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1st Report of the Informal Online Working Group on Eutrophication

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I. Introduction

In the framework of the gradual application of the ecosystem approach (EcAp) for the management of human activities in the Mediterranean region, it is necessary to assess the environmental status of marine areas using well defined methodological criteria. In order to decide if a marine area is in "Good Environmental Status" (GES), it is necessary to establish threshold values for key parameters in order to distinguish between acceptable (good) and unacceptable (not good) environmental conditions.

In the Mediterranean region, threshold values for eutrophication related parameters are lacking and have to be developed. To date UNEP/MAP-MED POL work on monitoring of nutrients and chlorophyll-a in marine environment has resulted in background information and on the methodology to be followed for the definition of thresholds for the Mediterranean.

In line with the recommendations of the Integrated EcAp Correspondence Group on Good Environmental Status (GES) and Targets Meeting (UNEP(DEPI)/MED WG.3940/4), in the context of the Barcelona Convention a common indicator is an indicator that summarizes data into a simple, standardized and communicable figure and is ideally applicable in the whole Mediterranean basin, but at least on the level of sub-regions and is monitored by all CPs. A common indicator is able to give an indication of the degree of threat or change in the marine ecosystem and can deliver valuable information to decision makers.

In accordance with the relevant decisions of COP 18, there is now a need to advance this important work in order to finalize the development of well-defined methodological criteria. The CorrGEST meeting held in February 2014 in Athens agreed on the following common indicators with regards to ecological objective 5 on Eutrophication:

Table 1. Eutrophication common indicators (ecological objective 5)

Common Indicator 7	Concentration of key nutrients in the water column
Common Indicator 8	Chlorophyll α concentration in the water column

II. Objectives of the informal online working group on eutrophication

Based on the above common indicators, the main objective of the work of the informal online expert working group is to deliver threshold values based on data availability and a proposal on eutrophication assessment criteria.

III. Composition of the group and preparation of the report

Group members with experience in providing practical scientific advice and the range of expertise applicable to the task are nominated by contracting parties. The nominated expert have scientific background and experience on statistical interpretation of field data, including trend analysis. Following communication on this matter the list the group's members is given in Annex I.

The work of the informal online working group on eutrophication (Eutrophication Working Group) is chaired by Dr Kalliopi Pagou (Greece). Eutrophication Working Group experts who provided input into this First Report of the Eutrophication Working Group include : Professor Mohamed Dorgham (Egypt), Dr Dilek Ediger (Turkey), Dr Robert Precali (Croatia), while comments and some information was given by Dr Marinko Antunović (Bosnia Hercegovina), Dr Franco Giovanardi and Dr Erica Magaletti (Italy) and Dr Suleyman Tugrul (Turkey). The full list of experts is given in Annex I. Furthermore, the chair of the group, Dr Kalliopi Pagou (Greece) was supported by a group of HCMR experts: Dr A. Pavlidou, Dr G. Assimakopoulou and Dr I. Varkitzi.

The full list of experts of the Eutrophication Working Group is given in Annex I.

IV. Common definitions on thresholds, baseline and assessment criteria for eutrophication

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. Therefore core group of experts accept the definitions of common indicators 7 & 8.

For the purpose of the UNEP/MAP Barcelona Convention Integrated Monitoring and Assessment Programme, Integrated (Ecosystem) Assessment means both a process and a product.

As a process, an assessment is a procedure by which information is collected and evaluated following agreed methods, rules and guidance. It is carried out from time to time to determine the level of available knowledge and to evaluate the environmental state.

