The IMAP Environmental Assessment of the Central Mediterranean Sea (CEN) Sub-region

331. Given the lack of quality-assured, homogenous data prevented the application of both EQR and simplified EQR assessment methodologies, the assessment of eutrophication within the preparation of the 2023 MED QSR was undertaken in the sub-divisions of the Aegean-Levantine Sea (AEL), the Ionian Sea and Central Mediterranean Sea (CEN) and the Western Mediterranean Sea (WMS) by evaluating only data for Chla available from the remote sensing sources, whereby the typology-related assessment was impossible to apply.

332. The application of the Simplified G/M comparison assessment methodology for Common Indicator 14 in the CEN relied on the use of COPERNICUS data for Chl a obtained by remote sensing.

Available data.

333. The application of the Simplified G/M comparison assessment methodology for Common Indicator 14 in the CEN relied on the use of COPERNICUS data for Chl a obtained by remote sensing.

334. A detailed data analysis was performed for the Central Mediterranean Sea Sub-region (CEN) in order to decide on the assessment methodologies that can be found optimal at the level of Sub-divisions given the present circumstances related to the lack of data reporting.

335. Table 3.1.3.3.1. informs on data availability in CEN by considering data reported in IMAP IS by 31st October, the cut-off date for data reporting. Figure 3.1.3.3.1.a. shows the locations of sampling stations in the WMS Sub-region.

Table 3.1.3.3.1: Data availability by country and year for the Central Mediterranean Sea Sub-region (CEN) Sub-region showing data reported by the CPs for the assessment of EO5 (CI 13 and CI 14) up to 31st Oct 2022.

Country	Year	Amon	Ntri	Ntra	Phos	Tphs	Slca	Cphl	Temp	Psal	Doxy
Greece	2016-2021	No data provided									
Italy	2016	By 31st October 2022, Italy reported data relevant to the Central Mediterranean Sea Sub-region, in 4 data files with all together 260 208 data points up to 2018-2019 On 16 Dec 2022 data for 2020 were also provided. Without building of a dedicated quality assured database, it is impossible to analyse data availability and ensure their use for the assessment. It should be noted that quantum of data reported guarantees a near monthly sampling frequency on 11 profiles with 4 stations.									
	2017										
	2018										
	2019										
	2020										
	2021										
Libya	2016-2021	No data provided									
Malta	2016	-	-	-	-	-	-	-	-	-	-
	2017	93	93	107	93	93	93	263	263	263	263
	2018	165	165	186	165	165	165	480	481	481	473
	2019	59	59	66	59	59	59	78	77	77	77
	2020	-	-	-	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-	-	-	-
Tunisia	2016-2021	No data provided									

Amon - Ammonium; Ntri- Nitrite; Ntra – Nitrate; Phos – Orthophosphate; Tphs—Total phosphorous; Slca – Orthosilicate; Cphl – Chlorophyll *a*; Temp – Temperature; Psal – Salinity; Doxy – Dissolved Oxygen.

