ADAPTING COASTAL CITIES AND TERRITORIES TO SEA LEVEL RISE IN MEDITERRANEAN REGION

Challenges and Best Practices

OCEAN & CLIMATE PLATFORM

SEA'TIES
SHARING SOLUTIONS WITH COASTAL CITIES TO TACKLE SEA LEVEL RISE

Partners

Plan Bleu

MedEC
Mediterranean Experts on Climate and environmental Change

ACKNOWLEDGEMENTS

This report was co-authored by Sarah Palazot, Théophile Bongarts Lebbe, Lisa Devignol and coordinated by Raphaël Cuvelier (Ocean & Climate Platform) with the support of Hervé Menchon (City of Marseille), François Guerquin, Michael Karner, Antoine Lafitte, Coline Mias, Pauline Simon (Plan Bleu) and Katarzyna Marini (MedECC/Plan Bleu), Julie Gattacceca (MedECC).

This publication benefited from the collaborative efforts of Kamal Ben Amara (City of Bizerte), Rym Benzina (La Saison Bleue), Marie Baduel (Agence des Villes et Territoires Méditerranéens), Habib Ben Moussa, Céline Cabaye (City of Sète) and Patrick Réamot (Sète Agglopôle), Josep Canals and Carolina Pérez Valverde (MedCities), Lorédane Cuffolo (Région Sud), Brigitte Vautrin and Peggy Bucas (DREAL Provence-Alpes-Côte d'Azur), Salem Gharbia (Atlantic Technological University Sligo), Bostjan Krapez and Tjasa Babic (City of Koper), Aubrée Louarne (Université de Bretagne Occidentale), Daria Povh Skugor (Priority Actions Programme Regional Activity Centre), Silvia Torresan (Centro Euro-Mediterraneo sui Cambiamenti Climatici) who provided review and editorial support, recommended resources and shared their valuable insights.

Recommended citation: Ocean & Climate Platform. (2022). Adapting Coastal Cities and Territories to Sea Level Rise in the Mediterranean Region: Challenges and Best Practices. Ocean & Climate Platforme. 48 pp.

Contact: Théophile Bongarts Lebbe, Project Manager of the Sea'ties Initiative, Ocean & Climate Platform: tbongarts@ocean-climate.org

Website: ocean-climate.org/en/seaties-2

Editing and layout: Natacha Bigan
Cover photos: ©Keval Singh, ©Thomas Zsebok, ©Borchee Karpathos, ©Wirestock
Back cover photos: ©titouanc, ©Zhivko Dimitrov, ©Spencer Davis

©Milda

The Ocean & Climate Platform, Who are we?

The Ocean & Climate Platform is an international network of more than 90 organisations from civil society - including NGOs, research institutes, foundations, local authorities, international organisations and private sector entities - united around a key message: "a healthy ocean for a protected climate". The Platform aims to promote scientific expertise and advocate for a better recognition of ocean-climate-biodiversity issues by national and international decision makers. At the science-policy interface, the Platform supports policymakers in need of scientific information and guidance in the implementation of public policies. In addition, the Platform provides a forum for exchange and reflection where stakeholders can build a common and holistic approach to the challenge of protecting marine ecosystems and tackling climate change. Drawing on its members' expertise, the Platform brings light to concrete solutions, based on the latest available science, to preserve the ocean, its biodiversity and the climate.

The OCP's agenda on adaptation at the United Nations Framework Convention on Climate Change (UNFCCC)

As an observer organisation to the UNFCCC, the OCP is committed to a better integration of ocean-related mitigation and adaptation measures into climate strategies, most notably the Parties' Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs), and as such, is mobilised to scale up States' ambitions to meet the targets of the Paris Agreement.

Expert Group on "Ocean and Coastal Zones" of the Nairobi Work Programme on adaptation (NWP-Ocean). The NWP-Ocean aims to develop knowledge tools for a better comprehension and integration of marine issues in States' adaptation strategies. Since 2019, the OCP has been one of the 23 constituting organisations and in quality of co-Chair, represented the NWP-Ocean during the first SBSTA Dialogue on Ocean and Climate Change, held online in 2020.

The Ocean and Climate Change Dialogue under the Subsidiary Body for Scientific and Technological Advice (SBSTA). Pursuant to the decision 1/CP26 paragraph 61, the Ocean and Climate Change Dialogue was mandated by the 26th Conference of the Parties to be organised annually to strengthen the understanding of and action on ocean and climate change adaptation and mitigation. The OCP will submit inputs collectively drafted with its members to feed in the discussions of the dialogue and will actively take part in each session.

The Global Climate Action Agenda under the Marrakech Partnership (MP-GCA). The MP-GCA establishes a dialogue between Parties and non-Party stakeholders (e.g. cities, regions, NGOs, businesses and investors) around seven priority climate actions, including the ocean. As co-focal point for the "Ocean and Coastal Zones" group, the OCP mobilises non-state actors around key messages, aligned with the Ocean Pathway, to scale-up ocean-based climate action towards a resilient, nature-positive and net-zero future.

©Alex_Blajan

TABLE OF CONTENTS

Acknowledgements 3
The Ocean and Climate Platform, who are we ? 4
The Sea'ties Initiative 6
Editorial : City of Marseille 8
Editorial : Plan bleu 9
Executive Summary 10
Acronyms 11

Introduction 13

The Mediterranean Basin confronted with sea level rise
Mediterranean cities tackling sea level rise

1. Improving collective resilience by enlarging and strengthening territorial cooperation around adaptation 16

1.1. Strengthening Mediterranean-wide cooperation towards coastal adaptation
1.2. Enhancing local synergies among cities and their territories

Challenges of reconciling emergency responses with long-term adaptation, testimony from the City of Bizerte 30

2. Preparing the transformation of the Mediterranean coastlines over the short, medium and long-term 31

2.1. Articulating immediate response with long-term adaptation
2.2. Redesigning coastal uses: transitioning the tourism sector

Resources 43

Case Studies

- **Chapter 1.** SCORE EU Project - Learning from each other to co-design tailored adaptation strategies, Atlantic Technological University, Sligo, Ireland 26
- **Chapter 2.** From Sète to Marseillan: Combining engineered solutions with the managed realignment of coastal assets, Sète Agglopôle Méditerranée 40

Boxes

- **Box 1.** A Mediterranean Observatory for Environment and Sustainable Development - Plan Bleu 20
- **Box 2.** A knowledge platform on adaptation to climate change for the Adriatic coast - AdriAdapt, PAP/RAC 20
- **Box 3.** Training architect students on developing climate-resilient coastal cities in the Mediterranean - MELIMED, AViTeM 21
- **Box 4.** Managed retreat of the coastal state road Koper-Izola and sustainable requalification of the coast – Municipalities of Koper and Izola, Slovenia 22
- **Box 5.** Exchanging data and good practices to build a learning and active community in Provence-Alpes-Côte-d'Azur Region, France - monlittoral.fr online platform 25
- **Box 6.** Sea level rise scenarios along the Mediterranean coast - SAVEMEDCOAST 33
- **Box 7.** Supporting local capacities to implement ecosystem-based coastal management - MedCities 34

The Sea'ties Initiative

The Sea'ties Initiative aims to facilitate the development of public policies and the implementation of adaptation solutions to support coastal cities threatened by rising sea levels. Led by the Ocean & Climate Platform, the initiative is intended for elected representatives, administrators and stakeholders involved in this transition as a forum to exchange knowledge and experiences of sustainable solutions towards coastal resilience. Sea'ties is an international initiative which mobilises coastal experts and cities from five regions of the world featuring a diversity of climatic, geographic, social, economic and political contexts. A diversity of solutions has already been implemented across the world and can be inspirational for other coastal cities and territories. By making connections between real world experiences and characterising them through illuminating scientific works, we can promote the most suitable practises and support the choices of political decision-makers and regional administrators. .

Primary goals

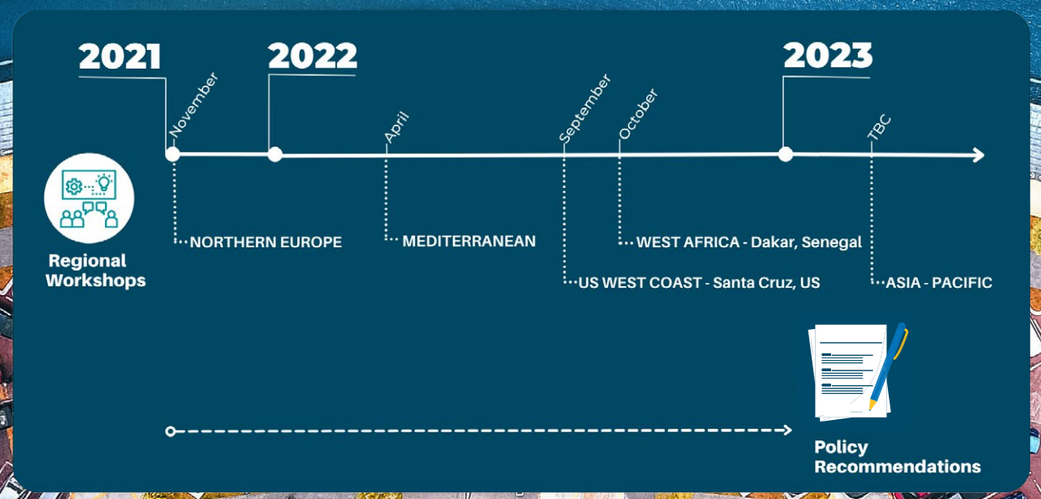
1/ Compile scientific knowledge and data into accessible summaries and databases, identifying and analysing solutions deployed by coastal cities across the world.

2/ Foster the emergence of good practices and facilitate the exchange of knowledge and experiences between coastal stakeholders during regional workshops. Leverage collective reflection for the identification of enabling factors for the deployment of sustainable adaptation solutions.

3/ Encourage the integration of adaptation challenges into public policies by promoting real world experience complemented with scientific knowledge, and by submitting policy recommendations to decision makers so they can integrate the most suitable solutions into their international and national public policies.

Regional workshops

By bringing together experts and key stakeholders working on adapting coastal cities and territories to sea level rise - e.g. scientists, regional planners, NGOs, civil society representatives, elected officials - regional workshops aim to provide an understanding of the plurality of adaptation responses deployed in diverse geographical and socio-economic settings. To highlight the plurality of approaches and solutions implemented across the world, five regional workshops are scheduled between 2021 and 2023.



To improve the integration of adaptation challenges into public policies, concrete returns on experience shared by participants will inform the production of recommendation and the advocacy work of the Ocean & Climate Platform, including at the UNFCCC.

Reference tools and documents

The Sea'ties Initiative contributes to the enhancement and diffusion of knowledge on adaptation issues through the production of scientific papers, reference tools and documents to the address of the scientific community, policymakers and the general public.

• Regional Reports

Each Sea'ties workshop, as well as preliminary individual interviews, inform the production of a regional report, providing an overview of the current obstacles and needs to be addressed to implement adaptation strategies, highlighted by regional experts. Intended for policymakers, city and territorial planners, and residents willing to pursue transformational change on their coasts, the reports shed light on good practices to inspire action. The first report of this series, "Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe, Challenges and Best Practices", is available on the Sea'ties webpage.

• The Sea'ties Declaration

Initiated by the OCP, the French Government and the City of Brest, with the support of ICLEI and Race to Resilience, the Sea'ties Declaration commits more than 40 mayors, governors and city networks across the world to the challenges of adapting coastal cities and territories to sea level rise. The Declaration is a call to accelerate adaptation action addressed to the international community, which highlights four priority strategies: (1) the mobilisation of science and observation systems, (2) the integration of societal issues within adaptation plans, (3) the fostering of adaptive and hybrid solutions, and (4) the increase of public funding and private investments for adaptation to sea level rise.

• Scientific Article - Designing Coastal Adaptation Strategies to Tackle Sea Level Rise[2]

The article "Designing Coastal Adaptation Strategies to Tackle Sea Level Rise" is a synthesis of scientific literature and presents four archetypes of adaptation strategies to sea level rise. These are analysed according to their governance modalities and characterised based on their degree of implementation complexity. This synthesis was co-written by scientists from the RTPi-Sea'ties, co-led by the OCP and CNRS, and was published in the Journal Frontiers in Marine Science, Ocean Solutions in November 2021.

• The Blue-Tinted White Paper, Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building highlights the financial gaps and opportunities for coastal cities' adaptation and provides recommendations to unlock financial flows at scale.

• Policy Brief - Adapting Coastal Cities and Territories to Sea Level Rise[3]

The policy brief "Adapting Coastal Cities and Territories to Sea Level Rise" addresses the challenges faced by stakeholders in the field of adaptation, and highlights the essential elements of a sustainable transition of coastal territories.

• Map of Solutions

The Map of Solutions is an interactive cartography listing hybrid responses implemented around the world to tackle the risks associated with sea level rise. It provides project leaders with concrete feedback, highlighting the outcomes, takeaways, and cautionary remarks to inspire and support coastal stakeholders in the implementation of adaptation strategies in their coastal cities and territories.

1/ Ocean & Climate Platform. (2022). Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe: Challenges and Best Practices. Ocean & Climate Platform. 39 pp. https://ocean-climate.org/wp-content/uploads/2022/04/SEATIES_Report_Adaptation_SLR_Northern-Europe_V2.pdf

2/ Bongarts Lebbe, T., Rey-Valette, H., Chaumillon, É., Camus, G., Almar, R., Cazenave, A., et al. (2021). Designing Coastal Adaptation Strategies to Tackle Sea Level Rise. Frontiers in Marine Science. doi: 10.3389/fmars.2021.740602

3/ Ocean & Climate Platform. (2021). Adapting Coastal Cities and Territories to Sea Level Rise. Ocean & Climate Platform

Editorial

CITY OF MARSEILLE

The coastline is a defining feature of the City of Marseille. Stretching over nearly 57 kilometers, it is an essential landmark for many citizens. The city's economic activities, notably ports, social links, cultural identies and political life have been shaped throughout centuries along the Mediterranean coastline. Boasting a unique landscape, ecological and environmental wealth, Marseille's coastline and its harbour are nonetheless faced with multiple threats.