As a product, an assessment is a report which synthesises and documents this information, presenting the findings of the assessment process, typically according to a defined methodology, and leading to a classification of environmental status in relation to GES

According to UNEP(DEPI)MED WG 401/3 three approaches may be used for GES determination:

a. In order to assess quantitatively the achievement of GES in relation to eutrophication, a measurable assessment threshold may be set, including the definition of reference conditions. GES assessment thresholds and reference conditions (background concentrations) may not be identical for all areas, especially where the marine environment is already disturbed by human presence for many years. In these cases a decision has to be made whether to set the threshold value for GES achievement independently to the setting of the reference conditions. The approach is based on the recognition that area-specific environmental conditions must define threshold values. A threshold value could include provisions to allow for statistical fluctuations (example: No nutrients and chl-a values exceeding the 90th percentile are present in a frequency more than statistically expected for the entire time series). GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.

b. A second approach to determine GES for eutrophication is to use trends for nutrients contents, and direct and indirect effects of eutrophication. When using the trend approach, a reference value representing the actual situation is needed, for comparison. In the case of nutrients and chl-a, such reference values exist due to data availability in most areas. Therefore, GES could be defined as no increasing trends in nutrient and/or chlorophyll-a concentrations over a defined period of time in the past (ex. 6 years), which are not explained by hydrological variability. For indirect effects, GES could ask for no decreasing trend in oxygen saturation beyond what would be statistically expected.

c. GES thresholds and trends are recommended to be used in a combined way, according to data availability and agreement on GES threshold levels. In the framework of MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between "good" (GES) and "moderate" (non GES) conditions for coastal waters could be based as appropriate on the work that is being carried out in the framework of the MED GIG intercalibration process of the EU Water Framework Directive (WFD), a project closely followed by the MED POL programme.

In this context, sub-regional thresholds have been proposed for chlorophyll-a only, in three types of marine water based on seawater density (Sigma_t annual mean values). Description of this water typology follows:

1. Description of the Typology scheme

A considerable number of eutrophication experts have built a typology scheme for the Mediterranean during the first inter-calibration phase for the EU Water Framework Directive implementation which is still in use and represents a very simple typology approach that could be easily applied Mediterranean wide.

Typology is very important for further development of classification schemes of a certain area.

The recommended water types for applying eutrophication assessment is based on hydrological parameters characterizing a certain area dynamics and circulation. The typological approach is based on the introduction of a static stability parameter (derived from temperature and salinity values in the water column): such a parameter, on a robust numerical basis, can describe the dynamic behaviour of a coastal system. It is accepted that surface density is adopted as a proxy indicator for static stability as both temperature and salinity are relevant in the dynamic behavior of a coastal marine system. More information on typology criteria and setting is presented in document UNEP (DEPI) MED WG. …..

On the basis of surface density and salinity values three major water types have been defined:

Table 2. Definition of major water types in Mediterranean.

	Type I	Type II	Type III
σ t (density)	<25	25<d<27	>27
salinity	<34.5	34.5<S<37.5	>37.5

The three different water types, in an ecological perspective, can be described as follows:

- Type I coastal sites highly influenced by freshwater inputs
- Type II coastal sites not directly affected by freshwater inputs
- Type III coastal sites not affected by freshwater inputs

In addition, the splitting of the coastal water type III in two different sub-basins, the Western and the Eastern Mediterranean ones, according to the different trophic conditions, well documented in literature was also done. Some examples of Water Types presence finally defined for the European countries, Party to the Barcelona convention and LBS Protocol are shown in the Table 3.

Table 3. Examples of water types in Mediterranean countries

New types		**Croatia**	**Cyprus**	**France**	**Greece**	**Italy**	**Slovenia**	**Spain**
	Description							
Type I	Highly influenced by freshwater input			**X**		**X**		
Type II	Moderately influenced by freshwater input	**X**		**X**		**X**	**X**	**X**
Type III WM	Not influenced by freshwater input	**X**		**X**		**X**		**X**
Type III EM	Not influenced by freshwater input		**X**		**X**			

2. Thresholds and reference conditions for chlorophyll-a in the different water types

Reference and threshold (Good/Moderate status) values (based on long time series (>5 years) of monthly sampling at least) differ from type to type on a sub-regional scale and were built with different strategies. Summaries values are given in table 4.

Table 4. Reference and threshold values of Chla in Mediterranean water types.

