	Cd, Sediment (mg/kg DW)
Nyborg Fjord	##### ###	100,48		Biota	11671 10,7	30878 80,8	Dioxins, Shellfish (µg/kg WW)
Helnæs Bugt	0,63	0,52		Biota	0,63	0,76	Cd, Shellfish (µg/kg DW)
Langelandssund	1,75	0,42		Biota	1,75	2,00	PBDEs, Shellfish (µg/kg WW)
Odense Fjord, ydre	17829 0,18	0,25		Biota	17829 0,18	61757 6,25	Dioxins, Shellfish (µg/kg WW)
Storebælt, NV	0,91			Biota	0,91	0,96	Cd, Shellfish (µg/kg DW)

Assessment unit	**Biota**	**Sediment**		**Worst**	**CHASE**	**OOAO**	**Indicator with worst status**
Lillebælt, syd 12 sm		0,95		Sediment	0,95	0,88	Anthracene, Sediment (µg/kg DW)
Genner Bugt	1	0,63		Biota	1	1	Cd, Shellfish (µg/kg DW)
Åbenrå Fjord	1,53	2,12		Sediment	2,12	2,93	Anthracene, Sediment (µg/kg DW)
Als Fjord	1,09	1,93		Sediment	1,93	2,87	Anthracene, Sediment (µg/kg DW)
Als Sund	6,90	0,22		Biota	6,90	16,00	PBDEs, Shellfish (µg/kg WW)
Augustenborg Fjord	3,27	2,17		Biota	3,27	5,65	PBDEs, Shellfish (µg/kg WW)
Haderslev Fjord	2,68			Biota	2,68	3,22	PBDEs, Shellfish (µg/kg WW)
Juvre Dyb, tidevandsområde	4,09			Biota	4,09	4,71	PBDEs, Shellfish (µg/kg WW)
Avnø Vig		0,39		Sediment	0,39	0,42	Anthracene, Sediment (µg/kg DW)
Hejlsminde Nor	2,93	3,50		Sediment	3,50	5,93	Anthracene, Sediment (µg/kg DW)
Nybøl Nor	256,12	0,35		Biota	256,12	560,44	PFOS, Fish (µg/kg WW)
Lister Dyb	3,60	0,37		Biota	3,60	4,29	PBDEs, Shellfish (µg/kg WW)
Flensborg Fjord, indre	1,18			Biota	1,18	1,65	Cd, Shellfish (µg/kg DW)
Flensborg Fjord, ydre	0,67	0,87		Sediment	0,87	0,65	Anthracene, Sediment (µg/kg DW)
Knudedyb, tidevandsområde	2,55	0,20		Biota	2,55	2,95	Hg, Shellfish (µg/kg WW)
Grådyb, tidevandsområde	118,11	0,74		Biota	118,11	370,39	PFOS, Fish (µg/kg WW)
Vejle Fjord, ydre	0,92	0,45		Biota	0,92	0,69	Hg, Shellfish (µg/kg WW)
Vejle Fjord, indre		0,64		Sediment	0,64	0,58	Cd, Sediment (mg/kg DW)
Kolding Fjord, indre		2,41		Sediment	2,41	3,50	Anthracene, Sediment (µg/kg DW)
Kolding Fjord, ydre		0,73		Sediment	0,73	0,61	Anthracene, Sediment (µg/kg DW)
Horsens Fjord, ydre	144,50			Biota	144,50	377,91	Hg, Shellfish (µg/kg WW)
Horsens Fjord, indre	3,75	0,83		Biota	3,75	7,35	PBDEs, Shellfish (µg/kg WW)
Nissum Fjord, ydre		0,06		Sediment	0,06	0,05	Pb, Sediment (mg/kg DW)
Nissum Fjord, Felsted Kog		1,54		Sediment	1,54	1,53	Anthracene, Sediment (µg/kg DW)
Ringkøbing Fjord	5,10	0,22		Biota	5,10	6,50	PBDEs, Shellfish (µg/kg WW)
Randers Fjord, Grund Fjord		0,32		Sediment	0,32	0,37	Anthracene, Sediment (µg/kg DW)
Randers Fjord, ydre	191,05	0,44		Biota	191,05	632,56	PFOS, Fish (µg/kg WW)
Hevring Bugt		0,13		Sediment	0,13	0,09	Pb, Sediment (mg/kg DW)