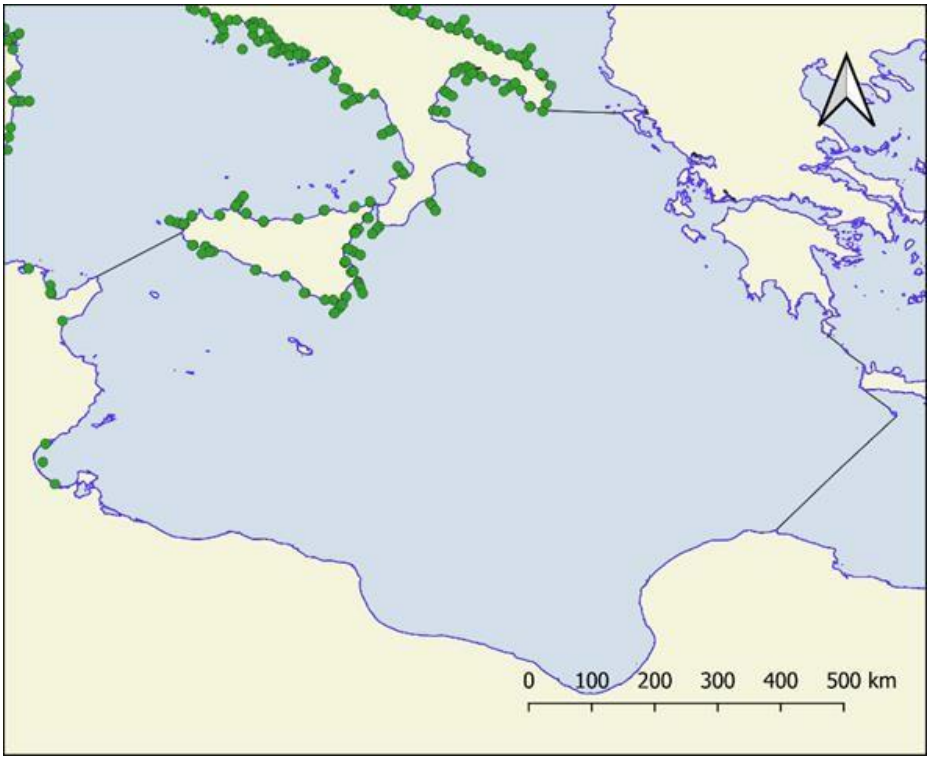

Figure 3.1.3.3.1.a. The locations of sampling stations in the CEN Sub-region.

336. As elaborated above for the AEL, in the CEN there was also the lack of homogenous and quality assured data reported in line with IMAP requirements, as shown in Table 3.1.3.3.1. Therefore, the Copernicus source was found relevant regarding the existence of a systematic repository of remote

sensing data for Chl a, with a good geographical coverage (1 x 1 km) and high sensing frequency (daily).

337. Chlorophyll a data for the CEN were downloaded from the Copernicus site (OCEANCOLOUR_MED_BGC_L4_MY_009_144).

338. The Copernicus product with ID: OCEANCOLOUR_MED_BGC_MY_009_144 was downloaded for the period from Jan 2016 to Dec 2021. It consists of Level 4 monthly values of Chlorophyll a concentration (CHL) with a resolution of 1 x 1 km. The file format is NetCDF-4 (.nc).

339. Data elaboration was performed by using R, an open-source language widely used for statistical analysis and graphical presentation (R Development Core Team, 2023)58. Maps are elaborated using QGIS 3.30, an open-source GIS tool. For the elaboration all relevant R

340. After download from the Copernicus site, as NetCDF file- .nc, data were transferred to R data table using the tidync package. The transfer and data elaboration were very time demanding as the dataset comprise 52 358 577 records.

341. For every point of the grid (Figure 3.1.3.3.1.b), a geometric annual mean (GM) was calculated (Attila et al, 2018)59. The parameter values were expressed in µg/L of Chl *a*, for the *GM* calculated over the year in at least a five-year period as required in the COMMISSION DECISION (EU) 2018/229[60] . These *GM* annual values were later used as a metric for the development of the assessment criteria and present assessment of CI 14.

Setting the areas of assessment.

342. The application of the Simplified G/M comparison assessment methodology for Common Indicator 14 in the CEN relied on the use of COPERNICUS data for Chl a obtained by remote sensing.

343. The two zones of assessment were defined in the CEN for the purpose of the present work: i) the coastal zone and ii) the offshore zone.

344. The GIS layers for the Assessment Areas were provided by France and Spain, as well as from other relevant sources (International Hydrographic Organization – IHO Seas subdivisions, European Environment Information and Observation Network – EIONET (WFD delimitation (2018)); VLIZ marine subregions).

[58] R Development Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. http://www.R-project.org

[59] Attila, J., Kauppila, P., Kallio, K.Y., Alasalmi, H., Keto, V., Bruun, E and Koponen, S. Applicability of Earth Observation chlorophyll-a data in assessment of water status via MERIS — With implications for the use of OLCI sensors. Remote Sensing of Environment 212 (2018) 273–287. https://doi.org/10.1016/j.rse.2018.02.043

[60] Commission Decision (EU) 2018/229 of 12 February 2018 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration.

