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The Results of Marine Environment Assessment for IMAP Common Indicator 19 in the Mediterranean

UNEP/MAP
Athens, 2023

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List of Abbreviations / Acronyms

ADR	Adriatic Sea
AEGS	Aegean Sea
AEL	Aegean Sea and Levantine Sea
AIS	Automatic Identification System
ALBS	Alboran Sea
BAC	Background Assessment Concentration
CAS	Central Adriatic Sea
CHASE	Chemical Status Assessment Tool
CI	Common Indicator
CSN	Clean sea Net Service
DPSIR	Driver-Pressure-Status-Impact-Response
ECAP	Ecosystem Approach
ECEN	Entire Central Mediterranean Sea
EMODNET	European Marine Observation and Data Network
EMSA	European Maritime Safety Agency
EO	Ecological Objective
EWMS	Entire Western Mediterranean Sea
GES	Good Environmental Status
HFO	Heavy Fuel Oil
HNS	Hazardous and Noxious Substances
ICZM	Integrated Coastal Zone Management
IMAP	Integrated Monitoring and Assessment Program
ITOPF	International Tanker Owners Pollution Federation Limited
LEVS	Levantine Sea
MADR	Middle Adriatic Sea
MEDGIS-MAR	Mediterranean Integrated Geographical Information System on Marine Pollution Risk Assessment and Response
NADR	Northern Adriatic Sea
NEAT	Nexus Environment Assessment Tool
NPA	Non-problem area
O&G	Oil and Gas
QSR	Quality Status Report
SADR	Southern Adriatic Sea

1 Methodology and datasets considered for the assessment

1.1 Available databases

1. For the present study, the following databases have been considered:

- MEDGIS-MAR
- Lloyd List Intelligence Seasearcher (hereafter Lloyd)
- CleanSeaNet Service

2. MEDGIS-MAR

3. The Mediterranean Integrated Geographical Information System on Marine Pollution Risk Assessment and Response (MEDGIS-MAR) is a database managed by REMPEC containing national data about response equipment, accidents, oil and gas installations, and oil handling facilities. Data on accidents are collected in MEDGIS-MAR since 1977 and include following parameters of interest for the assessment:

- Country
- Date
- Latitude and longitude
- Type of accident
- Whether the accident caused or not pollution (YES or NO field)
- Pollution size (volume or affected surface) expressed in different measure units
- Spilled substance
- Name and characteristics of the ship involved in the accident.

4. It shall be noted that data are not fully homogeneous. In particular, data about the spilled substance and size are missing for some events classified as polluting events.

5. For this assessment, MEDGIS-MAR data were filtered considering the events causing pollution (“Pollution” = YES) and located into the sea or within a 1 km inland buffer (to include events in any case occurring close to the sea, as for example in port areas).

6. Lloyd List Intelligence Seasearcher

7. This database, privately managed, gathers several data on shipping, including ship incidents, recorded since the 70s. This data can be retrieved for pre-defined geographic areas, including the “Western Mediterranean” and the “Eastern Mediterranean and Black Sea” regions. Downloadable data (paid service) includes following parameters of interest for the assessment:

- Location and date of the incident
- Name and characteristics of the ship involved in the incident
- Type of incident
- Whether the accident caused or not pollution (YES or NO field).

8. The exportable tables do not include information about the spilled substances and volumes. The information on spilled substances is included in the textual report for most of the reported incidents, while the information about volumes is present only in some cases. Finally, it shall be noted that several incidents registered in the Lloyd database are also included in MEDGIS-MAR.

9. For this assessment, Lloyd data were filtered considering the events causing pollution (“Pollution indicator = YES”) and located in the Mediterranean Sea (thus, excluding those in the Black Sea).

10. CleanSeaNet Service

11. CleanSeaNet is a European satellite-based service for oil spills and vessel detections managed by the European Maritime Safety Agency (EMSA). The information retrieved by satellites includes among others: spill location, spill area and length, confidence level of the detection and supporting information on the potential source of the spill (i.e. detection of vessels and oil and gas installations).

12. The full access to CleanSeaNet database is granted to Member States National Competent Authorities, while the open access website provides access to the so-called yearly “Detection and Feedback data”, for the period 2015-2021. These pdf documents have been used for this assessment and include the following parameters of interest for the assessment:

- Classification of the detected event: A = high confidence, B = low confidence
- Latitude and Longitude
- Length of the detection
- Area of the detection

13. The available dataset does not include information enabling to distinguish the spilled substance. For the assessment Class A events (high confidence of detection) were considered.

14. <u>Consideration on the data used for the assessment</u>

15. **It is worth noting that the considered databases are based on two different approaches:** MEDGIS-MAR and Lloyd are populated with incident reports provided by ships or countries. CleanSeaNet includes satellite observations of possible spills. The number of events reported in each database is therefore very different: MEDGIS-MAR and Lloyd register tens of events per year in the Mediterranean while CleanSeaNet registers hundreds of events per year in the sea basin. CleanSeaNet detections can be caused by mineral oil and other pollutants, but may also indicate naturally occurring features (e.g. algae blooms, areas of upwelling, etc.). CleanSeaNet includes observations spills of different sizes (very small ones, too), not only related to incidents but also to accidental or illicit discharges. In addition to that, it should be observed that spills recorded by CleanSeaNet can derive from other offshore activities (e.g. O&G prospections and extractions) or from coastal activities, not linked to maritime transport.

16. The datasets extracted from the three databases provide different and complementary information and were therefore assessed separately.

17. With reference to MEDGIS-MAR and Lloyd, the two databases show some overlaps (this means that some incidents are present in both databases). For recent data, integration between the two datasets has been carried out by REMPEC. Despite this, a number of differences between the two databases still remain and need to be considered by the Contracting Parties and others A full integration of the two datasets remains outside the scope of this study.

18. CleanSeaNet data are considered in the study in order to accomplish for operational pollution events. Such events refer to voluntary or accidental release of oil or other substances. They can result from human decision, error or technical failure. In the Mediterranean any discharge into the sea of oil or oily mixture from the cargo area of an oil tanker is prohibited, according to Annex I of the International Convention for the Prevention of Pollution from Ships (MARPOL). Notwithstanding this, operational pollution and, particularly, illicit discharges, is recognized as a major problem in the region. With the worldwide and regional decrease in the number of big spills caused by important ship accidents, the issue of small but very numerous spills has become an important element to be considered when assessing the state of this indicator in the Mediterranean (REMPEC, 2022).

19. When considering CleanSeaNet dataset, uncertainty related with oil spill detection should be considered. Percentage of correctly detected slicks is known to vary with sensor type, data processing and slick recognition methods, as well as their temporal evolution. Such a percentage is reported to generally rank above 80% (e.g. Carvalho et al., 2021; Shaban et al., 2021; Huang et al., 2022). A fixed correction factor cannot be applied to the entire Mediterranean and to the whole temporal range considered, because this percentage not only depend on above elements but may vary also in relation with several local conditions. Thus, for the purpose of the present study, all reported CleanSeaNet Class A records (observations) have been considered in the assessment. It is recognised that the

adopted methodological approach can lead to an overestimation of the number of oil spills events detected by CleanSeaNet and of their extension. To cope with this possible overestimation, CleanSeaNet data have been used in relative terms (as detailed further below in paragraph 4.3), to identify the areas with the highest spill occurrence and to calculate differences between time periods. In addition to that, in the integrated evaluation of the three datasets and formulation of the final assessment, CleanSeaNet data have been considered with a lower weight than the data reported by MEDGIS-MAR and Lloyd. This approach is considered to be in line with the precautionary principle and with the need to account for small spills and illicit discharges.

1.2 Contents of the report and methodology for the assessment

20. Besides this first chapter about data sets and methodology, this assessment includes five chapters plus a sixth one providing some conclusive considerations.

21. Based on the results of several technical meetings held in the frame of IMAP, chapter 2 summarises and illustrates the most relevant human pressures affecting the status of the indicator CI 19 on acute pollution events. Most relevant pressures are then briefly described based the literature and including a more detailed analysis on vessel density data provided by the EMODnet Human Activity Portal.

22. The following two chapters form the core of the integrated spatial-temporal assessment of the CI 19.

23. Chapter 3 provides the temporal analysis of data on spills events in the Mediterranean. Such analysis is distinguished for oil and other substances. The trend analysis of oil spill events (section 3.1) considered the following parameters:

- Yearly number of oil spills in the Mediterranean and its sub-divisions (as identified in section 1.3) for the period 2002-2021 in the case of MEDGIS-MAR and Lloyds datasets and for the period 2015-2021 for CleanSeaNet (due to unavailability of data before 2015).
- Yearly number of oil spills in the Mediterranean categorised according to ITOPF classes of spilled volume in the period 2002-2021 for MEDGIS-MAR.
- Polluted surface per year in the Mediterranean and its sub-divisions (as identified in section 1.3) for the period 2015-2021, derived by CleanSeaNet data.

24. MEDGIS-MAR is the only dataset among the three which also enabled to assess the temporal evolution of the number of spills events related to substances other than oil: Hazardous and Noxious Substances (HNS), other substances (non-HNS) and Unknown substances (section 3.2).

25. Chapter 4 focuses on the assessment of the status for the indicator CI 19 in the period 2018-2021. The assessment jointly considers the density of spills and the trend of occurrence (considering the variation in comparison with the previous period 2013-2017). The latter element (variation of spill density) is based on a CHASE-like approach and capitalises some elements of the methodology adopted by Helcom for the assessment of oil spill in the Baltic Sea (HELCOM 2018).

26. More details on how the status was assessed are reported in par. 4.3.

27. As for the temporal analysis, the three datasets were assessed slightly differently in chapter 4, considering the different information they provide. For each dataset, the assessment was based on the following steps:

i) Quantification of the average number of oil spills per year in the period 2018-2021 for the entire Mediterranean Sea and its sub-divisions as identified in section 1.3.

ii) The average number of oil spills was standardised on the extension of each sub-division, thus enabling to calculate the average number of spills per 10000 km^2 in the assessment period for the entire Mediterranean and its sub-divisions.

iii) The three sub-divisions characterised by higher values of the indicator calculated in step 2 were highlighted in dark red/red/orange to remark the three highest oil spill occurrences.

iv) Steps 1 and 2 were repeated for the reference period: 2013-2017 for MEDGIS-MAR and Lloyds and 2015-2017 for CleanSeaNet.

v) Percentage of variation (2018-2021 vs. 2013-2017) of average yearly spill occurrence was then calculated for the entire Mediterranean and for each sub-division.

vi) Based on the computed percentage variation, following colour-based classes were defined for variation in percentage: blue = no spills recorded in the sub-division, in the period of assessment (2018-2021) nor in the previous reference period (2013-2017); green = decreased frequency of spill occurrence in the sub-division; yellow = increased frequency of spill occurrence ≤ 100% in the sub-division; red = increased frequency of spill occurrence > 100% in the sub-division.

28. In the case of CleanSeaNet dataset, the same assessment above described was implemented also for the extension of areas interested by pollution due to oil spills, still comparing 2018-2021 with the previous 2015-2017 period.

29. MEDGIS-MAR enabled to implement the same assessment also on the number of spills of substances other than oil: Hazardous and Noxious Substances (HNS), other substances (non-HNS) and Unknown substances (section 4.2).

30. Chapter 5 provides a brief summary of evidences of environmental impacts from oil spills documented for the Mediterranean.

31. Chapter 6 includes some conclusive considerations.

1.3 Areas of analysis

32. In the Mediterranean Sea region, four main sub-regions and related sub-divisions have been established for assessment purposes (Figure 1 and) namely: the Western Mediterranean Sea (including the Alboran Sea characterized by the exchange of the Mediterranean waters with the Atlantic Ocean), the Adriatic Sea (which is a double semi-enclosed area by itself and the Mediterranean Sea), the Central Mediterranean (acting as the nexus for the eco-regions and located in the centre of the basin with a low anthropogenic influence), and the Aegean and Levantine Sea in the Eastern Mediterranean part.

Figure 1. Map of the sub-divisions considered for the purposes of the present assessment.

Table 1. The Mediterranean sub-regions and sub-divisions considered for the purposes of the present assessment and related extension

Sub-regions	**Sub-divisions**	**Surface (km^2)**
(Entire) Western Mediterranean Sea (EWMS)	Alboran Sea (ALBS)	56,130
	North Western Mediterranean Sea and Western Mediterranean Islands and Archipelago (WMS)	572,548
	Tyrrhenian Sea (TYRS)	216,810
(Entire) Central Mediterranean (ECEN)	Central Mediterranean (CEN)	550,205
	Ionian Sea (IONS)	168,842
Adriatic Sea (ADR)	North Adriatic (NADR)	33,445
	Middle Adriatic (MADR)	44,107
	South Adriatic (SADR)	61,739
Aegean and Levantine Seas (AEL)	Aegean Sea (AEGS)	202,388
	Levantine (LEVS)	619,105

2 DPSIR elements most relevant for the CI 19

33. The interactions between pressures and impacts for EO5 and EO9, as measured by IMAP Common Indicators, is shown here below in Table 2. The interrelations reported in the Table were agreed during the Meetings of CorMon Pollution Monitoring (April 2019); Meeting of MED POL Focal Points (May 2019), 7th Meeting of the Ecosystem Approach Coordination Group (September 2019) and Integrated Meetings of the Ecosystem Approach Correspondence Groups on IMAP Implementation (CORMONs) (December 2020). The interrelations served as a basis for proposing the GES/Environmental Assessment methodologies for IMAP CIs, as well as the approaches aimed at interrelating the DPSIR and GES assessment findings.

Table 2. Natural and anthropogenic pressures (selected based on the main activities in terms of pressures as provided by ICZM Protocol and other Barcelona Convention`s Protocols) affecting the marine ecosystems and the related measurement of IMAP Common Indicators for EO5 and EO9. Following the analysis presented in this table that is based on the expert judgement, the members of the EcAp Coordination Group can better define/refine specific interactions, for activities contributing to pressures at Common Indicator level.

Pressures vs. measured IMAP Common Indicators (EO5 and EO9)	**Non-Construction Zone**	**Natural Hazards**	**Natural disasters**	**Climate Change**	**Agric. and forestry runoffs**	**Coastal Urbanization**	**Damming (demand on**	**Waste water discharges**	**Industry**	**Tourism frequentation**	**Yachting**	**Marine mining**	**Dredging**	**Desalinization**	**Coastal artificialization.**	**Port operations**	**Offshore structures**	**Cables and pipelines**	**Shipping**	**Oil and gas extraction**	**Renewable energy**	**Fishing (incl. recreational)**	**Sea-based food harvesting**	**Extraction of genetic**	**Aquaculture**	**Solid waste disposal**	**Storage of gases**	**Research and education**	**Defence operations**	**Damping of munitions**
C13. Nutrients																														
C14. Chlorophyll *a*																														
CI17: Key harmful contaminants																														
CI18: Pollution effects																														
CI19: Acute pollution events																														
C20: Contaminants in seafood																														
CI21: Intestinal enterococci																														

34. Some main anthropogenic pressures relevant for CI 19 are briefly described here below.

35. Maritime traffic

36. Due to its strategic position at the interface between Africa, Asia and Europe, and connected with three strategic maritime passages, the Strait of Gibraltar, the Suez Canal and the Strait of Bosporus, the Mediterranean Sea is a key area for maritime transport at world level.

37. Mediterranean port calls in 2019 due to passenger and merchant vessels were about 453,000, made by 14,403 ships (REMPEC, 2020). These, together with ships transiting through the basin without making a port call (5,251 in 2019), represented a little more than 24% of the global fleet of ships. Passenger vessels, mostly ferries, accounted for 42.8% of the total port calls. Container carriers accounted for the 18% of the total port calls in the Mediterranean, while other dry and ro-ro vessels for the 16.9%, tankers for the 16.8% and bulk carriers for the 5.6% (REMPEC, 2021).

38. Considering only the oil and chemical tankers calling to ports or passing through the Mediterranean, they represented in 2019 27% of the world fleet (REMPEC 2020). Passengers transport is another important activity in the Mediterranean, related to shipping between different countries and also within the same country. This is also linked to the need to connect the numerous Mediterranean islands with the mainland (Randone et al., 2019). Cruise traffic also contributes to passenger transport: the Mediterranean is the second largest market globally for cruising, after the Caribbean. The sector has been extremely impacted by the Covid-19 pandemic: the total number of cruise ship calls in 2021 reached 5,182 but still represents only 38.1% of the pre-pandemic period (2019) (Med Cruise 2021).

