UNITED NATIONS

EP

UNEP/MED WG.568/16

UN environment programme

Mediterranean Action Plan
Barcelona Convention

12 July 2023
Original: English

Meeting of MAP Focal Points

Istanbul, Türkiye, 12-15 September 2023

Agenda Item 5: Specific Matters for Consideration and Action by the Meeting, including draft Decisions

Draft Decision 26/13: Assessment Studies: Summary for Policymakers of the MedECC Special Report on Climate and Environmental Coastal Risks

UNEP/MAP
Athens, 2023

Note by the Secretariat

Mediterranean Experts on Climate and environmental Change (MedECC, www.medecc.org) is a network of scientific experts aiming at gathering, updating and consolidating the best scientific knowledge about climate and environmental change in the Mediterranean basin and rendering it accessible to policymakers, key stakeholders and citizens. MedECC activities contribute directly to the MTS 2022-2027 (Decision IG.25.1). Hosted by Plan Bleu/RAC, MedECC's main contribution to the 2022-2023 Program of Work (Decision IG.25/19) is mandated through activity 3.3.1. Develop and provide policy recommendations to address thematic impacts of climate change: MedECC Reports on a) adaptation in coastal zones, based on literature review; b) climate change and water - energy- food - ecosystems management at watershed level, based on literature review; c) environment, conflicts, and migration, based on literature review.

Since 2018, Plan Bleu has hosted MedECC's Scientific Secretariat as part of a partnership with the Union for the Mediterranean (UfM) and helps ensure its functioning through various funding sources. MedECC published the First Mediterranean Assessment Report (MAR1) in November 2020. The Summary for Policymakers (SPM) of MAR1 has been formally endorsed by the Contracting Parties to the Barcelona Convention (Decision IG.25/4).

The three MedECC Special Reports mentioned above aim at addressing topics identified in MAR1 as requiring further study, and at informing regional and national decision-makers in the identification of current and future risks and key areas requiring further joint or coordinated action. They draw elements for the MAP Medium Term Strategy (MTS) 2022-2027 and are expected to feed the forthcoming review of the implementation of the current Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas by 2025, and the development of an updated Regional Strategy on Climate Change Adaptation.

MedECC launched in 2021 the preparation of these reports, through a series of scoping and thematic workshops. In November 2022, the tables of contents of the Special Reports were shared with policymakers and governments, including MAP Focal Points. Between May and July 2023, the First Order Draft (FOD) and the draft of the Summary for Policymakers (SPM) of the MedECC Special Report on climate and environmental coastal risks underwent the external review by peer scientists. In June-July 2023 the draft SPM underwent the consultation with decision-makers and key stakeholders, including, MAP Focal Points, Plan Bleu Focal Points and other MAP Components' Focal Points, as relevant, the Members of the Mediterranean Commission on Sustainable Development (MCSD), and MAP Partners as well as the members, observers and partners of UfM Climate Change Expert Group (UfM CCEG), UfM Working Group on Environment and Climate Change (WG ENV-CC) members. The plenary discussion on SPM of the MedECC Special Report on climate and environmental coastal risks will be held between 30 October 2023 and November 2023 (date tbc). The Plenary discussion will involve MAP and Plan Bleu Focal Points and MCSD Steering Committee Members, UfM CCEG and UfM WG ENV-CC members.

Annex of this draft decision includes the draft of the Summary for Policymakers (SPM) of the Special Report on climate and environmental coastal risks.

Following the MAP Focal Points Meeting (Istanbul, Türkiye, 11-14 September 2023), the MedECC Special Report will be updated to account for recent developments, in particular outcomes of the Plenary consultation to be held between 30 October and 3 November 2023 (date tbc).

The implementation of this decision has budgetary implications on MTF and external resources, reflected in the proposed Programme of Work and Budget.

[Decision IG.26/13

Assessment Studies: Summary for Policymakers (SPM) of the MedECC Special Report on Climate and Environmental Coastal Risks

The Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, and its Protocols, at their twenty-third meeting,

Recalling General Assembly resolution 70/1 of 25 September 2015, entitled "Transforming our world: the 2030 Agenda for Sustainable Development",

Recalling also the United Nations General Assembly resolution 76/296 of 21 July 2022, entitled "Our ocean, our future, our responsibility",

Recalling further the Environment Assembly resolution of 15 March 2019, UNEP/EA.4/Res.23 entitled "Keeping the world environment under review: enhancing the United Nations Environment Programme science-policy interface and endorsement of the Global Environment Outlook",

Having regard to the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols, and in particular Article 4 thereof on general obligations,

Recognizing that there are gaps in the knowledge of the state of the environment and risks related to climate and environmental change in Mediterranean coastal zones and that there is an urgent need to continue to strengthen efforts to bridge those gaps through building and reinforcing existing mechanisms,

Expressing appreciation for the work undertaken by the network of Mediterranean Experts on Climate and environmental Change (MedECC), including the publication of MAR1 in 2020 and the ongoing preparation of three Special Reports, but also MedECC's involvement in other MAP processes and products such as the MED2050 foresight exercise, the Mediterranean observatory on environment and development and the Mediterranean Commission on Sustainable Development,

Having considered the conclusions of the meeting of the Plan Bleu Focal Points (Marseille, France, 12-13 June 2023), and the 20th meeting of the Mediterranean Commission on Sustainable Development (Marseille, France, 14-16 June 2023),

1. *Endorse* the Summary for Policymakers (SPM) of the MedECC Special Report on climate and environmental coastal risks, as set out in Annex I to the present Decision;

2. *Urge* the Contracting Parties and the Secretariat to make all possible efforts to overcome the knowledge gaps that are identified in the MedECC Special Report on climate and environmental coastal risks;

3. *Encourage* the Contracting Parties and partners to support the streamlining of the report findings at all levels of policy- and decision-making; and organise on a voluntary basis national or sub-regional presentation and meetings;

4. *Invite* the Contracting Parties to provide adequate and sustained support, to MedECC, and its science-policy-society interface within the UNEP/MAP – Barcelona Convention system, and encourage larger participation from all the Mediterranean and women scientists;