Coastal waters Typology	Reference conditions of Chla (μg L^{-1})		Boundaries of Chla (μg L^{-1}) for G/M status	
	G_mean	90% percentile	G_mean	90% percentile
Type I	1.4	3.93	6.3	17.7
Type II-FR-SP		1.28		3.50
Type II-A Adriatic	0.33	0.8	1.5	4.0
Type II-B Tyrrhenian	0.32	0.77	1.2	2.9
Type III-W Adriatic			0.64	1.7
Type III-W Tyrrhenian			0.48	1.17
Type III_W FR-SP		0.79		1.89
Type IIIE GR-CY		0.1		0.4

Note: The 90th percentile and the geometrical mean can be derived one from the other according to the following equation:

Chl-a 90th p. = 10^(Log10 (G_mean Chl-a) + 1.28 x SD).

The above boundaries developed under the EU WFD 2nd intercalibration phase and the 3rd MED GIG intercalibration phase results which are being finalised. With regard to nutrient concentrations, until commonly agreed thresholds have been determined, negotiated and agreed upon at a sub-regional or regional level under the ECAP process, GES may be determined on a trend monitoring basis (as discussed on paragraph b above).

V. List, review and analysis of the available metadata and reports on eutrophication common indicators in Mediterranean Sea.

The eutrophication working group experts had and will continue uploading in the InfoMAP groupware MED POL library, information on eutrophication metadata and reports, according to:

- Geographical axis (national, subregional, regional)
- Temporal axis

based on:

- Relevant available data and/or reports and papers,
- Relevant web-sites links

At the time of the drafting of this preliminary report of the eutrophication working group (March 2015), the core group of experts from several Mediterranean countries made available data and

metadata on eutrophication from several countries from 2000 up to day. The metadata are listed to table 5. However, more metadata and information is needed to be incorporated from other Mediterranean countries and especially from Southern Mediterranean.

These meta data and data will be used to find out potential differences or similarities on eutrophication studies among Mediterranean countries in regional and sub-regional axis, in order to identify today existing inconsistencies and gaps, research needs, to propose ways to overcome and apply common methodologies feasible to follow regionally, in order to deliver if possible common threshold values sub-regionally based on data availability and a proposal on common eutrophication assessment criteria, as those in Tables 2 and 4, applicable in at least sub-regional level.

For examble: Eutrophication related data from Greece, such as nutrient concentrations (nitrates, ammonium, phosphates) and phytoplankton parameters (mostly chlorophyll-a, less phytoplankton density) are available from a wide range of coastal areas. In the frame of the WFD implementation, a great number of monitoring sites were added recently, covering all coastal water bodies of Greece. In the case of two metropolitan coastal areas, long times series data are available (Saronikos and Thermaikos Gulfs).

At this stage this work has been initiated but still is far from being completed. The data from table 5, already show that they differ among the countries which submitted them in relation to sampling frequencies, depths, whereas sampled parameters were more or less in agreement.

Furthermore, the Eutrophication Working Group experts noted that more detailed information on meta-data can also be found in the European project IRIS-SES inventory and meta-data base including pressure analysis and EMODNET data base and PERSEUS outcomes.

Table 5. **Metadata on eutrophication related monitoring in some Mediterranean countries**

