Black Sea Eutrophication Status - the Integrated Assessment Limitations and Obstacles *(Luminița Lazăr, Laura Boicenco, Oana Marin, Oana Culcea, Elena Pantea, Elena Bișinicu, Florin Timofte, Valeria Abaza, Alina Spînu)*	"Cercetări Marine" Issue no. 49 Pages 57 - 74	2019

BLACK SEA EUTROPHICATION STATUS - THE INTEGRATED ASSESSMENT LIMITATIONS AND OBSTACLES

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ABSTRACT

The paper aims to investigate the peculiarities and difficulties of the integrated assessment of the Romanian Black Sea's eutrophication status encountered during the second cycle reporting under the Marine Strategy Framework Directive (MSFD). Thus, we discussed the geographical and legislative constraints, overlaps and, gaps of the Water Framework Directive (WFD) and MSFD, our lack of knowledge and data for the second cycle report of the marine environment status. We collected samples along the Romanian Black Sea during 13 cruises (2012-2017) and used historical data, where available, for causes (nutrients) and effects (dissolved oxygen, transparency, chlorophyll *a*, *Noctiluca scintillans* blooms, macroalgae and, macrozoobenthos) of eutrophication classified as criteria by the European legislation. Fragmentation of the criteria because of natural characteristics, including seasonality, or lack of knowledge and data makes it difficult to integrate them in a global assessment.

Use of Black Sea Eutrophication Assessment Tool (BEAST) showed us that the Romanian waters of the Black Sea have reached a good state in a proportion of 49% (stations of the total number), representing about 7900 km^2 and about 49% of the surface (km^2) of the Romanian Black Sea waters (exclusive economic zone). Despite improvements in water quality for some parameters (e.g. phosphorus), nutrient concentrations are still high and create effects, particularly in the warm season. The coupled effect of climate change and the anthropic impact of point and diffuse sources may have an impact on increasing nutrient concentrations as a result of hydrological changes in river flows but also stratification of water masses and the regime of winds and currents thus intensifying eutrophication. The evaluation can provide the information needed to take the measures to achieve or maintain good environmental status (GES) in the marine environment for descriptor 5 (Eutrophication).

Key-Words: Black Sea, eutrophication, MSFD, BEAST

AIMS AND BACKGROUND

Black Sea eutrophication has been a major topic since at least the 80s. Major components of the ecosystem had begun to collapse as early as 1973 when records showed significant areas of summer hypoxia on the north-western shelf as a result of eutrophication (Mee, Friedrich and Gomoiu, 2012). Unfortunately, due to absence of measures, eutrophication effects continued from year to year and considerable changes in the pelagic ecosystem at a basin-wide scale became noticeable in the second half of the 1980s and the beginning of the 1990s (Yunev, Moncheva and Carstensen, 2005). Thus, during the 1980s and early 1990s, the Black Sea ecosystem was in a catastrophic condition (Kideys, 2002). Laying downwards the Danube's discharge mouths, the Romanian coast was particularly affected by eutrophication due to the Danube's increased nutrients input from point and diffuse sources of pollution (agriculture, untreated waters, industry, atmospheric deposition) because of the cascade effects that followed – a general increase in phytoplanktonic production (mass species have become more numerous, algal blooms chronic and more frequent), the increase in the quantities of organic matter; disturbances in oxygen condition and appearance of hypoxia and anoxia phenomena; mass mortalities of benthic organisms; the impoverishment of the genetic fund, the reduction of species diversity and simplification of community structure; the exuberant development of opportunistic species and great qualitative and quantitative fluctuations within the population (Gomoiu, 1992). After 1992-1993, the nutrient limitation abruptly shifted from nitrogen to phosphorus, which then severely reduced plankton production and the system maintained low biomass of bacterioplankton, zooplankton, and total marine living resources, but moderate *Noctiluca scintillans* and gelatinous biomass (Oguz and Velikova, 2010). During the decade following the regime shift of the 1990's, fish stocks gradually improved as a result of good recruitment and a possibly favourable climate, shrinking fishing effort and diminishing *Mnemiopsis leidyi* biomass, and the outcome was a partial recovery to pre-shift conditions (Daskalov *et al.*, 2017) considered as an alternative pristine state dominated by jellies and opportunistic species than the fish-dominated healthy pristine state (Oguz and Velikova, 2010).

