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Regions and Sub-regions of the Mediterranean - Black Sea Terrestrial and Marine System (MBTMS)

Abstract

The MBTMS is featured by a total marine surface area of ca. 3×10^6 km², representing about 1% of the total area occupied by the global ocean, while its watershed spreads over more than 7×10^6 km². Although the marine domain of the MBTMS accounts only for approximately 0.4% of the world's oceans volume, it presents a great biodiversity hosting about 7% of all the marine species known worldwide, while presently more than 687 million people live in the 26 countries bordering the Mediterranean and Black seas. The current contribution provides the existing official (and /or commonly used) boundaries of the regions and sub-regions comprising the MBTMS (taking also into account the associated drainage basins), in order to fulfill the requirements of regional physiographic, oceanographic, and environmental issues. Thus, the MBTMS can be compartmentalized into four principal regions, i.e., Western Mediterranean (WMED), Central Mediterranean (CMED), Eastern Mediterranean (EMED), and Black Sea (BLS), which may be further divided into the following sub-regions: (i) Alboran (ALB), WestMED (WEST), and Tyrrhenian (TYR) basins, constituting WMED; (ii) Adriatic (ADR), Ionian (ION), and CentralMED (CEN) basins, constituting CMED; (iii) Levantine (LEV), Aegean (AEG), and Marmara (MAR) basins, constituting EMED; and (iv) Black and Azov seas, constituting BLS.

Keywords: basins, catchments, sea limits

Introduction

The Mediterranean - Black Sea terrestrial and marine system (MBTMS) extends to more than 10^7 km², of which 30% is represented by the marine component, while the rest by the terrestrial component (i.e., drainage area). The MBTMS is considered as the cradle of the western civilization, since some of the most important global civilizations (e.g., Egyptians, Phoenicians, Greeks, Romans) thrived for thousands of years throughout the area.

Twenty-six countries, occupying coastal areas ranging from 2 km² (Monaco) up to 17×10^6 km² (Russia) and two island countries (i.e., Malta and Cyprus) share the MBTMS coastline. In addition, seventeen more countries (eight European and Asian, and nine African) are located within the MBTMS watershed. In the beginning of the 21st century, the total population of the MBTMS had been estimated at 687 million (after Gazeaou, 2004).

Although the volume of the marine part of the MBTMS appears limited compared to the world's oceans volume (around 0.4%), a high biodiversity corresponding to about 7% of all the marine species known worldwide is demonstrated. However, the dense coastal population

and the plethora of related economic activities as well as the human impact on the extensive MBTMS catchment area, have been raising a series of major environmental issues (UNEP, 2012) such as severe changes and threats in the marine biological status, heavy pollution of sediments and biota, uncontrolled sprawl driven by urban and touristic development, and serious disruption of seafloor integrity (e.g., trawling activities, dredging). Therefore, a systemic approach, based on the knowledge of the physical characteristics of the various marine and associated terrestrial sectors of MBTMS has been initiated aiming to establish better management responses for the sustainable development and adaptation to the consequences of the current and future (e.g., climate change) threats.

The present work provides in detail the existing official (and /or commonly used) limits of the primary and secondary regions of the MBTMS (also incorporating the related drainage area), in order to contribute to the optimum management of regional physiographic, oceanographic, and environmental issues.

Methodology

The Mediterranean and Black sea earth and Ocean system has been graphically elaborated in a G.I.S. environment following the projection system WGS84. For all measurements, an equal area pseudocylindrical projection (Eckert IV) was used. The watersheds were delineated by using the Hydrosheds dataset (Lehner & Grill, 2013) as a base. Bathymetry was derived from the GEBCO 30 arc-second dataset.

The official limits of the various marine regions and sub-regions have been reproduced from data published (revised version of 2002) by the International Hydrographic Organization (IHO). Only for the determination of the west limit of the Levantine sub-region, the geological boundary (derived from the seabed topography) proposed by Carter (1974) has been used.

Results and Discussion

The analysis and processing of the IHO data derived the results that are illustrated in Figure 1. The terrestrial and marine components of MBTMS can be classified into four main regions, i.e., Western Mediterranean (WMED), Central Mediterranean (CMED), Eastern Mediterranean (EMED), and Black Sea (BLS).

WMED expands from the west termination of Gibraltar Strait to the Sicily Island (at the Sicily and Messina straits). The east limit of Gibraltar Strait is depicted by the Line A that joins Ras Espartel (35°54' N - 5°18' W) (in Africa) northward to Cape Trafalgar (36°11' N - 6°02' W), on the southern coast of Spain. The boundary at Sicily Strait may be represented by the Line B joining Cape Lilibeo (37°48' N - 12°26' E), the western extremity of Sicily, to Cape Bon (37°05' N - 11°03' E), the northeastern extremity of Tunisia. The boundary at Messina Strait is

illustrated by the Line C joining Cape Paci in Italy (15° N- 42' E) westward to Cape Peloro (38°16' N - 15°39' E), the northeastern extremity of Sicily.

