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Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring

Videoconference, 27 and 30 May 2022

Agenda Item 5: GES Assessment for IMAP Common Indicator 17 in the Areas with Limited Data Availability

The Methodology and the Results of the NEAT Tool Application for GES assessment of IMAP Common Indicator 17 in the Adriatic Sea Sub-region

UNEP/MAP
Athens, 2022

Note by the Secretariat

In line with the Programme of Work 2020-2021 adopted by COP21 (Naples, Italy, December 2019), the MED POL Programme has prepared a Proposal of Integration and Aggregation Rules for Monitoring and Assessment of National Data for IMAP Pollution and Marine Litter Cluster. The proposed integration and aggregation rules for monitoring and assessment set the basis for testing the NEAT tool application for GES assessment in the Adriatic Sea Sub-region within the preparation of the 2023 MED QSR in line with the 2023 MED QSR Roadmap implementation (Decision IG.24/4 of COP21).

Considering the initial discussion on the NEAT tool application during the Regional Meeting on IMAP Implementation: Best Practices, Gaps and Common Challenges (Rome, Italy, 10-12 July 2018), in the context of applying different tools related to GES assessment, this document provides detail elaboration of the NEAT tool application for GES assessment of IMAP CI17 in the Adriatic Sea Sub-region in line with the conclusions of this meeting, as well as the Meeting of CorMon on Pollution Monitoring (Teleconference, 26-27 April 2021) and the Meeting of MEDPOL Focal Points (Resumed Session 9 July 2021). Specifically, the integration and aggregation rules were elaborated in the context of the NEAT tool application for GES assessment of IMAP CI 17 in the Adriatic Sea Sub-region as provided in UNEP/MED WG. 533/5 further to detail elaboration provided in present document UNEP/MED 533/Inf.4, including optimal temporal and spatial integration and aggregation of the assessment findings within nested approach agreed for IMAP implementation. To ensure the application of the NEAT tool, the present document sets the spatial scope of the finest scales of assessment and the scales of assessment nested to the levels of integration that are considered meaningful for the IMAP CI 17. The scope of various levels of spatial integration (nesting) is provided in order to ensure scaling of the assessment findings i.e. the assessment findings integration to the meaningful level. The proposal of the scope of the spatial assessment units is accompanied by the geospatial datasets that will also serve as input in preparing the GIS catalog of the scales of monitoring and assessment for IMAP Pollution and Marine Litter Cluster.

The present document along with UNEP/MED 533/Inf.5 are submitted to support consideration of UNEP/MED WG. 533/5 by the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring in terms of getting its feedback on the results of GES assessment and further application of the NEAT tool in other sub-regions/areas with sufficient data for GES assessment within the preparation of the 2023 MED QSR.

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List of Abbreviations / Acronyms

BAC	Background Assessment Concentration
BC	Background Concentration
BDL	Below Detection Limit
CAS	Central Adriatic Sea
CI	Common Indicator
COP	Conference of the Parties
CORMON	Correspondence Group on Monitoring
CPs	Contracting Parties
DL	Detection Limit
EMODNET	European Marine Observation and Data Network
EIONET	European Environment Information and Observation Network
EO	Ecological Objective
ESRI	Environmental Systems Research Institute
EU	European Union
GES	Good Environmental Status
nonGES	not Good Environmental Status
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
MAP	Mediterranean Action Plan
MedEAC	Mediterranean Environmental Assessment Concertation
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MED QSR	Mediterranean Quality Status Report
MSFD	Marine Strategy Framework Directive
MRU	Marine Reporting Unit
MSs	Member States
NAS	North Adriatic Sea
NEAT	Nested Environmental Assessment Tool
SAS	South Adriatic Sea
SAU	Spatial Assessment Unit

1. Introduction

In the course of the implementation of the recommendations of the Meeting of CorMon on Pollution Monitoring (Teleconference, 26-27 April 2021) and the Meeting of the MEDPOL Focal Points (Resumed Session, 9 July 2021), related to the adjustment needed for the Meeting document UNEP/MED WG.492/13/Rev.2 on Integration and Aggregation Rules for Monitoring and Assessment, the Secretariat started a testing process of the proposed methodology in the Adriatic Sea Sub-region. Therefore, the scope of the current document is to show the outcome of the testing of the proposed methodology for IMAP CI 17 in the Adritic Sea Sub-region.

The scope of the work is to provide an assessment of the Quality Status for the Adriatic Sea subregion of the Mediterranean Sea within preparation of 2023 Mediterranean Quality Status Report focusing on contaminants that are mandatory according to IMAP Common Indicator 17. In brief, the nested approach is followed (UNEP/MAP (2016; 2019)) which ensures that a balance is achieved between a too broad scale, that can mask significant areas of impact in certain parts of a region or subregion, and a very fine scale that could lead to very complicated assessment processes.

The harmonized application of the nested approach, including within the application of the NEAT tool, requires defining the Integration Rules for Assessments. Therefore, this document applies the definition of integration and aggregation as provided in UNEP/MED WG.492/13/Rev.2[1]. 'Rules of Integration of Assessments' refer to the principles that underlie meaningful assessments on appropriate scales of assessment. The rules already defined for the Eutrophication, Pollution and Marine Litter Cluster in UNEP/MAP 2021 ('*4.2 Rules for integration of assessments within the nested approach'* [2]and Table 5 therein) are applied. 'Rules for aggregation and integration of GES assessments' refers to the methods (i.e. numerical calculations) for combining data in order to produce findings on the status of a specific area of assessment. The use of 'aggregation' and 'integration' in the concept of GES assessment methods has been introduced by Borja et al (2014)[3]. The term aggregation is used for the combination of comparable elements across temporal and spatial scales, indicators and criteria, within a descriptor respectively IMAP Common Indicator. The term integration is used for the combination of different elements (e.g., across descriptors i.e. IMAP Common Indicators) to produce a single value of GES as a whole. Under this concept, integration is conceived only across IMAP indicators and in the ecosystem space as a whole.

As it is indicated in several UNEP/MAP, document, for a nested approach, the two types of scales (i.e. scales of monitoring and scales of assessment) are interrelated; however a clear description of them is needed for a better comprehension of this interrelationship. The scales or units of monitoring refer to the physical spatiotemporal space where the observations are made (or samples taken) i.e. the points in time and space which are monitored. Monitoring scales are usually defined upon significance of the environmental parameters that are monitored, the expected variability and the types of pressures posed on a particular area/habitat. The parameters monitored within a specific monitoring unit may reflect the environmental conditions/impacts/extent of impacts of the monitoring unit itself or the environmental conditions/ impacts/ extent of impacts of a larger unit.

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[2] For the purpose of building the methodology for aggregation and integration rules contained in this document only the scientific elements have been considered from any reference included in this document. Legal considerations are out of the scope of the present document, which serves exclusively scientific purposes
[3] For the purpose of building the methodology for aggregation and integration rules contained in this document only the scientific elements have been considered from any reference included in this document. Legal considerations are out of the scope of the present document, which serves exclusively scientific purposes

The first element that needs to be considered for the implementation of the nested approach is the definition of the areas of assessment within the Adriatic Sea based on the areas of monitoring. As it is indicated in IMAP, this can be defined by applying relevant criteria, e.g. representativeness/importance of the areas of monitoring for establishing areas of assessment; presence of impacts of pressures in monitoring areas; sufficiency of quality assured data for establishing the areas of assessment covering as many as possible IMAP Common Indicators to the extent possible, and ensuring that adequate consideration is given to the risk based principle (both in pristine areas and areas under pressure). The existing monitoring and assessment areas defined by the concerned CPs were used, in case they were compatible with IMAP requirements; in case inconsistency appeared, the necessary adjustments were undertaken.

The harmonization of the scales approach among the concerned Contracting Parties (CPs) is the starting point for the integration process for IMAP CI 17 i.e., to scale up the marine assessment areas from the national to sub-regional and regional scales as required under IMAP. In order to support harmonization, there is a need to define Integration Rules for Monitoring Activities, which refer to a set of guidelines that should be followed when implementing monitoring programmes, in order to produce coherent data sets that will facilitate the subsequent process of providing nested GES assessments. For the purposes of the present work data on contaminants produced within implementation of the national monitoring programmes of the CPs and delivered either to the IMAP Info System or to the European Marine Observation and Data Network (EMODnet) have been gathered. Information on the availability of data is given in chapter 3 below.

This document also follows on definition of integration and aggregation as provided in UNEP/MAP 2021. 'Rules of Integration of Assessments' refer to the principles that underlie meaningful assessments on appropriate scales of assessment.

2. From monitoring areas to IMAP Spatial Assessment Units (IMAP SAUs) in the Adriatic Sea in line with the nested approach

In the absence of declared areas of monitoring by all the concerned CPs, following the rationale of the IMAP national monitoring programmes and distribution of the monitoring stations, as well as the methodology described in UNEP/MED WG.492/13/Rev.2, the two zones of areas of monitoring are defined for the purposes of the present work: i) the coastal zone and ii) the offshore zone.

Detailed explanation on the data sources used and methodology followed for setting of the two zones (coastal and offshore) is provided for the purpose of the present work, as elaborated in UNEP/MED WG.533/Inf.5. In summary, GIS layers collected from different sources (International Hydrographic Organization - IHO, European Environment Information and Observation Network - EIONET, VLIZ Maritime Boundaries Geodatabase) by the MEDCIS project (https://www.lifewatchitaly.eu/en/related-projects/medcis-3/) were used for the present work for Slovenia, Croatia and Italy; for Albania, Montenegro and Greece these data were not accurate or do not include the relevant information and therefore were replaced/corrected in line with relevant national sources i.e. results of GEF Adriatic Project and provisions of relevant national legal acts. The MEDCIS work takes into consideration the existence of bays and inlets which are numerous in particular in the east part of the Adriatic Sea and calculates the baseline using the straight baseline method by joining appropriate points, as explained here-below.

Following the rules of integration of assessments within the nested approach, for the assessment of EO9 Common Indicators, the coastal monitoring zone is equal to the respective assessment zone as defined for the purposes of the present work and explained above. For the offshore zone, monitoring areas may be representative of broader assessment areas and in these cases the offshore monitoring areas are not necessarily equal to the offshore assessment areas. For those CPs which are EU MSs the stations positioned within the offshore zone are considered representative of a wider offshore area, as officially declared by the countries for the purposes of the MSFD implementation. For these cases the offshore IMAP SAUs are based on the MSFD MRUs.

For IMAP CI 17, integration of assessments up to the subdivision level is considered meaningful. Therefore, the three main subdivisions of the Adriatic Sea, namely, North, Central and South Adriatic (NAS, CAS, SAS) have been chosen following the specific geomorphological features as available in relevant scientific sources (e.g. bottom depths and slope areas, existence of deep depression, salinity and temperature gradient, water mass exchanges) (Cushman-Roisin et al., 2001). The coverage of the 3 sub-divisions is shown in Figure 1

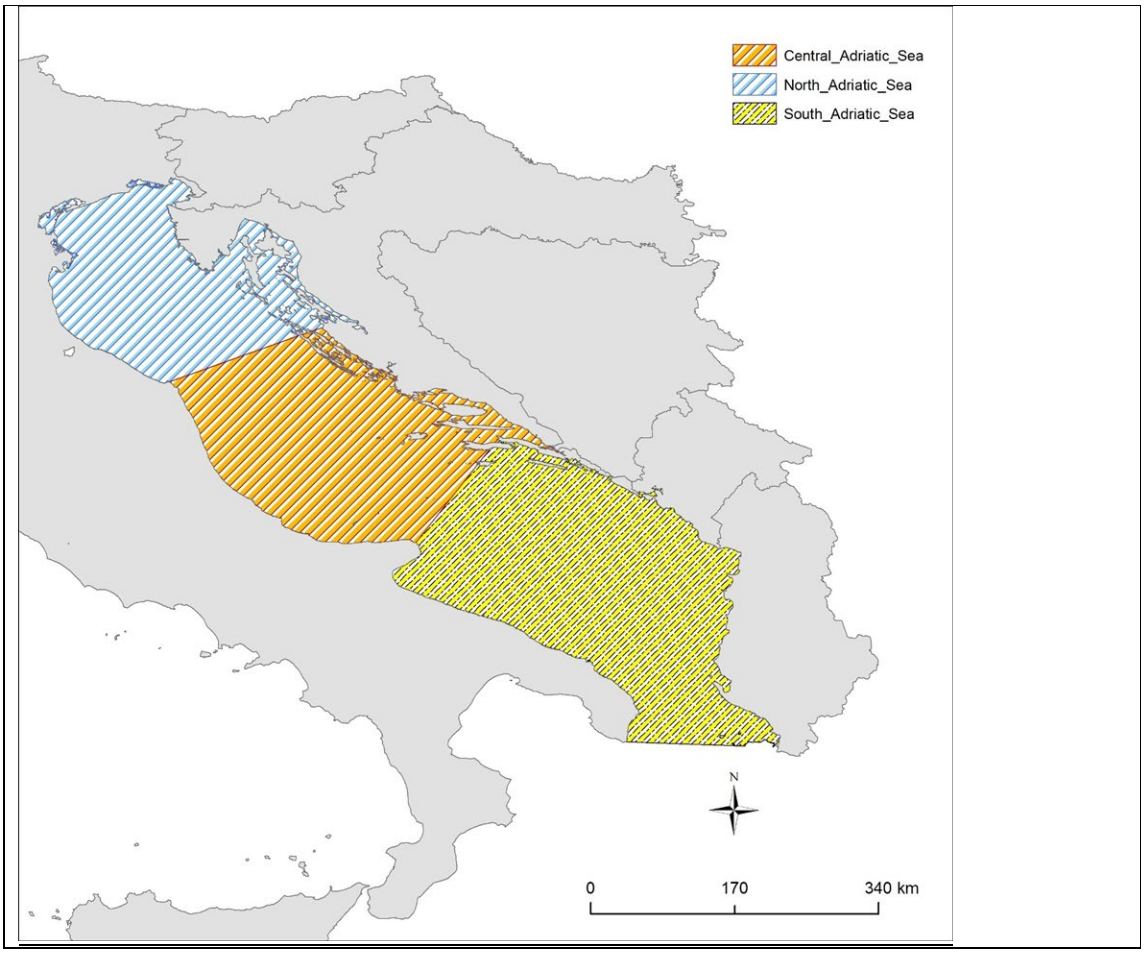

Figure 1. The 3 subdivisions of the Adriatic subregion defined based on Cushman-Roisin et al. (2001).

The following working steps have been followed to accomplish the objectives of the current work:

Step 1 Defining coastal and offshore waters. By using the information from the MEDCIS project, it was possible to define the two zones i.e. the coastal zone and the offshore zones for the purposes of the present work in the Adriatic Sea Subregion as elaborated in UNEP/MED WG.533/Inf.5. Given the distance of the monitoring stations defined by the CPs in the offshore waters and ecological and hydrographic characteristics, the breadth of the marine waters up to 12 nautical miles from the straight baseline is then set . The layers provided by the MEDCIS project correspond to i) a layer that includes all indentations i.e. inlets, gulfs and bays and ii) the layer of marine waters up to 12 nautical miles. Based on these data the two zones have been defined for the purpose of the present work: 1) the coastal zone: including all indentations (inlets, bays, gulfs) from the straight baseline landward, as well as the 1 nautical mile zone from the straight baseline seaward (in different literure sources, this 1 nautical mile zone is also called the buffer zone); 2) the offshore zone: including the area beyond the 1 nautical mile seaward and up to 12 nautical miles. It was found however that this MEDCIS datasets had errors for the case of Montenegro and Albania. Therefore, for these two countries data from the GEF Adriatic project were used as well as the national legislation of Albania and Montenegro (*Albania:* Degree No. 4650 of March 1970 and the Decree on a Modification to Decree No. 4650, dated 9 March 1970, on the State Border of the People's Socialist Republic of Albania, 1990; ; *Montenegro*: Decree on the Proclamation of the Law on the Sea "Official Gazette of Montenegro", No. 17/07 date on 31.12.2007, 06/08 dated on 25.01.2008, 40/11 dated on 08.08.2011). In addition, the MEDCIS data do not include any information for Greece, however the number and position of monitoring stations were pointed in the offshore waters only, as explained in detail in UNEP/MED WG.533/Inf.5.

pollution sources in this area, for this country only the offshore monitoring area is considered.

Step 2 “Recognizing scope of IMAP areas of monitoring”: In the absence of monitoring areas reported by the CPs, the distribution of monitoring stations was investigated by considering the coordinates of their positions provided by the CPs in the IMAP Info System. Monitoring stations are grouped under the two zones coastal and offshore defined under Step 1, following the IMAP methodology as described in UNEP/MED WG. 493/13/Rev2 for the needs of EO9, and in line with the IMAP monitoring stations` design (hotspots, coastal, offshore). This was followed by the preparation of relevant GIS layers/maps containing positions of IMAP monitoring stations on the two zones; in this way and in the absence of the areas of monitoring (i.e. monitoring transects) set by the CPs, the areas of monitoring were recognized based on distribution of the monitoring stations. As explained above, spatial coverage of the coastal waters and the offshore marine waters is based on available data from MEDCIS and the GEF Adriatic Projects. For Greece only one monitoring station exists in South Adriatic waters at a distance 6 nm from land. In the absence of any known pollution sources in this area, for this country only the offshore monitoring area is considered.

Step 3 “Setting IMAP area of assessment”: This step included the definition of the IMAP areas of assessment (IMAP SAUs) based on the anticipated areas of monitoring. To recognize the areas of monitoring, the criteria already set for that purpose in UNEP/MED WG.492/13/Rev2 were taken into consideration to the largest possible extent. Namely i) the spatial distribution of monitoring stations in relation to the sufficiency of quality-assured data as collated for NEAT application, having in mind the risk-based principle; ii) representativeness/importance of the areas of monitoring for setting of the areas of assessment; iii) in the case of Montenegro, information available regarding the presence of impacts of pressures in monitoring areas was also taken into account; to that purpose the cumulative pressures layer from GEF Adriatic Project has been used. In addition, the interrelations of the MRUs for the CPs that are EU MSs with the IMAP monitoring areas was investigated and whether these fit for their use as IMAP SAUs, following the criteria described previously. Final results are GIS layers/maps of IMAP SAUs prepared per country from the GIS layers. They also provide the positions of monitoring stations in the areas of monitoring that were recognized within present work. This was based on the equalization of the areas of monitoring with the SAUs for Albania and Montenegro, while for Slovenia, Croatia and Greece the SAUs uses to the extent possible the areas already set by the CPs. For Italy, the approach followed is slightly different because its MRUs do not fully fit the purposes of the IMAP. Details per each country separately are presented here - below.

Step 4 "Nesting of the areas of assessment within application of NEAT tool": For the step of nesting, the areas of assessment were first classified under the 3 subdivisions of the Adriatic Sea (i.e. North, Central, South); then a nesting scheme approach was followed. The delimitation of the three Adriatic subdivision was made according to Cushman-Roisin et al, (2001)[4] . The approach followed for the nesting of the areas is 4 levels nesting scheme where 1st level is the finest and 4th level is the highest:

- 1st level provided nesting of all national IMAP SAUs & subSAUs within the two key IMAP assessment zones per country i.e. coastal and offshore zones;
- 2nd level provided nesting of the assessment areas set in the key IMAP assessment zones i.e. coastal and offshore zones, on the subdivision level i.e. i) NAS coastal, NAS offshore; ii) CAS coastal, CAS offshore; iii) SAS coastal, SAS offshore);
- 3rd level provided nesting of the areas of assessment within the 3 subdivisions (NAS, CAS, SAS);
- 4th level provided nesting of the areas of assessment within the Adriatic Sea Sub-region.

After setting of the finest IMAP areas of assessment, similarly the integration of the assessment results is conducted: following the 4 levels nesting approach:

- 1st level: Detailed assessment results provided per subSAUs and SAUs;
- 2nd level: Integrated assessment results provided per i) NAS coastal (NAS-1), NAS offshore (NAS-12); ii) CAS coastal (CAS-1), CAS offshore (CAS-12); iii) SAS coastal (SAS-1), SAS offshore (SAS-12);
- 3rd level: Integrated assessment results provided per subdivision NAS, CAS, SAS;
- 4thlevel: Integrated assessment results provided for the Adriatic Sea Sub -region.

The graphical depiction of this nesting scheme is shown in Figure 14. The description of the IMAP SAUs and details on specificities for each country are provided in UNEP/MED WG.533/Inf 5, while the summary is provided here-below in Section 2.1.

2.1 Defining the IMAP areas of assessment (IMAP SAUs) for the Adriatic countries

The application of the 3 first working steps for the definition of IMAP SAUs per each of the Adriatic countries separately are described below. After having defined all national SAUs, the 4th step on their nesting follows. Given Bosnia and Herzegovina faced the lack of data for contaminants, it is not considered in the present work aimed at providing GES assessment for IMAP CI 17.

Albania: The monitoring areas have not been defined in the National IMAP of Albania prepared in the framework of the GEF Adriatic Project. Within the present testing of NEAT application, the IMAP areas of assessment are proposed considering distribution of 6 monitoring stations only as they were defined in the National IMAP within the GEF Adriatic Project. Therefore, the only area of monitoring is the site between the river Buna/Bojana flows into the Adriatic Sea and the cape of Rodon. This area of monitoring was also considered as the area of assessment. Within the 1st working step it was found that the MEDCIS data had errors. Namely, these data do not cover the north marine area, between the river Buna/Bojana flows into the Adriatic Sea and the cape of Rodon, where the 6 monitoring stations are placed, so rework was undertaken for the spatial data to propose areas of assessment. For the current work, the available monitoring stations are at the north part, in proximity the border with Montenegro. Two IMAP SAUs have been set, i.e., the coastal waters AL-1 and the offshore waters AL-12 (Figure 2). The surface area of the Albanian IMAP SAUs is given in Table 1. The correctness of the spatial coverage

[4] Cushman-Roisin, B., Gačić, M., Poulain, P-M., Artegiani, A., 2001. Physical Oceanography of the Adriatic Sea, Past, Present and Future, Springer Science + Business Media, Dordrecht, 312 pp

of the zones of 1nautical mile and 12 nautical miles was checked against relevant national legislation[5]. No further split into finer areas of assessment was made; however, when new monitoring stations will be established, further work will be needed to tune and further define the areas of assessment, both in the small area tested for NEAT application and in the entire marine waters of Albania (Figure 2).

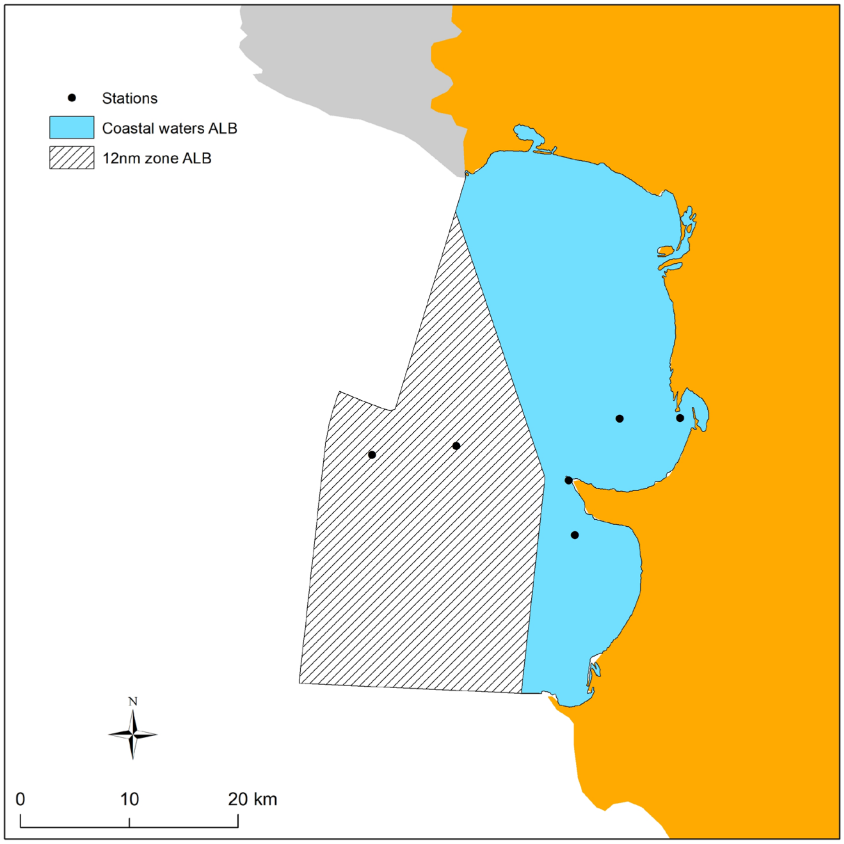

Figure 2. The IMAP areas of assessment (IMAP SAUs) of Albania, proposed within present NEAT testing in the Adriatic Sea. The resulting IMAP SAUs for Albania are coastal AL-1 and offshore AL-12.

Croatia: The network of monitoring stations of Croatia for IMAP CI 17 is shown in Figure 3 further to the elaboration provided in UNEP/MED WG. 533/Inf.5.

[5] Decree No. 465O of March 9, 1970, of the Borders of the People's Republic of Albania, ANNEX, Decree on a Modification to Decree No. 4650, dated 9 March 1970, on the State Border of the People's Socialist Republic of Albania, 1990

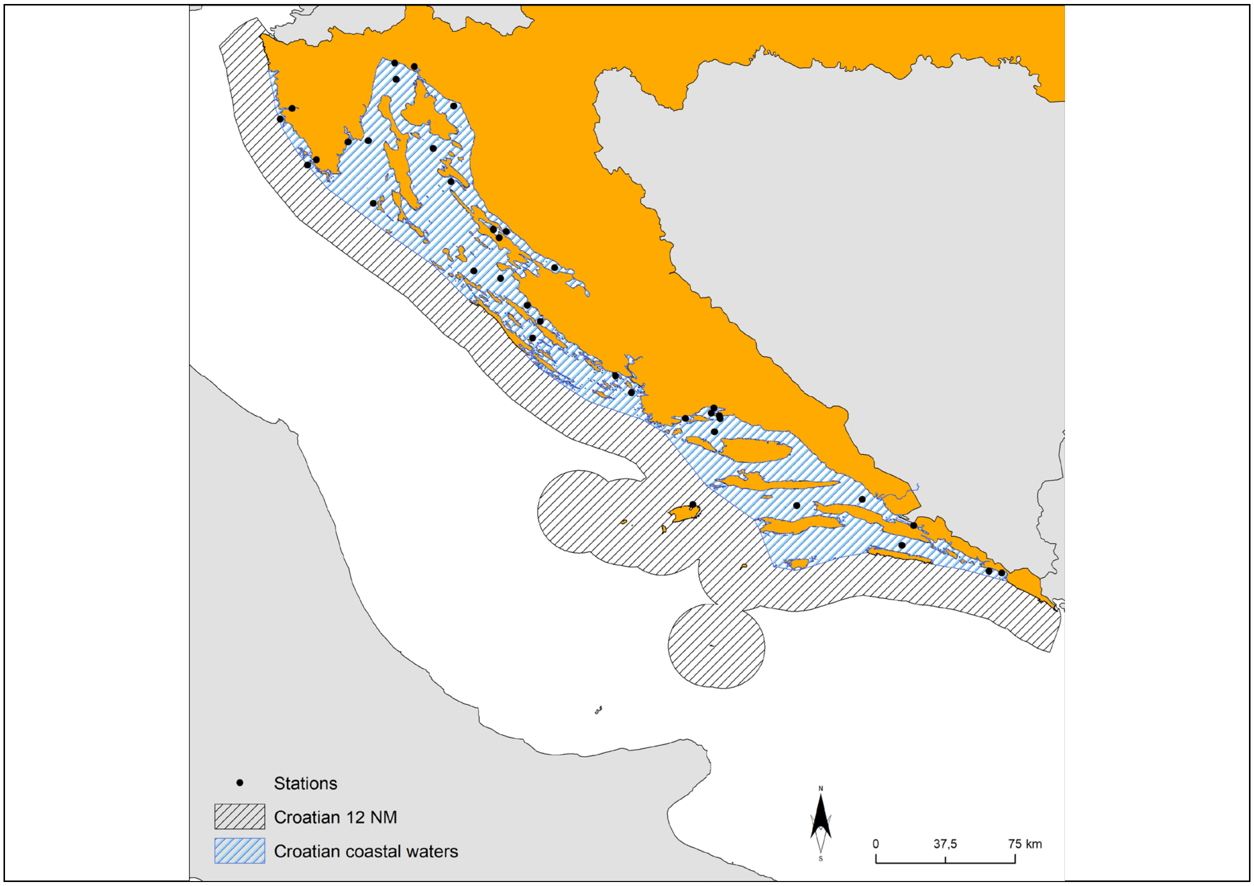

Figure 3. The IMAP coastal and the offshore assessment zones of Croatia overlaid on the network of monitoring stations. The coordinates of the monitoring stations are as reported in IMAP IS.