The coastal waters' nutrients enrichment has been addressed in the European legislation since 1991 (Urban Waste-Water Treatment-UWWT and Nitrates Directives) (Palialexis *et al.*, 2014). In 2000, the European Commission put into practice the Water Framework Directive (WFD) to reach a "Good Ecological Status" (GEcS) in all water bodies of the member states. In terms of eutrophication, for transitional and coastal waters, Member States indicated the phytoplankton, macroalgae and angiosperm biological quality elements were most likely to be used for the assessment of ecological status in relation to nutrients pressure and that macroinvertebrates and fish (in transitional waters only) were most likely to be used in relation to oxygen depletion (WFD-CIS, 2009). Since WFD was mainly focused on catchments, with only small assessment areas along the coast (up to 1 NM distance from shore), it was extended towards the marine environment by the Marine Strategy Framework Directive (MSFD) in 2008. MSFD requires EU Member States to achieve and maintain "Good Environmental Status" (GES) of their marine waters, i.e. the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a sustainable level, thus safeguarding the potential for uses and activities by current and future generations (PCEU, 2008). Hence, the WFD and the MSFD constitute legislative frameworks to combat eutrophication in European seas (Greenwood *et al.*, 2019), including Black Sea (Boicenco *et al.*, 2018). Both directives have a common conceptual approach but different criteria to implement it. In addition to EU legislation, there are a number of international conventions on river basin management e.g. for the protection of the Danube River (ICPDR) as well as conventions for the protection of the marine environment, e.g. for the Black Sea (Bucharest Convention) (Ibisch *et al.*, 2016). In line with European legislation, the Regional Sea Convention, Black Sea Commission identified the eutrophication reduction as one of the ecological quality objectives, EcoQO 3 (BSC, 2009) coordinated also with the Black Sea Integrated Monitoring and Assessment Program (BSIMAP) for 2017-2022 (2016) (Table 1). All these international frameworks are supplemented by national legislation.

In 2010, Decision 2010/477/EU considered for Descriptor 5 that the assessment of eutrophication in marine waters needs to take into account the assessment for coastal and transitional waters under Directive 2000/60/EC in a way which ensures comparability, taking also into consideration the information and knowledge gathered and approaches developed in the framework of regional sea convention (European Commission, 2010). In the initial assessment (2012) descriptor 5 criteria were evaluated qualitatively, being considered inadequate by the EU (Dupont *et al.*, 2014). To ensure that the second cycle of implementation of the marine strategies of the Member States further contributes to the achievement of the objectives of MSFD and yields more consistent determinations of good environmental status, Decision 2010/477/EU was reviewed to achieve a clearer, simpler, more concise, more coherent and comparable set of GES criteria and methodological standards and develop specific guidance to ensure a more coherent and consistent approach for assessments in the next implementation cycle (European Commission, 2017). Consequently, in 2017 it came into force Decision 2017/848/EU introducing primary and secondary criteria instead of direct and indirect effects of nutrient's enrichment.

Finally, in 2018, we completed the second assessment reporting (MSFD) fulfilling all primary criteria for descriptor 5 but with difficulties related to geographical and legislative constraints, overlaps and gaps of WFD and MSFD, lack of data and knowledge that we want to discuss in this paper.

EXPERIMENTAL

Between 2012-2017 we performed 13 expeditions on the monitoring network consisting of 45 stations with bottom depths from 5 m to 100 m, covering all water body typologies (transitional/with variable salinity, coastal, and marine) and located in the neighbourhood of the main land-based sources pollution from Romanian Black Sea coast (Danube, WWTPs, ports) (Fig.1). Water and biological samples were analysed at NIMRD laboratories in compliance with the good practice (Grasshoff, Kremling and Ehrhardt, 1999). Thus, we analysed nutrients (phosphate, nitrate, nitrite, ammonium, silicate, total phosphorus, total nitrogen), dissolved oxygen, chlorophyll *a*, phytoplankton, zooplankton, macroalgae, and zoobenthos. Measurements in-situ were completed for temperature, salinity (CTD) and transparency (Secchi disc). Trends were completed using monitoring data from 2006 - 2017 and long-term data (1964-2017) from Est Constanța profile.