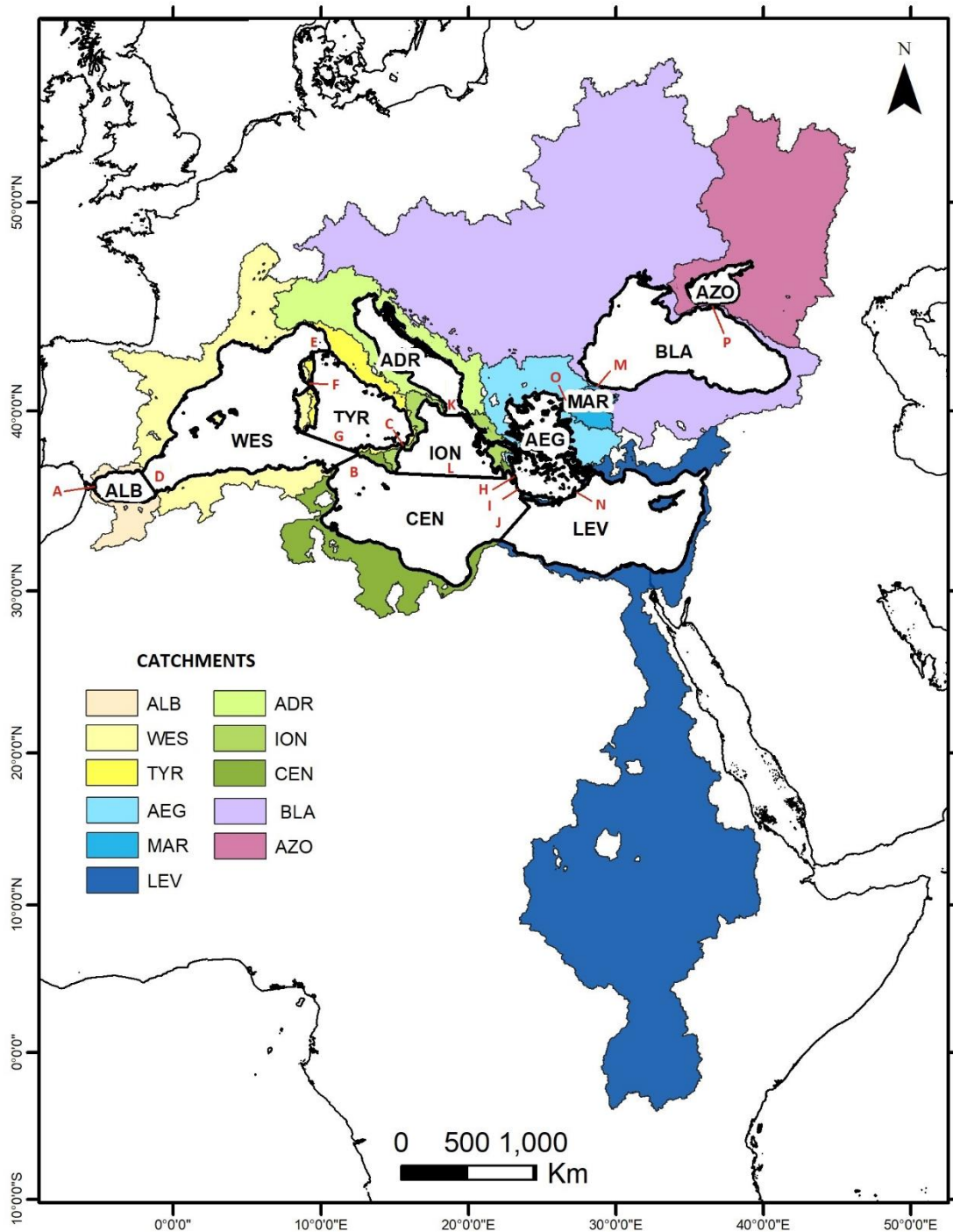


Figure 1. The MBMS regions and sub-regions together with the associated catchments

The WMED region is further divided into three sub-regions, i.e., Alboran (ALB), West Mediterranean (WEST) (also called as Algero-Provençal), and Tyrrhenian (TYR). The ALB sub-region stretches from the Line A (to the west) to the Line D (to the east), which joins Punta

Almina (35°54' N - 5°17' W), on the northern coast of Morocco, northward to Punta Europa (36°07' N - 5°21' W), on the southern coast of Spain. The north boundary of TYR is visualized by the Line E, joining Cape Corse (43° N - 9°27' E) in Corsica Island eastward (along the parallel of 43°) to the coast of Italy. The TYR south boundary is the **Line G** that connects Cape Lilibeo (37°48' N - 12°26' E), the western extremity of Sicily, with Cape Teulada (38°52' N - 8°39' E), the southern extremity of Sardegna Island. The TYR west limit is demarcated by the Strait of Bonifacio, appeared as Line F, which connects Cape Testa, on the northern coast of Sardegna Island, northward to Cape Feno (41°23' N - 9°06' E), on the southern coast of Corsica Island.