For Croatia the two zones of coastal and offshore waters based on data from the MEDCIS project comply well with the 4 officially declared MRUs for the purposes of the MSFD implementation[6] (Figure 4). Two MRUs namely MAD_HR_MRU_4 and MAD_HR_MRU_5 correspond to the offshore zone and are considered as IMAP SAUs in the offshore assessment zone, while MAD_HR_MRU_2 and MAD_HR_MRU_3 correspond to the coastal zone and are considered as IMAP SAUs (Figure 4). In addition, the country has officially defined subMRUs for the purposes of the implementation of the WFD and the MSFD. The WFD delimitations are used in the present work for setting of the areas of assessment for IMAP Ecological Objectives 5, 9 and 10. In particular, the MAD_HR_MRU_2 and MAD_HR_MRU_3 are further divided to 15 and 26 WFD subMRUs respectively as shown in Figure 5. All these subMRUs are considered the finest IMAP sub SAUs. Most areas are nested under the Central Adriatic Sea (CAS). There was a need to split MAD_HR_MRU_2 between the Central and South Adriatic subdivisions in order to comply with the nesting of areas in the Adriatic Sea sub-divisions. SubMRUs HRO_3132-ZUC and HRO_423_MOP are nested under the South Adriatic Sea (SAS). The surface area (km^2) of the IMAP SAUs correspond to the official MRUs areas (Table 1). Geographical

[6] https://cdr.eionet.europa.eu/hr/eu/msfd_art17/2018reporting/spatialdata/envxj4tsg.

data for Croatia are obtained from the EOINET data portal[7]. The correctness of the coastal waters and offshore/open sea was checked in relevant legal acts.[8]

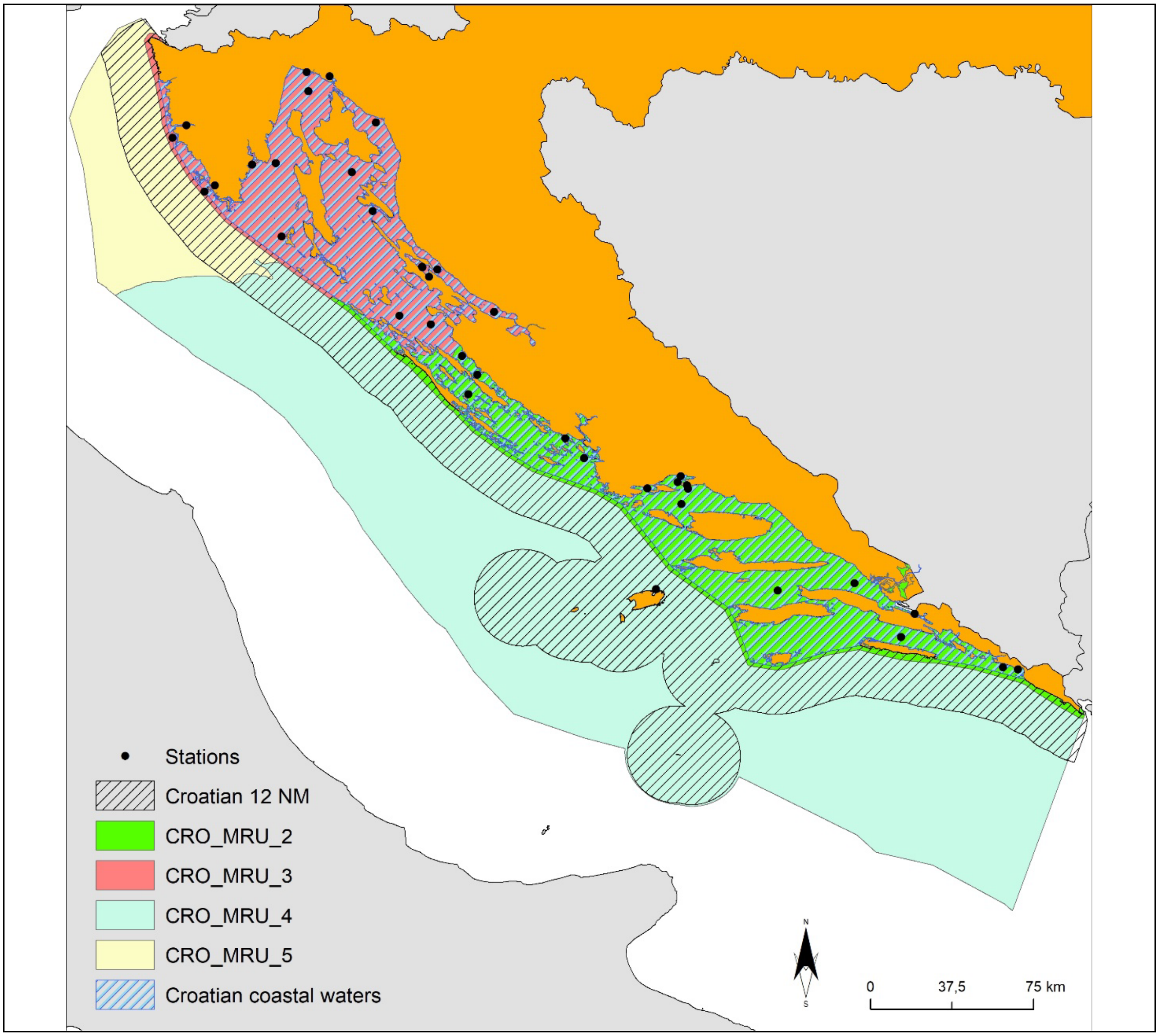

Figure 4. The four official MSFD MRUs of Croatia overlaid on the MEDCIS coastal and offshore zones and the network of monitoring stations. The source of data for MRUs is the EIONET folder of Croatia available at **https://cdr.eionet.europa.eu/hr/eu/msfd_art17/2018reporting/spatialdata/envxj4tsg.**

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[7] https://cdr.eionet.europa.eu/hr/eu/msfd_art17/2018reporting/spatialdata/envxj4tsg

[8] Maritime Code (Pomorski Zakonik – PZ) of Republic of Croatia, Off. Gazette, No. 26/01, 12 Apr 2001
Barić Punda, V., Filipović, V. 2015. Protocol on the interim regime along the southern border (2002) with special regard to the decisions of the governments of the Republic of Croatia and Montenegro on the exploration and exploitation of hydrocarbons in the Adriatic., PPP 54 (2015), 169, pp. 73–88.

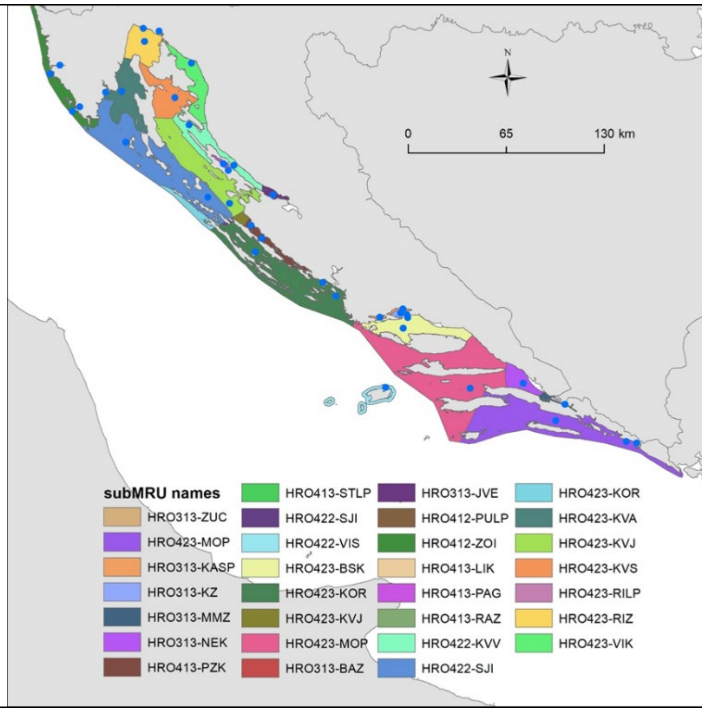


Figure 5. The subMRUs of Croatia as used for the needs of Marine Strategy Framework Directive and reporting obligations, overlaid on the monitoring stations network. The source of data is EEA SDI (https://cdr.eionet.europa.eu/hr/eu/msfd_art17/2018reporting/spatialdata/envxj4tsg). For the purpose of present work, a further update of the dataset was undertaken by including a buffer zone around the Vis Island in order to ensure use of monitoring data for NEAT application from the monitoring station set in the area, given it was included in data reported to IMAP IS.

Greece: One official MRU of Greece related to the MSFD implementation falls within the South part of the Adriatic (SAS) (MAD-EL-MS-AD)[9] with one offshore monitoring station at a distance of 6 nm from the closest land. This MRU is detached from the Greek mainland, and the coast therein corresponds to areas with no pollution pressures. Therefore, it is considered as representative of offshore waters and considered as an IMAP SAU in the offshore zone. The surface area of the Greek MRU is given in Table 1.

[9] https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/99869345-d8b0-4933-a9d0-3c9e08055c4a

Figure 6. The Greek official MSFD MRU in the South part of the Adriatic Sea used as offshore IMAP SAU. The source of data for MRUs is the EIONET folder of Greece available at https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/99869345-d8b0-4933-a9d0-3c9e08055c4a . The coordinates of monitoring stations are from the Greek monitoring programmes for the MSFD implementation, Gov. Gazette No 3799/25-11-16.

Italy: The distribution of monitoring stations of Italy and their relation to the two coastal and offshore zones is shown in Figure 7 further to elaboration provided in UNEP/MED WG. 533/Inf. 5. Italy has officially declared Marine Reporting Units at 3 levels. The latest dataset is available in the relevant folder of EIONET[10]. For the Adriatic Sea the 3 subMRUs are available namely IT-NAS-0001, IT-CAS-0001 and IT-SAS-0001 (Figure 8).

[10] https://cdr.eionet.europa.eu/it/eu/msfd_art17/2018reporting/spatialdata/envxd9fqa

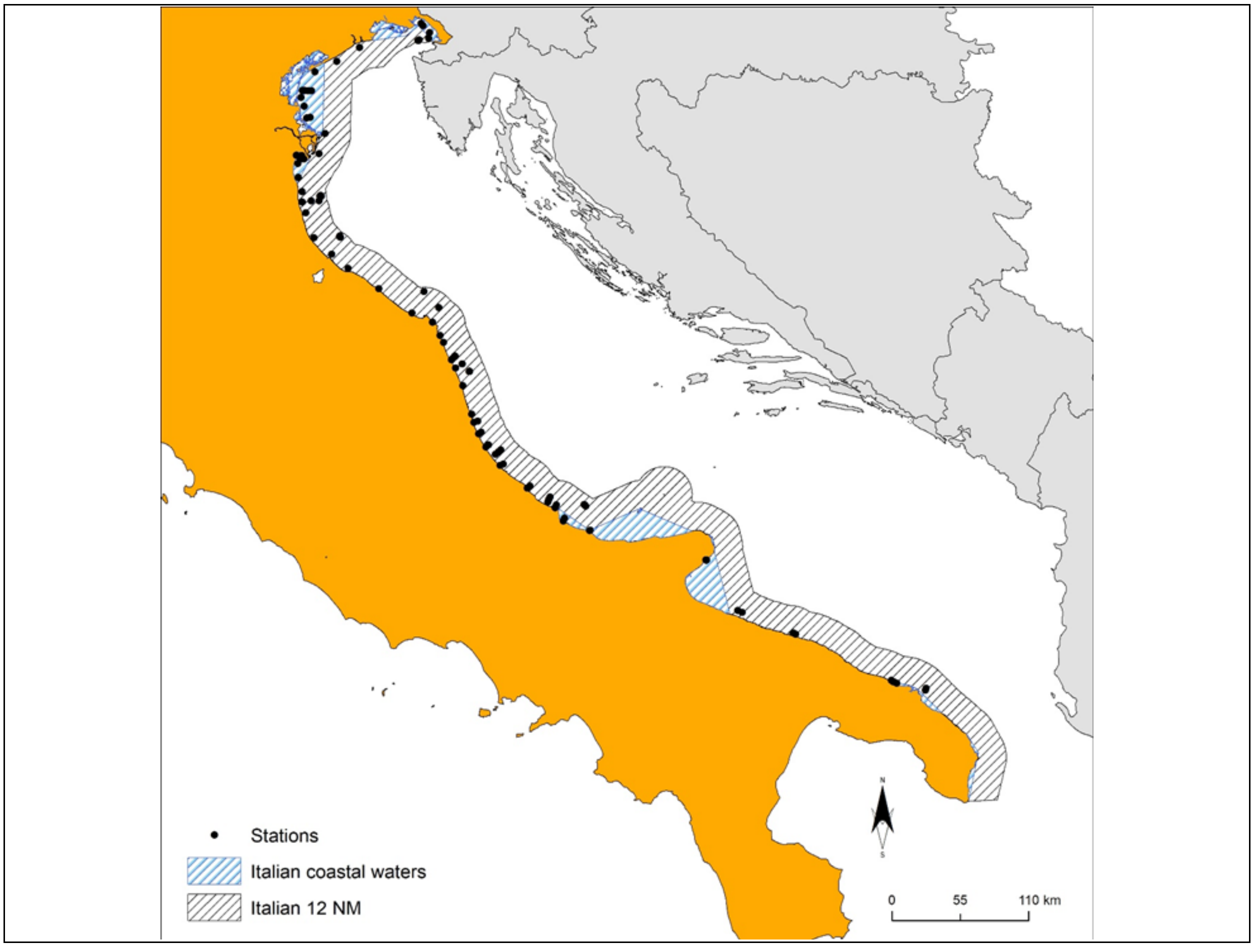


Figure 7. The MEDCIS coastal and offshore zones of Italy overlaid on the network of monitoring stations. The data source is the MEDCIS project[11]. The positions of the monitoring stations are as reported to IMAP IS.

[11] https://www.lifewatchitaly.eu/en/related-projects/medcis-3/

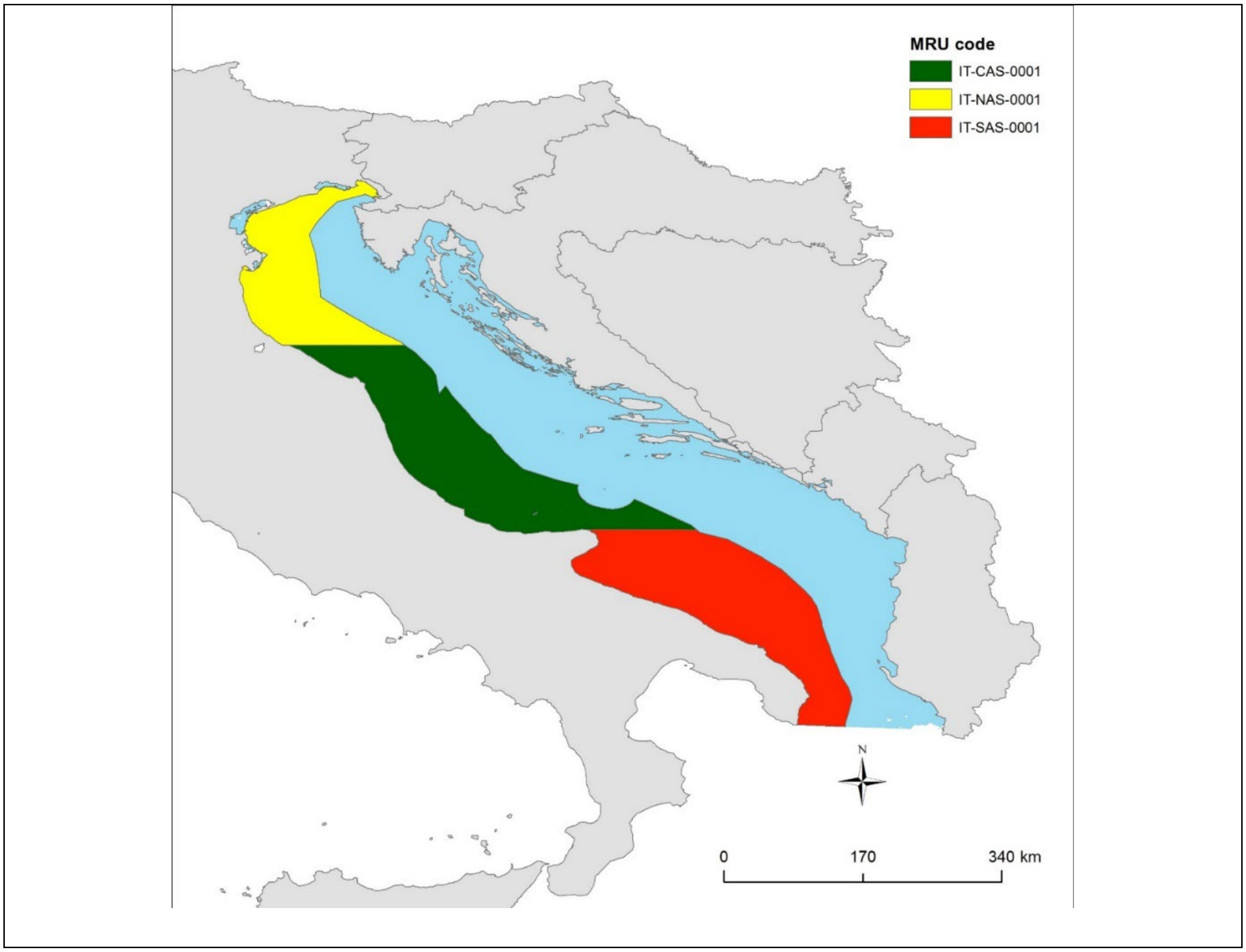


Figure 8. The official subMRUs of Italy IT_MRU_SUBDIV_2018 is further subdivided into 3 subMRUs in the Adriatic Sea. The data come from the Spatial Data Infrastructure of the European Environment Agency, the layer on the Marine Reporting Units used in Marine Strategy Framework Directive (MSFD) 2012-2018 reporting cycle - version 1.0, Feb. 2020.[12]

The relation of the monitoring stations network to the coastal and offshore zones and the 3 Italian sub-MRUs for the Adriatic Sea are shown in Figure 9.

[12] https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/99869345-d8b0-4933-a9d0-3c9e08055c4a

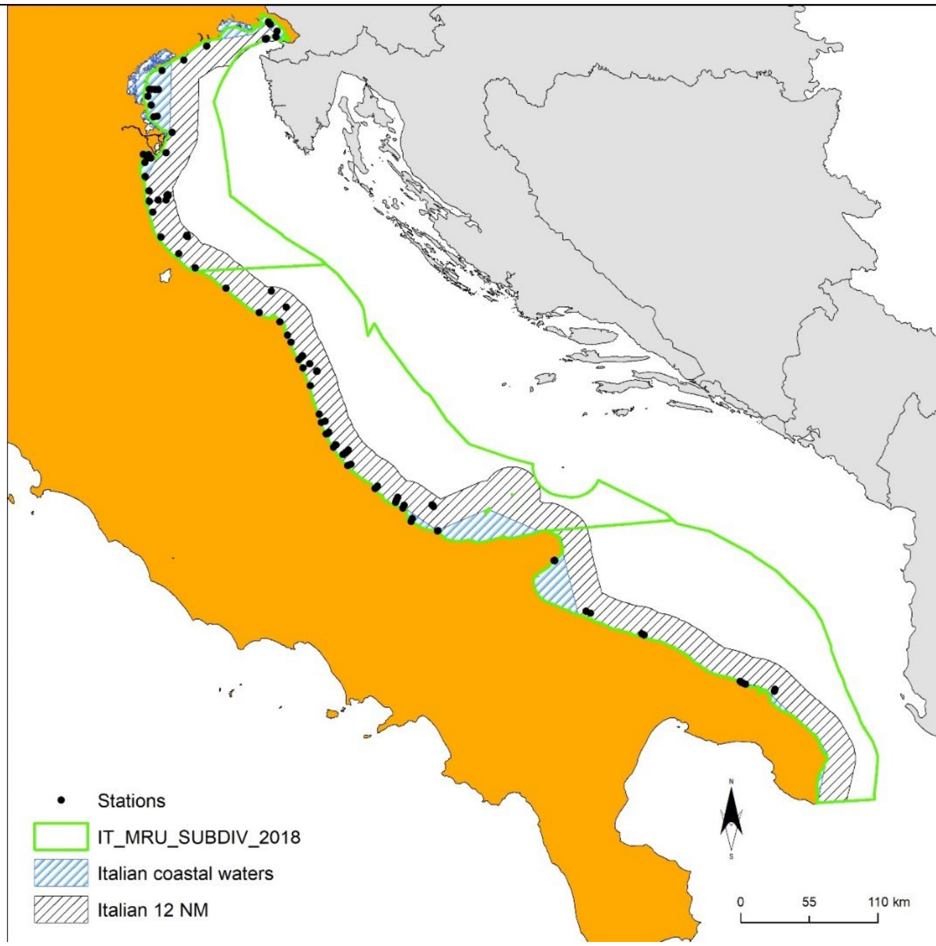


Figure 9. The official subMRUs of Italy overlaid on the coastal and offshore zones and network of monitoring stations are marked in green. The data source is the MEDCIS project[13].The position of monitoring stations are as reported to IMAP IS. MRUs come from the Spatial Data Infrastructure of the European Environment Agency, the layer on the Marine Reporting Units used in Marine Strategy Framework Directive (MSFD) 2012-2018 reporting cycle - version 1.0, Feb. 2020 [14]

As it is elaborated in the UNEP/MED WG. 533/Inf 5, in order to reach a common, harmonized IMAP spatial scale among all the Adriatic countries, the Italian coastal zone was further subdivided. In the absence of ecological characterization of the area this was done according to the Regional/Administrative subdivision of Italy. The first level of administrative division is provided by the Database of Global Administrative Areas - GADM[15]. The coastal zone was further sub-divided into finer IMAP SAUs (subSAUs) according to the administrative units of Italy.

This was then followed by derivation of the IMAP assessment areas (IMAP SAUs) of the offshore waters of Italy. They were derived from the official subMRUs (IT-NAS-001, IT-CAS-001, IT-SAS-001) excluding the coastal part, i.e. the surface area in km^2 for the IMAP SAUs in the offshore zone is

[13] https://www.lifewatchitaly.eu/en/related-projects/medcis-3/
[14] https://sdi.eea.europa.eu/catalogue/srv/eng/catalog.search#/metadata/99869345-d8b0-4933-a9d0-3c9e08055c4a
[15] https://biogeo.ucdavis.edu/data/gadm3.6/shp/gadm36_ITA_shp.zip

calculated by subtracting the surface of area of the coastal zone from the surface area of the 3 official subMRUs (IT-NAS-0001, IT-CAS-0001, IT-SAS-0001). The offshore zone was not further subdivided due to the overall limited number of monitoring stations there. For Italy the proposal of the IMAP SAUs includes the coastal units based on i) the MEDCIS coastal zone and the country's administrative (UNEP/MED WG. 533/Inf.5); and ii) the offshore units based on the official Adriatic sub-MRUs excluding the surface area of the coastal subSAUs (Figure 10). In total 10 IMAP SAUs have been proposed for Italy. Their coding and surface of the areas are given in Table 1.

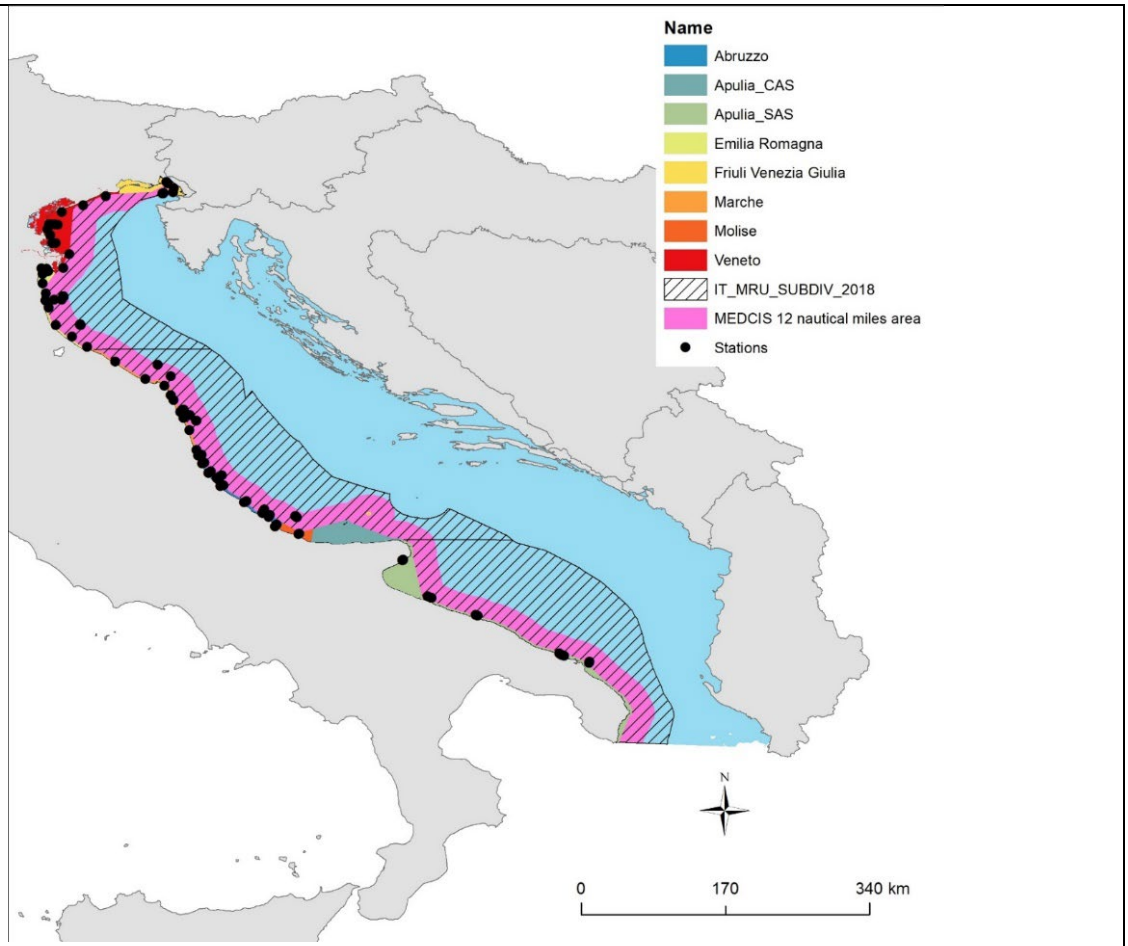


Figure 10. The IMAP finest areas of assessment of Italy (IMAP subSAUs) produced for the coastal zone of Italy and used for testing of the NEAT application in the Adriatic Sea Sub-region. It is based on the administrative division[16] and overlaid on the monitoring stations network. The stations in the offshore zone (in purple) are representative of broader assessment units (IMAP SAUs) derived for the MSFD MRUs (shaded areas).

[16] The coastal zone has been divided at the limits of each first-level Administrative Divisions layer of Italy (source of the First-level Administrative Divisions, Italy, 2015 https://maps.princeton.edu/catalog/stanford-bb489fv3314

Another issue which is related to the nesting of the SubMRUs of Italy is the delimitation of the IT-NAS-0001, IT-CAS-0001, IT-SAS-0001. This division is slightly different from the one used in the present work for the 3 subdivisions of the Adriatic Sea, as described above and shown in Figure 1. The differences are related to the limits between the Central and the North Adriatic Sea, and the Central and the South Adriatic Sea, as can be seen by comparing of Figure 1 and Figure.8. The surface area of the Italian IT-CAS-0001 MRU is larger than the surface area of the Central Adriatic subdivision as shown in Figure 1. The two parts of the IT-CAS-0001 overlapping with the North and the South Adriatic subdivisions are considered small. In the north overlapping part only 3 stations exist in the Marche subMRU while in the south overlapping part no monitoring stations are present. Hence for the present work, all monitoring data in the subMRU IT-CAS-0001 of Italy were aggregated under the Central Adriatic subdivision (CAS).

Montenegro: The monitoring areas have not been defined in the National IMAP of Montenegro prepared in the framework of GEF Adriatic Project. Within the present testing of NEAT application, the IMAP areas of assessment are proposed considering the distribution of monitoring stations (Figure 11), as provided in National IMAP. During the 1st working step it was found that the MEDCIS zoning was not useful due to lack of coherence with the nationally defined maritime boundaries in Montenegro as elaborated in UNEP/MED WG. 533/Inf. 5. To overcome these inaccuracies, a relevant and available expert knowledge of the ecosystem characteristics was considered, including the results of the GEF Adriatic Project and findings from literature cited in this document[17] (UNEP/MED WG. 533/Inf.5). The main data that have been used are spatial data from the GEF Adriatic Project[18].

[17] Cushman-Roisin, B., Gačić, M., Poulain, P-M., ARTEGIANI, A., 2001. Physical Oceanography of the Adriatic Sea, Past, Present and Future, Springer Science + Business Media, Dordrecht, 312 pp.
Gaytan Aguilar, S., Verlaan, M., 2018. EMODnet High Resolution Seabed Mapping (HRSM), EMODnet Phase III, National coastlines and baselines – data set collection for European countries, 32 pp. www.emodnet-bathymetry.eu
Suárez de Vivero, J. l., 2010, Jurisdictional Waters in the Mediterranean and Black Seas, Directorate General for Internal Policies, Policy Department B: Structural And Cohesion Policies, Fisheries, 140 pp.
http://www.rac-spa.org/sites/default/files/doc_medmpanet/marine_biodiversity_in_boka_kotorska_bay_ecap_montenegro.pdf

[18] https://www.unep.org/unepmap/what-we-do/projects/GEF-Adriatic-project

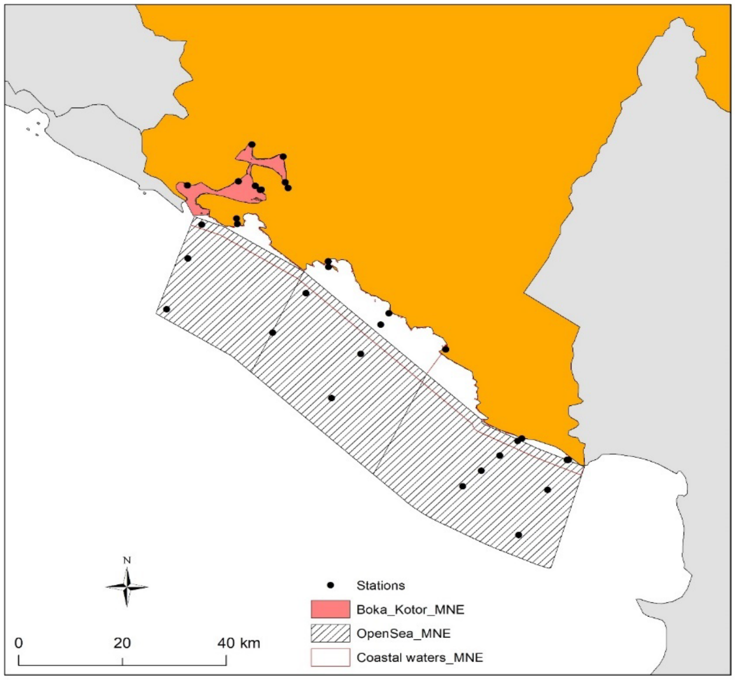


Figure 11. The 7 IMAP SAUs defined for Montenegro based on the data from the GEF Adriatic Project. The monitoring stations positions are shown.

Three main assessments zones have been set, the Boka Kotorska bay, the coastal waters and the offshore sea zone. For the purpose of setting the finest areas of assessment, the two latter have been split into the North, the Central and the South areas, as it is elaborated in UNEP/MED WG. 533/Inf.5, by considering ecological and hydrological characteristic as found in scientific literature used for preparation of this document. These IMAP SAUs are shown above in Figure 11 shows for the purpose of NEAT testing in Montenegro within the Adriatic Sea sub-region.

The final dataset has been created by utilizing the spatial files from the GEF Adriatic Project and by further improvements of the spatial files related to the delineation of the Boka Kotorska bay as indented area of assessment, as well as by the delineation of the coastal area of monitoring based on the straight baseline and the 1 nautical mile and the offshore waters area. The last two have been further delimited into three zones due to their large spatial coverage. By that, three areas of monitoring for the coastal waters i.e. the North, the Central, the South and three for the open sea-offshore waters were recognized i.e. the North, the Central, the South. From such recognized areas of monitoring, seven areas of assessment were proposed for Montenegro. Namely, the IMAP SAUs for Montenegro include: 4 in the coastal- waters (Kotor, MNE1-N, MNE-1-C, MNE-1- S) and 3 defined by the 12 nautical miles offshore zone (MNE-12-N, MNE-12-C, MNE-12-S) (Table 1).

The spatial layer of the GEF Adriatic Project providing the potential cumulative pressures from pollution in the marine area of Montenegro (Figure 12) was used as a source to support present expert work that resulted in recognition of the areas of monitoring further to the distribution of the monitoring stations and from there proposing the areas of assessment from the areas of monitoring.