5. *Request* the Secretariat (Plan Bleu) to continue its institutional support to MedECC, hosting its secretariat and make efforts in collaboration with MAP Partner Institutions and Organizations and Contracting Parties to provide the necessary financial support to MedECC work and operation;

6. *Request* the Secretariat to further mainstream the results of the MedECC Special Report on climate and environmental coastal risks and other results stemming from MedECC into relevant UNEP/MAP work;

7. *Request* the Secretariat and *invite* the Contracting Parties to properly disseminate the results of the MedECC Special Report on climate and environmental coastal risks and its SPM through an extensive dissemination and communication campaign in all relevant national and international fora beyond Barcelona Convention;

8. *Request* the Secretariat to *invite* the Contracting Parties to participate in the consultation process of the two upcoming MedECC Special Reports on climate-water-energy-food-ecosystems nexus and on environmental change, conflict, and human migration;

9. *Request* the Secretariat and *invite* the Contracting Parties to make the efforts in cooperation with the other supporting institutions to ensure the adequate and sustained support to the preparation of the Second Mediterranean Assessment Report (MAR2) planned for 2024-2027.]

Annex I

Summary for Policymakers of the MedECC Special report on Climate and Environmental Coastal Risks in the Mediterranean

MedECC Special Report

Climate and Environmental Coastal Risks in the Mediterranean

Draft of the Summary for Policymakers

Note: Version submitted for external consultation by governments, policymakers, and stakeholders June-July 2023

Foreword

The **Special Report on environment and climate change risks in the Mediterranean** responds to the MedECC Steering Committee's decision to prepare three special reports during the 2021-2023 MedECC work program focusing on specific issues identified after the publication of the First Mediterranean Assessment Report (MAR1) in November 2020 and considering suggestions from government representatives and stakeholders.

This Special Report identifies and assesses environmental and climate change hazards in the coastal zone of the Mediterranean Basin, related risks, adaptation options and solutions along five chapters: Chapter 1 provides the context, background and key dimensions of this assessment, Chapter 2 assesses the drivers of coastal risks in the Mediterranean and their changes, Chapter 3 assesses the coastal impacts of climate and environmental drivers, and the risks posed on human and natural systems, Chapter 4 assesses the existing and prospective responses and management approaches to address climate change and environmental risks, the final Chapter 5 synthesizes the available knowledge about climate resilient sustainable development pathways, building on the outcomes of Chapters 2 to 4.

The Special Report was prepared by a team of leading experts and scientists in the various fields of research, who volunteered to contribute without any economic compensation. The outline of the Report was developed during a Scoping Meeting with experts and scientists, consulted with government representatives and stakeholders, and validated by the MedECC Steering Committee. The authors were approved by the MedECC Steering Committee on the basis of their expertise, country and gender balance (55 authors from 17 countries).

The Special Report includes the Summary for Policymakers (SPM) composed of headline statements and a top-level summary and narrative of the key messages of the longer report. The First Order Draft of the report is currently undergoing expert peer review and **the corresponding draft SPM, is open for a large consultation with governments, decision-makers and stakeholders.**

The particular aim of this present consultation is to ascertain that the SPM is fully comprehensible and unambiguous. The First Order Draft of the longer report is also supplied with the SPM as background information and is not the object of the consultation.

MedECC Special Report
Climate and Environmental Coastal Risks in the Mediterranean

Summary for Policymakers (DRAFT for external consultation)

Date of Draft: **06 June 2023**

Report Coordinators: Salpie Djoundourian (Lebanon), Piero Lionello (Italy), María Carmen Llasat (Spain)

Report Coordinating Lead Authors: Mohamed Abdrabo (Egypt), Murat Bulivermiş (Türkiye), Z. Selmin Burak (Türkiye), Dario Camuffo (Italy), José A. Jiménez (Spain), Nathalie Hilmi (Monaco), Suzan Kholeif (Egypt), Stefano Moncada (Malta), Anna Pirani (Italy), Agustín Sánchez-Arcilla (Spain), Athanasios Vafeidis (Germany)

MedECC Coordinators: Wolfgang Cramer (France), Fatima Driouech (Morocco), Joël Guiot (France)

MedECC Secretariat: Julie Gattacceca (France), Katarzyna Marini (France/Poland)

Notes :

- In the Summary for Policymakers, references for material contained in the full Special Report (First Order Draft) are given in **curly brackets {}** at the end of each paragraph.
- **Placeholders** indicate missing content, etc. to be implemented in the final draft. Any suggestions and comments on these placeholders are welcome.
- For the elements which remain to be finalised the following abbreviations are used: **tba**-to be added, **tbc**-to be completed.
- In the Summary for Policymakers **Shared Socioeconomic Pathways (SSP)** defined in the IPCC AR6 based on future greenhouse gases (GHG) emissions are cited: SSP1-1.9 - very low GHG emissions (CO_2 emissions cut to net zero around 2050), SSP1-2.6 - low GHG emissions (CO_2 emissions cut to net zero around 2075), SSP2-4.5 - intermediate GHG emissions (CO_2 emissions around current levels until 2050, then falling but not reaching net zero by 2100), SSP3-7.0: high GHG emissions: (CO_2 emissions double by 2100), SSP5-8.5- very high GHG emissions: CO_2 emissions triple by 2075.
- In the Summary for Policymakers **Representative Concentration Pathways (RCP)** defined in IPCC AR5 are cited. RCPs are greenhouse gas concentration (not emissions) trajectories labelled after a possible range of radiative forcing values in the year 2100 (2.6, 4.5, 6, and 8.5 W m^{-2}, respectively and corresponding to one stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high GHG emissions (RCP8.5).