CMED, located in between WMED and EMED regions, has as west limits the Sicily Strait (Line B) and Messina Strait (Line C) and as east ones the northwest and southwest Cretan straits; the former is represented by the two successive lines H and I, while the latter by the Line J. Line H joins Cape Maleas (36°26' N - 23°12' E), the southeastern extremity of Peloponnese, southward to Cape Blembadha (35°53' N - 23°19' E), the northeastern extremity of Antikythera Island, and thence from Cape Blembadha southward, along the western coast of Antikythera, to Cape Apolytares (35°50' N - 23°20' E), the southern extremity of this island. In succession, Line I joins Cape Apolytares to Cape Kokkala (35°39' N - 23°35' E), the northern extremity of Agria Gramvousa Island, which is located off the northwestern extremity of Crete Island. Finally, Line J extends from the southwestern point of Crete (36°23' N - 22°29' E) southeastward to the northern point of Gavdos Island (34°51'45" N - 24°02'15" E) and thence through Gavdos west coast to its southern point (34°48' N - 24°07'20" E) southwestward to Cape Ra's al-Hilal (32°56' N - 22°09' E) in Libya.

The CMED region includes, from north to south, three sub-regions, i.e., Adriatic (ADR), Ionian (ION), and Central (CEN). The ADR sub-region is separated from ION by the Line K, which begins from Cape Santa Maria di Leuca (39°48' N - 18°22' E), the southeastern extremity of Italy, and extends eastward to Cape Kefali (39°45' N - 19°38' E), the northwestern extremity of Corfu Island (Greece), and along this island's north coast to Cape Kouloura (39°45' N - 19°57' E), on the Corfu northeastern coast, and thence eastwards to the mouth of Butrinto River (39°45' N - 19°59' E), on the coast of Albania. The south limit of the ION sub-region appears as Line L stretching from Cape Passero (36°40' N - 15°08' E), the southeastern extremity of Sicily, eastward to the south extremity of Antikyra Island (Cape Apolytares; 35°50' N - 23°20' E), west Cretan passage (Greece). To the west, ION is bounded by the east coast of Sicily and the Messina Strait (Line C), while to the east, ION is limited by the Line H (as described above). Finally, the CEN sub-region occupies the southern part of CMED, with its boundaries exhibited by line B to the west and lines H, I and J to the east.

The EMED region, which is the eastward continuity of CMED (with the Line J being their common boundary) has as its southeast limit the north entrance of Suez Canal and as its northeast limit the north entrance of Bosphorus Strait; the latter is represented by the Line M that joins Rokettas Burnu (41°14' N - 29°07' E) southeastward to Anadolu Burnu (41°13' N - 29°09' E). It has to be emphasized that the Line J is the only marine limit not defined by IHO,

determined through the morphosedimentary analysis of the Eastern Mediterranean seabed by Carter (1972).

EMED incorporates, from south to north, three sub-regions, i.e., Levantine (LEV), Aegean (AEG), and Marmara (MAR). LEV is separated from CEN of CMED by the aforementioned Line J, whilst its boundary with AEG is represented by the Line N joining the mouth of Dalaman River ($36^{\circ}42' \text{ N} - 28^{\circ}44' \text{ E}$), on the southwestern coast of Turkey, southward to Cape Zonari ($36^{\circ}28' \text{ N} - 28^{\circ}13' \text{ E}$), the northern extremity of Rhodes Island (Greece), and along this island's western coast, to Cape Prasson ($35^{\circ}53' \text{ N} - 27^{\circ}45' \text{ E}$), the southern extremity of Rhodes, and thence to Cape Vrondi ($35^{\circ}33' \text{ N} - 27^{\circ}13' \text{ E}$), on the eastern coast of Karpathos Island, continuing southward and along this island's eastern coast to Cape Kastellos ($35^{\circ}24' \text{ N} - 27^{\circ}08' \text{ E}$), the southern extremity of Karpathos, terminating to Cape Plaka ($35^{\circ}12' \text{ N} - 26^{\circ}19' \text{ E}$), on the eastern coast of Crete. AEG expands from the north coast of Crete and associated west (lines H and I) and east (Line N) Cretan straits to the north coastline of Macedonia and Thrace, having as its northeast sea limit the west entrance of Dardanelles Strait; the latter is represented by the Line O stretching from Mehmetcik Burnu ($40^{\circ}03' \text{ N} - 26^{\circ}11' \text{ E}$) southward to Kumkale Burnu ($40^{\circ}01' \text{ N} - 26^{\circ}12' \text{ E}$). Finally, MAR, including the straits of Dardanelles and Bosphorus, extends between the aforementioned lines O (west sea limit) and M (east sea limit).