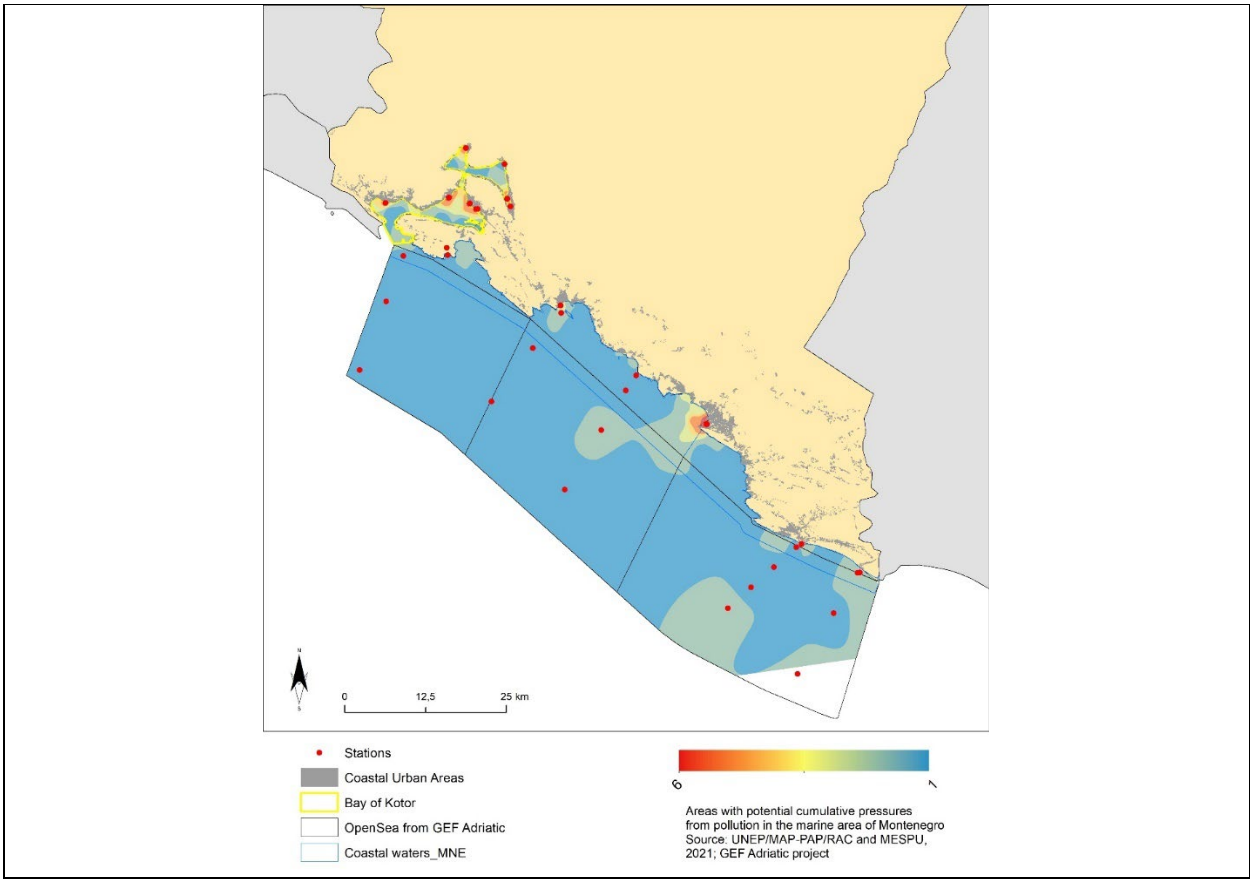


Figure 12. The network of monitoring stations of Montenegro, superimposed on the geospatial product for areas with potential cumulative pressures from pollution in the marine waters of Montenegro (source: the GEF Adriatic Project).

Slovenia: In Figure 13 the distribution of monitoring stations of Slovenia for IMAP CI 17 is shown.Two official MRUs MAD-SL-MRU-11 and MAD-SL-MRU-12 are declared by Slovenia in the EIONET data portal[19]. These do not exactly correspond to coastal and offshore waters as shown by the MEDCIS coastal and offshore zones and most monitoring stations are positioned beyond the 1 nautical mile distance from land. In order to ensure compatibility with Slovenian national assessments, the MAD-SL-11_MRU was considered in the coastal IMAP SAU and the MAD-SL-12 in the offshore IMAP SAU. For Slovenia the two IMAP SAUs used are MAD-SL-MRU_11 representative of the coastal IMAP SAU and MAD-SL-MRU-12 representative of the offshore IMAP SAU.

[19] https://cdr.eionet.europa.eu/si/eu/msfd_art17/2018reporting/spatialdata/envw1gosq

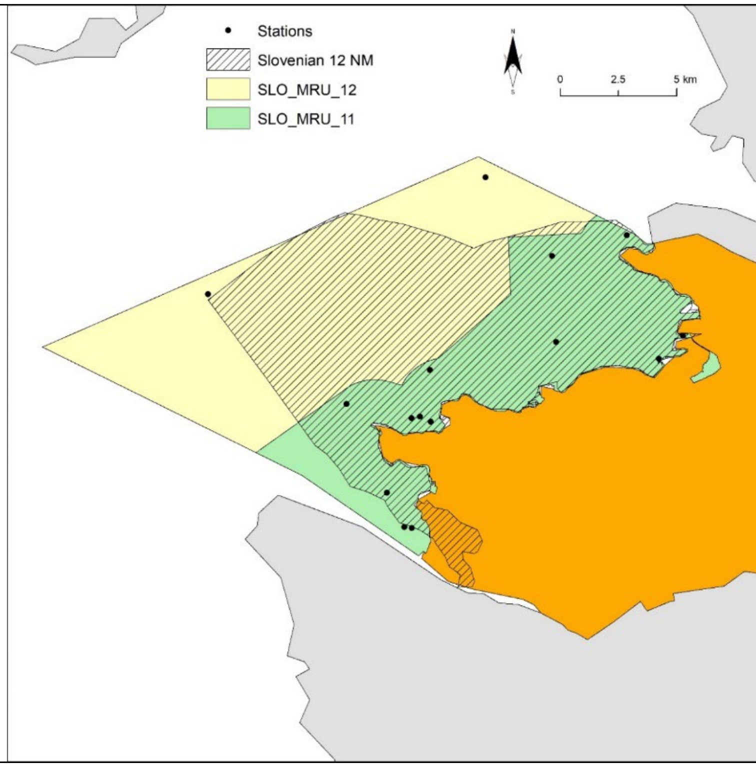


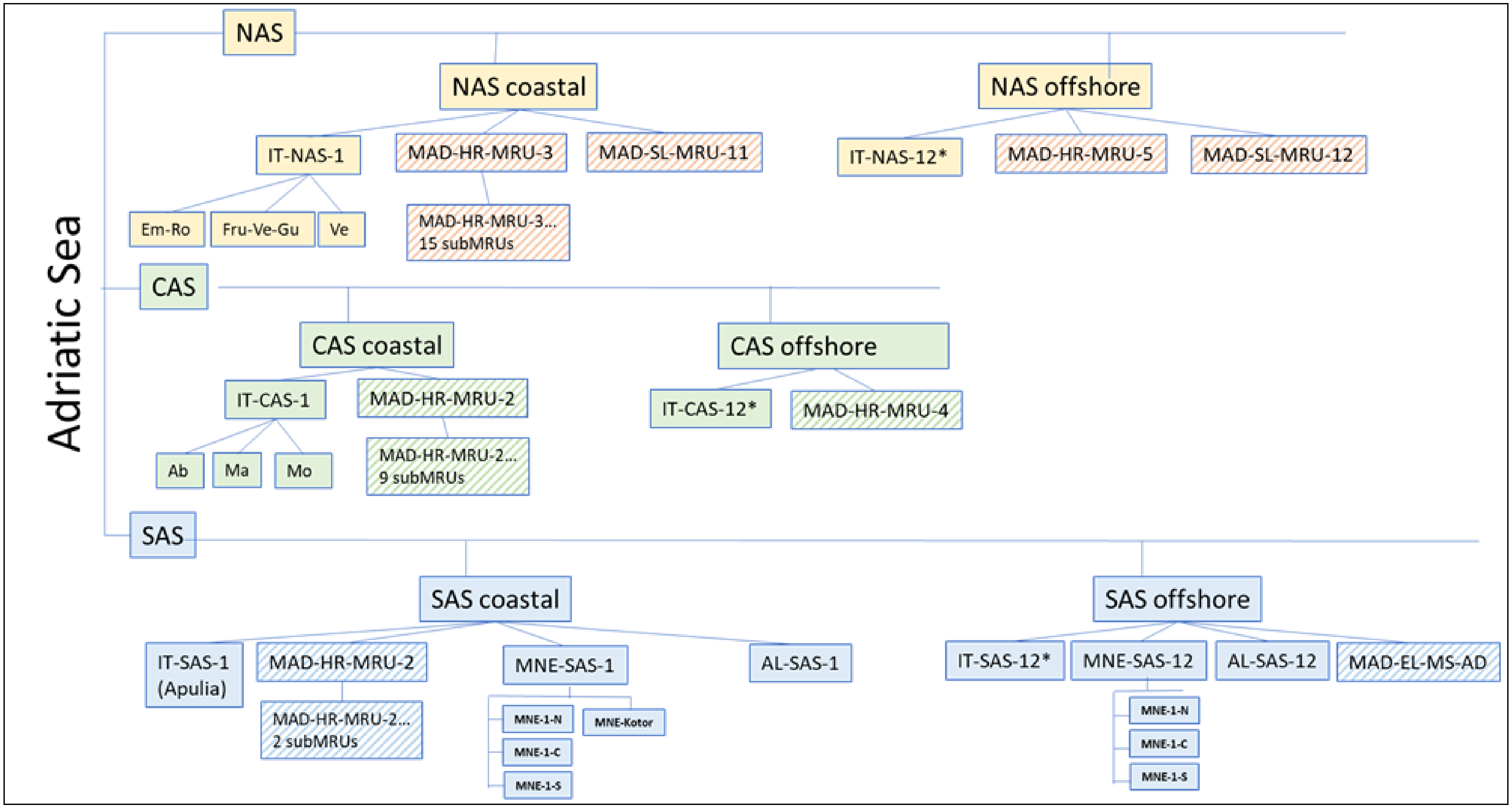
Figure 13. The finest IMAP SAUs for Slovenia, used for the NEAT application in the Adriatic Sea Sub-region, proposed in line with the officially declared MRUs. The MEDCIS offshore zone is also shown.

2.2 The nesting approach for SAUs in the Adriatic Sea

After setting of the finest IMAP areas of assessment, their nesting within three sub-divisions of the Adriatic Sea sub-region was undertaken. As it is explained above in chapter 2, the approach followed for the nesting of the areas is 4 levels nesting scheme (1 - being the finest level, 4 - the highest):

- 1st level provided nesting of all national IMAP SAUs & subSAUs within the two key IMAP assessment zones per country i.e. coastal and offshore zone;
- 2nd level provided nesting of the assessment areas set in IMAP assessment zones i.e. the coastal and offshore zones, on the subdivision level i.e. i) NAS coastal (NAS-1), NAS offshore (NAS-12); ii) CAS coastal (CAS-1), CAS offshore (CAS-12); iii) SAS coastal (SAS-1), SAS offshore (SAS-12);
- 3rd level provided nesting of the areas of assessment within the 3 subdivisions (NAS, CAS, SAS);
- 4th level provided nesting of the areas of assessment within the Adriatic Sea Sub Region.

This nesting scheme is shown schematically in Figure 14.



*For Italy the offshore IMAP SAUs areas (IT-NAS-12, IT-CAS-12, IT-SAS-12) is calculated by subtracting the surface of area of the coastal zone from the surface area of the 3 official MRUs (IT-NAS-0001, IT-CAS-0001, IT-SAS-0001)

Figure 14: The nesting scheme of the SAUs defined for the Adriatic Sea based on the available information. Shaded boxes correspond to official MRUs declared by the countries that are EU MSs and that were decided to be used as IMAP SAUs.

The following maps show the nested approach per sub-divisions of the Adriatic Sea Sub-region. For each sub-division, the IMAP SAUs of every country have been selected and showed in Figures. 15, 16 and 17, while Table 1 provides consolidated information of the maps for further use.

In North Adriatic Sea (NAS) (Figure 15) Italy has 1 offshore SAU and 3 coastal SAUs, Slovenia has 1 offshore SAU and 1 coastal SAU and Croatia has 2 offshore SAUs and 16 coastal SAUs.

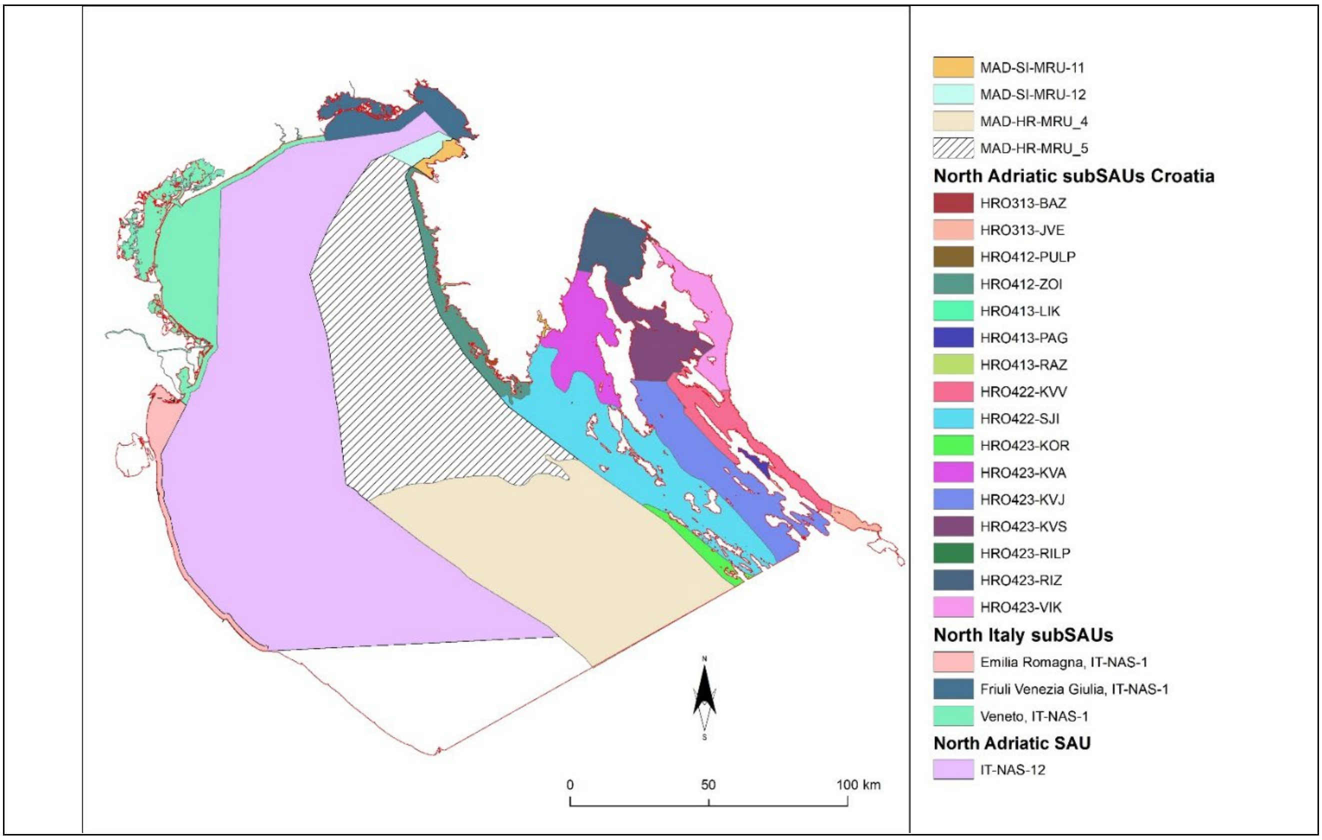


Figure 15. The nesting approach of the IMAP SAUs in North Adriatic Sea based on spatial assessment units defined for testing of NEAT application in the Adriatic Sea Sub-region.

In Central Adriatic Sea (CAS) (Figure 16), Italy has 1 offshore SAU and 4 coastal SAUs, Croatia has 1 offshore SAU, and 12 coastal SAUs[20]. In Italy the offshore SAU of the Central Adriatic Sea has a different shape defined by its official Central Adriatic Sea MRU as explained above in 2.1 section related to Italy and in UNEP/MED WG. 533/Inf.5. Therefore, data from monitoring stations of Italy falling into the NAS are aggregated under CAS.

[20] In Central Adriatic Sea (CAS), Bosnia and Herzegovina has 1 coastal SAU as explained in UNEP/MED WG. 533/Inf.5

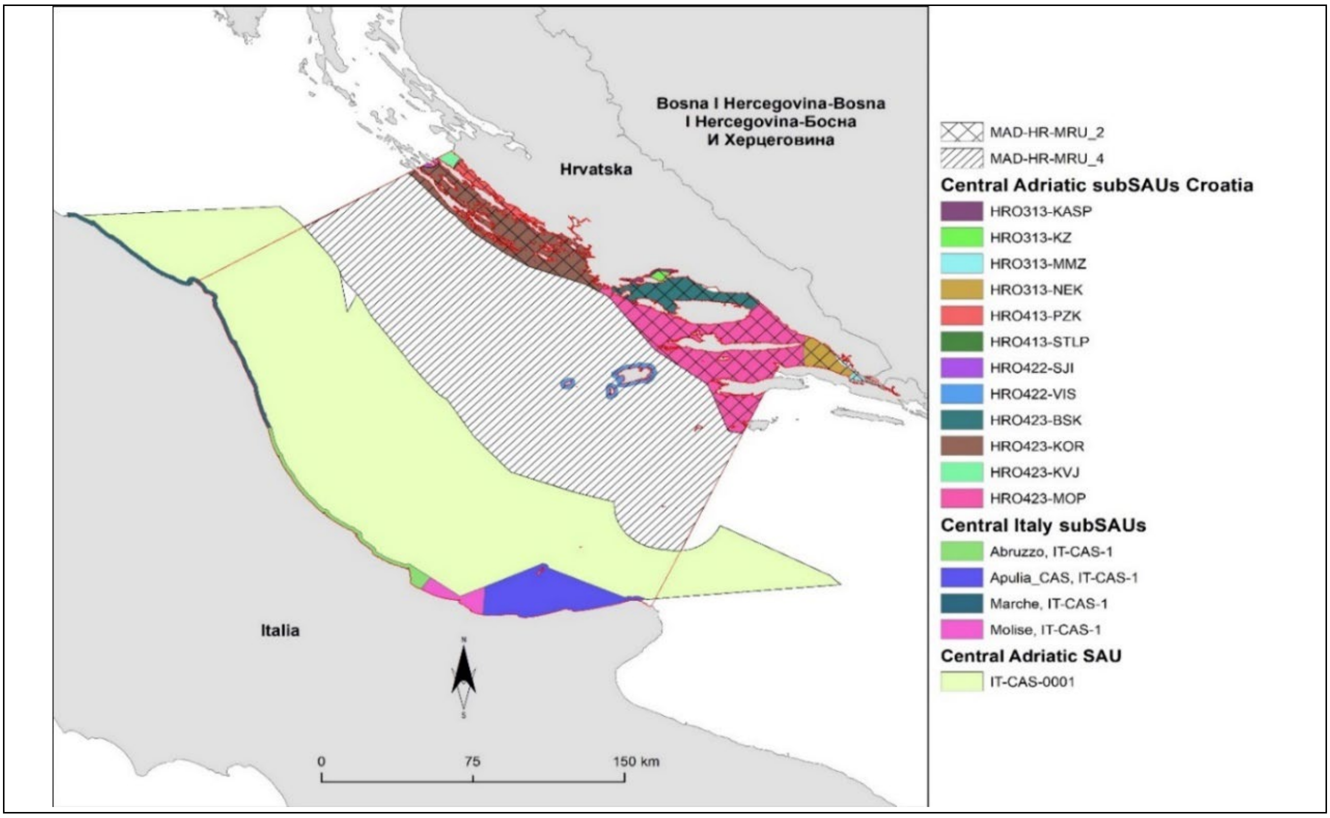


Figure 16. The nesting approach of the IMAP SAUs in Central Adriatic Sea based on the spatial assessment units defined within testing of NEAT application in the Adriatic Sea Sub-region.

In South Adriatic Sea (SAS) (Figure 17) Italy has 1 offshore SAU and 1 coastal SAU, Croatia has 1 offshore SAU and 2 coastal SAUs, Montenegro 3 offshore SAUs and 4 coastal SAUs, Albania has 1 offshore SAU and 1 coastal SAU and Greece 1 offshore SAU in absence of coastal stations.

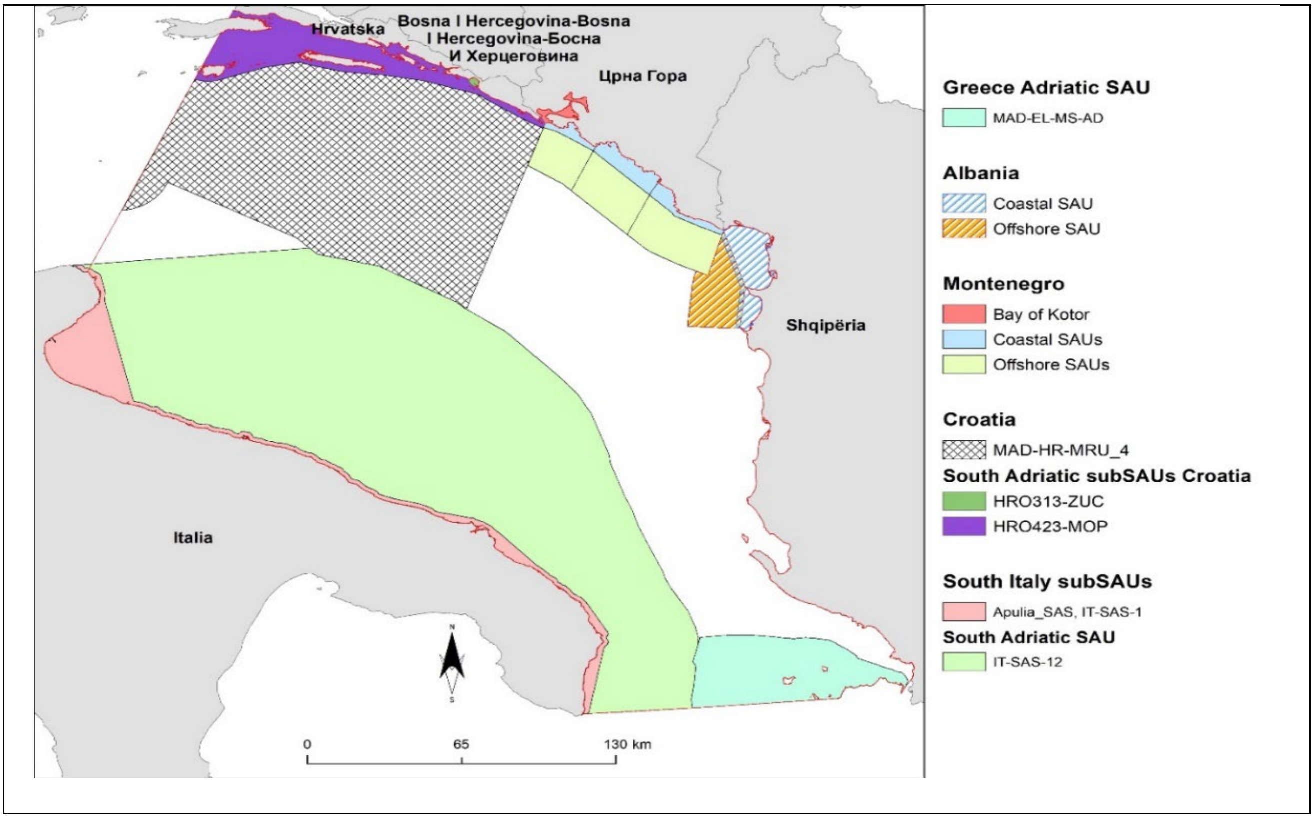


Figure 17. The nesting approach of the SAUs in South Adriatic Sea based on the spatial assessment units defined within testing of NEAT in Adriatic Sea.

Table 1. The spatial assessment units (SAUs) for the Adriatic Sea Sub-region and their respective surface area (km^2) and number of monitoring stations located in the SAUs.

Sub-division	IMAP Assessment Zone	IMAP SAU	IMAP sub SAU	Area (km^2)	Total No stations	stations / area
North Adriatic (NAS)				**31856**	**68**	**0.002**
	NAS coastal			**9069**		
		MAD-HR-MRU_3		6422	19	0.003
			HRO3-0313-JVE	73	1	0.014
			HRO-O313-BAZ	4	1	0.259
			HRO-O412-PULP	7	1	0.149
			HRO-O412-ZOI	473	3	0.006
			HRO-O413-LIK	7	1	0.150
			HRO-O413-PAG	30	1	0.033
			HRO-O413-RAZ	10	1	0.097
			HRO-O422-KVV	494	2	0.004
			HRO-O422-SJI	1923	2	0.001
			HRO-O423-KVA	686	1	0.001
			HRO-O423-KVJ	1089	1	0.001
			HRO-O423-KVS	577	1	0.002
			HRO-O423-RILP	6	1	0.178
			HRO-O423-RIZ	475	1	0.002
			HRO-O423-VIK	455	1	0.002
		IT-NAS-1		2592	19	0.007
			Emilia Romagna	371	6	0.016
			Friuli Venezia Giulia	575	4	0.007
			Veneto	1646	9	0.005
		MAD_SI_MRU_11		55	6	0.110
	NAS offshore			**22788**		
		IT-NAS-12		10540	23	0.002
		MAD_SI_MRU_12		129	2	0.016
Central Adriatic (CAS)				**63696**	**60**	**0.001**
	CAS coastal			**9394**		
		MAD-HR-MRU-2		7302	14	0.002
			HRO-0313-NEK	253	1	0.004
			HRO-O313-KASP	44	2	0.045
			HRO-O313-KZ	34	1	0.029
			HRO-O313-MMZ	55	1	0.018
			HRO-O413-PZK	196	2	0.010
			HRO-O413-STLP	1	1	1.580
			HRO-O423-BSK	613	2	0.003
			HRO-O423-KOR	1564	3	0.002

Sub-division	IMAP Assessment Zone	IMAP SAU	IMAP sub SAU	Area (km^2)	Total No stations	stations / area
			HRO-O423-MOP	2480	1	0.000
		IT-CAS-1		2092	20	0.010
			Abruzzo	282	8	
			Marche	319	8	
			Molise	229	2	
	CAS offshore			**54303**		
		IT-CAS-12		22393	25	0.001
		MAD-HR-MRU_4		18963	1	0.000
South Adriatic (SAS)				**44231**	**58**	**0.001**
	SAS coastal			**7276**		
		MAD-HR-MRU_2		4252	3	0.001
			HRO313-ZUC	13	1	0.078
			HRO423-MOP	1756	2	0.001
		IT-SAS-1	(Apulia)	1810	8	0.004
		MNE-1		483	11	0.023
			MNE-1-N	86	3	
			MNE-1-C	246	6	
			MNE-1-S	151	5	
			MNE-Kotor	85	13	0.153
		AL-1		646	4	0.006
	SAS offshore			**36955**		
		IT-SAS-12		22715	5	0.000
		MNE-12		2076	12	0.006
			MNE-12-N	513	3	
			MNE-12-C	713	4	
			MNE-12-S	849	6	
		AL-12		716	2	0.003
		MAD-EL-MS-AD		2253	1	0.0004

3. Data availability

Data on contaminants (Cd, Hg, Pb, PAHs and PCBs) have been collected from all Contracting Parties bordering the Adriatic Sea for the years 2015 to 2020, except from Bosnia & Herzegovina that does not monitor contaminants in marine environment. Details on the temporal and spatial availability of data per IMAP SAUs, per environmental matrix (sediments, biota) and per contaminants group (trace metals (TM), PAHs, PCBs) are provided in Tables 2 and 3. The spatiotemporal coverage varies largely among the various IMAP SAUs. Sediments stations have in general higher spatial coverage. For some IMAP SAUs data are not existent or correspond to only 1 or 2 stations sampled once. Trace metals in sediments are monitored in the highest number of stations (184) and all SAUs have at least one station sampled once, followed by PAHs stations (99) and PCBs (49). The Central Adriatic subdivision is the least monitored for PAHs in sediments while it is not at all monitored for PCBs in sediments. All monitoring stations for biota refer to samplings of the mussel species, *Mytilus galloprovincialis*, therefore no data on organic compounds are available for fish matrix. Regarding the spatial coverage of monitoring stations for biota this is by far lower than that in sediments. Trace metals are monitored in 53 stations, PAHs in 16 and PCBs in 30. Contaminants' data in fish were scarce, reported only for trace metals in 27 stations in Croatian waters and 4 stations in Montenegrin waters. In addition, not always the same fish species was sampled making comparisons and harmonized assessment difficult.

As explained above in chapter 2, a set of criteria was applied to propose the scope of the areas of monitoring. To better understand differences in the spatial coverage of the SAUs the ratio of number of stations to surface of the area (no of stations/km^2) ratio is calculated as shown in Table 1. This ratio was calculated to support application of the criteria related to representatives of the areas of monitoring for establishing areas of assessment. It is understood that the highest the ratio, the better the spatial coverage. However, in areas with limited presence of pressures a low ratio may be equally suitable for the purposes of a sound assessment. For this reason, the calculated ratios are only indicative and comparisons among them should be made keeping in mind the specific features of the SAUs. On the Adriatic sub-division level, the North Adriatic Sea is better covered by monitoring stations. Further to this criterion, the spatial distribution of monitoring stations and its comparison with the sufficiency of quality-assured data as collated for NEAT application were analyzed as provided in Tables 2 and 3. Table 2 provides the spatial coverage of monitoring data collected per each SAU in the Adriatic Sea and per environmental matrix (sediments, biota) and per contaminant group (trace metals (TM), PAHs, PCBs) separately. Table 3 provides the temporal coverage of monitoring data used again per each SAU in the Adriatic Sea and per environmental matrix (sediments, biota) and per contaminant group (trace metals (TM), PAHs, PCBs) separately.

Table 2: Spatial coverage of monitoring data collected for the Adriatic Sea. The number /of monitoring stations in the IMAP SAUs of the Adriatic Sea per environmental matrix (sediments, biota) and per contaminant group (trace metals (TM), PAHs, PCBs) is shown.