0. Framing: scope and basic concepts

0.1 This Special Report identifies and assesses environmental and climate change hazards in the coastal zone of the Mediterranean Basin, the related risks, adaptation options and solutions. It further assesses and provides information to address the United Nations Sustainable Development Goals (SDGs), such as combating climate change, increasing food security, managing natural resources, reforming health systems, creating opportunities for social inclusion, and economic prosperity. Adaptation plans are presented placing the social and cultural values in context of the region and its local traditions, considering the need to protect communities and minimize impacts on the natural environment and addressing ethical considerations important for socially-oriented adaptation policies.

0.1.1 Policies to manage coastal risks and adaptation strategies in the coastal Mediterranean zone are important to the whole region as a third of the Mediterranean population lives close to the sea and depends on infrastructure and economic activities in its immediate vicinity.

0.1.2 The coastal zone can be defined using objective and subjective criteria, many times with a high level of uncertainty or fuzziness. Depending on the technical, economic or legal implications, the definition and extent of the coastal zone may vary significantly in the literature. This report does not aim to propose a general definition, instead it adopts a loose criterion that the coastal zone consists of areas geographically connected to the coastline, including land areas where marine processes are relevant and sea areas where terrestrial processes are relevant.

0.1.3 The Mediterranean coastal zone is often narrow and over-pressured and requires a specific risk assessment tailored to its characteristics to inform adaptation pathways and support decisions towards risk reduction and sustainability in coastal governance, policies and social perception.

0.2 This Special Report, as with other MedECC assessments, international and national assessment processes, is based on the available, relevant and traceable evidence in the published scientific literature, including different lines of evidence (observational products, model-based findings and other types of data and analyses).

0.2.1 This report applies the calibrated terms that were adopted transversally by the Intergovernmental Panel on Climate Change (IPCC) since the 5th Assessment Report in order to communicate either qualitatively or quantitatively the robustness and certainty of assessment findings. The calibrated terms quantify confidence and likelihood[1]. The terms are attributed to the assessment outcome by the author team following an evaluation of the available evidence. The designation of confidence and likelihood are agreed upon through a consensus-building discussion of the evidence, reflecting all expert views that are expressed.

0.2.2 A common set of key dimensions is used in this report on the basis of information that is available in the scientific literature, including well-defined time frames, baselines for past changes and conditions, a subset of representative scenarios of future changes, and well-known frameworks, such as the Sustainable Development Goals (SDGs).

A. Present status of the climatic and environmental drivers for the coastal area

[1] Each finding is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, for example, *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or result: virtually certain 99–100% probability; very likely 90–100%; likely 66–100%; about as likely as not 33–66%; unlikely 0–33%; very unlikely 0–10%; and exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%; more likely than not >50–100%; and extremely unlikely 0–5%) are also used when appropriate. Assessed likelihood is typeset in italics, for example, *very likely.*

A.1 Climate change and specifically warming is affecting the whole Mediterranean environment, including its coastal zone, both its terrestrial and marine components. {2.2}

A.1.1 As a whole, the near surface air temperature of the Mediterranean region at the beginning of the 2020s is 1.5°C warmer than in the pre-industrial time (1850-1900), with an increasing trend of the order of 0.01–0.05°C yr^{-1} in the most recent decades (since the 1980s) *(high confidence)*. The sign of the observed precipitation trends over the Mediterranean exhibits pronounced spatial variability and depends on the time period and season considered *(high confidence)*. {2.2.1, 2.2.2}

A.1.2 The evolution of the Mediterranean Sea surface temperature has been characterized by multidecadal variations superimposed by a long-term positive trend since the preindustrial period with an increase of about 0.86°C *(high confidence)*. Satellite data show since the 1980s spatially different warming rates of the sea surface between +0.29°C and +0.44°C per decade, stronger in the eastern basin. Over the last two decades the frequency and duration of marine heat waves increased by 40% and 15%, respectively *(high confidence)*. {2.2.1, 2.2.5}

A.1.3 The estimated decrease of the pH of the Mediterranean Sea surface waters is between 0.055 and 0.156 pH units since the preindustrial period *(high confidence)*. {2.2.5}

A.1.4 PLACEHOLDER FOR THE FINAL DRAFT: information on heavy rains and flash floods {2.2.4}

A.2 The Mediterranean coastlines have experienced relative sea level rise[2] with an accelerated rate during the last three decades (1993–2018) significantly amplified by land subsidence in some locations. {2.2.7, 2.2.8}

A.2.1 Mean Sea level rise in the Mediterranean has increased by 2.8 ± 0.1 mm yr^{-1} in the last three decades (1993–2018) *(high confidence)*. Data from coastal tide gauges, after being corrected for the vertical land motion, show an approximate trend of mean sea level rise at the Mediterranean coasts of ~1.4 mm yr^{-1} during the 20th century *(high confidence)*. This trend is superimposed on interannual and decadal variability that can temporarily mask the relative sea level rise *(high confidence)*. {2.2.7}

A.2.2 Land subsidence along the Mediterranean coasts is mainly determined by geological factors, but it is increased by human activities and it significantly contributes to relative sea level rise in some areas (such as the coastal region of the eastern Nile Delta in Egypt, Thessaloniki in Greece, the city of Venice, the Po Delta and Arno river in Italy, the Ebro delta in Spain, or the Medjerda near Tunis in Tunisia) with values that can reach or exceed 10 mm yr^{-1} *(high confidence)*. {2.2.8}

A.2.3 Coastal flooding in the Mediterranean due to storm surges and wind waves threatens the flood-prone areas in the waterfronts (river mouths and deltas) and low-lying coastal plains. The attribution of increased frequency of floods to relative sea level rise has been made for Venice, Italy *(high confidence)*. {2.2.4}

[2] Relative sea level rise is the sum of sea level rise (SLR) and local land subsidence (LLS)

A.3 Many coasts along the Mediterranean are heavily polluted by micro- and macroplastics, toxic metals and emerging pollutants, with nutrients inputs from land producing eutrophication in several coastal areas. {2.4}

PLACEHOLDER FOR THE FINAL DRAFT: The metrics and confidence levels will be implemented to the assessments of the whole section A.3.[3]

A.3.1 Coastal water pollution originates mainly from land-based points either directly or from pollutant deposits in sheltered waters such as harbour domains, with ship-induced and air pollution contributing the remaining part. Pollution hotspots result from coastal squeeze, intense industrialization, uncontrolled discharges of municipal and industrial wastewater, riverine inputs and low seawater circulation.