39. The maps below illustrate the distribution of vessel density in the Mediterranean Sea expressed as yearly average of total monthly hours of vessels presence per square kilometre in the year 2021. These data are provided by European Marine Observation and Data Network (EMODnet) Human Activities portal and are derived from AIS data. The first maps reported below, refer to the three most relevant categories of vessels in terms of pressures for CI 19, respectively: tankers (Figure 2), cargo (Figure 3) and passengers (Figure 4).

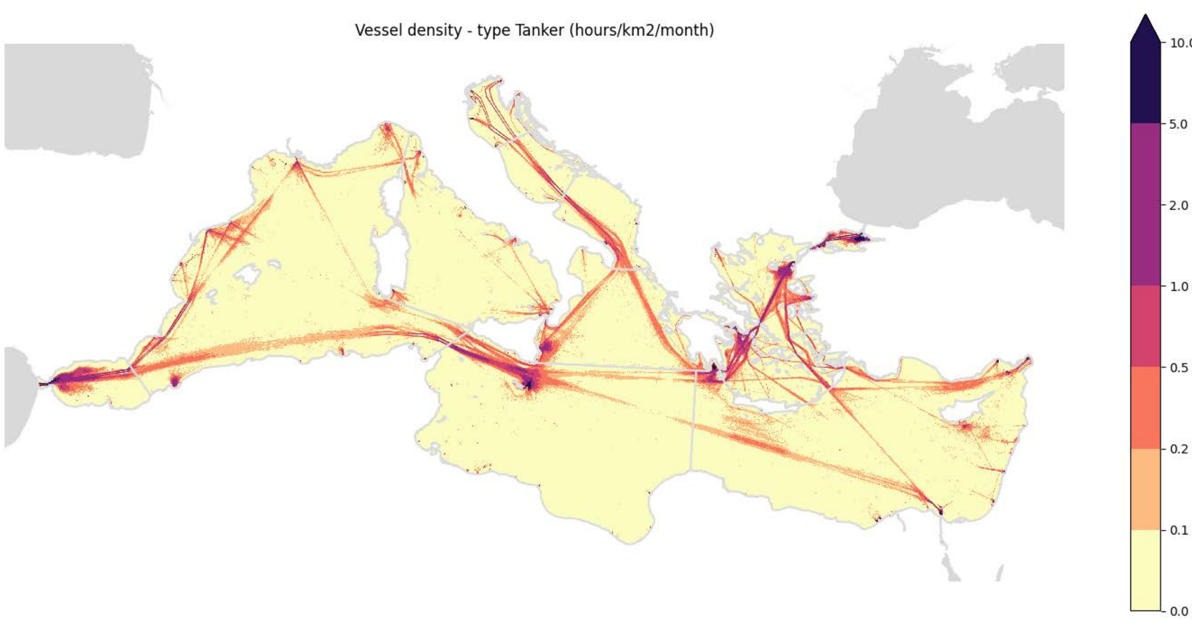

Figure 2. Vessel density of tankers in 2021 expressed as yearly average of total monthly hours per square kilometre. Data source: EMODnet Human Activities portal.

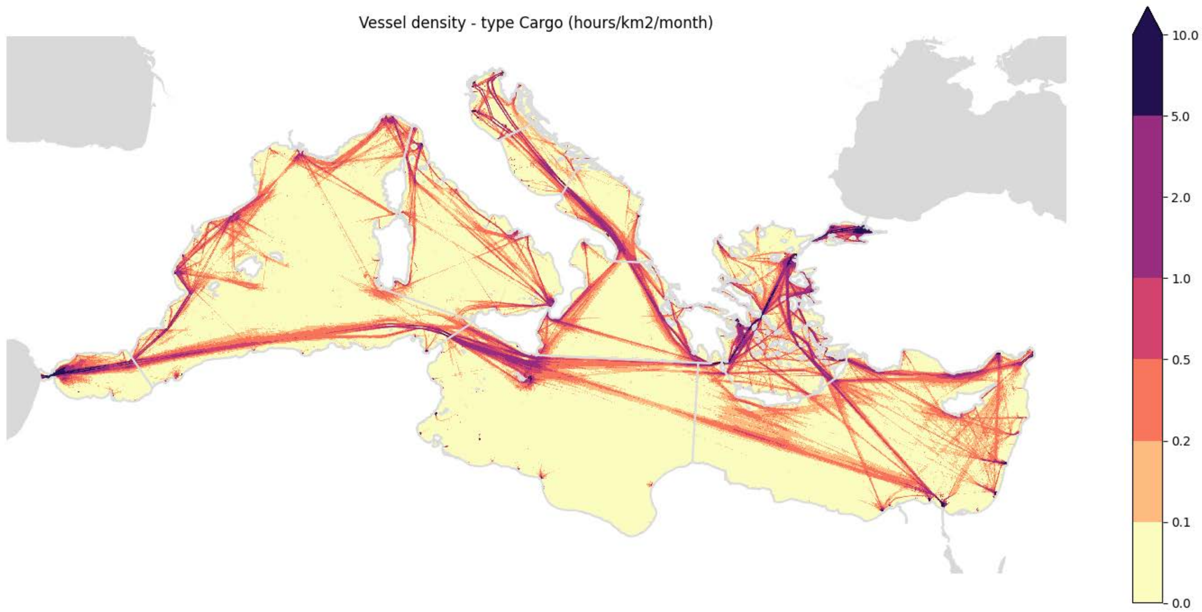

Figure 3. Vessel density of cargos in 2021 expressed as expressed as yearly average of total monthly hours per square kilometre. Data source: EMODnet Human Activities portal.

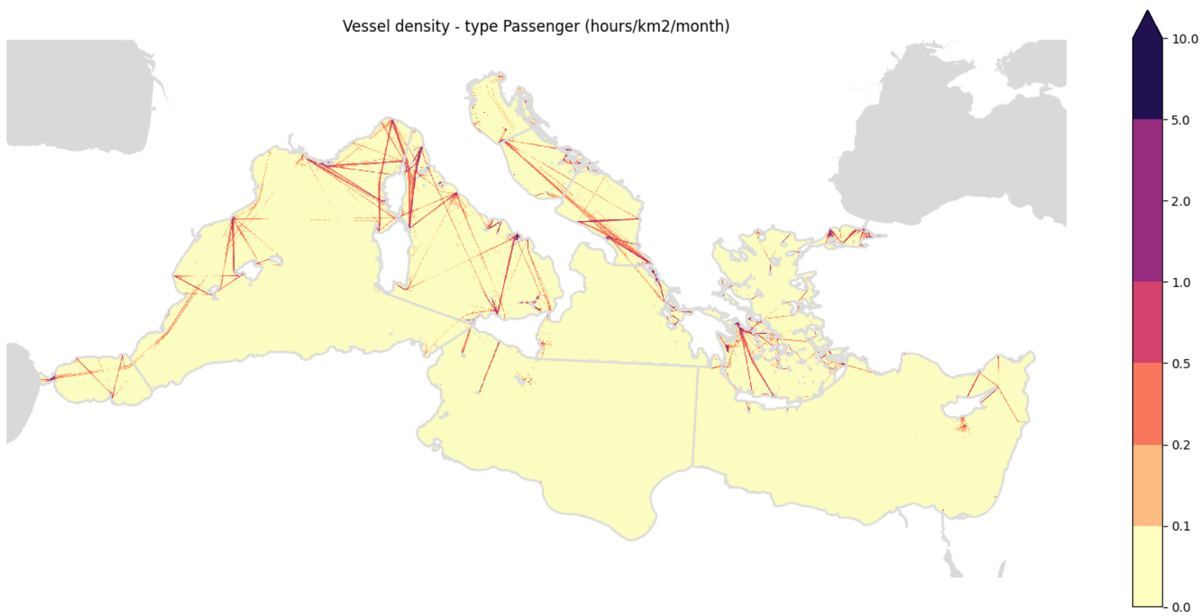

Figure 4. Vessel density of passenger vessels in 2021 expressed as yearly average of total monthly hours per square kilometre. Data source: EMODnet Human Activities portal.

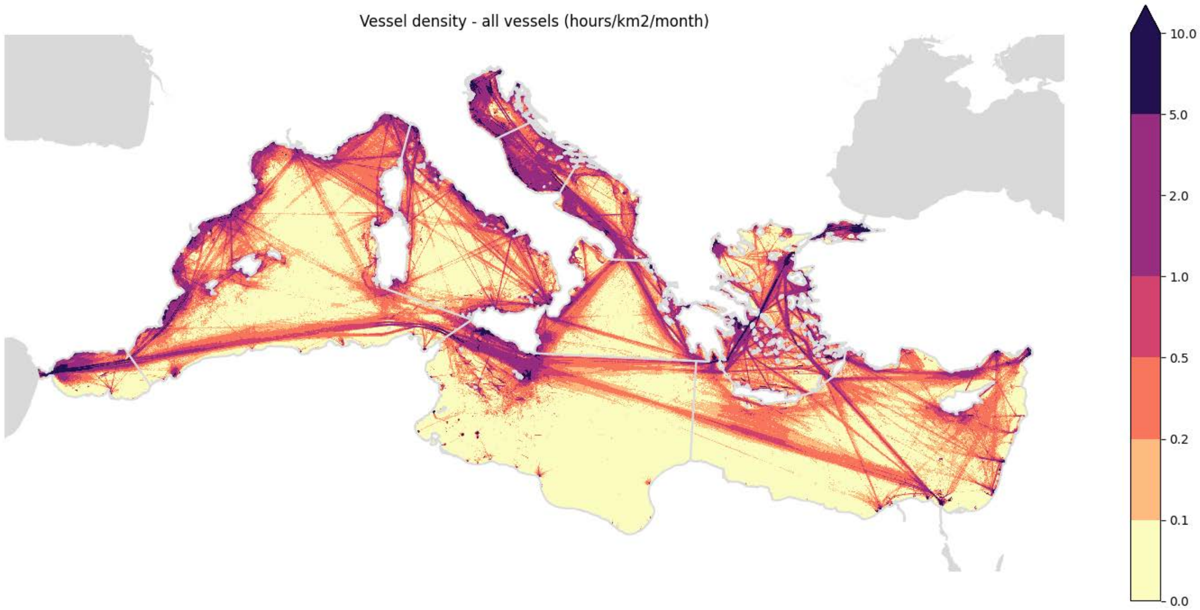

Figure 5. Vessel density of all the typologies of vessels transiting in the Mediterranean (tankers, cargos, passenger vessels and all other typologies) expressed as yearly average of total monthly hours per square kilometre. Data source: EMODnet Human Activities portal.

40. The data represented in the maps above are presented in and Figure 6 (here the traffic data are standardised for the extension of each sub-division) in order to highlight the most trafficked areas of the Mediterranean basin. The Aegean Sea is the area most affected by maritime traffic: all other typology of vessels represents the 42% of the total traffic, followed by cargos (30%), tankers (16%) and passenger vessels (12%). The second more trafficked area is the Alboran sea, being the passage from and to the Atlantic Ocean. In this sub-division the percentage of traffic related to all other typologies of vessel is 43%, the one related to cargos is 31%, takers reach 23% while passenger vessel represents a minor component (only the 3%). The Northern Adriatic Sea ranks third as most trafficked area, with other typologies of vessel reaching 63% (importance of fishing vessels), cargos being the second most important component (21%), followed by tankers (9%) and passengers (7%). The maps also show that high vessel density occur in areas close the coasts of Northern and Eastern Mediterranean counties, and in particular in front of major ports.

Table 3. Yearly average of total monthly hours spent in each sub-division of the Mediterranean Sea by typology of vessel (main categories) in 2021. Data source: EMODnet Human Activities portal.

	ALBS	**TYRS**	**AEGS**	**SADR**	**CEN**	**NADR**	**MADR**	**IONS**	**WMS**	**LEVS**
Cargo	223,717	1,082,688	325,482	231,226	184,567	155,316	170,131	126,170	1,218,813	501,469
Tanker	69,078	131,899	40,971	73,108	43,084	31,935	15,218	27,513	366,864	218,256
Passenger	52,160	68,813	25,481	53,773	27,440	14,443	4,501	9,266	192,098	65,946
Other types of vessel, including fishing ones	6,691	42,729	47,050	4,754	24,278	10,537	18,025	12,387	145,663	20,550

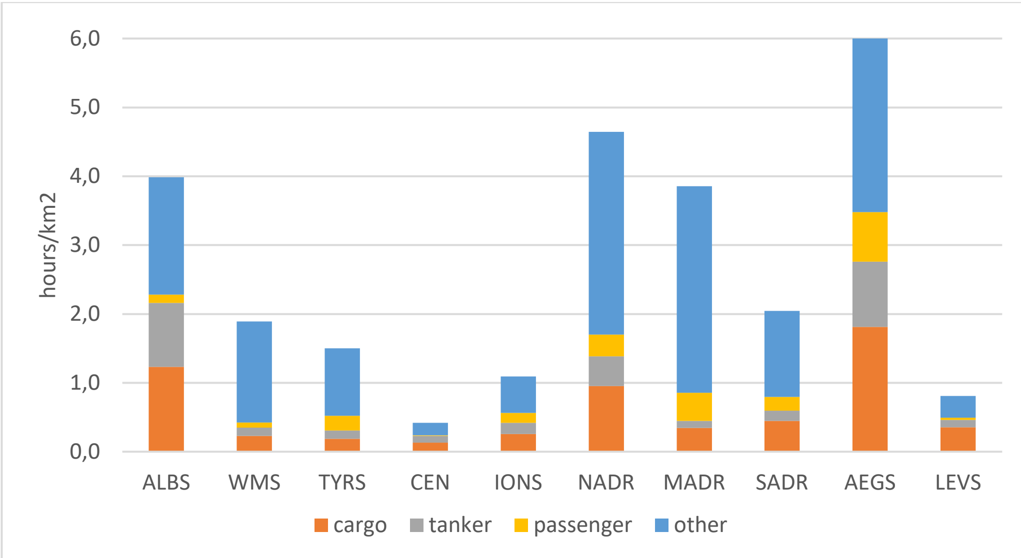

Figure 6. Yearly average of monthly vessel density per sub-division (total hours spent in a month/km²) per typology of vessel in 2021. Data source: EMODnet Human Activities portal.

Port operations

41. The Mediterranean includes 706 ports: 497 in Southern Europe, 96 in North Africa and 113 in the Eastern Mediterranean (REMPEC, 2021). A great number of ports are located in Italy (191) and in Greece (153). Some of these ports rank among the 100 most important ones according to various criteria.

42. The ports of the Mediterranean host different core activities. Ports like the Spanish ports of Valencia and Algeciras, the Tanger-Med in Morocco, Malta's Marsaxlokk along with the Egyptian ports like Damietta, Port Said and Alexandria are transhipment hubs not only for freight moving throughout the greater Mediterranean region but act as a connector to ports as distant as the Americas or the Far East. Other ports like Genoa or Marseille serve their own industrial regions and connect to Northern European markets (Lauriat, 2019).

#	Port	Country	2018 TEUs	2017 TEUs	#	Port (cont.)	Country	2018 TEUs	2017 TEUs
1 .	Valencia	Spain	5,104,000	4,832,136	11.	Port Said	Egypt	2,610,000	2,528,000
2.	Algeciras	Spain	4,772,000	4,380,849	12.	Alexandria	Egypt	1,757,000	1,589,000
3.	Marport	Turkey	1,591,983	1,711,357	13.	Haifa	Israel	1,464,000	1,343,000
4.	Piraeus	Greece	4,908,000	4,060,000	14.	Ashdod	Israel	N/A	1,525,000
5.	Gioa Tauro	Italy	2,301,000	2,448,570	15.	Beirut	Lebanon	1,300,000	1,305,038
6.	Marsaxlokk	Malta	3,310,000	3,150,000	16.	Marseille-Fos	France	1,400,000	1,362,204
7.	Genoa (Savona-Vado)	Italy	2,609,000	2,622,187	17.	Izmir-Alsancak	Turkey	610,908	610,908
8.	Barcelona	Spain	3,423,000	3,006,872	18.	Tanger-Med	Morocco	3,472,451	3,312,409
9.	Mersin	Turkey	1,723,000	1,591,983	19.	Damietta	Egypt	1,150,132	1,131,226
10.	La Spezia	Italy	1,543,000	1,473,571	20.	Koper	Slovenia	988,501	911,528

Figure 7 Mediterranean ports and volume handled in 2010. Source: Lauriat, 2019.