Assessment unit	Biota	Sediment		Worst	CHASE	OOAO	Indicator with worst status
Anholt	0,72			Biota	0,72	0,53	Hg, Shellfish (µg/kg WW)
Djursland Øst		0,11		Sediment	0,11	0,13	Anthracene, Sediment (µg/kg DW)
Ebeltoft Vig	1,07	0,66		Biota	1,07	1,05	Cd, Shellfish (µg/kg DW)
Kalø Vig, indre		1,22		Sediment	1,22	1,15	Anthracene, Sediment (µg/kg DW)
Norsminde Fjord		0,22		Sediment	0,22	0,19	Cd, Sediment (mg/kg DW)
Århus Bugt, Kalø og Begtrup Vig	124,65	0,47		Biota	124,65	390,59	PFOS, Fish (µg/kg WW)
Kattegat, Læsø		0,07		Sediment	0,07	0,08	Pb, Sediment (mg/kg DW)
Nissum, Thisted, Kås, Løgstør, Nibe, Langerak	230,80	0,67		Biota	230,80	780,22	PFOS, Fish (µg/kg WW)
Lovns, Skive, Riisgårde, Bjørnholms bugt	1,67	0,75		Biota	1,67	1,69	PBDEs, Shellfish (µg/kg WW)
Hjarbæk Fjord	1,17	0,90		Biota	1,17	1,24	Cd, Shellfish (µg/kg DW)
Mariager Fjord, indre	1,06	0,06		Biota	1,06	1,76	PBDEs, Shellfish (µg/kg WW)
Mariager Fjord, ydre	1,99	0,24		Biota	1,99	2,35	PBDEs, Shellfish (µg/kg WW)
Nordlige Kattegat, 12 sm		0,22		Sediment	0,22	0,18	Pb, Sediment (mg/kg DW)
Isefjord, indre	1,33			Biota	1,33	1,54	Pb, Shellfish (µg/kg DW)
Kattegat, Nordsjælland		0,07		Sediment	0,07	0,06	Pb, Sediment (mg/kg DW)
Køge Bugt	2,38	0,72		Biota	2,38	2,36	Cd, Shellfish (µg/kg DW)
Kattegat, SØ 12 sm		0,08		Sediment	0,08	0,07	Anthracene, Sediment (µg/kg DW)
Storebælt, nord 12 sm		1,08		Sediment	1,08	1,08	Anthracene, Sediment (µg/kg DW)
Jammerland Bugt	1,59	1,68		Sediment	1,68	2,46	Anthracene, Sediment (µg/kg DW)
Smålandsfarvandet, åbne del	200,70	0,58		Biota	200,70	620,11	PFOS, Fish (µg/kg WW)
Nakskov Fjord	2,87	0,13		Biota	2,87	3,24	PBDEs, Shellfish (µg/kg WW)
Rødsand	1,37	0,51		Biota	1,37	1,39	Cd, Shellfish (µg/kg DW)
Østersøen, 12 sm		0,64		Sediment	0,64	0,44	Pb, Sediment (mg/kg DW)
Faaborg Fjord		3,02		Sediment	3,02	3,84	Anthracene, Sediment (µg/kg DW)
Torø Vig og Torø Nor		0,43		Sediment	0,43	0,31	Cd, Sediment (mg/kg DW)
Det sydfynske Øhav, åbne del	1,11			Biota	1,11	1,21	Cd, Shellfish (µg/kg DW)
Storebælt, syd 12 sm	2,14			Biota	2,14	1,75	Cd, Shellfish (µg/kg DW)

Assessment unit	Biota	Sediment		Worst	CHASE	OOAO	Indicator with worst status
Lillebælt, syd	3,61	0,45		Biota	3,61	5,28	PBDEs, Shellfish (µg/kg WW)
Lillebælt, Bredningen	2,86	0,71		Biota	2,86	5,18	PBDEs, Shellfish (µg/kg WW)
Vesterhavet, 12 sm	8,33	0,08		Biota	8,33	12,65	PBDEs, Shellfish (µg/kg WW)
Århus Bugt syd, Samsø og Nordlige Bælthav	1,28	0,53		Biota	1,28	1,00	Pb, Shellfish (µg/kg DW)
Kattegat, SV 12 sm		0,10		Sediment	0,10	0,09	Pb, Sediment (mg/kg DW)
Skagerrak	1,14			Biota	1,14	1,09	Hg, Shellfish (µg/kg WW)
Kattegat, Aalborg Bugt	2,21	0,13		Biota	2,21	2,35	PBDEs, Shellfish (µg/kg WW)
Skagerrak, 12 sm		0,15		Sediment	0,15	0,14	Pb, Sediment (mg/kg DW)
Nordlige Lillebælt	0,97	0,75		Biota	0,97	1,05	Cd, Shellfish (µg/kg DW)
Nordlige Kattegat, Ålbæk Bugt		0,17		Sediment	0,17	0,15	Anthracene, Sediment (µg/kg DW)

As Table 10 shows, for 87 of the 90 Danish waterbodies tested here, the CHASE method gave the same overall status as the OOAO method. In one of the remaining three waterbodies (Nordlige Lillebælt) a similar pattern was observed to that seen in the case of the Mittlere Schlei in the Schleswig Holstein (DE) example above (Table 8). That is; a single substance had a concentration exceeding the threshold value by less approximately 5% but the overall CHASE results was “Good”. In the remaining 2 waterbodies (Genner Bugt, Århus Bugt syd), several substances had concentrations close to but not exceeding their thresholds, resulting in a “Not good” status overall when using the CHASE aggregation method.

