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**The Marine Environment Assessment in the Areas with Insufficient Data: The Results of Assessment for IMAP
Common Indicator 21 in the Mediterranean**

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List of Abbreviations / Acronyms

AEL	Aegean and Levantine Seas Sub-region
ADR	Adriatic Sea Sub-region
BWQ	Bathing Water Quality
CEN	Central Mediterranean Sea Sub-region
CFU	Colony forming units
CI	Common Indicator
CORMON	Correspondence Group on Monitoring
COP	Conference of the Parties
CP	Contracting Party
EEA	European Environmental Agency
E. coli	Escherichia coli
EC	European Commission
EU	European Union
GES	Good Environmental Status
IE	Intestinal enterococci
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
Log	Logarithm
MAP	Mediterranean Action Plan
MED	Mediterranean
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
QSR	Quality Status Report
UNEP	United Nations Environmental Program
WMS	Western Mediterranean Sea Sub-region
WHO	World Health Organization

1. Introduction

1. This document updates and replaces the Working Document UNEP/MED WG.533/9 as amended and approved by the Meeting of CorMon on Pollution Monitoring held on 27 and 30 May 2022 (UNEP/MAP WG. 533/10, Appendix VII). In line with the Conclusions of the Meeting of CorMon on Pollution Monitoring, the present update is based on the assessment of new data reported by the CPs into IMAP IS by October 31st, 2022, the cutoff date for data reporting.

2. Updated Guidance Fact sheet for IMAP CI 21¹ was approved in 2019 further to the revised Mediterranean guidelines for bathing waters that was provided in 2007 based on the WHO guidelines for “Safe Recreational Water Environments” and on the EC Directive for “Bathing Waters” (Directive 2006/7/EC)². The latter was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data.

3. The initial target of GES under Common Indicator 21, as stated in the updated IMAP Guidance fact sheet for CI 21 “will be an increasing trend in measurements to test that levels of intestinal enterococci comply with established national or international standards and the methodological approach itself. Particularly, under Decision IG.20/9 and the EU 2006/7 Directive, excellent (95th percentile < 100 CFU/100 mL) or good (95th percentile < 200 CFU/100 mL) quality categories are set for the “last assessment” which means the last four years”.

4. The COP 17³ agreed on the threshold values in the Mediterranean region as presented in Table 1. In the present assessment these values are used to set the boundary limit between GES and non-GES status regarding the pathogens in bathing waters. Therefore, the categories A, B and C are considered as in GES while category D is considered as non-GES for intestinal enterococci (IE) in bathing waters in the Mediterranean.

Table 1. Microbial Water Quality Assessment Category based on Intestinal enterococci (cfu/100 mL) in bathing waters in the Mediterranean (Decision IG.20/9).

Category	A	B	C	D
Limit values	<100*	101-200*	185**	>185**(1)
Water Quality	Excellent	Good	Sufficient	Poor/Immediate Action

*Based on the 95th percentile; ** Based on the 90th percentile;

- ⁽¹⁾ For single sample appropriate action is recommended to be carried out once the count for IE exceeds 500 cfu/100 mL:
- For classification purposes at least 12 sample results are needed spread over 3-4 bathing seasons;
- Reference method of analysis: ISO 7899-2 based on membrane filtration technique or any other approved technique;
- Transitional period 4 years (starting by 1st January 2012).

5. For the indicator calculation, the IMAP Guidance fact sheet for CI 21 provides the methodology that has been proposed by Directive 2006/7/EC with the specification as explained here below.

