2018

REPUBLIC OF TURKEY
MINISTRY OF ENVIROMENT
AND URBANISATION

MARINE QUALITY BULLETIN

Marmara Sea

DIRECTORATE GENERAL OF ENVIRONMENTAL IMPACT ASSESSMENT,
PERMIT AND INSPECTION

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Ministry of Environment and Urbanization has been conducting pollution and quality monitoring studies in all seas of Turkey -the Black Sea, the Marmara Sea and Straits, the Mediterranean Sea and the Aegean Sea- since the 2000s under the Regional Sea Conventions signed by Turkey (Barcelona and Bucharest Conventions) and national and international legislation. Since 2011, the marine monitoring studies have been carried out on the basis of ecosystem-based management approach under the "Integrated Marine Pollution Monitoring Program". Through the monitoring program, it is aimed to establish a scientific background for the determination of national marine and coastal management policies and strategies for the Turkish seas; where comprehensive assessment reports are prepared about the findings based on the historical and up-to-date data.

The "Integrated Marine Pollution Monitoring Programme" conducted by the Ministry has been operated in 3-year periods since 2014 under the coordination of TÜBİTAK-Marmara Research Center with the cooperation and contributions of many acknowledged specialists and scientists from the universities and research institutions.

In the framework of the monitoring program; the physicochemical properties of the water column, ecological status indicators, state of pollution, radioactivity levels, marine litter accumulated at the coasts and the seas, the seafloor and water column biodiversity/habitats, contaminant levels in the target species of economic value are monitored. With these results, quality classifications have been made for assessing the status of coastal water bodies and marine areas. Also, multi-variable data sets have been created to determine and follow up the definitions and targets of "good environmental status" for our seas. The monitoring activities in all Turkish Seas -Black Sea, Marmara Sea and the Straits, Mediterranean Sea and Aegean Sea- consist of the following components:

- Monitoring of biodiversity and ecological quality (including alien species),
- Monitoring of eutrophication,
- Monitoring of pollutant levels and their trends as well as in terms of human consumption,
- Monitoring of marine litter in sediments, water and at the coasts.

The Marmara Sea - Marine Quality Bulletin-2017 contains the eutrophication component assessments for the 2014-2017 period and ecological quality status assessments for the year 2016.

2 DEFINITIONS

CTD: Conductivity and **T**emperature measurements of sea water relative to **D**epth (In situ measurements).

Ecological Status: The structural and functional quality of aquatic ecosystems. According to the Water Framework Directive, coastal waters are assessed with 3 biological quality elements (phytoplankton, zoobenthos and macro algae) and in 5 quality classes (high/good/moderate/poor/bad).

Monitoring of Eutrophication: Relevant indicators like nutrient levels and their temporal changes, dissolved oxygen levels at the bottom and/or intermediate layer depths and their temporal changes, chlorophyll-a levels in euphotic water column, light penetration, prevalence and distribution of opportunistic macro algae are monitored at the seafloor and in the water column. The assessments are made with integrated data on pressures and impacts.

Secchi Disk Depth (SDD): It is an indicator of light transmittance in the marine environment which is commonly used in eutrophication assessments owing to both the ease of measurement and the possibility of comparison with historical data. The Secchi disk depth decreases when the particulate matter in water column increases, however, it increases when the light transmittance increases.

Coastal Water Body (Water Management Unit, CWB): Identifies a surface water part characterized by significant physical, hydro-morphological, ecological properties and by pressure analyses. It is the smallest coastal water management unit handled by the Water Framework Directive (2000/60/EC).

Marine Assessment Unit (MAU): Marine areas defined for monitoring as specified in the Marine Strategy Framework Directive (2008/56/EC); and initially was set with DeKoS Project which are still subject to official confirmation.

TRIX Index: Trophic Index (TRIX) is a scale for the trophic status (eutrophication) classification of coastal surface waters. It is a logarithmic calculation method including such parameters as the Total Phosphorus (TP) and Total Inorganic Nitrogen (TIN) which are among nutrients; Chlorophyll-a (Chl-a) which is a quantitative indicator of planktonic biomass; and aDO% (oxygen saturation deviation from 100%DO) which is an indicator of photosynthesis intensity.

TRIX index (Vollenweider *et al*. 1998; Bendoricchio *et al*. 2005) is calculated with the following formula;

$$TRIX = (Log_{10}[Chl\text{-}a \times aDO\% \times TIN \times TP] + k) / m$$

Chl-a: Chlorophyll-a concentration (µg/L),
aDO%: Absolute deviation from the oxygen saturation value: I 100-DO% I

DIN: Dissolved inorganic nitrogen: (NO_3+NO_2+NH_4)-N (µg/L)

TP: Total phosphorus (µg/L)

k: Equation constant; 1.5

m: Equation constant; 1.2

Classification ranges according to this index are given in the Table below.

Table 2.1 TRIX Values and Class Definitions

TRIX Value	Class Definition
< 4	No Risk of Eutrophication (High quality)
4 - 5	Less risk of eutrophication (Good quality)
5 – 6	High Risk of eutrophication (Moderate quality)
>6	Eutrophic (Bad quality)

Supplementary information about the sampling, measurement and analysis methods can be found in the Appendices.

3 GENERAL INFORMATION

This section includes general information about the monitoring stations and campaigns in the Marmara Sea. The monitoring activities from 2014 to 2017 were carried out by the TÜBİTAK Marmara Research Vessel which is a fully equipped oceanographic research ship with a hull length of 41.2 meters. The information about the monitoring stations in the 2014-2017 period is given in Table 3.1. Also, the detailed information about the stations monitored in 2017 is available in Appendix-1.

Table 3.1 Information about the Monitoring Stations in the Marmara Sea

Monitoring Components	2014	2015		2016		2017
	Summer	Winter	Summer	Winter	Summer	Summer
Water Column	59	59	61	68	91	90

3.1 The Marmara Sea Coastal Water Bodies (Water Management Unit)

There are 22 Coastal Water Bodies (CWBs) in the Marmara Sea, listed in Table 3.2 and shown in Figure 3.1.

Table 3.2 Marmara Sea Coastal Water Bodies (Water Management Units)

Coastal Water Bodies (Water Management Units)
MRM01: Susurluk Riverbank
MRM02: Susurluk River - open
MRM03: West of Susurluk
MRM04: Gulf of Bandırma
MRM05: North of Kapıdağ Peninsula and the Islands
MRM06: Deltas of Biga and Gönen Creeks - Gulf of Erdek
MRM07: Entrance of Çanakkale Strait- south and north coasts-Şarköy
MRM08: West of Tekirdağ – East Şarköy
MRM09: Tekirdağ – Marmara Ereğlisi
MRM10: Silivri- Büyükçekmece
MRM11: Küçük Çekmece - Zeytinburnu
MRM12: Golden Horn
MRM13: İstanbul Strait-Marmara exit
MRM14: Kadıköy-Prince Islands
MRM15: Tuzla
MRM16: Inner Gulf of İzmit
MRM17: Central-Outer Gulf of İzmit
MRM18: Yalova- North of Bozburun
MRM19: Gulf of Gemlik –South of Bozburun
MRM20: West of Mudanya-Susurluk
MRM21: West of Mudanya-Susurluk open
MRM22 : İmralı Island