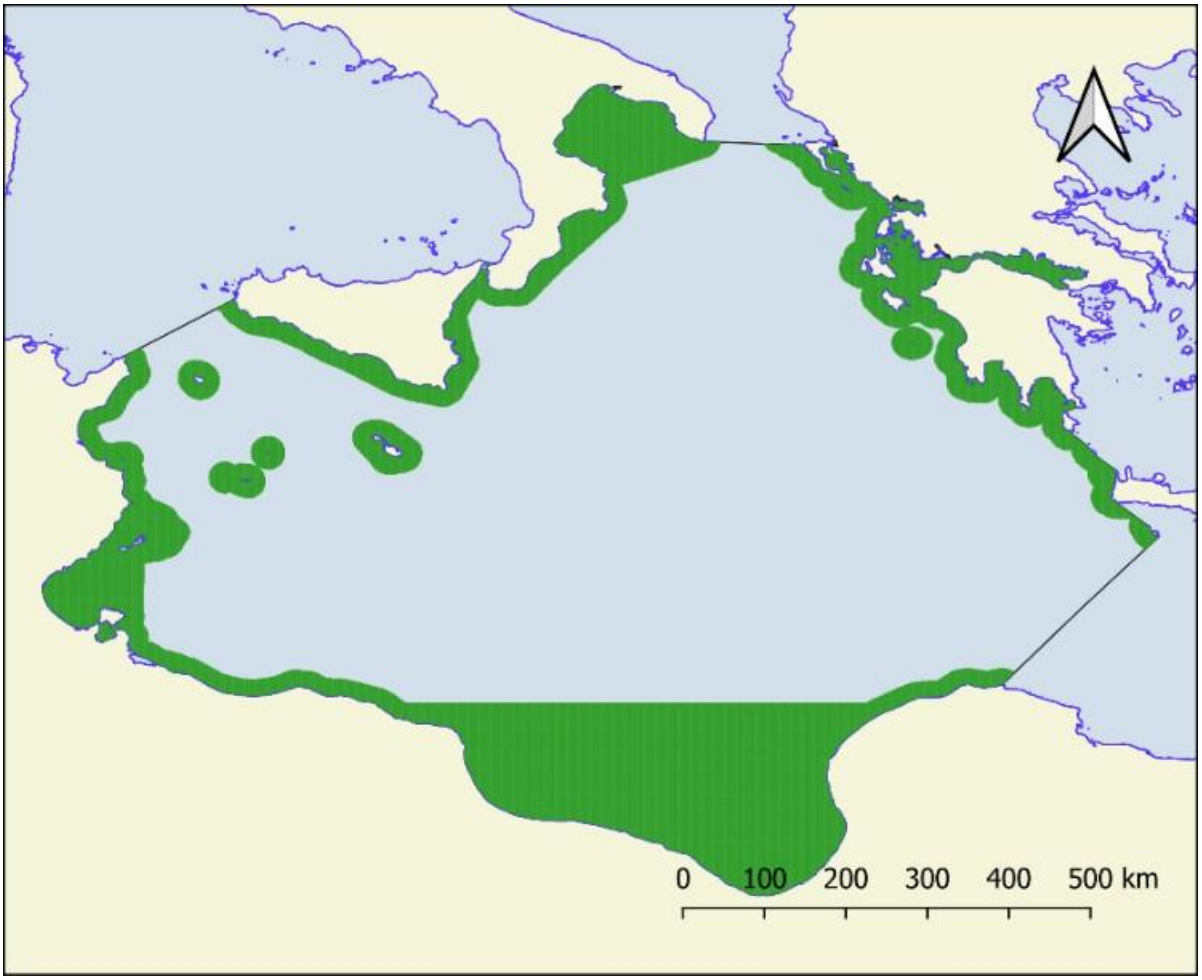

Figure 3.1.3.3.1.b The CEN Sub-region: The dots in the assessment zones represent data in the grid (1 x 1 km).