¹ UNEP/MED WG473/7 Annex I

² IMAP Guidance Fact Sheet for IMAP CI 21 (UNEP/MED WG.473/7)

³ Decision IG.20/9 Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol, COP 17, Paris, 2012 (UNEP/MAP, 2012)

6. Based upon percentile evaluation of the log₁₀ normal probability density function of microbiological data acquired from the particular bathing water, the 90th and 95th percentile values are derived as follows⁴:

- i. Take the log₁₀ value of all bacterial enumerations in the data sequence to be evaluated; If a zero value is obtained, take the log₁₀ value of the minimum detection limit of the analytical method used instead;
- ii. Calculate the arithmetic mean of the log₁₀ values (μ);
- iii. Calculate the standard deviation of the log₁₀ values (σ);

7. The upper 90-percentile point of the data probability density function is derived from the following equation: upper 90-percentile = antilog ($\mu + 1,282 \sigma$).

8. The upper 95-percentile point of the data probability density function is derived from the following equation: upper 95-percentile = antilog ($\mu + 1,65 \sigma$).

9. It should also be noted that IMAP Guidance fact sheet for CI 21 sets the minimum sampling frequency i.e. at least one per month and not less than four in a bathing period, including an initial one prior to the start of the bathing period.

2. The assessment related to IMAP CI 21 provided in the MED QSR 2017 (<https://www.medqsr.org/background-ci21>)

10. The previously explained assessment methodology of IMAP CI 21 was considered for application during the preparation of the 2017 Mediterranean Quality Status Report (2017 MED QSR). At that time, no sufficient updated datasets were available, therefore the assessment was undertaken based on the assessment report from the European Environment Agency (EEA) on Bathing Water Quality (from 2015) that was then integrated with the assessment of monitoring data reported from Tunisia to MEDPOL (2014).

11. In the 2017 MED QSR, it was recommended to prepare the future assessments of IMAP CI 21 based on the statistics from datasets submitted by national authorities or/and the corresponding agencies. However, up to the end of March 2022, only a few data sets were reported to the IMAP-IS. Those are presented in Table 2.

Table 2. Available data for IMAP CI 21 in IMAP-IS starting from 2015 and up to October 31st, 2022, the cutoff date for data reporting for the 2023 MED QSR.

Source	IMAP file	Country	Sub-region	Year
IMAP-IS	403	Morocco	WMS	2018
IMAP-IS	404	Morocco	WMS	2019
IMAP-IS	616	Morocco	WMS	2020-2021
IMAP-IS	547-551	Spain	WMS	2017-2021
IMAP-IS	262,535	Bosnia and Herzegovina	ADR	2015-2021
IMAP-IS	385	Croatia	ADR	2016-2020

⁴ UNEP/MED WG473/7 Annex I

Source	IMAP file	Country	Sub-region	Year
IMAP-IS	653	Croatia	ADR	2021
IMAP-IS	655	Croatia	ADR	2022
IMAP-IS	#	Montenegro	ADR	2017-2021
IMAP-IS	146	Slovenia	ADR	2019
IMAP-IS	440	Slovenia	ADR	2020
IMAP-IS	642	Slovenia	ADR	2021
IMAP-IS	490	Malta	CEN	2016-2020
IMAP-IS	147	Lebanon	AEL	2019
IMAP-IS	649	Lebanon	AEL	2017-2021
IMAP-IS	605	Israel	AEL	2021

Reported directly to MEDPOL, still to be uploaded in the IMAP-IS.

3. Location of sampling stations

12. Given lack of data reported by the CPs prevents implementation of the recommendations of COP 19, the input for the 2023 Mediterranean Quality Status Report (2023 MED QSR) related to the assessment of IMAP CI 21 was performed using the approach applied for the 2017 MED QSR. Namely, it combines the assessment results as presented in the assessment report⁵ from the European Environment Agency (EEA) on the State of Bathing Water Quality in 2020⁶ and the assessment of monitoring data reported for IMAP CI 21 from Bosnia and Herzegovina, Israel, Lebanon, Montenegro and Morocco (Table 3).

13. Recent data Croatia (2021-2022) and Slovenia (2021) were reported into IMAP-IS. However, for consistency, the status of Croatia and Slovenia were not re-assessed by applying the approach used for the data set reported by Montenegro, Morocco and Lebanon (see para 14 and 15) and the assessment was based on the EEA 2020 assessment of the state of bathing water quality. The data were analyzed only to check for possible problem areas.