<u>Oil and Gas extraction</u>

43. The Mediterranean Sea is a relatively small producer of offshore oil and gas at world level. Today, the principal countries extracting offshore oil are Egypt and Libya. Indeed, in the case of Egypt the great majority of offshore oil fields and the biggest ones are located in the Gulf of Suez in the Red Sea, with marginal activity in the Mediterranean. Other countries such as Italy and Tunisia (and to a minor extent Greece and Spain) contribute with a more marginal production (REMPEC, 2021). Egypt is also the main offshore gas producer in the Mediterranean, historically followed by Italy. In recent years the Italian production of offshore natural gas significantly decreased, while the production of Israel has greatly increased, in particular thanks to the discovery of and production in the rich Leviathan gas field. Libya, Croatia and Tunisia contribute marginally to the offshore production of natural gas in the Mediterranean basin. However, in the next years other Eastern Mediterranean countries (e.g. Turkey and Cyprus) are expected to play a significant role as producers in the Mediterranean offshore gas market, also due to new gas fields recently discovered (REMPEC, 2021).

44. According to REMPEC (2021), four major areas of oil and gas production can be identified in the Mediterranean basin: (i) the Levantine Sea where Egyptian and Israeli offshore production occur (mainly gas) and where other countries are expected to increase their activities, (ii) the Channel of Sicily (Italian and Tunisian activities), (iii) the Gulf of Gabes (Tunisia) and the neighbouring Libyan marine area, and (iv) the northern Adriatic, where most of the Italian offshore gas activities are concentrated and where Croatian gas production is located.

3 Spills in the Mediterranean: a temporal analysis

45. In this chapter the temporal evolution of spill events in the Mediterranean is illustrated. The period of analysis varies in relation to the availability of data in the considered data set: 2002-2021 for MEDGIS-MAR and Lloyd and 2015-2021 for CleanSeaNet. As highlighted in chapter 1, the number of spills reported in the considered database is very different: MEDGIS-MAR and Lloyd accounts for tens of spills per year in the overall Mediterranean, due to incidents, while CleanSeaNet, being based on satellite data

acquisition, records hundreds of potential spills per year. The data from such heterogenous database should not be compared, but used as complementary information, as proposed in this assessment.

3.1 Analysis on oil

46. The temporal evolution of oil spills events reported in the MEDGIS-MAR (considering only those events for which the spilled substance is identified as volatile or non-volatile oil in the dataset) is illustrated in Table 4 and Figure 8 for the period 2002-2021. In particular, Figure 8 illustrates the evolution of the yearly number of events occurred in the entire Mediterranean in the period 2002-2021, classified according to the ITOPF categorisation of spilled volumes.

47. A more detailed analysis about the size (volume or affected extension) of oil spills was not possible, as the MEDGIS-MAR dataset includes heterogenous data for this parameter (characterised by diverse units of measure), as well as missing information for several polluting events. Large spills above 700t have not been recorded since 2015 and medium size spills (7-700t) that represented the most frequent class until 2017 (e.g. 68% in 2012, 50% in 2013 and 44% in 2017) have not been recorded in the last four years. The overall number of spills has significantly decreased in the last four years, but the number of small spills (<7t) have increased. The spatial distribution of oil spills events registered by MEDGIS-MAR in the period 2002-2021 is reported in Figure 9, highlighting the Aegean Sea – and to a minor extent the Ionian Sea – as the mostly affected sub-divisions.

Table 4. Number of oil spills events (volatile and non-volatile oil) per year in the Mediterranean and related sub-divisions in the period 2002-2021 reported by MEDGIS-MAR.

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0
2007	2	0	0	0	0	0	0	1	0	0	1
2008	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0
2012	16	0	0	1	0	0	0	0	3	12	0
2013	22	0	2	0	2	0	0	0	1	15	2
2014	9	0	0	0	1	0	0	0	2	6	0
2015	14	0	1	0	0	0	0	0	1	10	2
2016	19	0	1	0	0	0	0	0	1	16	1
2017	32	0	0	0	0	0	0	0	1	29	2
2018	7	0	0	0	0	0	0	0	1	6	0
2019	8	0	0	0	0	0	0	0	1	7	0
2020	14	0	0	0	0	0	0	0	4	10	0
2021	4	0	0	0	0	0	0	0	0	4	0

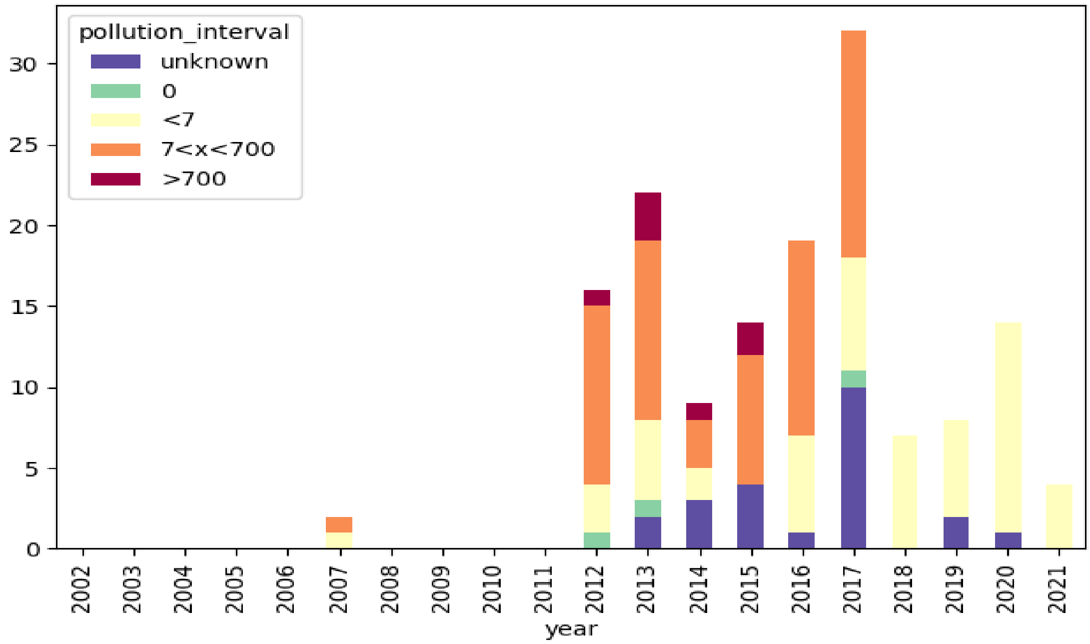

Figure 8. Number of oil spills events (volatile and non-volatile oil) per year in the period 2002-2021 in the Mediterranean. Events are categorised according to ITOPF classes of spilled volumes (values in legend = tonnes). Data source: MEDGIS-MAR,

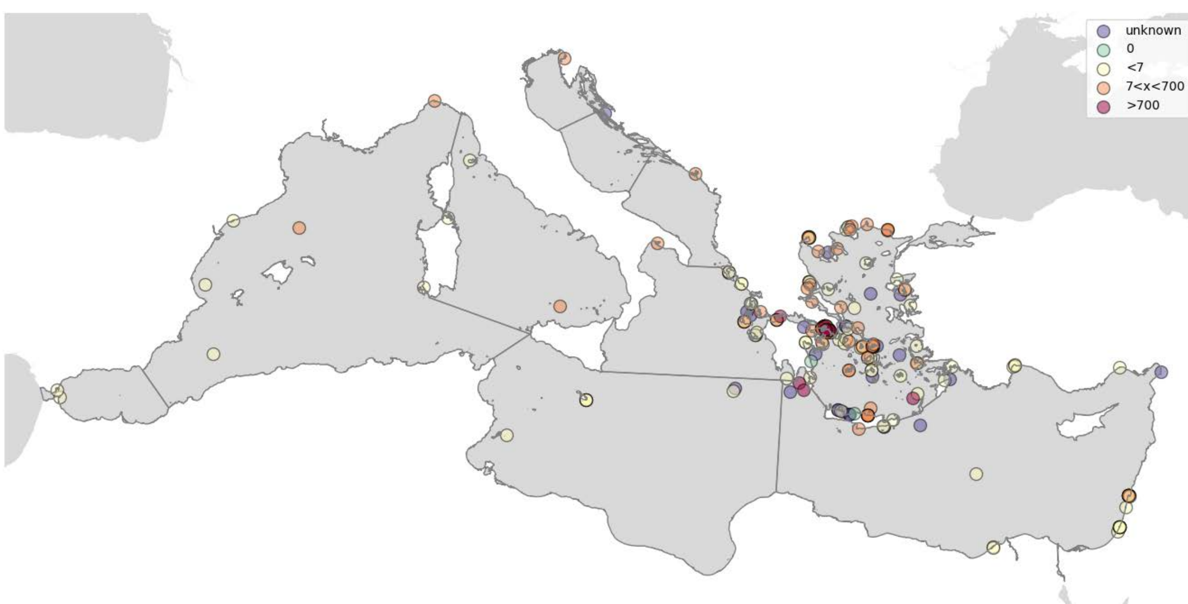

Figure 9. Spatial distribution of oil spills events (volatile and non-volatile oil) in the Mediterranean in the period 2002-2021 per ITOPF class of spilled volume (values in legend = tonnes). Data source: MEDGIS-MAR

48. A similar analysis was conducted for the data included in the Lloyds database still for the period 2002-2021. This database does not provide detailed information on the spilled substance and the category of spilled volume. Therefore, in this case, differently from MEDGIS-MAR, all registered incidents

causing polluting events have been considered for the temporal analysis. The annual number of events for each sub-division is reported in Table 5, while the for the entire Mediterranean is also visualised in the graphic of Figure 10; Figure 11 illustrate their spatial distribution. In this case, the temporal evolution of the number of spills does not highlight a clear trend, rather an heterogenous behaviour with peaks in 2006, 2009 and 2016. The comparison of the average number of annual events in the last four years (2018-2021) with those in the previous four years shows a modest decrease.

Table 5. Number of spill events per year in the Mediterranean and its sub-divisions in the period 2002-2021 reported by Lloyd List Intelligence Seasearcher.

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2002	6	3	0	0	0	0	0	0	0	3	0
2003	6	1	0	0	0	0	1	0	0	3	1
2004	12	0	3	0	0	0	0	0	0	6	3
2005	7	1	0	2	0	0	0	0	1	2	1
2006	5	0	0	0	0	0	0	0	1	3	1
2007	6	2	2	0	0	0	0	0	1	1	0
2008	23	3	1	0	1	0	0	0	0	14	4
2009	23	2	1	0	0	0	0	1	2	16	1
2010	9	0	2	1	0	0	1	0	0	4	1
2011	12	4	3	0	0	0	0	0	1	3	1
2012	6	1	0	0	0	0	0	0	3	2	0
2013	9	1	1	0	0	0	0	0	1	2	4
2014	11	1	1	0	0	0	0	0	1	6	2
2015	9	0	2	0	2	0	0	0	0	5	0
2016	25	1	4	1	0	0	0	1	0	13	5
2017	4	0	0	0	1	0	0	0	0	2	1
2018	14	0	5	0	0	0	0	0	0	7	2
2019	8	1	0	0	0	1	0	0	0	5	1
2020	15	2	2	0	0	0	0	0	0	10	1
2021	15	1	2	1	0	0	0	0	0	8	3

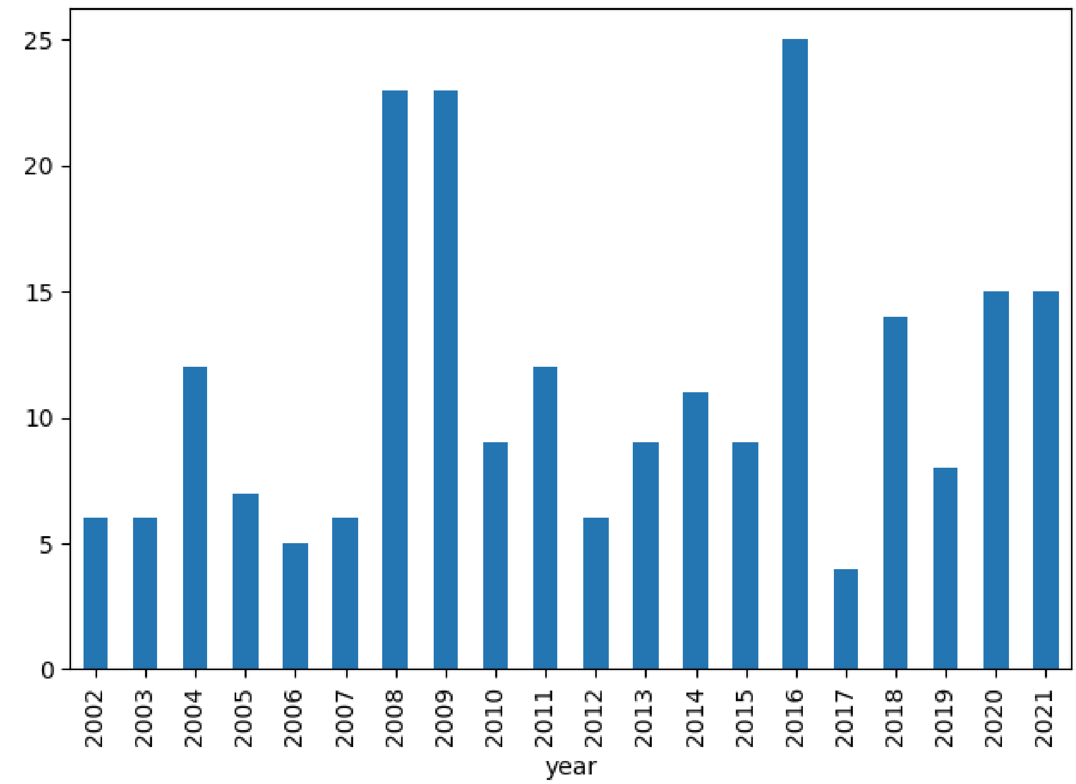

Figure 10. Number of spills events per year in the period 2002-2021 in the Mediterranean reported by Lloyd List Intelligence Seasearcher.

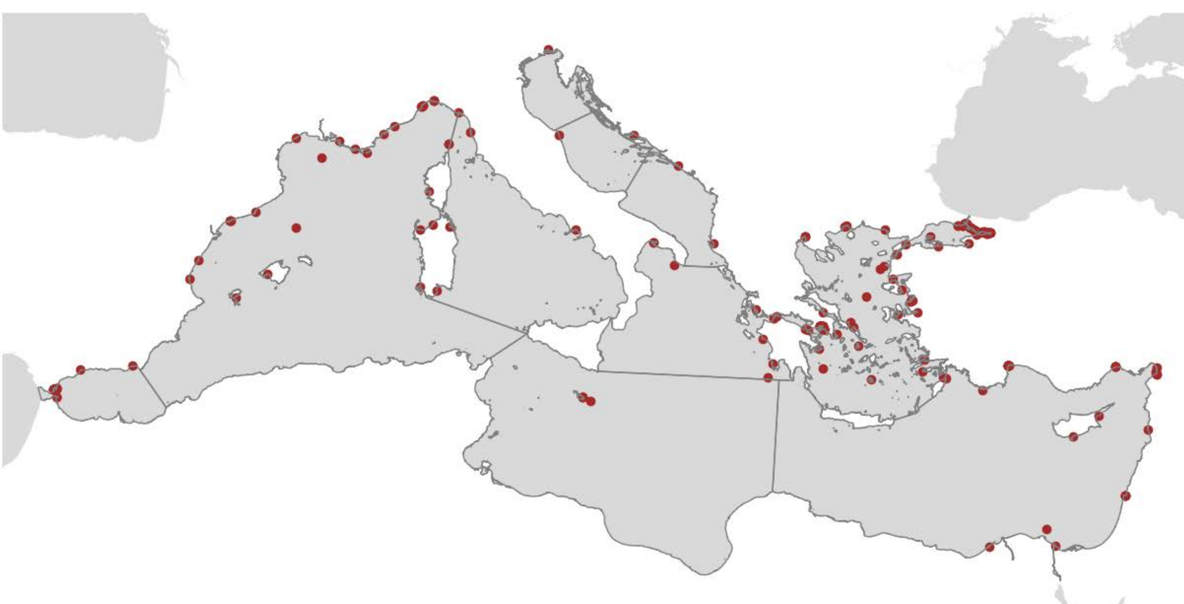

Figure 11. Spatial distribution of spills events in the Mediterranean in the period 2002-2021 reported by Lloyd List Intelligence Seasearcher.