Our seafront is both confronted to the risks of marine submersion and subjected to rapid erosion which are aggravated as the impacts of climate change are intensifying.

As highlighted by the First Assessment Report (MAR1) of the independent network of Mediterranean Experts on Climate and Environmental Change (MedECC), the Mediterranean Basin will experience a similar sea level rise to the global average, but its population will be notably more vulnerable to coastal risks as it will experience unprecedented conditions.

Indeed, our livelihoods that have developed under relatively stable conditions are now confronted with such rapid and intense changes that immediate responses are necessary. Nonetheless, experience in Marseille, from the northern to the southern shores, has shown that reinforcing protection levels through the hardening of the shoreline is not enough. Instead, we must develop a new culture around the sea that adapts and anticipate the effects of future climatic variations.

In light of this ecological and social challenge, designing adaptation strategies that are fair, equitable and tailored to the needs of all stakeholders is crucial. Well beyond the sole competence of the City of Marseille, this transformation calls on the joint efforts and intelligence of all the populations of the Mediterranean region and of the international community. For this reason, the City of Marseille is supporting the Seaties initiative of the Ocean & Climate Platform. By becoming a signatory of the Seaties Declaration and sponsor of the Mediterranean workshop organised in April 2022, Marseille calls on the cooperation of coastal cities from all over the world confronted to this same challenge in order to step up the implementation of concerted and innovative solutions for the transition of the coasts.

Hervé Menchon,
Deputy Mayor of Marseille

Editorial

PLAN BLEU

Tied together by 46,000 km of shared coastline, Mediterranean countries have long understood the importance of concerted action to ensure a sustainable future. By signing the Barcelona Convention in 1976, they acknowledged the necessity of a collective approach to protecting the maritime and coastal space as an indispensable condition to the development of their societies.

Plan Bleu is one of the 6 Regional Activity Centres of the Mediterranean Action Plan (MAP) of the United Nations Environment Program (UNEP), made available by France in 1977. For the last 45 years, the core mission of Plan Bleu has been to protect the Mediterranean basin by guiding the authorities for informed decision-making. It has become a reference in knowledge production and dissemination among regional decision-makers and stakeholders. In line with this, Plan Bleu hosts the Scientific Secretariat of MedECC, the network of Mediterranean Experts on Climate and Environmental Change as part of a partnership with the Union for the Mediterranean (UfM). MedECC is an open and independent network of scientists founded in 2015 to assess the best available scientific knowledge on climate and environmental change and the associated risks in the Mediterranean Basin and to make these results accessible to decision-makers, stakeholders, and citizens. In 2020, with the support of Plan Bleu, MedECC published the first Mediterranean Assessment Report (MAR1).

This report provides undeniable evidence of the impacts of climate and environmental change in the Mediterranean. Among the cumulative risks, rising sea levels could profoundly transform the coasts and societies that depend on them. Around 2100, depending on the scenario, the Basin's mean sea level will likely be 37-90 cm higher than at the end of the 20th century, but possibly more than 110 m in the case of further ice-sheet destabilisation in Antarctica. Meanwhile, the Mediterranean coastline draws a growing population into increasingly dense and extensive urban centres. This phenomenon is particularly observed on the southern shores, where urban growth is the strongest.

Partly driven by anthropogenic pressures, erosion across the Mediterranean could be significantly slowed down. Yet, considering sea level rise projections in 30, 50, or 100 years, adaptation will require transformative changes to our cities and territories, thus to our ways of living on the coast. From Marrakech to Bizerte, through Alexandria, Dubrovnik, Venice, Marseille, or Barcelona, both elected officials and populations must be informed of the risks and the possible solutions.

Cooperation, experience-sharing, knowledge, and resource pooling among Mediterranean cities are critical levers for action. In light of this, Plan Bleu is supporting the Sea'ties initiative of the Ocean & Climate Platform. By sponsoring the Mediterranean Workshop organised in April 2022 and contributing to this report, Plan Bleu encourages collective intelligence to identify needs and promote flagship initiatives that will enable the development of tailored and sustainable responses.

François Guerquin,
Director of Plan Bleu

EXECUTIVE SUMMARY

The present report draws on elements discussed during the Sea'ties workshop "Adapting coastal cities to sea level rise in the Mediterranean region", hosted virtually by the Ocean & Climate Platform with the support of Plan Bleu and the City of Marseille on April 26, 2022, as well as 28 individual interviews held between December 2021 and March 2022. The workshop mobilised 43 experts (mayors, local planners, scientists, representatives of environmental and maritime programmes, agencies, associations and networks) from Croatia, Cyprus, France, Greece, Italy, Morocco, Slovenia, Spain and Tunisia.

This workshop provided a forum for participants to share and discuss their practices as well as the main obstacles that remain to be addressed in the region. Divided into two thematic sessions, the workshop first focused on the issue of accessing and disseminating scientific knowledge, then discussed the importance of adapting coastal infrastructure and activities to SLR. While the issues of financing adaptation[4] and port transformation are critical concerns across the Mediterranean Basin, these complex, inherently distinctive issues require specific expertise that could not be provided during the workshop and are therefore not developed in the present report.

The report provides an overview of the main obstacles that coastal managers from the Mediterranean region face in adapting their cities. Accordingly, it addresses the issues of how to design sustainable adaptation strategies through a coordinated approach at the regional and local levels; how to articulate measures over time, particularly in the context of the transformation of key sectors such as tourism.
Intended for policymakers, city and territorial planners, and residents willing to pursue transformational change on their coasts, the report highlights good practices through dedicated Boxes and Case-studies.

As sea level rise poses regional challenges and unilateral actions are likely to impact the entire coastline, further regional cooperation and territorial integration is necessary. Capacity imbalances and knowledge gaps emphasise the importance of structuring regional cooperation (i.e. knowledge-sharing, networks, cross-border projects, regional frameworks) around the issue of coastal adaptation to SLR. In parallel, enlarging the management scope beyond cities' administrative boundaries and strengthening territorial synergies and coordination will be paramount, to address the interrelated effects of SLR across cities and their surrounding territories.

Defining pathways to articulate short-term agendas with transformational changes is pivotal as Mediterranean cities' immediate responses to rapid erosion impact long-term resilience. Meanwhile, short and mid-term planning which draws on sustained stakeholder engagement helps implement transformational change. Articulating time horizons is particularly relevant to the adaptation of the tourism sector, whose realignment will be better accepted as it is co-conceived with all relevant stakeholders.

4/ See "Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building. Blue-tinted white paper." (2022)

ACRONYMS

APAL - Agence de Protection et d'Aménagement du Littoral (translated into: Coastal Protection and Development Agency)

AViTeM - Agence des Villes et Territoires Méditerranéens Durables

CADS - Consell Assessor per al Desenvolupament Sostenible de Catalunya (translated into: Advisory Council for the Sustainable Development of Catalonia

C3S - European Union Copernicus Climate Change Service

CCLL - Coastal City Living Labs

DRR - Disaster Risk Reduction

EbA - Ecosystem-based Adaptation

EU - European Union

GDP - Gross Domestic Product

GHG - Green-house gases

ICZM - Integrated Coastal Zone Management

MAP - Barcelona - Mediterranean Action Plan

MAR1 - First Mediterranean Assessment Report

MedECC - Mediterranean Experts on Climate and environmental Change

MONGOOS - Mediterranean Operational Network for the Global Ocean Observing System

MP-GCA - Global Climate Action Agenda under the Marrakech Partnership

MSP - Marine Spatial Planning

MSSD - Mediterranean Strategy for Sustainable Development

NAP - National Adaptation Plan

NbS - Nature-based Solutions

NDC - Nationally Determined Contributions

NGO - Non-governmental Organisation

NWP - Nairobi Work Programme

OCP - Ocean & Climate Platform

OECD - Organisation for Economic Co-operation and Development

PAP/RAC - Priority Actions Programme Regional Activity Centre

PSMSL - Permanent Service for Mean Sea Level

RCCAF - Regional Climate Change Adaptation Framework for Marine and Coastal Areas

RECO - Réseau d'Expertise sur les Changements Climatiques en Occitanie (translated into: Expert Network on Climate Change in Occitanie)

RMN - Rete Mareografica Nazionale (translated into: Italian Tide Gauge Network)

SBSTA - Subsidiary Body for Scientific and Technological Advice

SIS - Sectoral Information System

SLR - Sea Level Rise

UNDP - United Nations Development Programme

UNEP - United Nations Environment Programme

UNFCCC - United Nations Framework Convention on Climate Change

UNESCO - United Nations Educational, Scientific and Cultural Organisation

© Polina Rytova

INTRODUCTION

The Mediterranean Basin confronted with sea level rise

The Mediterranean region is considered a "hotspot" of climate change with SLR being one of its most important slow-onset consequences. As a semi-enclosed sea connected to the ocean, the Mediterranean Basin has been subjected to sea level variations similar to that of global means[5]. In the last two decades, sea level has risen at an accelerated rate of 3 cm per decade[6]. As a consequence of climate change, global estimates project an irreversible and continuous rise for the coming centuries to millenium[7]. By the end of the century, the region could observe an elevation of 110 cm higher than at the end of the 20th century in a high GHG emission scenario (RCP8.5)[8]. However, regional projections of sea level change are uncertain due to important knowledge gaps on the interaction patterns between the Atlantic Ocean and the Mediterranean Sea[9] as well as on local processes (i.e. vertical land motion[10]). Meanwhile, sea level extreme events will become more intense and frequent as sea levels continue to rise in combination with extreme weather variations[11]. As the Mediterranean shoreline undergoes major changes, human activities, settlements and constructions, i.e. hard protections, are further altering coastal processes, and the multiplication of climate change risks are concerning both inland and coastal cities (e.g. riverine flooding, heatwaves and fires, droughts). All territories will be affected by these changes, but more intensive effects will be felt along the Southern and Eastern shores where adaptive capacities are generally institutionally and economically constrained, as well as along low-lying coasts found in deltas (e.g., Alexandria and the Nile Delta, Egypt), lagoons (e.g., Venice, Italy), tidelands and islands (e.g., Kerkennah archipelago in Tunisia[12])

Mediterranean cities and their growing populations are at the frontline of these adverse effects. Disruption in livelihoods will be even more impactful as they have developed in relatively stable environmental conditions and non-dynamic water levels throughout the 20th century, allowing the settlement of populations and activities in the narrow coastline strip[13][14]. Across the Basin, about one-third of the population lives in coastal cities, with the Southern shore recording most of the urban growth observed in the last decades[15]. As such, the consequences of SLR on population safety and the socio-economic costs could be dramatic. Damages to human physical and mental health, as well as cities' built environments, facilities and supporting infrastructures such as roads, ports, railroads, airports and electricity lines will severely affect Mediterranean socio-economic

5/ Cherif, S., Doblas-Miranda, E., Lionello, P., Borrego, C., Giorgi, F., Iglesias, A., et al. (2020). Drivers of change. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 59-180. htpps://doi.org/10.5281/zenodo.7100601

6/ Cramer, W., Guiot, J., Fader, M. et al. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. Nature Clim Change 8, pp. 972–980. https://doi.org/10.1038/s41558-018-0299-2

7/ IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. et al. (eds.)]. Cambridge University Press. In Press.

8/ Cherif, S., Doblas-Miranda, E., Lionello, P., Borrego, C., Giorgi, F., Iglesias, A., et al. (2020).

9/ Cramer, W., Guiot, J., Fader, M. et al. (2018).

10/ Marcos, M., Jorda, G., & Cozannet, G. L. (2016). Sub-chapter 2.2.1. Sea level rise and its impacts on the Mediterranean. In Moatti, J., & Thiébault, S. (Eds.), The Mediterranean region under climate change : A scientific update. IRD Éditions. doi :10.4000/books.irdeditions.23454

11/ Cherif, S., Doblas-Miranda, E., Lionello, P., Borrego, C., Giorgi, F., Iglesias, A., et al. (2020).

12/ Balzan, M.V., Hassoun, A.E.R., Aroua, N., Baldy, V., Bou Dagher, M., Branquinho, C., Dutay, J-C., et al. (2020). Ecosystems. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 323-468. https://doi.org/10.5281/zenodo.7101090

13/ Vafeidis, A.T., Abdulla, A.A., Bondeau, A., Brotons, L., Ludwig, R., Portman, M., et al. (2020). Managing future risks and building socio-ecological resilience in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 539-588. https://doi.org/10.5281/zenodo.7101119

14/ Antonioli, F, De Falco, G., Lo Presti, V., Moretti, L., Scardino, G., Anzidei, M., et al. (2020). Relative Sea-Level Rise and Potential Submersion Risk for 2100 on 16 Coastal Plains of the Mediterranean Sea. Water, 12(8), 2173. https://doi.org/10.3390/w12082173

15/ Balzan, M.V., Hassoun, A.E.R., Aroua, N., Baldy, V., Bou Dagher, M., Branquinho, C., Dutay, J-C., et al. (2020).

development. Impacts on neighbouring territories such as the salinisation of coastal aquifers and the loss of agricultural land will also greatly affect cities and their populations. France, Spain, Greece and Italy are projected to face the highest damage in absolute terms, as well as Egypt and Tunisia in relation to their annual GDP[16]. Moreover, SLR poses serious threats to Mediterranean identities and cultural heritage. Indeed, of the 49 UNESCO world heritage sites located in low-lying coastal areas of the Mediterranean, 37 are at risk from a 100-year flood and 42 from coastal erosion[17].

Meanwhile, marine and coastal ecosystems in and around coastal cities are rapidly degrading as a result of "coastal squeeze". SLR threatens critical ecosystems such as lagoons, deltas, sandy beaches and coastal wetlands. In the Balearic Islands, for example, beaches could retreat by 50 m (RCP8.5) due to rising sea levels[18]. This depletion is accentuated as the artificialisation of soils and urban sprawl progress due to tourism development and the decentralisation of residential areas. Eventually, the degradation of key habitats could cause significant biodiversity loss. For instance, a 1.2 m SLR could cause the loss of 67.3% of loggerhead turtle nests and 59.1% of green turtle nests.[19].

