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The Marine Environment Assessment in the Areas with Insufficient Data: The Assessment Results of IMAP Common Indicator 17 in the Central Mediterranean (CEN) Sub-region by Applying the CHASE+ Environmental Assessment Methodology Harmonized with the NEAT GES Assessment Methodology

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List of Abbreviations / Acronyms

ADR	Adriatic Sea Sub-region
AEL	Aegean and Levantine Seas Sub-region
BC	Background Concentration
BAC	Background Assessment Concentrations
CEN	Central Mediterranean Sub-region
CENS	Central Mediterranean Sea sub-division
CHASE	Chemical Status Assessment Tool
CI	Common Indicator
CORMON	Correspondence Group on Monitoring
COP	Conference of the Parties
CR	Contamination Ratio
CS	Contamination Score
EAC	Environmental Assessment Criteria
EMODnet	European Marine Observation and Data Network
ERL	Effects Range Low
EEA	European Environmental Agency
GES	Good Environmental Status
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
IONS	Ionian Sea sub-division
LEVS	Levantine Basin Sea sub-division
MAP	Mediterranean Action Plan
MED	Mediterranean
MB	*Mullus barbatus*
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
NEAT	Nested Environmental Status Assessment Tool
NPA	Non Problem Area
OOAO	One Out All Out
OWG	Online Working Group
PA	Problem Area
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
QSR	Quality Status Report
SAU	Spatial Assessment Units
TM	Trace metals
UNEP	United Nations Environmental Program
WMS	Western Mediterranean Sea Sub-region

1. Introduction

1. Updated BC and BAC values for IMAP Common Indicator 17 (CI 17) were calculated and proposed, as presented in documents UNEP/MAP WG. 533/10, Appendix I and UNEP/MAP WG. 533/Inf.3/Rev.1. Their calculation was based on new national monitoring data received up to December 31st, 2021, that have not been previously used for the calculation of the assessment criteria in the 2017 and 2019 assessments. In addition, following the OWG on Contaminants recommendation, data since 2015 were used in the calculation as well, even if used in the previous assessment.

2. This document presents the results of the application of the above mentioned updated assessment criteria for the Central Mediterranean Sea Sub-region using the CHASE+ (Chemical Status Assessment Tool) methodology as initially tested in the Levantine Sea (LEVS) sub-division (UNEP/MAP WG. 533/10, Appendix IV), as well as by considering its subsequent harmonization with NEAT assessment methodology, as explained in Section 2. Due to insufficient data, the two sub-divisions of the CEN, the Ionian Sea (IONS) and Central Mediterranean Sea (CENS) were assessed together, stressing possible similarities/differences between them, if available,

3. The CHASE+ methodology is applied for GES assessment only in the Sub-divisions and Sub-regions with insufficient data reported, in which the NEAT GES assessment methodology cannot be applied due to lack of data.

2. CHASE+ assessment methodology and its adaptation for the use in the 2023 MED QSR Assessment

4. The CHASE+ (Chemical Status Assessment Tool) methodology was used by the European Environmental Agency (EEA) to assess environmental status categories for the European Seas (Andersen et al. 2016, EEA 2019). This assessment methodology uses just one threshold, compared to the two used in the traffic light system.

5. The first step in this tool is to calculate the ratio $C_{measured}/C_{threshold}$ called the contamination ratio (CR) for each assessment element in a matrix. Then a contamination score (CS) is calculated as follows[1]:

$$CS = \frac{1}{\sqrt{n}} \sum_{i=1}^{n} CR_i$$

where n is the number of elements assessed for each matrix.

6. Based on the contamination ratio (CR) or on contamination score (CS), the elements are assessed. In line with the results of assessments, the stations/areas can be classified into non problem area (NPA) and problem area (PA), by applying 5 categories: NPAhigh (CR or CS=0.0-0.5), NPAgood (CR or CS =0.5-1.0), PAmoderate (CR or CS =1.0-5.0), PApoor (CR or CS =5.0-10.0) and PAbad (CR or CS > 10.0). NPA areas are considered in GES while PA areas are considered as non-GES. The boundary limit of 1 between GES and non-GES is based on the choice that only values that are equal or below the threshold are considered in GES.

7. Both methodologies need to define decision rules to determine the quality status. One decision rule used is the "One out all out approach" (OOAO) that says that if one element of the assessment is not

[1] The contamination sum minimizes the problem of 'dilution' of high values when several substances from an area are analyzed, and takes to some extent possible synergistic effects of contaminants into account by using square root of 'n' instead of 'n'.

in good status, the whole area is described as not in GES. This decision rule is very stringent. An additional approach is based on setting a limit, such as a proportion (%) of elements, that should each be in GES for the area to be classified as in GES. Here we recommend that if at least 75% of the elements are in GES, the station should be considered in GES. The same recommendation is given when assessing certain areas or the whole Sub-region or Sub-division i.e., when 75% of the stations are in GES for a certain parameter, the whole sub-region is in GES for this particular parameter and not the overall status of the Sub-region or Sub-division. This more lenient approach for the GES-non GES decision rule compensates for stricter thresholds applied within the CHASE+ methodology (See section 4.3). This approach was discussed and confirmed by the Meeting of CorMon Pollution by approval of UNEP/MED WG. 533/10, Appendix IV, and therefore it is also applied in this assessment of the CEN.

8. The regional Mediterranean assessment regarding CI-17 is be based on the assessments provided for the sub-divisions within the four sub-regions of the Mediterranean. The sub-division assessments are performed using the two methodologies i.e., NEAT and CHASE+. Therefore, there was a need to harmonize the two methodologies in order to prevent a bias in the Mediterranean regional assessment and assure compatibility.

9. For this purpose, the following assessments and comparison were performed: i) assessment of the Adriatic Sea (ADR) Sub-region (UNEP/MED WG.533/10, Appendix III) ensuring a comparison between applications of the NEAT and the CHASE+ assessment methods in the ADR; ii) assessment of the Levantine Sea (LEVS) sub-division using the CHASE+ assessment methods, including its comparison to the traffic light system (UNEP/MED WG.533/10, Appendix IV); iii) assessment of the Western Mediterranean Sea (WMS) Sub-region by applying the NEAT and CHASE+ assessment methods.