Sub-division	Zone	SAU	sub SAU	No stations sediment			No stations biota		
				TM	**PAHs**	**PCBs**	**TM**	**PAHs**	**PCBs**
North Adriatic (NAS)				**68**	**43**	**23**	**21**	**4**	**11**
	NAS coastal/intercoastal								
		MAD-HR-MRU-3		**19**	**-**		**11**		**11**
			HRO3-0313-JVE	1			1		1
			HRO-O313-BAZ	1					
			HRO-O412-PULP	1					
			HRO-O412-ZOI	3			1		1
			HRO-O413-LIK	1			1		1
			HRO-O413-PAG	1			1		1
			HRO-O413-RAZ	1					
			HRO-O422-KVV	2			1		1
			HRO-O422-SJI	2			1		1
			HRO-O423-KVA	1			1		1
			HRO-O423-KVJ	1			1		1
			HRO-O423-KVS	1			1		1
			HRO-O423-RILP	1					
			HRO-O423-RIZ	1			1		1
			HRO-O423-VIK	1			1		1
		IT-NAS-1		**19**	**23**	**13**			
			Emilia Romagna	6	16	6			
			Friuli Venezia Giulia	4					
			Veneto	9	7	7			
		MAD_SI_MRU_11		**6**	**8**		**8**	**4**	
	NAS offshore								
		IT-NAS-12		**23**	**12**	**10**	**2***		
		MAD_SI_MRU_12		**2**					
Central Adriatic (CAS)				**58**	**23**		**12**		**6**
	CAS coastal/intercoastal								
		MAD-HR-MRU-2		**14**			**6**		**6**

Sub-division	Zone	SAU	sub SAU	No stations sediment			No stations biota		
				TM	**PAHs**	**PCBs**	**TM**	**PAHs**	**PCBs**
			HRO-0313-NEK	1			1		1
			HRO-O313-KASP	2			1		1
			HRO-O313-KZ	1					
			HRO-O313-MMZ	1			1		1
			HRO-O413-PZK	2			1		1
			HRO-O413-STLP	1					
			HRO-O423-BSK	2			1		1
			HRO-O423-KOR	3			1		1
			HRO-O423-MOP	1					
		IT-CAS-1		**18**	**8**				
			Abruzzo	8	8				
			Marche	8					
			Molise	2					
	CAS offshore								
		IT-CAS-12		25	**7**		**6**		
		MAD-HR-MRU_4		1					
South Adriatic (SAS)				**58**	**33**	**26**	**20**	**12**	**13**
	SAS coastal/intercoastal								
		MAD-HR-MRU_2		**3**			**5**		**2**
			HRO313-ZUC	1			1		1
			HRO423-MOP	2			2		1
		IT-SAS-1	**(Apulia)**	**8**			**2**		
		MNE-1		**27**	**22**	**15**	**15**	**12**	**11**
			MNE-1-N	3	3	1			
			MNE-1-C	6	6	5	2	2	2
			MNE-1-S	5	5	3	1	1	1
			MNE-Kotor	13	8	6	12	9	8
		AL-1		**4**					
	SAS offshore								
		IT-SAS-12		**5**					
		MNE-12		**12**	**11**	**11**			
			MNE-12-N	3	2	2			
			MNE-12-C	4	4	4			
			MNE-12-S	6	5	5			
		AL-12		**2**					
		MAD-EL-MS-AD		**1**	**1**				

Table 3: Temporal coverage of the monitoring data collected for the Adriatic Sea. The years of data collected per SAU and per contaminant group (trace metals (TM), PAHs, PCBs) are shown.

Sub-division	Zone	SAU	Years monitored Sediments			Years monitored biota		
			TM	PAHs	PCBs	TM	PAHs	PCBs
North Adriatic (NAS)								
	NAS coastal/intercoastal							
		MAD-HR-MRU-3	’17, ’19			’19, ’20		‘19
		IT-NAS-1	’15, ’16, ’17, ‘18, ‘19	’16, ’17, ‘18, ‘19	’16, ’17, ‘18, ‘19			
		MAD_SI_ MRU_11	‘19	’13, ’14, ‘15, 16			’16, ‘20	
	NAS offshore							
		IT-NAS-12	’16,’17, 18, ‘19	’16, ’17, ‘18,	’16, ’17, ‘18,	’15, ’16, ‘17		
		MAD_SI_ MRU_12				’17, ’18, ’19, ‘20		
Central Adriatic (CAS)								
	CAS coastal/intercoastal							
		MAD-HR-MRU-2	’17, ‘19			’19, ’20		‘19
		IT-CAS-1	’15, ’16, ’17, ‘18, ‘19	’16, ’17, ‘18				
	CAS offshore							
		IT-CAS-12	’15, ’16, ’17, ‘18,	’16, ’17, ‘18		’15, ’16, ‘17		
		MAD-HR-MRU_4	’17, ‘19					
South Adriatic (SAS)								
	SAS coastal/intercoastal							
		MAD-HR-MRU_2	’17, ‘19			’19, ’20		‘19
		IT-SAS-1	’15, ’16, ’17, ‘18, ‘19			’15, ’16, ’17, ‘18,		
		MNE-1	’16, ’17, ’19, ‘20	’18, ’19, ‘20	’19, ‘20	’19, ‘20	’19, ‘20	’19, ‘20
		AL-1	‘20					
	SAS offshore							
		IT-SAS-12	’16, ‘17					
		MNE-12	‘19	’18, ’19, ‘20	’19, ‘20	‘18, ’19, ‘20		’19, ‘20
		AL-12	‘20					
		MAD-EL-MS-AD	‘18	‘18				

4. Setting the assessment criteria

Upgrading of the baselines and threshold values for IMAP CI 17 in the Mediterranean Sea is an ongoing process. Detail information on their present status is provided in the present Meeting documents UNEP/MED WG.533/3 & UNEP/MED WG. 533/Inf.3. The assessment criteria used in the present assessment analysis, i.e. the GES-nonGEs boundaries are based on the MedEAC values and are defined in the Decisions IG.22/7 and IG.23/6 for contaminants. For those groups of contaminants, i.e. TM and PAHs, which occur naturally in the environment the highest assessment status is defined by using the Background assessment concentrations (BAC) and it is needed for providing sound assessment results. For the Adriatic Sea BACs have been calculated as elaborated in UNEP/MED WG.492/12 and updated by taking into consideration more available data from the CPs in the period 2015-2019. Due to significant delay in monitoring data reporting by the CPs, the present implementation of the NEAT tool for the Adriatic Sea-subregion was conducted in parallel to the updating of the BCs and BACs calculation and for this reason, the BAC values used in the NEAT tool are those based on data received from the CPs until August 2021, which means that there may be discrepancies for the BACs as presented in]. These differences may only affect the classification of the SAUs between the 2 status classes under GES; however, they cannot affect the classification of areas in relation to GES-non GES boundary Despite the fact that PCBs are synthetic compounds, and their BACs are expected to be zero, BACs were calculated also for PCBs in sediments and biota, to compensate for any differences in the analytical accuracy among the laboratories. BACs for PAHs in biota (mussels) were not possible to be calculated due to lack of data availability. For contaminants in fish there are no accepted GES-nonGES boundaries, and overall data for the Adriatic Sea are very limited. Further to this fact findings, the present assessment is limited to TM, PAHs, PCBs in sediments and TM, PCBs in mussels.

In line with the IMAP traffic light methodology, the range of concentrations equal to or below the MedEAC values correspond to the good environmental status i.e. in GES; the range of concentrations above the MedEAC values correspond to non-good environmental status i.e. non-GES. Within the GES range of concentrations, two classes are further defined the good and moderate status classes. The BAC value is used as a threshold value between them. For the nonGES range only one status class is defined, the bad status.

Following the methodology described in UNEP/MED WG. 493/13/Rev2 , the NEAT tool is used for the present assessment analysis. The use of NEAT tool for IMAP assessment of the GES status is compatible with the IMAP traffic light methodology but further produces two more status classes under the non-GES status. In total five status classes are set (high, good, moderate, poor, bad). The tool requires two boundary limit values for the best and worse conditions (these are not threshold values but the minimum and maximum values that determine the scale of the assessment) and one threshold value for the GES – nonGEs status. These are mandatory by the tool which then produces five status classes linearly, depending on the distance of the concentrations from the two boundary limit values and the GES-nonGES threshold. However, the user may also assign threshold values for all other status classes as appropriate.

For the present analysis, the two boundary limit values are: i) zero contaminant concentration for the best conditions; ii) the maximum concentration of contaminants used for the present analysis for the worse conditions. It would have been more appropriate to use for example the 90^{th} or 95^{th} percentiles of the concentration data as the upper worse boundary. However, with the exception of Hg data, for all other contaminants the 90^{th} and 95^{th} percentiles fall below the MedEAC thresholds and thus cannot be used as an upper boundary for the NEAT tool. For the GES-nonGEs threshold the MedEAC value is used. Two more threshold values were used in the present analysis: i) The BAC value to discriminate between the High -Good status, and ii) a value equal to 3 times the MedEAC to discriminate between the Moderate – Poor status. The latter has been proposed by Borja et al. (2019) to compensate for the large variation in the concentrations range, i.e. from the MedEAC value to the worse conditions limit, as is clearly the case for Hg data in sediments. By setting a nonlinear moderate-poor threshold a better discrimination of the poor status is made possible. Otherwise, areas with substantially elevated concentrations of contaminants might be classified under moderate status. For Cd and Σ_7PCBs in biota the range of measured concentrations is close to the MedEAC value, hence there is no need to assign a user defined moderate-poor threshold. Finally, the Poor -Bad threshold for all contaminants is calculated by the NEAT tool.

Based on these the following five status classes are produced: i) the high status referring to 0 (best conditions) < measured concentrations ≤BAC range; ii) the good status referring to the BAC < measured concentrations ≤ MedEAC range; iii) the moderate status referring to the MedEAC < measured concentrations ≤ 3xMedEAC range; iv) the poor and bad statuses referring to 3xMedEAC< measured concentrations ≤ Max. conc. (worse conditions) range, with bad status having the highest distance from the MedEAC threshold. Following the IMAP -traffic light methodology, NEAT class named ‘high’ is considered as ‘good’ *sensu* IMAP i.e. in GES; NEAT class named ‘good’ is considered as ‘good’ *sensu* IMAP i.e. in GES; NEAT classes named ‘moderate’ and ‘poor’ are considered as ‘Bad’ *sensu* IMAP i.e. not in GES (Table 4). The boundary/threshold values used for all the groups of contaminants in the two environmental compartments (sediments and biota) are given in Table 5.

Table 4: Relation of assessment status classes set in line with the IMAP methodology and NEAT tool and respective color coding. The position of the 2 boundary limit values and the thresholds for the NEAT tool are shown.

	GES		**non-GEs**		
IMAP – traffic light approach	Good	Moderate	Bad		
NEAT tool	High	Good	Moderate	Poor	Bad
	0< meas. conc. ≤ BAC	BAC<meas. conc. ≤MedEAC	MedEAC<meas. conc. ≤ 3xMedEAC	3xMedEAC<meas. conc. ≤ max. conc.	
Boundary limits	**0**				**Max. conc.**
Thresholds	**BAC**	**MedEAC**	**3xMedEAC**		

Table 5: Boundary limits of the assessment scale and class Threshold values used for the application of the NEAT tool for IMAP. The Poor/Bad threshold for all cases and the moderate/poor for Cd and Σ_7 PCBs in mussels are automatically generated by the tool (shown in italics).

	Low Boundary limit	**Threshold** High/Good	**Threshold** Good/Moderate	**Threshold** Moderate/poor	**Threshold**$^{\infty}$ Poor/Bad	**Upper Boundary Limit**
Sediments	**(μg/kg)**	**BAC (μg/kg)**	**MedEAC (μg/kg)**	**3 x MedEAC (μg/kg)**		**Max. conc. (μg/kg)**
Cd	0	180	1200	3600	*6300*	9000
Hg	0	75	150	450	*7725*	142∞00

Pb	0	23500	46700	140100	*248050*	356000
*Σ_{16} PAHs	0	197	4022	12066	*19357.5*	26649
+Σ_7 PCBs	0	0.32	68	204	*319*	434
Biota						
Cd	0	1052	5000	*5333.3*∞	*5666.7*	6000#
Hg	0	135	2500	7500	*8750*	10000
Pb	0	1742	7500	22500	*95192*	167884
+Σ_7 PCBs	0	25	136	*148.7*∞	*161.3*	174

∞ generated by the NEAT tool
*sum of the individual BACs or MedEACs values of the 16 PAH compounds
+ sum of the individual BACs or MedEACs values of the 7 PCB compounds
# For Cd max conc. equals 2188 (μg/kg,) lower than the MedEAC, so a value >MedEAC had to be used as the worse condition boundary limit.

For the application of the NEAT software, data on contaminants were grouped per parameters, ecosystem components (i.e. for the purpose of present NEAT application these are considered biota and sediment matrixes) and SAUs in all the Adriatic sub-divisions (NAS, CAS, SAS). Average concentrations (arithmetic means) and their respective standard errors were then calculated in the respective groups as follows:

Arithmetic mean concentration: $\bar{C} = \frac{\sum_{i=1}^{n} C_i}{n}$,

Standard Deviation: $SD = \sqrt{\frac{\sum_{i=1}^{n}(C_i - \bar{C})^2}{n-1}}$,

Standard Error : $SE = \frac{SD}{\sqrt{n}}$

where, $\bar{C}$ is the average (arithmetic mean) concentration for each SAU, C_i is the individual contaminant concentration measured in each station/date in the SAU, and n is the total number of concentration records for each SAU; SD is the sample standard deviation for a specific contaminant and SAU and SE is the standard error for a specific contaminant and SAU.
Several records on PAHs and PCBs individual compounds were reported as below detection limit values (DL) or were left blank. In a separate technical paper, prepared by MEDPOL in consultations with OWG, it was recommended to incorporate into the BC and BAC calculations of the BDL values and not to exclude them21. For the present application of NEAT these cases were substituted by the BDL/2 value, given a rather small quantum of data available, this does not influence the calculation of the assessment findings. In the Slovenian data, the BDL values were left blank so these were substituted by a value equal to 1μg/kg

[21] In a separate technical paper, prepared by MEDPOL in consultations with OWG on Contaminants, it was suggested to 'replace BDL values with a fraction of the reported value. The fraction could be 1 (BDL value), 0.5 (BDL/2), 0.7 (BDL/SQRT(2)), other' and not exclude BDL values from BC calculation. The decision to replace BDL with the reported value or a fraction of it should be based on the available data and expert evaluation. Italy, Spain and France supported the use of LOD/2 or LOQ/2 in the BCs calculation. Israel pointed out that the US-EPA suggests this only when less than 15% of the data is BDLs. Therefore, the calculation was performed with the reported value and not half of it (UNEP/MED WG.533/3 & UNEP/MED WG. 533/Inf.3). This is because the wide range of BDL values for a specific contaminant in a specific matrix, depending on the country and it varies even within the country.

which corresponds to the average BDL/2 value from the whole data set. Furthermore, due to this fact, but also considering the list of substances the monitoring of which is mandatory according to IMAP[22], the sum of the 16 EPA compounds (Σ16PAHs) and sum of the 7 PCBs compounds (Σ7PCBs) was taken into account for the present assessment. In this way the assessment results show the cumulative impact by each of these two groups of contaminants.

A data matrix for the NEAT software was prepared and given below in Tables 6 – 10.

[22] According to IMAP i.e. IMAP Guidance Fact Sheet and Data Dictionaries for IMAP CI 17, monitoring of the sum of 7 PCB congeners: 28, 52,101,118,138,153 and 180 and sum of 16 US EPA PAHs is considered mandatory.

Table 6: Average concentrations and standard error (±SE) for Cd, Hg, Pb (µg/kg) in sediments per SAU of the Adriatic subregion.

Sub-Division	**Coastal**					**Offshore**				
	SAU	**subSAU**	**Cd (µg/L)**	**Hg (µg/kg)**	**Pb (µg/kg)**	**SAU**	**subSAU**	**Cd (µg/kg)**	**Hg (µg/kg)**	**Pb (µg/kg)**
North Adriatic										
	NAS-1					**NAS-12**				
	MAD-HR-MRU_3									
		HRO313-JVE *n = 2*	132 ± 16	48 ± 6	28766 ± 788					
		HRO313-BAZ *n = 1*	232	338	50753					
		HRO412-PULP *n = 1*	177	2993	59625					
		HRO412-ZOI *n = 6*	95 ± 2	52 ± 7	14794± 915					
		HRO413-LIK *n = 2*	103 ± 13	82 ± 1	33994 ±1631					
		HRO413-PAG *n = 2*	151 ± 1	61±11	25868±2449					
		HRO413-RAZ *n = 1*	133	44	27044					
		HRO422-KVV *n = 4*	120±12	32±6	17836±2914					
		HRO422-SJI *n = 4*	76±11	21±5	11050±641					
		HRO423-KVA *n = 1*	109	40	21605					
		HRO423-KVJ	101±9	35±7	24089±1582					

Sub-Division	Coastal					Offshore				
	SAU	**subSAU**	**Cd (µg/L)**	**Hg (µg/kg)**	**Pb (µg/kg)**	**SAU**	**subSAU**	**Cd (µg/kg)**	**Hg (µg/kg)**	**Pb (µg/kg)**
		n = 4								
		HRO423-KVS	87±14	55±25	18041±1884					
		n = 2								
		HRO423-RILP	547	108	37254					
		n = 1								
		HRO423-RIZ	111±6	52±9	27782±651					
		n = 2								
		HRO423-VIK	118±15	94±70	27272±3712					
		n = 2								
	IT-NAS-1					IT-NAS-12				
		Emilia Romagna	179±18	104±2	15446±1169			140±8	456±68	18898±1017
		n = 16						*n = 86*	*n = 84*	*n = 106*
		Friuli Venezia Giulia	141±10	3538±732	33750±1733					
		n = 12								
		Veneto	412±36	441±21	15325±1496					
		n = 17								
	MAD_SI_MRU_11									
		n = 1	100	310	28000					
Central Adriatic										
	CAS-1					**CAS-12**				
	MAD-HR-MRU_2					MAD-HR-MRU_4				
		HRO313-NEK	187±0.35	66±4	3008±2032	*n = 2*		102±12	34±1	12489±116
		n = 2								
		HRO313-KASP	214±31	451±160	30279±4620					

Sub-Division	Coastal					Offshore				
	SAU	subSAU	Cd (µg/L)	Hg (µg/kg)	Pb (µg/kg)	SAU	subSAU	Cd (µg/kg)	Hg (µg/kg)	Pb (µg/kg)
		n = 4								
		HRO313-KZ	166	410	22391					
		n = 1								
		HRO313-MMZ	147±0.37	39±5	24250±1024					
		n = 2								
		HRO413-PZK	102±19	87±39	25546±5361					
		n = 4								
		HRO413-STLP	190	335	21202					
		n = 1								
		HRO423-BSK	180±12	93±22	24005±651					
		n = 4								
		HRO423-KOR	103±17	40±12	13238±2766					
		n = 6								
		HRO423-MOP	131±27	22±7	17405±2420					
		n = 2								
	IT-CAS-1					IT-CAS-12				
		Abruzzo	172±16	50	8025±354			225±23	86±13	11883±577
		n = 24						*n = 98*	*n = 71*	*n = 101*
		Marche	214±7		6236±735					
		n = 10								
		Molise	122±21	108±38	7817±1799					
		n = 6								
South Adriatic										
	SAS-1					**SAS-12**				
	MAD-HR-MRU_2									

Sub-Division	Coastal					Offshore				
	SAU	**subSAU**	**Cd (µg/L)**	**Hg (µg/kg)**	**Pb (µg/kg)**	**SAU**	**subSAU**	**Cd (µg/kg)**	**Hg (µg/kg)**	**Pb (µg/kg)**
		HRO313-ZUC *n = 4*	141±4	42±7	11452±736					
		HRO423-MOP *n = 2*	136±19	46±13	27554±3297					
	IT-SAS-1	Apulia	176±19 *n = 9*	21±4 *n = 6*	6660±733 *n = 9*	IT-SAS-12 *n = 15*		125±9	46±4	12879±1104
	MNE-1	MNE-1-N *n = 7*	195±21	21±9	4595±2251	MNE-12	MNE-12-N *n = 2*	95±5	19±2.5	20500±2500
		MNE-1-C *n = 11*	322±132	196±70	59625±15954		MNE-12-C *n = 4*	103±2.5	22±5	22500±3122
		MNE-1-S *n = 10*	133±28	52±13	8097±1194		MNE-12-S *n = 5*	118±5	31±2	28800±1342
		MNE Kotor *n = 27*	878 ±380	2140±764	89440±18078					
	AL-1 *n = 4*		75±7	645±285	6670±368	AL-12 *n = 2*		68±7	169±142	10059±809
						MAD-EL-MS-AD *n = 1*		77		13674

Table 7: Average concentrations and standard error (±SE) for Σ_{16}PAHs (μg/kg) in sediments per SAU of the Adriatic subregion.

Sub-Division	**Coastal**			**Offshore**		
	SAU	**sub SAU**	**Σ_{16} PAHs (μg/kg)**	**SAU**	**Sub SAU**	**Σ_{16} PAHs (μg/kg)**
North Adriatic						
	NAS_1			**NAS-12**		
	IT-NAS-1			IT-NAS-12		
		Emilia Romagna *n = 40*	236 ± 79	*n = 81*		69 ±8
		Veneto *n = 7*	264 ± 60			
	MAD_SI_MRU_11 *n = 8*		185 ± 34			
Central Adriatic						
	CAS-1			**CAS-12**		
	IT-CAS-1			IT-CAS-12		
		Abruzzo *n = 52*	19 ± 2	*n = 45*		23 ± 4
South Adriatic						
	SAS-1			**SAS-12**		
	MNE-1			MNE-12		
		MNE-1-N *n = 4*	1339 ± 1284		MNE-12-N *n = 2*	30 ± 3
		MNE-1-C *n = 8*	710 ± 306		MNE-12-C *n = 4*	18 ± 1
		MNE-1-S *n = 5*	4713 ± 4669		MNE-12-S *n = 5*	20 ± 3
		MNE_Kotor	7491 ± 2193			

Sub-Division	Coastal			Offshore		
	SAU	sub SAU	Σ_{16} PAHs (µg/kg)	SAU	Sub SAU	Σ_{16} PAHs (µg/kg)
		n = 14				
				MAD-EL-MS-AD *n = 1*		43

Table 8: Average concentrations and standard error (±SE) for Σ_7PCBs (µg/kg) in sediments per SAU of the Adriatic subregion.

Sub -Division	Coastal			Offshore		
	SAU	Sub SAU	Σ_7PCBs (µg/L)	SAU	Sub SAU	Σ_7PCBs (µg/L)
North Adriatic						
	NAS_1			**NAS-12**		
	IT-NAS-1			IT-NAS-12		
		Emilia Romagna *n = 16*	3.88 ± 0.92	*n = 50*		1.84 ±0.30
		Veneto *n = 14*	3.50 ±0.80			
South Adriatic						
	SAS-1			**SAS-12**		
	MNE-1			MNE-12		
		MNE-1-N *n = 1*	0.21		MNE-12-N *n = 2*	0.09 ±0.003
		MNE-1-C *n = 7*	1.97± 0.68		MNE-12-C *n = 2*	0.13±0.04
		MNE-1-S *n = 4*	0.68±0.45		MNE-12-S *n = 2*	0.08±0.01
		MNE Kotor *n = 12*	83±36			

Table 9: Average concentrations and standard error (±SE) for Cd, Hg, Pb (µg/kg) in mussels per SAU of the Adriatic subregion.

Sub-Division	**Coastal**					**Offshore**				
	SAU	**SubSAU**	**Cd (µg/kg)**	**Hg (µg/kg)**	**Pb (µg/kg)**	**SAU**	**SubSAU**	**Cd (µg/kg)**	**Hg (µg/kg)**	**Pb (µg/kg)**
North Adriatic										
	NAS_1					**NAS-12**				
	MAD-HR-MRU_3									
		HRO313-JVE *n = 2*	1052 ± 37	192 ± 85	1840 ± 559					
		HRO412-ZOI *n = 1*	521	81	1059					
		HRO413-LIK *n = 2*	726 ± 228	108 ± 15	1124 ± 160					
		HRO413-PAG *n = 2*	757 ± 61	83 ± 1	1394 ± 286					
		HRO422-KVV *n = 2*	917 ± 9	139 ± 4	1620 ± 370					
		HRO422-SJI *n = 2*	825 ± 124	82 *n = 1*	1377 ± 10					
		HRO423-KVA *n = 2*	722 ± 135	85 *n = 1*	1032 ± 338					
		HRO423-KVJ *n = 2*	1057 ± 305	93 ± 3	683 ± 138					
		HRO423-KVS *n = 2*	799 ± 201	116 ± 46	1861 ± 682					
		HRO423-RIZ *n = 2*	1044 ± 110	148 ± 70	1991 ± 551					
		HRO423-VIK	979 ± 117	107 ± 44	1797 ± 484					

Sub-Division	Coastal					Offshore				
	SAU	SubSAU	Cd (µg/kg)	Hg (µg/kg)	Pb (µg/kg)	SAU	SubSAU	Cd (µg/kg)	Hg (µg/kg)	Pb (µg/kg)
		n = 2								
	IT-NAS-1					IT-NAS-12				
						n = 10			301 ± 47	
	MAD_SI_MRU_11									
			601 ± 61	150 ± 15	918 ± 133					
			n = 18	*n = 18*	*n = 12*					
Central Adriatic										
	CAS-1					**CAS-12**				
	MAD-HR-MRU_2									
		HRO313-NEK	669 ± 41	76 ± 15	877 ± 202					
		n = 2								
		HRO313-KASP	589 ± 100	144 ± 14	1643 ± 5					
		n = 2								
		HRO313-MMZ	811 ± 113	104 ± 21	1668 ± 325					
		n = 2								
		HRO413-PZK	738 ± 170	89	2426 ± 953					
		n = 2		*n = 1*						
		HRO423-BSK	897 ± 240	102 ± 9	1470 ± 404					
		n = 2								
		HRO423-KOR	719 ± 13	102 ± 13	1757 ± 21					
		n = 2								
		IT-CAS-1				IT-CAS-12				
						n = 22			543 ± 451	
South Adriatic										
	SAS-1					**SAS-12**				

Sub-Division	Coastal					Offshore				
	SAU	SubSAU	Cd (µg/kg)	Hg (µg/kg)	Pb (µg/kg)	SAU	SubSAU	Cd (µg/kg)	Hg (µg/kg)	Pb (µg/kg)
	MAD-HR-MRU_2									
		HRO313-ZUC *n = 2*	1017 ± 108	90 ± 6	1785 ± 642					
		HRO423-MOP *n = 2*	999 ± 193	129 ± 35	2457 ± 97					
	IT-SAS-1									
		Apulia-SAS *n = 10*		20 ± 4						
	MNE-1									
		MNE-1-C *n = 4*	1303 ± 360	104 ± 10	50211 ± 39741					
		MNE-1-S *n = 2*	66 ± 18	15 ± 4	162 ± 71					
		MNE Kotor *n = 18*	669 ± 99	86 ± 10	3466 ± 2013					

Table 10: Average concentrations and standard error (±SE) for Σ_7PCBs (μg/kg) in mussels per SAU of the Adriatic subregion.

Sub-Division	Coastal			Offshore		
	SAU	Sub SAU	Σ_7PCBs (μg/L)	SAU	Sub SAU	Σ_7PCBs (μg/L)
North Adriatic						
	NAS-1			**NAS-12**		
	MAD-HR-MRU_3					
		HRO313-JVE	48			
		n = 1				
		HRO412-ZOI	17			
		n = 1				
		HRO413-LIK	18			
		n = 1				
		HRO413-PAG	33			
		n = 1				
		HRO422-KVV	35			
		n = 1				
		HRO422-SJI	27			
		n = 1				
		HRO423-KVA	19			
		HRO423-KVJ	23			
		n = 1				
		HRO423-KVS	38			
		n = 1				
		HRO423-RIZ	23			
		n = 1				
		HRO423-VIK	11			

Sub-Division	Coastal			Offshore		
	SAU	Sub SAU	Σ_7PCBs (µg/L)	SAU	Sub SAU	Σ_7PCBs (µg/L)
		n = 1				
Central Adriatic						
	CAS-1			**CAS-12**		
	MAD-HR-MRU_2					
		HRO313-NEK	21			
		n = 1				
		HRO313-KASP	173			
		n = 1				
		HRO313-MMZ	28			
		n = 1				
		HRO413-PZK	68			
		n = 1				
		HRO423-BSK	17			
		n = 1				
		HRO423-KOR	81			
		n = 1				
South Adriatic						
	SAS-1			**SAS-12**		
	MAD-HR-MRU_2					
		HRO313-ZUC	54			
		n = 1				
		HRO423-MOP	49			
		n = 1				
	MNE-1					
		MNE-1-C	14 ± 19			

Sub-Division	Coastal			Offshore		
	SAU	**Sub SAU**	**Σ_7PCBs (µg/L)**	**SAU**	**Sub SAU**	**Σ_7PCBs (µg/L)**
		n = 4				
		MNE-1-S *n = 2*	1.23 ± 0.74			
		MNE Kotor *n = 15*	14 ± 10			

5. Adjusted application of the NEAT software for the assessment of IMAP Common Indicators related to Ecological Objective 9

NEAT is a structured, hierarchical tool for making marine status assessments (Berg et al., 2017; Borja et al., 2016), and freely available at www.devotes-project.eu/neat. NEAT was developed to assess biodiversity status of marine waters under the MSFD and has been used to assess different ecosystem components and geographical areas (Nemati et al., 2017; Borja et al., 2019; Pavlidou et al. 2019; Kazanidis et al., 2020; Borga et al., 2021). NEAT uses a combination of high-level integration of habitats and spatial units and an averaging approach, allowing for specification on structural and spatial levels, applicable to any geographical scale. As explained here-below, the use of NEAT is not limited to the assessment of biodiversity but can be used for assessment of pollution impact. The analysis provides an overall assessment for each case study area and a separate assessment for each of the ecosystem components included in the assessment. The final value has an associated uncertainty value, which is the probability of being determinative in a certain class status (GES - nonGES) (Uusitalo et al., 2016). Essentially, the final assessment value is calculated as a weighted average. The weighting factors are based on the respective surface of the areas and are combined with the respective monitoring data for the indicator/chemical contaminant in question. Detailed explanation on the calculation of the weighting factors is given in Annex I. No special rules are applied but the tool design allows assigning different aggregation rules at the various steps in the calculation of the overall assessment value. In order to assess the uncertainty in the final assessment value, the standard error/ standard deviation of every observed indicator value is used (Borja et al., 2016). Therefore, the standard deviation values as obtained from the monitoring data play a major role in the uncertainty associated with the final assessment result. This emphasizes the importance of the standard deviation for the accuracy and evaluation of the final assessment result.