Country	**Croatia**	**Greece**	**Egypt**	**Turkey-1**	**Turkey-2**	**Turkey-3**	**Turkey-4**	**Turkey-5**
Organization	IOF & CMR	HCMR: Hellenic Centre for Marine Research	MSEA: Ministry of State for Environmental Affairs and EEAA: Egyptian Environmental Assessment Authority	METU_IMS / Ministry of Environment	Derinsu LTD (company consortium) / Ministry of Environment and Urbanization	ALKA (company consortium) / Ministry of Environment and Urbanization	TUBITAK-MRC consortium including METU-IMS / Ministry of Environment and Urbanization	DEU-IMST
Sub_Basin	Adriatic	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean	Eastern Mediterranean
Area	Eastren Adriatic	Saronikos Gulf, Thermaikos Gulf, WFD stations network	Along the Egyptian Mediterranean coast, from Salloum in the west to Rafah in the east.	Mersin Bay	Mediterranean and Aegean Sea_coastal waters	Mediterranean and Aegean Sea_coastal waters	Mediterranean and Aegean Sea_coastal waters	İzmir Bay
Activities associated to pressures	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.	Harbours, marinas, sewerage and untreated sewage discharges, riverine inputs, industrial zone, tourism, aquaculture farms.				
Proposed frequency	monthly or seasonally	monthly or seasonally	seasonally	bimonthly	2 times/yr (summer, autumn)	2 times/yr (summer, autumn)	2 times/yr (winter, summer)	seasonally
Actual frequency	seasonally	seasonally	seasonally	4-8 times/yr	2 times/yr (summer, autumn)	2 times/yr (summer, autumn)	2 times/yr (winter, summer)	seasonally

Number of Stations	17	80	47	16	85	139	122	37
Surface/water column	water column	water column	surface/bottom	water column	at 3 depths	at 3 depths	water column	water column
Start/end of data series	2000-to date	2000-to date	1998 to date	2005-2010	2011	2013	2014-2016	2000-2015
PO4	X	X	X	X	X	X	X	x
TP	X	X	X	X	X	X	X	x
DOP								
SiO4	X	X	X	X	X	X	X	x
TNOx	X	X	X	X	X	X	X	x
NO2	X	X	X	X	X	X		x
NH4	X	X	X	X	X	X	X	x
TN	X	X	X					
DON								
POC								
DOC								
HumicSubs								
Chla	X	X	X	X	X	X	X	x
Dissolved Oxygen	X	X	X	X	X	X	X	x
Secchi disk	X	X	X		X	X	X	x
Phytoplankton	survey and laboratory analysis	X	X (some sts)	X	X (some sts)	X (some sts)	X (some sts)	x
In-situ fluorescence profile	available upon request	X (some sts)					X	
Method	http://baltazar.izor.hr/azopub/bindex	Standard and common	Various methods	Standard and common	Standard and common	Standard and common	Standard and common	Standard and common
Data availability		available upon request	available upon request	available upon request	available upon request	available upon request	available upon request	available upon request
Web links								
Comments								

VI. Review and catalogue on methods and criteria for eutrophication assessment, existing target values and thresholds of eutrophication parameters

During the Eutrophication Working Group discussions, the current advances on assessment methods, criteria, targets and thresholds were mentioned and described, if possible, according to a:

- National
- Subregional
- Regional

It emerged that in sub-regional level in Mediterranean only the results of the MEDGIG exercise used in the implementation of WFD can be mentioned as an assessment method providing targets and thresholds but regarding only the chla concentrations for marine water quality status, as described above in subchapter 4. However, this method can be applicable in a wider scale in Mediterranean and countries are invited to test it. However, a combination rule to combine all eutrophication parameters assessment has to be defined.

However, a rather large set of methods, criteria and targets for a more integrated eutrophication assessment exist, which are used mostly in national level and less frequently in a multinational level, based either to nationally developed and adopted methods or adopted and adjusted methods from other European regional seas toolboxes, as those of HELCOM.

Some examples of these used methods in several Mediterranean countries are presented below.

Greece (and Cyprus)

The eutrophication assessment method used in Greece and Cyprus is based on the eutrophication scale developed by Ignatiades *et al.* (1992), Karydis (1999) and Pagou *et al.* (2002), and has been used extensively ever since.

The original eutrophication scale (table 6) included four levels of eutrophication: eutrophic, higher mesotrophic, lower mesotrophic and oligotrophic.