10. Comparison of the NEAT and CHASE+ assessment methods by using available data as reported by the CPs, showed that the two assessment methodologies are compatible only at the level of very basic assessment per contaminant, per SAU. Still at this level some discrepancies appeared for the non-GES categories moderate and poor. When aggregation of all contaminants data was attempted to obtain the overall pollution (CI17) assessment (NEAT overall value and contamination score (CS) by applying CHASE+ assessment methodology), the two methodologies behaved differently. These discrepancies were related to different calculations within the two assessment methods for the aggregation of contaminants, as well as differences in setting the boundary limits between the moderate/poor, and poor/bad classes.

11. To overcome the above-described discrepancies and to ensure compatible assessments for all four sub-regions of the Mediterranean Sea on the SAU and on station level for the purposes of the 2023 MED QSR, the approach described here-below is followed. The approach is based on the application of a tailor-made assessment along the general rationale of the CHASE+ tool while ensuring compatibility with the NEAT tool:

- For Sub-regions where the CHASE+ assessment methodology is applicable: Calculation of contamination ratios (CRs) based on the (xBAC) thresholds.
- For Sub-regions where the CHASE+ assessment methodology is applicable: Calculation of the CS for the overall CI17 aggregated assessment per station as a simple average of CRs and not as used by the EEA, where CS is calculated as the sum of CR divided by the square root of the number of CRs in the sum (Section 2, paragraph 4).
- For all Sub-regions and for both NEAT and CHASE+ assessment methodologies: The GES/non-GES boundaries are based on the BAC values. The BAC values (xBAC) multiplied by 1.5 for Cd, Hg, Pb and by 2 for PAHs and PCBs were approved by the Meeting of CorMon Pollution (27 and 30 May 2022). This approach was chosen because it is based on the Mediterranean sub-regional background concentrations of contaminants, therefore having the boundary limits based on the values calculated form monitoring data reported by the CPs, and second because it is more stringent than the Med_EAC approach. approach. At the same time, it corresponds with the

definition of GES target according to the concentrations of specific contaminants needs to be kept below Environmental Assessment Criteria (EACs) or below reference concentrations (UNEP/MED WG 473/7). In many cases the Med_EAC thresholds are higher than the maximum value recorded for a particular contaminant, resulting in a very lenient classification of the SAUs/stations. In this way biased assessments in different Mediterranean sub-regions are avoided.

- For all Sub-regions: Alignment is ensured of the moderate/poor and the poor/bad boundary limits/ thresholds between the two assessment methodologies. For the moderate/poor class, the use of 2(xBAC) value as boundary is proposed and for the poor/bad class, the 5(xBAC) value. In this way, a fine classification in line with the precautionary principle is ensured. The NEAT tool is flexible and accepts either the thresholds values calculated by the tool itself (based on the GES/ non-GES and the maximum concentration of contaminants), or threshold values predefined by the user. In the present assessment all thresholds will be user defined. In the CHASE+ assessment methodology , the CR or CS ratios for the moderate/poor and poor/bad classes are set at 2x and 5x times the GES/ non-GES threshold, instead of x5 and x10 that are used in the previous application of the tool. The boundary limits between the assessment classes are updated as shown in Table 1 below.

12. A comparison between the NEAT and CHASE+ results for the WMS sub-region was performed by applying above approach further to the recommendations for the harmonization of the two assessment methods as provided in the SIDA project document2 and described in UNEP/MED WG. 566/Inf.7, chapter 2. Briefly all thresholds used were identical in the two methodologies, while the CHASE+ methodology was adapted regarding the calculation of the CS score for compatibility reasons. Consolidated results on the percentage of SAUs as classified by the two assessment methodologies are presented in UNEP/MED WG. 566/Inf.7, Table 14, using the xBAC GES/nGES boundary limit/threshold. Based on these comparisons it is apparent that the harmonization of the two tools in this case gives identical results for the classification (in-GES or non-GES) of the individual contaminants assessments per SAU. There are very small differences between the statuses found for the individual contaminants per SAU, i.e small differences in the division between high and good statuses the in-GES classification and between moderate and poor in the non-GES classification. When aggregation is conducted for all contaminants on the individual SAU level comparisons differ by 5% and still can be considered acceptable.

13. The harmonized application of the two assessment methodologies for the assessment of WMS Sub-region provided highly comparable results and shows that the two assessment methodologies can be used indifferently for the various sub-divisions of the Mediterranean Sea. The harmonization of the NEAT and CHASE+ assessment methodologies was as good as possible. They are still different methodologies and the results will not be identical, however the harmonization ensured their alignment to the extent which prevents bias assessment of the four Mediterranean sub-regions within the preparation of the 2023 MED QSR. The NEAT is the methodology which properly supports efforts aimed at the GES assessment in line with the Decision IG. 23/6 on the 2017 MED QSR (COP 20, Tirana, Albania, 17-20 December 2017), and therefore its further application across all four Mediterranean sub-regions should be foreseen within preparation of the future QSR. The CHASE+ assessment methodology may continue being used in specific cases, i.e., for the local areas and limited assessments with insufficient data reported for the GES assessment to guide decision making.

[2] Technical paper on the comparison of the assessment findings for CI 17 in the Adriatic Sea Sub-region generated by an application of the NEAT and the CHASE+ assessment methodologies already tested in the Levantine Sea Basin (chapter 6), the SIDA Project Meeting (10 November 2022, Tunisia).

Table 1. Proposed updated assessment classification boundary limits/thresholds for a harmonized application of NEAT and CHASE+ tools in the Mediterannean Sea sub-regions.

	GES		non-GEs		
IMAP – traffic light approach	Good	Moderate	Bad		
NEAT tool	High	Good	Moderate	Poor	Bad
	0< meas. conc. ≤ BAC	BAC<meas. conc. ≤GES/nGES threshold	GES/nGES<meas. conc. ≤ moderate/poor threshold	moderate/poor threshold <meas. conc. ≤ max. conc.	**Max. conc.**
Boundary limits and NEAT scores **0**	1 < score ≤0.8	0.8<score≤ 0.6	0.6<score ≤ 0.4	0.4< score ≤0.2	Score<0.2
Thresholds	**BAC**	**(xBAC)**	**2 (xBAC)**	**5 (xBAC)**	
CHASE+ tool	High	Good	Moderate	Poor	Bad
Thresholds	**1/2(xBAC)**	**(xBAC)**	**2(xBAC)**	**5(xBAC)**	
CHASE+ Scores	0 <CR,CS ≤0.5	0.5<CR,CS≤ 1	1<CR,CS ≤ 2	2< CR,CS ≤5	CR,CS> 5