The main elements and principles of NEAT application are:

- **NEAT Indicators**: they constitute the basis of the assessment. NEAT integrates an indicator catalogue (Teixeira et al., 2016) as a source for choosing predefined indicators for the biodiversity assessment. However, the tool is not limited to those indicators; it allows the addition of as many indicators as required, not only related to biodiversity, but any kind of indicator, specific to each assessment performed (e.g. eutrophication, organic pollution, etc.). In practice these refer to the parameters/elements of the criteria that are subject of assessment (i.e. IMAP Common Indicators or MSFD Criteria) and can be either synthetic biological metrics/indices (i.e. Eutrophication Index E.I., BENTIX, AMBI) or individual parameter values (i.e. nutrients, chlorophyll-a, chemical contaminants concentrations). Under 'Indicators' the actual monitoring data reported by the CPs are introduced for preparing 2023 MED QSR assessments. Thresholds and boundary values correspond to the parameters ('Indicators') used.
- **Habitats**: Some examples are pelagic, benthic, rocky, ice habitats and may include sub-categories in a hierarchical order.
- **Ecosystem Components**: Examples are phytoplankton, microbes, mussel, sediments.
- **Weighting and hierarchies**: the central principle in the NEAT method is a hierarchical, nested structure of spatial assessment units (SAUs) and habitats. Thus, it avoids the dominance of certain indicators or habitats or SAUs by using a proper weighting procedure, which considers what information is available for different real spatial scales. The weighting factors are based on the respective surface of the areas and are combined with the respective monitoring data for the indicator/chemical contaminant in question (see Annex I). In addition, each indicator is related to a specific ecosystem component, which exists in a certain habitat, and information has been collected for a specific area or SAU (e.g. North Adriatic Sea (NAS)). Thus, no bias is introduced into the assessment by the choice of the indicators.
- **Aggregation**: In order to aggregate monitoring data, they are all normalized into a scale of 0 to 1, independently of their original scale. Specific boundaries of the indicators (e.g. boundary between moderate and good status) are also normalized. By default, aggregation is done across

all indicators assessed within concerned SAU, either by ‘Ecosystem Component’ or by ‘Habitat’. For example, the method can be used to aggregate all indicators of a specific SAU and show the status divided among the different ecosystem components of that SAU in line with the aggregation and integration rules as defined in the documents of UNEP/MAP (2021). The first level of the spatial aggregation of the ‘Indicators’ data is not shown by default.

- **Integration** is done spatially across all the SAUs used with a weighting factor related to the SAU surface area in line with the aggregation and integration rules as defined in the documents of UNEP/MAP (2021).
- **NEAT value**: the outcomes of the aggregation are visualized into a number (NEAT value) and a colour, which corresponds to the status (i.e. high, good, moderate, poor and bad). This NEAT value is obtained for the whole assessed area but can be visualized in different forms. For example, it is possible to visualize how the information from the different ecosystem components (e.g. fish, phytoplankton, etc.) has contributed to the assessment, or how the information available to the different areas contributes to the overall assessment.
- **Confidence**: each NEAT value is accompanied by its quantitative estimate of the confidence of the result. This estimate is performed using the standard deviation (entered at the same time as the indicator value/monitoring data), and performance of Monte Carlo simulations, as a mean to understand how this error propagates throughout the assessment. More explanation on the confidence of the assessments is provided in Chapter 6.1.

The NEAT tool is primarily designed for assessing biodiversity status and works well with other MSFD descriptors of either state or pressure/impact, especially when these are linked to one type of pressure/impact. The way the tool makes the aggregation of data theorizes that all ‘Indicators’ data introduced for a specific habitat or ecosystem component have the same type of impact on the ecosystem, hence they are related (for example nutrients and chlorophyll-a are interrelated for the eutrophication EO5 status; beach litter data and floating microplastics are both related to a common pressure and interrelated for assessing the EO10 status). For chemical contaminants status, the above assumption is not true. Pollution from one chemical compound is not necessarily related to another. Therefore, for assessing the chemical status of an area it is important to get also a detailed picture per contaminant (i.e. first level spatial aggregation of the Indicators data inserted in the tool).

An example of using NEAT for the assessment of the chemical status i.e. for EO9/CI 17 in the Adriatic Sea, is described: ‘Indicators’ (e.g. PAHs, Cd) are measured in one or more ‘Ecosystem Components’ (e.g. mussels, sediments, waters, phytoplankton). ‘Ecosystem Components’ are assigned to specific ‘Habitats’, i.e. pelagic habitat includes waters and phytoplankton; benthic habitat includes mussels and sediments. NEAT then aggregates all the Indicators normalized values (PAHs and Cd) per SAU on either the Habitat level (all data in pelagic, all data in benthic) or on the Ecosystem Component level (all data in: mussels, sediments, waters, phytoplankton). An assessment classification (high, good, bad, etc.) is then obtained for all the nested SAUs of an area, for the chemical status of the pelagic and benthic habitats separately (Habitat level) or for the chemical status of the mussels, sediments, water, phytoplankton separately (Ecosystem Component level). In this way the information on the first level of aggregation of indicators per SAU is lost. It is not transparent which of the Indicator (contaminant measured) PAHs or Cd is responsible for the obtained chemical status, and this may mislead managers and policy makers in the designing and implementation of measures.

Therefore, for the transparent assessment of IMAP EO9/CI 17, it is considered useful to get the information on the status of each chemical compound separately per SAU. In order to get this information, the following adjustments were made in the NEAT software, regarding the use and meaning of ‘Indicators’, ‘Habitats’ and ‘Ecosystem Components’.

- *NEAT Indicators*: These refer to 5 chemical compounds that constitute mandatory contaminants of IMAP CI17 (Cd, Hg, Pb, Σ_{16}PAHs, Σ_{7}PCBs). Figure 18.

- *Habitats:* In the absence of integrated assessment of IMAP EO9/CI 17 and CI 1, and given the data available for contaminants were measured in the two mandatory matrices of sediment and biota, two 'habitats' are used, sediments and biota. Assessment results are aggregated for each of them separately to get the status of EO9 /CI 17 in sediments and in biota separately for all SAUs (Figure 19). Alternatively, under 'Habitats' it is possible to use the various chemical contaminants (Cd, Hg, Pb, ΣPAHs, ΣPCBs) and get an overall assessment status (for both matrices together) for each of the contaminants.
- *Ecosystem Components*: Instead of using ecosystem categories, the Ecological Objective 9 (EO9) is used as ecosystem component, and the 'Indicators' are listed again as subcategories of EO9 in a hierarchical structure. In this way an aggregated assessment status result on the EO9 level can be achieved and at the same time the assessment result on each of the 'Indicators'- chemical compounds listed is provided in Figure 20.

This approach can support also EO5 and EO10 and produce a final assessment on the IMAP Pollution Cluster level.

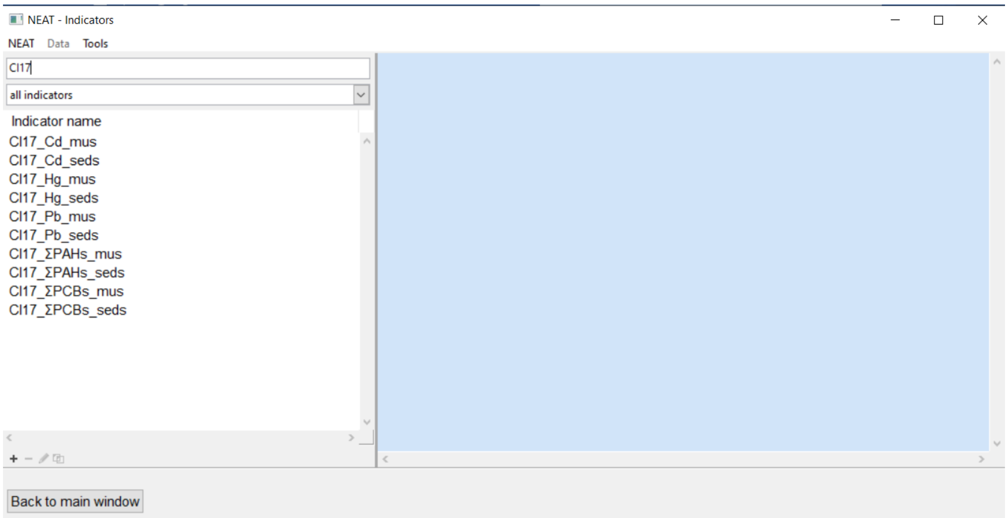


Figure 18: Depiction of the EO9/CI17 chemical parameters as inserted in the NEAT tool under the Indicators assessment item.

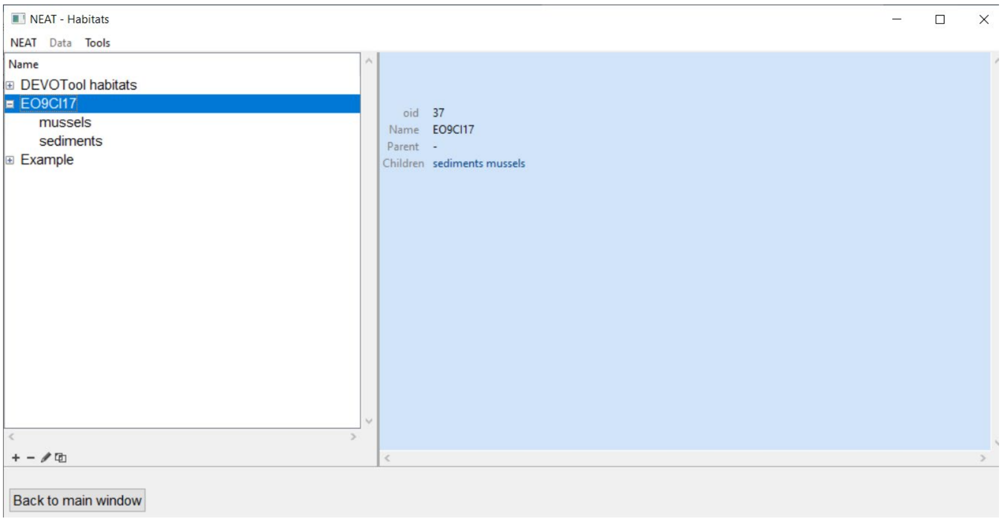


Figure 19: Depiction of the EO9/CI17 inserted in the NEAT tool under the Habitats assessment item. Mussels and Sediments habitats are hierarchically clustered under EO9/CI17.

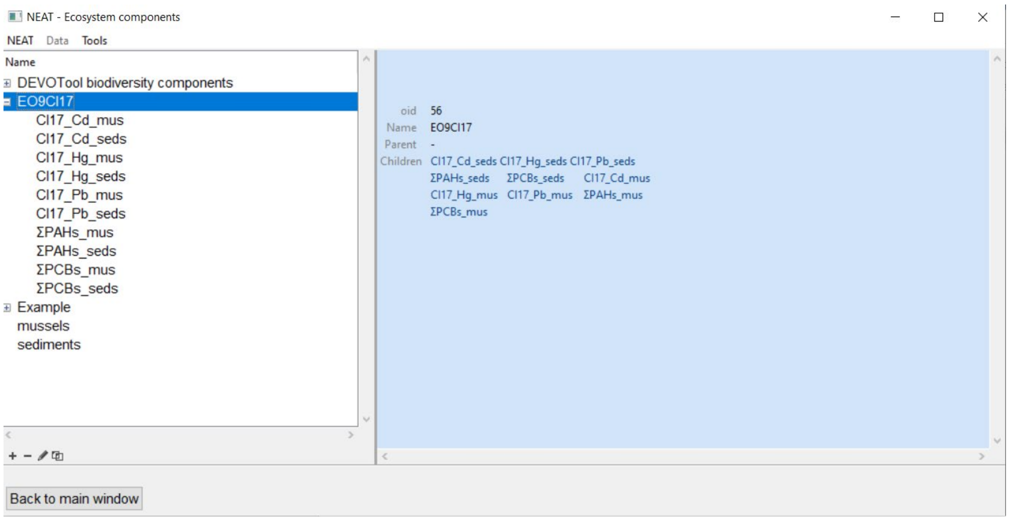


Figure 20: Depiction of the EO9/CI17 chemical parameters as inserted again in the NEAT tool under the Ecosystem Component assessment item.

5. 1 Insertion of data, boundary limits and class thresholds in the NEAT software per each Indicator and SAUs.

Further to spatial analysis of the monitoring stations distribution, along with recognition of corresponding monitoring and assessment areas, as well as optimal nesting of the finest areas of assessment, as described in Chapter 2, the scope of all Adriatic SAUs and subSAUS were defined. All of them were introduced in the NEAT tool along with their respective codes and surface area (km^2) as provided in Table 1 and Figure 21.

Within each SAU under 'habitats' the sediments and biota are introduced. Under 'ecosystem component' the 5 chemical compounds of EO9/CI17 are assigned.

For each SAU and 'Ecological Component' (EO9 contaminants in our case) and 'Habitat' (sediments, biota), average value and standard deviation per chemical compound is inserted as explained in Chapter 4 and provided in Tables 6 -10.

Boundary limits and class Threshold values per SAU per parameter and per matrix (i.e. NEAT habitat) are inserted by the user. The tool requires 2 mandatory boundary limits which define the best and worst conditions and one threshold discriminating between GES-nonGES status. A 5-class assessment scale 'High-Good-Moderate-Poor-Bad' is then produced. The GES-nGES threshold discriminates between the Good-Moderate classes. Although not mandatory two more thresholds were introduced. For the High-Good threshold the BAC value is used, for the Good-Moderate the MedEAC and for the Moderate-Poor a value equal to 3xMedEAC. Details on boundary limits and threshold values are given in Chapter 4 and in Tables 4 and 5.

Then the data (i.e. average values inserted), as well as boundary limits and threshold values are normalized by NEAT in a scale of 0 to 1 to be comparable among parameters and to facilitate aggregation on the CI or EO level.

Threshold concentrations are normalized in a 0 to 1 scale as follows:

$0 \leq$ bad $< 0.2 \leq$ poor $< 0.4 \leq$ moderate $< 0.6 \leq$ good $< 0.8 \leq$ high ≤ 1

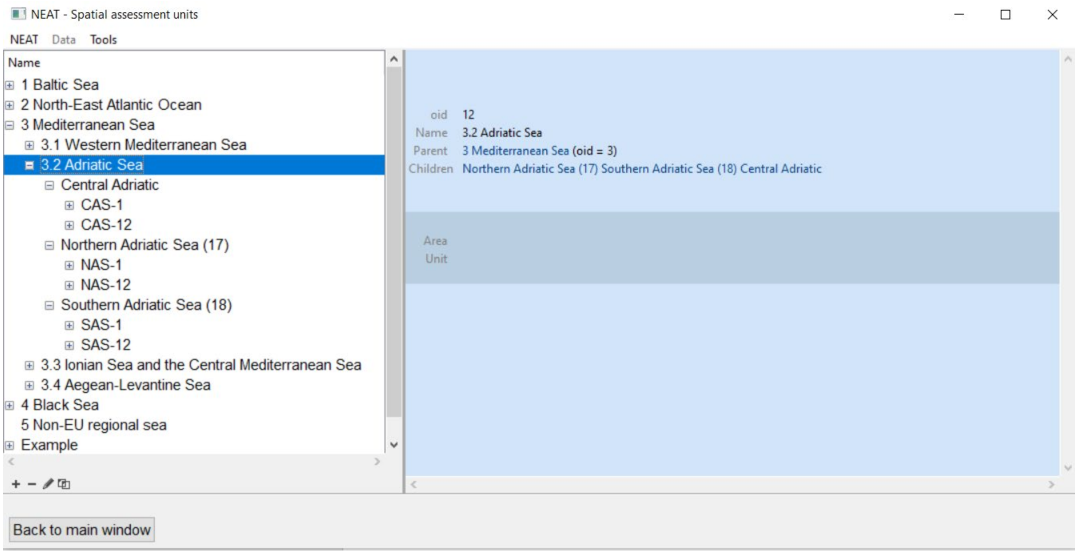
NEAT further aggregates data by calculating the average of normalized values of contaminants (Cd, Pb, PAHs, etc.) on the SAU level. This can be done either per each contaminant per habitat (i.e., sediments, biota) separately or for all contaminants per habitats (i.e. sediments, biota) within specific SAU. The first option leads to one value for each chemical compound separately for a specific SAU.

The process is then repeated for all nested SAUs (in a weighted or non- weighted mode) and in the end one NEAT value for the larger/nested SAU is obtained (i.e. for the Adriatic Sea) either for all ecosystem components - contaminants separately, or for all ecosystem components by habitat (sediments, biota). In the weighted mode a weighting factor based on the surface area of each SAU is used.

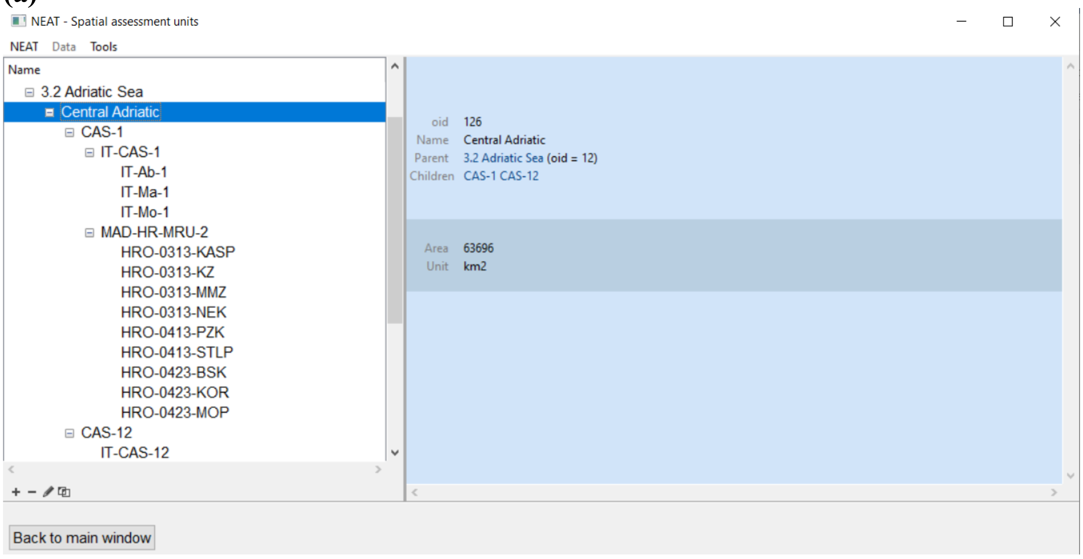
The NEAT values are values between 0 to 1 and correspond to an overall assessment status per contaminant according to the 5-class scale.

The decision rule of GES/ non-GES is by comparison to the boundary class defined by the MedEAC and this is above/ below Good (0.6).

Examples of the data insertion process are given in Figure 22.

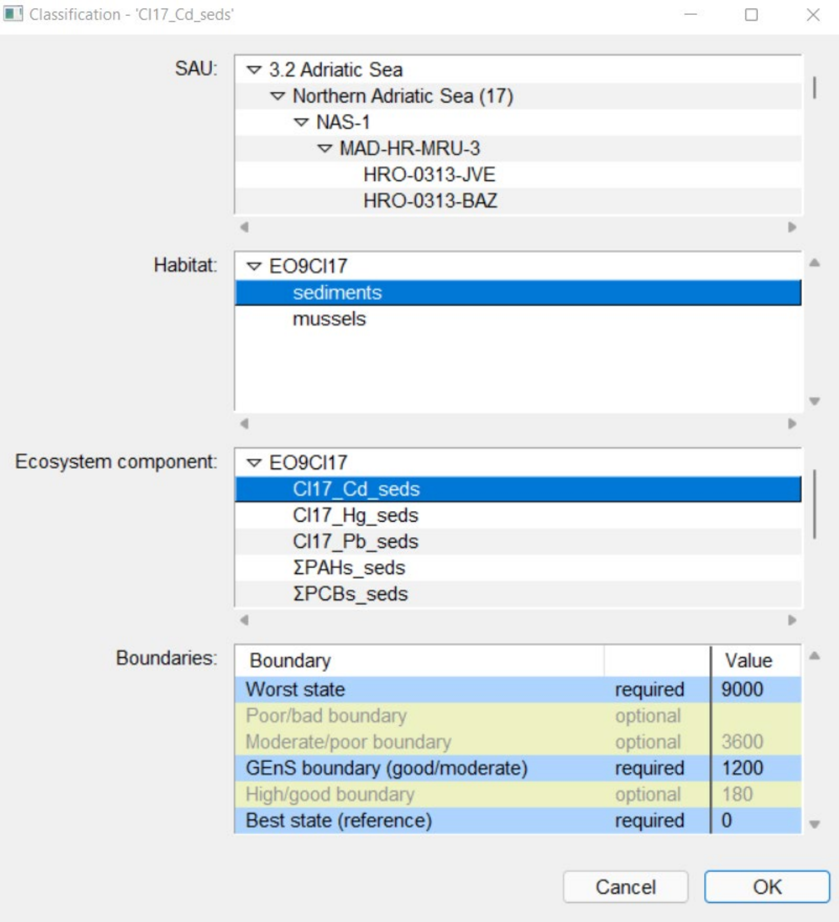


(a)

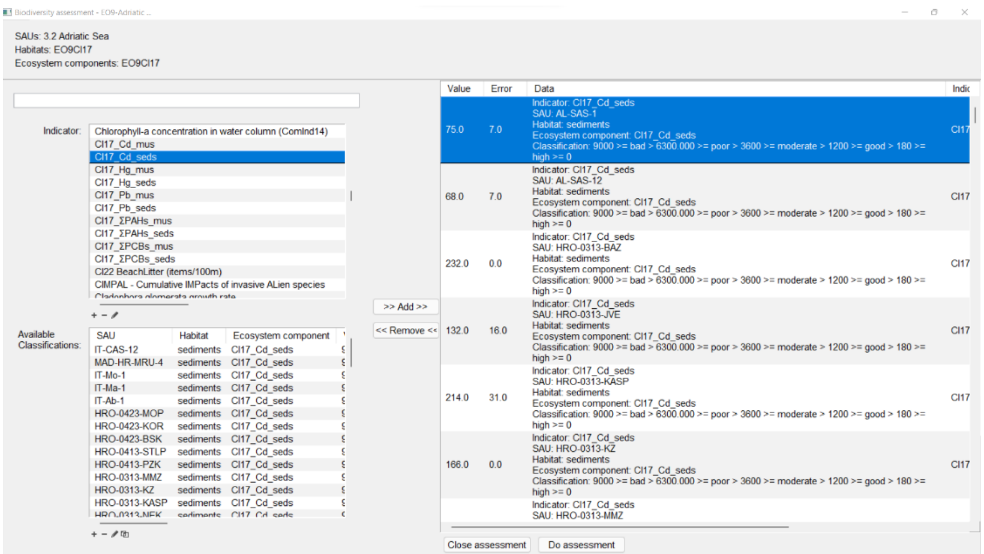


(b)

Figure 21. The nesting of Adriatic SAUs in the NEAT tool. (a) The 3 highest levels (4^{th}, 3^{rd}, 2^{nd}) SubRegion, SubDivision, key IMAP coastal and offshore assessment zones of SubDivisions; (b) the 1^{st} level of nesting of national SAUs and subSAUs within the two coastal and offshore assessment zones per country.



(a)



(b)

Figure 22. NEAT windows for: (a) the insertion of boundary values per SAU, Habitat and Ecosystem component; (b) Indicator data.

6. Results of the NEAT tool for the Assessment of the IMAP EO9-CI17 status in the Adriatic subregion

The results obtained from the NEAT tool are shown in Tables 11 and 12 below. Table 11 provides detailed assessment results on the EO9/CI 17 level per contaminant and also spatially integrated within the nested scheme at i) the IMAP national SAUs & subSAUs, as the finest level; ii) the IMAP coastal and offshore assessment zones of SubDivisions (NAS-1, NAS-12, CAS-1, CAS-12, SAS-1, SAS-12); iii) the sub-division level (NAS, CAS, SAS) and iv) the sub-regional level (Adriatic Sea). At the same time aggregation of all contaminants data is done in order to obtain one chemical status value (NEAT value) for all the levels of the nesting scheme. In other words the data matrix in Table 11 shows the results per contaminant per habitat per SAU in the finest level which are i) integrated along the nesting scheme (in columns A- I bold lines); and ii) are aggregated for all contaminants and habitats per SAU (in rows) leading to one NEAT value per SAU (column EO9). The latter is further integrated along the nesting scheme (column EO9 bold lines).
The tool has the possibility also to provide assessment results by aggregating data per habitat in this case sediments and biota (mussels) and then spatially integrated within the nested scheme (Table 12). The final integrated result per SAU (NEAT value) is the same for the two ways of assessment (i.e. per contaminant or per habitat) as expected.

The Tabulated NEAT results of Tables 11 and 12 are presented also schematically in Annex II herein.

The detailed status assessment results per contaminant show that most SAUs achieve GES conditions (high, good status) indicated by the blue and green cells in Table 11. For Hg in sediments however, some of the SAUs are found in non-GES status (yellow, brown) as follows: i) in the North Adriatic Sea, zone NAS-1, SAUs, HRO-0313-BAZ and HRO-0412-PULP in Croatia; 'Fruili-Venezia-Giulia-1' and 'Veneto-1' in Italy and in zone NAS-12, IT-NAS-12; ii) in the Central Adriatic Sea, zone CAS-1, SAUs, HRO-0313-KASP, HRO-0313-KZ, HRO-0413-STLP; iii) in the Southern Adriatic Sea, non- GES status is related to Hg in sediments of the zone SAS-1, SAUs MNE-1-C and MNE-Kotor, AL-1 and for the zone SAS-12, SAU AL-12. Regarding Pb concentrations in sediments a smaller number of SAUs is found in non-GES status: i) in the North Adriatic, zone NAS-1, SAUs, HRO-0313-BAZ and HRO-0412-PULP in Croatia and ii) in the South Adriatic, zone SAS-1, SAUs MNE-1-C and MNE-Kotor. For the organic contaminants the SAUs of Montenegro MNE-1-C and MNE-Kotor in the Southern Adriatic Sea, zone SAS-1, do not achieve GES status regarding Σ_{16}PAHs and MNE-1-S, MNE-Kotor regarding Σ_7PCBs.

Even though some of the Adriatic SAUs are found in non- GES conditions especially regarding Hg in sediments, mussels do not seem to be affected in the same extent. Only SAUs HRO-0413-PZK in the zone CAS-1 and MNE-1-C in the zone SAS-1 are found in non-GES regarding Pb in mussels. Finally, an extreme value of Σ_7PCBs in the SAU HRO-0313-KASP in CAS leads to bad status (red). However, the assessment status results for Σ_7PCBs in mussels are based on only one measurement per SAU and should not be considered as truly representative. More data are needed so that the assessment results can be considered more robust.

The aggregation of the chemical parameters data per SAU leads to the NEAT value per SAU which represents the overall chemical status of the SAUs, as shown in Table 11. It is clear that the above described non-GES classifications, do not affect the overall chemical status and all SAUs fall under the GES status (high, good) with the exception of SAU HRO-0412-PULP in Croatia, zone NAS-1, which is classified under nonGES- moderate status.

Similarly, the aggregation-integration within the nested scheme results in GES status for the Adriatic subregion, its sub-divisions (NAS, CAS, SAS) and relevant IMAP assessment zones (NAS-1, NAS-12, CAS-1, CAS-12, SAS-1, SAS-12) (bold lines in Table 11). Within the GES status most SAUs are further classified under the high-status class. Only the zone NAS -12 is classified under good status, and this affects also the classification of the NAS subdivision (good).

In Table 12 the NEAT assessment results are aggregated per habitat (sediments, mussels). It is apparent that the sediments of the two SAUs HRO-0412-PULP in zone NAS-1 and MNE-Kotor in zone SAS-1 are classified under nonGES, moderate status. All other cases are classified under GES (high, good status).

Overall, it can be seen from the Tables and schematic diagrams, that TM in sediments have the largest spatial coverage with 47 out of 49 SAUs covered. For the other compounds and 'habitats' (sediments, mussels) several SAUs totally lack of data. In these cases, the integrated assessment result on the subdivision level (NAS, CAS, SAS) is based on only a few SAUs and cannot be considered representative. This is true for the assessment of Σ_{16}PAHs in sediments which is based on 14 out 49 SAUs and data delivered by from Italy, Slovenia, Montenegro; Σ_7PCBs in sediments which is based on 10 out of 49 SAUs and data delivered by Italy and Montenegro. In addition, Σ_7PCBs data in sediments for the CAS are non-existent. For the mussels, TM have the largest coverage and are measured in 26 out of the 49 SAUs, based on data delivered by Croatia, Italy (only for Hg in 3 SAUs), Slovenia (only in the coastal SAUs), Montenegro (only in the coastal SAUs). Σ_7PCBs in mussels are measured in 22 out of 49 SAUs based on data delivered by Croatia and Montenegro, however most of the SAUs have been sampled only once.

The integrated results for the higher spatial units (NAS, CAS, SAS), shown in bold, and the overall assessment for EO9/CI 17 (NEAT value) show a high or good status. However, with the exception of TM in sediments, based on the availability of data for contaminants as delivered by the CPs in the Adriatic Sea sub-region, the present integrated assessment status results produced by applying the NEAT tool on the sub-division (NAS, CAS, SAS) and/or the Adriatic sub-Region level (shown in Tables 11 and 12 and Annex II) can only be considered as an example of how the tool works (4th and 3rd nesting levels). This is related to the fact that several SAUs either lack data (blank cells in Tables 11, 12 and blank boxes in Annex II). The assessment per SAU and integrated assessment on the two key nesting IMAP assessment zones i.e. coastal and offshore (NAS-1, NAS-12; CAS-1, CAS-12; SAS-1, SAS-12) (1st and 2nd nesting levels) can be considered more detailed for decision making[23].

[23] Given lack of data for some SAUs, integration at a higher level that also includes these SAUs makes the uncertainty high.

Table 11. Status assessment results of the NEAT tool applied on the Adriatic nesting scheme for the assessment of EO9/CI17. The various levels of spatial integration (nesting) are marked in bold. Blank cells denote absence of data. The % confidence is based on the sensitivity analysis described in 6.1.