2. Confidence of the assessment

2.1 Confidence method

As with previous versions of CHASE, the CHASE tool also makes a secondary confidence assessment, in addition to the primary Chemical Status assessment. The confidence assessment reflects the availability of data and the quality of indicators. The method determines the assessment confidence beginning at the indicator level and aggregating confidence scores to arrive at a final overall confidence assessment.

To make a confidence assessment, expert judgement is used to assign a Confidence rating to each indicator: “High”, “Moderate” or “Low”. This rating represents both the quality and quantity of the data used to determine the monitored status value as well as the reliability of the threshold value.

The confidence rating (High, Moderate or Low) is translated to a numerical confidence score for each indicator:

$$c_i = \begin{cases} 1.0, & \text{"}High\text{"} \\ 0.5, & \text{"}Moderate\text{"} \\ 0.0, & \text{"}Low\text{"} \end{cases}$$

The confidence score for the Category (I,II,III) is given by the average of the indicator confidence scores:

$$c_{cat} = \frac{1}{n}\sum_{i=1}^{n} c_i t$$

The overall confidence score is given by the average of the Category confidence scores.

$$c_{overall} = \frac{1}{n}\sum_{i=\mathrm{I}}^{III} c_{cat}$$

Finally, the overall confidence score is converted to a Confidence Status, according to Table 11.

Table 11 Confidence Classes.

Confidence Score	**Confidence Status**
c ≥ 0.75	Class I / High
0.5 ≤ c < 0.75	Class II / Medium
c <0.50	Class III / Low

2.2 Assigning indicator confidence

In CHASE 1.0 and CHASE 2.0, separate confidence ratings were assigned to both the threshold value and the status value for each indicator. In the present version of CHASE a single rating is assigned to each indicator, representing confidence in both the status value and threshold value.

Table 12 shows the rules used to determine the confidence ratings of threshold and status values in CHASE 1.0. Although we are now assigning only one rating per indicator, rather than two, the same principles can be used to guide the choice of confidence rating.

Table 12 Rules for assigning confidence rating in CHASE 1.0 that can be applied as principles to guide the choice of confidence rating in the current version of CHASE.

Confidence	**Threshold**	**Status data**
Low	Statistical No ecotoxicology	Single measurement Rough transformation
Moderate	From different regions Normalization problems Methodological uncertainty	Data from one year Several values <DL Transformation not adequate
High	Published in peer-reviewed journal Sound science Acceptable methodology	Median over years Time trend acknowledged

2.3 Minimum indicator requirements and confidence "penalties"

Additionally a method is needed that makes allowances for the reduction in confidence which might be expected if the assessment were based on a limited number of indicators or based only on indicators for a single matrix (i.e. single category).

The confidence criteria should cover all three categories (**Table 13**). Where assessment units do not meet the suggested requirements for numbers and types of indicators, the resulting confidence scores will be low.

Table 13 Confidence "Penalties" alternative 2.

Applies to	Criteria	Confidence penalty applied if the criteria is NOT met
Overall	At least 2 distinct Heavy metal indicators are included in the assessment (all Categories)	50%
Overall	At least 3 distinct Organic indicators are included in the assessment (all Categories)	50%

As an option to improve the overall confidence of the hazardous substances assessment, assessment units for which the confidence score is very low (e.g. <0.25) the assessment unit could be excluded from the overall assessment. However considering the low data availability in some offshore units a confidence reduction if the minimum requirement list is not fulfilled instead of excluding the assessment unit is considered relevant. Thus, assessment units in which not all matrices or indicators are presently monitored could still be part of the assessment.

3. CHASE 3.0 manual- Step-wise description to apply the hazardous substances integration tool

Step 1 - Prepare the CHASE input data

The input data to the CHASE tool must be prepared so that the structure is as shown in Table 14, below.

The tool does not process "raw" measured data. For each indicator in an assessment unit, the input table should contain only one single representative value for the status value, rather than several measured values. Ideally, several measurements of concentration with a suitable temporal and spatial coverage should be analysed using suitable statistical methods to determine an "average" value. For each indicator "status" value there should be a corresponding threshold value.