3. Available data and location of sampling stations

14. Data for the CEN sub-region were very limited. Table 2 summarizes data availability. Trace metals (TM – Cd, Hg and Pb) in sediments were available for 22 stations in Malta, 12 for 2017 and 10 for 2018, belonging to the CENS sub-division, and data for Cd and Pb were available for 4 stations in Greece for 2020, 2 belonging to the IONS sub-division and 2 to the CENS. Concentrations of Σ16 PAHs in sediments were available for 21 stations in Greece (20 in the IONS, 1 in CENS), 18 from 2019 and 3 from 2018; and for 5 stations in Tunisia (CENS) for 2019 (Jebara et al. 2021). For Malta (CENS), data for Σ5 PAHs[3] in sediments were available for 15 stations sampled in 2017 and 10 stations sampled in 2018. Concentrations of total PCBs i.e. Σ7 PCBs4 and individual concentrations for each PCB congener, were reported in sediments for the same 5 stations in Tunisia as for Σ16 PAHs (Jebara et al. 2021). Malta reported concentrations of hexachlorobenzene in sediments for 21 stations. Data for trace metals in the fish M. barbatus were available for 3 samples from 2017 and 2 samples from 2019 in Malta (CENS). In addition, data for TM in the mussel *M. galloprovincialis* from 2016 and 2017 were retrieved from data reported by Italy to EMODNet: 4 samples with Cd and Pb concentrations and 8 with Hg concentrations.

Table 2. Data available for the environmental assessment of the Central Mediterranean (CEN) Sub-region.

Source	IMAP-File	Country	Sub-division	Year	Cd	Hg	Pb	Σ_{16} PAHs	Σ_5 PAHs	Σ_7 PCBs
Sediment										
IMAP-IS	652	Greece	IONS	2018				2	2	

[3] Σ_5 PAHs is the sum of the concentrations of Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene and Benzo(ghi)perylene. Σ5 PAHs is a non-mandatory parameters for CI 17, whereby Σ16 PAHs, is a mandatory parameter.

[4] PCBs congeners 28,52,101,118,132,153,180

Source	IMAP-File	Country	Sub-division	Year	Cd	Hg	Pb	Σ_{16} PAHs	Σ_5 PAHs	Σ_7 PCBs
IMAP-IS	652	Greece	CENS	2018				1	1	
IMAP-IS	652	Greece	IONS	2019				18	18	
IMAP-IS	652	Greece	IONS	2020	2	0	2			
IMAP-IS	652	Greece	CENS	2020	2	0	2			
IMAP-IS	489	Malta	CENS	2017	12	12	12		15	
IMAP-IS	489	Malta	CENS	2018	10	10	10		10	
Lit[1]		Tunisia	CENS	2019				5		5
M. galloprovincialis										
EMODNet		Italy	CENS	2016		2				
EMODNet		Italy	CENS	2017	4	6	4			
M. barbatus										
IMAP_IS	489	Malta	CENS	2017	3	3	3			
IMAP_IS	489	Malta	CENS	2019	2	2	2			

[1]Jebara et al., 2021

15. The locations of the sampling stations/ areas are presented in Figures CEN1-CEN3 (Annex I). The data were compiled from the IMAP-IS, as of 31st October 2022. Additional data from the scientific literature (Jebara et al, 2021) and from EMODNet were also used.

16. Based on the available data, the assessment was performed for TM and Σ16 PAHs in sediment. In addition, the CEN was assessed based on Σ5 PAHs in sediments as well. This is not a mandatory parameter, but was included here given significant more data available for Σ5 PAHs compared to Σ16 PAHs (48 vs 28 data points, respectively) encompassing a larger area of the CEN. Therefore, an exception was made to possibly increase confidence of the assessment. A very limited assessment was provided also for the additional parameters: Σ7 PCBs in sediments, TM in M. barbatus and in *M. galloprovincialis* due to the small amount of data available. The 2023 MED QSR needs to be based on data reported as of 2018 onward. However, given limited data availability, an exception was made and data available for 2016 and 2017 were also used in order to increase reliability of the assessment.

4. Details of CHASE+ assessment methodology application in the CEN

4.1 Setting the GES/non GES thresholds and boundary values for the CHASE+ application in the CEN

17. The thresholds used for the CHASE+ assessment methodology were the updated Mediterranean regional BACs. Table 3 summarizes the thresholds values. For most parameters, the sub-regional BACs were not available Namely, for sediments, only one CEN_BAC is available for TM (Pb), and for Σ16 PAHs. Regarding biota matrix, sub-regional CEN_BACs are not available for TM in *M. barbatus*, while for *M. galloprovincialis*, the CEN_BACs are available for Cd and Hg. By having only 4 CEN BACs, it was impossible to ensure homogenous assessment by combing sub-regional and regional BACs, in particular because the sub-regional BACs were calculated with a few data points as described in UNEP/MED 533/10, Appendix I[5]. For this reason, an exception was made for the CEN assessment and it

[5] Excerpts from document WG.533/10, Appendix I about BCs in the CEN sub-region. BACs are multiplications of the BCs (Paragraph 36).

was decided to use only the Mediterranean regional MED_BACs as thresholds in the assessment (UNEP/MED WG. 533/10, Appendix I). It should also be noted that the four sub-regional CEN_BACs are about one order of magnitude lower than the MED_BACs.

18. The boundaries between the 5 environmental classifications (high, good, moderate, poor and bad) are given in Table 1.

Table 3. Summary of the threshold values (MED_BACs) used in application for GES assessment of the Central Mediterranean Sea sub-division (UNEP/MED 533/10, Appendix I). Available CEN_BAC and MedEAC values are given for comparison.

	CEN_BAC	**MED_BAC**	**MedEAC**
Sediments, µg/kg dry wt			
Cd	#	161	1200
Hg	#	75	150
Pb	2708	22500	46700
Σ_{16} PAHs	9.5	41	4022*
Σ_5 PAHs^	#	31.8	
Σ_7 PCBs	#	0.40	68+
***M. barbatus*, µg/kg wet wt**			
Cd	#	7.8	50
Hg	#	81.2	1000
Pb	#	36.6	300
***M. galloprovincialis*, µg/kg dry wt**			
Cd	117&	1065	5000
Hg	18.5&	117	2500
Pb	#	1650	7500

BACs not available for CEN (UNEP/MED WG.533/10, Appendix I). & Based on 4-8 data points, * ERL value derived for the sum of 16 PAHs by Long et al., 1995, do not appear in the Decisions of COP. + Sum of the individual MedEACs values of the 7 PCB compounds as they appear in Decision IG.23/6.^Values do not appear in Decisions of COP. Calculated as a sum from the individual BAC values for each or the 5 PAHs compounds.

