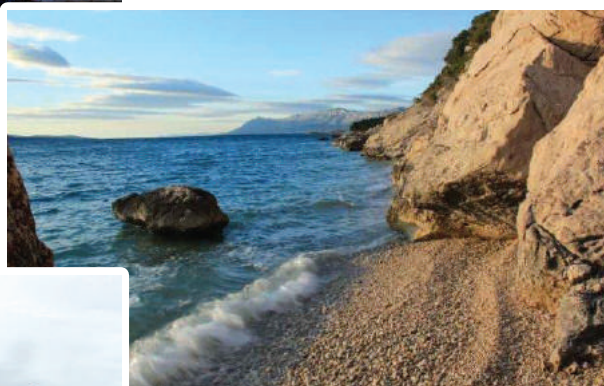


## Guidelines for Adapting to Climate Variability and Change along the Mediterranean Coast



## Note

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This document was prepared by the Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP/UNEP) in the frame of the project “Integration of Climate Variability and Change into National Strategies to implement the ICZM Protocol in the Mediterranean” (the ClimVar & ICZM project). This project is complementary to the MedPartnership project (i.e. the Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem initiative) funded by GEF and other donors, including the European Commission, and implemented by MAP/UNEP and partner institutions, including PAP/RAC.

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## List of Acronyms

ACRI Arab	Climate Resilience Initiative
AR5	Fifth Assessment Report
CAMPs	Coastal Area Management Programmes
Cap	Common Agricultural Policy
CBA	Community-Based Adaptation
CBD	Convention on Biological Diversity
CCBio	<i>Connaissance d'impact du Changement Climatique sur la Biodiversité en France</i>
CCST	Carbon Capture and Storage
CDM	Clean Development Mechanism
CF	Cohesion Fund
CHy	Commission for Hydrology
CIF	Climate Investment Fund
CIRCE	Climate Change and Impact Research the Mediterranean Environment
CLIM-RUN	Local Climate Information to Respond to User Needs
ClimVar	Climate Variability
CMP	Meeting of the Parties
CO <sub>2</sub>	Carbon Dioxide
COP	Conference of Parties
CRISTAL	<u>C</u> ommunity-based <u>R</u> isk <u>S</u> creening <u>T</u> ool – <u>A</u> daptation and <u>L</u> ivelihoods
CV&C	Climate Variability and Change
DEM	Digital Elevation Model
DEPI	Division of Environmental Policy Implementation
DFIs	Development Finance Institutions
DIVA	Dynamic and Interactive Vulnerability Assessment
DPSIR	Driving forces-Pressures-States-Impacts-Responses (APPROACH)
EAFRD	European Agricultural Fund for Rural Development
EbA	Ecosystems-Based Adaptation
ECHAM	European Centre Hamburg Model (global climate model)
EEA	European Environment Agency
EEAA	Egyptian Environmental Affairs Agency
EMFF	European Maritime and Fisheries Fund
ENPI	European Neighbourhood and Partnership Instrument
EO	Earth Observation
ERDF	European Regional Development Fund
ESA	European Space Agency
ESF	European Social Fund
ESIF	European Structural Investment Fund
ESPON	European Spatial Planning Observation Network
<i>eSurge</i>	ESA Storm Surge Project
ETWCH	Expert Team on Waves and Coastal Hazards Forecasting Systems
EU	European Union
FAO	Food and Agriculture Organization of the UN
FP	Framework Programme
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHGs	Greenhouse Gas Emissions
GtC	Cumulative Carbon emissions
ICZM	Integrated Coastal Zone Management
IIASA	International Institute of Applied Systems Analysis
IMF	Integrative Methodological Framework
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
LCEI	Low Carbon Economy Index
LDCF	Least Developed Countries Fund