49. From CleanSeaNet, data on the number of and extension of potential spills are available from 2015. This service processes satellite data into images to extract several information, including those on spills. Being based on remotely acquired data, the dataset can also include false detection. For the specific scope of this assessment only spills with a high confidence level (class A) were used. Moreover, it shall also be recalled that CleanSeaNet detections can be caused by oil and other pollutants, but may also indicate naturally occurring features (e.g. algae blooms, areas of upwelling, etc.). Table 6 and Figure 12 respectively report the number of Class A detected spills and visualise their trend, while Table 7 and Figure 13 report total surface (in km^2) affected by spills. Both the number of spills and the affected surface show an increasing trend from 2015 to 2021. The two trends are similar, with a minor exception in the last two years (2020-2021), when the number of registered spills keeps increasing while the total polluted surface shows a slight decrease.

50. The observed trend disagrees with those from MEDGIS-MAR and Lloyds. However, it shall be highlighted again that these datasets are based on different approaches and provide different information. In any case, the increase in the frequency of small spills seems to be captured by both MEDGIS-MAR and CleanSeaNet. Finally, it shall be noted that the trend of CleanSeaNet detected spills and related affected sea surface could be biased from an increase in the monitoring effort (e.g. extension of the sea surface which has been annually surveyed through the analysis of satellite data). It was not possible to obtain information on this aspect from European Maritime Safety Agency.

Table 6. Number of spill events per year in the Mediterranean and its sub-divisions in the period 2015-2021. Source: CleanSeaNet service.

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2015	488	8	122	72	67	9	30	49	16	9	106
2016	602	20	181	61	63	14	13	22	31	38	159
2017	875	56	283	87	118	10	16	30	50	73	152
2018	911	37	322	70	85	49	36	29	34	53	196
2019	1385	26	257	77	264	33	60	82	120	95	371
2020	1576	34	324	104	270	32	52	99	122	142	397
2021	1443	27	363	90	258	39	38	53	103	77	395

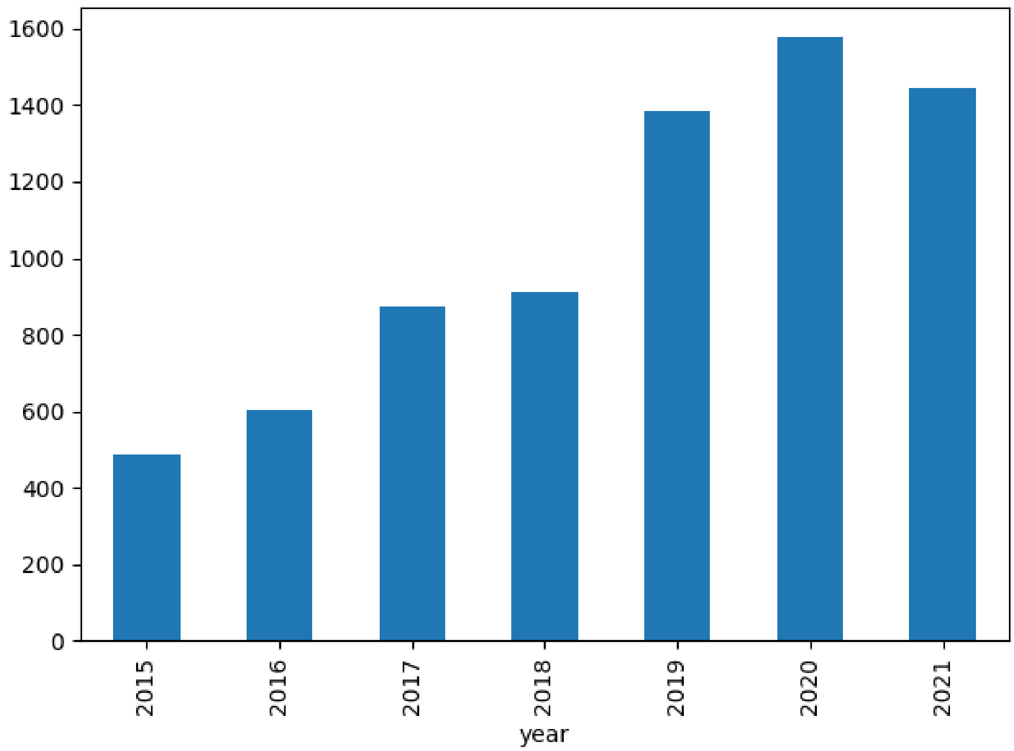

Figure 12. Number of spills events per year in the period 2015-2021 in the Mediterranean. Source: CleanSeaNet service.

Table 7. Polluted surface (km^2) per year in the Mediterranean and its sub-divisions in the period 2015-2021. Source: CleanSeaNet service.

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2015	5572.5	39.5	1249.4	609.2	571.9	129.4	469.8	691.8	202.4	99.6	1509.6
2016	4292.6	63.3	1181.8	322.3	367.0	69.8	157.5	194.6	251.8	172.1	1512.4
2017	6368.5	319.6	2088.9	690.6	1075.4	39.2	160.0	125.2	347.9	729.1	792.6
2018	7578.3	153.5	3020.8	535.1	971.2	467.6	293.3	197.0	217.7	311.9	1410.2
2019	10432.7	89.4	2106.5	411.3	2096.9	219.5	578.9	605.5	796.0	338.8	3189.9
2020	14007.1	216.4	3099.4	713.5	3844.6	186.5	607.5	990.5	738.7	753.3	2856.6
2021	14936.6	151.1	4776.0	1097.9	3121.5	296.1	219.8	575.7	657.0	219.8	3821.8

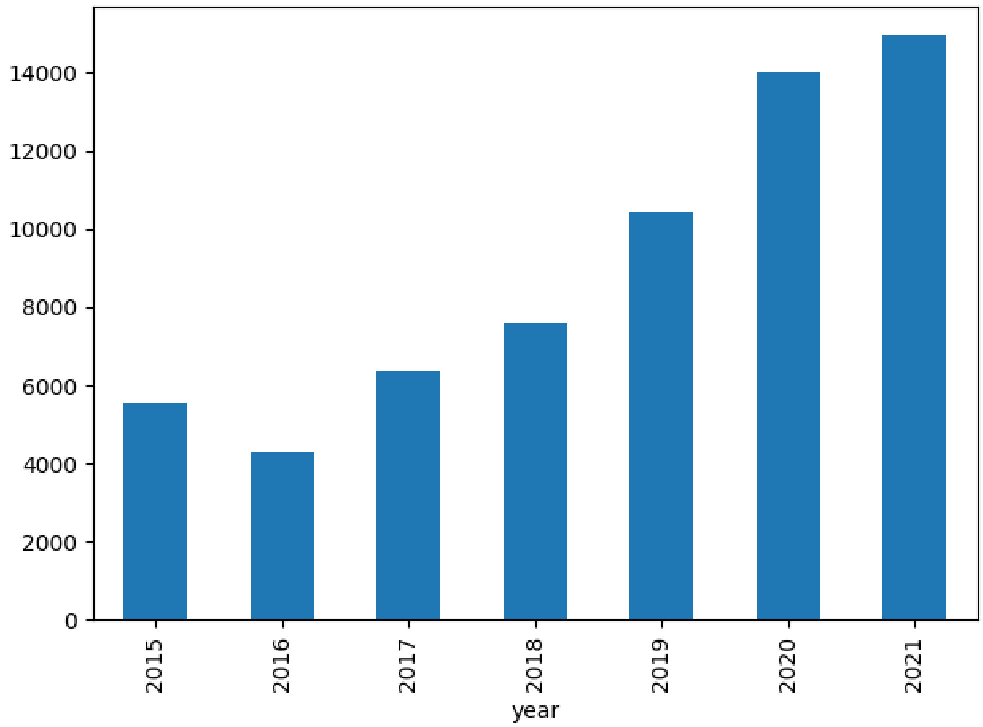

Figure 13. Polluted surface (km^2) per year in the Mediterranean in the period 2015-2021. Data source: CleanSeaNet service.

3.2 Analysis of other substances

51. MEDGIS-MAR is the only datasets among the three considered in this assessment allowing to describe the trend in the number of spills of substances other than oil (Table 8 and Figure 14). In MEDGIS-MAR, such substances are categorized as Hazardous and Noxious Substances (HNS), other substances (non-HNS) and Unknown substances. In general, the number of reported events is smaller than those attributed to volatile and non-volatile oil; the two trends are similar. The number of spills related to substances other than oil reported in MEDGIS-MAR is very small (and often null) before 2012 and tends to increase consistently in the period 2012-2016. The total number of events is slightly smaller in the last four years. Large (above 700t) and medium size spills (7-700t) have not been reported since 2018. The last four years are characterised only by small spill events, although several events with unknow size (4 in 2019) have been registered. The most affected sub-divisions are the Aegean Sea (as remarked also for the oil spill events), the Levantine Sea and to a minor extent the Ionian Sea.

Table 8. Number of non-oil related spills events (HNS, non-HNS and unknow) per year in the Mediterranean and related sub-divisions in the period 2002-2021 reported by MEDGIS-MAR.

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2002	3	0	0	0	0	0	0	0	0	0	3
2003	4	0	0	0	0	0	0	0	0	0	4
2004	6	0	0	0	0	0	0	0	0	0	6
2005	4	0	0	0	0	1	0	0	0	0	3
2006	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0
2008	1	0	0	0	0	0	0	0	0	0	1

Year	TOTMED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
2009	0	0	0	0	0	0	0	0	0	0	0
2010	2	0	0	0	0	0	0	0	0	0	2
2011	3	0	0	0	0	0	0	0	0	0	3
2012	5	0	0	2	0	0	0	0	0	3	0
2013	3	0	0	0	0	0	0	0	0	2	1
2014	8	1	1	0	0	0	0	0	1	3	2
2015	15	0	0	0	3	0	0	0	2	6	4
2016	13	1	1	0	1	0	0	0	0	7	3
2017	6	0	0	0	0	0	1	0	0	4	1
2018	9	0	0	0	0	0	0	0	4	5	0
2019	9	0	0	0	0	0	0	0	2	6	1
2020	12	0	0	0	0	0	0	0	1	11	0
2021	1	0	0	0	0	0	0	0	0	1	0

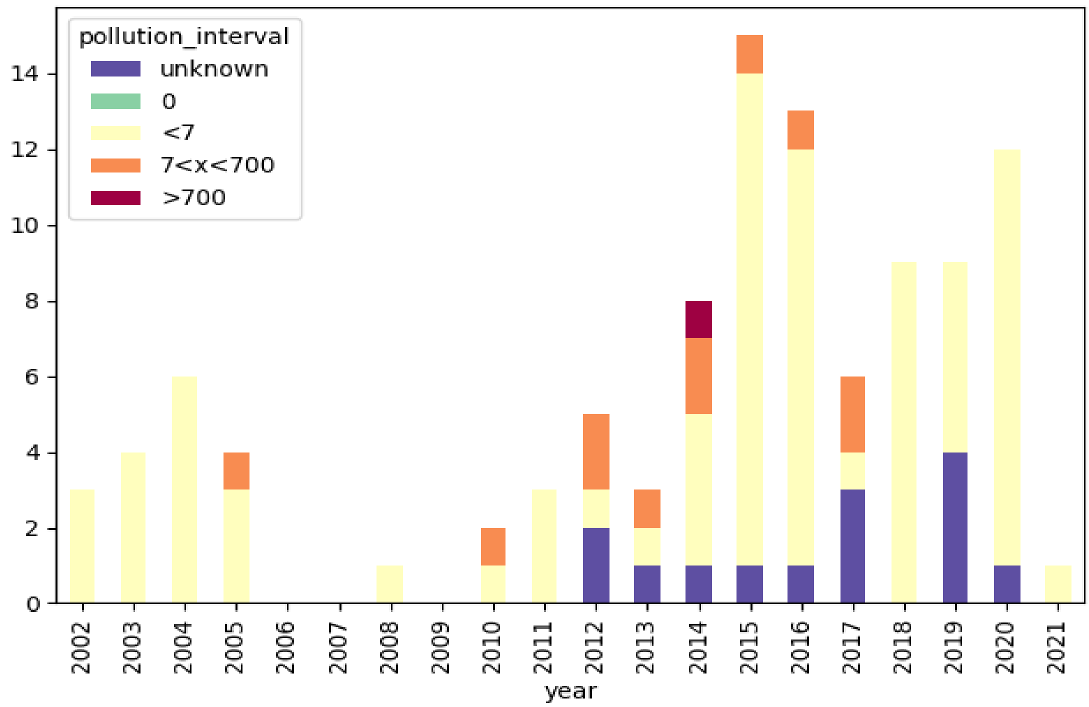

Figure 14. Number of non-related oil spills events (HNS, non-HNS and unknow) per year in the period 2002-2021 in the Mediterranean reported by MEDGIS-MAR. Events are categorised according ITOPF classes of spilled volumes (values in legend = tonnes).

4 Assessment of marine environment status for CI 19

4.1 Acute pollution from oil

52. Based on the data from MEDGIS-MAR, Figure 15 illustrates the distribution of spills in the Mediterranean in the assessment period (2018-2021). Figure 16 shows the relative occurrence in the different sub-divisions (seas) and occurrence in the same period. The Aegean Sea is the area where occurrence of spills is higher in the period. 2020 was the year with most numerous events registered.

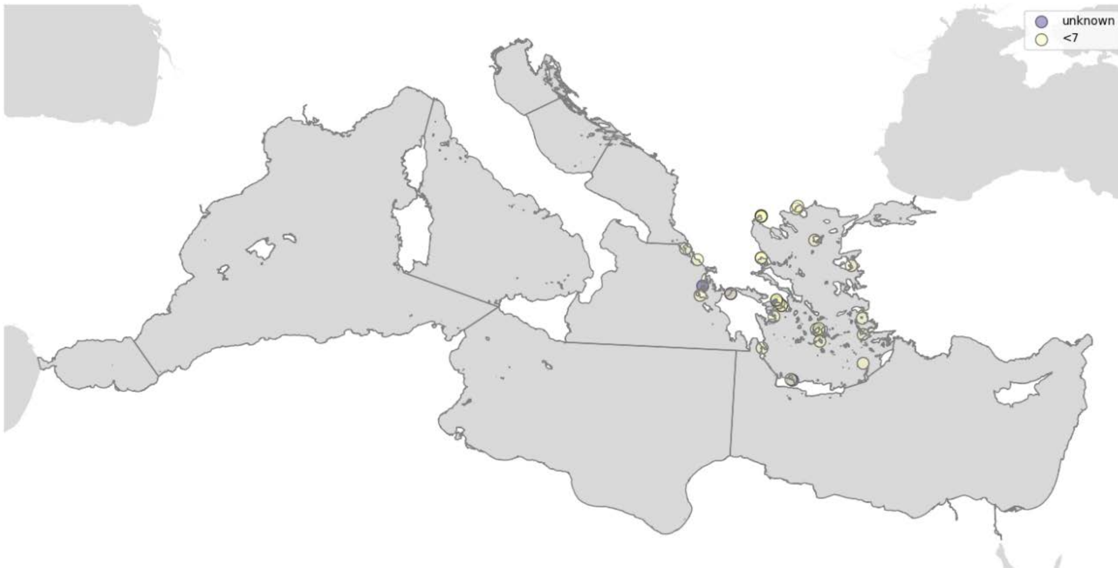

Figure 15. Spatial distribution of oil spills events (volatile and non-volatile oil) in the Mediterranean in the period 2018-2021 per ITOPF class of spilled volume (values in legend = tonnes). Only events if volume <7 tonnes or unknown occurred in the considered period. Data source: MEDGIS-MAR.