4.2 Integration of the areas of assessment for the CEN

19. The locations of the sampling stations were sorted by group of contaminants and matrix. As explained above, data were available mainly for the sediment matrix, with a few data points for TM in the fish *M. barbatus* and the mussel *M. galloprovincialis*.

- It was possible to calculate BC for Pb (in sediments) at the CEN sub-region in 2022, however with only 29 data points. The BC value for Pb in CEN was about one order of magnitude lower than the BCs calculated for the other sub-regions and should be re-examined when additional data will be available (Paragraph 38).
- Σ_{16} PAHs in sediments. The lowest values were calculated for the CEN, however the number of data points was low and not representative (Paragraph 39).
- TM in *M. galloprovincialis* .A few data points (4 for Cd and 8 for Hg with 4 Pb, all BDL) were available for the CEN. The calculated BCs were lower than in the other sub-regions, however, the few data is not representative of the CEN (Paragraph 40).
- TM in *M. barbatus*. There were 5 data points available for the CEN, however Cd and Pb were all BDL while the median Hg concentration was 152 µg/kg wet wt, much higher than in the other sub-regions. Given the lack of data for the CEN, it was not possible to propose values for BC in this sub-region, therefore it is suggested to use the regional MED BC values for GES assessment (Paragraph 40).

20. Further to IMAP implementation, the monitoring stations were considered for grouping in the two main assessment zones i.e., the coastal (within 1 nm from the shore) and offshore zones. All the sediment stations reported by Malta were classified as coastal while the stations where M. barbatus specimens were collected were classified as offshore. The 5 sediment stations from Tunisia were classified as coastal (Jebara et al., 2021). For Greece, 11 sediment stations were classified as coastal and 11 as offshore stations. Six of the offshore stations were located in semi-enclosed areas. *M. galloprovincialis* in Italy (data from EMODNet) were collected from one coastal location and three offshore locations.

21. Due to the limited number of data points, more so if dividing into coastal and offshore stations, the spatial nesting of stations in spatial assessment units (SAUs) to the level considered meaningful for IMAP CI 17 was not possible in the CEN. Spatial nesting would decrease the reliability and the representativeness of each station for the assessment. Therefore, at this stage, the assessment was based on specific stations irrespective of their positions either in offshore or coastal zones.

5. Results of the CHASE+ Assessment of CI 17 in the CEN

22. For each measured parameter at each station a contamination ratio (CR) was calculated. Thresholds were the MED_BACs as explained above (Section 4.1, Table 3) (UNEP/MED WG. 533/10, Appendix I). CHASE+ assessment methodology in the CEN was provided without spatial integration and aggregation of the areas of assessment and assessment results. Instead, aggregation was possible only for TM in sediments, and only partially. A contamination score (CS) aggregating 2-3 metals was further calculated. Table 4 summarizes the results of the CHASE+ application; Figures CEN1-CEN3 in Annex I, the resulting maps; and Tables CEN1-CEN4 in Annex II present detailed calculation of the assessment results.

Table 4. Number of data points and their percentage from the total number of data points in each category based on the CHASE+ tool, calculated using the proposed new MED_BACs (UNEP/MED WG.533/10, Appendix I; UNEP/MED WG.533/Inf.3/Rev.1).

CHASE+		**Blue** **High**	**Green** **Good**	**Yellow** **Moderate**	**Brown** **Poor**	**Red** **Bad**
		NPA or GES		**PA or non-GES**		
Sediment	Total number of data points					
		CS=0.0-0.5	**CS =0.5-1.0**	**CS =1.0-2**	**CS =2-5**	**CS >5**
Cd, Hg, Pb	26*	23	0	1	0	2
% from total number of data points		*88*	*0*	*4*	*0*	*8*
		CR=0.0-0.5	**CR=0.5-1.0**	**CR =1.0-2**	**CR =2-5**	**CR>5**
Σ_{16} PAHs	26	12	4	4	5	1
% from total number of data points		*46*	*15*	*15*	*19*	*4*
Σ_5 PAHs	46	25	6	5	6	4

CHASE+		Blue High	Green Good	Yellow Moderate	Brown Poor	Red Bad
		NPA or GES		PA or non-GES		
% from total number of data points		*55*	*13*	*11*	*13*	*9*

* 4 stations with Cd and Pb only.

5.1 Assessment of Trace metals in sediments of the CEN

23. Data for TM were available for 26 stations: 22 from Malta with all three TM (Cd, Hg and Pb) and 4 from Greece with Cd and Pb only. Most stations (23) were classified in high status (Figure CEN1 and Table CEN1, Annexes I and II, respectively). One station, in the IONS offshore, was classified in moderate status due to the concentration of Cd. Two stations were classified in poor status due to the high concentrations of Hg and Pb. These two stations were located at the Port il- Kbir off Valetta, an area affected by industrial plants and marine traffic.

24. Although most of the stations (88%) were in-GES, it is not possible to classify the sub-region nor the sub-division as a whole. Twenty-two sampling stations were located along the coast of Malta (CENS), 2 on the offshore area of the IONS and 2 on the offshore of the CENS. Due to the uneven distribution of the stations, it is not possible to assess an environmental status to the whole sub-region regarding TM in sediments.

25. Key findings. Most of the stations (88%) were in-GES with respect to TM in sediments. However, due to the uneven distribution of the stations (sampled mostly along the coast of Malta), it was not possible to classify the environmental status to the whole sub-division nor of the CEN sub-region.

5.2 Assessment of Σ_{16} PAHs and of Σ_5 PAHs in sediments of the CEN

26. Σ16 PAHs in sediments were available only for 21 stations in Greece (20 in the IONS, 1 in CENS) and 5 stations in Tunisia (CENS)6. All the stations in Tunisia were classified in-GES and assigned a high environmental status. Out of the 21 stations reported by Greece, 12 stations (52%) of the stations were in-GES and 10 were non-GES (48%), with 4 stations in moderate status, 5 stations in poor status and 1 station in bad status (Figure CEN2 and Table CEN2, Annexes I and II, respectively). The non-GES stations were located along the eastern Ionian coast, in the Gulf of Patras and the Gulf or Corinth, with 4 stations in poor status and one station in bad status in Kerkyraiki. Due to the lack of data it was not possible to classify the environmental status to the whole sub-division nor the sub-region with respect to Σ16 PAHs in sediments.