A.3.2 Diffuse pollution sources such as wastewater treatment plants and runoffs from agricultural practices or distributed urban run-off introduce emerging contaminants in the coastal zone, with higher concentrations in the northern than the southern shores. Pollution from polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) has been detected particularly in Egypt, France, Italy, and Spain, with the highest levels observed around harbour and industrial areas. Shipping is one of the main sources of oil pollution in Mediterranean coasts with about 90% of tanker spills occurring near the coastlines and affecting particularly the Levantine Sea coast *(confidence level tbc) (metrics tba)* {2.4.4}

A.3.3 The Mediterranean Sea is considered as one of the most heavily plastic polluted areas across the globe *(metrics tbc)* and floating plastics squeeze along its coasts due to human activities and as a result of marine circulation *(high confidence)*. About two thirds of all the plastic debris from land-based sources (rivers and cities) is retained in the coasts *(medium confidence)*. The Mediterranean coastlines of Algiers in Algeria, Israel, Marche and Po Delta in Italy, Barcelona in Spain, Bizerte in Tunisia, Mersin in Türkiye, and Syria are the most heavily plastic-polluted *(high confidence)*. {2.4.2, 2.4.3}

A.3.4 High nitrogen and phosphate nutrient pollution flows due to agricultural practices, urban and industrial uses, have decreased in most parts of the northern Mediterranean and increased in the southern and eastern Mediterranean in the last decades *(high confidence)*. {2.4.1} *(metrics tba)*

A.3.5 Human activities have increased the concentrations of toxic metals and technology-critical elements along the Mediterranean coasts with hotspots located in its central-northern and southeastern shores *(high confidence)*. In general, release of toxic metals is decreasing for EU countries, while opposite trends are reported in some areas (examples documented in the literature are the Nile Delta and the Venice Lagoon). {2.4.2} *(metrics tba)*

A.4 The Mediterranean Sea is experiencing severe ecological events. Recent mass mortalities in coastal waters have been observed and some have been attributed to marine heat waves. **Over a thousand of non-indigenous species have been identified in the Mediterranean and along its coasts, making it a major invasion hotspot**. {2.3, *2.3.2: content tba*}

A.4.1 Mass mortality events have progressively increased in the Mediterranean Sea and they have been attributed to the increase in frequency and intensity of marine heat waves *(medium confidence)*. *(assessment tbc, metrics tba). {2.3.2: content tba} PLACEHOLDER FOR THE FINAL DRAFT: Adding the statement on mass mortalities in aquacultures envisaged.*

[3] The assessment of the confidence levels is in progress in the corresponding chapter. For more information on the issue please refer to the corresponding chapter of the report. Depending on your expertise, you are also invited to suggest additional information, if you are aware of supplementary material published on this subject that can help improve the quality of the assessment.

A.4.2 Most non-indigenous fish species enter the Mediterranean through the Suez Canal, whose limited depth favours the selection of coastal species. Further, non-indigenous species are accidentally introduced in estuaries or coastal lagoons by aquaculture facilities, aquarium species trade and boats' ballast waters *(confidence level tbc)*. Warming of the Mediterranean waters is creating increasingly suitable conditions for thermophilic species, which are expanding their distribution ranges *(high confidence)*. The frequency of jellyfish blooms has increased in the Mediterranean Sea *(medium confidence)*. {2.3.1, 2.3.2, 2.3.3}

A.5 The Mediterranean coastal region is characterised by rapid and spatially diverse socioeconomic development, mainly related to demographic trends and human settlement patterns

A.5.1 The total population of Mediterranean countries in 2020 was about 540 million people, around one-third of them living in the coastal zone, with a high concentration of urban settlements near the coast *(medium confidence)*. {2.5.1}

A.5.2 The Mediterranean is the world's leading tourism destination in terms of both international and domestic tourism with over half of the EU's tourist accommodation establishments in coastal areas.

A.5.3. Port infrastructures are not homogeneously distributed: 75% of Mediterranean ports are on the northern coast, while only 9% of ports are in Türkiye and Cyprus; 7% in northern Africa and the rest are in the eastern part.

A.5.4. The damming of Mediterranean rivers has significantly affected the supply of sediment to the coast, estimated to reduce the potential sediment supply by at least 50%.

PLACEHOLDER FOR THE FINAL DRAFT: a dedicated subsection on the importance of economic activity envisaged.

B. Future evolution of climatic and environmental drivers for the coastal area

B.1 Mean surface air temperature in the Mediterranean region is projected to *very likely* continue to increase more than the global average, together with an increase in frequency and intensity of hot extremes, reduction of precipitation and increase of evapotranspiration, depending on the level of future mitigation of greenhouse gas emissions.

B.1.1 Mean surface air temperature in the Mediterranean region, relative to 1850–1900, is projected to increase by 2.1 [1.6 to 2.7] °C[4] over the period 2041–2060 and 2.2 [1.6 to 3] °C over the period 2081–2100 under the low greenhouse gas emissions scenario (SSP1-2.6), and by 2.2 [2.3 to 3.6] °C over 2041–2060, and 5.5 [4.2 to 6.8] °C over 2081–2100 under the very high emissions scenario (SSP5-8.5). {2.2.1}

B.1.2 Over land, temperature and heat waves will increase *(high confidence)* and precipitation will decrease *(medium confidence)*, heavy rainfalls will increase in some areas of the northern Mediterranean *(medium confidence)*.

B.1.3 Future reduced precipitation, associated with increased evaporation demand will lead to hydrological drought with a decline of runoff in the Mediterranean region and coastal fresh water supply. Agricultural and ecological droughts are projected to become more severe under moderate emission scenarios and strongly enhanced under severe emission scenarios *(high confidence)*. {2.2.6}

B.1.4 Compared to the end of the 20th century (1976–2005), the mean sea surface temperature of the Mediterranean Sea is expected to increase by 0.6°C to 1.3°C by mid-21st century (2021–

[4] In this Report, unless stated otherwise, square brackets [x to y] are used to provide the assessed *very likely* range, or 90% interval.