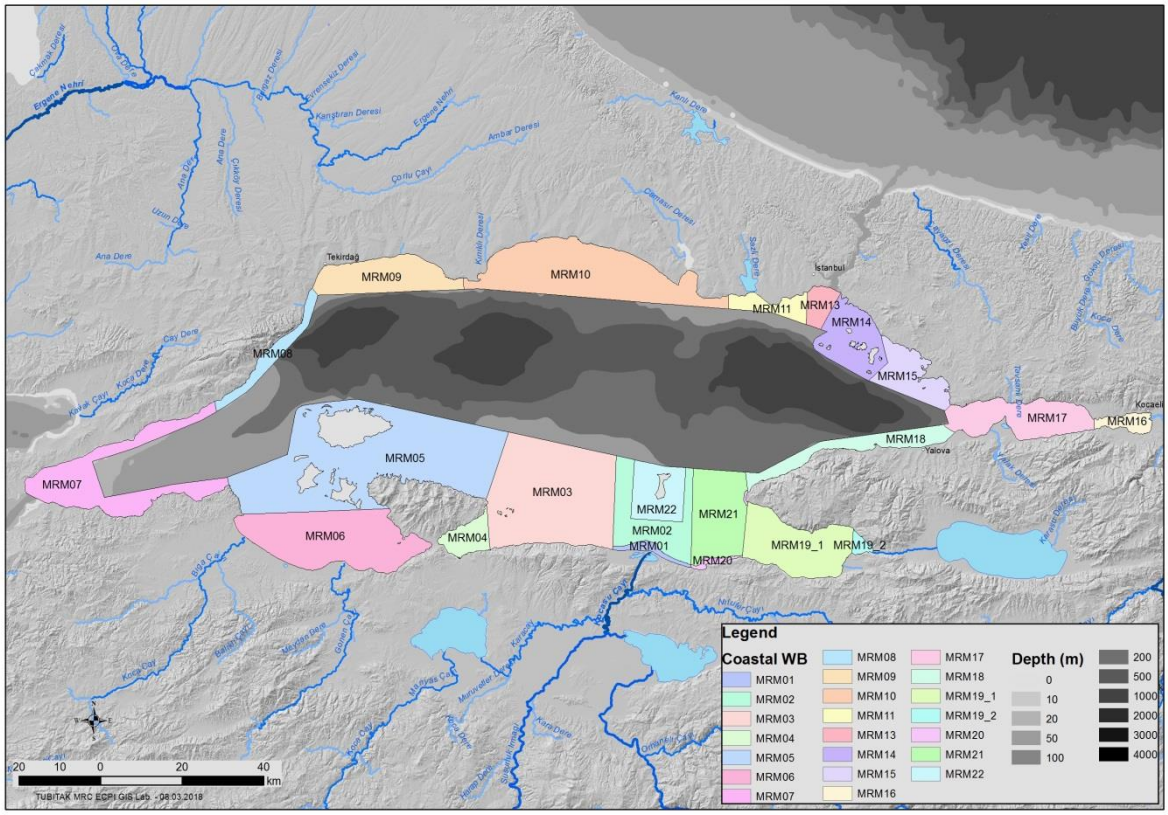

Figure 3.1 The Marmara Sea Coastal Water Bodies (Water Management Units) (DEKOS, 2014)

3.2 Information on the monitoring stations and campaigns in the Marmara Sea

Information about the monitoring stations (codes/location, coordinates, depths, etc) studied in the Marmara Sea in the spring and summer of 2017 are given in Appendix-1. The studies in the Marmara Sea and Straits were conducted at 87 stations in the spring and at 90 stations in the summer of 2017. At all of the stations; CTD including in-situ fluorescence and radiation, dissolved oxygen, pH, nutrients, Secchi depths and chlorophyll-a were measured.

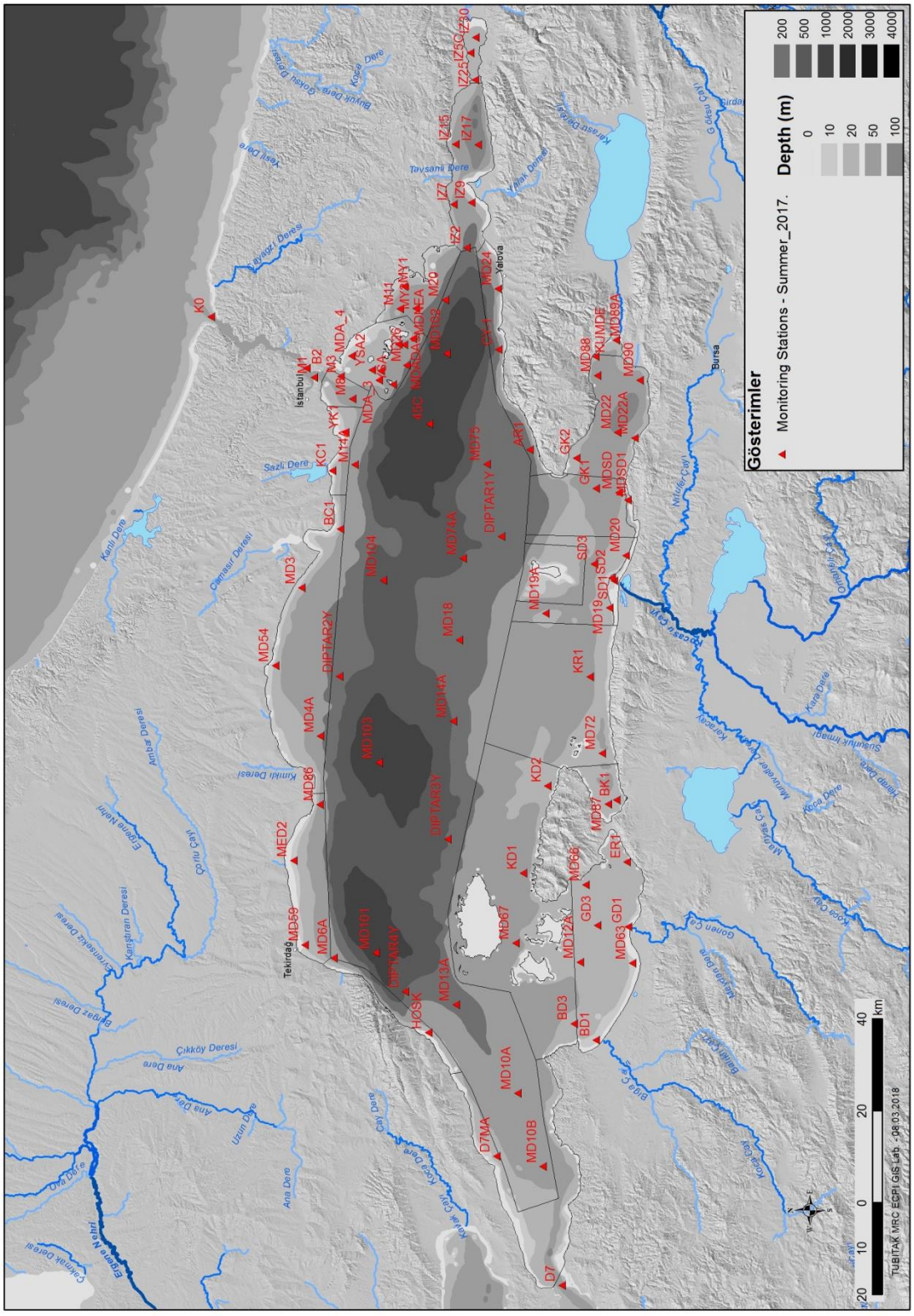

Figure 3.2 Map of the Stations in the Marmara Sea in the Summer of 2017

4 EUTROPHICATION STATUS of THE MARMARA SEA

As part of the eutrophication assessment of the Marmara Sea, the following variables were also assessed together with Physical Variables (salinity, temperature, pH, density changes, etc.).

- Nutrient levels
- Chlorophyll-a levels
- Dissolved Oxygen levels
- Secchi Disc Depths

This section includes the assessment results of the above mentioned variables in the Marmara Sea coastal water bodies.

4.1 Variability of Nutrients

For surface distributions of nutrients; the surface dissolved inorganic nitrogen (DIN), silicate (Si), nitrite-nitrate nitrogen (Nox) and total phosphorus (TP) concentrations were assessed. 2014-2017 data (4 summers and 2 winters) from the Marmara Sea CWBs on the surface layer (0-10m average) nutrients (NO_3+ NO_2 –N [Nox], NH_4, PO_4^{-3}, TP ve Si), their ratios (N:P, Si:N) and comparisons of salinity-temperature properties are given in Figure 4.1 and Figure 4.2.