LECZ	Low Elevation Coastal Zone
MAP	Mediterranean Action Plan
MCSD	Mediterranean Commission on Sustainable Development
MedPartnership	Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem (LME)
MENA	Middle East and North Africa
MFF	Multi-annual Financial Framework
MSSD	Mediterranean Strategy on Sustainable Development
MSP	Marine Spatial Planning
NAPAs	National Adaptation Programmes of Action
NBSAPs	National Biodiversity Strategies and Action Plans
NEPAD	The New Partnership for Africa's Development
NGO	Non-Governmental Organization
NOAA	National Oceanographic and Atmospheric Administration
NOP	National Operational Programme
NRT	Near Real Time service (eSurge-Venice live)
NW	Northwest
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PAP/RAC	Priority Actions Programme / Regional Activity Centre
PB	Plan Bleu
PD	Presidential Decree
PEGASO	People for Ecosystem-Based Governance in Assessing the Sustainable Development of Ocean and Coast
PESETA	Projection of Economic Impacts of Climate Change in Sectors of the European Union Based on Bottom-Up Analysis
PoW	Programme of Work
PPCR	Pilot Programme for Climate Resilience
PPM	Parts Per Million
PPPs	Public-Private-Partnerships
RAC	Regional Activity Centre
REDD	Reducing Emissions from Deforestation and Degradation
SAP-BIO	Strategic Action Programme for the Conservation of Biological Diversity
SAP-MED	Strategic Action Programme to Address Pollution from Land-Based Activities
SCCF	Special Climate Change Fund
SEA	Strategic Environmental Assessment
SGP	Small Grants Programme
SiteS	Collaborative Application (PEGASO CASES)
SLR	Sea-Level Rise
SRES	Special Report on Emissions Scenarios
SRTM	Shuttle Radar Terrain Mission
SSPs	Shared Socio-Economic Pathways
TCI	Tourism Climatic Index
TDA	Transboundary Diagnostic Analysis
UfM	Union for the Mediterranean
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP/GPA	UNEP Global Programme of Action
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNWTO	United Nations World Tourism Organization
USAID	United States Agency for International Development
WASSERMED	Water Availability and Security in Southern Europe and the Mediterranean
WB	World Bank
WGs	Working Groups
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development
WWF	World Wide Fund for Nature



# Objective and Structure of the Report

## Aim of the Report

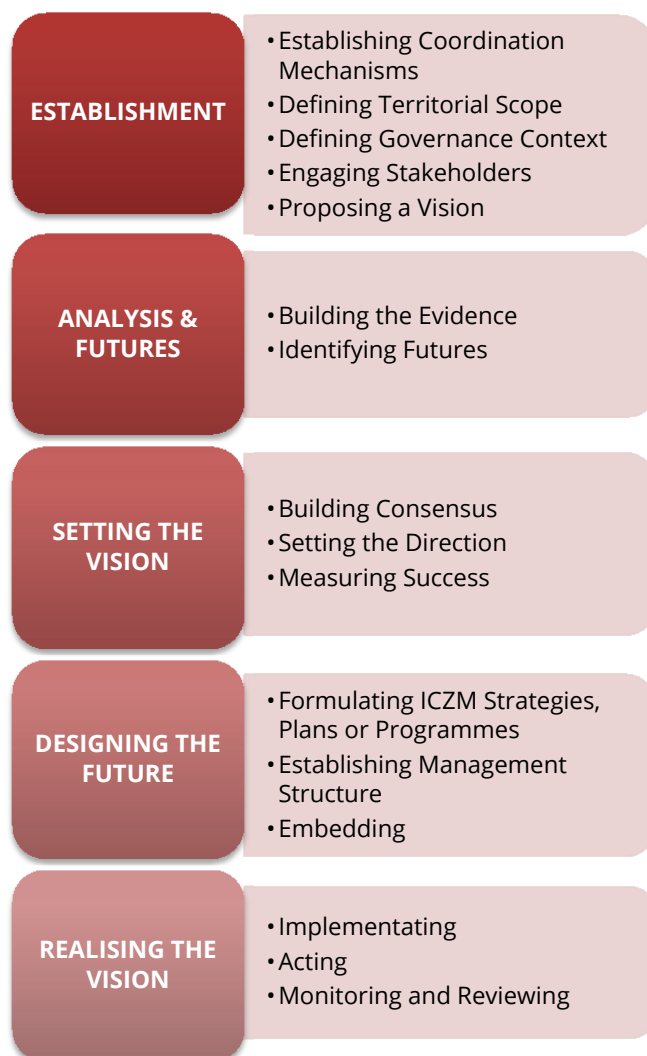
The aim of this document is to provide planners and policy-makers in the Mediterranean with:

- A guide to the impact of climate variability and change (CV&C) on coastal zones in the region,
- Information on how such impacts can be integrated into the Integrated Coastal Zone Management (ICZM) process<sup>1</sup>,
- Lessons learned from the experience of handling CV&C in specific locations in the region and elsewhere.

In terms of background material, the document draws on an earlier report “Integrating Climate Change into the ICZM Planning Process” (Markandya, 2012), prepared for PAP/RAC by one of the authors of this document. This earlier report showed how CV&C can be included as an integral part of the different steps of ICZM. Building on that report, the present guidelines provide a more detailed understanding of different key CV&C aspects in the Mediterranean coastal zones and aid in interpreting the CV&C dimension with regard to the format, content and provisions of the ICZM process. These guidelines also provide a critical review of CV&C adaptation efforts and mitigation measures, paving the way toward the rational application of ICZM Protocol requirements for the CV&C dimension.

To place the present report in the context of ICZM, we lay out below the stages envisaged for the preparation of national ICZM strategies, plans or programmes, as proposed in recently published documents.<sup>1</sup>

<sup>1</sup> The ICZM process has been presented in three related documents prepared by the Priority Actions Programme: “Guidelines for the Preparation of National ICZM Strategies Required by the Integrated Coastal Zone Management (ICZM) Protocol for the Mediterranean” (2011); “Toward Converging Management Approaches for Mediterranean Coastal Zones: An Integrated Methodological Framework for Coastal, River Basin and Aquifer Management” (2012) – IMF Document; and “The ICZM process” (Pegaso Wiki: [www.pegasoproject.eu](http://www.pegasoproject.eu)).



The present report offers specific guidance on how to integrate CV&C into each of these stages as summarised in Table 0.1.

Table 0.1: Consideration of CV&C elements in the ICZM Structure

Stage of ICZM	Issues Addressed in this Report	Comment
1. Establishment, which sets out the ICZM strategy and plans within the context of the ICZM Protocol.	Introduction to international legal and policy framework to address the CV&C issue.	What are the legal requirements for dealing with CV&C, who is responsible for what and how can the different levels be integrated?
2. Analysis and Futures: Building the evidence and identifying the futures.	Introduction to climate science and practice to explain the need for mainstreaming CV&C into the ICZM planning processes.  Presentation of current CV&C impacts on Mediterranean coastal zones and future projections for major economic sectors (i.e. tourism, agriculture, fisheries, etc.) and on coastal populations; land use should be considered with regard to sustainable coastal development.	Provide the latest evidence on climate science in coastal zones in the Mediterranean.  The reasons why these factors imply a need to include CV&C in the ICZM planning processes.  Provide the latest results of CV&C impacts on the main sectors (human and economic) and their future projections.
3. Setting the Vision: Engage stakeholders in setting priorities and agreeing on key policies and measures for the analysis stage.	Introduction to inclusive governance and presentation of resilience-building approaches and initiatives for coastal communities (e.g., Climagine used within the ClimVar project).	How to build a resilient strategy in a participatory manner, taking account of existing governance structures?
4. Designing the Future: Formulating plans to deal with climate impact and establishing a management structure.	Presentation of vulnerability assessment approaches and proofing methodologies using, for example, the DIVA model applied within PAP/RAC projects.  Explanation of CV&C adaptation approaches and provision of practical examples of good responses from the Mediterranean and elsewhere (including lessons learned from local experiences).  Introduction to CV&C-related financial considerations.	Discuss approaches to assessing vulnerability and give examples of their application.  Provide a list of the main adaptation policies and measures that have been identified for coastal zones.
5. Realising the Vision: Implementing the strategy.	Introduction to international legal and policy framework to address the CV&C issue.  Introduction to CV&C-related financial aspects.	Steps to be taken to implement the strategies and related legal issues.  Different financial channels for mobilising resources to implement the selected policies and measures.