2050), and by 1.1°C to 2.1°C under the intermediate greenhouse gas emissions scenario (RCP4.5) and 2.7°C to 3.8°C under the very high greenhouse gas emissions scenario (RCP8.5) by the end of the 21st century (2071–2100) *(high confidence)*. Warming is expected to be stronger in summer than in winter *(medium confidence)* and associated with longer and more intense marine heat waves *(high confidence)*. {2.2.5}

B.1.5 Seawater acidification is projected to continue with a pH decrease of up to –0.46 in Mediterranean surface waters by the end of this century compared to pre-industrial period under the very high greenhouse gas emissions scenario (RCP8.5) *(virtually certain*). {2.2.5}

B.2 Mediterranean mean sea level is expected to continue to rise during the coming decades and centuries at a rate depending on the future emissions of greenhouse gases *(virtually certain*). **The increase of relative sea level will cause more frequent coastal floods covering larger coastal areas** *(virtually certain*). {2.2.4, 2.2.7}

B.2.1 Mediterranean mean sea level is projected to rise during the coming decades and centuries, *likely* reaching 0.15–0.33 m by mid-21st century, and 0.32–0.62 m under the very low greenhouse gas emissions scenario (SSP1-1.9) and 0.63–1.01 m under the very high greenhouse gas emissions scenario (SSP5-8.5) by the end of 21st century, relative to 1995–2014 *(medium confidence)*. The process is irreversible at the scale of centuries to millennia *(high confidence). {2.2.7}*

B.2.2 Future mean sea level rise will lead to an increased frequency and intensity of coastal floods *(high confidence)*. A moderate scenario suggests a *likely* 10% and 30% increase in 100-year extreme sea levels by mid and end of 21st century, respectively. A very high-emission scenario shows a 25 % increase already by mid 21st century, reaching 65% by 2100. These ranges are further enlarged if uncertainty ranges in scenario projections are considered. {2.2.4}

B.2.3 Saltwater intrusion in rivers, estuaries, and coastal aquifers will *likely* increase, affecting the groundwater resources, the river discharges, the use of the coastal areas, and the most extensive wetlands that are found in relation to the major Mediterranean rivers *(high confidence)*. {2.2.4}

B.3 In the next decades, future pollution levels of the Mediterranean coasts are expected to exhibit contrasting trends between northern and southern coastlines and to differ depending on pollutants.

B.3.1 Nutrient fluxes to the coastal zone are expected to decrease in the north due to the implementation of European environmental regulations and to increase in the south if urban development and agricultural intensification continue at the present pace *(high confidence)*. The current nutrient imbalance in coastal ecosystems, with increasing availability of nitrogen relative to phosphates and leading to exacerbated eutrophication problems, is expected to increase *(high confidence)*. {2.4.1}

B.3.2 Concentrations of some pollutants, such as lead and polychlorinated biphenyls, will *very likely* continue to decline in the Mediterranean coasts due to diminished dependency and outlawing *(confidence level tbc)*, while others, such as antidepressants, are expected to increase due to emerging industries, and socioeconomic alteration *(confidence level tbc)*. {2.4.2, 2.4.4}

B.3.3 Plastic pollution of the coastline is *likely* to increase because plastic degradation is a very slow process and microplastics bury in deep sediment {2.4.3}. The leakage of plastics in the sea depends on the rate of plastic production and is *likely* to decrease by 2040 if annual growth is reduced to 1% or more and waste management is improved. {2.2.4}

B.3.4 Since the Mediterranean Sea is one of the hotspots of non-pollutant drivers, such as seawater warming, acidification and deoxygenation, along with the pollutant drivers, such as plastics, trace elements, and emerging pollutants, their co-occurrence will *likely* increase along the Mediterranean coasts. {2.2.5, 2.4}

B.4 Total coastal population of the Mediterranean is expected to grow faster than the inland population under most scenarios, thus leading to increased exposure of population and assets to coastal hazards *(high confidence).* {2.5.1}

B.4.1 Mediterranean coastal population is expected to increase under most Shared Socioeconomic Pathways, leading to a population of up to 96 million people in 2100 within the low elevation coastal zone (below 10 metres). This increase strongly depends on the pathway and varies considerably between the geographic sub regions. The northern Mediterranean may experience coastal population decline under some scenarios while the highest increases in coastal population are expected in the Mediterranean Middle East and Maghreb countries *(medium confidence)*.

C. Observed impacts and future risks

C.1 In general, the Mediterranean coastline is presently retreating, with a large spatial variability. The most dramatic erosion is observed in river mouth areas, coastal stretches around harbours and other coastal infrastructures. **In the absence of adaptation and protection measures, beaches will continuously erode during the next decades increasing risks of storm induced damages and reducing the extension of areas for sun-and-beach tourism *(high confidence).*** {3.2.2}

C.1.1 Coastal erosion will increase under the effect of climate change, as mean sea level rise will enhance erosion under energetic storms, aggravating a generalised shoreline retreat. The observed median projected shoreline retreat since 1985 is 1.7 [0.1 to 3.2] m decade^{-1}. In the future the projected median value of shoreline retreat for the Mediterranean with respect to 2010 is 17.5 [8.8 to 27.7] m and 23 [11.1 to 36.3] m by 2050 under the intermediate (RCP4.5) and very high greenhouse gas emissions scenarios (RCP8.5), increasing to 40 [20.1 to 65.1] m and 65 [31.3 to 115.0] m respectively by 2100. {3.2.2}

C.1.2 Coastal erosion will increase flooding and expose existing infrastructures along the coast to increased risk of storm induced damages *(high confidence)*. Coastal erosion will also lead to a loss of ecosystem services as coastal zone habitats will be affected, degraded and, eventually, disappear due to coastal squeeze *(medium confidence)* {3.2.2}.