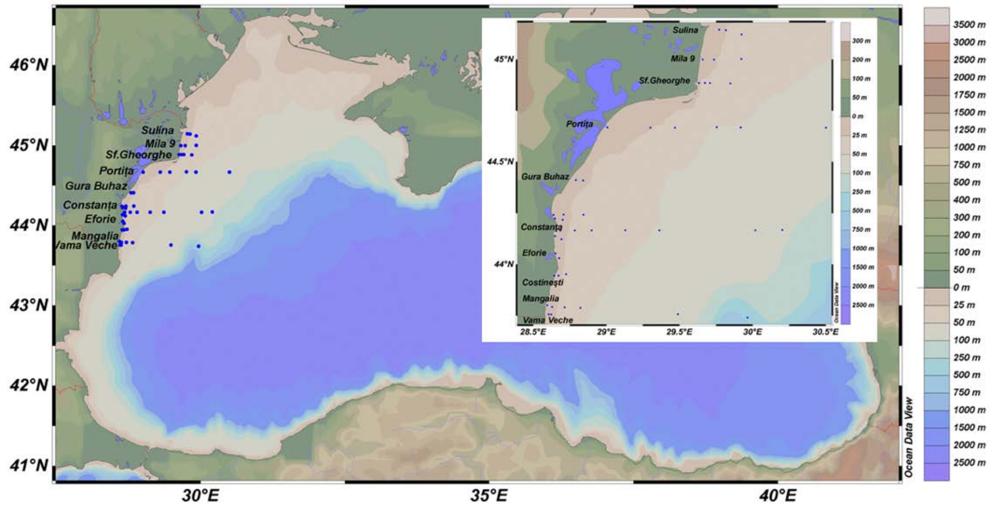

Fig. 1. The network of monitoring stations – Romanian Black Sea, 2012-2017.

The infralittoral phytobenthic communities were monitored annually, in the coastal waters (bottom depths up to 3 m) along the central and southern littoral, where is their maximum abundance, from Năvodari to Vama Veche (Năvodari, Pescărie, Constanța Nord, Cazino Constanța, Agigea, Eforie Nord, Eforie Sud, Tuzla, Costinești, Mangalia, 2 Mai, Vama Veche).

Data were processed with MS Excel 365, Primer version 6, OceanDataView (ODV), version 5.1.2 (Schlitzer, 2018). ODV's distribution maps represent products made by gridding procedure (DIVA). Original data are accentuated on the map by the black dots.

RESULTS AND DISCUSSION

The integrated, ecosystem approach of the eutrophication assessment under the MSFD's descriptor 5 was completed in view of its purpose: *Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters* and eight criteria from which three are mandatory (primary). We investigated only seven criteria and we must specify that the transitional waters body as defined in WFD was named "variable salinity" body for MSFD report due to the not accepted terminology. Accordingly, we consider the necessary review of typologies of the Black Sea's water bodies for MSFD. The assessment methodologies against threshold values (Fig.2) for each parameter, criterion, and water body are:

D5C1 – Primary - Nutrients in water column

For nutrient concentrations evaluation we used different parameters for the water bodies, due to legislative constraints. Thus, according to WFD, in transitional and coastal waters, the concentration of total phosphorus (TP, 0.1 mg/L), nitrate ($N\text{-}NO_3$, 1.5 mg/L), nitrite ($N\text{-}NO_2$, 0.03 mg/L) and ammonium ($N\text{-}NH_4$, 0.1 mg/L) were compared with the maximum admissible concentrations from national legislation[1]. For marine waters (MSFD), the evaluation was performed by calculating the 75th percentile for phosphate concentrations, representing dissolved inorganic phosphorus (DIP) and dissolved inorganic nitrogen (DIN - sum of nitrate, nitrate, and ammonium) from surface waters and comparison with threshold values

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[1]Governmental Decision No. 161 of 16.02.2006 "On approval of norms concerning water surface quality classification in order to establish qualitative status of water bodies". The legal document has printed out NO_3 and NO_2 limits reversed, without any errata.

(GES). The integrated assessment used "OneOutAllOut" (OOAO) principle. The criterion is contrasting with the WFD's requirements where only surface waters were noticed. In 2012-2017 Romanian Black Sea surface waters didn't achieve GES for nutrients concentrations because of both Danube's influence and other rivers in the NW Black Sea as well as the coastal area's anthropic contribution (Table 2). The effects of climate change, atmospheric deposition, and groundwater input have not been quantified.