Table 6. The Greek eutrophication scale involves four levels of trophic status, as mentioned above:

	Tophic status			
Parameter	**Oligotrophic**	**Lower mesotrophic**	**Upper mesotrophic**	**Eutrophic**
N-NO_3 (μM)	<0.62	0.62 - 0.65	0.65 - 1.19	>1.19
N-NH_4 (μM)	<0.55	0.55 - 1.05	1.05 - 2.20	>2.20
P-PO_4 (μM)	<0.07	0.07-0.14	0.14 - 0.68	>0.68
Chlorophyll α (μg L^{-1})	<0.10	0.10 - 0.60	0.60 - 2.21	>2.21
Phytoplankton density (cells L^{-1})	<6 10^3	6 10^3 - 1.5 10^5	1.5 10^5 - 9.6 10^5	>9.6 10^5

In order to fit the five step ecological status scale of WFD, chlorophyll-a values were modified by Simboura *et al.* (2005) by splitting the lower mesotrophic range in two, resulting in the good quality class and the moderate quality class (see following Table 7).

The boundaries of this new scale were intercalibrated during the WFD Intercalibration activity (Simboura *et al.* 2015). The five ecological status scale as modified for the WFD needs based on chlorophyll-a values from the Greek eutrophication scale (Simboura *et al.* 2005), is presented below (the splitting of the lower mesotrophic range into two was performed by using the median value of the

two boundary limits (0.1–0.6), resulting into the good quality class (0.1–0.4) and the moderate quality class (0.4–0.6) (Simboura *et al*. 2005)).

Table 7. The new eutrophication scale based on chla concentrations (Simboura *et al.* 2005).

Eutrophication scale	**Chlorophyll α ($\mu g\ L^{-1}$)**	**Ecological Status**
Oligotrophic	< 0.1	High
Lower mesotrophic	0.1 – 0.4	Good
Mesotrophic	0.4 – 0.6	Moderate
Higher mesotrophic	0.6 – 2.21	Poor
Eutrophic	>2.21	Bad

More recently, the Eutrophication Index (EI) of Primpas *et al.* (2010) was proposed for the assessment of the eutrophication status in Greek coastal waters, combining the concentrations of nutrients (phosphate, nitrate, nitrite, ammonia) and the chlorophyll-α biomass into a single formula. E.I. is also adapted to a five step ecological status scale of WFD (see following Table). Simboura *et al*. (2015) have elaborated E.I. over a wide range of coastal areas in Greece.

According to the Eutrophication Index ranges reported by Primpas *et al.* (2010), oligotrophy corresponds to the ranges of EI (0.04-0.38), mesotrophy to the EI range (0.37-0.87) and eutrophication to EI (0.83-1.51). The upper limit of the moderate range of the EI scale was set as the average of the lower limit of the eutrophic and the upper limit of the mesotrophic groups (Table 8).

Table 8. Eutrophication assessment and status scale according to Primpas *et al.* (2010).

Ecological Status	**Eutrophication Index**
High	less than 0.04
Good	0.04-0.38
Moderate	0.38-0.85
Poor	0.85-1.51
Bad	higher than 1.51

It must be reminded here that for Greece, target values are the values consistent with oligotrophic status and thresholds are the boundaries between the lower and upper mesotrophic status.

Croatia (and Slovenia, Italy for Adriatic Sea)

In 2001 an Eutrophication degree (status) classification scheme (Table 9) was developed and used for the evaluation along the Croatian cost. The classification scheme was supplemented with TRIX taken from the Italian legislation (D. LGS. 152/99).

Table 9. Croatian eutrophication degree (status) classification scheme.

Eut. status Eut. degree Color	**z_{Sd}/m**	**$\gamma(O_2/O_2')$**	**$c(TIN)^{-1}$ µmol L^{-1}**	**$c(TP)^{-1}$ µmol L^{-1}**	**$c(Chla)^{-1}$ µg L^{-1}**	**TRIX**	**Description**
High Oligotrophic Blue	**>10**	**0.8-1.2**	**<2**	**<0.3**	**<1**	**2-4**	- low trophic level - good water transparency - absence of anomalous colours of water - absence of subsaturation of dissolved oxygen
Good Mezotrotrophic Green	**3-10**	**s.- 1.2-1.7 b.-0.3-0.8**	**2-10**	**0.3-0.6**	**1-5**	**4-5**	- average trophic level - occasional clouding of water - occasional anomalous colours of water - occasional hypoxia
Moderate Eutrophic Yellow	**<3**	**s.- >1.7 b.- 0.3-0.8**	**10-20**	**0.6-1.3**	**5-10**	**5-6**	- average trophic level - occasional clouding of water - occasional anomalous colours of water - hypoxia and occasional anoxia - problems in benthic communities
Poor Ekstremely eutro. Orange	**<3**	**s.- >1.7 b.- 0.0-0.3**	**>20**	**>1.3**	**>10**	**6-8**	- high trophic level - high turbidity of water - persistent colouring of water - persistent hypoxia and anoxia - dying of benthic organisms - alteration of benthic communities