Mediterranean cities tackling sea level rise

Without timely and sustainable coastal adaptation strategies, damages due to SLR will increase in cities and their surrounding territories. Yet, the uptake on the issue is slow, partly due to weak risk perception. Indeed, the Mediterranean Basin has been relatively spared by tidal and extreme variations in sea levels in comparison to other regions[20].

Consequently, SLR is rarely regarded as a priority, especially as cities are eager to maintain and develop their economies[21]. As such, the necessity to preserve key industries favours strategies maintaining the status quo and Mediterranean cities usually respond reactively and incrementally, preferring protection-based measures such as breakwaters and seawalls. In Tunisia, about 42% of the coastline is subjected to erosion which has been mainly addressed by protection works[22]. Of the 11 to 18% of artificial coastline, over 60% of constructions are dedicated to protection works (dikes, revetments, breakwaters)[23]. The construction a mobile barrier, the so-called MOSE system, to protect Venice and its lagoon is also emblematic of this approach[24]. Soft protection measures such as beach nourishment and dune replenishment are also rapidly developing in France, Spain and Italy as an attractive strategy for municipalities to maintain recreational activities linked with tourism[25]. Conversely, accommodation measures and managed retreat[26] are almost nonexistent across the Basin[27].

As coastal changes already affect and threaten livelihoods, it is paramount to break from path dependencies and plan long-term, dynamic and integrative adaptation strategies. Mediterranean cities have critical enablers at regional scale that could facilitate their design and implementation. Regional experience in urban and coastal management, supported by multiple cross-border networks, projects and research institutions are notable assets they can build on. Nonetheless, remaining socio-economic, institutional, and knowledge barriers, uneven capacities to implement adaptation between the Northern and Southern shores are likely to result in acute inequalities and disrupt regional balance in the long run. Considering that Mediterranean cities are confronted with common challenges and that unilateral actions are likely to affect the entire region, adapting cities to SLR requires the engagement of all Mediterranean stakeholders.

The present report provides an overview of current practices and obstacles to defining and implementing adaptation strategies, put forth during the Sea'ties workshop "Adapting cities to SLR in the Mediterranean region". Complementing the conclusions drawn from the precedent regional report dedicated to Northern Europe, two key issues are addressed in the following sections:

1 Regional linkages and local interdependencies underline the relevance of enlarged and deepened coordination across the Mediterranean Basin;among cities and their territories to provide ambitious and sustainable strategies.

2 As Mediterranean cities are compelled to find timely responses to rapid erosion, it is crucial to define pathways that articulate short-term agendas with long-term and transformational changes that are needed to build resilient coastal cities. This applies to the tourism sector, which will undergo a smoother, more gradual and anticipated transition if it is co-conceived with all relevant stakeholders.

16/ Vafeidis, A.T., Abdulla, A.A., Bondeau, A., Brotons, L., Ludwig, R., Portman, M., et al. (2020).
17/ Reimann, L., Vafeidis, A.T., Brown, S. et al. (2018). Mediterranean UNESCO World Heritage at risk from coastal flooding and erosion due to sea-level rise. Nat Commun 9, 4161. https://doi.org/10.1038/s41467-018-06645-9
18/ Balzan, M.V., Hassoun, A.E.R., Aroua, N., Baldy, V., Bou Dagher, M., Branquinho, C., Dutay, J-C., et al. (2020).
19/ Ibid.
20/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021). Cahier Régional Occitanie sur les Changements Climatiques. RECO. ed. 2021. https://reco-occitanie.org/crocc_2021/
21/ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020). State of the Environment and Development in the Mediterranean. Nairobi. https://wedocs.unep.org/handle/20.500.11822/38057
22/ Oueslati, A. (2015). Atlas de la vulnérabilité du littoral tunisien à l'élévation du niveau marin. APAL, UNDP.
23/ Maalej, A. (2022). Évaluation de la situation initiale de l'indicateur commun 16 d'IMAP pour les zones côtières et marines méditerranéennes de la Tunisie dans le cadre du projet ECAP MED III. Centre d'Activités Régionales pour le Programme d'Actions Prioritaires. http://iczmplatform.org//storage/documents/oVjQ9qdNRKYerxvGIRcyBcQV5dR4XgF1Si16XqNx.pdf
24/ AdriAdapt. (2022). Integrated system for the protection of Venice and its lagoon against flooding. Retrieved August 8, 2022, from https://adriadapt.eu/case-studies/integrated-system-for-the-protection-of-venice-and-its-lagoon-against-flooding/
25/ Vafeidis, A.T., Abdulla, A.A., Bondeau, A., Brotons, L., Ludwig, R., Portman, M., et al. (2020).
26/ Definitions of the different types of adaptation responses to sea level rise are given in the article "Designing Coastal Adaptation Strategies to Tackle Sea Level Rise" doi: 10.3389/fmars.2021.740602
27/ Ibid.

1 IMPROVING COLLECTIVE RESILIENCE BY ENLARGING AND STRENGTHENING TERRITORIAL COOPERATION AROUND ADAPTATION

Despite pan-Mediterranean initiatives to coordinate coastal management, the region lacks cohesion and faces important discrepancies in its approach towards SLR adaptation. Strengthened regional cooperation has the potential to unlock capacities and enhance collective resilience to climate change. Meanwhile, it further complements an integrated local approach able to account for territorial specificities and to promote more cohesive strategies.

1.1. Strengthening Mediterranean-wide cooperation towards coastal adaptation

Building on existing regional frameworks of cooperation on coastal management

The Mediterranean Basin constitutes a relevant scale to develop a coordinated approach to coastal adaptation. In spite of the diversity of environmental, political, cultural and socio-economic conditions, particularly between the Northern and Southern shores of the Mediterranean[28], regional coordination around SLR adaptation is crucial and has the potential to foster more ambitious and sustainable plans. With the growing impacts of climate change and pressures of human activities along the shores of the Mediterranean Sea, regional cooperation now extends to climate change action and coastal management. A series of agreements, instruments, organisations and projects are articulated by the UNEP/MAP-Barcelona Convention[29], such as the Mediterranean Strategy for Sustainable Development (MSSD) which defines climate change as a priority action for the region; or the Regional Climate Change Adaptation Framework for Marine and Coastal Areas (RCCAF) which seeks to enhance regional natural and socio-economic resilience by improving governance layouts and awareness, promoting and mainstreaming best practices of adaptation, improving finance access as well as research capacities[30]. The Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean is considered the most significant outcome of the Convention. It is complemented by the Common Regional Framework for ICZM (2019) which further consolidates the principles of ecosystem-based management and Maritime Spatial Planning (MSP) and provides a legally binding instrument to implement national coastal policies across the Basin that "*ensure that the environment and landscapes are taken into account in harmony with economic, social and cultural development*"[31]. To support Mediterranean countries in the implementation of the Protocol, the Priority Actions Programme Regional Activity Centre (PAP/RAC) leads coastal management programme plans, while Plan Bleu provides decision-makers with data and information[32]. Since its adoption, local governments, regions and cities have been proactive in developing coastal management strategies. In 2014-2016, the Šibenik-Knin County in Croatia was the first to adopt a coastal plan in compliance with the Protocol's provisions under the PAP/RAC leadership. Since then, new coastal plans have been adopted or are being prepared in Croatia (Split-Dalmatia region, the cities of Kaštela and Vodice, the Primorsko-Goranska region, the Jadro Basin), Italy (Marche region), Montenegro (cities of Kotor, Herceg Novi and Tivat in Kotor Bay) and Morocco (Tanger-Tetouan Al Hoceima region).

Synergies among Mediterranean cities through the creation of cities networks further support the application of these guidelines and requirements on coastal management at municipality level. For instance, MedCities[33] connects and develops partnerships among local authorities across the Mediterranean region on sustainable development, climate change mitigation and socio-economic equality[34]. Cities are also encouraged to collaborate through transboundary projects such as MedSeaties which involved six Mediterranean cities together with international actors, businesses, universities and civil society to establish innovative governance systems and tools for the management of urban coastal areas[35].

Adjusting structures of Mediterranean cooperation to the distinct patterns of sea level rise adaptation

Region-wide SLR adaptation has better chances of success as specific strategies and tools are integrated into and/or complete existing Mediterranean-wide governance frameworks. To date, strategic orientations at State and regional levels often prioritise socio-economic development over environmental and climate change objectives[36]. In light of this, building synergies and strengthening coordination between the agendas is a prerequisite to integrating climate change adaptation into all socio-economic development strategies. Besides, even within coastal management strategies and frameworks, coastal adaptation to SLR has rarely, or only recently, been addressed and identified as a priority. Indeed, these were not developed to tackle SLR and primarily seek to address a multitude of climatic and non-climatic stressors (pollution, fires, heatwaves, riverine floods etc.), thereby failing to account for SLR adaptation distinct challenges[37]. While ICZM is effective in integrating climate risks in broader multi-stressed situations, there is no evidence that it can support decisions and solutions in conditions of high uncertainty and over a long time horizon (100 years)[38]. Therefore, specific methodologies are needed to complete existing environmental frameworks, such as the ICZM Protocol, and thus to better channel climate action in coastal adaptation to SLR.

Adjusting resources, including human and financial, will be crucial to effectively translate new commitments into concrete action. Although regional agreements commit states to similar standards of coastal management, uneven access to resources and economic instruments accentuates geographical disparities in the enforcement and monitoring of coastal management plans[39,40]. With the predicted increase in expenses linked to coastal adaptation, cities' budgets - especially from emerging economies - will not be able to support their transition alone. Therefore, region-scale mobilisation of private and public finance is a critical enabler for coastal adaptation.

28/ MedECC. (2020). Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer, W., Guiot, J., Marini, K. (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 1-63, ISBN: 978-2-9577416-0-1, https://doi.org/10.5281/zenodo.7224821

29/ United Nations Environment Program. (2022). Climate change in the Mediterranean. Retrieved July 13, 2022, from https://www.unep.org/unepmap/resources/factsheets/climate-change

30/ Climate change in the Mediterranean. (2022).

31/ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020).

32/ United Nations Environment Program. (2022).

33/ MedCities. (2021). Activity Report 2021. Barcelona. https://medcities.org/wp-content/uploads/2022/06/AR-MedCities_paginat_compressed.pdf

34/ MedCities. (2022). About us. Retrieved July 13, 2022, from https://medcities.org/about-us/

35/ MedCities. (2022). MedSeaties. Retrieved August 1, 2022, from https://medcities.org/project/medseaties/

36/ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020).

37/ Nicholls, R. J., (2018). Chapter 2 - Adapting to Seal-Level Rise. In: Resilience - The Science of Adaptation to Climate Change. [Zommers, Z., & Alverson, K. (eds.)] Elsevier, pp. 13-29. https://doi.org/10.1016/B978-0-12-811891-7.00002-5

38/ Ibid.

39/ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020).

40/ Bongarts Lebbe, T., Beguin Billecocq, I., Vegh, T., & Sarkozy-Banoczy, S. (2022) Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building. Blue-tinted white paper. Race to Resilience, High-Level Climate Champions.

Strengthening Mediterranean-wide knowledge and experience sharing initiatives

Growing regional expertise in maritime and coastal sciences contribute to informed coastal management and will be pivotal for SLR adaptation. MedECC's first Mediterranean Assessment Report (MAR1) constitutes a knowledge reference as it assesses the best available scientific knowledge on climate and environmental change in the Mediterranean Basin[41]. Local expert groups such as Grec-Sud[42], the Advisory Council for the Sustainable Development of Catalonia (CADS), the Expert Network on Climate Change in Occitanie (RECO), as well as coastal observatories networks, i.e. the EURIOMCODE provided by the Bologna Charter[43], the Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS)[44] and the MedGLOSS[45] programme of sea level monitoring network in the Mediterranean and Black seas, contribute to better inform global and regional projections and to downscale scientific data and projections.

However, there remain important gaps in ocean sciences regarding observational data and monitoring systems. These gaps are reinforced by insufficient cooperation systems and networks, resulting in geographical biases between the Northern and Southern shores of the Mediterranean[46]. These discrepancies are particularly acute in sea level observation and projections. The lack of long-term records of sea levels along the Southern bank prevents the computing of robust estimation of SLR and extreme events detection locally and regionally[47]. To date, the Permanent Service for Mean Sea Level (PSMSL) serves as a principal source of information to assess long-term sea level trends and variability, collects and interprets data from global tide gauge networks, including in the Mediterranean. One of the main limitations is that out of the 38 tide gauges with monthly records longer than 50 years in the Mediterranean and Black Sea region, only two stations are on the southern shores (Alexandria and Ceuta[48]). This contrasts with current and predicted levels of exposure as Tunisian coasts and the Nile Delta in Egypt are considered amongst the most exposed to sea level extremes and most prone to high flood risks[49,50].

Therefore, Mediterranean-wide initiatives that encourage knowledge dissemination and scientific cooperation have the potential to overcome geographical biases in data collection and analysis, thus closing knowledge gaps in risk and vulnerability assessments. In this regard, transboundary observation systems, data sharing, research projects and platforms contribute to improving the mapping of existing and missing information, developing standardised methods, long-term monitoring, improving SLR projections, forecasting of extreme events that impact the Basin.

Likewise, regional training and experience-sharing is also relevant, considering that Mediterranean cities are eager to learn from peers to elaborate, replicate and adapt methods and solutions at scale, while avoiding repeating the same mistakes - especially regarding the development of NbS in urban settings.

41/ MedECC. (2020).
42/ Grec-Sud. (2022). Le Grec-Sud. Retrieved August 1, 2022, from http://www.grec-sud.fr/
43/ Bologna Charter. (2022). The Charter. Retrieved August 1, 2022, from http://www.bolognacharter.eu/the-charter/
44/ EuroGOOS. (2022). Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS). Retrieved August 1, 2022, from https://eurogoos.eu/roos/mediterranean-operational-network-global-ocean-observing-system-mongoos/
45/ CIESM, The Mediterranean Science Commission. (2020). CIESM MedGLOSS Program. Retrieved August 1, 2022, from https://www.ciesm.org/marine/programs/medgloss.htm
46/ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020).
47/ Pérez Gómez, B., Vilibic, I., Šepic, J., Medugorac, I., Licer, M., Testut, L., et al. (2022). Coastal sea level monitoring in the Mediterranean and Black seas. Ocean Science, 18, pp. 997–1053, https://doi.org/10.5194/os-18-997-2022
48/ Ibid.
49/ Ibid.
50/ MedECC. (2020).