Table 2. Percentage of samples (%) fulfilling GES (green), Romanian Black Sea, nutrients, 2012-2017

Water body	**N**	**PO_4 (DIP)**	**TP**	**NO_3**	**NO_2**	**NH_4**	**DIN**	
Variable salinity (Transitional)	70	Not applicable	93%	100%	94%	53%	Not applicable	Non-GES
Coastal	148		95%	100%	93%	56%		Non-GES
Marine	149	63%	Not applicable				58%	Non-GES

<u>D5C2 – Primary - Chlorophyll *a* concentrations are not at levels that indicate adverse effects of nutrient enrichment</u>. For transitional and coastal waters, the maximum allowable concentration from national legislation, 5 mg/L (5000 µg/L) was considered unacceptable. Consequently, our experts the threshold developed by their own expert judgment and historical data (11.88 µg/ L – Northern littoral and 5.97 µg/L – Southern littoral). For marine waters, the 75th percentile for chlorophyll *a* corresponding to the surface layer (0-10 m) of the warm season was compared with threshold values (Fig.2). Due to the lack of data for chlorophyll *a* in the warm season of 2012, data were assessed for 2013-2017. The highest concentrations of chlorophyll *a* (maximum values - 56.92 µg/L - Sulina, 20 m and 21.20 µg/L - Mila 9, 30 m) were observed in waters with variable salinity, respectively, the marine waters near the Danube mouths. Chlorophyll *a* in coastal waters, ranged between 0.28-15.70 µg/L, the peak being recorded at Mangalia, 5 m. The assessment showed that the variable salinity (transitional) and marine waters are not achieving GES while the coastal ones, did.

<u>D5C3 – Secondary - The number, spatial extent and duration of harmful algal bloom events are not at levels that indicate adverse effects of nutrient enrichment.</u> It is well known that light and dissolved inorganic nutrients are major limiting factors for phytoplankton growth. Phytoplankton species are limited to grow and increase in the upper layer of the water column, within which dissolved inorganic nutrient concentrations decrease frequently to very low levels in spring–summer in temperate waters, while nutrient supplies from the nutrient-rich deeper layer are obstructed by

seasonal stratification. In these waters, *Noctiluca scintillans* may serve as a nutrient regenerator due to its high contents of ammonia and phosphate. The large amounts of nutrients regenerated and released by *Noctiluca scintillans* can increase the N and P concentrations in ambient seawater, especially in the upper layer in spring–summer, and consequently affect phytoplankton (diatom) abundance. These may exacerbate eutrophication by a mutually supportive relationship between phytoplankton and *Noctiluca scintillans*: bottom-up control (phytoplankton – *Noctiluca scintillans*) and nutrient supply by *Noctiluca scintillans* to phytoplankton through excretion (Ara et al., 2013). The evaluation of the *Noctiluca scintillans* biomass was done by comparing each value with the threshold values established for the cold season (November-April) and the warm season (May-October). The "OneOutAllOut" principle (WFD) was not considered, being too restrictive. Therefore, the proportion method was used, considering that if at least 50% of the samples (for each season and water body) are in GES, then the whole body is. During 2012-2017, *Noctiluca scintillans* biomass reached GES in all water bodies and seasons.

D5C4 – Secondary - The photic limit (transparency) of the water column is not reduced, due to increases in suspended algae, to a level that indicates adverse effects of nutrient enrichment. Assessment of the transparency of the sea for WFD was made by comparing all the measured values with the minimum allowable value (2 m). For marine waters (MSFD), the evaluation was performed by calculating the 10th percentile for the transparency from warm season and comparing with the proposed threshold value (GES). In both cases the ecological status was established on the principle of “OneOutAllOut”. None of the water bodies (N = 239) fulfilled the requirement for transparency GES. The best correlation with chlorophyll *a* concentrations were found in marine waters (r = -0.58).

Table 1. Comparison of assessment under various policies for waters responding to nutrient enrichment (based on the assumption that the WFD classification is the starting point and that the different sources of pollution are relevant), (after WFD-CIS, 2009)

Ecological status	**WFD**	**UWWT** Directive	**Nitrates** Directive	**MSFD**	**BSC**[2]
High	Nearly undisturbed conditions	Non-eutrophic, designation of sensitive area is not required	Non-eutrophic, not a polluted water, designation of nitrate vulnerable zone is not required	Human induced eutrophication is minimised (GES)	Reduce eutrophication
Good	Slight change in composition, biomass				
Moderate	Moderate change in composition, biomass	Eutrophic or may become eutrophic in the near future, designation of sensitive area is required	Eutrophic or may become eutrophic in the near future, polluted water, designation of nitrate vulnerable zone is required	Human induced eutrophication is not minimised (non-GES)	
Poor	Major change in biological communities	Eutrophic, designation of sensitive area is required	Eutrophic, polluted water, designation of nitrate vulnerable zone is required		
Bad	Severe change in biological communities				

[2] Black Sea Commission - Ecological Quality Objective, EcoQO 3 (BSC, 2009)