345. The principle of the NEAT IMAP assessment methodology applied in the Adriatic Sea Sub-region, as well as in the Western Mediterranean Sea Sub-region regarding CI 17, for setting of the spatial assessment units (SAUs) within the two main assessment zones along the IMAP nesting scheme, was also followed for setting of the coastal (CW) and the offshore monitoring zones (OW) in the CEN Sub-region. The CW included internal waters and one Nautical Mile outward. The offshore waters in the CEN start at the outward border of CW and extend to 20 km outward given this coverage corresponds to the area where national monitoring programmes are performed as shown in Figure 3.1.3.3.1.a.

346. Within the two Sub-divisions i.e., the Central Mediterranean Sea and the Ionian Sea, the CW and OW AZs were divided in the four areas: Northern, Western, Eastern and Southern, which delimitations are shown on Figure 3 (upper map). It resulted in eight SAUs (i.e., CW_NCEN – Northern CW; OW_NCEN – Northern OW; CW_WCEN – Western CW; OW_WCEN – Western OW; CW_ECEN – Eastern CW; OW_ECEN – Eastern OW; Southern CW – CW_SCEN and Southern OW – OW_SCEN). The finest IMAP subSAUs were further set on the base of nested assessment areas (AZs, four areas) by considering the national areas of monitoring and hydrographic characteristics.

347. The finest IMAP subSAUs set in the CEN Sub-region for the purpose of the present CI 14 assessment are depicted in Figure 3.1.3.3.2 (lower map) along their nesting in the two main assessment zones i.e., CW and OW of the CEN Sub-region.