It is possible to assert that the nutrient levels revealed higher scores in winter periods than in spring and summer periods (with the influence of vertical mixing); however, there are also some differences between the years. All of the nutrients are at the lowest level in the spring period; which indicate that they are consumed by the primary producers (phytoplankton). Phosphorus compounds measured at MAR04 (Gulf of Bandırma) indicated the highest level in all seasons, which reveals the permanent existence of industrial and domestic pressures. **Besides, relatively high nitrogen compounds and silicate were detected at the CWBs (1-2-20-21) under the influence of Susurluk River. The defined N:P (Redfield molar) ratio for euphotic zones of oceanic and marine systems without any pressure is 16 which is generally below 5 in the Sea of Marmara; and even at the levels <2 that are obviously the undesirable levels (DeKoS, 2014). On the other hand, a Si:N ratio <5 is an undesired situation too which causes shifts especially from phytoplankton diatom group to other groups and consequently changes the ecosystem structure.

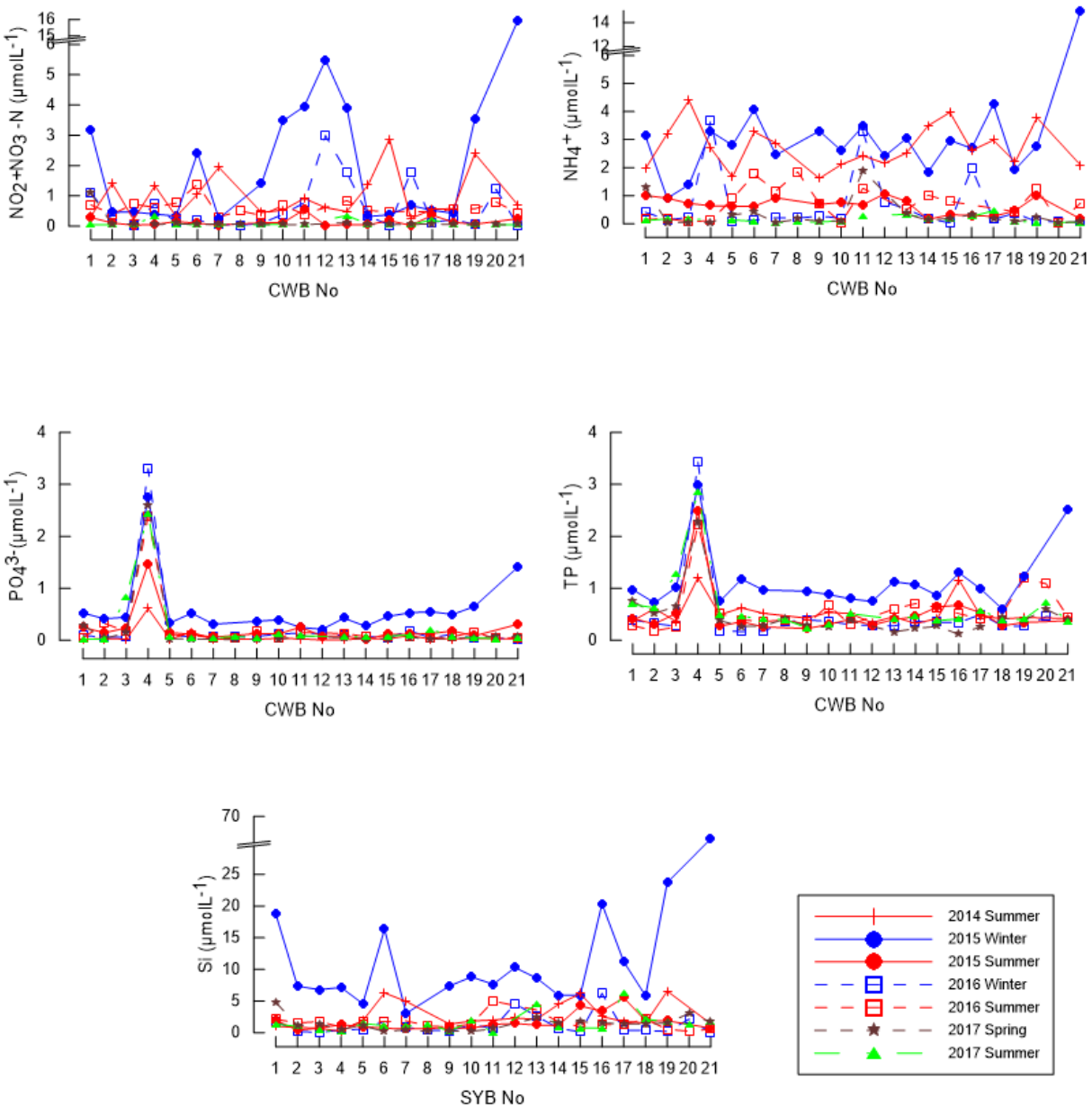

Figure 4.1 Comparison of the 2014-2017 data from the Marmara Sea CWBs on surface layer (0-10m average) nutrients