z_{Sd} - transparency, γ – oxygen saturation rate, c - concentration, TIN – Total Inorganic nitrogen, TP – Total phosphorous, Chla – Chlorophyll a, TRIX– Trophic index, s.- surface and b.- bottom layer

The scale is still in use and is part of the Croatian legislation (OG 73/13, 151/14). In the meantime, for the purpose of WFD implementation a scale based solely on the chlorophyll *a* concentration was developed and is water type oriented (Table 10).

Table 10. Category limits of ecological status for the concentration of chlorophyll *a* by type of coastal waters (Croatia).

		c(Chl *a*)/µg L^{-1}	
Ecological status	**Type**	**HR-O_3**	**HR-O_4**
	reference	≤ 0.70	≤ 0.50
	very good	0.71 - 0.94	0.51 - 0.62
	good	0.95 - 1.34	0.63 - 0.91
	moderate	1.35 - 1.95	0.92 - 1.35
	poor	1.96 - 4.00	1.36 - 2.78
	bad	> 4.00	> 2.78

HR-O_3 Polyhaline coastal sea, HR-O_4 Euhaline coastal sea

In parallel through the MedGIG (WFD Mediterranean Geographical Intercalibration Group) Italy, Slovenia and Croatia developed a common approach on the Adriatic scale that resulted in a new classification scheme that is presented in Table 11. The approach and scale is under evaluation by the EU commission.

Table 11. Boundaries in terms of geometric mean and 90th percentile of Chl-a (µg/L) and EQR for Type I, Type II-A.

Type		**Type I**		**Type II-A ADRIATIC**	
		G_Mean	**90th p.**	**G_Mean**	**90th p.**
Ref. Conditions (Chl-a, µg/L)		1.4	3.93	0.33	0.8
Boundaries (Chl-a, µg/L)	**H/G**	2.5	7.1	0.64	1.7
	G/M	6.3	17.7	1.5	4.0
Boundaries (EQR normalized)	**H/G**	0.83		0.81	
	G/M	0.61		0.60	

Turkey

The eutrophication assessment method developed for the Water Framework Directive Biological Quality Element (Chlorophyll-a) have been applied Turkey in NE Mediterranean (MED-GIG 2011 and JRC, 2009) in part of the "Marine and coastal waters quality status determination and classification project" (Beken *et al.,* 2014) (MED-GIG 2011 and JRC, 2009). The method applied to 3 chosen different sites in NE Mediterranean, which are Erdemli (oligotrophic site), Mersin Bay (impacted area) and İzmir Bay. .Class boundary values and Ecological Quality Ratios have been determined and results given in table 12. Details are given in table 14 "National reference conditions and boundary setting". Seasonal class boundary values have also been calculated in these areas, in order to examine seasonal variations.