The BLS region covers the area east of the north entrance of Bosphorus Strait (Line M), comprising two sub-regions, i.e., Black and Azov seas. The marine boundary of these two sub-regions is marked by the south entrance of Kertz Strait, displayed by the Line P joining Mys Takil' ($45^{\circ}06' \text{ N} - 36^{\circ}27' \text{ E}$) eastward to Mys Panagiya ($45^{\circ}08' \text{ N} - 36^{\circ}38' \text{ E}$).

On the basis of the above provided MBTMS division, which indicates the occurrence of four principal marine regions and eleven marine sub-regions, the boundaries of the associated drainage basins were identified. Then, the extents of the sea surface and corresponding drainage basin were estimated, while the coastline length related to each one of the countries being involved with the MBTMS was calculated and displayed in Table 1.

Concluding remarks

The Mediterranean - Black Sea Terrestrial and Marine System (MBTMS) may be divided into four primary marine regions (WMED, CMED, EMED and BLS) and eleven marine sub-regions together with their terrestrial components (i.e. drainage basins).

Among the eleven marine sub-regions determined, Levantine borders the majority (nine) of the coastal countries, while Adriatic and Black Sea basins are associated with eight and seven countries, respectively. In contrast, Marmara Sea is related only with Turkey, while each one of the Alboran and Azov basins share their coastline with two countries (Spain and Morocco, and Ukraine and Russia, respectively).

In terms of coastline length, Azov, Marmara and Alboran seas display the shortest coastlines (< 2000 km), whilst Aegean Sea presents the longest one, exceeding 13,000 km.

The ratios between the marine and terrestrial component of each region, as indicator of the magnitude of the terrestrial influence upon the marine environmental state, reveal values greater than 1 for the Western and Central Mediterranean regions and lower than 1 for the Eastern Mediterranean and Black Sea regions. Regarding the MBTMS sub-regions, West Mediterranean, Tyrrhenian, Ionian, and Central Mediterranean basins exhibit ratios lower than 1, with the lowest value of 1:14.5 appearing in the Azov Sea.

Table 1. Physiographic characteristics of the MBTMS regions and sub-regions

	Sea surface (SS) area	Drainage basin (DB) extent	SS:DB ratio	Coastline length	Coastal countries
	(10 ³ km ²)	(10 ³ km ²)		(km)	
ALB	54.2	88.8	1:1.6	1,002	ES, MO
WEST	573.3	477.1	1:0.8	6,207	ES, FR, MC, IT, LY, TN
TYR	217.5	72.1	1:0.3	3,343	FR, IT
<i>WMED</i>	<i>845.0</i>	<i>638.0</i>	<i>1:0.8</i>	<i>10,552</i>	
ADR	140.3	223.3	1:1.6	8,436	IT, SI, CO, RS, BA, ME, AL, GR
ION	173.5	68.0	1:0.4	5,692	IT, GR, AL
CEN	616.5	302.5	1:0.5	3,040	IT, GR, LY, TN, MT
<i>CMED</i>	<i>930.3</i>	<i>593.8</i>	<i>1:0.6</i>	<i>17,168</i>	
LEV	552.1	3,153.3	1:5.7	5,042	GR, TR, CY, SY, LE, IL, PS, EG, LY
AEG	192.0	229.7	1:1.2	13,277	GR, TR
MAR	11.9	37.6	1:3.2	1,140	TR
<i>EMED</i>	<i>756.0</i>	<i>3,420.6</i>	<i>1:4.5</i>	<i>19,459</i>	
MED	2,531.3	4,652.4	1:1.8	47,179	
BLA	422.2	1,798.1	1:4.3	4,869	BG, RO, UA, RU, GE, TR
AZO	41.3	599.9	1:14.5	1,842	UA, RU
<i>BLS</i>	<i>463.5</i>	<i>2,398.0</i>	<i>1:5.2</i>	<i>6,711</i>	
MBEOS	2,994.8	7,050.4	1:2.3	53,890	

ES: Spain, MO: Morocco, FR: France, MC: Monaco, IT: Italy, LY: Libya, TN: Tunisia, SI: Slovenia, CO: Croatia, RS: Serbia, BA: Bosnia-Herzegovina, ME: Montenegro, AL: Albania, GR: Greece, MT: Malta, TR: Turkey, CY: Cyprus, SY: Syria, LE: Lebanon, IL: Israel, PS: Palestine, EG: Egypt, BG: Bulgaria, RO: Romania, UA: Ukraine, RU: Russia, GE: Georgia

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