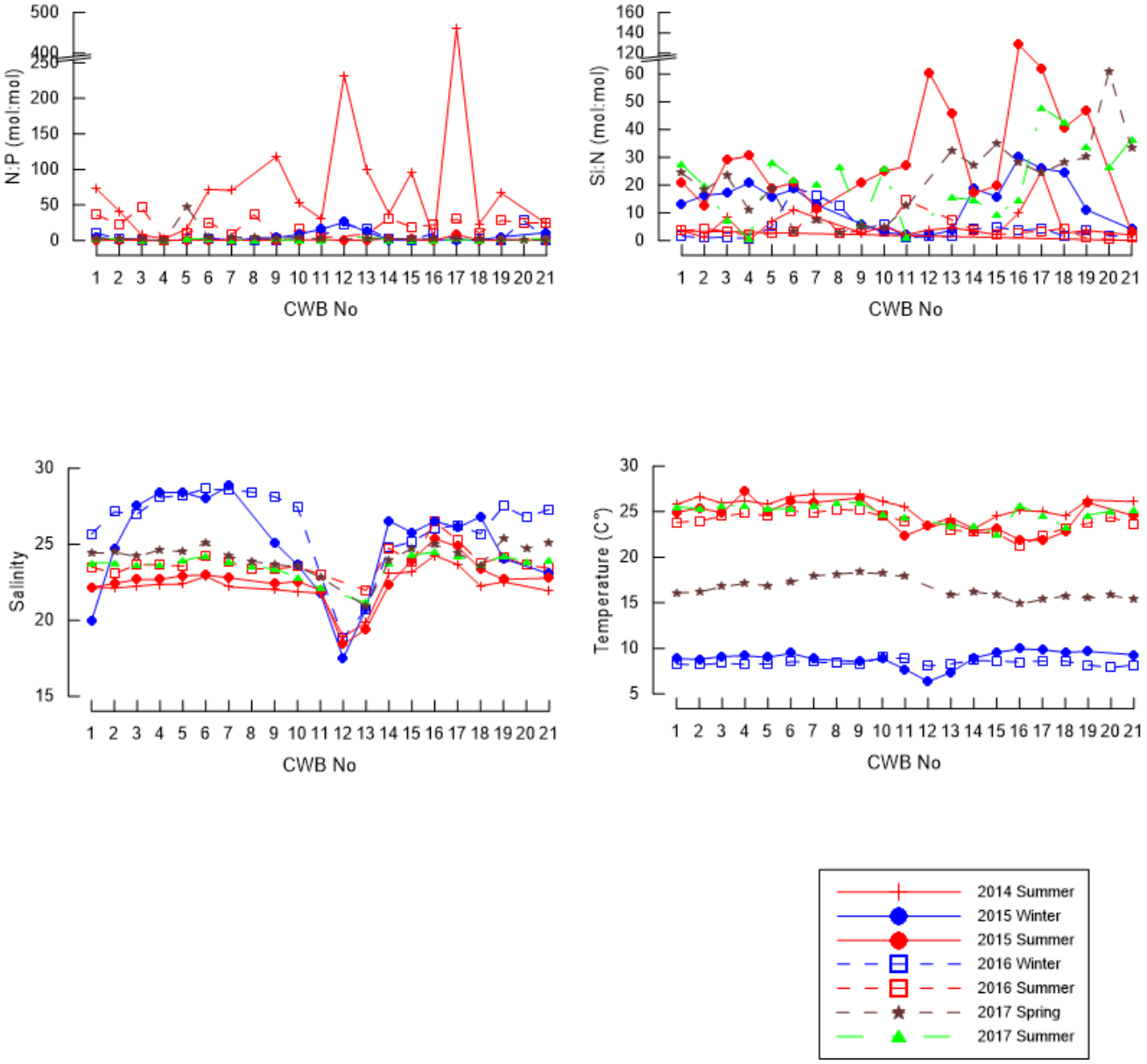

Figure 4.2 Comparison of the 2014-2017 data from the Marmara Sea CWBs on the rates of surface layer (0-10m average) nutrients and some physical properties

4.2 Chlorophyll-a levels

Figure 4.3 shows the comparison of the 2014-2017 surface layer (0-10m average) chlorophyll-a concentrations at the Marmara Sea CWBs. The comparison of the 2014-2017 data from the CWBs on surface layer (0-10m average) chlorophyll-a concentrations indicates that the concentrations in the winter periods are generally higher than those in the summer periods; nevertheless, the measurements in the summer of 2017 revealed the highest concentration among the summer measurements. Spring concentrations those were measured in 2017(2nd half of May) for the first time within the monitoring programme, turns out to be close to the summer concentration levels (Figure 4.3). The summer concentrations in 2017 reveal compatibility with the ones in previous periods.

Chlorophyll-a levels vary depending on the increase/decrease of both nutrients and light conditions. The nutrient increase in surface waters owing to vertical mixing in winter has led to an increase in the chlorophyll-a levels. This increase was expected to continue and even reach the highest levels in the spring season. The only glitch here about the spring conditions is that the measurements reflected a period which was close to the summer season, hence the expected spring blooming could not be caught. The chlorophyll-a levels over 4-4.5 µg/L represent eutrophic/hypertrophic conditions (YSKY, 2016).

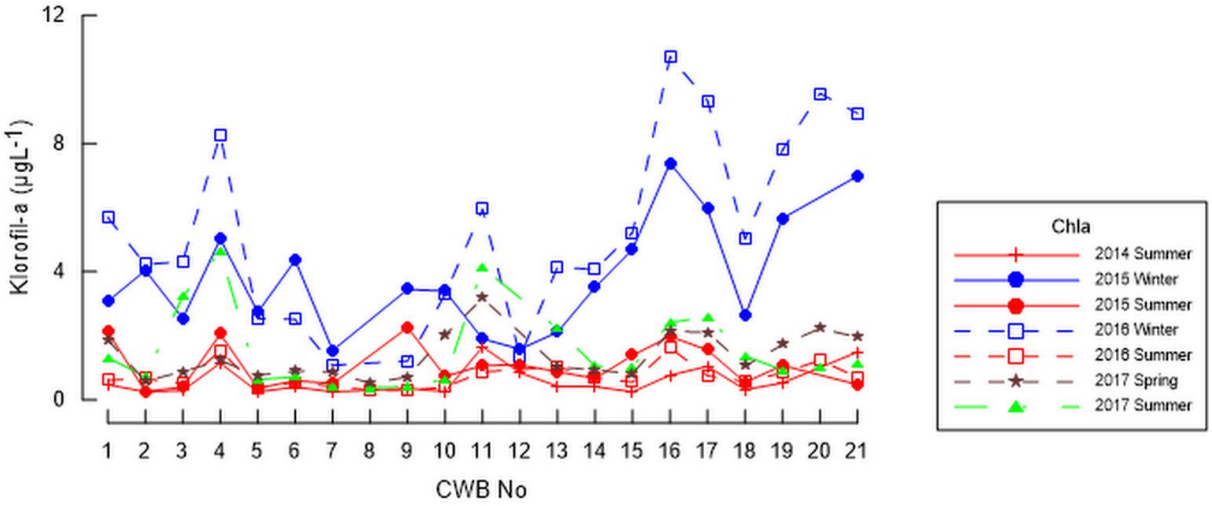

Figure 4.3 Comparison of the 2014-2017 data from the Marmara Sea CWBs on surface layer (0-10m average) chlorophyll-a concentrations.

4.3 Dissolved Oxygen Levels

Dissolved oxygen profiles of the Marmara Sea in the spring seasons of 2017 are given in the below graphics showing all stations together (Figure 4.4). The dissolved oxygen in the spring period was detected to be ≈0.3 mg/L at about ≈1000 m depth. Since the western part of the Marmara Sea is under the influence of the Mediterranean waters; DO values of the intermediate layer and bottom depths in this region were relatively high.

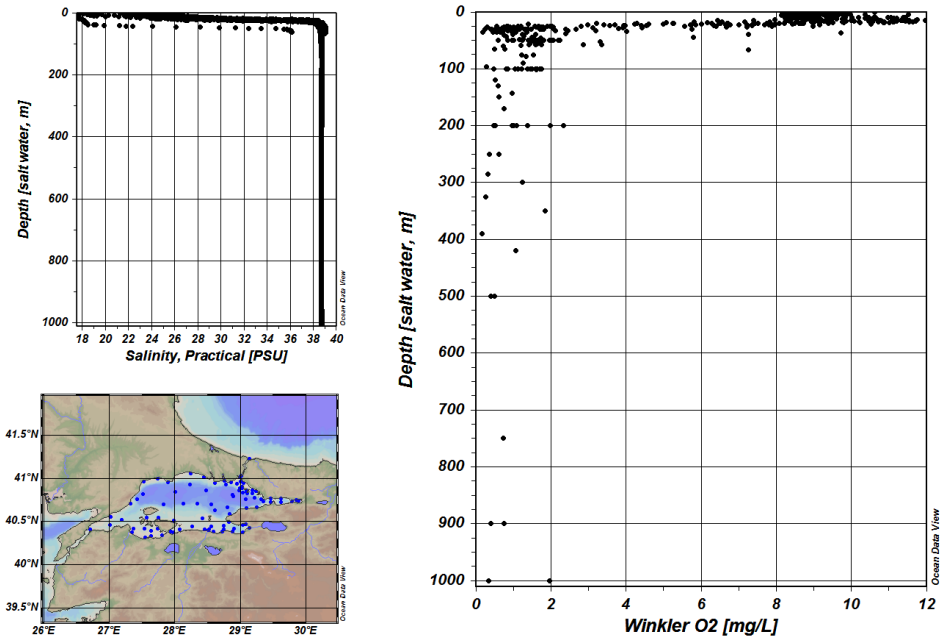

Figure 4.4 Dissolved oxygen profiles in the 2017 spring samplings of all the stations in the Marmara Sea

Figure 4.5 shows the map of saturated oxygen levels in the bottom waters in August 2016. If this parameter gets below 20-30%, it constitutes an absolutely undesirable condition for the ecosystem quality. In the deep trenches and in almost all of the east and west parts of the Marmara Sea, this parameter is below this threshold except the shelf waters and south western part that is under the direct influence of fresh Mediterranean waters.