## Outline of the Report by Stage

Given below are the key details of what will be covered in each stage of the ICZM strategy, plan or programme.

**Establishment:** The guidelines will indicate where responsibilities lie with different aspects of climate change policy within a country. Some elements are

set at the national level and some at the regional and local levels. However, all of them have implications for coastal zones and for decisions related to ICZM.

**Analysis and Futures:** This section provides an up-to-date discussion on climate science and climate

change impacts in coastal zones, especially in the Mediterranean. It draws on IPCC reports, including the latest IPCC WGII report<sup>2</sup>, and other relevant references. It also discusses how a more detailed assessment of the impacts can be made. Finally, it explains why the evidence indicates an urgent need to consider CV&C.

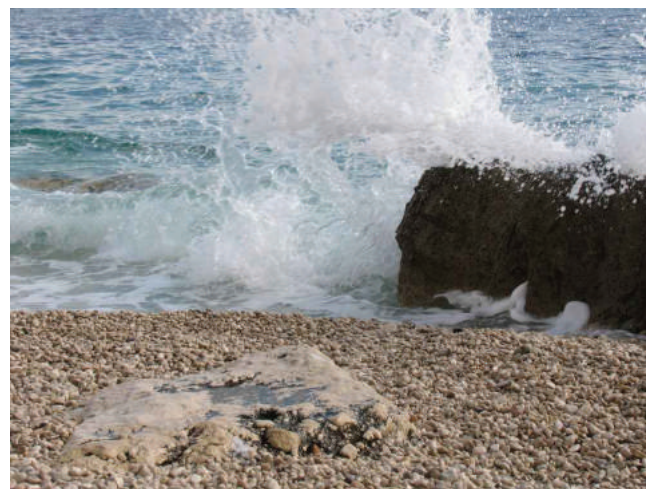
**Setting the Vision:** The key addition in this part of the guidelines is getting stakeholder engagement on the priorities related to CV&C. Since we are dealing with complex outcomes, it is important to communicate them to provide information that is understandable without being alarmist. It is also important to communicate the uncertainties about the impacts in a clear way. The next stage is to discuss preferences for adaptation action, which will require conveying information about the possible benefits and costs of such actions and uncertainties. This section elaborates issues that arise when building a strategy for dealing with CV&C given the problems described above.

**Designing the Future:** This section presents the technical aspects of the analysis of CV&C. Different sectoral impacts require different methodologies to evaluate their economic and social consequences. It also describes methods and answers questions regarding to what level the analysis should be carried out and what technical and financial resources are required. Finally, it provides examples of the application of the method for selected sectors in selected coastal zones.

Once the consequences of CV&C are established, the options for adaptation can be evaluated. In a number of methodologies (e.g., for storm surges in coastal zones) the two are integrated into one approach (DIVA)<sup>3</sup>. This section will look at how adaptation options can be evaluated, using techniques of cost-benefit, cost-effectiveness and multi-criteria analysis. Recommendations for the most appropriate methods to be used as part of the ICZM will be made. Monetary aspects of the options, including costs and benefits, resource mobilisation and the use of fiscal instruments to influence the demand and supply of climate-related

services, will be covered. The guidelines will provide advice on how to derive and use estimates for costs and benefits in a consistent way to calculate the net benefits of different options. The report will cover private and public financing that is available for resource mobilization for countries in the region, depending on their status (EU members, developing countries with access to the Climate Fund, etc.). Finally, the report will discuss how fiscal instruments can provide a means to reduce or share the costs of CV&C (e.g., insurance instruments) and to mobilise resources for undertaking adaptation measures.