⁵ <https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/assessments/state-of-bathing-water/state-of-bathing-waters-in-2020>

⁶ The updated IMAP Guidance fact sheet for CI 21 provided in 2019 mentions the EEA as an available data source for some Mediterranean countries European and non-European.

Table 3. Details of data on CI 21 available from IMAP_IS used in the assessment update compared to initial results (UNEP/MED WG. 533/10, Appendix VII).

Source	IMAP file	Country	Sub-region	Year	Number stations	Number of data points per station
IMAP-IS	403-404	Morocco	WMS	2018-2019	129	10*
IMAP-IS	616	Morocco	WMS	2020-2021	147	15
IMAP-IS	262	Bosnia and Herzegovina	ADR	2017-2020	3	9,10,13
IMAP-IS	#	Montenegro	ADR	2017-2020	23	30-39
IMAP-IS	605	Israel	AEL	2021	105	20-184
IMAP-IS	649	Lebanon	AEL	2017-2021	38^	12-47

Reported directly to MEDPOL, still to be uploaded in the IMAP-IS, *9 stations with less than 10 data points. ^ Not all stations available for all years.

14. The methodology used in the EEA 2020 assessment of the state of bathing water quality was as defined in the EU 2006/7 Directive and in IMAP decision IG.20/9, i.e. the classification of the bathing waters was provided according to the 90th or 95th percentile of the log10 normal probability density function of microbiological data. The number of data points for each location was at least 16, over 4 bathing seasons⁷, at least 4 for each bathing season. It should be mentioned that the EU 2006/7 Directive defines two indicators: Intestinal enterococci (IE) (cfu/100 ml) and Escherichia coli (E. coli) (cfu/100 ml). Therefore, the classification of the bathing waters is based on the combination of both microbiological parameters, classifying the stations based on the worse status between the two criteria⁸. For example, if status for IE is excellent but for E. coli the status is poor, the station is classified as poor.

15. The same methodology used in the EEA 2020 of the state of bathing water quality was applied to the data set reported by Montenegro, Morocco and Lebanon using just intestinal enterococci as indicator.

16. This methodology could not be applied to data from Bosnia and Herzegovina and Israel because 16 data points for 4 consecutive bathing seasons were not available (Table 3). Therefore, for these 2 CPs, the classification was based on the geometric mean calculated for each location. The geometric mean was chosen because it reduces the effect of outliers on the mean and is not influenced by skewed distribution as the arithmetic mean. Table 4 compares between the two methodologies.

⁷ Exceptions are outlined in Directive 2006/7/EC and in Decision IG.20/9. Shortly, bathing water quality assessments may be carried out on the basis of three bathing seasons if the bathing water is newly identified or any changes have occurred that are likely to affect the classification of the bathing water. Sets of bathing water data used to carry out bathing water quality assessments shall always comprise at least 16 samples. Only 12 samples may be used to assess bathing water quality in special circumstances when the bathing season does not exceed 8 weeks or location is situated in a region subject to special geographical constraints (Annex IV, paragraph 2).

⁸ EEA Guidelines for the assessment under the Bathing Water Directive Prepared by: ETC/ICM (Lidija Globevnik, Luka Snoj, Gašper Šubelj), October 2021

Table 4: Comparison between the methodology used by the EEA and the methodology used in present document for the assessment of Bathing waters quality (CI-21)

Assessment methodology	EEA	Present assessment of IMAP CI 21*
Assessment Category	Based on Intestinal enterococci and Escherichia coli (cfu/100 mL)	Based on Intestinal enterococci (cfu/100 mL)
Number of data points	At least 16	Less than 16, depending on the CP*
Number of monitoring years	4	Less than 4, depending on the CP*
Classification of station	percentile evaluation of the log10 normal probability density function	Geometric mean

* Bosnia and Herzegovina, and Israel. Lebanon, Montenegro and Morocco were classified using the same methodology as the EEA, using 16 data points over 4 consecutive bathing seasons, however using just Intestinal enterococci values and by applying percentile evaluation of the log10 normal probability density function.