© Leszek Czerwonka

As showcased by the three examples below, Mediterranean-wide knowledge production and dissemination initiatives on the issues of coastal management and climate change have developed in recent years. Ranging from (1) observational systems, (2) experience-sharing platforms to (3) training programs, they contribute to forming a chain of understanding critical to facilitate decision-makers' uptake of science which could be applied to the challenge of coastal adaptation to SLR.

BOX 1

A Mediterranean Observatory for Environment and Sustainable Development - Plan Bleu[51]

As part of its dual function as an observatory of the environment and sustainable development, as well as a systemic and foresight analysis centre, Plan Bleu's mission is to provide Contracting Parties to the Barcelona Convention with data, statistics and indicators to feed into assessments, scenarios, and to support decision-making. Plan Bleu notably proposes thematic publications and a series of thematic maps highlighting relations between anthropogenic pressures and state of the environment, mainly at sea and coast (e.g., population settlement and built-up environment in the Mediterranean coastal belt; population living at less than 5 m above sea level).
Since 2020, Plan Bleu, in partnership with UNEP/GRID in Geneva, is developing the WESR/Mediterranean. It is a knowledge, data and information UNEP platform which offers, through the cartographic viewer (MapX), the possibility to visualise, query and combine geospatial data and maps at different scales. This cartographic tool seeks to enhance knowledge-sharing, support decision-making and monitor progress towards the achievement of sustainable development goals in relation to the environment and multilateral environmental standards. More and more institutions are feeding the Observatory and a real observatory "in network" is under implementation gathering both national and regional competent organisations.

BOX 2

A knowledge platform on adaptation to climate change for the Adriatic coast - AdriAdapt, PAP/RAC[52]

The AdriAdapt platform has been developed as part of the EU Interreg Italy-Croatia Adriadapt project. It aims at supporting the building of local and regional resilience by developing the knowledge base required to identify and plan appropriate climate change adaptation options. This knowledge platform for the Adriatic region contains, a step-by-step guide for adaptation planning, an overview of different adaptation options (40 in total), case studies (11), guidance documents, legal frameworks and other useful material on climate change adaptation including videos, conferences and training. The knowledge platform was notably tested during the implementation of Adriadapt pilot projects in Cesena, Cervia, Udine, Šibensko-Kninska županija and Vodice.

51/ Plan Bleu. (2020). Mediterranean Observatory on Environment and Sustainable Development. Retrieved August 1, 2022, from https://www.obs.planbleu.org/en/

52/ Adriadapt. (2022). About. Retrieved August 1, 2022, from https://adriadapt.eu/about/

BOX 3

Training architect students on developing climate-resilient coastal cities in the Mediterranean - MELIMED, AViTeM[53]

MeliMed aims to raise awareness on the risks associated with rampant urbanisation on the Mediterranean coastline among students from architecture schools. The project offers a new training program dedicated to the issue of coastal resilience of Mediterranean cities confronted with climate change, building on three case studies: the Tangier-Tetouan region (Morocco), the Venice lagoon (Italy) and the Etang de Berre located in the Aix-Marseille-Provence urban area (France). MeliMed is a partnership of four higher-education institutions willing to pool their competencies and knowledge: the Ecole Nationale Supérieure d'Architecture de Marseille as the leading institution, the School of Architecture La Cambre-Horta of the Université Libre de Bruxelles (ULB), the Ecole Nationale d'Architecture de Rabat and the Istituto Universitario di Architettura of Venice. The Agency for Sustainable Mediterranean Towns and Territories (AVITEM) is associated to bring insight from the socio-professional world. The aim is to draw on workshops to exchange skills and methods, develop teaching models and open the way to tailor-made solutions.

53/ Melimed, Métropoles du littoral méditerranéen, enjeux climatiques et solutions de résilience. (2022). Accueil. Retrieved August 1, 2022, from https://www.melimed.eu/home

1.2. Enhancing local synergies among cities and their territories

Accounting for the intertwinement of risks and vulnerabilities across territories

The definition of the relevant geographic scale for action must account for the ecological continuity across the coast as well as with the hinterland. In this regard, sediment-cell boundaries serve as references for delimiting the scales of shoreline management to preserve the ecological connectivity and ecosystemic integrity of the territory, therefore to avoid the transfer of impacts related to sediment transport[54,55]. Studies have shown that the construction of upstream river dams (e.g. High Aswan Dam in Egypt[56]), harbours (e.g. Greece and Cyprus[57]), breakwaters (e.g. breakwaters of Soliman in Tunisia[58]) although they provide benefits locally, are likely to obstruct the sediment supply of neighbouring beaches. Interestingly, while beach replenishments are developing across the Basin, some instances have been shown to aggravate erosion through the destruction of Posidonia seagrass meadows (e.g. Poniente Beach in Benidorm, Spain[59])[60]. Conversely, accounting for the ecological continuity of a territory can extend the

54/ Cerema. (2020). Adaptation des territoires littoraux méditerranéens au changement climatique, Phase 1 : Benchmarking des expériences existantes, Rapport d'étude 2020. Cerema Méditerranée, Montpellier. Pp. 1-88. https://www.cerema.fr/system/files/documents/2021/09/01_benchmarking_rapport_v1-2.pdf

55/Cerema. (2021). Adaptation des territoires littoraux méditerranéens au changement climatique, Phase 3 : Propositions d'outils et méthodologies, Rapport d'étude 2021. Cerema Méditerranée, Montpellier. Pp. 1-112. https://www.cerema.fr/system/files/documents/2021/09/03_outils_methodo_propositions_v1-0.pdf

56/ Masria, A., Iskander, M., Negm, A. (2015). Coastal protection measures, case study (Mediterranean zone, Egypt). J. Coast. Conserv. 19, pp. 281–294. doi: 10.1007/s11852-015-0389-5

57/ Tsoukala, V.K., Katsardi, V., Hadjibiros, K., Moutzouris, C.I. (2015). Beach Erosion and Consequential Impacts Due to the Presence of Harbours in Sandy Beaches in Greece and Cyprus. Environ. Process. 2, pp. 55–71. https://doi.org/10.1007/s40710-015-0096-0

58/ Saïdi, H., Souissi, R., Zargouni, F. (2012). Environmental impact of detached breakwaters on the Mediterranean coastline of Soliman (North-East of Tunisia). Rend. Lincei 23, pp. 339–347. doi: 10.1007/s12210-012-0191-3

59/ Aragonés, L., García-Barba, J., García-Bleda, E., López, I., Serra, J.C. (2015). Beach nourishment impact on Posidonia oceanica: Case study of Poniente Beach (Benidorm, Spain). Ocean Eng. 107, pp. 1–12. doi: 10.1016/j.oceaneng.2015.07.005

60/ MedECC. (2020).

space available for cities to deploy hybrid adaptation measures. Indeed, enlarging the scope to surrounding peri-urban and rural areas paves the way for certain solutions, i.e. NbS, requiring additional land surface that has become scarce in densely urbanised areas. This also allows for a better consideration of compound risks to which Mediterranean coasts and hinterland are particularly exposed to and affected by, e.g. riverine floods, droughts. Projects such as the International Centre for Advanced Studies on River-Sea Systems DANUBIUS-RI[61] are contributing to build a holistic understanding of risks and coastal management. DANUBIUS-RI is a pan-European research infrastructure working on test sites (i.e. Guadalquivir Estuary in Spain, Po Delta in Italy) which seeks to provide integrated knowledge on the continuum sea-river, required to sustainably manage and protect River-Sea Systems.

Considering institutional and socio-economic interdependence among coastal cities and inland municipalities is crucial when defining the governance scale. Cities cannot act in isolation when designing adaptation as they are interconnected through critical infrastructure (e.g. roads, ports, electricity lines) and activities (e.g. mobility, tourism). This challenge is particularly salient in the case of coastal mobility[62] (see Box 4.).

Fostering local understanding of coastal dynamics

The creation and mobilisation of observatories' networks and universities capable of yielding transdisciplinary expertise are pivotal to a holistic mapping and analysis of coastal dynamics. In this regard, based on hydrobiologic and hydrodynamic data collected by lab buoys deployed across the coast, Tunisia's Coastal Protection and Development Agency (APAL), in partnership with UNDP, were able to produce an "Atlas of Coastal Vulnerability to Rising Sea Levels". This Atlas highlights coastal continuities, disruptions and the intertwining of vulnerabilities across land by displaying a

BOX 4

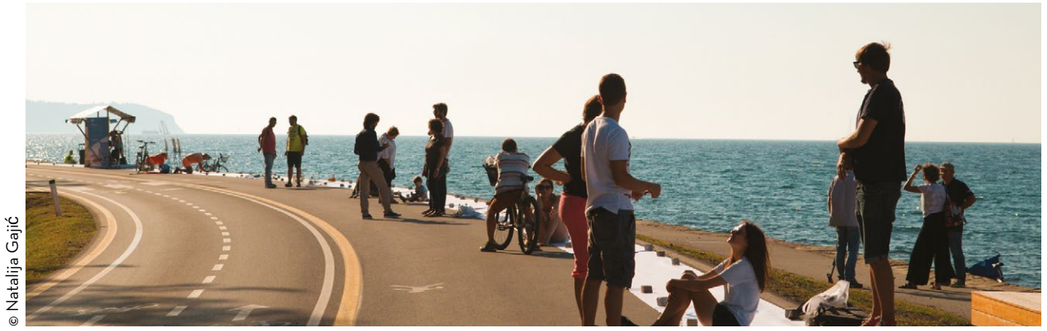
Managed retreat of the coastal state road Koper-Izola and sustainable requalification of the coast – Municipalities of Koper and Izola, Slovenia[63]

Koper is the regional urban centre of the wider coastal conurbation (along with Izola and Piran) of international importance as it is a logistic and traffic nexus with developed cargo and passenger ports. Meanwhile, Izola is a touristic urban centre of lower rank, connected to Koper by a state road. Hugging the coast for its entire length, the road has been responsible for the rapid degradation of coastal and marine habitats and is increasingly at risk of rising sea levels. The Ministry of Infrastructure and the Ministry of the Environment and Spatial Planning and DARS initiated the construction of a new road further inland to ensure public security and the maintenance and improvement of the road connection between the two cities. The municipalities of Koper and Izola then took on the initiative for temporary and long-term coastal rearrangement. With the goals of ensuring a modern road connection and rehabilitating degraded coastal areas, the project became an opportunity to coordinate visions and actions for the entire rearrangement of the coastal belt as part of a Regional Spatial Plan. This project drew on the participation of a wide range of stakeholders, mobilised during participatory community spatial planning activities. For instance, in September 2018, the PiNA association organised the one-day event "Let's draw the coast", which gathered more than 1.000 people of all generations from Slovenia and other parts of Europe to draw their visions for the future coast.

61/ International Centre for Advanced Studies on River-Sea Systems DANUBIUS-RI. (2019). Home. Retrieved August 1, 2022, from https://www.danubius-ri.eu/index.html

62/ Cerema. (2021).

63/ Adriadapt. (2022). Managed retreat of the coastal state road Koper-Izola and sustainable requalification of the coast. Retrieved August 1, 2022, from https://adriadapt.eu/case-studies/managed-retreat-of-the-coastal-state-road-koper-izola-and-sustainable-requalification-of-the-coast/



© Natalija Gajić

series of large-scale and site-specific maps[64]. Tide gauge networks are also significant to understand and assess changes in sea levels at spatial and temporal scales[65]. In Italy, the Italian Tide Gauge Network (RMN) federates 36 stations distributed evenly across the coast that provide information to analyse sea level variation, predict storm surges and develop early warning systems for tsunamis[66]. Since the 2010s, Algeria has made considerable efforts to create a multi-observation platform, notably through the development and upgrade of its tide gauge network which now includes six stations in Ghazaouet, Oran, Ténès, Algiers, Jijel, Annaba and their respective ports[67]. Social and human sciences are equally relevant to ameliorate the understanding of local dynamics. Research have suggested the interest of using interactive maps and historical analysis of iconographic material to highlight connectivity and interdependencies throughout the territory and its perception among stakeholders[68]. For instance, iconographic studies of past extreme events can help unveil patterns of disruption in human settlements and mobility along the coast, pinpointing connections and interdependencies across lands and cities. The research project RestEAUr'lag seeks to foster the appropriation of water governance by local authorities in the context of climate change, by drawing on historical mapping and analyses of coastal occupation, uses and responses developed in light of coastal dynamics[69].

Developing a collective understanding of - and relationship with - the coastline can facilitate cities' cooperation around coastal adaptation. Indeed, appreciating that risks and responsibilities are differentiated but shared is critical to overcome cognitive and behavioural biases and to foster territorial solidarity. It is particularly relevant along the Mediterranean sea, where touristic destinations concentrate activities and populations with different proximity, occupations and uses of the coast (e.g. permanent and secondary residents, tourists and seasonal industries), thereby affecting their perception of risks, responsibility and ability to adapt[70].

This collective understanding partly depends on effective knowledge dissemination and appropriation locally. Interestingly, peer-to-peer learning tools and platforms contribute to improved mapping and connecting knowledge across localities, e.g. monlittoral.fr[71] (see Box 5.). In parallel, prospective approaches can support appropriation and consensus around climate and coastal change scenarios[72]. Besides, developing participatory science is an opportunity to simultaneously raise awareness of coastal risks and to improve data collection while connecting citizens within and from different municipalities, using science as a medium. For instance, walking tours are relevant to building a collective diagnosis of the coast by mobilising participants' perceptions to identify strengths, vulnerabilities and stressors on the shoreline[73].

64/ Oueslati, A. (2015).

65/ Pérez Gómez, B., Vilibic, I., Šepic, J., Medugorac, I., Licer, M., Testut, L., et al. (2022).

66/ Instituto Superiore per la Protezione e la Ricerca Ambientale. (2011). The National Tidegauge Network. Retrieved August 1, 2022, from https://www.mareografico.it/?session=0S2401921144D8276LY769077&syslng=ing&sysmen=-1&sysind=-1&syssub=-1&sysfnt=0&code=HOME

67/ Pérez Gómez, B., Vilibic, I., Šepic, J., Medugorac, I., Licer, M., Testut, L., et al. (2022).