27. Key findings. Due to the lack of data it was not possible to classify the environmental status of the CENS sub-divisions nor of the CEN Sub-region for Σ16 PAHs in sediments. Non-GES stations were located in the Gulf of Patras, Gulf or Corinth and in Kerkyraiki

28. Σ5 PAHs in sediments were available only for 21 stations in Greece (20 in the IONS, 1 in CENS) and 25 stations in Malta (CENS). The classification of the stations reported by Greece were better using Σ5 PAHs compared to Σ16 PAHs: 16 stations (76%) of the stations were in-GES and 5 were non-GES (24%), with 3 stations in moderate status, 2 stations in poor status and no station in bad status. Non-GES stations were located in the Gulf of Patras, Gulf or Corinth and in Kerkyraiki. Out of the 25 stations reported by Malta, 15 stations (60%) of the stations were in-GES and 10 were non-GES (24%), with 2

[6] Jebara et al., 2021

stations in moderate status, 4 stations in poor status and 4 stations in bad status (Figure CEN3 and Table CEN2, Annexes I and II, respectively). The non-GES stations were located at the north-eastern and south-eastern part of Malta, in particular two stations were located at the Port il- Kbir off Valetta, an area affected by industrial plants and marine traffic, and impacted by TM in sediments as well (Section 5.1). Two additional stations in bad status were located at the Operational Wied Ghammieq, affected by industrial plants. However, due to the lack of data and uneven distribution of the stations it was not possible to classify the environmental status to the whole sub-division nor the sub-region with respect to Σ5 PAHs in sediments. It must also be noted that in the absence of data reported for Σ16 PAHs, as mandatory parameter, these initial findings were provided as indicative for Σ5 PAHs, as non-mandatory parameter reported by the two CPs.

29. Key findings. Due to the lack of data and uneven distribution of the stations it was not possible to classify the environmental status of the whole sub-division nor the sub-region with respect to Σ5 PAHs in sediments. Stations with non-GES status were located in Port il- Kbir off Valetta, Operational Wied Ghammieq, in the Gulf of Patras, Gulf or Corinth and in Kerkyraiki.

5.3 Assessment of Σ_7 PCBs in sediments of the CEN

30. Σ7 PCBs in sediments were available only for 5 stations in Tunisia (CENS)[7]. Four of the stations were classified in-GES, in good status while only one, Chebba, was classified as non-GES, in moderate status (Table CEN3, Annex II). Concentrations of all individual PCBs were higher at the location of Chebba than those from other locations, which could be linked to the discharge of wastewater from the neighboring fishing port in this area (Jebara et al., 2021).

31. Key findings. The meager data on Σ7 PCBs in sediments in the CEN does not allow for the regional assessment of the CEN nor of its sub-divisions.

5.4 Assessment of Organochlorinated contaminants other than Σ_7 PCBs in sediments of the CEN

32. Malta reported the concentration of hexachlorobenzene in sediments, one of the mandatory organochlorine contaminants, for 22 stations. All the concentrations were below the detection limit of 0.05 μg/kg dry wt. Therefore, only this compound could not be used for GES assessment.

5.5 Assessment of Trace metals in biota of the CEN

33. *M. barbatus*: Cd and Pb in all the 5 samples for which Malta reported data were below the detection limit (100 and 250 for Cd and Pb, respectively). The detection limits were much higher than the MED_BACs for these metals in *M. barbatus* (Table 3). Hg in all the 5 samples were not in-GES, with 3 samples classified in moderate status, one in poor status and one in bad status (Table CEN4, Annex II).

34. *M. galloprovincialis*. Data were available only for Italy (EMODNet). All the 8 samples were in-GES, 7 classified in high status and one in good status (Table CEN4, Annex II).

35. Key findings. The meager data on biota for the CEN does not allow for the regional assessment of the CEN nor of its sub-divisions.

[7] Jebara et al., 2021

Annex I

Maps providing spatial visualization of CHASE+ assessment results for IMAP CI-17 in the Central Mediterranean (CEN) Sub-region