4. The assessment findings related to IMAP CI 21 and Discussion

17. The results of the assessment of the state of bathing water quality for Mediterranean countries, EU Member States and Albania are presented in Figure 1. Most (>90%) of the bathing waters in all countries were in the excellent and good GES classifications. A small percentage of bathing waters were classified as poor D category: 0.1% in Spain, 1% in France, 1.7% in Italy and 3.5% in Albania.

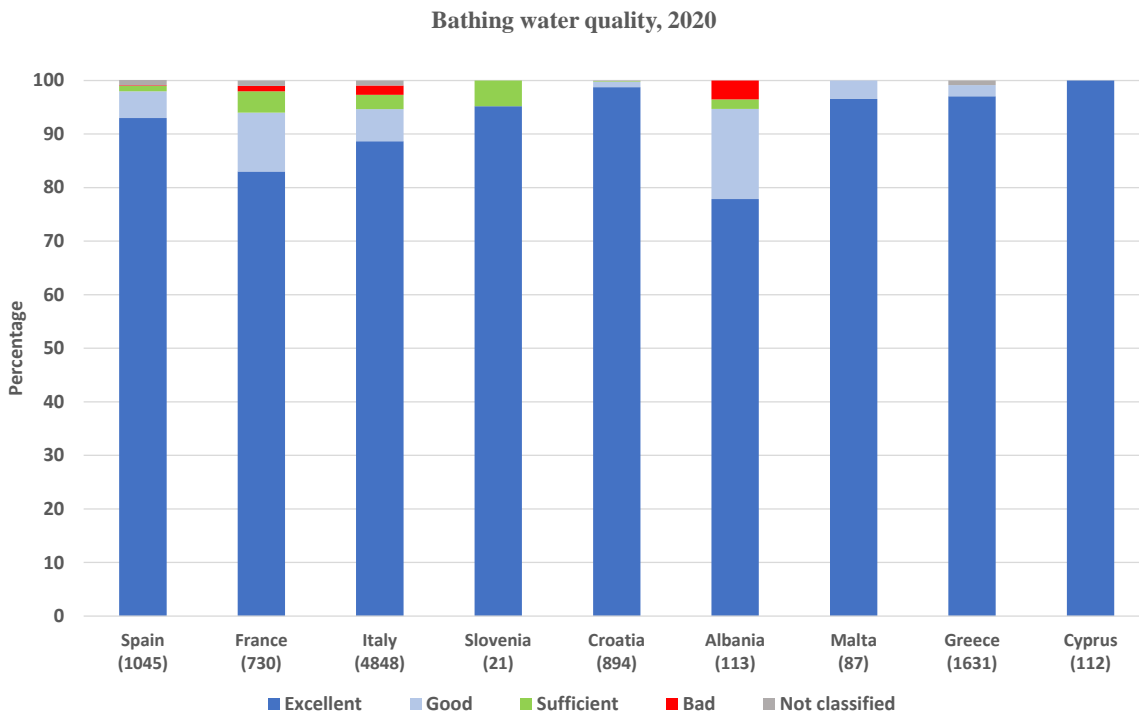


Figure 1: Percentages of the bathing water quality assessment with respect to IMAP CI 21 in 2020 for some Contracting Parties of the Barcelona Convention. (Source: EEA, 2020). In parenthesis, number of stations.

18. The analysis of the data reported into IMAP-IS by Croatia (2021-2022) and Slovenia (2021) indicated that the classification status of bathing water quality for both countries are the same as the status provided in the EEA 2020 assessment shown in Figure 1.