68/ Cerema. (2021).

69/ Centre Norbert Elias. (2019-2022). RestEAUr'lag, La restauration écologique des socio-éco-systèmes lagunaires méditerranéens. Retrieved August 1, 2022, from https://centrenorbertelias.cnrs.fr/programmes-de-recherche/resteaurlag/

70/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021).

71/ Mon Littoral. (2022). Présentation, Historique. Retrieved August 1, 2022, from https://www.monlittoral.fr/presentation/historique/

72/ Cerema. (2021).

73/ Ibid.

BOX 5

Exchanging data and good practices to build a learning and active community in Provence-Alpes-Côte-d'Azur Region, France - monlittoral.fr online platform[74,75]

Addressing the absence of a coastal observatory in the Provence-Alpes-Côte d'Azur Region, the "Mon Littoral Provence-Alpes-Côte d'Azur" platform, was created in 2020 to assist local stakeholders in their strategic reflections and decision-making on short-term (coastal development and integrated shoreline management) and long-term issues (coastal adaptation to climate change) by pooling knowledge and practices, providing observation and analysis data, connecting actors, exchanging feedback and identifying good practices. monlittoral.fr aims to bring together and connect all stakeholders involved in coastal management and adaptation drawing on:

- **Collaboration and the co-creation of content (data, analyses)**
- **Open Data and interoperability of tools and data**
- **Interdisciplinarity**
- **Data sharing and accessibility to all types of actors (public, private, citizens)**
- **Exchange of practices, feedback and sustainable solutions.**

74/ Mon Littoral. (2022). Présentation, Historique. Retrieved August 1, 2022, from https://www.monlittoral.fr/presentation/historique/

75/ Introduction video about monlittoral.fr: https://www.youtube.com/watch?v=R8gAyWL2m6E

Allowing a coordinated governance

Enlarging the geographical scale is an opportunity to foster territorial solidarity and build capacities, bringing in additional competencies, capital and insights from similar experiences. However, stakeholders may encounter difficulties to build partnerships as a result of competition over resources, overlapping competencies, diverging interests, or different work practices and ethics[76]. These differences are particularly acute between private and public stakeholders. Therefore, institutionalising cooperation may be a precondition to enable effective partnerships, allocate resources fairly and continuously while ensuring that strategies comply with a set of overarching objectives. In this regard, deciding on a leading authority helps articulate particular interests with collective objectives and ensure that local plans and projects comply with the principles and strategies defined internationally, nationally and regionally[77].

Defining shared interests, visions and objectives of adaptation strategies can guide collaboration as cities' particular interests may encroach on others'. This entails the fair and equitable representation of all relevant governments and stakeholders from coastal and inland municipalities. Indeed, engaging stakeholders in the identification of objectives and tipping points can help reflect desired and unwanted change, thus supporting the collective definition of scenarios of territorial projects. In France, the Occitanie region is proactive in developing territorial projects through participative prospective studies on scenarios of coastal realignment as part of the SOLTER programme[78], as well as through the creation of 'Parlements de la Mer[79]' ('Sea Parliaments') which consist in forums and assemblies building a dialogue, defining common objectives to facilitate the emergence of projects from concerted stakeholders (e.g. fishermen, oyster and shellfish farmers, elected officials, ports, tourism industries, associations and researchers) on different maritime and coastal issues. Likewise, the CASadapt project considers international agreements and national legal commitments on climate change adaptation in light of local value systems to establish a set of co-constructed proposals in local urban planning documents. In line with this, foresight workshops are conducted to bridge scientific, political, socio-economic communities and civil societies, thereby enabling the co-definition of a future for the Mediterranean Basin[80]. As illustrated by these examples, planning and implementing adaptation strategies provide opportunities for improved and deepened synergies between cities, neighbouring territories and populations.

76/ Cerema. (2021).

77/ Association des maires de France et des présidents d'intercommunalité. (2020). Pacte de gouvernance : comment associer les communes membres au fonctionnement de l'intercommunalité ? Retrieved August 1st, 2022, from https://www.amf.asso.fr/documents-pacte-gouvernance-comment-associer-les-communes-membres-au-fonctionnement-lintercommunalite/40338

78/ Direction Régionale de l'Environnement, de l'Aménagement et du Logement d'Occitanie. (2016). Solidarités territoriales et résilience du littoral à la submersion marine, SOLTER. https://www.occitanie.developpement-durable.gouv.fr/IMG/pdf/plaquette_resume_solter.pdf

79/ La Région Occitanie, Pyrénées, Méditerranée. (2022). Parlement de la mer. Retrieved August 1, 2022, from https://www.laregion.fr/-parlement-de-la-mer-

© Hert Niks

80/ Plan Bleu. (2022). CASadapt project, Research-action: analyze, imagine, consult, adapt the socio-ecosystems of the Mediterranean coast to climate change. Retrieved August 12, 2022, from https://planbleu.org/en/projects/casadapt/

SCORE EU Project - Learning from each other to co-design tailored adaptation strategies

Atlantic Technological University, Sligo, Ireland

Smart control of the climate resilience in European coastal cities[81]

SUMMARY

SCORE aims to reduce the impacts of SLR and extreme events due to climate change on European coastal cities. The project builds on Coastal City Living Labs (CCLL) implemented across ten coastal cities of Europe and Turkey. These user-centred, open-innovation urban ecosystems gather public and private agents to co-design and co-develop Ecosystem-based Adaptation (EbA) in their cities. The project promotes technology and innovation, integrated coastal zone management for implementing ecosystem-based and dynamic adaptation pathways to increase climate resilience tailored to local specificities.

CLASSIFICATION

Risks: Climate change, erosion, flooding

Typology of solutions: Research-action; Capacity-building and knowledge-sharing activities; Nature-based solutions; Hard and soft protections; Managed realignment

Geographical location: 10 pilot cities from European countries + Turkey

Budget: More than EUR 10 million

Typology of actors: University and research institute

Project duration: 2021-2025

OBJECTIVES

SCORE aims to study, design, develop, monitor, and validate robust adaptation measures in coastal and low-lying areas to protect them from increasing climate and sea level risks, therefore to enhance their overall long-term resilience. To that end, the project seeks to:

- Design, implement, and evaluate Coastal City Living Lab frameworks of ten coastal cities
- Integrate EbA with smart technologies (e.g. sensors, digital twin solutions) to enhance climate change adaptation and resilience
- Improve knowledge about EbA efficacy against extreme events, SLR and coastal erosion risks
- Improve the social acceptance of EbA
- Develop a digital twin of the solution for instant monitoring and control of climate resilience
- Develop, pilot and demonstrate the efficacy of a smart city early warning system for extreme events
- Strengthen the financial resilience of strategies in local and national policies and of ICZM plans
- Enhance the market uptake of EbA

© SCORE

ACTIVITIES

SCORE works through ten CCLLs located in seven different European countries and Turkey. End-users and stakeholders are actively involved throughout four logical phases of ideation and exploration (needs identification), co-creation and co-design, real-life experimentation and testing, and evaluation and validation of the solution. In addition, SCORE encourages synergies, engagement, empowerment and learning across cities and throughout the process. Indeed, the CCLLs will act as 'frontrunners' or 'followers' based on their experience, finance and technical capacities in each activity of the Work Packages.

RESULTS

The SCORE project will provide a replicable integrated framework for coastal cities pursuing the enhancement of their climate resilience. This framework will provide:

- Baseline risk analysis and mapping of extreme climate impacts and SLR
- Coastal City Living Lab design, implementation and evaluation framework and lessons learned
- Climatic downscaling methods, data and uncertainties and models for coastal hazard predictions
- Citizen science solutions for climate change monitoring
- New database containing the processed data and principal outcomes of the project
- Software for the design and evaluation of financial resilience strategies
- Socio-economic assessment of EbA interventions and policy recommendations
- Early warning Support and Digital Twin Solution

KEY TAKEAWAYS

(1) High competence of partners working in the SCORE consortium who provide a holistic and comprehensive vision of CCLLs components and a broad perspective on EbA and smart technologies.

(2) An iterative approach: all the CCLLs are both frontrunners and followers of different activities and mutually exchange their knowledge.

(3) Innovative and integrated solutions: through the CCLLs, SCORE will prove the technical feasibility and demonstrate the socio-economic viability of solutions in real-life settings.

(4) A coastal adaptation network composed of scientists, engineers, policymakers and the general public.

(5) Awareness-raising activities on the potential of EbA through monitoring, replication in pilot cities, and the organisation of multiple large-scale dissemination events.

(6) EbA Training Schools to empower local communities and stakeholders with operational findings; and Massive Open Online Courses (MOOC) to allow a broader outreach and make knowledge accessible to users outside CCLLs.

(7) A Digital Twin as a 'collaborative mentoring platform'.

81/ SCORE. (2022). Project Concept. Retrieved August 1, 2022, from https://score-eu-project.eu/project-concept/

Challenges of reconciling emergency responses with long-term adaptation, testimony from the City of Bizerte

Bizerte, Tunisia, is a mid-range City of 200.000 inhabitants situated at the most septentrional point of North Africa. Particularly exposed to rising sea levels, the city is already confronted with accelerating erosion compounded with strong winds (the so-called Chirch).

For instance, Corniche, the in-city coastline, has experienced accentuated degradations which resulted in significant beach loss and associated economic activities, including major infrastructures and tourist facilities.

Bizerte's authorities have decided on a series of emergency responses and short to mid-term measures to address coastal erosion. Since 2020, urgent measures have consisted in reinforcing the beach road. Addressing mid to long-term coastal adaptation has required the city to seek for additional data and resources. Authorities have notably commissioned a feasibility study to balance options. They eventually opted for technical responses as the shoreline is being reinforced by inshore construction of rock dykes associated with sand restoration operations (1 million m3 in total). Several socio-institutional and financial constraints are hindering the capacity of Bizerte to plan long-term and innovative strategies. The financial scheme of the technical operations already amounts to EUR 30 million of which only 50% could be secured so far.

2 PREPARING THE TRANSFORMATION OF THE MEDITERRANEAN COASTLINES OVER THE SHORT, MEDIUM AND LONG-TERM

Mediterranean cities are already facing rapid erosion due to current anthropogenic and climatic stressors. Articulating cities' immediate responses to current threats with long-term adaptation is pivotal as the former is likely to affect the latter. In parallel, planning for transformational changes such as managed retreat and relocations remains necessary but implies making decisions in the short-term in a context of high uncertainty about SLR. Particularly relevant to the region, tourism adaptation entails planning important transformations that will be better accepted and sustainable if a large range of stakeholders and the industry become drivers of this transition.

2.1. Articulating immediate response with long-term adaptation

Mediterranean cities tackling erosion and marine submersion at the expense of long-term resilience

With most disaster events related to climate change and SLR, building synergies between immediate action and adaptation is essential[82]. In response to extreme events and accelerated erosion, municipalities elaborate and implement immediate and urgent actions to protect populations and preserve activities on the shore. Indeed, landslides are already causing accidents and casualties[83] and extreme sea level events (e.g. Gloria Storm in 2020, Venice storm surges in 2019[84]) are predicted to occur more intensely and frequently as sea level rises. Besides, as part of states' international/regional commitments (e.g. Barcelona Convention), cities are compelled to undertake short and mid-term measures on coastal management.

Yet, reactive, incremental and protection-based responses are often preferred at the expense of transformational change and long-term strategies (e.g. NbS, managed realignment). For instance, beach replenishment operations are rapidly developing across the Basin as they are compatible with the maintenance of activities such as tourism[85]. In built environments, strengthening works and identical rebuilding are prefered in recovery policies as coastal planners are locked-in traditions of hard enginee-

82/ IBC on Environment and Climate Change. (2021). Review of good practices : Integrating Disaster Risk Reduction and Climate Change Adaptation for Risk-informed and Climate-smart Development. https://unece.org/sites/default/files/2021-10/IBC%20environment%20and%20climate%20change_Integrating%20Disaster%20Risk%20Reduction%20and%20Climate%20Change%20Adaptation_2021.pdf

83/ Les cahiers du GREC-PACA. (2017). La mer et le littoral de Provence-Alpes-Côte d'Azur face au changement climatique.Association pour l'innovation et la recherche au service du climat (AIR) (eds.). pp. 1-48. ISBN : 9782956006046

84/ Pérez Gómez, B., Vilibic, I., Šepic, J., Medugorac, I., Licer, M., Testut, L., et al. (2022). Coastal sea level monitoring in the Mediterranean and Black seas. Ocean Science, 18, pp. 997–1053, https://doi.org/10.5194/os-18-997-2022

85/ Vafeidis, A.T., Abdulla, A.A., Bondeau, A., Brotons, L., Ludwig, R., Portman, M., et al. (2020). Managing future risks and building socio-ecological resilience in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 539-588.

ring practices[86,87]. Such is the case of the Maresme railroad which connects Barcelona with Mataró[88], Spain. Despite being gravely damaged in 2020 by the Gloria storm and recurring landslides which have led several elected officials to demand its relocation, this operation keeps being delayed and damaged parts are rebuilt after each incident. By locking-in cities in path dependencies, these responses fail to prepare for future risks and underpin maladaptation.

The difficulties of articulating short-term and long-term agendas partly stem from significant differences of approaches between coastal management and adaptation on the one hand, and disaster risk reduction (DRR) policies on the other. While the first is closer to environmental norms and action, the latter stems from a tradition of civil protection[89]. Moreover, governance frameworks, research and financing schemes remain separated, reinforcing the incompatibility of norms, time horizons and actions. Indeed, the OECD notes that silos in financing mechanisms further constrain cities' access to funding and result in the prioritisation of short-term disaster financing needs over long-term risk reduction[90]. Meanwhile, separated monitoring processes and criteria hinder the assessment of the long-term impacts of recovery measures on coastal resilience.