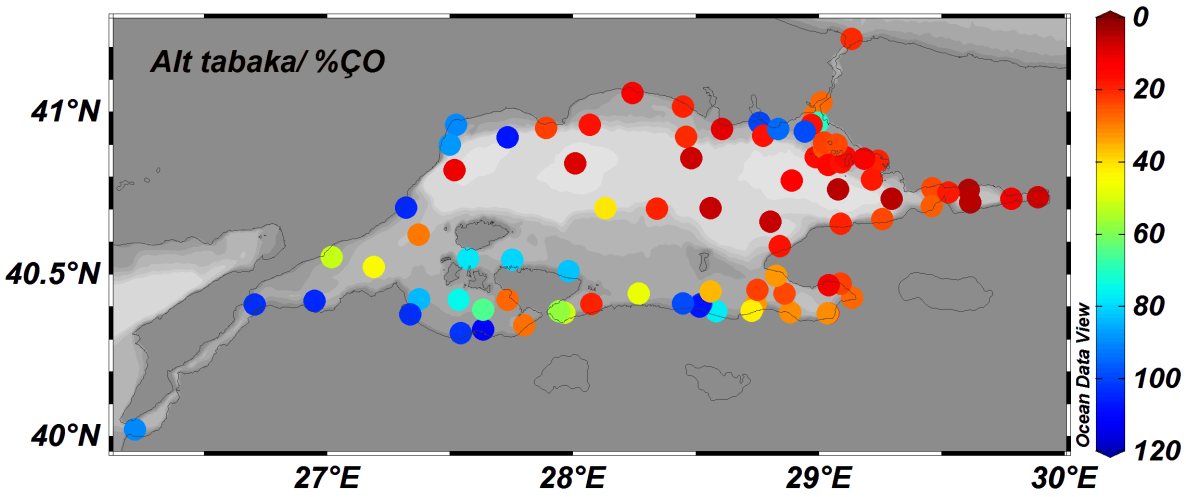

Figure 4.5 - Map of saturated oxygen value distribution in the bottom layer of the Marmara Sea (August 2016)

4.4 Secchi Disk Depth

Secchi disk depth in the Marmara Sea ranged from 1.5 to 8.5m in the spring, and from 2.5 to 13.5m in the summer 2017 sampling periods (Figure 4.5). SDDs were observed to be low in the spring, especially at the coasts of the European side of Istanbul, Bosphorus and the Gulfs of İzmit and Gemlik. When the 2014-2017 Secchi disk depths are compared, it is observed that the light transmission was observed to be higher in the summer period than in the winter period (Figure 4.5). Among the summer periods, the lowest SDD was observed in the year 2017.

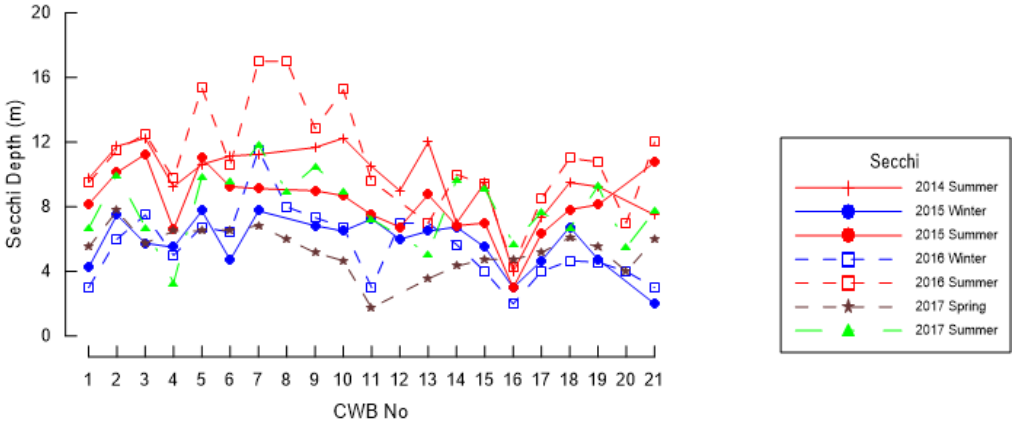

Figure 4.5 Comparison of 2014-2017 Secchi disk depth averages at the Marmara Sea CWBs

5 TRIX INDEX ASSESSMENT

TRIX values of the Marmara Sea in the 2017 spring and summer periods were calculated to be <4 (No risk of eutrophication) in general (Figure 5.1). The TRIX values at 4-5 which reflect high risk of eutrophication were observed only in the Gulf of Gemlik and Bandırma (CWB 19, 4) and at the coasts of the European side of İstanbul in the spring period. On the other hand, in the summer period, the TRIX values of the Gulfs of İzmit and Bandırma (CWB 16, 4) were observed in the range from 4 to 6. When the 2014-2017 TRIX values of the Marmara Sea are compared, the highest values (>5; high risk of eutrophication) are observed in the 2015 winter period, while the lowest values (<3; no risk of eutrophication) are observed in the 2017 summer period. The TRIX values in the 2017 spring period are generally low and close to the values of the 2017 summer period.

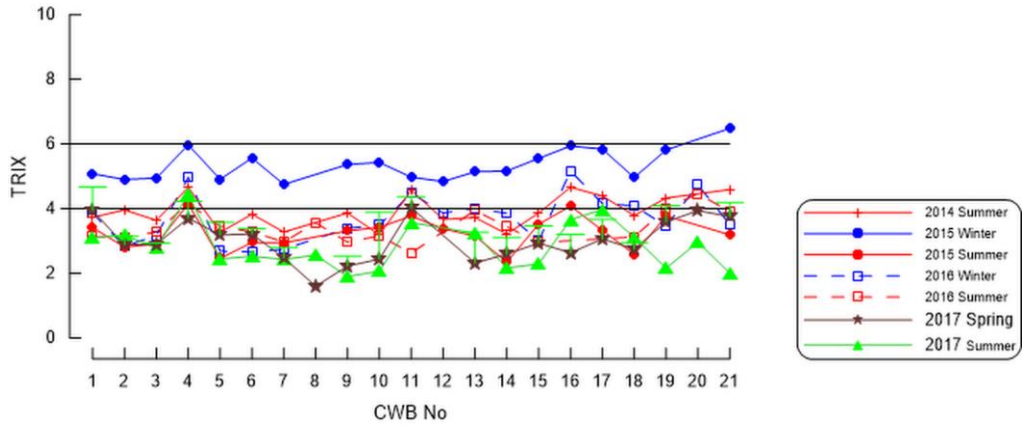

Figure 5.1 TRIX values for the CWBs of the Marmara Sea in 2014-2017 sampling periods

6 GENERAL ASSESSMENT

Ecological Quality Status of Coastal Water

This section includes quality status assessments for the August-2016 term on the basis of the findings of CWBs according to Water Framework Directive by biological parameters (phytoplankton, macroalgae and benthic invertebrates) as well as supporting parameters (TP, NO_X, SDD). Figure 6.1 shows the ecological quality status assessments of the Marmara Sea by WFD's 5-class characterization codes.

According to the 5-class scheme of WFD, a significant part of the CWBs have revealed "moderate" and less ("poor/bad") qualities. Only the coasts of Kapıdağ-Prince Islands and Çanakkale-Şarköy-Tekirdağ (MRM05, 07 and 08) were assessed to have "good/very good" quality for a three-year period between 2014 and 2016. Although MRM06 (Erdek) and MRM09 (Tekirdağ) revealed periodic changes between moderate/good, these CWBs also were assessed to be at "good" level in the 2016 period.