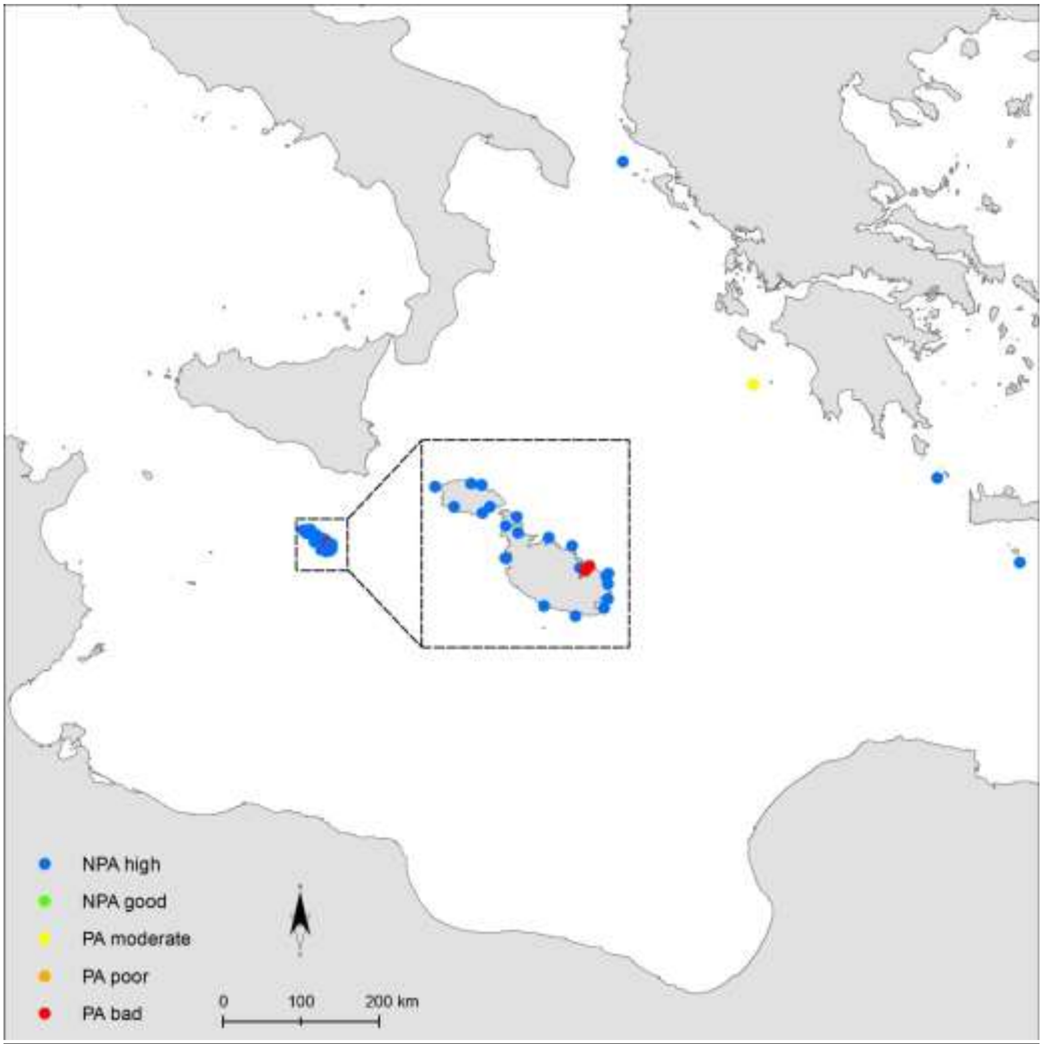

Figure CEN 1. Results of the CHASE+ approach to assess the environmental status of TM in sediments in the CEN, using MED_BACs as thresholds. Stations in blue - NPAhigh (CS=0.0-0.5); stations in green- NPAgood (CS =0.5-1.0); Stations in yellow- PAmoderate (CS =1.0-2.0); stations in brown - PApoor (CS =2.0-5.0) and stations in red - PAbad (CS > 5.0). Blue and green stations are considered in GES; yellow, brown and red stations are considered non-GES. The coastal area of Malta was enlarged to improve visibility and clarity (i.e. area delimited by broken line). Detailed classification of the stations' statuses are presented in Table CEN 1, Annex II.

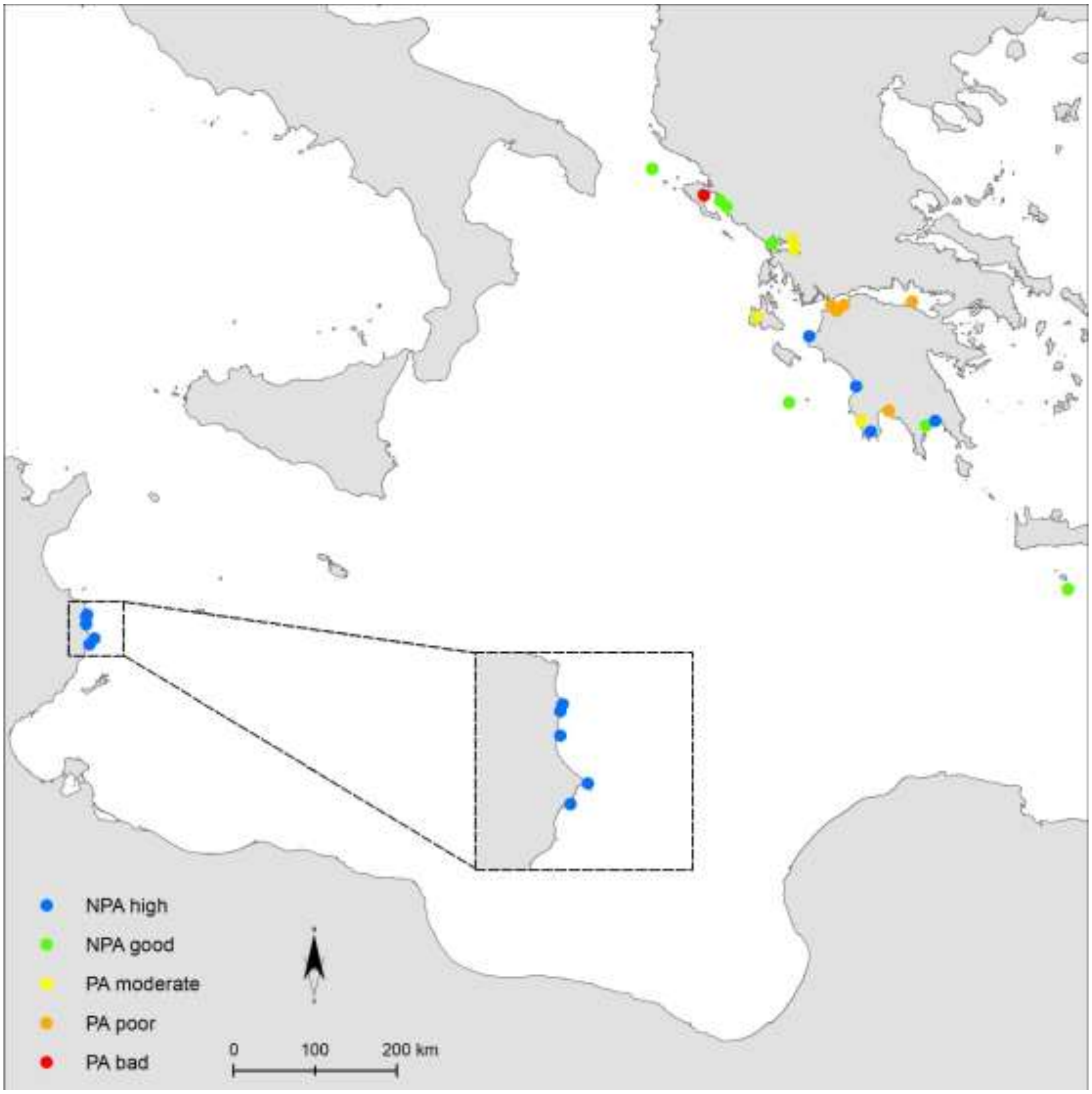

Figure CEN 2 . Results of the CHASE+ approach to assess the environmental status of Σ_{16} PAHs in sediments in the CEN, using MED_BACs as thresholds. Stations in blue - NPAhigh (CR=0.0-0.5); stations in green- NPAgood (CR =0.5-1.0); Stations in yellow- PAmoderate (CR =1.0-2.0); stations in brown - PApoor (CR =2.0-5.0) and stations in red - PAbad (CR > 5.0). Blue and green stations are considered in GES; yellow, brown and red stations are considered non-GES. Part of the coastal area of Tunisia was enlarged to improve visibility and clarity (i.e. area delimited by broken line). Detailed classification of the stations' statuses are presented in Table CEN 2, Annex II.