D5C5 - Primary (may be substituted by D5C8) - The concentration of dissolved oxygen is not reduced, due to nutrient enrichment, to levels that indicate adverse effects on benthic habitats (including on associated biota and mobile species) or other eutrophication effects. The criterion has no correspondence in the WFD referring to the bottom dissolved oxygen. In the transitional and coastal waters, was used only for the stations with 20 m depth and in the marine ones for the bathymetric strip 30 - 50 m, being replaced in the 50 - 100 m area with D5C8. The evaluation was done by calculating the 10^{th} percentile for dissolved oxygen concentrations and saturation (warm season) and comparing with the proposed threshold value (GES). The ecological status was established on the principle of "OneOutAllOut" being a primary criterion. Bottom waters (N = 137) were well oxygenated. Percentile 10^{th} (6.8 mgO_2/L, 67.7% saturation) was higher than GES target (6 mgO_2/L; 60%). Three events, all in summer (July and August), of oxygen deficiency (less than 60% saturation) were recorded in the marine waters form Northern area (stations - Sf. Gheorghe, 30 m and Portița, 30 m).

D5C6 - Secondary - The abundance of opportunistic macroalgae is not at levels that indicate adverse effects of nutrient enrichment. We assessed only the species included in the category of maximum sensitivity to the eutrophication gradient, respectively the species included in the ESG category I - ESG IA, ESG IB, ESG IC - perennial species indicative of areas generally included in good ecological status (with reference to the species of *Phyllophora, Cystoseira, Zostera*). The other categories are - ESG IIA - species with high adaptability and ESG IIB, ESG IICa, ESG IICb - opportunistic species, capable of growing in eutrophic areas, with a high reproductive capacity (*Ceramium, Ulva, Cladophora* species), whose dominance defines the areas included in a poor ecological state). After the ecological classification of each species, we calculate their wet biomass, refer to the square meter (by multiplying the coefficient 25) and calculate the proportion of perennial and opportunistic species from the total biomass (from a certain station), expressed as a percentage (%). The ecological state of the water body was determined by mediating the values and comparing it with the threshold value. We observed the high proportion of perennial species, sensitive towards the south of the coast (the area between Mangalia and Vama Veche). These areas allowed the restoration of some species included in the category of maximum sensitivity to environmental conditions, respectively ESG I. These are the species *Cystoseira barbata* (ESG IA) and *Zostera noltei* (ESG IB), dominant in these areas where form stable communities, with a rich fauna and associated algal flora. Also, in the area of North Constanța were recently found clusters of *Coccotylus truncatus* (a species of the genus *Phyllophora*), which allowed us to classify the area in a good ecological state. However, the global assessment for 2012-2017 indicated non-GES status of this criterion due to the failure to achieve the threshold proportion (60%) of perennial species.

D5C7 - Secondary - The species composition and relative abundance or depth distribution of macrophyte communities achieve values that indicate there is no adverse effect due to nutrient enrichment including via a decrease in water transparency. The monitoring is ongoing, but the criterion was not assessed due to the lack of data to develop thresholds values.

D5C8 - Secondary (except when used as a substitute for D5C5) - The species composition and relative abundance of macrofaunal communities, achieve values that indicate that there is no adverse effect due to nutrient and organic enrichment. The status of large benthic habitats based on the M-AMBI*(n) index was evaluated by averaging the value of the index on the monitoring stations throughout the evaluation period (Abaza *et al.*, 2016, 2018). For the determination of the total state on each water body, the proportion method was used, because the average can distort the result and mask the problems. The "OneOutAllOut" principle (WFD) was not considered, as being too restrictive. Regarding the method of proportions, it was considered that if at least 75% of the analysed samples on each habitat type are in good condition, then the respective habitat is in good condition; the same principle was used to assess the quality of each water body. In 2012-2017 only the biogenic reefs with *Mytilus galloprovincialis* on circalittoral mud habitat (marine waters, bottom depths 27-57 m) didn't achieve the good environmental status.

The integrated assessment is based on the principle addressed by the Water Framework Directive, "OneOutAllOut" (OOAO) according to which if a single indicator and/or criterion does not meet the conditions of good ecological status then the condition of the water body is not considered good. Fragmentation of the criteria due to the natural characteristics of the Romanian Black Sea waters makes it difficult to integrate them in a global assessment. Thus, the most restrictive "OneOutAllOut" principle highlighted the failure to achieve good ecological status for the descriptor 5 Eutrophication (Table 3).