Table 12. Boundary class values and EQR in Erdemli, Mersin Bay and İzmir Bay (Beken *et al*., 2014)

ERDEMLI (<30m)					
	HIGH	**GOOD**	**MEDIUM**	**POOR**	**BAD**
ALL DATA	**10%**	**25%**	**50%**	**75%**	**90%**
	0,10	0,17	0,39	0,84	1,30
	<0,10	0,11-0,17	0,18-0,39	0,4-0,84	>0,84
EQR %25 (0,089)	**0,93**	**0,51**	**0,23**	**0,10**	**0,07**

GULF OF MERSIN (<30m)					
	HIGH	**GOOD**	**MEDIUM**	**POOR**	**BAD**
ALL DATA	**10%**	**25%**	**50%**	**75%**	**90%**
	0,33	0,80	1,36	2,47	3,95
	<0,33	0,34-0,80	0,81-1,36	1,37-2,47	>2,47
EQR %25 (0,32)	**0,97**	**0,40**	**0,24**	**0,13**	**0,08**

Gulf of İzmir (<30m inner bay)					
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
	10%	**25%**	**50%**	**75%**	**90%**
	0.16	0.52	1.50	4.14	8.29
	<0,16	0,17-0,52	0,53-1,5	1,54-4,14	>4,15
EQR % 25 (0,15)	**0.96**	**0.30**	**0.10**	**0.04**	**0.02**

Gulf of İzmir (>30m central)					
	HIGH	**GOOD**	**MODERATE**	**POOR**	**BAD**
	10%	**25%**	**50%**	**75%**	**90%**
	0.11	0.16	0.41	1.08	1.79
	<0,11	0,12-0,16	0,17-0,41	0,42-1,08	>1,08
EQR % 25 (0,10)	**0.93**	**0.64**	**0.25**	**0.09**	**0.06**

The eutrophication assessment is made according to the recently developed HELCOM Eutrophication Assessment Tool (HEAT) in Mersin Bay (NE Mediterranean) (Kaptan, 2014). Some of the key assessment principles of the Water Framework Directive is used by the application of HEAT, for instance, the calculation of an Ecological Quality Ratio (EQR) and also the 'one out, all out' principle (Andersen *et al.,* 2011 and references therein). Therefore, HEAT combines both the principles of the HELCOM Baltic Sea Action Plan and the EU Water Framework Directive. The values for the parameters of Eutrophication Classification in the Eastern Mediterranean coastal and bay surface waters derived from spring-autumn observations (2008-2011) in the Mersin Bay influenced by major rivers in the region (for the water bodies with salinity >38.5).

The reference, threshold, good/moderate and moderate/poor boundary values for Eutrophication classification in NE Mediterranean derived from 2008-2011 seasonal data sets from Mersin Bay, by HEAT method developed for Baltic region are given in table 13 below (Kaptan, 2014).

Table 13

PARAMETER	Poor-Bad (EQR: <0.52)	Moderate (EQR 0.52-0.66)	Good (EQR:0.67-0.80)	High (EQR: >0.80)	Reference Value (oligotrophic water properties)
Phosphate (PO_4) µM	>0.08	>0.06-0.08	0.05-0.06	<0.05	0.04
Otal-P (TP) µM	>0.4	>0.3-0.4	0.25-0.3	<0.25	0.2
Nitrate (NO_3 +NO_2) µM	>0.4	> 0.3- 0.4	0.25-0.3	<0.25	0.2
Ammonium-N (NH_4) µM	>0.4	>0.3-0.4	0.25-0.3	<0.25	0.2
Silicate(Si) µM	<0.4	0.4-0.54	0.55-0.65	>0.65	0.8
Si/(NO_3) Ratio	<1.0	1.0-1.3	>1.3-1.6	>1.6	2.0
Chll-a (µg/l)	>0.6	>0.45- 0.6	0.38-0.45	<0.38	0.3
Secchi Disc Depth (m)	<3.5	3.5-4.5 m	>4.5-6.0 m	>6.0	7
O2- saturation (%) (summer - autum, depth <100m)	<75	75-80	>75-85	>85	95
TRIX Index	>5	>4.0-5.0	3.0-4.0	<3	2.5
Color Code	Red	Yellow	Green	Blue	

The eutrophication risk of NE Mediterranean Turkish coastal waters has been assessed according to TRIX index (Rinaldi and Giovanardi 2011).

In table 14 below, a summary on details regarding national reference conditions and boundary setting are given for some Mediterranean countries.