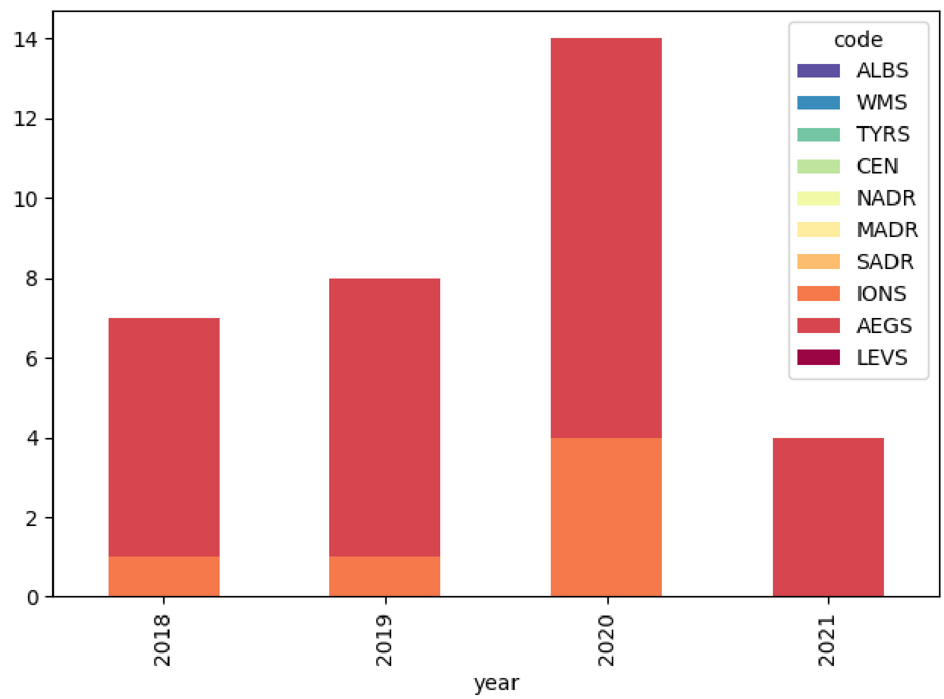

Figure 16. Number of oil spills events (volatile and non-volatile oil) per year in the period 2018-2021 per sub-division.

53. As indicated in the methodology, both the frequency of occurrence of oil spills in the considered period (2018-2021) and the relative variation of the frequency with respect to the previous reporting period (2013-2017) are considered for the assessment. Average yearly frequencies are normalized over the extension of each sub-division of analysis.

54. *Table 9* summarizes data and results of the assessment. The yearly average number of oil spills per 10000 km^2 in the period 2018-2021 and the classification of its percentage variation between the periods 2018-2021 and 2013-2017 (in colour-based classes) are also mapped in *Figure 17*.

Table 9. Assessment of oil (Part 1). (1) Extension of the assessment areas (10000 km^2); (2) average number of spills in the period and average number of spills per 10000 km^2 in the assessment period (2018-2021) - the three highest values only are highlighted; (3) average number of spills in the previous period and average number of spills per 10000 km^2 in the previous period (2013-2017); (4) % of variation of average yearly spill occurrence.

Colour code for spill frequency: dark red = highest value; red = second highest; orange = third highest. Colour code for % variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: MEDGIS-MAR.

	TOT MED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
(1) Extension of the areas of assessment											
Area /10000 km^2	252.53	5.61	57.25	21.68	55.02	3.34	4.41	6.17	16.88	20.24	61.91
(2) 2018-2021 frequency of spill occurrence											
n/y	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.8	0.0
n/y/10000 km^2	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.089**	**0.334**	0.000
(3) 2013-2017 frequency of spill occurrence											
n/y	19.2	0	0.8	0	0.6	0	0	0	1.2	15.2	1.4
n/y/10000 km^2	0.076	0.000	0.014	0.000	0.011	0.000	0.000	0.000	0.071	0.751	0.023
(4) Variation % between the two periods											
Variation % of n/y	-57	-	-100	-	-100	-	-	-	25	-56	-100

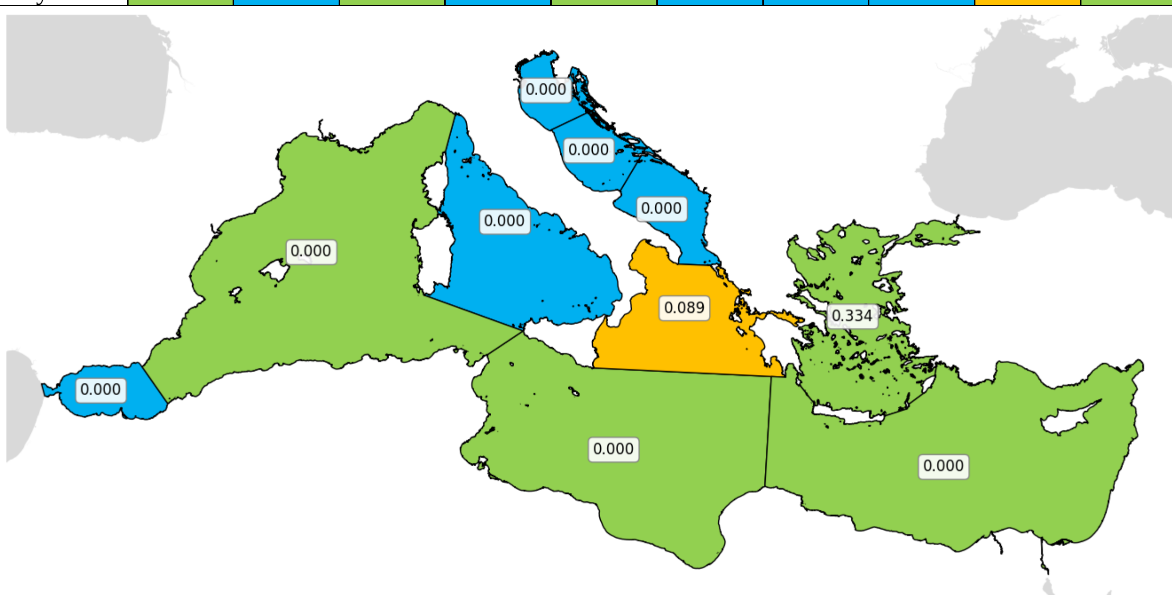

Figure 17. Yearly average number of oil spills per 10000 km^2 in the period 2018-2021 and classification of its percentage variation between the periods 2018-2021 and 2013-2017; Colour code for %

variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: MEDGIS-MAR.

55. The same approach is used here below to assess the status on the basis of the Lloyd List Intelligence Seasearcher database in the assessment period (2018-2021). *Figure 18* shows the relative occurrence in the different sub-divisions and *Figure 19* shows the occurrence in the four years of assessment. The Aegean Sea is again the area where occurrence of spills is higher. In 2020 and 2021 the highest number of events are registered.

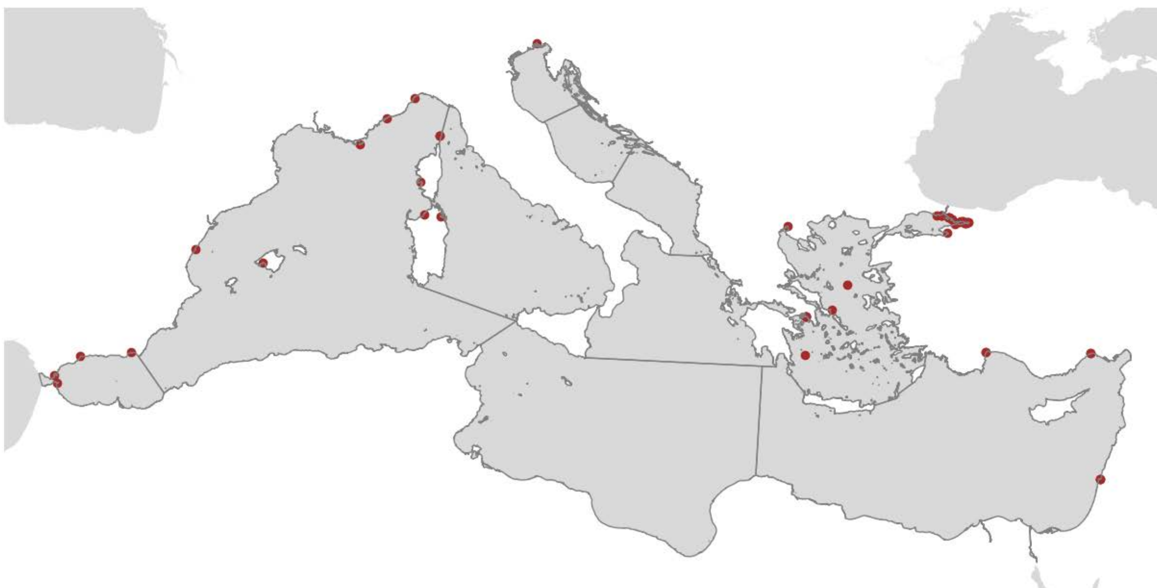

Figure 18. Spatial distribution of oil spills events (volatile and non-volatile oil) in the Mediterranean in the period 2018-2021. Data source: Lloyd List Intelligence Seasearcher.

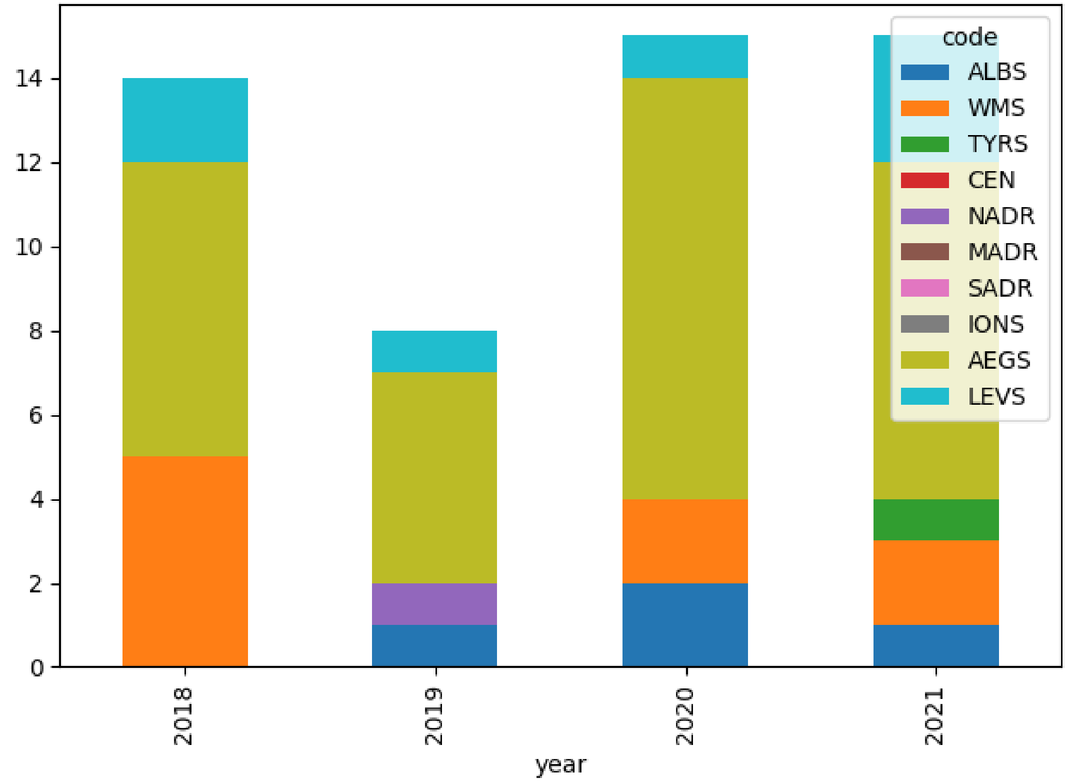

Figure 19. Number of oil spills events per year in the period 2018-2021 per sub-division. Data source: Lloyd List Intelligence Seasearcher.

56. As above, to provide an assessment of the status for this indicator, both the frequency of occurrence of oil spills in the considered period (2018-2021) and the relative variation of the frequency with respect to the previous reporting period (2013-2017) are considered with reference to the Lloyd List Intelligence Seasearcher database. Average frequencies are normalized over the extension of each sub-division of analysis.

57. Table 10 summarizes data and results of the assessment. The yearly average number of oil spills per 10000 km^2 in the period 2018-2021 and the classification of its percentage variation between the periods 2018-2021 and 2013-2017 (in colour-based classes) are also mapped in *Figure 20*.

Table 10. Assessment for oil (Part 2). (1) Extension of the assessment areas (10000 km2); (2) average number of spills in the period and average number of spills per 10000 km2 in the assessment period (2018-2021) - <u>the three highest values only are highlighted</u>; (3) average number of spills in the previous period and average number of spills per 10000 km2 in the previous period (2013-2017); (4) % of variation of average yearly spill occurrence.

Colour code for spill frequency: dark red = highest value; red = second highest; orange = third highest. Colour code for variations: blue = no spills recorded in the assessment period, nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: Lloyd List Intelligence Seasearcher.

	TOT MED	**ALBS**	**WMS**	**TYRS**	**CEN**	**NADR**	**MADR**	**SADR**	**IONS**	**AEGS**	**LEVS**
(1) Extension of the areas of assessment											
Area /10000 km^2	252.53	5.61	57.25	21.68	55.02	3.34	4.41	6.17	16.88	20.24	61.91
(2) 2018-2021 frequency of spill occurrence											
n/y	13.0	1.0	2.3	0.3	0.0	0.3	0.0	0.0	0.0	7.5	1.8
n/y/10000 km^2	0.051	**0.178**	0.039	0.012	0.000	**0.075**	0.000	0.000	0.000	**0.371**	0.028
(3) 2013-2017 frequency of spill occurrence											
n/y	11.6	0.6	1.6	0.2	0.6	0.0	0.0	0.2	0.4	5.6	2.4
n/y/10000 km^2	0.046	0.107	0.028	0.009	0.011	0.000	0.000	0.032	0.024	0.277	0.039
(4) Variation % between the two periods											
Variation % of n/y	12	67	41	25	-100	-	-	-100	-100	34	-27

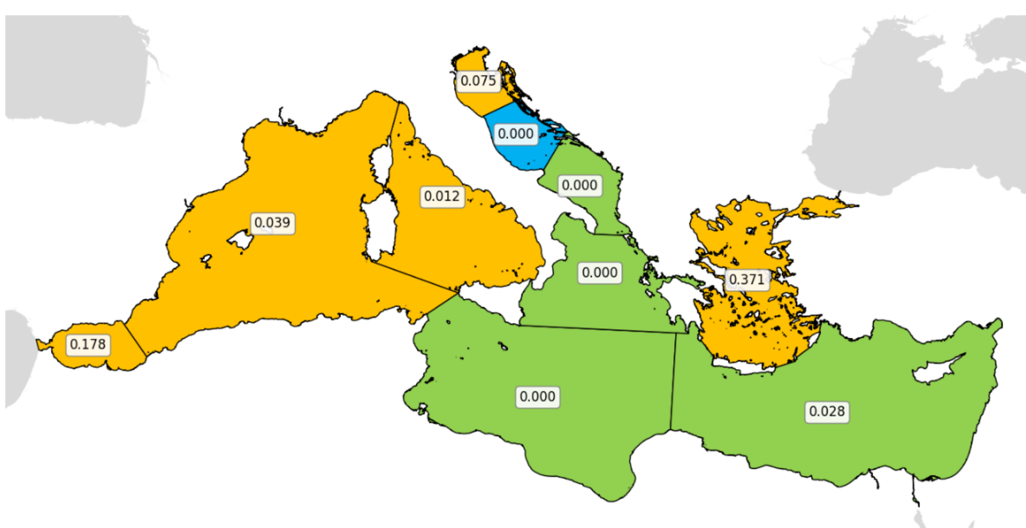

Figure 20. Yearly average number of oil spills (n/y/10000 km^2) in the period 2018-2021 and classification of its percentage variation between the periods 2018-2021 and 2013-2017; Colour code for % variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: Lloyd List Intelligence Seasearcher.

58. Again, the same approach is used here below to assess the status of the indicator on the basis of the CleanSeaNet database in the assessment period (2018-2021). Figure 21 shows the relative occurrence in the different areas (sub-divisions) and Figure 22 shows the occurrence in the four years of assessment. The Levantine Sea shows the highest frequency of spill detection, followed by the Western Mediterranean and by the Central Mediterranean. Within the assessment period, 2020 is the year showing the highest frequency of spills.