			EO9			A	B	C	D	E	F	G	H	I
SAU	**Area (km^2)**	**SAU weight factor**	**NEAT value**	**Status class**	**% Confidence**	**CI17_Cd seds**	**CI17_Hg seds**	**CI17_Pb seds**	**Σ16 PAHs seds**	**Σ7 PCBs seds**	**CI17_Cd mus**	**CI17_Hg mus**	**CI17_Pb mus**	**Σ7 PCBs mus**
Adriatic Sea	**139783**	**0**	**0.839**	**high**	**100**	**0.856**	**0.822**	**0.881**	**0.929**	**0.819**	**0.835**	**0.785**	**0.805**	**0.780**
Northern Adriatic Sea	**31856**	**0**	**0.786**	**good**	**99.9**	**0.849**	**0.536**	**0.836**	**0.910**	**0.795**	**0.836**	**0.791**	**0.848**	**0.814**
NAS-1	**9069**	**0**	**0.815**	**high**	100	**0.855**	**0.722**	**0.832**	**0.797**	**0.790**	**0.836**	**0.853**	**0.848**	**0.814**
MAD-HR-MRU-3	6422	0	0.856	high	100	0.892	0.891	0.840			0.836	0.854	0.847	0.814
HRO-0313-JVE	73	0.001	0.807	high	93.8	0.853	0.872	0.755			0.800	0.795	0.797	0.759
HRO-0313-BAZ	4	0	0.619	good	100	0.790	0.475	0.591						
HRO-0412-PULP	7	0	0.569	moderate	100	0.803	0.330	0.572						
HRO-0412-ZOI	473	0.003	0.879	high	100	0.894	0.861	0.874			0.901	0.880	0.878	0.864
HRO-0413-LIK	7	0	0.825	high	100	0.886	0.781	0.710			0.862	0.840	0.871	0.856
HRO-0413-PAG	30	0	0.828	high	100	0.832	0.837	0.780			0.856	0.877	0.840	0.786
HRO-0413-RAZ	10	0	0.835	high	100	0.852	0.883	0.770						
HRO-0422-KVV	494	0.004	0.841	high	100	0.867	0.915	0.849			0.826	0.800	0.814	0.782
HRO-0422-SJI	1923	0.014	0.881	high	100	0.916	0.944	0.906			0.843	0.879	0.842	0.796
HRO-0423-KVA	686	0.005	0.865	high	100	0.879	0.893	0.817			0.863	0.874	0.882	0.848
HRO-0423-KVJ	1089	0.008	0.852	high	100	0.888	0.907	0.795			0.800	0.862	0.922	0.777
HRO-0423-KVS	577	0.004	0.846	high	100	0.903	0.853	0.847			0.848	0.828	0.796	
HRO-0423-RILP	6	0	0.707	good	100	0.728	0.712	0.682						
HRO-0423-RIZ	475	0.003	0.818	high	100	0.877	0.861	0.763			0.802	0.799	0.791	0.816
HRO-0423-VIK	455	0.003	0.818	high	75.2	0.869	0.749	0.768			0.814	0.841	0.798	0.912

			EO9			A	B	C	D	E	F	G	H	I
SAU	**Area (km^2)**	**SAU weight factor**	**NEAT value**	**Status class**	**% Confidence**	**CI17_Cd seds**	**CI17_Hg seds**	**CI17_Pb seds**	**Σ16 PAHs seds**	**Σ7 PCBs seds**	**CI17_Cd mus**	**CI17_Hg mus**	**CI17_Pb mus**	**Σ7 PCBs mus**
IT-NAS-1	2592	0	0.712	good	100	0.789	0.416	0.819	0.797	0.790				
IT-Em-Ro-1	371	0.003	0.796	good	62.5	0.801	0.723	0.869	0.798	0.789				
IT-Fr-Ve-Gi-1	575	0.004	0.623	good	99.7	0.843	0.315	0.712						
IT-Ve-1	1646	0.012	0.723	good	100	0.755	0.406	0.870	0.796	0.791				
MAD-Sl-MRU-11	55	0	0.840	high	100	0.889		0.762	0.812		0.886	0.799	0.895	
NAS-12	**22788**	**0**	**0.774**	**good**	**100**	**0.844**	**0.400**	**0.840**	**0.930**	**0.796**		**0.786**		
MAD-HR-MRU-5	5571	0												
IT-NAS-12	10540	0.163	0.774	good	100	0.844	0.400	0.840	0.930	0.796		0.786		
MAD-Sl-MRU-12	129	0												
Central Adriatic	**63696**	**0**	**0.843**	**high**	**100**	**0.850**	**0.861**	**0.893**	**0.981**		**0.856**	**0.768**	**0.788**	**0.741**
CAS-1	**9394**	**0**	**0.856**	**high**	**100**	**0.843**	**0.881**	**0.876**	**0.981**		**0.856**	**0.853**	**0.788**	**0.741**
MAD-HR-MRU-2	7302	0	0.853	high	89.9	0.855	0.900	0.848			0.856	0.853	0.788	0.741
HRO-0313-NEK	253	0.003	0.831	high	100	0.799	0.824	0.744			0.873	0.887	0.899	0.832
HRO-0313-KASP	44	0	0.637	good	100	0.793	0.400	0.742			0.888	0.799	0.811	0.016
HRO-0313-KZ	34	0	0.684	good	100	0.816	0.427	0.810						
HRO-0313-MMZ	55	0.001	0.833	high	100	0.837	0.896	0.794			0.846	0.846	0.808	0.795
HRO-0413-PZK	196	0.002	0.762	good	64.9	0.887	0.768	0.783			0.860	0.868	0.400	0.723
HRO-0413-STLP	1	0	0.698	good	100	0.798	0.477	0.820						
HRO-0423-BSK	613	0.006	0.813	high	90.2	0.800	0.752	0.796			0.829	0.849	0.831	0.864
HRO-0423-KOR	1564	0.016	0.846	high	100	0.886	0.893	0.888			0.863	0.849	0.799	0.699
HRO-0423-MOP	2480	0.025	0.883	high	100	0.854	0.941	0.852						
IT-CAS-1	2092	0	0.870	high	100	0.815	0.786	0.940	0.981					
IT-Ab-1	282	0.005	0.897	high	100	0.809	0.867	0.932	0.981					
IT-Ma-1	319	0.006	0.870	high	100	0.793		0.947						

			EO9			A	B	C	D	E	F	G	H	I
SAU	**Area (km^2)**	**SAU weight factor**	**NEAT value**	**Status class**	**% Confidence**	**CI17_Cd seds**	**CI17_Hg seds**	**CI17_Pb seds**	**Σ16 PAHs seds**	**Σ7 PCBs seds**	**CI17_Cd mus**	**CI17_Hg mus**	**CI17_Pb mus**	**Σ7 PCBs mus**
IT-Mo-1	229	0.004	0.837	high	89.9	0.864	0.712	0.934						
CAS-12	**54303**	**0**	**0.840**	**high**	**100**	**0.851**	**0.858**	**0.896**				**0.765**		
MAD-HR-MRU-4	18963	0.178	0.897	high	100	0.887	0.909	0.894						
IT-CAS-12	22393	0.21	0.793	good	65.9	0.791	0.771	0.899				0.765		
Southern Adriatic Sea	**44231**	**0**	**0.872**	**high**	**100**	**0.866**	**0.865**	**0.881**	**0.955**	**0.922**	**0.815**	**0.910**	**0.760**	**0.770**
SAS-1	**7276**	**0**	**0.833**	**high**	**100**	**0.847**	**0.804**	**0.837**	**0.681**	**0.810**	**0.815**	**0.910**	**0.760**	**0.770**
MAD-HR-MRU-2	4252	0	0.809	high	100	0.849	0.877	0.766			0.810	0.809	0.775	0.756
HRO-0313-ZUC	13	0	0.841	high	100	0.843	0.888	0.903			0.807	0.867	0.799	0.748
HRO-0423-MOP	1756	0.031	0.809	high	89.4	0.849	0.877	0.765			0.810	0.809	0.775	0.756
IT-SAS-1 (Ap-1)	1810	0.013	0.934	high	100	0.804	0.944	0.943				0.970		
MNE-SAS-1	483	0	0.776	good	83.4	0.781	0.681	0.726	0.681	0.810	0.865	0.892	0.603	0.920
MNE-1-N	86	0.001	0.865	high	100	0.797	0.944	0.961	0.740	0.869				
MNE-1-C	246	0.002	0.704	good	97	0.772	0.569	0.572	0.773	0.795	0.787	0.846	0.324	0.888
MNE-1-S	151	0.001	0.895	high	100	0.852	0.861	0.931	0.583	0.799	0.987	0.978	0.981	0.990
MNE-Kotor	85	0.001	0.683	good	100	0.663	0.354	0.508	0.514	0.578	0.873	0.873	0.740	0.888
AL-SAS-1	646	0.005	0.752	good	89.1	0.917	0.395	0.943						
SAS-12	**36955**	**0**	**0.880**	**high**	**100**	**0.868**	**0.872**	**0.886**	**0.964**	**0.938**				
IT-SAS-12	22715	0.216	0.876	high	100	0.861	0.877	0.891						
MNE-SAS-12	2076	0	0.904	high	100	0.881	0.933	0.791	0.978	0.938				
MNE-12-N	513	0.005	0.917	high	100	0.894	0.949	0.826	0.970	0.944				
MNE-12-C	713	0.007	0.907	high	100	0.886	0.941	0.809	0.982	0.919				
MNE-12-S	849	0.008	0.894	high	100	0.869	0.917	0.755	0.980	0.950				
AL-SAS-12	716	0.007	0.809	high	59.1	0.924	0.587	0.915						

			EO9			A	B	C	D	E	F	G	H	I
SAU	**Area (km^2)**	**SAU weight factor**	**NEAT value**	**Status class**	**% Confidence**	**CI17_Cd seds**	**CI17_ Hg seds**	**CI17_Pb seds**	**Σ16 PAHs seds**	**Σ7 PCBs seds**	**CI17_Cd mus**	**CI17_Hg mus**	**CI17_Pb mus**	**Σ7 PCBs mus**
MAD-EL-MS-AD	2253	0.021	0.918	high	100	0.914		0.884	0.956					

Table 12: Status assessment results of the NEAT tool applied on the Adriatic nested scheme for the assessment of EO9/CI 17. Contaminants' data are aggregated and integrated per habitat (sediments, mussels). The various levels of spatial integration (nesting) are marked in bold. Blank cells denote absence of data. The % confidence is based on the sensitivity analysis described in 6.1.

SAU	Area (km^2)	Total SAU weight factor	NEAT value	Status Class	% Confidence	sediments	mussels
Adriatic Sea	**139783**	**0**	**0.839**	**high**	**100**	**0.856**	**0.789**
Northern Adriatic Sea	**31856**	**0**	**0.786**	**good**	**99.9**	**0.775**	**0.798**
NAS-1	**9069**	**0**	**0.815**	**high**	**100**	**0.802**	**0.839**
MAD-HR-MRU-3	6422	0	0.856	high	100	0.874	0.838
HRO-0313-JVE	73	0.001	0.807	high	94.2	0.827	0.788
HRO-0313-BAZ	4	0	0.619	good	100	0.619	
HRO-0412-PULP	7	0	0.569	moderate	100	0.569	
HRO-0412-ZOI	473	0.003	0.879	high	100	0.877	0.881
HRO-0413-LIK	7	0	0.825	high	100	0.792	0.857
HRO-0413-PAG	30	0	0.828	high	100	0.817	0.84
HRO-0413-RAZ	10	0	0.835	high	100	0.835	
HRO-0422-KVV	494	0.004	0.841	high	100	0.877	0.805
HRO-0422-SJI	1923	0.014	0.881	high	100	0.922	0.84
HRO-0423-KVA	686	0.005	0.865	high	100	0.863	0.867
HRO-0423-KVJ	1089	0.008	0.852	high	100	0.863	0.84
HRO-0423-KVS	577	0.004	0.846	high	100	0.868	0.824
HRO-0423-RILP	6	0	0.707	good	100	0.707	
HRO-0423-RIZ	475	0.003	0.818	high	100	0.834	0.802
HRO-0423-VIK	455	0.003	0.818	high	77.7	0.795	0.841
IT-NAS-1	**2592**	0	0.712	good	100	0.712	
IT-Em-Ro-1	371	0.003	0.796	good	62.1	0.796	
IT-Fr-Ve-Gi-1	575	0.004	0.623	good	99.6	0.623	

SAU	Area (km²)	Total SAU weight factor	NEAT value	Status Class	% Confidence	sediments	mussels
IT-Ve-1	1646	0.012	0.723	good	100	0.723	
MAD-Sl-MRU-11	55	0	0.84	high	100	0.821	0.86
NAS-12	22788	**0**	**0.774**	**good**	100	**0.762**	**0.786**
MAD-HR-MRU-5	5571	0					
IT-NAS-12	**10540**	0.163	0.774	good	100	0.762	0.786
MAD-Sl-MRU-12	129	0					
Central Adriatic	**63696**	0	0.843	high	100	0.868	0.771
CAS-1	**9394**	**0**	**0.856**	**high**	100	**0.868**	**0.809**
MAD-HR-MRU-2	7302	0	0.853	high	88.7	0.868	0.809
HRO-0313-NEK	253	0.003	0.831	high	100	0.789	0.873
HRO-0313-KASP	44	0	0.637	good	100	0.645	0.629
HRO-0313-KZ	34	0	0.684	good	100	0.684	
HRO-0313-MMZ	55	0.001	0.833	high	100	0.842	0.824
HRO-0413-PZK	196	0.002	0.762	good	63.6	0.812	0.712
HRO-0413-STLP	1	0	0.698	good	100	0.698	
HRO-0423-BSK	613	0.006	0.813	high	89.2	0.783	0.843
HRO-0423-KOR	1564	0.016	0.846	high	100	0.889	0.803
HRO-0423-MOP	2480	0.025	0.883	high	100	0.883	
IT-CAS-1	2092	0	0.87	high	100	0.87	
IT-Ab-1	282	0.005	0.897	high	100	0.897	
IT-Ma-1	319	0.006	0.87	high	100	0.87	
IT-Mo-1	229	0.004	0.837	high	86.8	0.837	
CAS-12	**54303**	**0**	**0.84**	**high**	**100**	**0.868**	**0.765**
MAD-HR-MRU-4	18963	0.178	0.897	high	100	0.897	
IT-CAS-12	22393	0.21	0.793	good	61.7	0.82	0.765

SAU	Area (km²)	Total SAU weight factor	NEAT value	Status Class	% Confidence	sediments	mussels
Southern Adriatic Sea	**44231**	**0**	**0.872**	**high**	**100**	**0.875**	**0.841**
SAS-1	**7276**	**0**	**0.833**	**high**	**100**	**0.827**	**0.841**
MAD-HR-MRU-2	4252	0	0.809	high	100	0.831	0.788
HRO-0313-ZUC	13	0	0.841	high	100	0.878	0.805
HRO-0423-MOP	1756	0.031	0.809	high	87.7	0.831	0.788
IT-SAS-1 (Ap-1)	1810	0.013	0.934	high	100	0.897	0.97
MNE-SAS-1	483	0	0.776	good	84	0.724	0.82
MNE-1-N	86	0.001	0.865	high	100	0.861	
MNE-1-C	246	0.002	0.704	good	96.8	0.696	0.711
MNE-1-S	151	0.001	0.895	high	100	0.805	0.984
MNE-Kotor	85	0.001	0.683	good	100	0.523	0.843
AL-SAS-1	646	0.005	0.752	good	92.4	0.752	
SAS-12	**36955**	**0**	**0.88**	**high**	**100**	**0.88**	
IT-SAS-12	22715	0.216	0.876	high	100	0.876	
MNE-SAS-12	2076	0	0.904	high	100	0.904	
MNE-12-N	513	0.005	0.917	high	100	0.917	
MNE-12-C	713	0.007	0.907	high	100	0.907	
MNE-12-S	849	0.008	0.894	high	100	0.894	
AL-SAS-12	716	0.007	0.809	high	60	0.809	
MAD-EL-MS-AD	2253	0.021	0.918	high	100	0.918	

The results of the assessment findings provided per contaminants of EO9/CI 17 without aggregation per habitat, i.e. sediment and biota, as presented in Table 11, are visualized in the schematic diagrams provided in Annex II. Also, the final GES assessment findings for all the IMAP SAUs in the Adriatic Sea, as provided in Table 11 are shown by the respective color in the maps included in the following Figures 22-24. The maps depict the integrated NEAT value for each SAU (i.e. aggregated value for all contaminants as provided in the 4th column of Table 11).

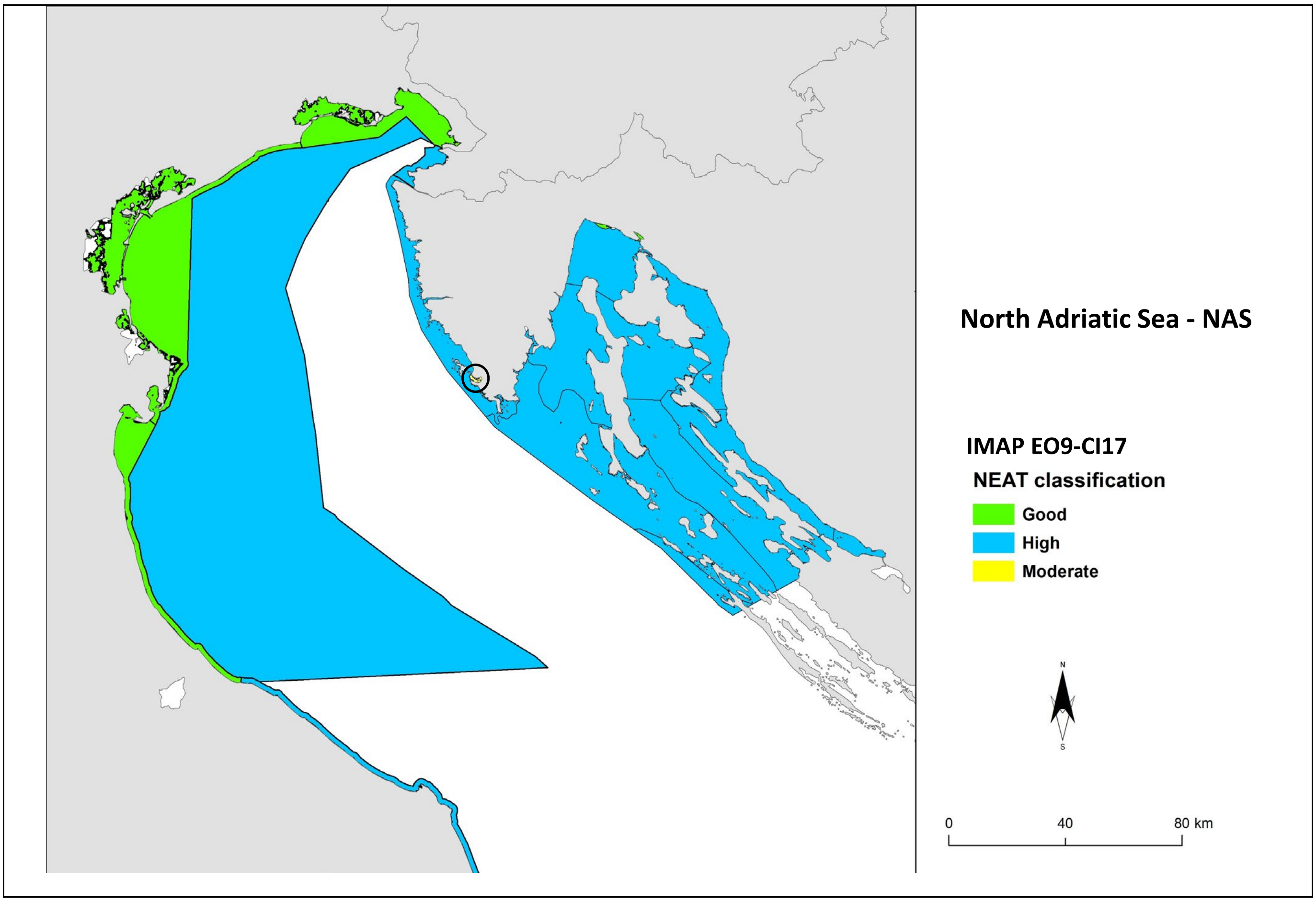


Figure 22: The NEAT assessment results for IMAP CI17 in the North Adriatic Sea. All IMAP SAUs are in GES characterized by High or Good status. Only SubSAU HRO-0412-PULP (denoted with circle) is found under nonGES-moderate status. Blank area corresponds to no available data.

The overall status of CI17 on the sub-division level for NAS is Good and in GES. Thirteen out of 20 SAUs are classified under High status and six under Good. Only one small subSAU is classified under moderate status and not in GES.

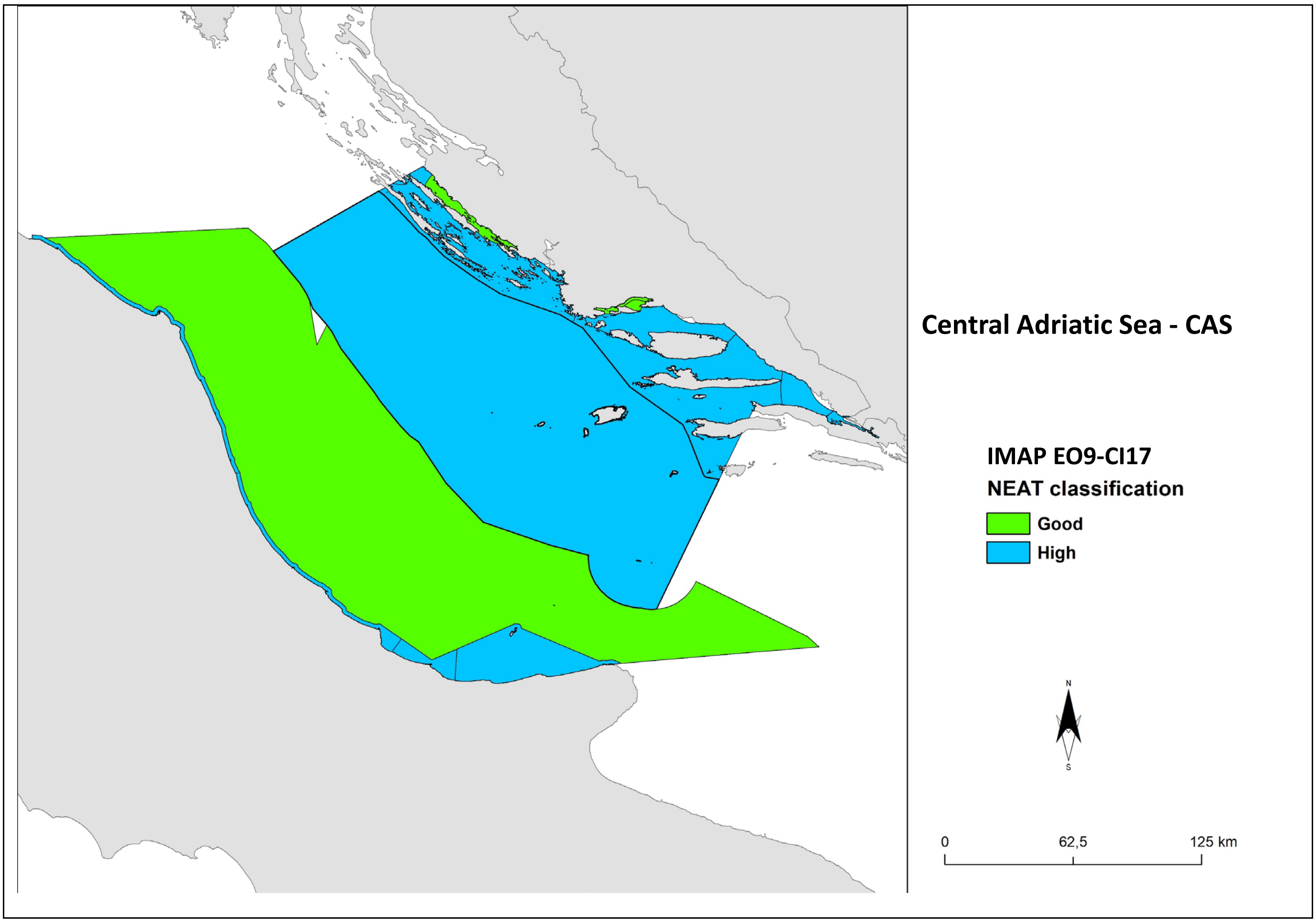


Figure 23: The NEAT assessment results for IMAP EO9/CI17 in the Central Adriatic Sea. All IMAP SAUs are in GES, characterized by High or Good status.

The overall status of CI17 on the sub-division level for CAS is High and in GES. Nine out of fourteen SAUs are classified under High status and five under Good.

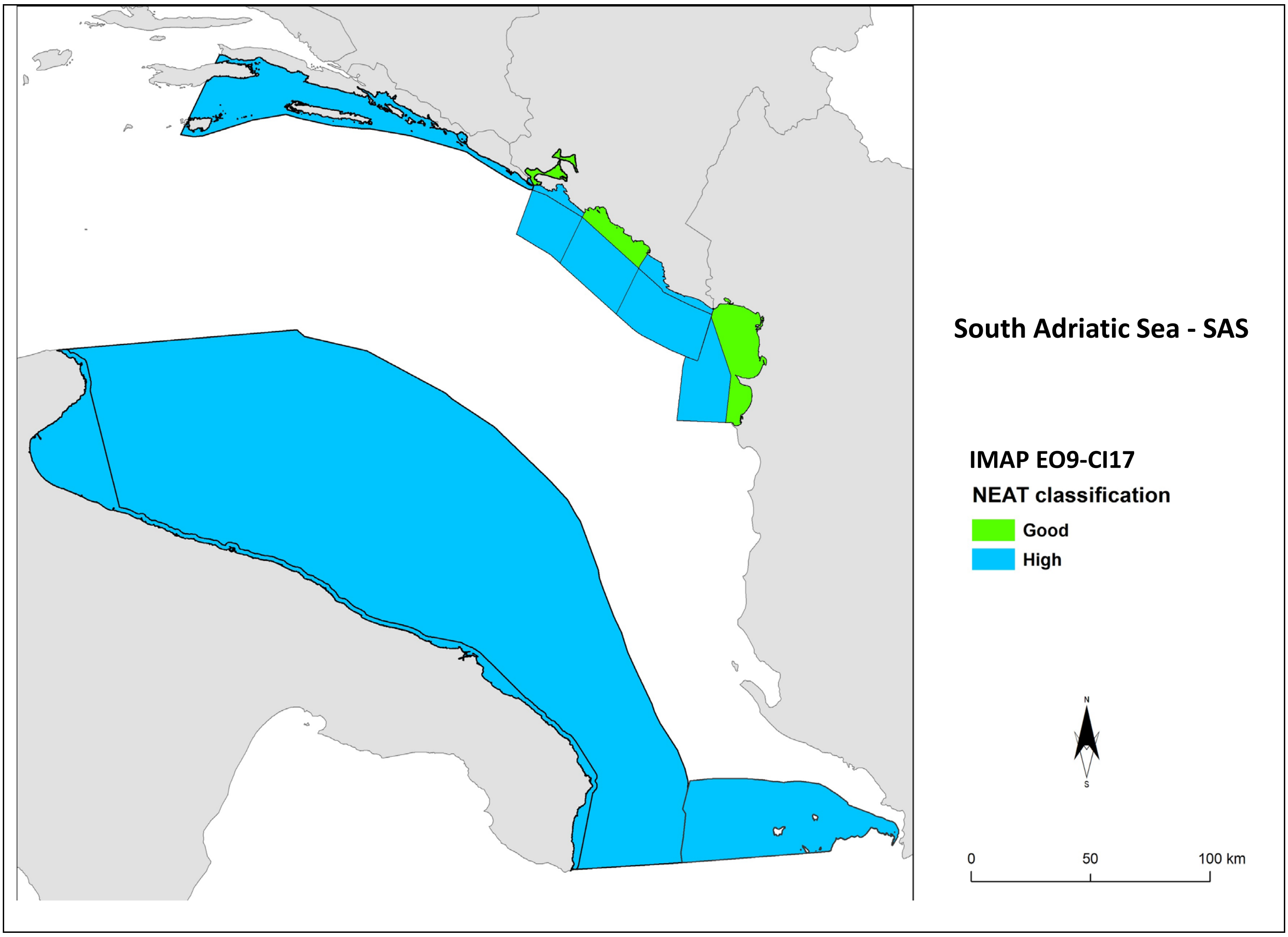


Figure 24: The NEAT assessment results for IMAP CI17 in the South Adriatic Sea. All IMAP SAUs are in GES, characterized by High or Good status. Blank area corresponds to no available data.

The overall status of CI17 on the sub-division level for SAS is High and in GES. Four out of 14 SAUs are classified under Good conditions the rest under High.

6.1 Sensitivity analysis of the assessment results

The assessment status as obtained by the NEAT tool is the one based on the average value of monitoring data. However, based on the standard deviation per chemical compound and per SAU, the NEAT tool provides a sensitivity analysis for calculating the uncertainty of the assessment results using a Monte-Carlo simulation model for 1000 iterations.

In other words, 1000 assessments are run using different random combinations of the data. Instead of using the average value of the parameters inserted by the user, other random values are used by the tool to run the assessment. The selection of these random values is done based on the standard deviation and it is repeated 1000 times with different combinations. The resulting assessment value of each of these 1000 assessment runs is recorded and may lead to a different assessment classification than the one based on the average value. The number of times (out of 1000) of the appearance of these different assessments is given in Table 13.

Table 13. Confidence assessment of all SAU/assessment class combinations as absolute counts falling into the specified classes (maximum possible count = 1000). The final level of confidence assessment for SAU is the one with the highest number of iterations.

SAU	bad	poor	moderate	good	high
Adriatic Sea	0	0	0	0	1000
Northern Adriatic Sea	0	0	0	999	1
Central Adriatic	0	0	0	0	1000
Southern Adriatic Sea	0	0	0	0	1000
NAS-1	0	0	0	0	1000
NAS-12	0	0	0	1000	0
CAS-1	0	0	0	0	1000
CAS-12	0	0	0	0	1000
SAS-1	0	0	0	0	1000
SAS-12	0	0	0	0	1000
MAD-HR-MRU-3	0	0	0	0	1000
IT-NAS-1	0	0	0	1000	0
MAD-Sl-MRU-11	0	0	0	0	1000
MAD-HR-MRU-5					
IT-NAS-12	0	0	0	1000	0
MAD-Sl-MRU-12					
MAD-HR-MRU-2	0	0	0	101	899
IT-SAS-1 (Ap-1)	0	0	0	0	1000
MNE-SAS-1	0	0	0	834	166
AL-SAS-1	0	0	0	891	109
IT-SAS-12	0	0	0	0	1000
MNE-SAS-12	0	0	0	0	1000
AL-SAS-12	0	0	0	409	591
MAD-EL-MS-AD	0	0	0	0	1000
MAD-HR-MRU-2	0	0	0	0	1000
IT-CAS-1	0	0	0	0	1000
MAD-HR-MRU-4	0	0	0	0	1000
IT-CAS-12	0	0	0	659	341
HRO-0313-JVE	0	0	0	62	938
HRO-0313-BAZ	0	0	0	1000	0

SAU	bad	poor	moderate	good	high
HRO-0412-PULP	0	0	1000	0	0
HRO-0412-ZOI	0	0	0	0	1000
HRO-0413-LIK	0	0	0	0	1000
HRO-0413-PAG	0	0	0	0	1000
HRO-0413-RAZ	0	0	0	0	1000
HRO-0422-KVV	0	0	0	0	1000
HRO-0422-SJI	0	0	0	0	1000
HRO-0423-KVA	0	0	0	0	1000
HRO-0423-KVJ	0	0	0	0	1000
HRO-0423-KVS	0	0	0	0	1000
HRO-0423-RILP	0	0	0	1000	0
HRO-0423-RIZ	0	0	0	0	1000
HRO-0423-VIK	0	0	0	248	752
IT-Em-Ro-1	0	0	0	625	375
IT-Fr-Ve-Gi-1	0	0	3	997	0
IT-Ve-1	0	0	0	1000	0
HRO-0313-ZUC	0	0	0	0	1000
HRO-0423-MOP	0	0	0	106	894
MNE-1-N	0	0	0	0	1000
MNE-1-C	0	0	0	970	30
MNE-1-S	0	0	0	0	1000
MNE-Kotor	0	0	0	1000	0
MNE-12-N	0	0	0	0	1000
MNE-12-C	0	0	0	0	1000
MNE-12-S	0	0	0	0	1000
HRO-0313-NEK	0	0	0	0	1000
HRO-0313-KASP	0	0	0	1000	0
HRO-0313-KZ	0	0	0	1000	0
HRO-0313-MMZ	0	0	0	0	1000
HRO-0413-PZK	0	0	0	649	351
HRO-0413-STLP	0	0	0	1000	0
HRO-0423-BSK	0	0	0	98	902
HRO-0423-KOR	0	0	0	0	1000
HRO-0423-MOP	0	0	0	0	1000
IT-Ab-1	0	0	0	0	1000
IT-Ma-1	0	0	0	0	1000
IT-Mo-1	0	0	0	101	899

For example, the overall status for the SAU AL-SAS-12 is reported as 'high'. However, from Table 13 it is understood that out of 1000 iterations, 409 lead to Good status, and 591 to High Status. These results imply a rather high uncertainty (confidence 59.1%), in contrast to HRO-0313-JVE where 938 iterations led to High status and only 62 to Good (confidence 93.8%).