Measured concentrations should also be normalized to the same basis on which threshold values are defined, for example to a specific fractional lipid content or on a dry-or wet weight basis.

Some agreed threshold values represent the total concentration of a group of substances (e.g. PCBs or dioxins). In these cases, the monitored status values of the individual substances must be summed to give the indicator value for the group of substances, before this is compared with the threshold value. For dioxins this step also requires use of a toxicity equivalence factor, where concentrations of individual substances are multiplied by different factors, depending on their toxicity.

Step 2 - Ensure data has the correct file format and data structure

When discussing data format, it is helpful to distinguish between the *file format* and the structure of the data. By *file format*, we refer to the proprietary program or method used to store the data in an electronic media, such as a Microsoft Excel spreadsheet. Input data for the CHASE tool should be provided in a semi-colon separated text (ASCII) format. By *data format* we are referring to the tabular structure in which the data should be prepared.

Since many programs allow data to be saved in text format, the choice of program used to prepare the input data is not of primary importance. More importantly, the following table shows the required structure of data for the CHASE tool, with each line in the table representing a single indicator in a spatial assessment unit (or waterbody sensu WFD).

Table 14. Data structure for CHASE assessment.

Waterbody	Category	Indicator	Type	Unit	Status	Threshold	Response	Confidence
Assessment unit 1	Sediment	Substance *X*	Org	µg/l WW	0.5	0.8	+	High
Assessment unit 1	Biota	Substance *X* in mussels	HM	µg/l WW	1	2.0	+	Medium

Waterbody Name of the assessment unit

Category Category to which the indicator belongs (Water, Biota, Sediment). It is not necessary to use precisely these names for the Categories but it is important that use of Category names is consistent.

Indicator Name of the substance / indicator

Type Org (Organic) or HM (Heavy metal). Counts of these are used in confidence calculations.

Unit Measurement unit for the indicator. This should be the units in which both Status and Threshold concentrations are given.

Status Value of the indicator, determined from measurements.

Threshold The threshold value for the indicator (substance).

Response Response indicates the “direction” of the indicator in response to worsening environmental. As described in Section 0 above, most hazardous substance indicators show a positive response. For this reason, the indicator response field is in fact treated as optional for the CHASE assessment tool and any missing entries are assumed to be positive.

Confidence Confidence rating assigned to the indicator: “High”, “Moderate” or “Low”

Step 3 – Run the CHASE R script

- For users familiar with the R, the script should be modified to specify the name and location of the input data.
- The script can then be run from the R environment.
- The output data can be read from the text files generated

- For users who do not wish to use R, the Shiny app can be used to run the script, generating output tables directly on the website. These results can be easily copied into a spreadsheet or other program.

4. Comparison of the CHASE methodology to the Commission Decision on GES criteria

The draft revision of the Commission Decision on GES criteria v. 10.11.2016 (hereafter revised COM DEC) states in the 'use of criteria' how the extent to which GES has been achieved should be expressed for hazardous substances.
The assessment should be given;

- Per assessment unit
    - Per substances as defined in **D8C1** (a,b,c) indicating the;
        - concentration,
        - matrix used, and
        - whether the threshold value has been achieved.
    - The proportion of contaminants (**D8C1** a,b,c) assessed that have achieved their threshold values, including indicating separately substances behaving like ubiquitous persistent, bioaccumulative and toxic substances
    - Per species, as defined in **D8C2**, the abundance of the species in the assessment area that is adversely affected
    - Per habitat, as defined in **D8C2**, an estimate of the area that is adversely affected

(D8C3 and D8C4 are not considered in this document)

4.1 HELCOM assessments in relation to the revised COM DEC

In relation to **D8C1**

- Assessment information per core indicator per assessment unit is provided in the HELCOM core indicator report. This information is aligned with the Commission Decision requirement on how information is to be presented per substance.
- The requirement to present a proportion of the substances that have either exceeded or not exceeded in an area can be complied in a table based on the core indicator results.
- The integrative assessment tool (CHASE) allows for integration of all substances per assessment unit. This provides a more detailed analysis than the requirement of the revised COM DEC.

In relation to **D8C2**

- Assessment information on station wise severity of the effect on single individuals or populations are available per assessment unit in the HELCOM core indicator reports. The core indicators do not provide information on the abundance of the species.
- No HELCOM indicators are available to estimate the effect on habitats.
- Effects on species and habitats are not included in the CHASE assessment tool.

The revised COM DEC states that 'The use of criterion D8C2 in the overall assessment of good environmental status for Descriptor 8 shall be agreed at regional or subregional level.' Based on the agreement at HELCOM STATE & CONSERVATION 5-2016 (outcome paragraph 4J.75) (see para 1.1) there is no integration applied in CHASE between D8C1 and D8C2.

5. References

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