C.2 Regional relative sea level rise will increase the risks of floods due to storms and lead to permanent flooding of some areas along the Mediterranean coasts. **Climate change will further increase the risk of flash floods in some coastal areas**. **Risks caused by meteorological and seismic tsunamis will continue to be relevant** {3.2.3, 3.2.4}

C.2.1 In the Mediterranean, waterfronts, seaward parts of coastal settlements and low-lying areas are exposed to flood risk caused by waves during energetic storms, which, in the absence of adaptation/protection measures, will increase in the future because of relative sea level rise *(high confidence).* {3.2.3}

C.2.2 Relative sea level rise will cause gradual and permanent inundation of low-lying unprotected areas in deltas and coastal plains, being locally often aggravated by subsidence, putting at risk natural values and important agricultural activities *(high confidence).* {3.2.3}

C.2.3 Risks posed by flash floods are high in several coastal stretches of the Mediterranean because of exposed urban settlements, densely populated areas, local meteorological regimes, and topographic conditions. In the future, in some coastal areas (including Italy, France and Spain), in the absence of adaptation, risks are expected to increase due to the increase in the frequency of heavy rainfall events and urbanization density *(medium confidence).* {3.2.3}

C.2.4 The northern Mediterranean coast is among high-risk areas in Europe to compound floods due to co-occurrence of heavy rainfall and high-water levels. The expected evolution of these events under climate change will be affected by the increase of both hazards, although with a

large spatial variability in their occurrence and no clear trend regarding their intensity *(medium confidence)*. {3.2.3, 4.5}

C.2.5 The occurrence of meteotsunamis is relatively frequent along some stretches of the Mediterranean coast (eastern Adriatic, Balearic Islands, strait of Sicily, Maltese Islands) with specific hotspots in some bays and inlets where resonance is favoured. Tsunamis produced by seismic events have caused severe damages and loss of lives in the past. They continue posing significant risks for Mediterranean coastal zones, despite being rare events. {3.2.4}

C.3 Risks of water scarcity in the coastal areas of the Mediterranean are caused by the overall drying trend affecting the region, salinisation of coastal aquifers, increasing demand associated with population growth, irrigation and touristic use. {3.2.5}

C.3.1 Seawater intrusion in coastal aquifers is documented in the Nile Delta (Egypt), North African coast, Greece and Spain. In the future salinisation will further increase due to relative sea level rise *(high confidence).* {3.3.6}

C.3.2 *PLACEHOLDER FOR FINAL DRAFT: A quantitative statement on the increase of water demand caused by increasing population, irrigation needs and tourism*

C.3.3 The quantity and quality of freshwater resources in the coastal areas will *very likely* decline, reducing the water available for future urban, agricultural and/or industrial development. Risks associated with water shortage will be amplified because of the expected reduction in aquifer recharge, sea level rise, the increase in water demand and the frequency and severity of droughts. In the future, reduced precipitation and increased evapotranspiration will lead to a decline of runoff in the Mediterranean region and consequently affect the supply of fresh water and sediment discharges into the receiving coastal systems *(high confidence)*. {2.2.6}

C.4 Mediterranean coastal wetlands have significantly declined since the beginning of the 20th century. Coastal ecosystems and their services are at risk of further reduction in the future. Risks can be further increased by changes of sediment supply, industrial development, and urban processes.

C.4.1 Mediterranean coastal wetlands have significantly declined *(metrics tba)* during the 20th century due to a combination of erosion, extreme events, salt-water intrusion, and mainly human-induced pressures like expansion of irrigated agriculture and urban development. They will be significantly affected by future changes in precipitation (*high confidence),* although with a high spatial variability. SLR-induced hazards will lead to the loss of coastal wetlands (*high confidence)* and are important in areas where existing rigid inland boundaries limit the potential horizontal migration of wetlands. {3.5}

C.4.2 Erosion along the Mediterranean coast resulting from sea level rise will lead to a decline in ecosystem services provided by coastal habitats due to their degradation and, eventually, disappearance as erosion progresses *(high confidence)*. For the northern Mediterranean coast, an overall decline in ecosystem services with respect to current conditions of about 5% by 2100 occurs under the very high greenhouse gas emissions scenario (RCP8.5), but with a high spatial variability and the largest decline occurring in the north-eastern Mediterranean areas *(medium confidence).* Lack of studies prevents assessing for the rest of the Mediterranean coastline. {3.5}

C.4.3 Any changes in sediment supply, industrial development, and urban processes will enhance the vulnerability of the coastal sandy beaches, saltmarshes, and mangrove forests to sea level rise. In addition, mangroves are experiencing compound threats due to ocean warming, sea level rise, eutrophication, and the low-oxygen zones formed as a climate change consequence. {3.5.2}

C.5 Non-indigenous species have been reported to affect indigenous species through predation, competition for resources, food web shifts and as vectors of pathogens or parasites. There are also examples of modification of coastal ecosystem services and functions *(high confidence).* {3.2.7} *(Assessment tbc)*

C.6 In the Mediterranean coastal region, climate change is expected to pose serious risks on important economic sectors such as summer beach tourism, agriculture and aquaculture.

C.6.1 In the future, hot temperatures and heat waves are expected to reduce the traditional attractiveness of the Mediterranean beaches in the summer, with several areas negatively affected, in favour of rendering spring and autumn seasons more suitable for beach tourism *(medium confidence)*. The narrowing and eventual disappearance of beaches poses high risks for the sun-and-beach tourism sector, especially in urbanised areas where the coastal zone is limited by physical barriers, such as the French, Greek, Italian, Maltese and Spanish coasts *(high confidence)*. {3.3.1}

C.6.2 Risks for agricultural productivity are posed by the overall drying trend in the Mediterranean region, by salinization of aquifers, loss of agricultural land and water scarcity. Loss of cropland in the coastal areas is caused by coastal erosion, permanent submersion (and replacement of cropland with wetlands). Further, there is a risk of farmland transformation to tourism-related areas to compensate for coastal erosion. Finally, risks for agricultural production are posed by the loss of related infrastructure (access roads, agricultural buildings, irrigation networks, etc.) in the coastal area (*confidence level tbc).* {3.3.2}

C.6.3 *PLACEHOLDER FOR FINAL DRAFT: information about fisheries and aquaculture that is specific of the Mediterranean coastal region to be added in {3.3.3}*

C.7 Sea level rise is expected to place at risk Mediterranean coastal structures, such as airports, transport networks, ports and cultural heritage sites.