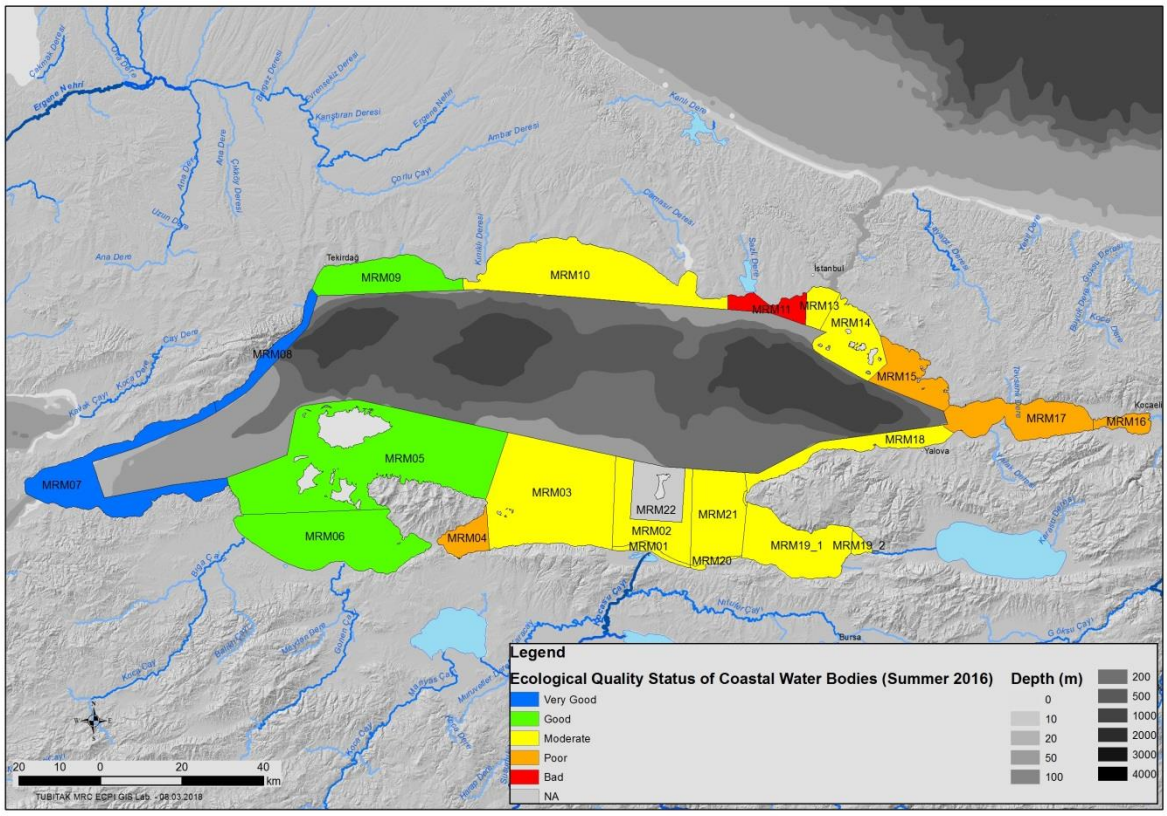

Figure 6.1 Coastal water bodies ecological quality assessment (2016)

7 APPENDICES

7.1 Appendix-1: Information on the stations and samplings in the spring and summer of 2017

Station number	Station Code	Station location	CWB/ MAU Number	Co-ordinates		Depth (m)	Distance from coast (km)
				Latitude	Longitude		
1	İZ2	Gulf of İzmit - Entrance of Marmara	MRM17	40° 43' 50"	29° 20' 57"	310	2,81
				40° 43' 59"	29° 21' 2"	319	2,51
2	İZ9	Gulf of İzmit	MRM17	40° 43' 40"	29° 28' 6"	46	1,14
				40° 43' 43"	29° 28' 5"	50	1,21
3	İZ7	Northern coast of İzmit Gulf	MRM17	40° 45' 53"	29° 27' 32"	64	0,64
				40° 45' 47"	29° 27' 39"	66	0,84
4	İZ15	Gulf of İzmit	MRM17	40° 46' 1"	29° 36' 53"	55	1,59
				40° 45' 55"	29° 36' 56"	56	1,80
5	İZ17	Gulf of İzmit - Center	MRM17	40° 43' 16"	29° 37' 3"	150	2,73
				40° 43' 18"	29° 37' 1"	153	2,80
6	İZ25	İzmit Gulf eastern basin entrance	MRM 16/17	40° 43' 56"	29° 47' 2"	40	0,95
				40° 44' 2"	29° 47' 1"	38	0,76
7	İZ5C	Gulf of İzmit - Dilburnu	MRM17	40° 44' 49"	29° 51' 8"	13	0,36
				40° 44' 45"	29° 51' 11"	18	0,46
8	İZ30	Gulf of İzmit - End of the Gulf	MRM16	40° 44' 17"	29° 53' 30"	27	1,97
				40° 44' 13"	29° 53' 37"	26	1,97
9	M20	The Prince Islands	MRM15	40° 46' 27"	29° 12' 57"	547	4,71
				40° 46' 10"	29° 12' 47"	618	5,23
10	MD102	Çınarcık Trench	MAU1	40° 45' 38"	29° 4' 48"	1240	12,29
				40° 45' 38"	29° 4' 29"	1240	12,50
11	MY2	The Prince Islands - Tuzla - offshore	MRM15	40° 49' 34"	29° 11' 12"	87	5,87
				40° 49' 32"	29° 11' 14"	88	5,81
12	MY1	Area between Tuzla and the Prince Islands	MRM15	40° 51' 3"	29° 14' 25"	41	1,37
				40° 51' 4"	29° 14' 31"	38	1,27
13	M11	Area between the Prince Islands and Tuzla	MRM15	40° 51' 25"	29° 11' 13"	65	3,09
				40° 51' 25"	29° 11' 1"	68	3,15
14	MDNEA	The Prince Islands	MRM15	40° 49' 41"	29° 6' 21"	65	8,79
				40° 49' 42"	29° 6' 31"	62	8,67
15	MDADA3	The Prince Islands	MRM14	40° 50' 39"	29° 5' 26"	65	7,81
				40° 50' 43"	29° 5' 30"	64	7,68
16	MDA6			40° 51' 23"	29° 5' 36"	50	6,60
				40° 51' 22"	29° 5' 33"	52	6,66
17	MD26	The Prince Islands	MRM14	40° 50' 15"	29° 2' 10"	100	11,54
				40° 50' 17"	29° 2' 22"	99	11,29
18	YSA	The Prince Islands	MRM14	40° 51' 38"	28° 59' 13"	90	12,39
				40° 51' 44"	28° 59' 18"	83	12,18
19	MDA3			40° 53' 16"	28° 59' 40"	45	9,34
				40° 53' 23"	28° 59' 46"	44	9,08
20	YSA1	The Prince Islands	MRM14	40° 53' 22"	29° 1' 15"	46	8,62
				40° 53' 16"	29° 1' 14"	52	8,81
21	YSA2	The Prince Islands	MRM14	40° 54' 23"	29° 1' 15"	32	6,76
				40° 54' 18"	29° 1' 19"	31	6,89
22	MDA4			40° 56' 51"	29° 3' 13"	16	1,78
				40° 56' 49"	29° 3' 16"	13	1,82
23	M3	The Bosphorus - Eastern exit to the Marmara Sea	MRM14	40° 57' 49"	29° 0' 1"	25	2,45
				40° 57' 55"	29° 0' 1"	24	2,33
24	K0	The Bosphorus - Exit to the Black Sea	MRM13	41° 13' 35"	29° 8' 10"	67	1,54
				41° 13' 35"	29° 8' 5"	66	1,61
25	B2	Bosphorus	MRM13	41° 1' 49"	29° 0' 35"	31	0,47
				41° 1' 59"	29° 0' 59"	34	0,34
26	M1	The Bosphorus - Exit to the Marmara Sea	MRM13	41° 1' 1"	28° 59' 51"	26	0,89
				41° 1' 3"	28° 59' 39"	45	0,62
27	M8	The Bosphorus - Entrance to the Marmara Sea	MRM13	40° 56' 26"	28° 56' 34"	61	5,39
				40° 56' 25"	28° 56' 39"	62	5,48
28	YK1	Yenikapı - Coast	MRM11	40° 56' 58"	28° 51' 23"	18	1,70