**Realising the Vision:** This last section will focus on the issues arising in the implementation of a strategy, plan or programme for CV&C. Some of these issues are the result of procedural aspects of who is responsible for which stages of implementation and who will undertake the important steps of monitoring and evaluation. Other issues are related to the legal aspects that regulate the procedures. Finally, implementation will require the funding of policies and measures and issues related to these steps, such as sharing the burden between the central and local government, which will also be discussed in this last section.



*Photo 0.1: Makarska riviera, Croatia  
(Source: Marko Prem, PAP/RAC, April 2008)*

<sup>2</sup> <https://www.ipcc.ch/report/ar5/wg2/>

<sup>3</sup> Richards, J. and R. Nicholls (2011) "Impacts of climate change in coastal systems in Europe. PESETA-Coastal Systems study. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Seville.

# 1 Establishment

This is an important stage of the ICZM process. The aim is to create an operational foundation for the subsequent preparation of the strategy or plan and its implementation, to begin the process of understanding the challenges facing an area and the differing perceptions of those challenges, and to begin building a constituency of support for the strategy or plan.

Before discussing the details of the steps involved in the ICZM process, it is important to know the legal and policy framework that countries face when dealing with climate change and variability. This section will begin by laying out that framework.

## Introduction to the legal and policy framework

The countries of the Mediterranean Sea Basin face a variety of shared coastal and marine environmental problems that are trans-boundary in nature. The key to success in addressing these trans-boundary environmental concerns - especially the CV&C issue - is mutual political commitment by all the countries in the basin. There is a widespread agreement that a “business as usual approach” is no longer a valid option to ensure the sustainability of coastal and marine resources, especially in the context of climate change, and that there is a need to revise existing policies, laws and strategies at the international, national and local levels in an integrated and participatory way to be more sensitive to climate change. For decades, ICZM has been recognised and practised globally as a strategy for the sustainable development of a coastal zone. It is widely promoted as an appropriate policy framework to deal with current and long-term coastal challenges that cut across traditional sectors.

Although the political, legal, and institutional dimensions are the most critical elements in coping with climate variability and change in coastal zone management, international bodies have devoted considerable effort to produce legal instruments, guiding policy documents, principles and guidelines that explicitly address climate change impacts on coastal management and models of co-operation. This section explores the legal and policy

frameworks that currently exist at the international and Mediterranean levels and that explicitly address climate change impacts on coastal management.

## International and Mediterranean legal frameworks

### International Conventions

Many international conventions and treaties that the Mediterranean states have signed have important repercussions for future coastal management and adaptation strategies in their region. Most of these agreements have emphasized the benefit of the ICZM process to promote sustainable development.

The main multilateral agreements that address climate change and coastal zones include:

- The 1992 **UN Framework Convention on Climate Change (UNFCCC)**,<sup>4</sup> which established an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. UNFCCC is the first binding international legal instrument to address the CV&C issue. It was opened for signature in Rio de Janeiro at the June 1992 UN Conference on Environment and Development (UNCED) and entered into force on 21 March 1994. Its long-term objective is “to stabilize atmospheric greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.” In 1998, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) set up the Intergovernmental Panel on Climate Change (IPCC) to provide an objective source of scientific information.

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<sup>4</sup> [www.unfccc.int](http://www.unfccc.int)

In 2002, the Johannesburg United Nations World Summit on Sustainable Development (WSSD) encouraged coastal states to promote ICZM at the national level and also stressed the need to strengthen regional co-operation and co-ordination among relevant regional organizations and programmes. In this regard, it is important to recall that Article 4.1e of the UNFCCC Convention urges countries to “co-operate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management.”