Capitalising on disaster risk management to develop long-term adaptation

Experience and research in DRR can offer valuable insights into SLR adaptation. Adaptation planning could draw from the capacity of emergency response to be flexible and reactive in deploying considerable means and resources after a disaster, as well as its advancement in better connecting observational and forecasting systems with decision-making[91]. Research on extreme events, meteorological and early warning systems deployed for disaster risk prevention could also support protection design by better informing on residual risks (see Box 6.). Mobile applications such as MyPredict, notably developed in the urban region of Toulon, France, are also relevant to strengthen risk culture - which plays a significant role in the acceptance of adaptation measures amongst populations. Linked with the French meteorological organisation, the application directly alerts populations of hydrometeorological risks (e.g. floods, storm surges)[92].

BOX 6

Sea level rise scenarios along the Mediterranean coast - SAVEMEDCOAST-2

The SAVEMEDCOAST-2 project aims to integrate climate change scenarios into disaster risk assessment and disaster risk management to face sea level rise up to 2100 in some of the most exposed river deltas and lagoons of the Mediterranean Basin, i.e. Ebro river delta in Spain, the Venice lagoon and Basento reclamation area in Italy, the Chalastra plain in Greece. The project retrieves flood risk scenarios accounting for amplification effects on storm surges, tsunamis and coastal erosion and undertakes communication activities to better inform decision-making in the selected areas[93].

Recovery and reconstruction phases from extreme events tend to be moments of public attention and involvement in decision-making. In line with this, they constitute key moments to draw attention to SLR and engage stakeholders in adaptation planning[94]. Indeed, they can contribute to making SLR a "salient" issue among decision-makers and populations, provided they are informed on the interlinkages between degradations due to extreme events and erosion with climate change, SLR and anthropogenic pressures. This is particularly relevant for the region where ocean-related hazards are less understood and heterogeneously perceived, since they are comparatively less visible than other climate change risks, e.g. heat waves and fires. Likewise, in touristic destinations, risk perception is altered by storms' occurrence in winter when tourist presence is lower[95]. For this reason, keeping the memory of the coast alive through time and space[96] is key to develop a long-term overview of coastal dynamics as storms occur, seasons change and coastal uses are

© Vitaly Edush

86/ Giordono, L., Boudet, H. & Gard-Murray, A. (2020). Local adaptation policy responses to extreme weather events. Policy Sci 53, pp. 609–636. https://doi.org/10.1007/s11077-020-09401-3
87/ Les cahiers du GREC-PACA. (2017).
88/ TV3 - Televisió de Catalunya. (2022). La línia de tren del Maresme, engolida pel mar: "No val seguir fent pedaços". Retrieved August 2, 2022, from https://www.ccma.cat/324/la-linia-de-tren-del-maresme-engolida-pel-mar-no-val-seguir-fent-pedacos/noticia/3154774/
89/ OECD. (2020), Common Ground Between the Paris Agreement and the Sendai Framework : Climate Change Adaptation and Disaster Risk Reduction, Éditions OCDE, Paris, https://doi.org/10.1787/3edc8d09-en.
90/ Ibid.

91/ Ibid.
92/ Métropole Toulon Provence Méditerranée. (2022). Le PAPI des Petits Côtiers toulonnais - Prévention des inondations. Retrieved August 2, 2022, from https://metropoletpm.fr/tourisme/proxy/papi

93/ Sea Level Rise Scenarios Along the Mediterranean Coasts-2. (2022). Overview. Retrieved August 2, 2022, from https://www.savemedcoasts2.eu/index.php/en/project/overview

94/ Giordono, L., Boudet, H. & Gard-Murray, A. (2020).
95/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021).
96/ Cerema. (2021).

modified. Iconographic tools and participatory site photography as developed by the 'Observatoire Photographique du Paysage Littoral vu depuis la Mer[97]' (Photography Observatory of Coastal Landscape seen from the Sea) in the Region Sud Provence-Alpes-Côte d'Azur, France, are good examples of tools that can contribute to more accurate perceptions of change and understanding of the impacts of storms, SLR and coastal uses on coastal dynamics.

Drawing on coastal management instruments to facilitate long-term adaptation

Building on the strengths and compatibilities of regional and international frameworks on coastal management with SLR adaptation can help cities articulate short, mid and long-term measures. Since they favour a preventive approach, ICZM principles, guidelines and tools can be pooled with and applied to coastal adaptation[98]. Article 8 of the Protocol on "*Protection and sustainable use of the coastal zon"* limits new constructions and the coastal linear extension of urban developments and transportation through the provision of coastal setback zones[99,100]. The delimitation of these zones must be at least 100 m in width, taking into account the highest winter waterline and the areas directly and negatively affected by climate change and natural risks. By limiting coastal urbanisation, these zones allow more space for ecosystems and the deployment of NbS, thereby constituting critical buffer zones where biodiversity can thrive. Besides, through the prioritisation of public services and activities, they improve the quality of coastal experiences among residents and tourists[101]. Additionally, by limiting urban development in the short-term, setback zones facilitate realignment in the long run. Studies have demonstrated the effectiveness of these setback zones in combination with coastal adaptation measures (i.e. managed retreat and protection) to reduce present and future costs of coastal flooding[102]. This measure is being increasingly adopted among Mediterranean countries, despite a certain delay and exceptions which have permitted the development of residential areas and of development projects of economic interest such as tourism facilities[103].

BOX 7

Supporting local capacities to implement ecosystem-based coastal management - MedCities

MedCities has been engaged in the development of "Coastal Protection Strategies Considering the Effects of Climate Change" in the Spanish provinces of Málaga, Cádiz and Almeria and in the Balearic Islands. MedCities facilitates communication and participation particularly among municipal administrations to support decision-making and management on coastal erosion risks. In addition to strengthening synergies with flood risk management and climate change adaptation, these strategies favour the natural resilience of the coastal physical environment to restore its protective function and improve biodiversity. MedCities is also working with the city of Sfax, Tunisia, and Tyre, Lebanon, to favour ecosystem-based management to address environmental and climate change through the ENI CBC MED initiative ENSERES.

97/ Objectif paysages, Ministère de la Transition Écologique. (2020). Observatoire Photographique du Paysage du littoral vu depuis la mer. Retrieved August 2, 2022, from https://objectif-paysages.developpement-durable.gouv.fr/observatoire-photographique-du-paysage-du-littoral-vu-depuis-la-mer-147#:~:text=Cet%20observatoire%20est%20le%20premier,que%20sont%20les%20paysages%20littoraux.

98/ Tobey, J., Rubinoff, P., Robadue, D., Ricci, G., Volk, R., Furlow, J., Anderson, G. (2010). Practicing Coastal Adaptation to Climate Change: Lessons from Integrated Coastal Management. Coastal Management - COAST MANAGE. 38, pp. 317-335. doi: 10.1080/08920753.2010.483169

99/ Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean (4th of February 2009). O.J. L34, p.19-28

100/ PAP/RAC. (2021). Coastal Resilience Handbook for the Adriatic. INTERREG AdriAdapt project, Split. http://iczmplatform.org//storage/documents/e8DKS6ReBi1qjsiJsyAWeq4dqddzJZ8J9VjnRF6b.pdf

101/ Ibid.

102/ Lincke, D., Wolff, C., Hinkel, J., Vafeidis, A., Blickensd Ãrfer, L., Povh Skugor, D. (2020). The effectiveness of setback zones for adapting to sea-level rise in Croatia. Regional Environmental Change, 20(46). doi:10.1007/s10113-020-01628-3

103/ Rochette, J., Du Puy-Montbrun, G., Wemaëre, M., Billé, R. (2010). Coastal setback zones in the Mediterranean: A study on Article 8-2 of the Mediterranean ICZM Protocol. IDDRI. Analyses 05/2010. https://www.iddri.org/sites/default/files/import/publications/an_1005_article-8-2-iczm-protocol.pdf

Considering uncertainty and the distinct time horizon of SLR adaptation

Notwithstanding, SLR adaptation entails unique considerations with respect to climate change. This implies that short-term actions need to be thought of as transitional stages towards longer-term goals where coastal uses align with environmental and societal changing conditions. Therefore, the theoretical framework of adaptation pathways helps design adaptation over different time scales, mobilising distinctive time references (i.e., 2100) compared to most short-term-ended public policies (i.e. DRR and coastal management). Besides, by integrating uncertainty, it allows adaptation strategies to adjust to changing societal and environmental conditions in order to achieve adaptation goals.

In line with this, options such as ecosystem preservation and setback zones, need to be put into perspective with a longer time horizon that integrates the impacts of rising sea levels (e.g. 2100). In the case of setback zones, the space between built infrastructure and the sea will inevitably reduce. Therefore, to ensure continued protection, periodical review of their delimitations will need to integrate the very long-term horizon, implying realignment in some instances. It is the case in Frontignan, France. Confronted with chronic erosion on the 8 km-long and 1 km-wide sand strip, the municipality has invested EUR 15 millions in protection works to protect its 3.500 inhabitants. In spite of this, continuous erosion aggravated by SLR, has prompted the region to plan longer-term options that include the relocation of activities and residences in a new action plan[104]. In this regard, co-conceiving adaptation pathways with stakeholders can support the realignment of activities and populations. As coastal uses and livelihoods will be radically impacted, rigorous stakeholder engagement is even more relevant to shift expectations regarding near to long-term coastal management.

104/ La région Occitanie, Pyrénées - Méditerranée. (2022). Le Plan Littoral 21 change d'approche pour protéger le lido de Frontignan. Retrieved August 10, 2022, from https://www.laregion.fr/Le-Plan-Littoral-21-change-d-approche-pour-proteger-le-lido-de-Frontignan

2.2. Redesigning coastal uses: transitioning the tourism sector

The necessary adaptation of the tourism sector to SLR

Considering the dependency of Mediterranean cities to the tourism sector - which is particularly vulnerable to SLR while being a major driver of coastal erosion - underlines the urgency to plan its transition. The Mediterranean Basin is a top destination for global tourism that has steadily grown over the last decades. Countries including Malta, Montenegro, Greece and Morocco have recorded an increase of 60% in the contribution of tourism to their GDP in the past 20 years[105]. Cities and seaside resorts have grown increasingly reliant on the sector as their demographic, socio-economic, cultural and institutional organisation revolve around tourism. Indeed, the sector has homogenised its model according to the "sea, sun and beach" paradigm at the expense of local dynamism and particularities[106]. Demographic fluctuations between summer and winter are particularly symptomatic as observed in the city of Marseillan, France, with a demographic decline from 60.000 habitants during the summer to 8.000 permanent residents in winter, turning the town into a "phantom seaside resort[107]".

The adaptation of the tourism sector is particularly intricate in the face of rising sea levels and the compound effects of climate change. Largely based on the appeal of coastal assets, studies predict a substantial drop in tourist visits as beaches shrink. In Les Madrigueres, Spain, surveys found that reductions in beach surface area could potentially affect the number of visitors: 25% of beach users would visit other beaches, 27.4% would no longer come during

105/ Dos Santos, M., Moncada, S., Elia, A., Grillakis, M., Hilmi, N. (2020). Development. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 469-492, https://doi.org/10.5281/zenodo.7101111

106/ Samora-Arvela, A., Ferreira, J., Vaz, E., & Panagopoulos, T. (2020). Modelling Nature-Based and Cultural Recreation Preferences in Mediterranean Regions as Opportunities for Smart Tourism and Diversification. Sustainability, 12(1), 433. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su12010433

107/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021).

the high season, and 5% would completely stop going to the beach[108]. Besides, coastal cities and territories concentrate a rich cultural heritage characterised by a strong presence of historical monuments and sites that reflect the long history of the region and contribute greatly to its economy.

In parallel, tourism development is a driver of coastal risks and vulnerability. The sector's rapid growth has considerably affected coastal environments by generating significant demographic influx, urban development and sprawl[109]. Construction and high-frequentation of pedestrian and motorised pathways have reduced dune ecosystems, thereby accelerating erosion. Moreover, the combination of tourism development and decentralisation of populations from high-density cores towards peripheries triggered urban sprawl, thus reducing available space for ecosystems along the coastline[110]. This occupation concentrates on the narrow coastal belt[111]. In Croatia, the urbanised coastal built-up grew by 500% between 1961 and 2011. With only 25% of demographic growth during this period, the development of built-up environments on the coastal belt can be attributed to tourism and secondary residencies[112]. These trends tend to exacerbate as perceptions of SLR remain low, especially within the industry, among visitors and non-permanent residents. Coastal cities' socio-economic and demographic organisation reinforces these cognitive biases. Given that extreme events and storm surges often occur during the low season, erosion and SLR are prone to remain invisible to non-permanent residents and businesses[113].

Shifting tourism demand and offer towards greater diversity and mobility

Promoting more diverse and mobile tourism models could facilitate long-term adaptation to SLR. In the short-term, promoting reversible constructions and installations (e.g. camp sites, mobile homes, elevated bungalows) while limiting the development of built infrastructure, facilitate the transition and relocation of economic sectors (e.g. outdoor hospitality) in the mid to long-term[114]. In line with this approach, the municipality of Gruissan, France, is developing "lodgeBoats" (floating cabins) that intend to be entirely moveable and resilient to higher sea levels[115]. Besides, as the cost of beach replenishment operations and reconstructions are expected to increase as sea level rises, and as tourists and residents are increasingly attracted by pristine coasts, it will make less and less socio-economic sense to maintain touristic installations on the waterfront. Meanwhile, the degradation of coastal assets urges the diversification of offers to develop outdoor and cultural activities that extend to inland areas (e.g. walking, cycling, mountain biking, and birdwatching[116]). Nonetheless, immobile built environments such as cultural sites pose unique challenges, underpinning the necessity to maintain protection strategies (understood as soft and hard protections, NbS and hybrid solutions) and develop early warning systems. In several European historical centres, including Venice, the HYPERION project delivers integrated and multi-hazard risk assessments and provides decision-makers with operational strategies to manage risks, protect and prepare, adapt and reconstruct resilient cultural sites[117].