19. The results of the assessment of the status of bathing water quality performed with data available from IMAP-IS for Lebanon, Montenegro and Morocco are presented in Figure 2, and for Bosnia and Herzegovina and Israel in Figure 3.

20. **Lebanon.** Data were available for 38 stations for the years 2017-2021, although 7 stations had no data available for all years (Table 3) and therefore were not classified due to insufficient data. Out of the 31 available stations, 6 stations were classified as in excellent category, 13 stations as in good category, 4 as in sufficient category, and 8 in bad category. The percentage of the stations in GES (excellent, good and sufficient category) was 74%. Four out of the 8 stations in bad category were classified as such based on data reported for almost all sampling days during all years. The stations were : Dbayeh Public Beach (DBY-2), Antelias – River Mouth (ANT-2), and Beirut (BEY-4, light house and BEY-6 Ramlet-El-Bayda Public Beach). If the 7 stations with insufficient data were taken into account, the percentage of the stations in-GES would be 61%.

21. **Montenegro:** Data were available for 23 stations for the years 2017-2020 (Table 3). As explained, bathing waters quality in Montenegro was classified using the same methodology as the EEA, at least 16 data points over 4 seasons, however using just Intestinal enterococci values and by applying percentile evaluation of the log₁₀ normal probability density function. Four stations had data available for only 3 bathing seasons, but they were classified in the same way, based on the exceptions outlined in Directive 2006/7/EC and in Decision IG.20/9. Out of the 23 available stations, 21 were classified in excellent category and 2 in good category.

22. **Morocco:** Data were available for 129-147 stations for the years 2018-2021 (Table 3). Sixteen stations were not sampled at each year and therefore could not be classified⁹. Out of the 131 available stations, 45 stations were classified in excellent category, 49 stations in good category, 17 in sufficient category and 20 in bad category. The percentage of the stations in GES (excellent, good and sufficient category) was 85%. If the 16 stations with insufficient data were taken into account, the percentage of the stations in-GES would be 76%.

⁹ Stations can be classified only if at least 12 sample results, spread over 3-4 bathing seasons, are available. Non-classified stations could be either in-GES or non-GES.

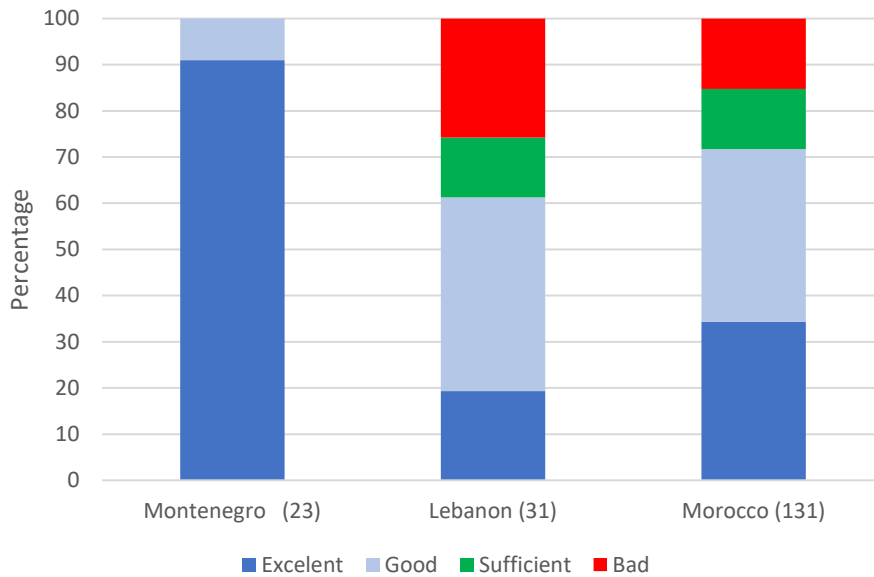


Figure 2: Percentages of the bathing water quality assessment with respect to IMAP CI 21 in 2020 for Lebanon, Montenegro and Morocco (Source IMAP InfoSystem). In parenthesis, number of stations.