An integrated evaluation tool, built on the Helcom Eutrophication assessment Tool (HEAT) principle used also in the Baltic Sea (HELCOM, 2017) is BEAST (Black Sea Eutrophication ASsessment Tool). BEAST was developed within the Baltic2Black project implemented by the Black Sea Commissions (BSC) and the Baltic Sea (HELCOM) in partnership. At the regional level it is proposed as an evaluation tool within the regional integrated monitoring program, the Black Sea Integrated Monitoring and Assessment Program (BSIMAP).

Table 3. Environmental status of Romanian Black Sea waters in relation with Descriptor 5 (Eutrophication) criteria – 2012-2017

Water body	Criteria	Bottom depth							
		0-5 m	0-5 m	5-20 m	5-20 m	30-50 m	30-50 m	50-100 m	50-100 m
		Cold season	Warm season	Cold season	Warm season	Cold season	Warm season	Cold season	Warm season
Transitional waters	D5C1	Non-GES	Non-GES	Non-GES	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C2	Non-GES	Not applicable	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C3	GES	GES	GES	GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C4	Non-GES	Non-GES	Non-GES	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C5	Not applicable	Not applicable	GES	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C6	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C8	GES	GES	GES	GES	Not applicable	Not applicable	Not applicable	Not applicable
Coastal waters	D5C1	Non-GES	Non-GES	Non-GES	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C2	Non-GES	Not applicable	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C3	GES	GES	GES	GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C4	Non-GES	Non-GES	Non-GES	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable
	D5C5	Not applicable	Not applicable	GES	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C6	Non-GES	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C8	GES	GES	GES	GES	Not applicable	Not applicable	Not applicable	Not applicable
Marine waters	D5C1	Not applicable	Not applicable	Not applicable	Not applicable	Non-GES	Non-GES	Non-GES	Non-GES
	D5C2	Not applicable	Not applicable	Not applicable	Not applicable	Non-GES	Not applicable	Non-GES	Not applicable
	D5C3	Not applicable	Not applicable	Not applicable	Not applicable	GES	GES	GES	GES
	D5C4	Not applicable	Not applicable	Not applicable	Not applicable	Non-GES	Not applicable	Non-GES	Not applicable
	D5C5	Not applicable	Not applicable	Not applicable	Not applicable	GES	Not applicable	Not applicable	Not applicable
	D5C6	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	D5C8	Not applicable	Not applicable	Not applicable	Not applicable	Non-GES	Non-GES	GES	GES
OOAO		Non-GES	Non-GES	Non-GES	Non-GES	Non-GES	Non-GES	Non-GES	Non-GES