As for any assessment results, the accuracy of the results described above, is dependent on the analytical accuracy of the chemical data i.e. the quality of data reported to IMAP IS and their reproducibility and comparability among all the laboratories as well by the amount of data available for each SAU. It should be stressed here, that the sensitivity analysis described above cannot compensate for the analytical differences among the laboratories or for the lack of data. For instance, in many of the subSAUs data were representative of one monitoring station visited once. Despite to small quantum of data assessed in this case, the value of standard error inserted in the NEAT tool is equal to zero and the propagated error is extremely low, therefore there is high confidence value. In other cases, many subSAUs totally lack of data (blank cells in Table11, 12 and Annex II), therefore the integrated results on the upper SAU level actually reflect the status of one or two subSAUs and cannot be considered indicative of the overall SAU status with confidence. In conclusion, the interpretation of the NEAT assessment results should always take into consideration the afore mentioned factors, having in mind that NEAT is just a tool which calculates numbers based on input data.

Annex I

Calculation of the SAUs weight factors by the NEAT tool

(provided by the NEAT developers: Torsten Berg and Angel Borja)

The total weight of a SAU is not the simple ratio of each SAU area to the total area of the parent SAU. The process of distributing the weight is more complex. SAU weighting by the NEAT tool has two options: i) do not weight by SAU area: weights are calculated based just on the nesting hierarchy of the SAUs; ii) weight by SAU area: weights are calculated based on the nesting hierarchy and the SAU surface area.

The overall principle is that the sum of all weights in the nesting scheme (SAU tree) is equal to 1. By adding up the weights of all individual SAUs in a SAU nesting scheme, this sum will always be 1.

The next thing is, a SAU without data will have a total weight of zero, e.g. for the present case there is no contaminants data for the top SAU, the Adriatic Sea. So, its weight will be zero and this will give more weight to the SAU lower in the hierarchy (or to siblings on the same hierarchy level).

<u>i) Weighting based on the nesting hierarchy only - NEAT option *'Do not weight by SAU area'*:</u>

For the case that every SAU has data for at least one chemical parameter and we do not weight by area (and we use no priority factors). Then the area is treated as if it were 1. There is one top-level SAU (the Adriatic Sea) and below there are the Northern, Central and Southern Adriatic Seas. Hypothetically it is assumed that there are also 4 SAUs beneath the Northern Adriatic Sea..

The calculation starts by assigning the total weight of the SAU tree that must be 1. This weight needs to be distributed among all SAUs in the tree. That means, the top SAU cannot have it all, it must share the 1 with its three children (Northern, Central, Southern). In total, this makes 4 SAUs that need to share the total weight of 1. So, the top-level SAU (the Adriatic Sea as a whole) and each of the children (Norther, Central, Southern) get 0.25 of the total tree weight:

w(total) = 1

w(Adriatic) = 0.25

v(Northern) = 0.25

v(Central) = 0.25

v(Southern) = 0.25

Note that we write w = final weight, and v = inherited weight.

For the top-level SAU, the 'w(Adriatic) = 0.25' is its final weight as it has shared the weight of 1 (which was inherited in the first place) among itself and its children. Now, each of the children must do the same. The weight which they now got, is not their final weight (named w above). It is the weight they inherit from their parent SAU (named v above) and that they need to share with their children. Hypothetically it is assumed that the 4 children of the Northern Adriatic Sea are called N1, N2, N3 and N4. The inherited weight of 0.25 needs to be shared among the Northern Adriatic Sea and N1, N2, N3 and N4. This is 5 SAUs. So, 0.25 is divided by 5 and it gets 0.05. That is the final weight of the Northern Adriatic Sea and the weight its children will inherit in the first place:

w(total) = 1 = v(Adriatic)

w(Adriatic) = v(Adriatic)/4 = 0.25

w(Northern) = v(Northern)/5 = 0.05

v(N1) = 0.05

v(N2) = 0.05

v(N3) = 0.05

v(N4) = 0.05

The total weight of 1 is the same as the weight inherited to the whole Adriatic Sea. And the final weight is its inherited weight divided by the number of SAUs involved.

The same principle can be applied to all further children in any possible SAU tree. If the tree stopped here, the one could take all w(...) values and add them together. As N1 through N4 have no children (as well as the Central and the Southern Adriatic) their inherited weight is the same as their total weight as they do not need to share it with any children. There are no further children anymore:

w(Adriatic) + w(Northern) + w(Central) + w(Southern) + w(N1) + w(N2) + w(N3) + w(N4)

= 0.25 + 0.05 + 0.25 + 0.25 + 0.05 + 0.05 + 0.05 + 0.05 = 1

The total weight of the tree is 1, as expected.

ii) <u>Weighting based on the nesting hierarchy and the SAU surface area - NEAT option: *'Weight by SAU area'*:</u>

In this case, the area is used instead of 1 but making sure the total weight is still 1. The one use a() for the area, for example:

a(Adriatic) = 139783 km^2

a(Northern) = 31856 km^2

a(Central) = 63696 km^2

a(Southern) = 44231 km^2

w(total) = 1 = v(Adriatic)

w(Adriatic) = v(Adriatic)*a(Adriatic)/[a(Adriatic) + a(Northern) + a(Central) + a(Southern)]

= 1 * 139783 / (139783 + 31856 + 63696 + 44231)

= 1 * 139783 / 297566

= 0.4698

Here, instead of adding the number of SAUs (the one at the top-level plus all its children), their areas are just added. The value of 0.4698 will now be the inherited weight for the Northern, Central and Southern Adriatic sub-divisions and is placed in the formula instead of the 1 above. So, v(Northern) will be 0.4698 and this weight is distributed among itself and N1 through N4. Again, the one add the areas of all those 5 SAUs, divide the area of the Northern Adriatic Sea by this sum and multiply with the inherited weight of 0.4698 and this will give the final weight of the Northern Adriatic Sea (and of its children if they do not have any children themselves).

The above apply under the assumption that there are data inserted to each of the nested SAUs. In the present analysis for the IMAP CI17 this is not the case and the weight calculation becomes more complex.

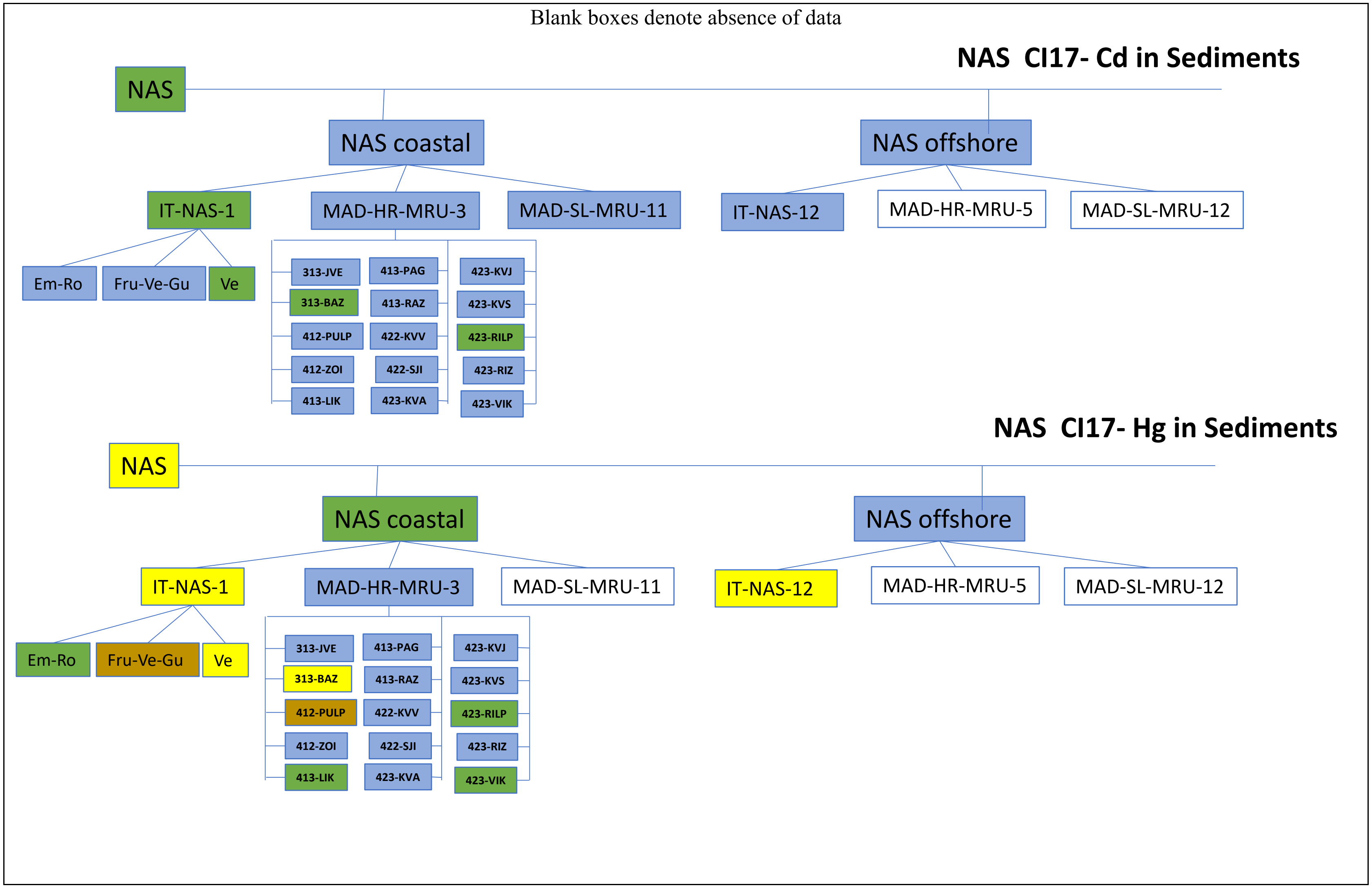
Annex II

Schematic representation of the NEAT assessment results in the nesting scheme of the Adriatic Sea sub-region according to the NEAT color scale

	GES		non-GEs		
IMAP	Good	Moderate	Bad		
NEAT	High	Good	Moderate	Poor	Bad
	0< meas. conc. ≤ BAC	BAC<meas. conc. ≤MedEAC	MedEAC<meas. conc. ≤ 3xMedEAC	3xMedEAC<meas. conc. ≤ max. conc.	
Boundary limits	**0**				**Max. conc.**
Thresholds	**BAC**	**MedEAC**	**3xMedEAC**		

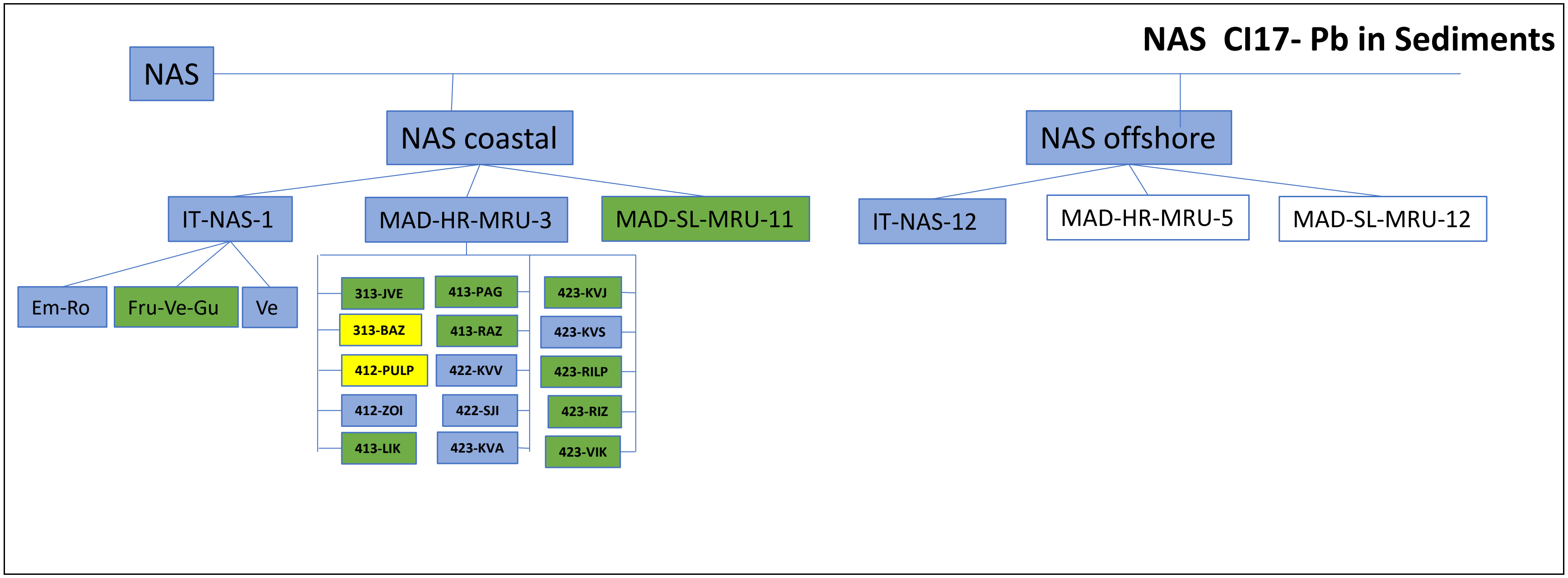
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the North Adriatic Sea (NAS) sub-division per contaminant in sediments (Cd & Hg).

Blank boxes denote absence of data



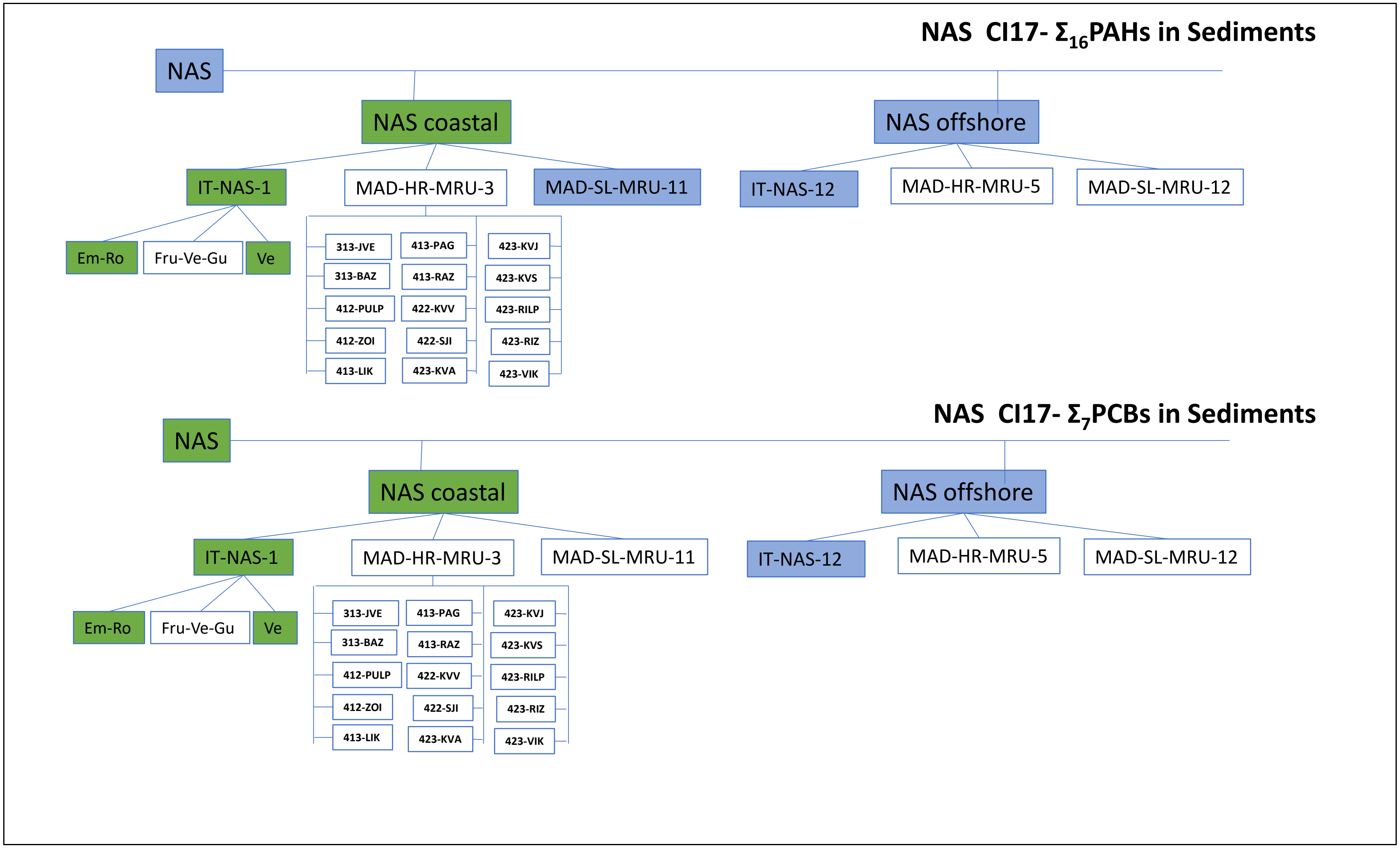
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the North Adriatic Sea (NAS) sub-division per contaminant in sediments (Pb)

Blank boxes denote absence of data



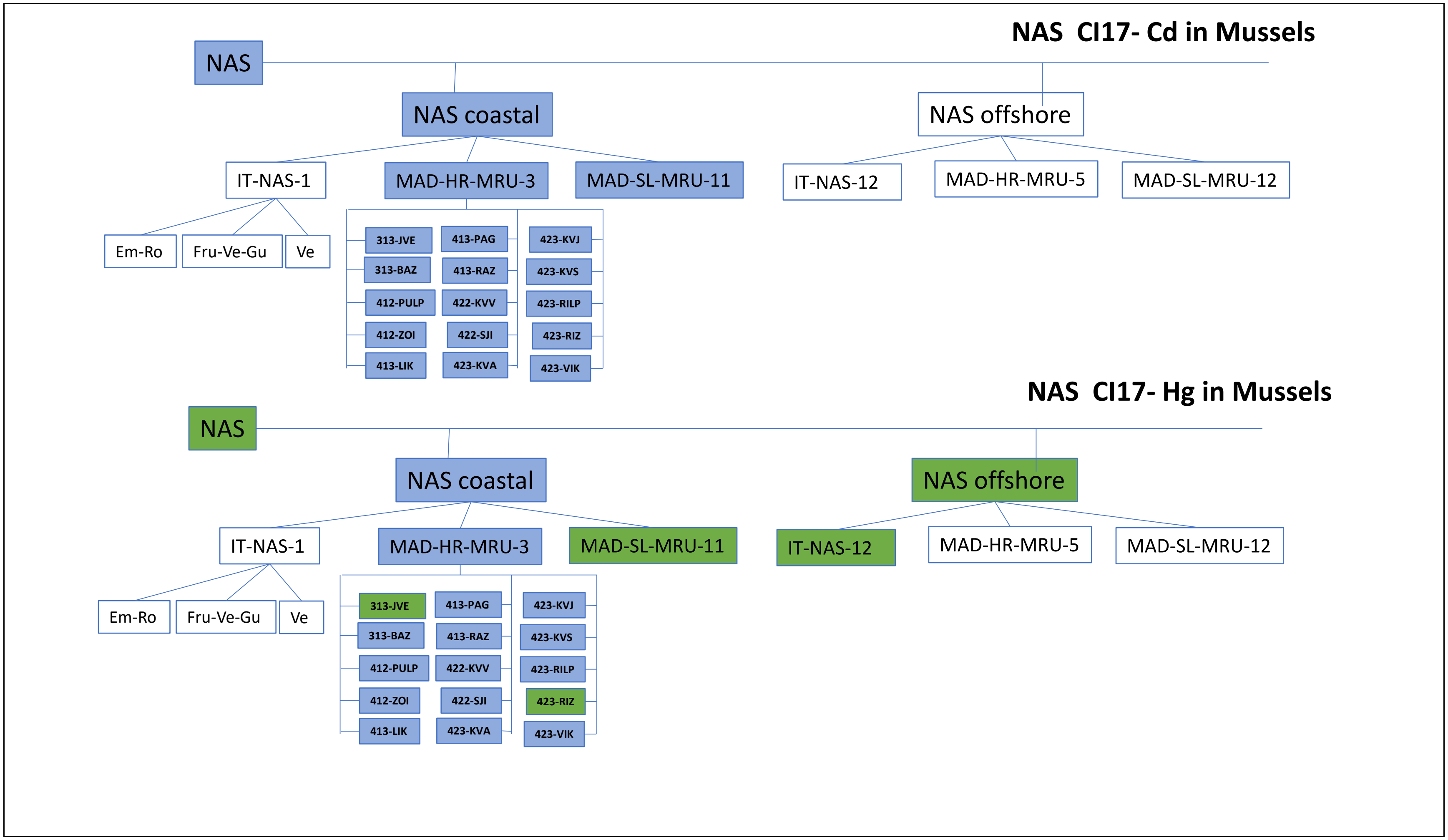
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the North Adriatic Sea (NAS) sub-division per contaminant in sediments (Σ_{16}PAHs & Σ_7PCBs)

Blank boxes denote absence of data



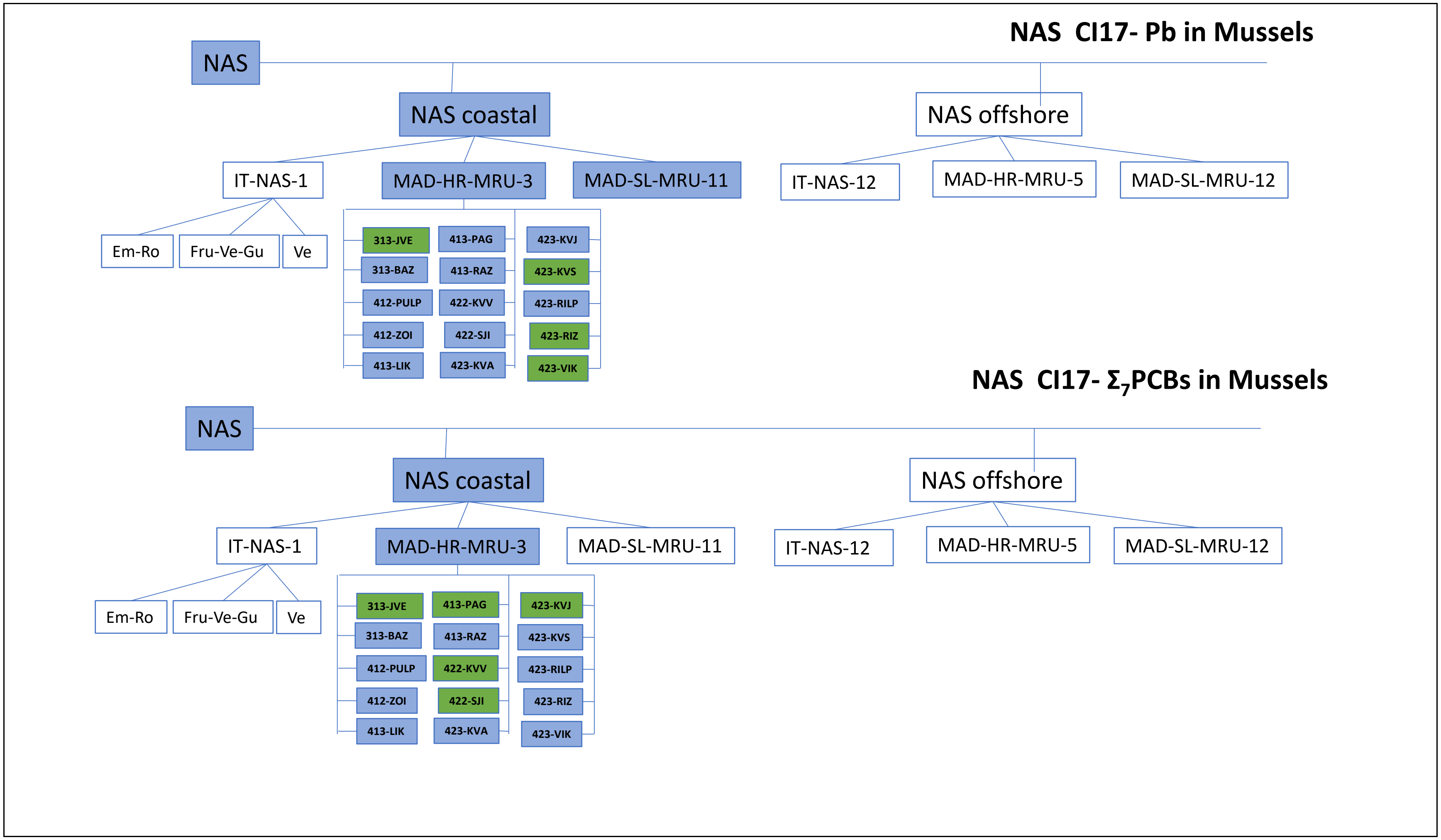
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the North Adriatic Sea (NAS) sub-division per contaminant in mussels (Cd & Hg)

Blank boxes denote absence of data



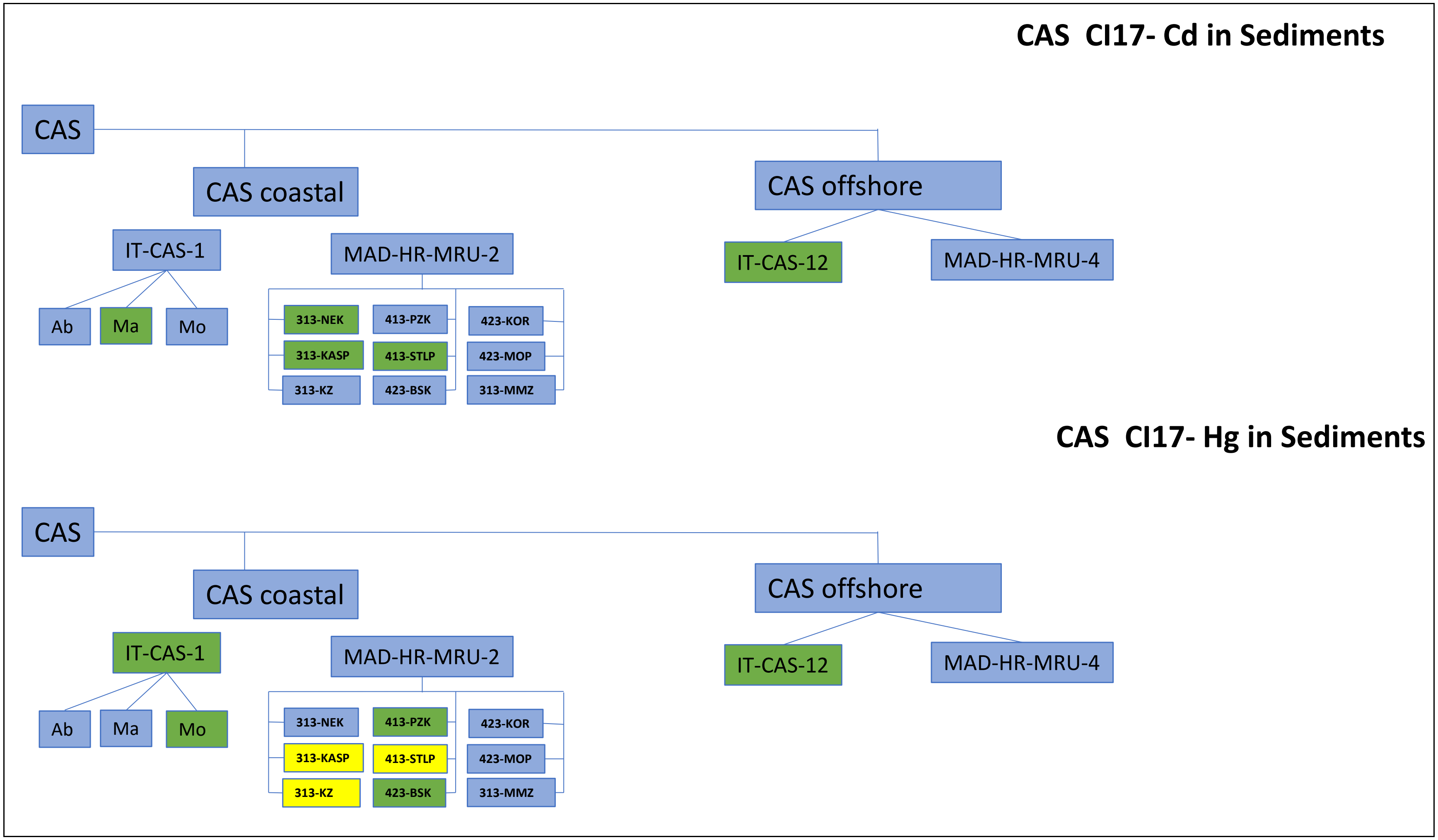
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the North Adriatic Sea (NAS) sub-division per contaminant in mussels (Pb & Σ_7PCBs)

Blank boxes denote absence of data



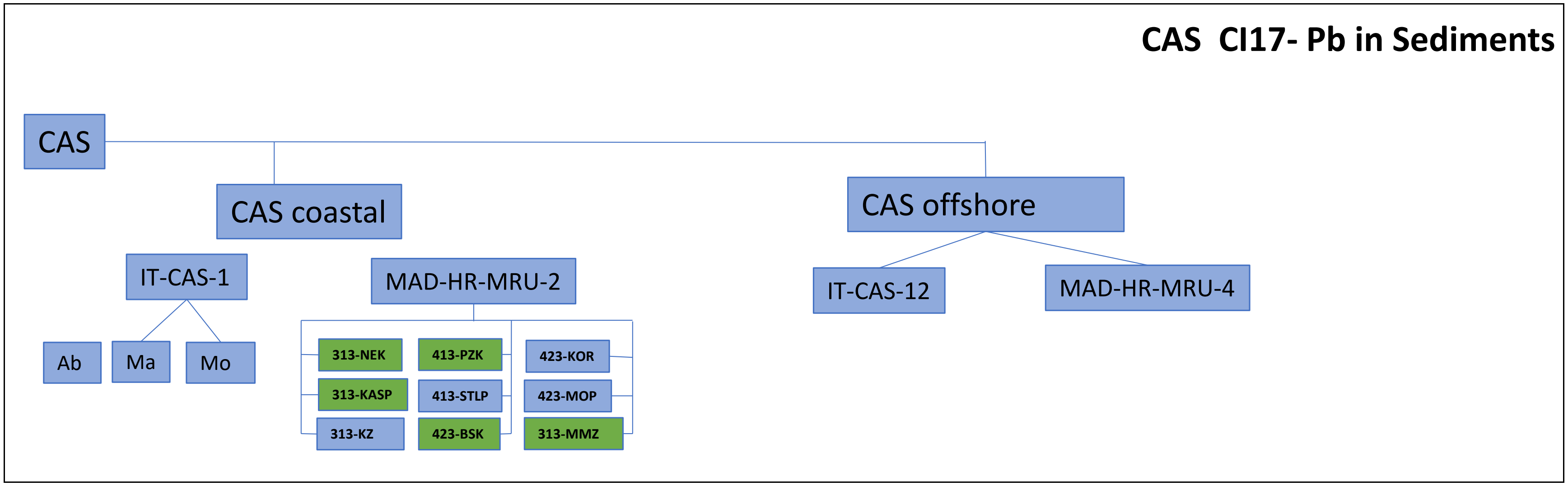
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the Central Adriatic Sea (CAS) sub -division per contaminant in sediments (Cd & Hg)