23. **Bosnia and Herzegovina:** Data were available for 3 stations for the years 2017-2021 (Table 3). All 3 available stations were classified in excellent category.

24. **Israel:** Data were available for 105 stations for 2021 (Table 3). All the stations were classified in excellent category.

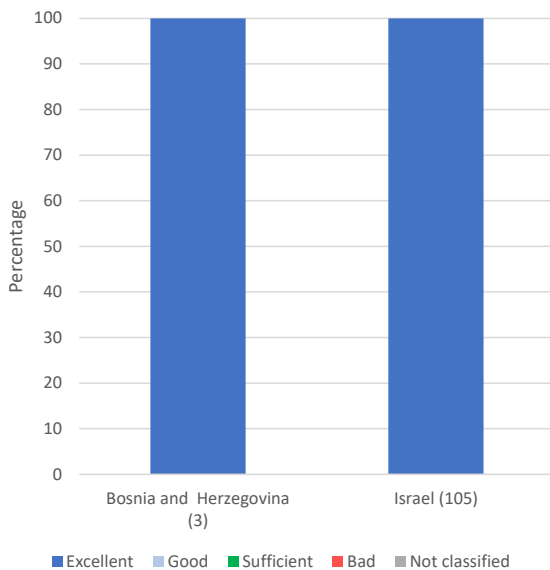


Figure 3: Percentages of the bathing water quality assessment categories with respect to IMAP CI 21 for Bosnia and Herzegovina, and Israel. (Source: IMAP InfoSystem). In parenthesis, number of stations.

5. The key findings

25. In line with the findings on the status of bathing water, as provided above in Section 4, based on the available data, the Mediterranean bathing waters can be classified in GES (excellent, good and sufficient status) whereby percentage are higher than 85% for the CPs for which the assessment was undertaken. Only for Lebanon the percentage of stations in-GES were 74%, however, mainly due to 4 stations. The confidence of this evaluation is high for areas with sufficient data points and bathing seasons and less so for areas with less data. Some areas of the Mediterranean could not be assessed given no data were reported.

26. The sub-regions with good representation were the Adriatic Sea Sub-region (ADR) with data from all the Adriatic countries (partial data for Bosnia and Herzegovina); and the Western Mediterranean Sea Sub-region (WMS) (with data from Morocco, Spain, France and Italy). The Central Mediterranean Sea Sub-region (CEN) had data from Italy, Malta and Greece, while the Aegean and Levantine Seas (AEL) Sub-region had data from Greece, Cyprus, Lebanon and Israel (partial).

27. Most of the data were available through EEA and not through IMAP IS, even up to October 31st, the cut off data for reporting for the 2023 MED QSR. It must be noted that the lack of data reporting for IMAP CI 21 into IMAP IS is a key obstacle to undertake related assessments for the preparation of the 2023 MED QSR. The evaluation of the state of the Mediterranean bathing waters should be improved by reporting additional data from the sub-regions/ sub-divisions with low quantity of data or no data reported. Therefore, the present assessment findings call on CPs to report monitoring data related to IMAP CI 21 so that they can be taken into account in the future, especially in the case of the countries that have established monitoring programs for CI 21 and regularly implement them.

28. It also must be noted that sufficient data reporting i.e., 16 data points for 4 consecutive bathing seasons would allow the application of uniform assessment methodology across the Mediterranean, therefore increasing the comparability and consistency of the assessment findings.

29. Compared to the 2017 MED QSR, the current assessment includes five CPs instead of one CP with data reported to IMAP_IS, along with the CPs assessed within the EEA 2020 assessment of the state of bathing water quality. However, lack of data reporting to IMAP IS implies the use of different assessment approaches that may bring certain discrepancy. Although the present situation is better than in 2017, more data must be reported by the CPs in order to provide comparable and consistent assessment findings.

Annex I
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