Legend	Primary criteria	Secondary criteria	GES	Non-GES	Not applicable

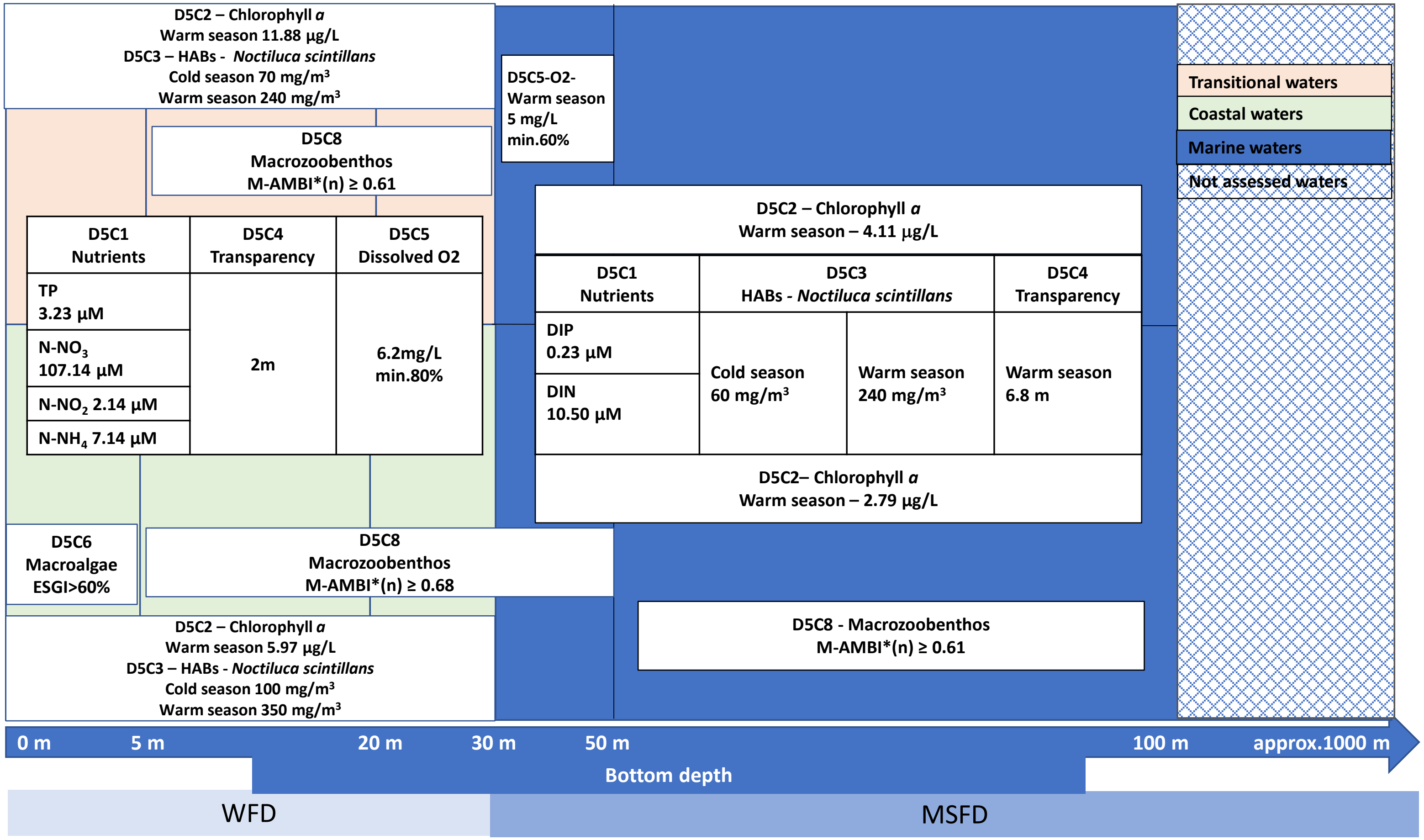

Fig. 2. Descriptor 5 (Eutrophication) - parameters, indicators, criteria and thresholds – Romanian Black Sea waters, 2012-2017.

BEAST is based on three criteria classified in causes of eutrophication, direct effects and indirect effects. Each criterion is described by a set of indicators. The results of the evaluation are included, depending on the indicator's own contribution, in a qualitative status: Very good, Good, Moderate, Poor and Bad. Among the criteria, BEAST uses the "OneOutAllOut" principle. For a better data visualization, we transformed the qualitative results into quantitative ones giving the coefficient 1-Very good; 2-Good; 3-Moderate; 4-Poor; 5-Bad. Thus, the limit between good and moderate becomes the limit for good ecological status (GES). Due to the spatial and temporal fragmentation of the indicators, a set of basic indicators was chosen, considered only for warm season (May-September), as follows:

- Causes - Nutrient concentrations given equal weight under the criterion - 25% each in variable salinity and coastal waters (total phosphorus, nitrates, nitrates, ammonium) and 50% each in marine waters (dissolved inorganic phosphorus and dissolved inorganic nitrogen)

- Effects - Chlorophyll *a* concentrations and Transparency which were given equal weight (50%).