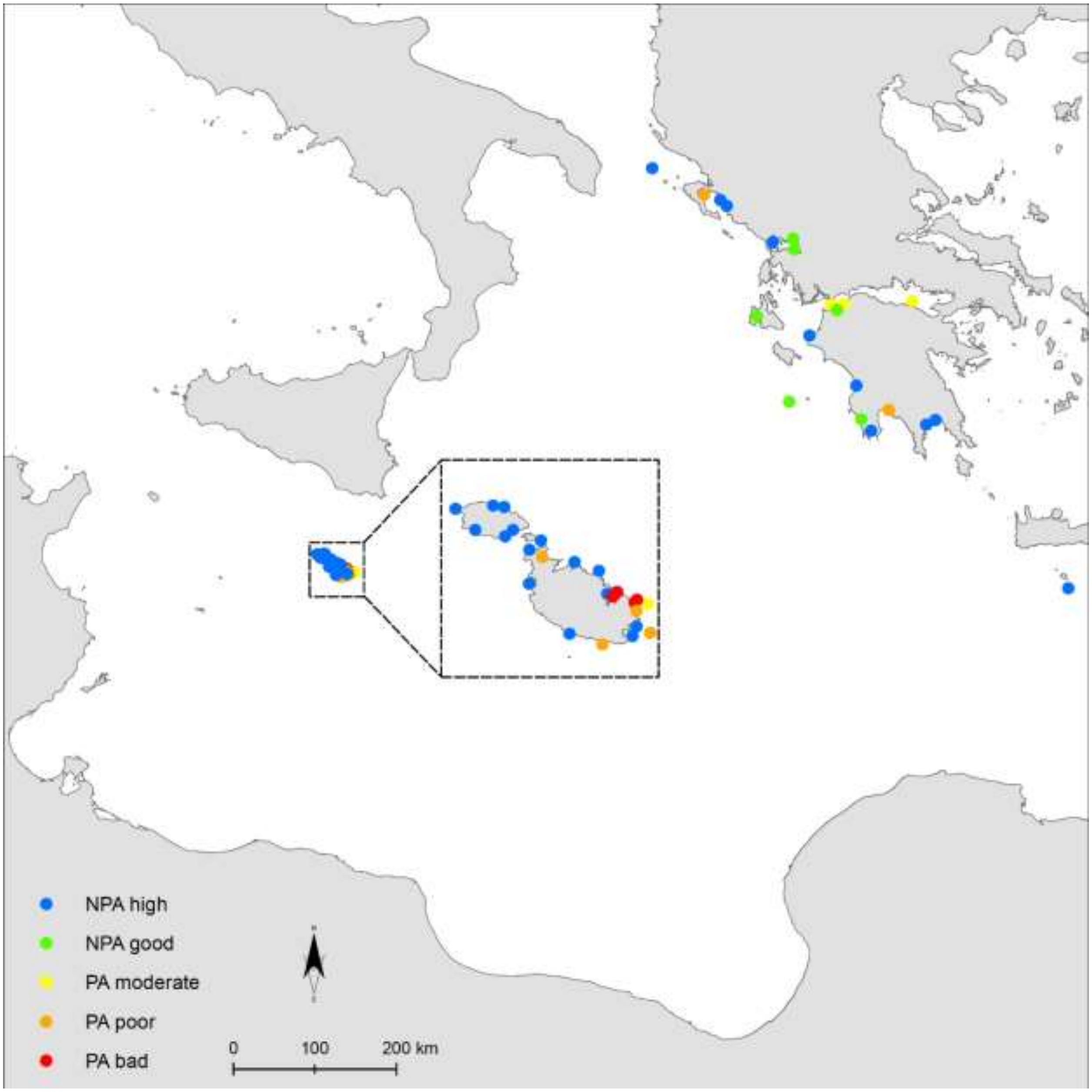

Figure CEN3. Results of the CHASE+ approach to assess the environmental status of Σ_5 PAHs in sediments in the CEN, using MED_BACs as thresholds. Criteria for Σ_5 PAHs were not adopted in Decisions IG.22/7 and IG.23/6 (COP 19 and COP 20) and not addressed in UNEP/MED WG. 533/10, Appendix I. Here we used the sum of the individual BAC values as provided for the 5 PAHs compounds in UNEP/MED WG. 533/10, Appendix I as Σ_5 PAHs_BAC. Stations in blue - NPAhigh (CR=0.0-0.5); stations in green- NPAgood (CR =0.5-1.0); Stations in yellow- PAmoderate (CR =1.0-2.0); stations in brown - PApoor (CR =2.0-5.0) and stations in red - PAbad (CR > 5.0). Blue and green stations are considered in GES; yellow, brown and red stations are considered non-GES. The coastal area of Malta was enlarged to improve visibility and clarity (i.e. area delimited by broken line). Detailed classification of the station’s statuses are presented in Table CEN2, Annex II.

Annex II

Tables of the results of application of the CHASE+ methodology on the Central Mediterranean (CEN) Sub-region

Table CEN 1. Results of the CHASE+ approach to assess the environmental status of TM in sediments in the CEN. Blue - NPAhigh (CS=0.0-0.5); Green- NPAgood (CS =0.5-1.0); Yellow- PAmoderate (CS =1.0-2.0); Brown - PApoor (CS =2.0-5.0) and Red - PAbad (CS > 5.0). Blue and green stations are considered in GES, yellow, brown and red stations are considered non-GES.