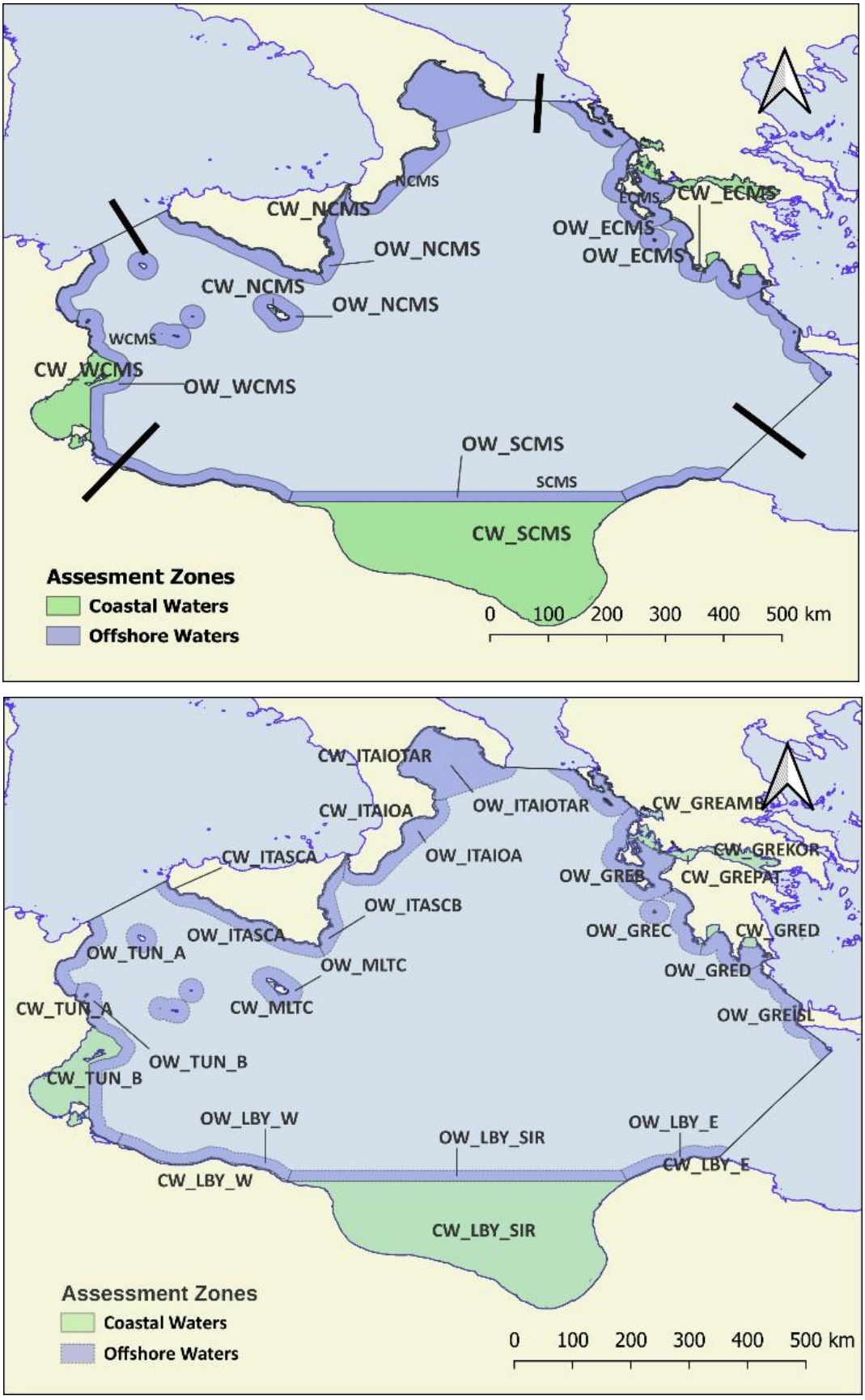

Figure 3.1.3.3.2. The nesting of IMAP SAUs set in the coastal (CW) and the offshore assessment (OW) zones for the CEN (upper map); and depiction of the finest IMAP subSAUs (lower map).

Setting the good/non good boundary value/threshold for the Simplified G/M comparison assessment methodology application in the CEN Sub-region.

348. The same approach for the statistical elaboration of satellite-derived Chla and the methodology for calculation of the assessment criteria were applied in the CEN, as elaborated above for the AEL. In order to calculate the assessment criteria applicable within the present work, the annual GM values were calculated. The results of calculation are presented in Table 3.1.3.3.2 and are obtained by the AZs and SAUs. As for the AEL, the two status classes i.e. good and non-good are assigned to the units assessed in the CEN by applying the simplified G/M assessment methodology since the assessment findings are based on the use of only one parameter and therefore, the integrated consideration of the minimum of parameters needed to assess the good environmental status for IMAP CIs 13 and 14 i.e. the GES was impossible.

Table 3.1.3.3.2: Reference conditions (oN10) and G/M threshold (oN85) set by IMAP Assessment zones (AZ) and Spatial Assessment Units (SAU) in the CEN Sub-region.

AZ	SAU	CHL_N	oN50	oN50+50	oN90	oN10	oN85	oN25
CW	CW_ECEN	17376	0,147	0,221	0,351	0,06	0,264	0,081
CW	CW_NCEN	4618	0,329	0,493	0,957	0,102	0,78	0,182
CW	CW_SCEN	298502	0,038	0,057	0,064	0,034	0,053	0,036
CW	CW_WCEN	41726	1,209	1,813	4,859	0,275	3,844	0,555
OW	OW_ECEN	98360	0,058	0,086	0,08	0,049	0,071	0,053
OW	OW_NCEN	152883	0,091	0,136	0,143	0,061	0,127	0,073
OW	OW_SCEN	80305	0,039	0,059	0,083	0,035	0,072	0,036
OW	OW_WCEN	46725	0,142	0,213	0,789	0,091	0,497	0,103

CHL_N – Number of calculated GM annual values, oN50 – Mean, oN50+50 – Mean + 50%, oN90 – 90th percentile, oN10 – 10th percentile, oN85 – 85th percentile, oN25 – 25th percentile

Results of the Simplified G/M comparison assessment methodology application in the CEN Sub-region

349. The results of CI 14 assessment using the satellite derived Chl a data are presented in Tables 3.1.3.3.3 and 3.1.3.3.4, and Figure CEN 3.1.3.3.3.E. The good status corresponds to the RC conditions, as well as to the values below the 85th percentile of normalized distribution set as G/M i.e., good/non-good boundary limit (i.e., blue coloured cells in the last column of Tables 3.1.3.3.3 and 3.1.3.3.4). The non-good status corresponds to the class above G/M boundary limit (i.e., red coloured cells in the last column of Table 3.1.3.3.4).