Blank boxes denote absence of data



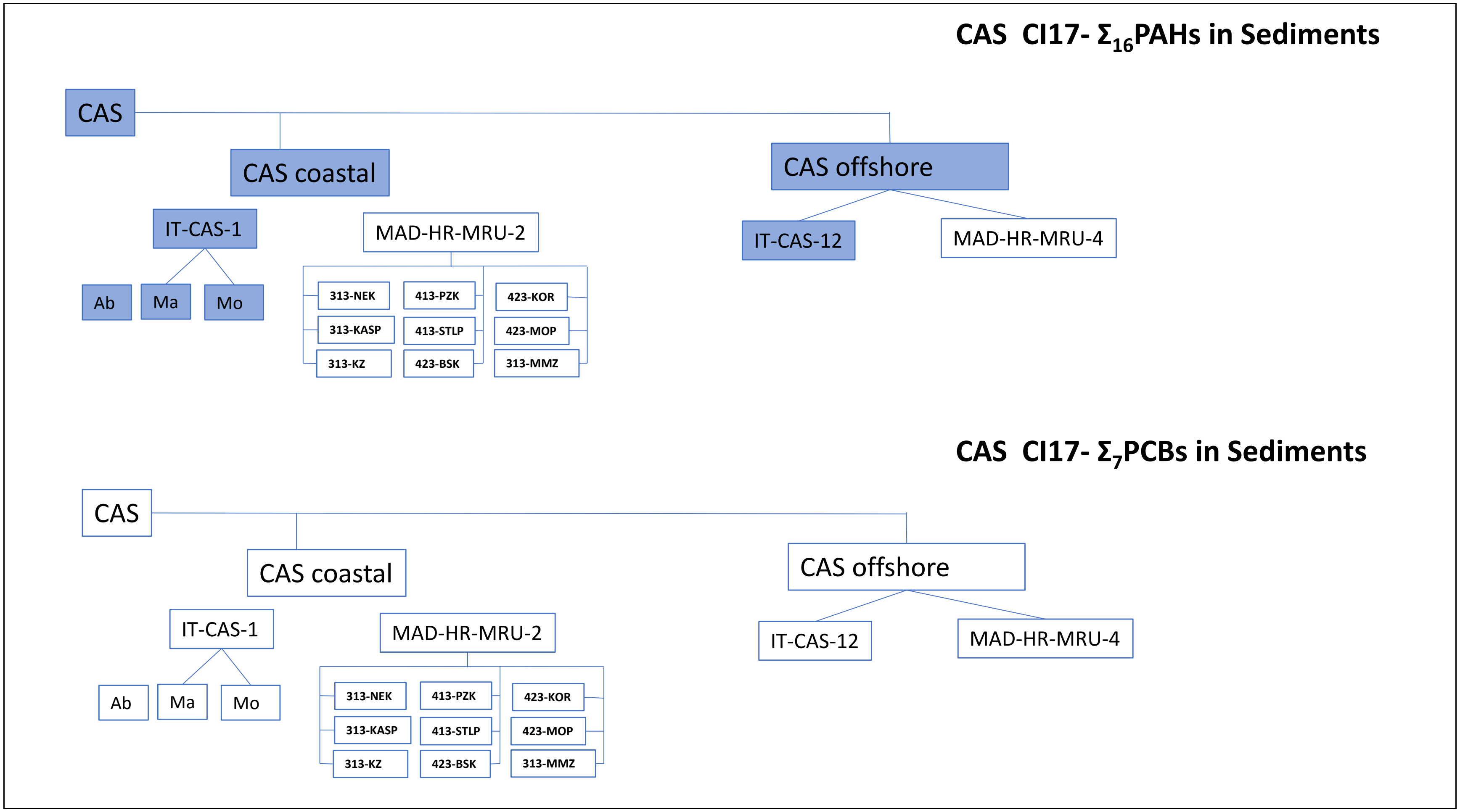
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the Central Adriatic Sea (CAS) sub -division per contaminant in sediments (Pb)

Blank boxes denote absence of data



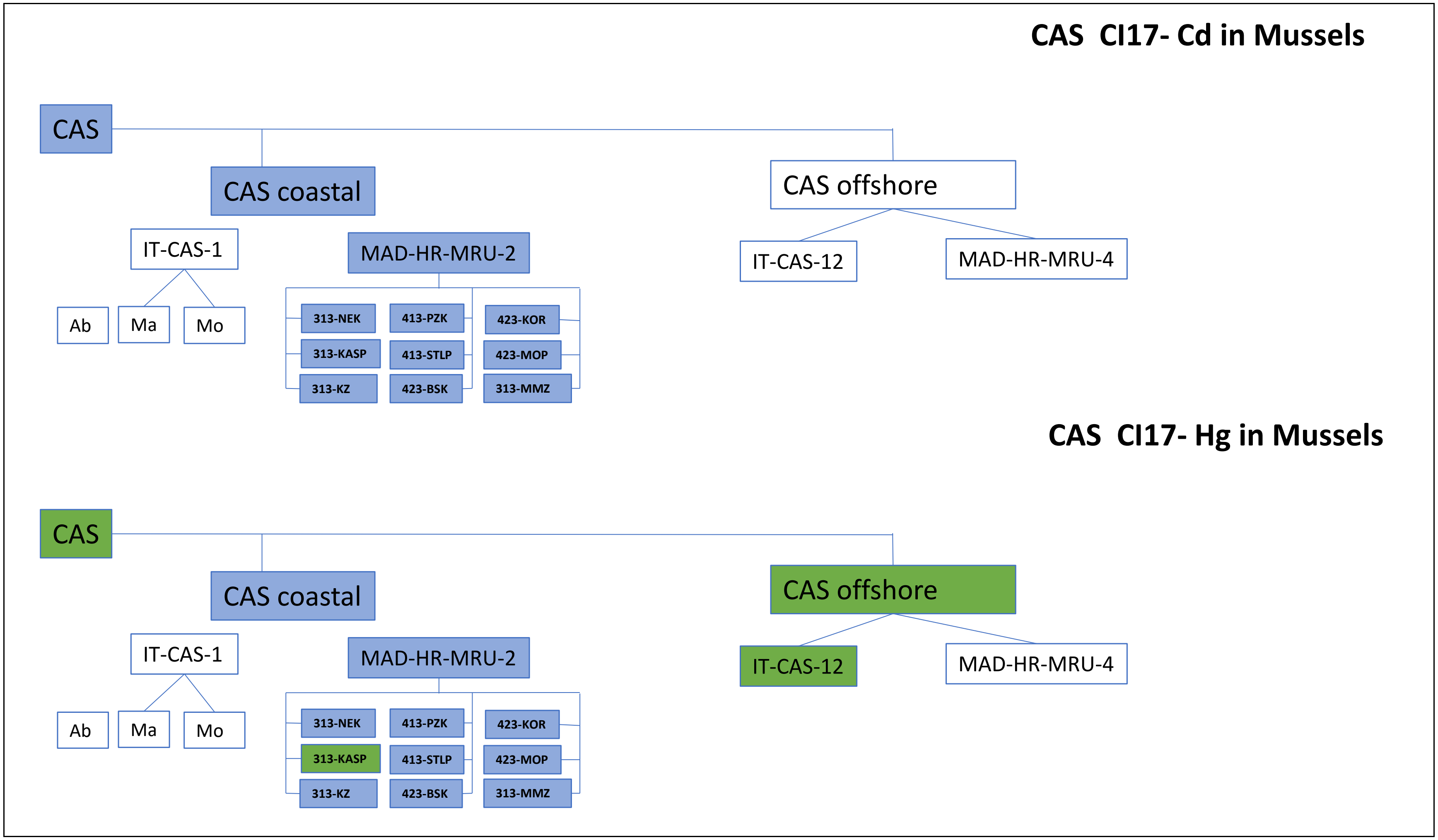
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the Central Adriatic Sea (CAS) sub -division per contaminant in sediments (Σ_{16}PAHs & Σ_7PCBs)

Blank boxes denote absence of data



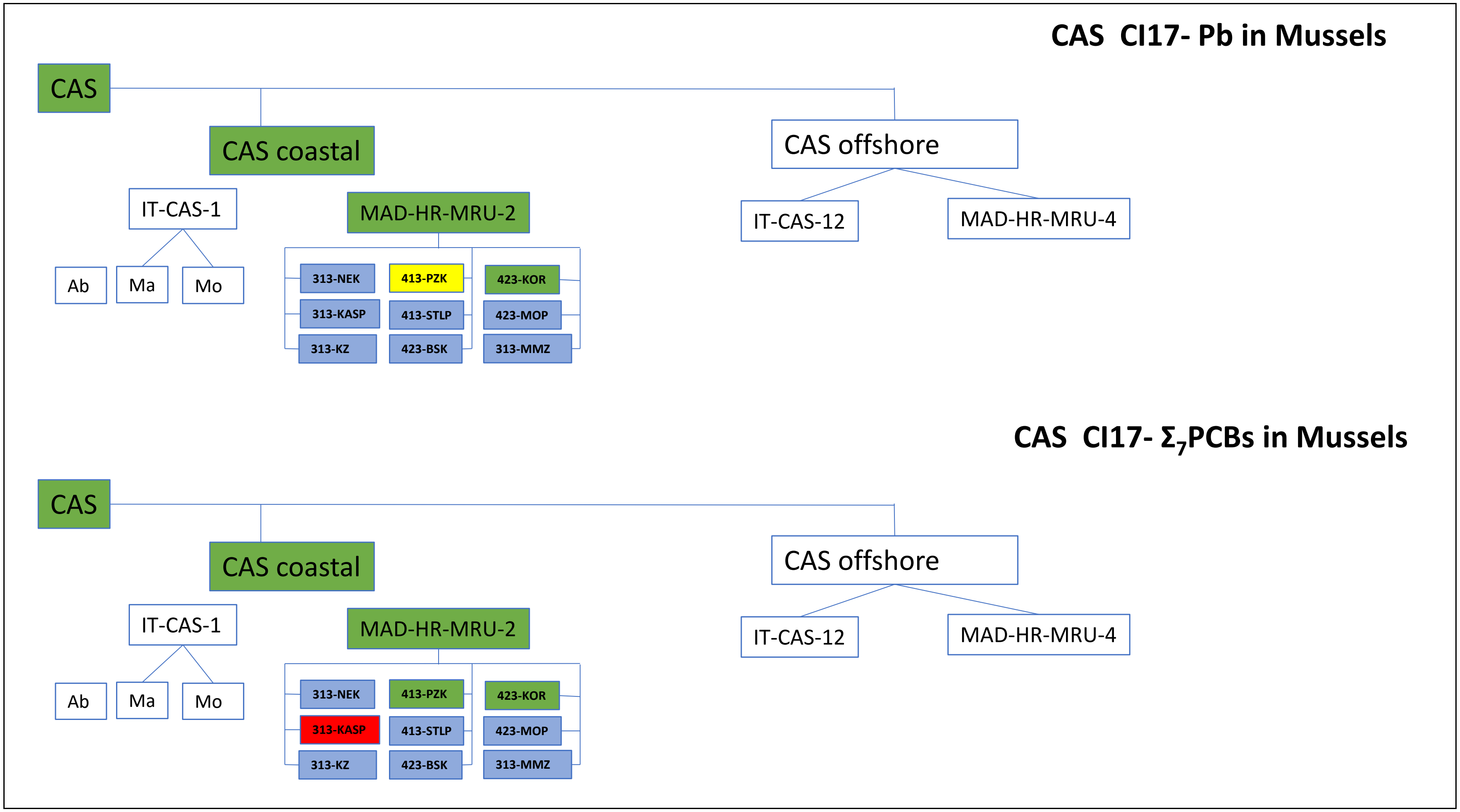
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the Central Adriatic Sea (CAS) sub -division per contaminant in mussels (Cd & Hg)

Blank boxes denote absence of data



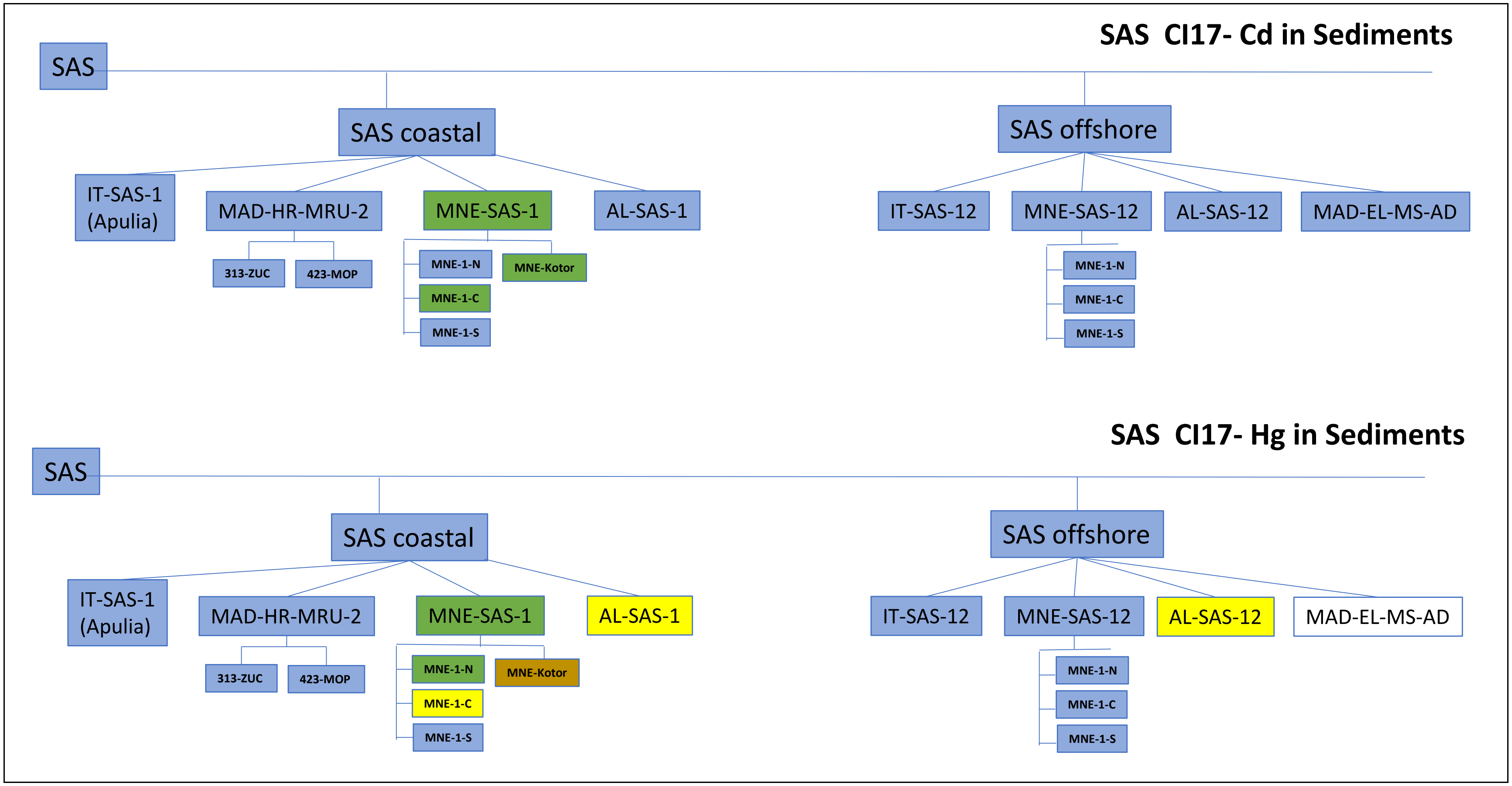
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the Central Adriatic Sea (CAS) sub -division per contaminant in mussels (Pb & Σ_7PCBs)

Blank boxes denote absence of data



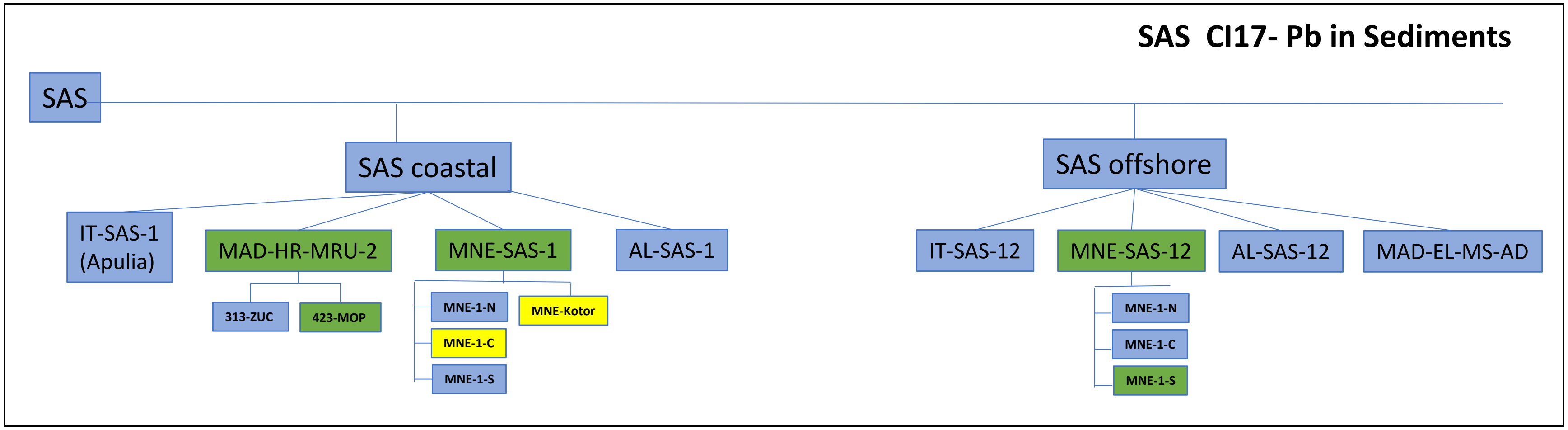
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the South Adriatic Sea (SAS) sub -division per contaminant in sediments (Cd & Hg)

Blank boxes denote absence of data



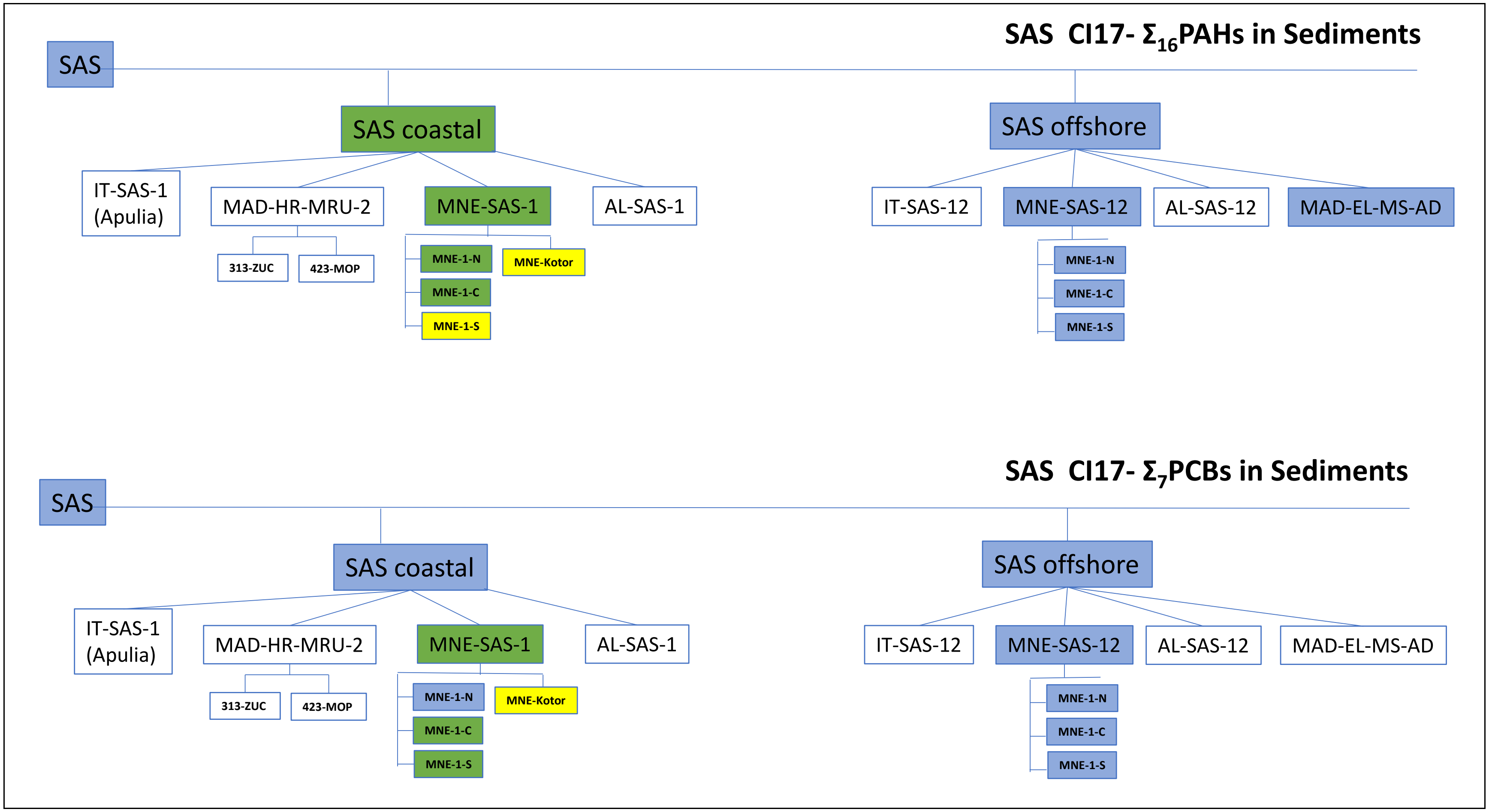
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the South Adriatic Sea (SAS) sub -division per contaminant in sediments (Pb)

Blank boxes denote absence of data



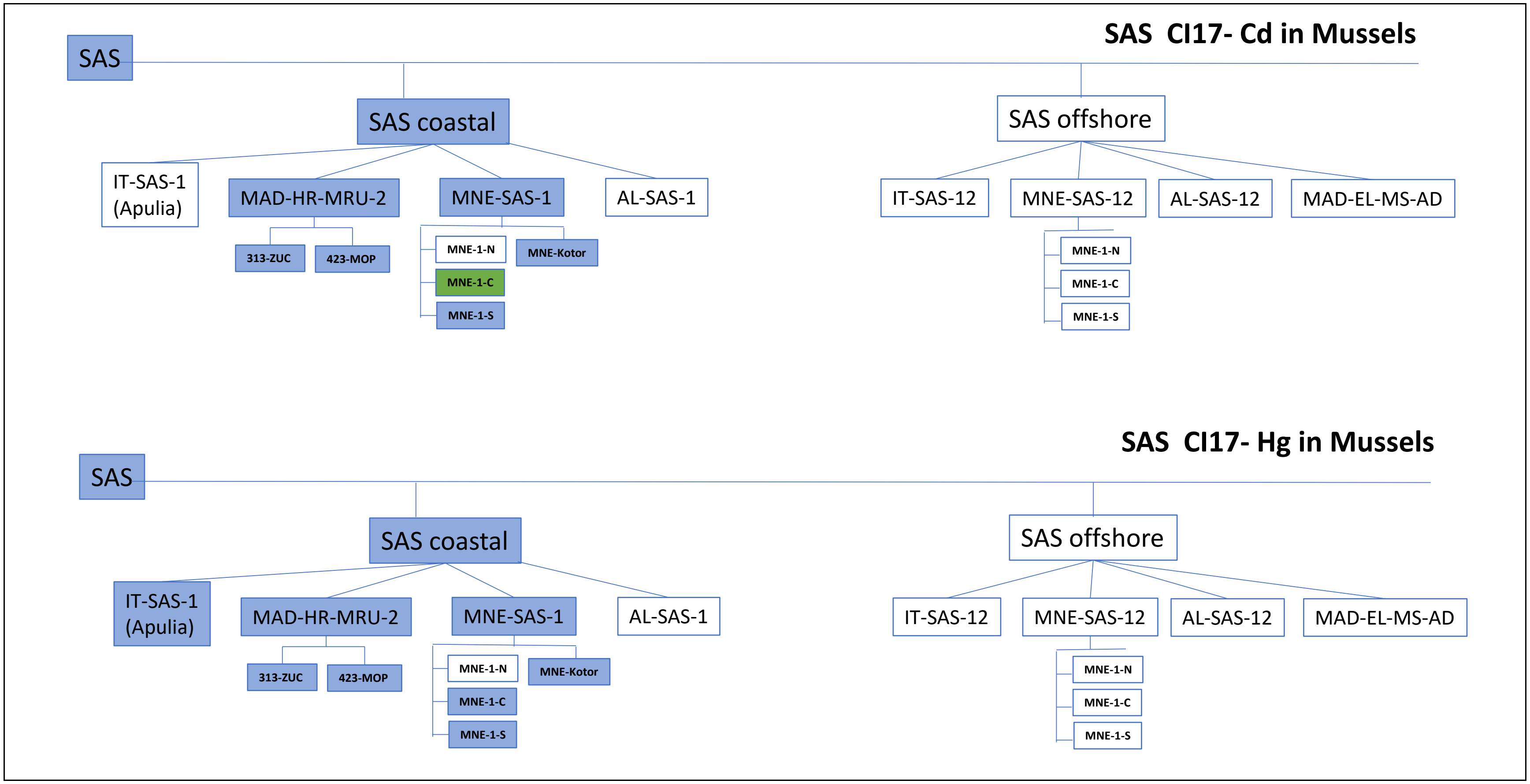
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the South Adriatic Sea (SAS) sub -division per contaminant in sediments (Σ_{16}PAHs & Σ_7PCBs)

Blank boxes denote absence of data



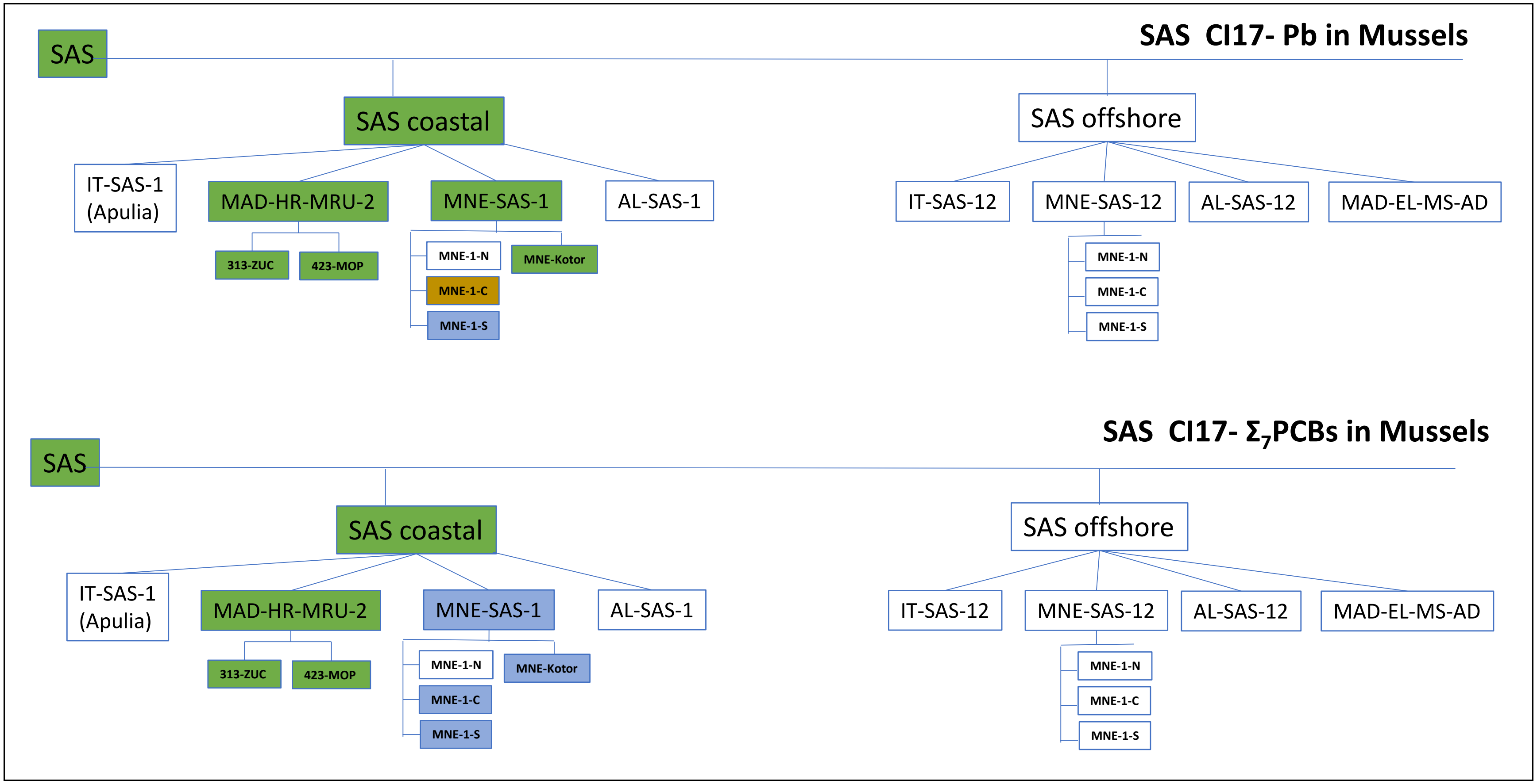
Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the South Adriatic Sea (SAS) sub -division per contaminant in mussels (Cd & Hg)

Blank boxes denote absence of data



Schematic presentation of the assessment results as presented in Table 11 for EO9/CI17 in the South Adriatic Sea (SAS) sub -division per contaminant in mussels (Pb & Σ_7PCBs)

Blank boxes denote absence of data



Annex III

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