C.7.1 Three out of the world's 20 airports most at risk of coastal flooding due to sea level rise are located in the Mediterranean (Ioannis Kapodistrias Intl in Greece, Pisa and Venice in Italy). In several Mediterranean countries, coastal roads and railways are located close to the shoreline in coastal plains and exposed to the risk of flooding and erosion. The increasing risk of overtopping during storms and damage to ports has been assessed in several Mediterranean countries. {3.3.5}

C.7.2. Along coastlines protected by parallel breakwaters, SLR is expected to reduce their effectiveness due to increasing overtopping conditions. The extent of this impact will largely depend on the height of the structures. Future sea level rise might make the design and planned operativity of the expensive defence system of the Venice city centre inadequate. In the absence of adaptation, the projected sea level rise by 2100 under the RCP8.5 scenario presents an elevated risk to Mediterranean ports, with the risk level (medium or low under current conditions) being expected to shift to very high or high (*medium confidence*). The extent of this increase will vary depending on local conditions, including especially port configuration *(medium confidence).* {3.3.5}

C.7.3 Mediterranean UNESCO cultural World Heritage Sites (WHS) in the low elevation coastal zone are currently at risk of erosion (42 out of 49) and coastal flooding (37 out of 49) *(medium confidence)*. The built heritage is *likely* to be also affected by climate change through slow cumulative deterioration processes, with an increase in the risk of decohesion and fracturing of porous building materials. {3.4}

C.8 Diverse pollutants affect the coastal waters of the Mediterranean Sea with negative impacts on ecological systems, human health and economic sectors (aquaculture, fishing, and coastal tourism). Risks are expected to increase with increasing anthropogenic pressures in coastal areas with combined effects of climate change and coastal pollution. {3.2.6}

PLACEHOLDER FOR THE FINAL DRAFT: The metrics and confidence levels will be implemented to the assessments of the whole section C.8.[5]

C.8.1 High nutrient fluxes from land sources cause eutrophication with adverse consequences, such as hypoxia or anoxia, episodes of massive mucilage formation and harmful algal blooms. Mucilage has been reported particularly in the highly productive and shallow Adriatic Sea and the semi-enclosed Marmara Sea. It reinforces hypoxic and anoxic conditions, negatively affecting benthic organisms and damaging tourism and fisheries.

C.8.2 Metals accumulate in estuaries and have negative impacts on organisms such as immunosuppression, impaired reproduction and development. Since trace metals are not degradable, they accumulate in marine organisms throughout food webs (the bioaccumulation of mercury is a representative example). {3.2.6}

C.8.3 Pharmaceutical residuals and other emerging contaminants reach coastal waters through discharges from wastewater treatment plants, which are unable to treat them by conventional processes. These emerging contaminants present a risk of acute or chronic toxicity to aquatic organisms. {3.2.6}

C.8.4 High concentration of plastics represents a high risk for marine biodiversity and human health due to the ingestion and accumulation by commercially exploited seafood. Coastal areas are in general hotspots for plastic ingestion. Existing risks are quite difficult to assess due to the different ecological requirements of multiple species, but there is evidence that coastal species are at higher risk than open-sea species. {3.2.6}

C.8.5 Complex interactions between climate change impacts and emerging pollutants in the coastal environment will become more frequent due to multiple stressors from both natural and anthropogenic sources *(medium confidence).* {3.2.6}

C.8.6 The occurrence of natural disasters and environmental degradation linked to pollution have multiple direct and indirect impacts on the health and well-being of coastal populations along the Mediterranean Basin. In the absence of adaptation, their impacts are expected to increase in the near future due to the expected increase in the hazardous conditions due to climate change and the increase of coastal population.

D. Adaptation measures and solutions

D.1 Adaptation primarily includes protection against coastal flooding, prevention of coastal erosion, conservation measures of coastal ecosystems

D.1.1 Protection against coastal flooding, except for few examples of relocation and nature-based solutions, typically relies on relatively high-cost engineering solutions, with residual risks on coastal landscape, biodiversity and ecosystems *(high confidence).* Lack of consideration of sea

[5] The assessment of the confidence levels is in progress in the corresponding chapter. For more information on the issue please refer to the corresponding chapter of the report. Depending on your expertise, you are also invited to suggest additional information, if you are aware of supplementary material published on this subject that can help improve the quality of the assessment.

level rise in coastal flood risk is widespread and implies the risk that during the 21st century the defence systems will reach soft limits, locks-ins and maladaptation *(high confidence).* {4.2.1}

D.1.2 Prevention of coastal erosion by engineering protection and artificial nourishment of beaches is becoming less efficient due to sediment scarcity *(medium confidence).* Nature-based solutions are increasingly implemented, but trade-offs with use of beaches and coastal resources limit the scale of their implementation *(high confidence)*. Current management of coastal erosion generally overlooks the risks posed by sea level rise (*high confidence)*. Transparent communication and governance are essential for avoiding short term interventions and maladaptation in the future *(medium confidence).* {4.2.1}

D.1.3 Many Mediterranean coastal species are already reaching their adaptation limits due to ocean warming and repeated marine heat waves and risks are increased by destruction of habitats, eutrophication and overfishing *(high confidence)*. Adaptation of coastal ecosystems requires adequate conservation measures, whose efficiency strongly depends on the success of climate change mitigation, that is limiting warming climate change below 1.5°C with no or small overshoot *(medium confidence)*. Adaptation limits of coastal terrestrial, freshwater and brackish water ecosystems will be reached above 3°C of global warming in the North-East Mediterranean and possibly earlier in the East and South Mediterranean *(high confidence)*. {4.2.3, 4.2.4, 4.3}