Additional research is essential to close important knowledge gaps about the capabilities of infrastructure and populations to accept new models. This entails a sound understanding of the risk exposure and vulnerability of local tourism (e.g. historical sites, tourism facilities and infrastructure, workforce), the identification of priority sites (e.g. world heritage sites), of the repercussions of potential adaptation options, as well as measuring the environmental and socio-economic impacts of tourism diversification and realignment inlands[118]. Research is further needed to identify the key enablers to effectively shift offers and demands (institutional, financial, governance arrangements, etc.). Besides, projects such as the EU Copernicus Climate Change Service (C3S) European Tourism are critical to develop targeted and actionable knowledge and to promote the uptake of scientific findings by the industry. This project delivers an operational Sectoral Information System (SIS), including on SLR, to a large variety of stakeholders and intermediaries (e.g. consultancy companies, environment agencies, tour operators, investors in tourist infrastructure and services, destination managers, tourist association) working in the tourism sector across Europe. This service notably provides climate projections and seasonal forecasts along with tools to downscale information and adapt the design of tourism adaptation strategies to local needs[119].

Informing and engaging stakeholders throughout the transition

Stakeholders' acceptability of tourism adaptation, including relocations, will improve as changes are co-designed by a large and diverse range of actors, who can best represent the interests and aspirations of coastal communities. Considering that seaside resorts and neighbouring territories are codependent on the evolution of tourism activities, building synergies and solidarities across territories and stakeholders is necessary and will allow a more cohesive and organised transition to take place. Likewise, one of the current obstacles to transforming the tourism sector is the lack of involvement and awareness of the industry and tourists. Therefore, including in the discussion tourists, seasonal workers and businesses (e.g. restaurants, cruises), real estate developers, financial supports, as well as neighbouring cities - besides inhabitants - enables a holistic apprehension of challenges and a fair representation of interests.

Changing marketing strategies is crucial to shift tourists' imaginary of Mediterranean coastline, thereby encouraging policy change. Indeed, marketed images of intact, static and immaculate Mediterranean coasts have encouraged coastal planners to pursue unsus-

© Ferrantraite

108/ Sauer, I., Roca, E., Vilares, M. (2019). Beach users' perceptions of coastal regeneration projects as an adaptation strategy in the Western Mediterranean. Journal of Hospitality & Tourism Research, 20(10), pp. 1–24. doi: 10.1177/1096348019889112
DOI: 10.1177/1096348019889112
109/ Balzan, M.V., Hassoun, A.E.R., Aroua, N., Baldy, V., Bou Dagher, M., Branquinho, C., Dutay, J-C., et al. (2020).
110/ Ibid.
111/ The narrow coastal belt is defined by the area within 1 km of the coastline
112/ PAP/RAC. (2021).
113/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021).
114/ Cerema. (2021).
115/ La Région Occitanie, Pyrénées - Méditerranée. (2022). A Gruissan, des hébergements flottants écologiques et uniques en France. Retrieved August 10, 2022, from https://www.laregion.fr/A-Gruissan-des-hebergements-flottants-ecologiques-et-uniques-en-France
116/ Samora-Arvela, A., Ferreira, J., Vaz, E., & Panagopoulos, T. (2020)
117/ Hyperion. (2019). HYPERION's Vision. Retrieved August 3, 2022, from https://www.hyperion-project.eu/hyperions-vision/
118/ Samora-Arvela, A., Ferreira, J., Vaz, E., & Panagopoulos, T. (2020).
119/ Tourism 2030 DestiNet Services.(2022). C3S European Tourism. Retrieved August 9, 2022, from https://destinet.eu/who-who/civil-society-ngos/climtour

tainable strategies to maintain tourists' demand, i.e. identical rebuilding and beach replenishment. For instance, the pressure to satisfy the "immaculate beach" imaginary has led authorities to clear Posidonia seagrass meadows out from the coasts. Integrating seagrass meadows into this imaginary and highlighting their role in erosion control and biodiversity provision could support demand change.

Developing innovative and multimedia communication strategies will be helpful in reaching tourists and the industry[120]. Mobilising key intermediaries can support communication with external audiences. Indeed, as tourists and businesses are not yearly residents, nor actively involved in the socio-economic activities and governance of coastal cities, traditional local information systems may be ineffective to reach out to these communities. In this regard, tourist information centres, hotels, campings, diving and navigation centres, local NGOs and associations can act as intermediaries between decision-makers and academics on the one hand and visitors on the other. In parallel, deploying communication tools at different scales, adopting a multimedia approach and mobilising different formats could help enlarge the scope of targeted audiences. Social media and platforms, notably through association and influencer accounts, can be more effective than traditional media to address external populations, especially younger demographics. Meanwhile, on-site strategies (e.g. informational signs on the beach) are relevant to inform on local risks. In the Occitanie region, France, authorities in partnership with local associations, have used touring vehicles ("Aucèl" trucks) to diffuse information on coastal risks and protection, targeting both residents and visitors[121]. Relying on distinct formats can further support this. Participatory observatories, new technologies such as virtual reality, arts and festivals are innovative mediums that can be actioned to engage both permanent and non-permanent audiences.

© Noah Mayer

120/ PAP/RAC. (2021).
121/ Direction régionale de l'environnement, de l'aménagement et du logement d'Occitanie. (2021). Adaptation au changement climatique en Occitanie, Livret n°7 : la mer et le littoral. Toulouse. https://www.occitanie.developpement-durable.gouv.fr/IMG/pdf/adaptation_au_changement_climatique_-_livret_7-_mer_littoral-4-webv.pdf

Creating new opportunities through tourism adaptation

Redesigning tourism models can create environmental and socio-economic opportunities. Indeed, limiting permanent constructions preserves space for coastal ecosystems and the deployment of NbS and hybrid solutions along the coast. This strategy is further supported by the aspiration of tourists and residents for preserved and healthy environments, as well as the attraction for authenticity and natural spaces[122].

Framing the transition of the tourism sector as an opportunity to co-design a new model which better corresponds to local aspirations and needs supports the development of a sense of ownership towards this transformation. Although inclusive decision-making is a complex process, identifying areas of complementarity between needs and preferences[123] can be conducive to mutual opportunities, whereby tourism experiences can be improved and diversified, local particularities and identities are acknowledged and preserved. Besides, benefits could extend to inland territories as new economic opportunities are developing with the redeployment of tourism activities further inlands. This could give momentum to promote local identities and particularities. "Cradle of civilisations", the Mediterranean Basin gathers unique and diverse identities and histories that mass tourism tends to homogenise and fragment. In line with this, the ENI CBC MED 'Med Pearls' project works across 13 pilot sites in 6 Mediterranean countries (Egypt, Palestine, Jordan, Greece, Italy and Spain) to develop a cross-border offer of slow tourism experiences, notably favouring secondary circuits and direct contact with local communities to honour and uphold regional identities[124].

122/ Réseau d'expertise sur les changements climatiques en Occitanie. (2021).
123/ Samora-Arvela, A., Ferreira, J., Vaz, E., & Panagopoulos, T. (2020).
124/ ENI CBCMED. (2020). Developing Slow Tourism in the Mediterranean: get to know the 13 Med Pearls pilot areas! Retrieved August 3, 2022, from https://www.enicbcmed.eu/get-know-13-med-pearls-pilot-areas

From Sète to Marseillan: Combining engineered solutions with the managed realignment of coastal assets

SÈTE AGGLOPÔLE MÉDITERRANÉE

SUMMARY

The barrier beach from Sète to Marseillan has significantly eroded and been damaged by extreme events (e.g. the 100-year storm of 1982). Between 1954 and 2000 the beach lost nearly 45 ha. This intense erosion and sediment reduction along critical facilities are both explained by natural processes and anthropogenic uses of the shoreline. To curb this rapid phenomenon while preserving and developing economic and human activities dependent on the coast (rail transport, shellfish farming and fishing, wine growing, tourism), Sète Agglopôle Méditerranée has implemented a set of combined measures. In addition to soft management, nature-based solutions and engineered innovations, the urban community has decided the relocation of critical assets and activities.

CLASSIFICATION

Risks: Erosion, Submersion

Typology of solutions: Nature-based solutions; Soft protections; Managed realignment

Geographical location: Sète, France

Budget: EUR 55 million from Europe, the State, the Région, Département, Sète Agglopôle Méditerranée and Ville de Sète

Typology of actors: State services; Regional and local authorities; University and research institutions

Project duration: 2007-2019

OBJECTIVES

Sète Agglopôle sought to curb the rapid erosion and restore the dune system by using innovation combined with an adaptive approach, consisting of accepting the natural evolution of the site rather than confronting it.

ACTIVITIES

The shoreline has completely been redesigned with the relocation of the road, the widening of the beach and rebuilding of the dune ridge. With the objective of preserving the pristine nature of the site, the coastal road was relocated by 100 m, car parks were installed, and walkways and cycle paths were designed across the dune strip. Meanwhile, the beach and dune systems were restored notably through beach nourishment operations combined with the installation of sand-filled geotextile bags. These bags located 350 m away from the shore and 4.5 m underwater, help mitigate wave impacts, thereby reducing pressures on the coastline.

RESULTS

The relocation and monitoring of human activities combined with the active restoration of the beach and the dune system have allowed the beach to be extended from 70 to 100 m. Meanwhile, the wave attenuator has allowed a gain of 12 m of beach in three years.
Sète to Marseillan beach barrier is the first site in Languedoc-Roussillon region, France, to act upon an adaptive approach. This approach was conducive to a complete redesign of the area's development path while its pristine nature remained preserved. Notwithstanding, local stakeholders are now seeing an opportunity for capitalising on the ecological potential of the site to develop sustainable green and cultural tourism.

KEY TAKEAWAYS

(1) Combination of solutions

(2) Adaptive approach

(3) Partnership and cooperation with State services, local authorities, and high-level technical and scientific stakeholders to provide funding and expertise.

RESOURCES

Presentations made at the Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region

Ben Amara, K. (2022) Bizerte Coastal Rehabilitation. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Benzina, R. (2022). Introduction to the Tunisian context. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Canals, J. (2022). The role of networks on climate change adaptation. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Cuffolo, L., Vautrin, B. (2022). The "monlittoral.fr" platform: A State/Region tool to meet the needs of stakeholders in the management of the shoreline in Provence-Alpes-Côte d'Azur. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Driouech, F. (2022). Scientific assessment of climate and environmental change in the Mediterranean Basin. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Gharbia, S. (2022). SCORE: Smart Control of the Climate Resilience in European Coastal Cities. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Guerquin, F. (2022). Plan Bleu's activities related to climate change. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Povh Škugor, D. (2022). Five lessons from the coastal plans. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Réamot, P. (2022). Protection and sustainable development of the barrier beach from Sète to Marseillan. Sea'ties Workshop Adapting Coastal Cities to Sea Level Rise in the Mediterranean Region, Online.

Literature

Antonioli, F, De Falco, G., Lo Presti, V., Moretti, L., Scardino, G., Anzidei, M., et al. (2020). Relative Sea-Level Rise and Potential Submersion Risk for 2100 on 16 Coastal Plains of the Mediterranean Sea. Water, 12(8), 2173. https://doi.org/10.3390/w12082173

Aragonés, L., García-Barba, J., García-Bleda, E., López, I., Serra, J.C. (2015). Beach nourishment impact on Posidonia oceanica: Case study of Poniente Beach (Benidorm, Spain). Ocean Eng. 107, pp. 1–12. doi: 10.1016/j.oceaneng.2015.07.005

Bongarts Lebbe, T., Beguin Billecocq, I., Vegh, T., & Sarkozy-Banoczy, S. (2022) Investment Protocol: Unlocking Financial Flows for Coastal Cities Adaptation to Climate Change and Resilience Building. Blue-tinted white paper. Race to Resilience, High-Level Climate Champions.

Bongarts Lebbe, T., Rey-Valette, H., Chaumillon, É., Camus, G., Almar, R., Cazenave, A., et al. (2021). Designing Coastal Adaptation Strategies to Tackle Sea Level Rise. Frontiers in Marine Science. doi: 10.3389/fmars.2021.740602

Cramer, W., Guiot, J., Fader, M. et al. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. Nature Clim Change 8, pp. 972–980. https://doi.org/10.1038/s41558-018-0299-2

Giordono, L., Boudet, H. & Gard-Murray, A. (2020). Local adaptation policy responses to extreme weather events. Policy Sci 53, pp. 609–636. https://doi.org/10.1007/s11077-020-09401-3

Lincke, D., Wolff, C., Hinkel, J., Vafeidis, A., Blickensd Ãrfer, L., Povh Skugor, D. (2020). The effectiveness of setback zones for adapting to sea-level rise in Croatia. Regional Environmental Change, 20(46). doi:10.1007/s10113-020-01628-3

Marcos, M., Jorda, G., & Cozannet, G. L. (2016). Sub-chapter 2.2.1. Sea level rise and its impacts on the Mediterranean. In Moatti, J., & Thiébault, S. (Eds.), The Mediterranean region under climate change : A scientific update. IRD Éditions. doi :10.4000/

books.irdeditions.23454
Masria, A., Iskander, M., Negm, A. (2015). Coastal protection measures, case study (Mediterranean zone, Egypt). J. Coast. Conserv. 19, pp. 281–294. doi: 10.1007/s11852-015-0389-5

Nicholls, R. J., (2018). Chapter 2 - Adapting to Seal-Level Rise. In: Resilience - The Science of Adaptation to Climate Change. [Zommers, Z., & Alverson, K. (eds.)] Elsevier, pp. 13-29. https://doi.org/10.1016/B978-0-12-811891-7.00002-5

Papadopoulos, G. (2016). Chapter 6 - Hazard, Vulnerability, and Risk Assessment. In: Tsunamis in the European-Mediterranean Region. [Papadopoulos, G. (eds.)] Elsevier. pp. 137-178. https://doi.org/10.1016/B978-0-12-420224-5.00006-5.