Station number	Station Code	Station location	CWB/ MAU Number	Co-ordinates		Depth (m)	Distance from coast (km)
				Latitude	Longitude		
				40° 57' 1"	28° 51' 24"	12	1,68
29	M14A		MAU1	40° 55' 35"	28° 46' 29"	82	4,46
				40° 55' 38"	28° 46' 29"	81	4,37
30	KC1	Küçükçekmece - Coast	MRM11	40° 58' 15"	28° 45' 21"	20	0,84
				40° 58' 14"	28° 45' 21"	20	0,86
31	BC1	Büyükçekmece - Coast	MRM10	40° 56' 48"	28° 36' 25"	50	1,83
				40° 56' 52"	28° 36' 23"	49	1,73
32	MD104	Büyükçekmece - Offshore	MAU1	40° 51' 25"	28° 28' 57"	819	15,01
				40° 51' 28"	28° 28' 52"	812	14,96
33	MD3	Tekirdağ - Coast	MRM10	41° 0' 53"	28° 26' 55"	33	1,66
				41° 0' 58"	28° 26' 54"	32	1,51
34	MD54	Silivri - Coast	MRM10	41° 3' 26"	28° 14' 35"	30	1,28
				41° 3' 29"	28° 14' 32"	29.5	1,24
35	DİPTAR2Y		MAU1	40° 55' 50"	28° 13' 38"	410	14,90
				40° 55' 53"	28° 13' 35"	400	14,82
36	MD4A		MAU1	-	-	-	-
				40° 57' 38"	28° 4' 8"	79	7,93
37	MD103	The Marmara Sea - Central Basin	MAU1	40° 50' 36"	28° 0' 32"	1247	14,10
				40° 50' 32"	28° 0' 41"	1245	14,28
38	MD86	Marmara Ereğlisi - Coast	MRM09	40° 57' 2"	27° 53' 25"	50	1,61
				40° 57' 7"	27° 53' 32"	53	1,48
39	MED2	Marmara Ereğlisi	MRM09	40° 59' 37"	27° 44' 36"	14	2,08
				40° 59' 44"	27° 44' 34"	13	1,95
40	MD59	Tekirdağ - Coast	MRM09	40° 57' 40"	27° 31' 29"	20	1,41
				40° 57' 38"	27° 31' 37"	22	1,50
41	MD6A			-	-	-	-
				40° 54' 8"	27° 29' 58"	63	2,54
42	MD101	Tekirdağ - Offshore	MAU1	40° 49' 8"	27° 30' 57"	1100	5,89
				40° 49' 16"	27° 31' 12"	1110	6,08
43	DİPTAR4Y		MAU1	40° 45' 24"	27° 25' 31"	450	5,60
				40° 45' 28"	27° 25' 35"	505	5,61
44	HOSK	Hoşköy	MRM08	40° 42' 17"	27° 19' 21"	20	0,80
				40° 42' 23"	27° 19' 31"	23	0,86
45	MD13A	Area between Tekirdağ and Marmara Island	MAU1				0,00
				40° 39' 26"	27° 24' 12"	152	9,43
46	D7MA	Şarköy (Çanakkale)	MRM07	40° 33' 16"	27° 1' 20"	31	2,09
				40° 33' 15"	27° 1' 23"	31	2,19
47	D7	The Dardanelles	MRM07	40° 24' 25"	26° 42' 24"	71	1,53
				40° 24' 20"	26° 42' 20"	71	1,63
48	MD10B		MAU1	40° 27' 42"	27° 0' 24"	50	5,90
				40° 27' 43"	27° 0' 20"	50	5,99
49	MD10A	The Dardanelles – Ent. of the Marmara Sea	MAU1	40° 31' 13"	27° 11' 8"	62	8,00
				40° 31' 22"	27° 11' 19"	62	8,37
50	MD67	Marmara Island - South	MRM05	40° 32' 53"	27° 34' 17"	58	10,81
				40° 32' 58"	27° 34' 23"	58	10,76
51	BD3	Karabiga-Islands-Gulf of Erdek	MRM05	40° 25' 20"	27° 22' 20"	36	3,48
				40° 25' 25"	27° 22' 37"	37	3,90
52	BD1	Karabiga-Islands-Gulf of Erdek	MRM06	40° 22' 40"	27° 20' 31"	12	1,35
				40° 22' 40"	27° 20' 25"	12	1,26
53	MD63	Karabiga-Islands-Gulf of Erdek	MRM06	40° 19' 6"	27° 32' 40"	15	1,72
				40° 19' 7"	27° 32' 37"	15	1,75
54	MD12A	Karabiga-Islands-Gulf of Erdek	MRM06	40° 25' 16"	27° 32' 2"	44	12,29
				40° 25' 16"	27° 32' 11"	44	12,17
55	GD3	Karabiga-Islands-Gulf of Erdek	MRM06	40° 23' 34"	27° 38' 7"	37	7,32
				40° 23' 31"	27° 37' 60"	38	7,22
56	GD1	Karabiga-Islands-Gulf of Erdek	MRM06	40° 20' 2"	27° 38' 8"	14	0,80
				40° 19' 54"	27° 38' 8"	9	0,59
57	ER1	Gulf of Erdek	MRM06	40° 20' 38"	27° 48' 7"	31	1,16
				40° 20' 37"	27° 48' 7"	32	1,14
58	MD66	Gulf of Erdek	MRM06	40° 25' 14"	27° 44' 5"	33	1,45
				40° 25' 14"	27° 44' 8"	33	1,38
59	KD1	Kapıdağ Peninsula-Northwest	MRM05	40° 32' 44"	27° 45' 12"	63	1,93
				40° 32' 40"	27° 45' 10"	63	1,79
60	DİPTAR3Y		MAU1	40° 41' 46"	27° 49' 33"	370	19,32