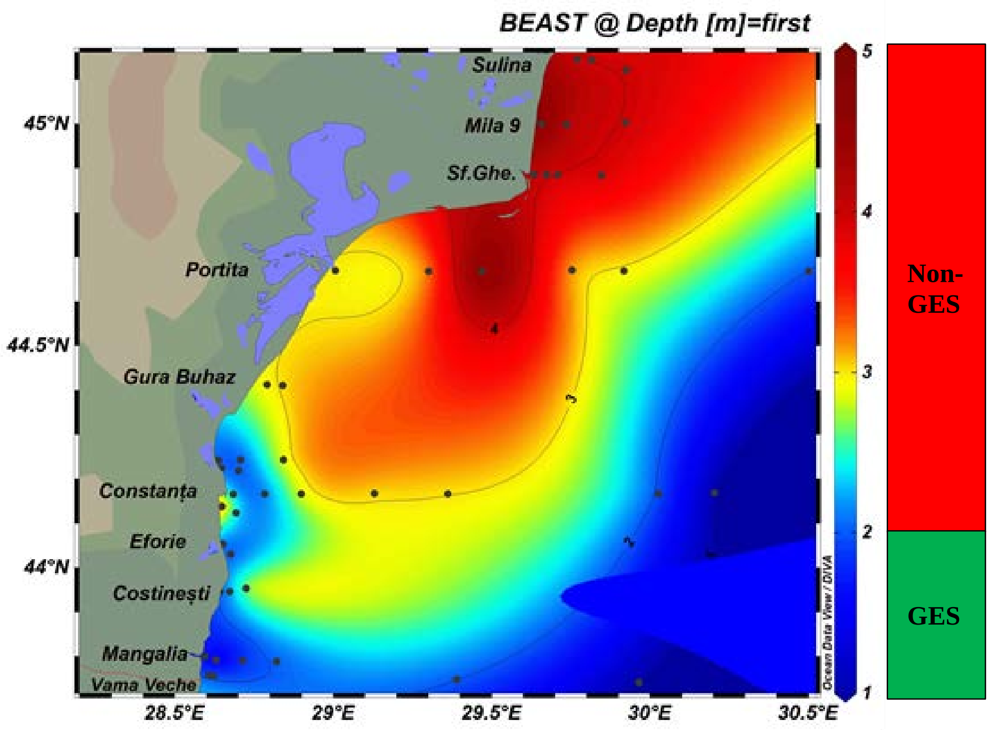

Fig. 5. Black Sea Eutrophication ASsessment Tool (BEAST), Romanian Black Sea coast, 2012-2017.

BEAST visualized the assessment in the sense that it shows us Romanian waters of the Black Sea that have not reached GES in a proportion of 51% (stations of the total number), representing about 7900 km^2 (45%) of the monitored surface, and about 27% of the Romanian waters of the Black Sea (exclusively economic area). The waters with variable salinity and the marine ones in the Northern area are the most eutrophicated. In the coastal waters GES was not reached at Constanța Sud, 5 m, located in the area of the port of Constanța and of the biggest WWTP of the Romanian coastline. On the most southerly profiles, Mangalia and Vama Veche as well as the stations on the bathymetric layer 70 - 100 m (Portița, Est Constanța and Mangalia) predominated a good and very good state, confirmed also by the biological elements that represent secondary criteria (macroalgae and benthic communities) (Fig.5).

CONCLUSIONS

Nowadays, eutrophication it's still a major problem in all enclosed seas and sheltered marine waters across the pan-European region (Bertram and Rehdanz, 2013; EEA, 2011). The effects of eutrophication are most pronounced in regional seas which have a combination of a high population density in the catchment area and physiographic characteristics predisposing the sea to nutrient enrichment, such as the Black Sea, and our assessment confirm this.

We agree that the general objectives of European and national policies, such as good ecological status (WFD) or the good environmental status (MSFD), need to be broken down to more specific objectives and quantitative targets to guide eutrophication abatement. Nutrient concentration targets (nutrient standards) are important management tools, when linked to direct and indirect ecological impacts of eutrophication, such as algal blooms and oxygen depletion (Ibisch *et al.*, 2016). Based on proposed targets and actual assessment we consider reductions of inorganic nutrients concentrations with approximately 34% (in the north) and 13% (in the south) - for phosphorus and 86% (in the north) and 62% (in the south) - for nitrogen, could represent a return to a pristine, reference state for the nutrients. In water bodies currently exceeding the nutrient standards, like Romanian Black Sea waters, these must be translated into targets for nutrient load reductions. Nutrient load reduction targets, using the desired state of the water body as the aim, are more ecologically sound than targets set with respect to some reference year (Ibisch *et al.*, 2016). The question that remains is whether human society can reduce its nutrient emissions by changing land use without compromising food security (Desmit *et al.*, 2018). On the other hand, by estimating nutrient loads to a few vulnerable European coastal zones in three periods (before eutrophication, during high eutrophication and in the current situation), Artioli *et al.*, 2008 showed that EU legislations had measurable impacts on reducing point source emissions (especially P) but less impact on reducing diffuse emissions (especially N) (Desmit *et al.*, 2018), which requires robust harmonization of the national legislation, methodologies and approach for nutrients emissions, loads and concentrations. In this respect it is necessary to strongly correlate pressure indicators (nutrient emissions and loads), state indicators (nutrient concentrations in the seawater) and impact indicators describing the health of aquatic ecosystems (such as biological indicators, oxygen and chlorophyll *a* concentration, Secchi depth correlated with chlorophyll *a* levels). In order to implement this approach, there is a strong need of data achieved at least from seasonal monitoring (4 times/year) and use of models and remote sensing products for seawater.

Also, because the strong transboundary influence is questioned, we consider as crucial the role of the Regional Sea Convention, Black Sea Commission for the development of criteria, methodologies and assessments at regional level.

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