D.2 Management of pollution both at the source point and at the receiving system require continued long-term monitoring, using an appropriate set of indicators, and adaptive recovery management plans *(high confidence)*. Actions at the source point are more efficient as they are usually simpler to implement, long-lasting, easier to monitor, and cheaper *(medium confidence).* {4.3}

D.3 Policies to address invasive non-indigenous species are best implemented at the regional level. The loss of apex predators is a major catalyst for the colonisation and expansion of non-indigenous species *(high confidence)*, and limits to fishing through large and sustained no-take protected areas are an important component for solutions *(medium confidence).* {4.4}

D.4 Adaptation needs to water shortages vary significantly across sub-regions, depending on the hydrogeological and coastal water management context. There is high confidence that adaptation to reduced water availability is taking place in the Mediterranean coastal areas. These adaptation options consist of increasing water supply, reducing water demand, improving water quality, and supporting measures and governance.

D.4.1 Observed adaptation to reduced water quality and availability often is based on increasing water supply, but reducing the demand is an important component to limit future risks of water scarcity *(high confidence).* {4.2.4}

D.4.2 The demand for water can be achieved by improving irrigation, changing agricultural practices, improved urban water management, economic and financial incentives, the regulation of distribution as well as migration or off-farm diversification *(high confidence).* {4.2.4}

D.4.3 Nature-based solutions such as favouring marsh accretion to reduce the surface saltwater inflow into aquifers and estuaries requires space for biophysical processes, and there is *low confidence* that they remain feasible and efficient for high rates of sea level rise {4.2.4}

D.4.4 A transformation of the water-food-energy nexus can bring substantial co-benefits, such as increased human health, aquaculture easing and healthier terrestrial and freshwater ecosystems *(high confidence).* {4.3}

D.5 The dialogue between scientists, policymakers, stakeholders, and citizens is a key factor to remove barriers (including lack of understanding and trust) and it is particularly

fruitful during the planning process. Turning stakeholders into partners strongly increases the possibility of successful implementation of solutions and adaptation measures *(high confidence)*. {4.7}

E. Recent developments and sustainable development pathways

E.1 The present actions towards solutions of environmental problems, adaptation to climate change and its mitigation are insufficient to attain the Sustainable Development Goals (SDGs) ensuring wellbeing of people and sustainability of resources in the Mediterranean coastal zone *(medium confidence).* {5.2, 5.3}

E.1.1 Climate change, in combination with other global change drivers (urbanisation, rural exodus, population growth), represents a threat to the vital services of Mediterranean marine and coastal ecosystems *(high confidence).* {5.4.5}

E.1.2 Further research is needed to establish the net impact of renewable energy sources on the unique Mediterranean biodiversity of coastal ecosystems *(medium confidence).* {5.3}

E.1.3 The most vulnerable actors in society, such as the elderly, migrants, women, children and low-income earners, who are often more exposed to risk, are in many cases not adequately considered in policy measures to ensure an efficient and just transition to a changed environment and climate *(medium confidence).* {5.4}

E.1.4 Crucial socioeconomic sectors such as tourism, construction and real estate are largely based on extractive models of development, insufficiently embracing circularity and sustainable development practices *(medium confidence).* {5.3}

E.1.5 While greenhouse gas emissions in northern Mediterranean countries have been systematically decreasing since 2005, in southern and eastern Mediterranean countries they have been increasing continuously since the 1960s, mainly driven by economic and population growth *(high confidence)* {5.2.1}.

PLACEHOLDER: Numbers on current/past emissions will be added in the final document, with mention to NDCs

E.1.6 Among energy renewable sources in the Mediterranean coastal zone, offshore wind energy represents a feasible viable option while wave, tidal current and thermal gradient energies are still in the early stages *(medium confidence)*. Despite some progress in promoting transition from fossil fuels towards renewable and clean energy sources and efforts to support conservation and restoration of blue carbon pools (such as coastal ecosystems), sustainable development pathways are not occurring sufficiently fast to enable reaching net zero targets by mid-21st century *(high confidence).* {5.3}

E.2 Transformative actions are urgently needed across all sectors, systems, and scales to avoid the exacerbating climate change risks and meet the UN Sustainable Development Goals *(high confidence).* A mix of economic instruments, including command and control and behavioral nudges, are available for local, national, and regional authorities to promote effective climate resilient sustainable development pathways in the Mediterranean coastal zone *(high confidence)* Properly identifying vulnerabilities related to human activities and climate change impacts, assessing opportunities to reduce risks to the affected communities and ecosystems, and adopting actions consistent with the Sustainable Development Goals (SDGs) are fundamental for pursuing these goals. {5.3, 5.4}

E.2.1 Carbon neutrality by 2050 can only be reached by adopting more circular and more sustainable models of development, especially in southern and eastern Mediterranean countries, which decouple energy consumption from economic growth *(high confidence).* Coastal tourism is likely to act as a strong economic driver also in the near future, and as such has a key role in fostering sustainable development pathways, especially by shifting from generally wasteful and

overconsumption practices to more circular and sustainable ones *(medium confidence).* {5.2.2, 5.3.1}

E.2.2 The proper conservation and restoration of blue carbon ecosystems in the coastal zone, such as coastal wetlands, which include seagrass meadows and salt marshes, and coastal terrestrial ecosystems, which include coastal dunes, have great potential in mitigating and adapting to climate change. The carbon sequestration capacity of coastal wetlands is about 10 times that of terrestrial ecosystems, but they are not sufficiently managed and protected *(medium confidence).* {5.2.2}

E.2.3 Existing social inequalities across the Mediterranean Basin can act as a further barrier to climate change adaptation and sustainable development pathways *(high confidence).* A careful analysis of distributional effects of policies, adaptation actions and development programmes is fundamental to avoid the risk of negatively impacting low-income earners. {5.4.1}