Station	Year	Cd_CR	Hg_CR	Pb_CR	CS
Malta IMAP-IS file 489			**MED_BACs used as threshold**		
MTCN02-1	2017	0.04	0.04	0.30	0.13
MTCN04-1	2017	0.04	0.04	0.25	0.11
MTCN05-1	2017	0.04	0.04	0.35	0.14
MTCN05-2	2017	0.04	21.33	3.48	8.29
MTCP04-2	2017	0.04	0.04	0.19	0.09
MTCP05	2017	0.04	38.67	2.73	13.81
MTCP06-1	2017	0.04	0.04	0.38	0.15
MTCP06-2	2017	0.04	0.04	0.29	0.13
MTCP07	2017	0.04	0.04	0.09	0.06
MTCS02	2017	0.04	0.04	0.15	0.08
MTCS03	2017	0.04	0.04	0.00	0.03
MTCS08	2017	0.04	0.04	0.38	0.16
MTCN01-2	2018	0.04	0.04	0.16	0.08
MTCN03-1	2018	0.04	0.04	0.07	0.05
MTCN03-2	2018	0.04	0.04	0.09	0.06
MTCN03-3	2018	0.04	0.04	0.04	0.04
MTCN06-1	2018	0.04	0.04	0.03	0.04
MTCN07-1	2018	0.04	0.04	0.18	0.09
MTCN08-1	2018	0.04	0.04	0.13	0.07
MTCP04-1	2018	0.04	0.04	0.00	0.03
MTCS01	2018	0.04	0.04	0.05	0.05
MTCS09	2018	0.04	0.04	0.02	0.04
Greece IMAP-IS File 652					
MSFD-1	2020	0.32		0.41	0.36
MSFD-2	2020	1.86		0.69	1.28
MSFD-3	2020	0.24		0.30	0.27
MSFD-4	2020	0.31		0.24	0.28

Table CEN 2. Results of the CHASE+ approach to assess the environmental status of Σ_{16} PAHs and Σ_5 PAHs in sediments in the CEN. Criteria for Σ_5 PAHs were not adopted in Decisions IG.22/7 and IG.23/6 (COP 19 and COP 20) and not addressed in UNEP/MED WG. 533/10, Appendix I. Here we used the sum of the individual BAC values as provided for the 5 PAHs compounds in UNEP/MED WG. 533/10, Appendix I as Σ_5 PAHs_BAC. Blue - NPAhigh (CR=0.0-0.5); Green- NPAgood (CR =0.5-1.0); Yellow- PAmoderate (CR =1.0-2.0); Brown - PApoor (CR =2.0-5.0) and Red - PAbad (CR > 5.0). Blue and green stations are considered in GES, yellow, brown and red stations are considered non-GES.

Station	Year	Σ_{16} PAHs_CR	Σ_5 PAHs_CR	Station	Year	Σ_{16} PAHs_CR	Σ_5 PAHs_CR
Malta IMAP-IS file 489				**Tunisia, Jebara et al., 2021**			
MTCBA02	2017		1.81	S1-Mahdia	2019	0.19	
MTCN02-1	2017		0.004	S2-Rejiche	2019	0.08	
MTCN04-1	2017		4.25	S3-Salakta	2019	0.06	
MTCN05-1	2017		0.004	S4-Chebba	2019	0.07	
MTCP04-2	2017		0.004	S5-Melloulech	2019	0.08	
MTCP07	2017		0.32	**Greece IMAP-IS File 652**			
MTCS02	2017		0.004	CW1	2019	4.35	2.62
MTCS03	2017		0.004	CW11	2019	0.18	0.08
MTCWA01	2017		1.10	CW12	2019	3.00	1.43
MTCS08	2017		2.83	CW13	2019	3.48	1.81
MTCBA04	2017		3.46	CW14	2019	2.01	0.94
MTCP06-2	2017		6.45	CW15	2019	1.50	0.84
MTCP06-1	2017		5.58	CW19	2019	0.47	0.24
MTCN05-2	2017		245.28	CW2	2019	1.32	0.74
MTCP05	2017		401.73	CW20	2019	0.16	0.05
MTCN01-2	2018		0.004	CW23	2019	1.11	0.59
MTCN03-1	2018		0.004	CW24	2019	6.73	4.25
MTCN03-2	2018		0.004	CW26	2019	0.67	0.37
MTCN03-3	2018		0.004	CW27	2019	0.48	0.33
MTCN06-1	2018		3.69	CW28	2019	0.83	0.46
MTCN07-1	2018		0.004	CW29	2019	1.77	0.84
MTCN08-1	2018		0.004	CW3	2019	0.14	0.04
MTCP04-1	2018		0.004	CW4	2019	0.12	0.04
MTCS01	2018		0.004	CW9	2019	4.48	1.55
MTCS09	2018		0.004	MSFD-1	2018	0.51	0.31
				MSFD-2	2018	0.95	0.57
				MSFD-4	2018	0.46	0.24

Table CEN 3. Results of the CHASE+ approach to assess the environmental status of Σ_7 PCBs in sediments in the CEN. Blue - NPAhigh (CR=0.0-0.5); Green- NPAgood (CR =0.5-1.0); Yellow- PAmoderate (CR =1.0-2.0); Brown - PApoor (CR =2.0-5.0) and Red - PAbad (CR > 5.0). Blue and green stations are considered in GES, yellow, brown and red stations are considered non-GES.

Station	Year	Σ_7 PCBs_CR
Tunisia, Jebara et al., 2021		
S1-Mahdia	2019	0.94
S2-Rejiche	2019	0.81
S3-Salakta	2019	0.81
S4-Chebba	2019	1.28
S5-Melloulech	2019	0.98

Table CEN 4. Results of the CHASE+ approach to assess the environmental status of TM in biota in the CEN. Blue - NPAhigh (CR=0.0-0.5); Green- NPAgood (CR =0.5-1.0); Yellow- PAmoderate (CR =1.0-2.0); Brown - PApoor (CR =2.0-5.0) and Red - PAbad (CR > 5.0). Blue and green stations are considered in GES, yellow, brown and red stations are considered non-GES.

Station	Year	Cd_CR	Hg_CR	Pb_CR	CS
		***M. galloprovincialis*, Italy, EMODNet**			
2016-05-31T12:00:00	2016		0.07		0.07
2016-07-05T12:00:00	2016		0.06		0.06
2017-03-20T12:00:00	2017	0.56	0.07	0.10	0.24
2017-04-12T12:00:00	2017	0.07	0.07	0.10	0.08
2017-07-10T12	2017		0.46		0.46
2017-07-10T13	2017		0.53		0.53
2017-11-02T12:00:00	2017	0.03	0.28	0.10	0.14
2017-11-03T12:00:00	2017	0.00	0.00	0.10	0.04
		***M. barbatus*, Malta IMAP-IS file 489**			
MEDITS haul 49	2019	*	1.32	*	1.32
MEDITS haul 5	2019	*	1.10	*	1.10
MEDITS haul 54	2017	*	17.09	*	17.09
MEDITS haul 55	2017	*	1.19	*	1.19
MEDITS haul 79	2017	*	2.71	*	2.71

*Cd and Pb in M. barbatus were below the detection limit that were much higher than the MED_BACs.

Annex III

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