Station number	Station Code	Station location	CWB/ MAU Number	Co-ordinates		Depth (m)	Distance from coast (km)
				Latitude	Longitude		
				40° 41' 51"	27° 49' 34"	385	19,47
61	MD14A	Central Marmara - South	MAU1	40° 42' 21"	28° 7' 52"	450	26,03
				40° 42' 11"	28° 7' 50"	460	25,72
62	MD18	Central Marmara - South	MAU1	40° 42' 16"	28° 20' 27"	200	33,62
				40° 42' 4"	28° 20' 28"	150	33,27
63	BK1	Gulf of Bandırma	MRM04	40° 22' 36"	27° 58' 21"	38	1,59
				40° 22' 23"	27° 57' 28"	34	1,60
64	MD87	Gulf of Bandırma	MRM04	40° 23' 10"	27° 56' 33"	35	2,31
				40° 23' 19"	27° 56' 44"	35	2,57
65	MD72	Gulf of Bandırma	MRM03	40° 24' 29"	28° 4' 31"	44	2,79
				40° 24' 28"	28° 4' 26"	44	2,81
66	KD2	Kapıdağ Peninsula-Northeast	MRM05	40° 30' 34"	27° 58' 52"	35	1,89
				40° 30' 33"	27° 58' 53"	35	1,86
67	KR1	Bursa Kurşunlu-Coast	MRM03	40° 26' 29"	28° 16' 10"	47	4,48
				40° 26' 29"	28° 16' 7"	47	4,46
68	MD19A	Bursa Bayramdere-Offshore	MRM02	40° 32' 15"	28° 25' 32"	42	15,81
				40° 32' 8"	28° 25' 25"	44	15,56
69	MD19	Bursa Bayramdere-Coast	MRM02	40° 24' 36"	28° 26' 60"	17	1,63
				40° 24' 43"	28° 26' 55"	19	1,88
70	SD1	Susurluk Stream - Entrance	MRM01	40° 24' 4"	28° 30' 57"	6	0,73
				40° 24' 21"	28° 31' 8"	8	1,31
71	SD2	Susurluk Stream - Entrance	MRM01	40° 24' 33"	28° 31' 28"	10	1,81
				40° 24' 39"	28° 31' 32"	11	2,01
72	SD3	Susurluk Stream - Entrance	MRM02	40° 26' 44"	28° 33' 27"	51	6,67
				40° 26' 52"	28° 33' 30"	52	6,91
73	MD20	Susurluk Stream - East	MRM01	40° 23' 6"	28° 35' 9"	21	1,33
				40° 23' 13"	28° 35' 2"	23	1,48
74	MDSD1	Mudanya West Coast	MRM20	40° 23' 9"	28° 43' 44"	22	0,32
				40° 23' 22"	28° 43' 35"	28	0,75
75	MDSD	Off the coast of western Mudanya	MRM20/21	40° 24' 28"	28° 44' 35"	53	2,15
				40° 24' 29"	28° 44' 41"	53	2,14
76	MD89A	Gulf of Gemlik	MRM19	40° 25' 51"	29° 8' 16"	38	0,87
				40° 25' 50"	29° 8' 7"	39	0,84
77	KUMDE	Gemlik G./Kumla	MRM19	40° 28' 15"	29° 5' 14"	36	0,52
				40° 28' 9"	29° 5' 23"	36	0,53
78	MD88	Gulf of Gemlik	MRM19	40° 27' 47"	29° 2' 23"	69	1,79
				40° 27' 49"	29° 2' 27"	68	1,74
79	MD90	Gulf of Gemlik	MRM19	40° 22' 45"	29° 2' 9"	68	1,55
				40° 22' 47"	29° 2' 7"	69	1,60
80	MD22A	Gulf of Gemlik	MRM19	40° 22' 56"	28° 53' 3"	34	0,33
				40° 23' 1"	28° 53' 13"	42	0,56
81	MD22	Gulf of Gemlik	MRM19	40° 25' 4"	28° 54' 3"	100	4,39
				40° 25' 3"	28° 53' 56"	100	4,30
82	GK1	Outer Gulf of Gemlik	MRM21	40° 27' 3"	28° 45' 2"	63	6,53
				40° 27' 10"	28° 45' 8"	64	6,71
83	GK2	Gemlik G/North West	MRM19	40° 29' 45"	28° 49' 32"	38	1,33
				40° 29' 41"	28° 49' 35"	38	1,47
84	DİPTAR1Y	Marmara - South East	MAU1	40° 37' 45"	28° 36' 51"	400	17,45
				40° 37' 58"	28° 36' 49"	400	17,69
85	M74A		MAU1	40° 42' 10"	28° 33' 4"	450	26,50
				40° 42' 16"	28° 33' 5"	498	26,60
86	MD75	Armutlu (Northeast)	MAU1	40° 40' 4"	28° 48' 13"	300	11,29
				40° 40' 10"	28° 47' 49"	320	11,68
87	AR1	Armutlu - Coast	MRM18	40° 35' 14"	28° 50' 22"	148	1,87
				40° 35' 13"	28° 50' 26"	141	1,80
88	45C	East deep basin	MAU1	40° 47' 22"	28° 53' 30"	1201	18,23
				40° 47' 12"	28° 53' 28"	1207	17,98
89	CY1	Çınarcık coast	MRM18	40° 39' 30"	29° 5' 39"	125	1,47
				40° 39' 35"	29° 5' 38"	267	1,63
90	MD24	Yalova - Coast	MRM18	40° 40' 1"	29° 14' 45"	42	0,63
				40° 40' 3"	29° 14' 59"	51	0,79

7.2 Appendix-2: Sampling Methods

MATRIX	PARAMETER	SAMPLING METHOD	STORAGE METHOD	REFERENCE
SEA WATER	T,S,D	*In-situ* measurement	-	CTD Manual –Software Sea Monitoring Guidelines (2017)
	DO	*In-situ* measurement / Reagent must be added from rosette to bottle without contacting with air.		Winkler CTD Manual -Software / MTS 163 Sea Monitoring Guidelines (2017)
	SD Depth	*In-situ* measurement: with a 30cm diameter white disk	-	Sea Monitoring Guidelines (2017)
	Chl-a	Roset sampling, filtering with GF/F filters	-20 ^{0}C in deep freezer	Water Pollution Control Regulation Sampling and Analysis Methods Communiqué UNEP/MAP, 2005. Sampling and Analysis techniques for the Eutrophication Monitoring Strategy of MED POL. Technical Reports Series No: 163 Sea Monitoring Guidelines (2017)
	PO_4^+	From rosette to bottle	In HDPE bottles in deep freezer at -20 ^{0}C or immediate measurement	
	TP			
	SiO_2			
	NO_3+NO_2-N			
	NH_4-N			

7.3 Appendix-3: Measurement and Analysis Methods

MATRIX	PARAMETER	METHOD	INSTRUMENT	REFERENCE	LOD/LOQ	Unit	Measurement-Analysis Laboratory
SEA WATER	T,S,D	*In-situ* measurement	CTD prop	CTD Manual –Software Sea Monitoring Guidelines (2017)	-	-	R/V TÜBİTAK MARMARA Research Vessel
	DO	Iodometric Method (Winkler Method)	Titrator	S.M. 4500 B:2005 Sea Monitoring Guidelines (2017)	-	mg/L	R/V TÜBİTAK MARMARA Research Vessel
	SD Depth	*In-situ* measurement	Secchi Disk	Sea Monitoring Guidelines (2017)	-	m	R/V TÜBİTAK MARMARA Research Vessel
	Chl-a	Spectrophotometric Method-Extraction With Aceton	Spectrophotometer	S.M 10200 H. Sea Monitoring Guidelines (2017)	0,05	µg/L	R/V TÜBİTAK MARMARA Research Vessel
	PO_4^+	Method of Determination of Orthophosphate	Autoanalyzer	S.M. 4500-P : 2005 G Sea Monitoring Guidelines (2017)	0,02/ 0,07	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	TP	Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus	Autoanalyzer, Autoclave	S.M. 4500- P J. Sea Monitoring Guidelines (2017)	0,055 / 0,183	µmol/L	TÜBİTAK MAM Environment and Cleaner Production Institute
	SiO_2	Colorimetric method	Autoanalyzer	SM 4500-SiO2- :2005 F Sea Monitoring Guidelines (2017)	0,06 /0,19	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	NO_3+NO_2.N	Cadmium Reduction Method	Autoanalyzer	S.M. 4500-NO3-I:2005 Sea Monitoring Guidelines (2017)	0,05 / 0,17	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	NH_4.N	Flow Injection Method	Autoanalyzer	S.M. 4500-NH3 H:2005 Sea Monitoring Guidelines (2017)	0,041 / 0,14	µmol/L	R/V TÜBİTAK MARMARA Research Vessel

8 REFERENCES

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017). Integrated Pollution Monitoring Project (2017-2019). ÇTÜE 5178702, Report No. ÇTÜE.17.2116 (Marmara Sea Final Report, 2017), February 2018, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.16.330 (Marmara Sea Final Report, 2016), May 2017, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2016). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.15.264 (Marmara Sea Final Report, 2015), April 2016, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2015). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.14.201 (Marmara Sea Final Report, 2014), April 2015, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017) Sea Monitoring Guidelines, Gebze-Kocaeli.

- DEKOS Project: TUBITAK-MRC and MoEU-GDEM (2014). Marine and Coastal Waters Quality Determination and Classification Project (DeKoS). ÇTÜE 5118703, Report No. ÇTÜE.13.155 (Final Report), February 2014, Gebze-Kocaeli, Turkey.

- Vollenweider, R.A., Giovanardi, F., Montanari, G. and Rinaldi, A. 1998. Characteriztion of the trophic conditions of marine coastal waters with specific reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. Environmetrics, 9: 329-357.

- Bendoricchio, G. and Boni, G. 2005, A water-quality model for the Lagoon of Venice, Italy. Ecological Modelling 184 (2005) 69–81

- UNEP/MAP, 2005. Sampling and Analysis techniques for the Eutrophication Monitoring Strategy of MED POL. Technical Reports Series No: 163