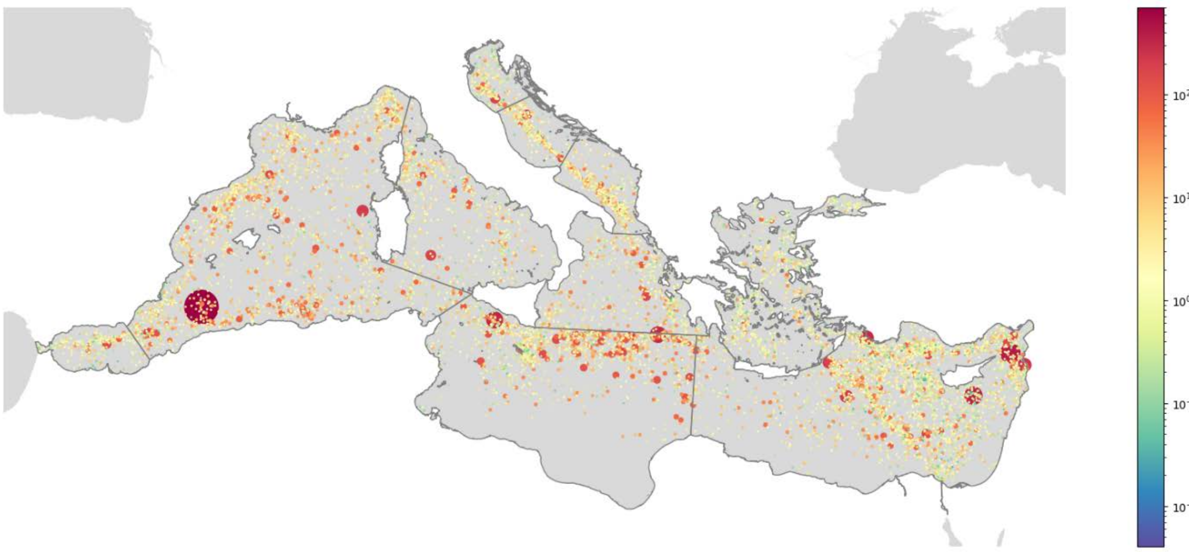

Figure 21. Spatial distribution of spills in the Mediterranean in the period 2018-2021 with their relative polluted area extension. Data source: CleanSeaNet.

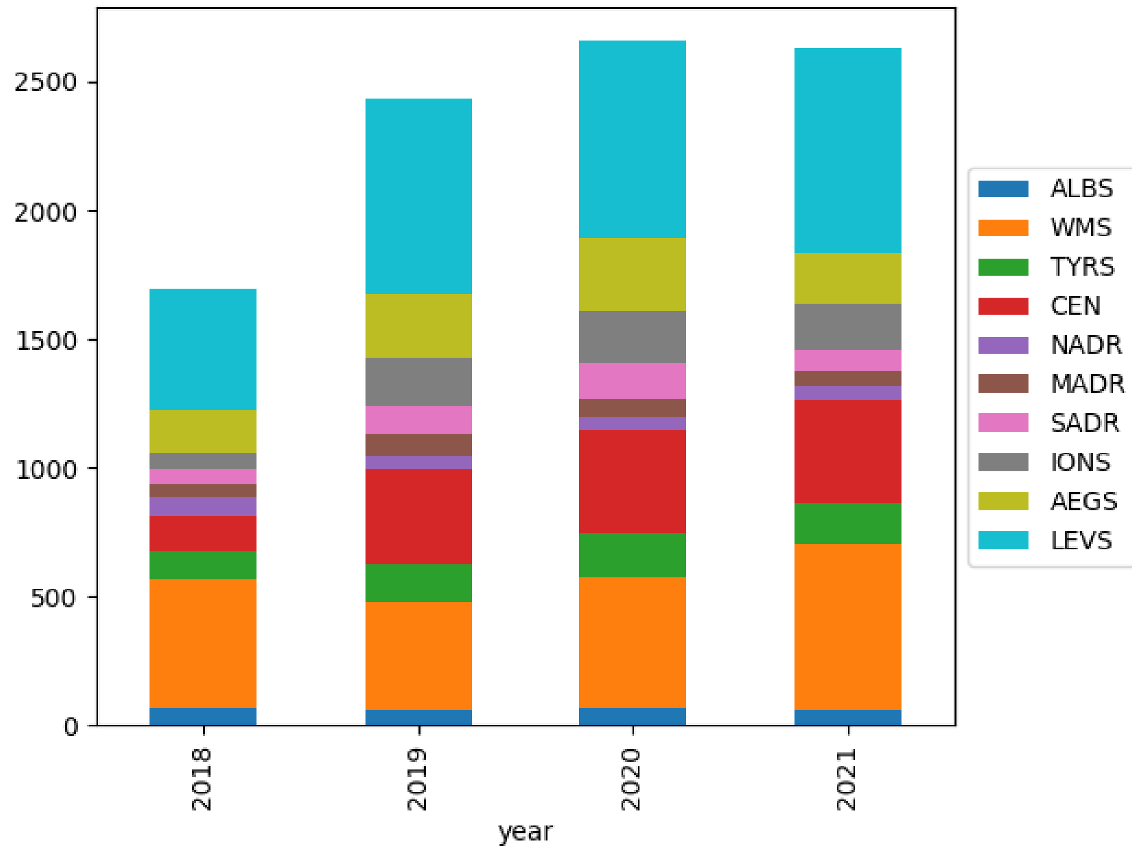

Figure 22. Number of spills per year in the period 2018-2021 per sub-division. Data source: CleanSeaNet.

59. As for the previous data sets, both the frequency of occurrence of oil spills in the considered period (2018-2021) and the relative variation of the frequency with respect to the previous reporting period (2013-2017) are considered with reference to CleanSeaNet database. Average frequencies are normalized over the extension of each sub-division of analysis.

60.

61. summarizes data and results of the assessment. The yearly average number of oil spills per 10000 km^2 in the period 2018-2021 and the classification of its percentage variation between the periods 2018-2021 and 2015-2017 (in colour-based classes) are also mapped in *Figure 23*.

Table 11. Assessment for oil (Part 3). (1) Extension of the assessment areas (10000 km^2); (2) average number of spills in the period and average number of spills per 10000 km^2 in the assessment period (2018-2021) - the three highest values only are highlighted; (3) average number of spills in the previous period and average number of spills per 10000 km^2 in the previous period (2015-2017); (4) % of variation of average yearly spill occurrence.

Colour code for spill frequency: dark red = highest value; red = second highest; orange = third highest. Colour code for variations: blue = no spills recorded in the assessment period, nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: CleanSeaNet.

	TOT MED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
(1) Extension of the areas of assessment											
Area /10000 km^2	252.53	5.61	57.25	21.68	55.02	3.34	4.41	6.17	16.88	20.24	61.91
(2) 2018-2021 frequency of spill occurrence											
n/y	2353.8	63.3	517.0	148.0	327.0	55.3	68.0	96.5	161.3	221.0	696.5
n/y/10000 km^2	9.321	11.269	9.030	6.826	5.943	**16.520**	**15.417**	**15.630**	9.550	10.920	11.250
(3) 2015-2017 frequency of spill occurrence											
n/y	1271	48	319	121	137	18	34	54	68	138	335
n/y/10000 km^2	5.033	8.552	5.572	5.581	2.490	5.382	7.708	8.746	4.027	6.819	5.411
(4) Variation % between the two periods											
Variation % of n/y	85	32	62	22	139	207	100	79	137	60	108

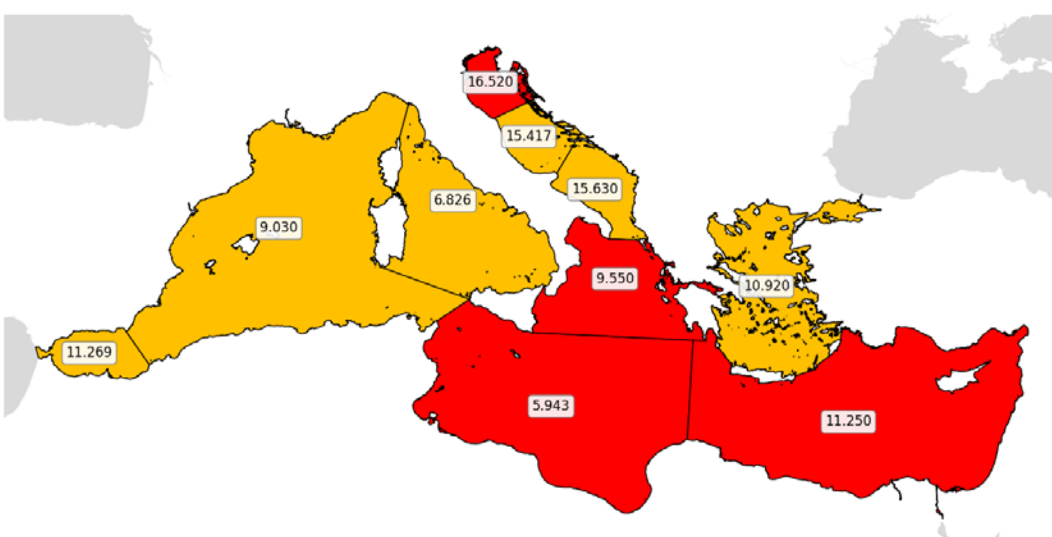

Figure 23. Yearly average number of oil spills (n/y/10000 km^2) in the period 2018-2021 and classification of its percentage variation between the periods 2018-2021 and 2013-2017; Colour code for % variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: CleanSeaNet.

62. Finally, CleanSeaNet data referring to the extension of areas interested by pollution are considered with reference to the same assessment period (2018-2021). *Figure 24* shows the total extension of areas interested by pollution in the four years of assessment. The Levantine Sea shows the highest extension of polluted areas detected over the period, followed by the Western Mediterranean and the Central Mediterranean. Within the assessment period and increasing trends in the overall extension of polluted areas is observed.

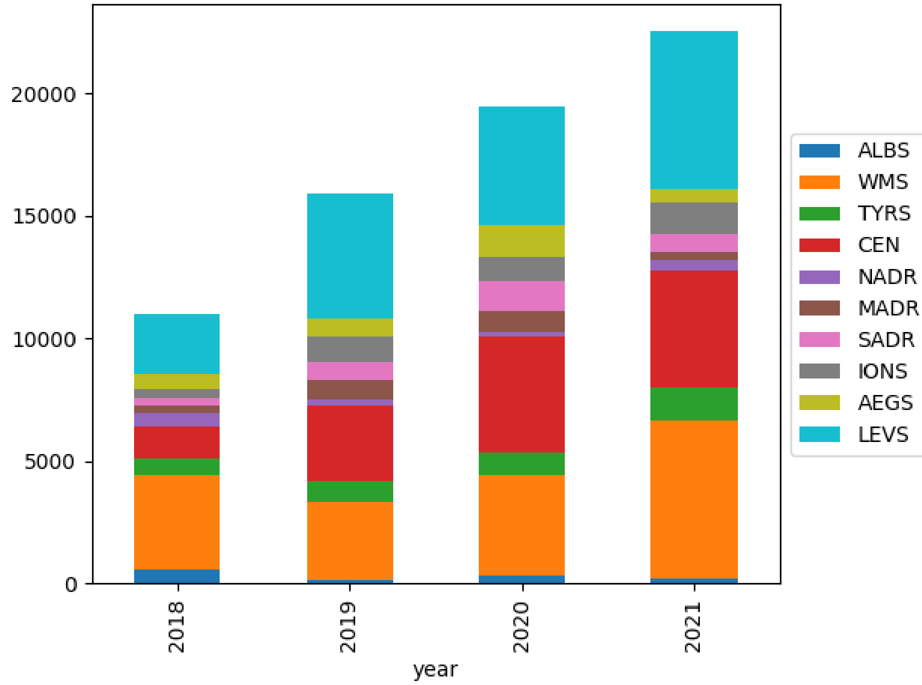

Figure 24. Extension of areas interested by spill events per year in the period 2018-2021 per sub-division. Data source: CleanSeaNet.

63. With the same approach as above, both the overall surface interested by spills in the considered period (2018-2021) and the relative variation of such surface with respect to the previous reporting period (2015-2017) are considered with reference to CleanSeaNet database for each of the areas (sub-divisions) of assessment. Extension of surface where pollution was detected is normalized over the extension of each area of analysis (sub-division).

64. summarizes the data used for the assessment. The yearly average extension of areas interested by pollution per 10000 km^2 in the assessment period (2018-2021) and the classification of its percentage variation between the periods 2018-2021 and 2015-2017 (in colour-based classes) are also mapped in *Figure 25*.

Table 12. Assessment for oil (Part 4). (1) Extension of the assessment areas (10000 km^2); (2) average extension of areas interested by pollution in the period and relative extension per 10000 km^2 in the assessment period (2018-2021) - <u>the three highest values only are highlighted</u>; (3) average extension of areas interested by pollution in the previous period and relative extension per 10000 km^2 in the previous period (2015-2017); (4) % of variation of extension of polluted areas per 10000 km^2. Colour code for spill frequency: dark red = highest value; red = second highest; orange = third highest. Colour code for variations: blue = no polluted areas detected in the assessment period, nor in the previous period; green = decreased extension of polluted area; yellow = increased extension of polluted area <= 100%; red = increased extension of polluted areas > 100%. Data source: CleanSeaNet.

	TOT MED	ALBS	WMS	TYRS	CEN	NADR	MADR	SADR	IONS	AEGS	LEVS
(1) Extension of the areas of assessment											
Area /10000 km^2	252.53	5.61	57.25	21.68	55.02	3.34	4.41	6.17	16.88	20.24	61.91
(2) 2018-2021 extension of polluted area											
Km^2/y	17214.6	322.5	4387.0	966.2	3453.5	350.2	575.7	742.8	918.5	800.9	4697.2
Km^2/y/ 10000 km^2	68.2	57.5	76.6	44.6	62.8	**104.7**	**130.5**	**120.3**	54.4	39.6	75.9
(3) 2015-2017 extension of polluted area											
Km^2/y	196.4	2134.6	782.0	1005.1	118.0	389.5	396.6	381.2	717.6	2365.3	196.4
Km^2/y/ 10000 km^2	35.0	37.3	36.1	18.3	35.3	88.3	64.2	22.6	35.5	38.2	35.0
(4) Variation % between the two periods											
Variation % of n/y	103	64	106	24	244	197	48	87	141	12	99

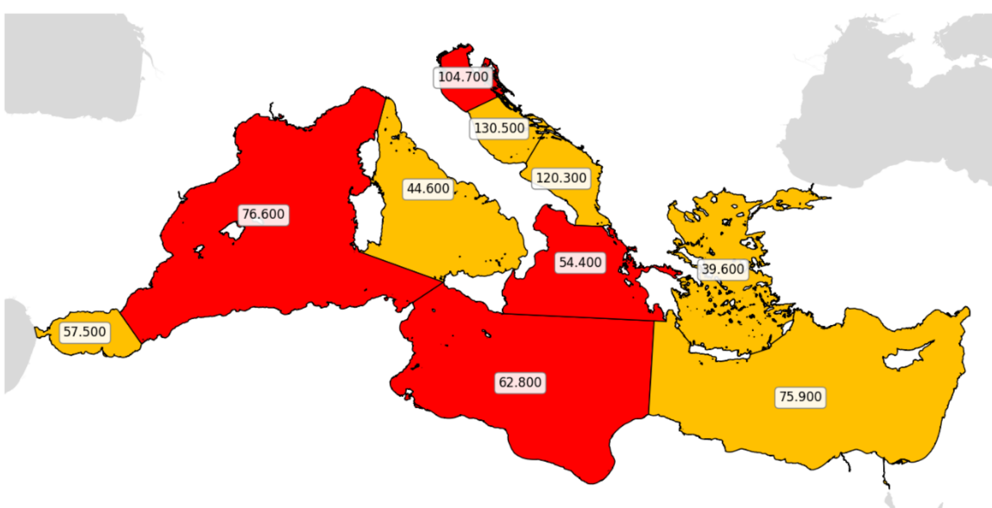

Figure 25. yearly average extension of areas interested by pollution per 10000 km^2 in the assessment period (2018-2021) and classification of its percentage variation between the periods 2018-2021 and 2015-2017; Colour code for % variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: CleanSeaNet.

4.2 Acute pollution from other substances (non-oil)

65. Assessment of the status of the indicator with reference to other substances (non-oil) is undertaken on the basis of the MEDGIS-MAR data set in the assessment period (2018-2021). The datasets considered spills determining dispersion of Hazardous and Noxious Substances (HNS), other substances non-HNS and other unknown substances. *Figure 26* shows the relative occurrence in the different areas (sub-divisions) and *Figure 27* shows the occurrence in the four years of assessment. The Aegean Sea shows the highest frequency for these spills, with only some events registered for the Ionian Sea and the Levantine sea. Within the assessment period, 2020 is the year showing the highest frequency of spills.

Figure 26. Spatial distribution of spills events related to non-oil substances in the Mediterranean in the period 2018-2021 per ITOPF class of spilled volume (values in legend = tonnes). Data source: MEDGIS-MAR.