Pérez-Gómez, B., García-León, M., García-Valdecasas, J., Clementi, E., Mösso Aranda, C., Pérez-Rubio, S., et al. (2021). Understanding Sea Level Processes During Western Mediterranean Storm Gloria. Front. Mar. Sci. 8:647437. doi: 10.3389/fmars.2021.647437

Pérez Gómez, B., Vilibic, I., Šepic, J., Medugorac, I., Licer, M., Testut, L., et al. (2022). Coastal sea level monitoring in the Mediterranean and Black seas. Ocean Science, 18, pp. 997–1053, https://doi.org/10.5194/os-18-997-2022

Reimann, L., Vafeidis, A.T., Brown, S. et al. (2018). Mediterranean UNESCO World Heritage at risk from coastal flooding and erosion due to sea-level rise. Nat Commun 9, 4161. https://doi.org/10.1038/s41467-018-06645-9

Rey-Valette, H., Rulleau, B. (2016). Gouvernance des politiques de relocalisation face au risque de montée du niveau de la mer. Développement durable et territoires. 7(1). doi: 10.4000/developpementdurable.11282

Rochette, J., Du Puy-Montbrun, G., Wemaëre, M., Billé, R. (2010). Coastal setback zones in the Mediterranean: A study on Article 8-2 of the Mediterranean ICZM Protocol. IDDRI. Analyses 05/2010. https://www.iddri.org/sites/default/files/import/publications/an_1005_article-8-2-iczm-protocol.pdf

Saïdi, H., Souissi, R., Zargouni, F. (2012). Environmental impact of detached breakwaters on the Mediterranean coastline of Soliman (North-East of Tunisia). Rend. Lincei 23, pp. 339–347. doi: 10.1007/s12210-012-0191-3

Samora-Arvela, A., Ferreira, J., Vaz, E., & Panagopoulos, T. (2020). Modelling Nature-Based and Cultural Recreation Preferences in Mediterranean Regions as Opportunities for Smart Tourism and Diversification. Sustainability, 12(1), 433. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su12010433

Sauer, I., Roca, E., Vilares, M. (2019). Beach users' perceptions of coastal regeneration projects as an adaptation strategy in the Western Mediterranean. Journal of Hospitality & Tourism Research, 20(10), pp. 1–24. doi: 10.1177/1096348019889112

Tobey, J., Rubinoff, P., Robadue, D., Ricci, G., Volk, R., Furlow, J., Anderson, G. (2010). Practicing Coastal Adaptation to Climate Change: Lessons from Integrated Coastal Management. Coastal Management - COAST MANAGE. 38, pp. 317-335. doi: 10.1080/08920753.2010.483169.

Tsoukala, V.K., Katsardi, V., Hadjibiros, K., Moutzouris, C.I. (2015). Beach Erosion and Consequential Impacts Due to the Presence of Harbours in Sandy Beaches in Greece and Cyprus. Environ. Process. 2, pp. 55–71. https://doi.org/10.1007/s40710-015-0096-0

Reports

MedECC. (2020). Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer, W., Guiot, J., Marini, K. (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 1-632 ISBN: 978-2-9577416-0-1, https://doi.org/10.5281/zenodo.7224821.

Balzan, M.V., Hassoun, A.E.R., Aroua, N., Baldy, V., Bou Dagher, M., Branquinho, C., Dutay, J-C., et al. (2020). Ecosystems. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 323-468. https://doi.org/10.5281/zenodo.7101090

Cherif, S., Doblas-Miranda, E., Lionello, P., Borrego, C., Giorgi, F., Iglesias, A., et al. (2020). Drivers of change. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 59-180. https://doi.org/10.5281/zenodo.7100601

Dos Santos, M., Moncada, S., Elia, A., Grillakis, M., Hilmi, N. (2020). Development. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 469-492. https://doi.org/10.5281/zenodo.7101111

Vafeidis, A.T., Abdulla, A.A., Bondeau, A., Brotons, L., Ludwig, R., Portman, M., et al. (2020). Managing future risks and building socio-ecological resilience in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer W, Guiot J, Marini K (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 539-588. https://doi.org/10.5281/zenodo.7101119

Cerema. (2020). Adaptation des territoires littoraux méditerranéens au changement climatique, Phase 1 : Benchmarking des expériences existantes, Rapport d'étude 2020. Cerema Méditerranée, Montpellier. Pp. 1-88. https://www.cerema.fr/system/files/documents/2021/09/01_benchmarking_rapport_v1-2.pdf

Cerema. (2021). Adaptation des territoires littoraux méditerranéens au changement climatique, Phase 3 : Propositions d'outils et méthodologies, Rapport d'étude 2021. Cerema Méditerranée, Montpellier. Pp. 1-112. https://www.cerema.fr/system/files/documents/2021/09/03_outils_methodo_propositions_v1-0.pdf

Direction Régionale de l'Environnement, de l'Aménagement et du Logement d'Occitanie. (2016). Solidarités territoriales et résilience du littoral à la submersion marine, SOLTER. https://www.occitanie.developpement-durable.gouv.fr/IMG/pdf/plaquette_resume_solter.pdf

IBC on Environment and Climate Change. (2021). Review of good practices : Integrating Disaster Risk Reduction and Climate Change Adaptation for Risk-informed and Climate-smart Development. https://unece.org/sites/default/files/2021-10/IBC%20environment%20and%20climate%20change_Integrating%20Disaster%20Risk%20Reduction%20and%20Climate%20Change%20Adaptation_2021.pdf

IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. et al. (eds.)]. Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA, 2391 pp.doi:10.1017/9781009157896

Les cahiers du GREC-PACA. (2017). La mer et le littoral de Provence-Alpes-Côte d'Azur face au changement climatique.Association pour l'innovation et la recherche au service du climat (AIR) (eds.). Pp. 1-48. ISBN : 9782956006046

Maalej, A. (2022). Évaluation de la situation initiale de l'indicateur commun 16 d'IMAP pour les zones côtières et marines méditerranéennes de la Tunisie dans le cadre du projet ECAP MED III. Centre d'Activités Régionales pour le Programme d'Actions Prioritaires. http://iczmplatform.org//storage/documents/

MedCities. (2021). Activity Report 2021. Barcelona. https://medcities.org/wp-content/uploads/2022/06/AR-MedCities_paginat_compressed.pdf

OECD. (2020), Common Ground Between the Paris Agreement and the Sendai Framework : Climate Change Adaptation and Disaster Risk Reduction, Éditions OCDE, Paris, https://doi.org/10.1787/3edc8d09-en.

Ocean & Climate Platform. (2022). Adapting Coastal Cities and Territories to Sea Level Rise in Northern Europe: Challenges and Best Practices. Ocean & Climate Platform. 39 pp. https://ocean-climate.org/wp-content/uploads/2022/04/SEATIES_Report_Adaptation_SLR_Northern-Europe_V2.pdf

Oueslati, A. (2015). Atlas de la vulnérabilité du littoral tunisien à l'élévation du niveau marin. APAL, UNDP.

PAP/RAC. (2021). Coastal Resilience Handbook for the Adriatic. INTERREG AdriAdapt project, Split. http://iczmplatform.org//storage/documents/e8DKS6ReBi1qjsiJsyAWeq4dqddzJZ8J9VjnRF6b.pdf

Réseau d'expertise sur les changements climatiques en Occitanie. (2021). Cahier Régional Occitanie sur les Changements Climatiques. RECO. ed. 2021. https://reco-occitanie.org/crocc_2021/

United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020). State of the Environment and Development in the Mediterranean. Nairobi. https://wedocs.unep.org/handle/20.500.11822/38057

Charters and Protocols

Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean (4th of February 2009). O.J. L34, pp. 19-28

Websites

Adriadapt. (2022). About. Retrieved August 1, 2022, from https://adriadapt.eu/about/

AdriAdapt. (2022). Integrated system for the protection of Venice and its lagoon against flooding. Retrieved August 8, 2022, from https://adriadapt.eu/case-studies/integrated-system-for-the-protection-of-venice-and-its-lagoon-against-flooding/

Adriadapt. (2022). Managed retreat of the coastal state road Koper-Izola and sustainable requalification of the coast. Retrieved August 1, 2022, from https://adriadapt.eu/case-studies/managed-retreat-of-the-coastal-state-road-koper-izola-and-sustainable-requalification-of-the-coast/

Association des maires de France et des présidents d'intercommunalité. (2020). Pacte de gouvernance : comment associer les communes membres au fonctionnement de l'intercommunalité ? Retrieved August 1st, 2022, from https://www.amf.asso.fr/documents-pacte-gouvernance-comment-associer-les-communes-membres-au-fonctionnement-lintercommunalite/40338

Bologna Charter. (2022). The Charter. Retrieved August 1, 2022, from http://www.bolognacharter.eu/the-charter/

Centre Norbert Elias. (2019-2022). RestEAUr'lag, La restauration écologique des socio-éco-systèmes lagunaires méditerranéens. Retrieved August 1, 2022, from https://centrenorbertelias.cnrs.fr/programmes-de-recherche/resteaurlag/

CIESM, The Mediterranean Science Commission. (2020). CIESM MedGLOSS Program. Retrieved August 1, 2022, from https://www.ciesm.org/marine/programs/medgloss.htm

Direction régionale de l'environnement, de l'aménagement et du logement d'Occitanie. (2021). Adaptation au changement climatique en Occitanie, Livret n°7 : la mer et le littoral. Toulouse. https://www.occitanie.developpement-durable.gouv.fr/IMG/pdf/adaptation_au_changement_climatique_-_livret_7-_mer_littoral-4-webv.pdf

ENI CBCMED. (2020). Developing Slow Tourism in the Mediterranean: get to know the 13 Med Pearls pilot areas! Retrieved August 3, 2022, from https://www.enicbcmed.eu/get-know-13-med-pearls-pilot-areas

EuroGOOS. (2022). Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS). Retrieved August 1, 2022, from https://eurogoos.eu/roos/mediterranean-operational-network-global-ocean-observing-system-mongoos/

Grec-Sud. (2022). Le Grec-Sud. Retrieved August 1, 2022, from http://www.grec-sud.fr/

Hyperion. (2019). HYPERION's Vision. Retrieved August 3, 2022, from https://www.hyperion-project.eu/hyperions-vision/

Instituto Superiore per la Protezione e la Ricerca Ambientale. (2011). The National Tidegauge Network. Retrieved August 1, 2022, from https://www.mareografico.it/?session=0S-2401921144D8276LY769077&sysl-ng=ing&sysmen=-1&sysind=-1&sys-sub=-1&sysfnt=0&code=HOME

International Centre for Advanced Studies on River-Sea Systems DANUBIUS-RI. (2019). Home. Retrieved August 1, 2022, from https://www.danubius-ri.eu/index.html

La Région Occitanie, Pyrénées, Méditerranée. (2022). Parlement de la mer. Retrieved August 1, 2022, from https://www.laregion.fr/-parlement-de-la-mer-

MedCities. (2022). About us. Retrieved July 13, 2022, from https://medcities.org/about-us/

MedCities. (2022). MedSeaties. Retrieved August 1, 2022, from https://medcities.org/project/medseaties/

Melimed, Métropoles du littoral méditerranéen, enjeux climatiques et solutions de résilience. (2022). Accueil. Retrieved August 1, 2022, from https://www.melimed.eu/home

Métropole Toulon Provence Méditerranée. (2022). Le PAPI des Petits Côtiers toulonnais - Prévention des inondations. Retrieved August 2, 2022, from https://metropoletpm.fr/tourisme/proxy/papi

Mon Littoral. (2022). Présentation, Historique. Retrieved August 1, 2022, from https://www.monlittoral.fr/presentation/historique/

Objectif paysages, Ministère de la Transition Écologique. (2020). Observatoire Photographique du Paysage du littoral vu depuis la mer. Retrieved August 2, 2022, from https://objectif-paysages.developpement-durable.gouv.fr/observatoire-photographique-du-paysage-du-littoral-vu-depuis-la-mer-147#:~:text=Cet%20observatoire%20est%20le%20premier,que%20sont%20les%20paysages%20littoraux.

Plan Bleu. (2022). CASadapt project, Research-action: analyze, imagine, consult, adapt the socio-ecosystems of the Mediterranean coast to climate change. Retrieved August 12, 2022, from https://planbleu.org/en/projects/casadapt/

Plan Bleu. (2020). Mediterranean Observatory on Environment and Sustainable Development. Retrieved August 1, 2022, from https://www.obs.planbleu.org/en/

SCORE. (2022). Project Concept. Retrieved August 1, 2022, from https://score-eu-project.eu/project-concept/

Sea Level Rise Scenarios Along the Mediterranean Coasts–2. (2022). Overview. Retrieved August 2, 2022, from https://www.savemedcoasts2.eu/index.php/en/project/overview

Tourism 2030 DestiNet Services. (2022). C3S European Tourism. Retrieved August 9, 2022, from https://destinet.eu/who-who/civil-society-ngos/climtour

United Nations Environment Program. (2022). Climate change in the Mediterranean. Retrieved July 13, 2022, from https://www.unep.org/unepmap/resources/factsheets/climate-change

Articles

La région Occitanie, Pyrénées - Méditerranée. (2022). A Gruissan, des hébergements flottants écologiques et uniques en France. Retrieved August 10, 2022, from https://www.laregion.fr/A-Gruissan-des-hebergements-flottants-ecologiques-et-uniques-en-France

La région Occitanie, Pyrénées - Méditerranée. (2022). Le Plan Littoral 21 change d'approche pour protéger le lido de Frontignan. Retrieved August 10, 2022, from https://www.laregion.fr/Le-Plan-Littoral-21-change-d-approche-pour-proteger-le-lido-de-Frontignan

TV3 - Televisió de Catalunya. (2022). La línia de tren del Maresme, engolida pel mar: "No val seguir fent pedaços". Retrieved August 2, 2022, from https://www.ccma.cat/324/la-linia-de-tren-del-maresme-engolida-pel-mar-no-val-seguir-fent-pedacos/noticia/3154774/oVjQ9qdNRKYerxvGIRcy-BcQV5dR4XgF1Si16XqNx.pdf

OCEAN & CLIMATE PLATFORM

SEA'TIES
SHARING SOLUTIONS WITH COASTAL CITIES TO TACKLE SEA LEVEL RISE

CONTACT

Théophile Bongarts Lebbe
tbongarts@ocean-climate.org

ocean-climate.org/en/seaties-2

PARTNERS

Plan Bleu

MedECC
Mediterranean Experts on Climate and environmental Change

ENDORSED BY

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

FINANCIAL SUPPORT

PRINCE ALBERT II OF MONACO FOUNDATION

INSTITUT PAUL RICARD OCÉANOGRAPHIQUE

Fondation de France

Fondation VEOLIA

cnrs

Gouvernement Princier
PRINCIPAUTÉ DE MONACO