Table 14. Some national reference conditions and boundary setting.

Country	Type and period of reference conditions	Number of reference sites	Location of reference sites	Reference criteria used for selection	Boundary setting based on Expert judgment – statistical – ecological discontinuity – or mixed for different boundaries?	Specific approach for G/M boundary	Boundary setting procedure: method tested against pressure
Croatia, Italy Slovenia	Period: 2000-2010 Sites: Among the same sites already used for defining typologies (Tyrrhenian and Adriatic sites)	All data used for defining one common reference condition	Threshold values used, defined from common database	Pressure: dilution factor as the primary indicator of pressure from land	Joint boundary setting for Croatia, Slovenia and Italy, a common database was built with Type I and Type IIA data. A combination of expert judgement and statistical approach was used	Derived from expert judgement in combination with statistical analysis of the common database	Yes, Total phosphorus
Greece and Cyprus	Existing pristine-near pristine sites, expert knowledge, historical data since 1980s or 1990s to date depending on the stations (data since 2000 to date for Cyprus)	All data used for defining one common reference condition	Threshold values used, defined from common database	Pressure: Index LUSI ≤ 2 Type III-E 90th percentile Chl-a (μg/l) <0.4	Boundary values resulted mainly from modification of the Greek Eutrophication Scale, in line with expert judgement and consensus from the 1st phase of IC exercise	Derived from an equidistant split of the lower mesotrophic class, where the median is taken as the G/M boundary	Yes, LUSI Index
Turkey	Period 1997-2003 (Erdemli) Period 2005-2011 (Mersin Bay) Period 2000-2012 (İzmir Bay) Sites: Among the same sites already used for defining typologies	All data for each region and seasonal used for defining reference condition	Threshold values used, defined from common database	90th percentile Chl-a (μg/l) Erdemli: <0,09 Mersin: <0,32 İzmir: <0,15	Boundary values resulted from 90th percentile both whole years and seasonal and with expert judgement	Derived from expert judgement in combination with statistical analysis of the common database	Yes, Index LUSI and LUSIVA,

It is obvious that the review and catalogue on existing methods and criteria, thresholds and target values is far of being complete and Mediterranean countries are kindly asked to submit their tools for the purposes of this report.

Again the Experts noted that more detailed information can also be found in the European project IRIS-SES inventory and toolboxes (GIS, assessment methods) and PERSEUS outcomes.

VII. Proposals for the definition of thresholds and methodological criteria for eutrophication assessment in Mediterranean.

During the discussions of the Eutrophication Working Group, it was noticed that a considerable amount of work must be devoted on the multiparametric indixes for eutrophication assessment evolving, nutrients, hydrological, bloom frequency, ratio of functional groups, etc considering the geographical approach (E. vs W. Mediterranean, Adriatic, and so on), tailored for all subregions. However, this was not possible during this phase of the work of the Eutrophication Working Group.
Nevertheless the experts encourage Mediterranean countries which do not have their own approach, to use one of the existing and described above methods and then based on that to build their own.

Finally, the experts of the Eutrophication Working Group proposed the following recommendations:

- Contracting parties are invited to agree on the proposed criteria for typology of waters as presented in table 2.
- Contracting parties are invited to apply the above criteria and define their water types with the support from MEDPOL if needed, until end of May 2015.
- The contracting parties are recommended to rely on the classification scheme on chl-a concentration (μg/l) as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in table 3.
- Following the evaluation of information provided by a number of countries and other available information it has to be noted that the Mediterranean countries are using different eutrophication assessment methods such as TRIX, Eutrophication scale, EI, HEAT, etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long term experience within countries which can reveal / be used for assessing eutrophication trends.

VIII. Next steps

Next steps can be based on:

- Discussion on available data from countries (validation of approaches and data, quality control, statistical approach), inter-calibration, methodologies.
- Development of a common (friendly) data base.
- Common indicators to be used by countries when possible.
- Countries to commit to apply eutrophication assessment

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ANNEX I
List of Experts

List of Experts

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