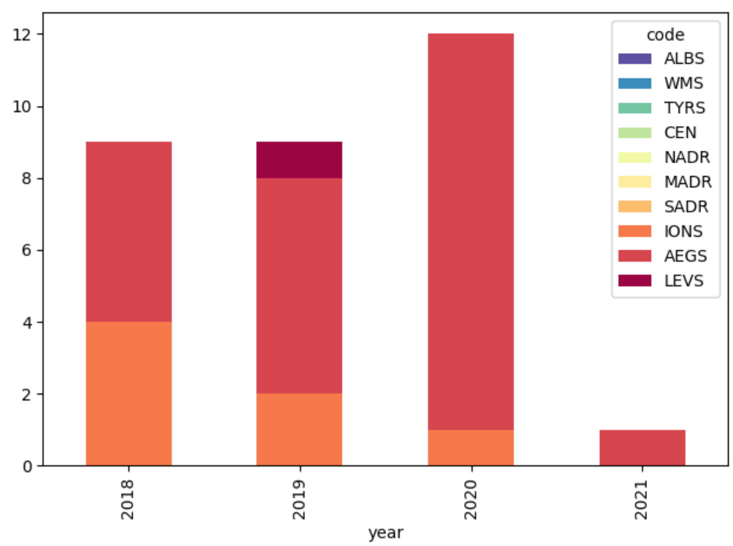

Figure 27. Number of spills related with other substances (non-oil) per year in the period 2018-2021 per sub-division.

66. The frequency of occurrence of spills (other substances, non-oil) in the considered period (2018-2021) and the relative variation of the frequency with respect to the previous reporting period (2013-2017) are considered with reference to MEDGIS-MAR database. Average frequencies are normalized over the extension of each area of analysis (sub-division). Table 13 summarizes data and results of the assessment. The yearly average number of spills (other substances, non-oil) per 10000 km^2 in the period 2018-2021 and the classification of its percentage variation between the periods 2018-2021 and 2013-2017 (in colour-based classes) are also mapped in *Figure 28*.

Table 13. Assessment for other substances (non-oil). (1) Extension of the assessment areas (10000 km^2); (2) average number of spills in the period and average number of spills per 10000 km^2 in the assessment period (2018-2021) - the three highest values only are highlighted; (3) average number of spills in the previous period and average number of spills per 10000 km^2 in the previous period (2013-2017); (4) % of variation of average yearly spill occurrence. Colour code for spill frequency: dark red = highest value; red = second highest; orange = third highest. Colour code for variations: blue = no spills recorded in the assessment period, nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: MEDGIS-MAR.

	TOT MED	**ALBS**	**WMS**	**TYRS**	**CEN**	**NADR**	**MADR**	**SADR**	**IONS**	**AEGS**	**LEVS**
(1) Extension of the areas of assessment											
Area /10000 km^2	252.53	5.61	57.25	21.68	55.02	3.34	4.41	6.17	16.88	20.24	61.91
(2) 2018-2021 frequency of spill occurrence											
n/y	7.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	5.75	0.25
n/y/10000 km^2	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.104**	**0.284**	**0.004**
(3) 2015-2017 frequency of spill occurrence											
n/y	9.00	0.40	0.40	0.00	0.80	0.00	0.20	0.00	0.60	4.40	2.20
n/y/10000 km^2	0.036	0.071	0.007	0.000	0.015	0.000	0.045	0.000	0.036	0.217	0.036
(4) Variation % between the two periods											
Variation % of n/y	-14	-100	-100	-	-100	-	-100	-	192	31	-89

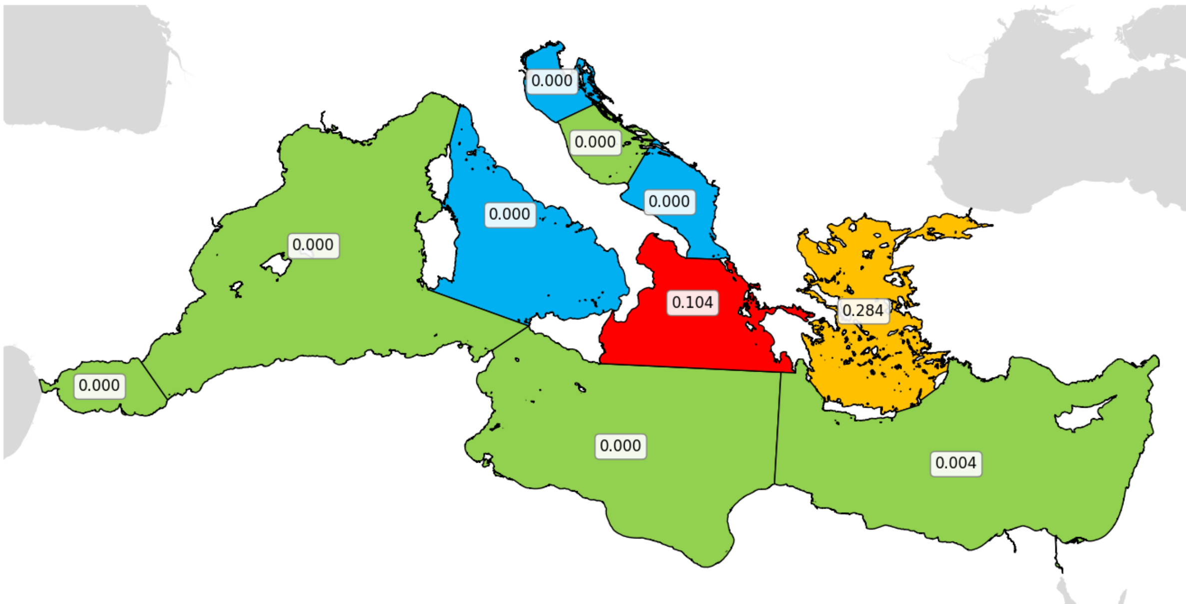

Figure 28. Yearly average number of spills (other substances, non-oil) per 10000 km^2 in the period 2018-2021 and classification of its percentage variation between the periods 2018-2021 and 2013-2017; Colour code for % variations: blue = no spills recorded, in the assessment nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data source: MEDGIS-MAR.

4.3 Assessment of the status for CI 19

67. The status for CI 19 in the period 2018-2021 is assessed by jointly considering:

- the information on the frequency of spill occurrence (yearly average number of spills/10000 km^2 and yearly average extension of areas interested by pollution/10000 km^2), and
- the information on the trend of such frequency (increasing, decreasing, stable with no spill), represented by the variation in % in comparison with the previous assessment period (2013-2017).

68. The assessment is based on all the three analysed datasets. Table 14 provides a complete overview of the data used for the assessment.

69. Considering the spills reported by the ships and the countries, MEDGIS-MAR and Lloyd List data indicate for the entire Mediterranean in the assessment period an average occurrence frequency of 0.033 and 0.051 n/y/10000 km2, respectively (Table 14). The most affected sea is the Aegean Sea, followed by the Ionian Sea, according to MEDGIS-MAR (no incidents reported by Lloyd List, instead) and the Alboran Sea according to Lloyd List (no incidents reported by MEDGIS-MAR, instead). The Northern Adriatic Sea ranks third for occurrence of incidents, according to the Lloyd List (no incidents reported by MEDGIS-MAR, instead). These results are in accordance with the relative intensity of vessel traffic (hours/km) (see Figure 6), that indicates the Aegean Sea, the Alboran Sean and the Northern Adriatic as the most trafficked areas of the Mediterranean.

70. Focusing on the spills detected by satellite monitoring (CleanSeaNet data), the Adriatic Sea is the area with the highest standardised (per 10000 km2) frequency of spill occurrence and the area where the largest extension of polluted areas is detected. This could be explained by the fact that satellite monitoring enables to detect also small spills (including small, non-reported incidents, illicit discharges, spills due to other offshore activities). These are particularly numerous in the Adriatic where, beside significant traffic

density due to cargos, tankers and passenger vessels, other type of vessels are present in large number (including fishing vessels).

71. The temporal variations in spill occurrence computed from the three different databases are very different: according to MEDGIS-MAR a general improvement of the status can be observed for this indicator, with Alboran Sea, Tyrrhenian Sea and the whole Adriatic Sea reporting no spills both in the considered and in the previous assessment period. Considering Lloyd, a general worsening of the status of the indicator can be observed, with the Alboran Sea, Western Mediterranean, the Tyrrhenian Sea, the Northern Adriatic the Aegean Sea showing increasing of spill occurrence. These findings mostly agree with the ones from CleanSeaNet which, additionally, highlight an increase of spill occurrence also for the Central Mediterranean, the Middle Adriatic Sea, the Ionian Sea and the Levantine Sea.

72. It is worth noting that CleanSeaNet datasets might be biased by increasing monitoring effort from 2015 to the present. Within the present assessment, it was to possible to obtain information on this aspect from EMSA.

Table 14. Assessment summary. (1) average number of oil spills in the assessment period (2018-2021) per 10000 km^2 for the three datasets - the three highest values only are highlighted; (2) average extension of areas interested by oil pollution in the assessment period (2018-2021) per 10000 km^2 (from CleanSeaNet) - the three highest values only are highlighted (3) average number of other substances spills in the assessment period (2018-2021) per 10000 km^2 (from MEDGIS-MAR) - the three highest values only are highlighted; (4) % of variation compared to the previous period of the above indicators for oil spills; (5) % of variation compared to the previous period of the above indicator on other substance spills. Colour code for spill frequency and variation in the extension of the area affected by pollution: dark red = highest value; red = second highest; orange = third highest. Colour code for % variations: blue = no spills recorded, in the assessment period, nor in the previous period; green = decreased frequency of spill occurrence; yellow = increased frequency of spill occurrence <= 100%; red = increased frequency of spill occurrence > 100%. Data sources: MEDGIS-MAR, Lloyd List Intelligence Seasearcher, CleanSeaNet.

Frequency of spills / total polluted area (average values in the period 2018-2021, per 10000 km^2)											
	TOT MED	**ALBS**	**WMS**	**TYRS**	**CEN**	**NADR**	**MADR**	**SADR**	**IONS**	**AEGS**	**LEVS**
Oil											
(1) MEDGIS-MAR	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.089**	**0.334**	0.000
(1) LLOYD	0.051	**0.178**	0.039	0.012	0.000	**0.075**	0.000	0.000	0.000	**0.371**	0.028
(1) CleanSeaNet (n)	9.3	11.3	9.0	6.8	5.9	**16.5**	**15.4**	**15.6**	9.6	10.9	11.3
(2) CleanSeaNet (km^2)	68.2	57.5	76.6	44.6	62.8	**104.7**	**130.5**	**120.3**	54.4	39.6	75.9
Other substances											
(3) MEDGIS-MAR	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.104**	**0.284**	**0.004**
Summary of variation %											
	TOT MED	**ALBS**	**WMS**	**TYRS**	**CEN**	**NADR**	**MADR**	**SADR**	**IONS**	**AEGS**	**LEVS**
Oil											
(4) MEDGIS-MAR	-57	-	-100	-	-100	-	-	-	25	-56	-100
(4) LLOYD	12	67	41	25	-100	-	-	-100	-100	34	-27
(4) CleanSeaNet (n)	85	32	62	22	139	207	100	79	137	60	108
(4) CleanSeaNet (km^2)	103	64	106	24	244	197	48	87	141	12	99
Other substances											
(5) MEDGIS-MAR	-14	-100	-100	-	-100	-	-100	-	192	31	-89

73. In order to summarize the above findings and provide an overall assessment of the status of CI 19 in the Mediterranean, the summary results from the analysis of the three datasets included in Table 14 are jointly considered. This assessment is provided through integration of the three major criteria described below:

- The first criterion refers to the occurrence of spills reported through MEDGIS-MAR and Lloyds, which are mainly linked to relatively large pollution events and to incidents. Occurrence of reported events is considered as a “negative” factor in the overall assessment of the quality status of a given sub-division, while the absence of reported events is considered as “positive”. As additional element, to the sub-divisions ranked among the first three for frequency of occurrence of spills, an additional “negative” factor was considered.
- The second criterion focuses on CleanSeaNet data, which are used as an indicator of relatively smaller spills, related to minor incidents or illicit discharges. This second criterion has been weighted less than the previous one, to take into consideration the possibility of overestimation of the number and extension of spills reported in this dataset (as discussed in paragraph 1.1). Thus, a negative contribution to the overall status was considered only for the sub-divisions ranking among the first three in terms of average extension of areas affected by oil pollution.
- Finally, the third criterion refers to the temporal variation of the average number of spills (for all the three datasets) and their extension (for CleanSeaNet) between the assessment period (2018-2021) and the previous reference period (2013-2017 for MEDGIS-MAR and Lloyds; 2015-2017 for CleanSeaNet). An increasing trend is considered as negative for the overall assessment of the quality status, while a decreasing trend provides a positive indication.

74. The combined application of the three criteria led to the classification of the quality status of CI 19 in the Mediterranean sub-divisions in five classes: bad (red), poor (brown), moderate (yellow), good (green), high (blue), as shown in Table 15, and mapped in Figures 29&30. According to the adopted methodology, four sub-divisions are classified as bad or poor, five as moderate, one as good and none as high.

75. In addition, the summary assessments of the ten subdivisions have been qualitatively aggregated, to obtain a summary assessment for the four marine sub-regions of the Mediterranean Sea. This aggregation also considered the extension of the different sub-division included in each sub-region: “Moderate” has been assigned to the (Entire) Western Mediterranean Sea (EWMS), as this category prevails in its sub-divisions (WMS and TYRS), while the poor status value characterises only the relatively smaller Alboran Sea (ALBS). Similarly, “moderate” has been assigned to the Adriatic Sea (ADR) too, considering the prevalence of this category in its sub-divisions (MADR and SADR).

76. The qualitative average between the poor status of the Ionian Sea (IONS) and the good status of the Central Mediterranean (CEN) has determined the assignment of “moderate” to the (Entire) Central Mediterranean.

77. In the case of the Aegean and Levantine Seas (AEL) sub-region, the qualitative average evaluation led to define a” poor” status for the sub-region.

Table 15. Summary assessment of the marine environment status for CI 19 for sub-divisions of the Mediterranean Sea

Sub-division	Considerations for the assessment	Status of CI 19
ALBS	Spills reported, second highest | Increase (in most of the datasets)	POOR
WMS	Spill reported | Increase (in most of the datasets)	MODERATE
TYRS	Spills reported | Increase (in most of the datasets)	MODERATE
CEN	No spills reported | Increase (only CSN)	GOOD
NADR	Spills reported, third highest | Third ranked for satellite observation (area extension) | Increase (in most of the datasets)	POOR
MADR	No spills reported | First ranked for satellite observation (area extension) | Increase (only CSN)	MODERATE
SADR	No spills reported | Second ranked for satellite observation (area extension) | Increase (only CSN)	MODERATE
IONS	Spills reported, second highest | Increase (for most of the datasets)	POOR
AEGS	Spills reported, first highest in two datasets | Increase (for most of the datasets)	BAD
LEVS	Spills reported | Increase (only CSN)	MODERATE

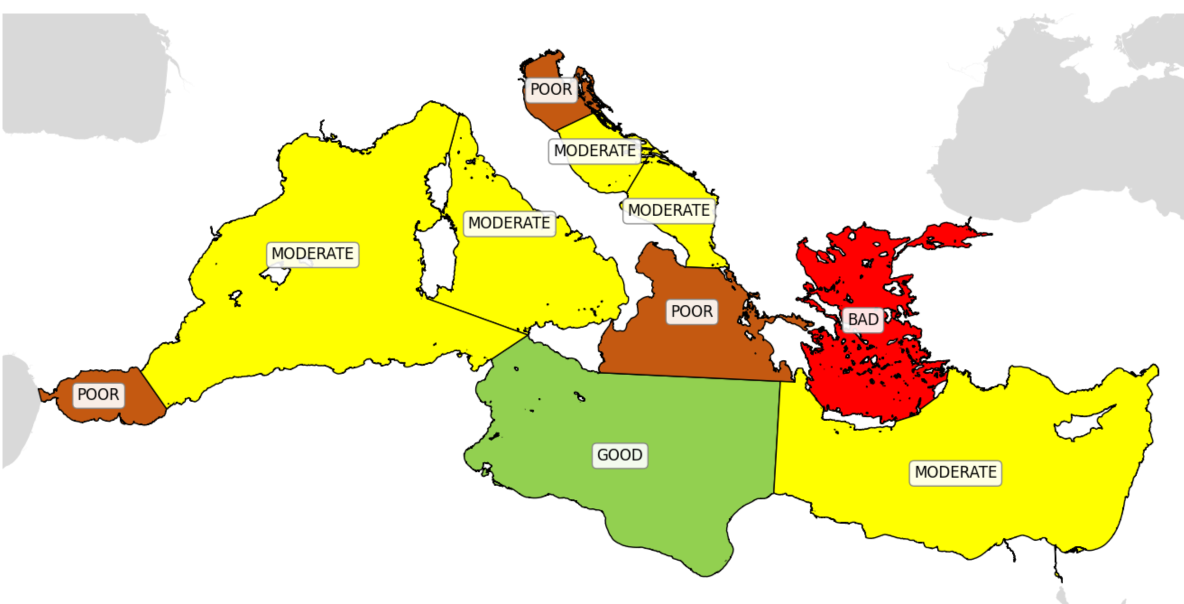

Figure 29. Map of the integrated assessment of the marine environment status for CI 19 for the sub-divisions of the Mediterranean Sea

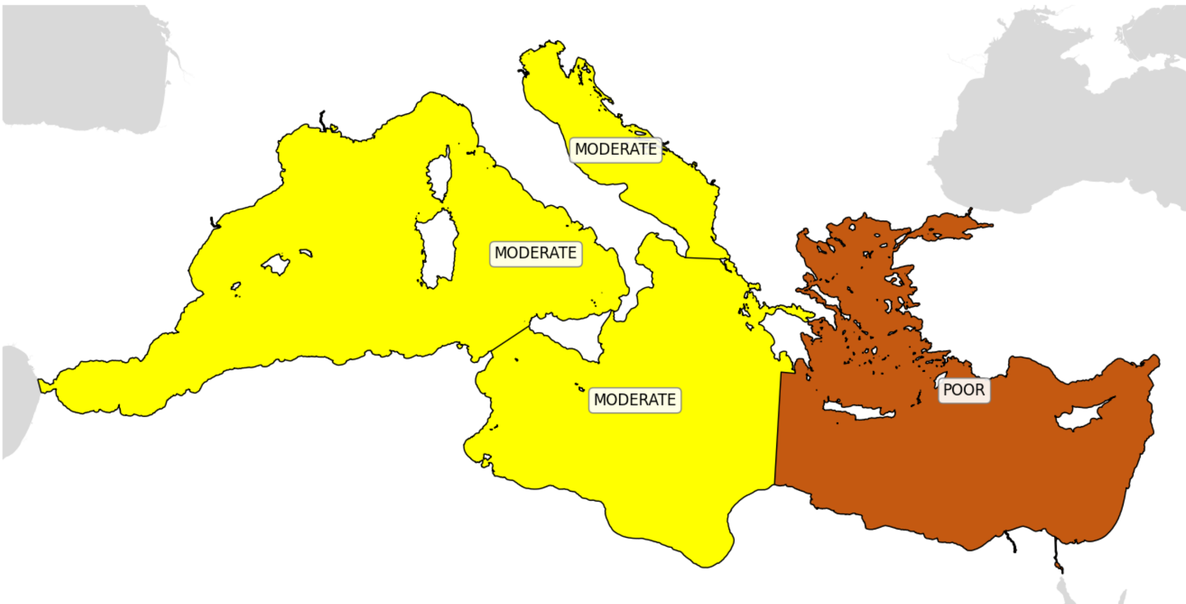

Figure 30. Map of the integrated assessment of the marine environment status for CI 19 for the four sub-regions of the Mediterranean Sea

78. It is worth noting that the methodology applied is subjected to uncertainty, mostly linked to the heterogeneity of the data sets it is based on. The results from the assessment should be interpreted as best knowledge-based indications on the status of CI 19, aiming at providing a relative indication of priority areas for future monitoring, assessment and, most importantly, pollution prevention measures.

5 Impacts from oil spills

79. Oil spills can determine severe impacts on the marine environment. Smothering, chemical toxicity (lethal or sub-lethal effects), direct ecological effects (e.g. loss of key organisms from an ecological community) and indirect ones (loss of habitat or shelter) are amongst the worldwide most frequently observed impacts. Oil characteristics are important in determining the extent of impact: heavy fuel oil (HFO) is less likely to cause toxic effects because its chemical components have low biological availability. Notwithstanding this such a type of fuel can cause extended damages in the intertidal zone of shoreline through smothering. Impacts can vary in severity also depending on the ambient conditions (winds. wave, currents, temperature, sunlight). Different sensitivity of organisms and their habitats to oil pollution is also relevant and it depends on the characteristic of the species, the period of the year, the stage of development of organisms and the environmental conditions.

80. Different impacts have been observed on different marine organisms (ITOPF, 2014a). In the case of plankton, significant declines in adult populations have not been observed due to the high recruitment rate of populations in the areas adjacent to the spill. Fish mass mortalities are rare too: adult fish are quite resilient to oil pollution and effects on wild stock levels have seldom been detected. Instead, seabirds are particularly vulnerable to oil because this substance damages the insulating properties of their plumage, which they require to survive in a maritime environment. Seabirds that spend most of their time afloat and that have little contact with the coast are the most vulnerable to oil pollution. Small amounts of oil in the plumage cause a bird to give up feeding and most casualties are due to starvation.

81. Large amounts of oil on the plumage cause instant immobility and possibly immediate death through suffocation and drowning (IFAW, 2013). Whales, dolphins and other cetaceans may be at risk from floating oil. Seals are more likely to suffer from the effects of oil, because they spend time onshore (ITOPF, 2014a). Floating oil may be a threat to turtles: loss of eggs and hatchings may occur if oil strands on sand beaches or if nests are disrupted during clean-up operations.

82. Regarding benthic habitats, seagrass and associated organisms may be impacted by oil spills at sufficiently high concentrations. Thanks to exposure to the scouring effects of wave action and tidal currents, rocky and sandy shores are the most resilient to the effects of a spill. While fine sediments are not as readily impacted, oil can become incorporated through flocculation with sediments stirred up by storm activity or penetration through worm burrows and open plat stems (ITOPF, 2014a). For example, the sinking of the tanker Eurobulker in the Southern Evoikos Gulf (Aegean Sea, Greece) in September 2000 resulted in a spill of 700 tons of crude oil. The most severe and direct effects were evidenced on the muddy benthic communities in the close vicinity, sampled shortly after the spill. The effects included reduction of the species richness and community diversity, but the communities reached full recovery 8 months later. The impact of the spill was more indirect and delayed in the coastal stations, whereas the hydrocarbon measurements indicated, the pollutants were transported later and induced their effects on the benthic communities 6 months after the accident (Zenetos et al., 2004)

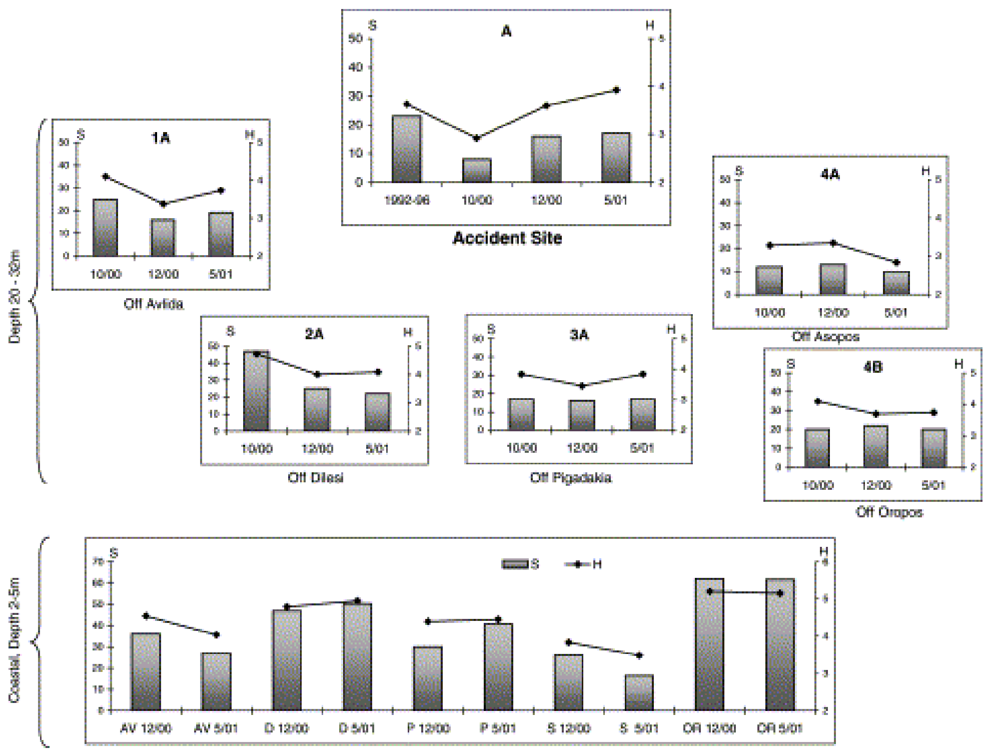

Figure 31. Temporal changes in the ecological indices (S: number of species, H: community diversity) at the sampling sites over the 8-month study period. The position of the plot frames in the figure represents the geographical orientation of the sampling sites in relation to the accident site. Source: Zenetos et al. (2004)

83. Following the chemical tanker Agia Zoni II sank in the Piraeus anchorage area in September 2017, the major consequences of the oil spill were constrained along the shoreline for a period of three months following the incident. No major findings regarding the presence of petroleum hydrocarbons were identified along the shoreline after December 2017 (REMPEC, 2019).

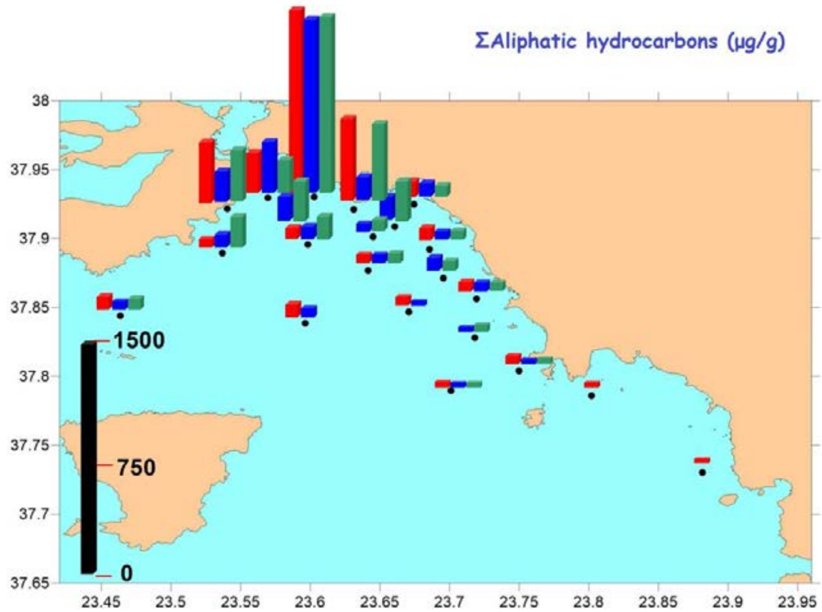

Figure 32. Concentrations of total aliphatic hydrocarbons (in μg/g of dry sediment) for the collected sediment samples on September 21-22nd 2017 (red colour), November 13-14th 2017 (blue colour) and January 23-24th 2018 (green colour) in the open Saronikos Gulf. Source: REMPEC (2019).

84. Oil spills can determine a wide variety of impacts on human activities, damaging economic sectors but also hindering the utilization of marine and coastal ecosystems by local communities, determining economic and societal impacts.

85. Oil spills can cause serious damage to fishery and mariculture resources through physical contamination, toxic effects on stocks and by disrupting business activities (ITOPF, 2014b). Main consequences are mortality of fish/shellfish caused by toxicity, damage to gears, facilities and boats, damage to the final product quality (through the tainting effect, meaning that the odour or flavour of oil is transferred to seafood). The occurrence of contamination in seafood organisms or products following a major spill can lead to public health concerns and may give raise to the imposition of fishing restrictions. Public health concerns and detection of taint are likely to lead to produce beige withdrawn from the market. A loss of primary market confidence may also occur leading to price reductions or outright rejection of seafood products by commercial buyers and consumers (ITOPF, 2014b).

86. Coastal tourism can also be impacted by disruption of traditional coastal activities such as bathing, boating, angling and diving. Such damages can determine a consequent effect for hotels, restaurants and bar, as well as sailing schools, camp sites, caravan parks and the many other businesses and individuals who gain their livelihood from tourism (ITOPF, 2014c).

87. Port operations are also susceptible to impacts related with oil spill (ITOPF, 2014c). Large vessels, leaving or entering the port, should move at slow speed to reduce wash that could disturb booms and other deployed resources, as well as to minimize the spread of floating oil around the port. Port, marinas and fishing harbours are usually enclosed by sea defences to protect moored vessels against adverse sea conditions. If oiled, these structures can be difficult to clean and they may become a source of secondary pollution. Once oil has entered a marina or a port the hull of vessels, mooring lines and berths can become oiled.

88. Sea water is widely used in a broad range of industries: as a coolant for thermal and nuclear power station and refineries, as a feedstock and as a coolant for desalination plants. The possibility the oil will be entrained into the water flow depends on the type of oil, the weather conditions and the design of the

intake itself. Occasionally, following an oil spill, water intake of electricity power plants are shut down as a precaution against damage to machinery and to avoid the more extensive shout-down of the entire plant should condenser tubes and other equipment need to be cleaned (ITOPF, 2014c).

5.1 CI 19 assessment: impact on biota

89. Common Indicator 19 is defined as "Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)". In the Mediterranean the data presently available do not allow to include in the assessment of this indicator the component related to the impacts on biota. In fact, as described above, few examples are available of monitoring of oil spill impacts in the region Mediterranean (e.g. spill in Baniyas, Syria in 2021- REMPEC, 2021; sinking of the Agia Zoni II, Piraeus, Greece in 2017 - REMPEC, 2019; spill from the Jieh power plant in Lebanon in 2006 - Saab et al., 2006). From available guidelines (re.g. the UK PREMIAM initiative: Kirby et al., 2018) and the experience available at European level (e.g. Belgium – Tornero et al. 2022), as well as from the above cases, monitoring of the following elements are recommended: visual survey of macroscopic evidences of pollution both on land and underwater (presence and extension of oil layers, tar-patches, dead or contaminated animals); chemical contamination of waters and sediments (total petroleum hydrocarbons, IPA, heavy metals); benthic communities (phytobenthos and zoobenthos); fish community; bioaccumulation in bivalves and fish. Based on such guidelines and experiences, REMPEC has recently prepared a revision of the Data Dictionary and Data Standard for CI19, by including also data aimed at assessment of impact on biota.

90. Based on the data that will be collected as indicated in the revised version of the Data Dictionary and Data Standard for CI19, we can expect the future QSR assessments will consider the impacts on biota too.

6 Suggested actions to improve the next assessments

91. From the experience of this study some possible actions can be identified to improve the assessment of the state of CI 19 in the next future.

92. *Improve quantity and quality of data*

- REMPEC to continue soliciting the submission of the report on incidents and spills from the Countries, underlining the importance to make use of the latest version of the Data Dictionary and Data Standard (DD&DS) prepared by REMPEC jointly with INFORAC and providing to any extent possible all the data required in DD&DS, including estimation of quantity and volume of oil or other substances released.
- The Countries to start collecting data on impacts on biota with reference to the above-mentioned updated version of DD&DS for CI 19.
- The Barcelona Convention system to align the definition of the minimum threshold for reporting with the one used under other regional sea conventions and in the framework of MSFD.
- REMPEC to continue to integrate newly available Lloyds data in MEDGIS-MAR database. REMPEC to prepare a comprehensive, integrated database, considering also old data, based on these two databases, cross-checking and resolving data duplication and inconsistencies.
- REMPEC to continue acquiring information and understanding about CleanSeaNet dataset and assessing the feasibility to integrate CleanSeaNet data for the Mediterranean in MEGIS-MAR.

93. *Improve the GES assessment*

- The definition of "acute pollution events" is highly debated under the Marine Strategy Framework

Directive and other Regional Sea Programmes and Agreements, in particular the Bonn agreement. It remains a complex issue for which consensus has yet to be reached. Additional work should be undertaken by REMPEC and the Countries to define operational criteria for the identification of acute pollution events. An integrated and escalating approach should be adopted, considering, among others, factors like the spilled volume, the nature of the spilled product(s), the proximity and sensitivity of threatened areas and/or human activities, the environmental conditions (i.e. evidence of an environmental impact), and the need for response operations.

- Based on data collected on impacts on biota, REMPEC and the Countries should work towards the definition of assessment criteria for CI 19 including biota as component, possible in coordination with other regional sea conventions.

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