The convention incorporated a number of newly emerging legal accords and principles that had been developed or affirmed by various climate conferences that included:

- *The UNFCCC Copenhagen Accord* (December 2009), which recognised the need for enhanced action on adaptation to reduce vulnerability and build resilience in the most vulnerable developing countries.
- *The Cancun Adaptation Framework*<sup>5</sup> (UNFCCC, 2011), which was adopted at the 2010 Climate Change Conference in Cancun, Mexico (COP 16/CMP 6). In the agreement the parties affirmed that adaptation must be addressed with the same level of priority as mitigation with a specific focus on developing countries.
- *The “Durban Platform for Enhanced Action”*, which was adopted at the United Nations conference in South Africa (UNFCCC, 2012). It agreed on a roadmap toward a new “protocol, another legal instrument or an agreed outcome with legal force” by 2015, applicable to all parties to the UN Climate Convention. Agreement was reached on the design and governance arrangements for the new Green Climate Fund.
- The ***Convention on Biological Diversity (CBD)***<sup>6</sup> has a specific mandate for marine and coastal diversity (Jakarta, 1995). Its key features include the implementation of integrated coastal and marine management as the most suitable framework for addressing human impact on

marine and coastal biological diversity (Article 6(b)) and the establishment of marine and coastal protected areas (Article 8(A)). Decision VII/5 of the CBD describes the various elements of an ecosystem-based marine and coastal management framework. The COP 10 (Decision X/29 (7)) “invites parties,... to further integrate climate change-related aspects of marine and coastal biodiversity into relevant national strategies, action plans and programmes, including, *inter alia*, national biodiversity strategies and action plans (NBSAPs), national adaptation programmes of action (NAPAs), national integrated marine and coastal management programmes, the design and management of marine and coastal protected areas, including the selection of areas in need of protection to ensure maximum adaptive capacity of biodiversity, and other marine environment and resource management-related strategies”.

At a regional level, these objectives are being promoted both by the Mediterranean state signatories through various work programmes and within the European Union through implementation of the Natura 2000 network at the Mediterranean state level.

## Mediterranean Conventions

- ***The Convention for the Protection of the Mediterranean Sea against Pollution (The Barcelona Convention)***<sup>7</sup> was signed on 16 February 1976, entered into force on 12 February 1978 and was revised in Barcelona, Spain, on 10 June 1995 and renamed the [\*Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean\*](#)<sup>8</sup>. The convention’s main objectives are to assess and control marine pollution; to ensure sustainable management of natural marine and coastal resources; to integrate the environment into social and economic development; to protect the marine environment and coastal zones through the prevention, reduction, and as far as possible, elimination of pollution, whether land- or sea-

<sup>5</sup> <http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf#page=4>

<sup>6</sup> <https://www.cbd.int/doc/legal/cbd-en.pdf>

<sup>7</sup> <http://www.unepmap.org/index.php?module=content2&catid=001001004>

<sup>8</sup> [http://195.97.36.231/dbases/webdocs/BCP/bc95\\_Eng\\_p.pdf](http://195.97.36.231/dbases/webdocs/BCP/bc95_Eng_p.pdf)



based; to protect the natural and cultural heritage; to strengthen solidarity among Mediterranean coastal states, and to contribute to an improvement in the quality of life. Although the Mediterranean Action Plan's (MAP's) initial focus was aimed at marine pollution control, its mandate gradually widened to include integrated coastal zone planning and management. The Barcelona Convention has gradually expanded its scope of action through seven protocols that address specific aspects of Mediterranean environmental conservation, including, protocols on specially protected areas and biological diversity, hazardous wastes and ICZM. The Compliance Committee (2008), and its Rules of Procedure (2009), is the official body for the effective implementation of the convention and protocols.

The main declarations adopted by various conferences of parties to the Barcelona Convention that specifically mention climate change and the coastal zones are the following:

- **The Almeria Declaration,**<sup>9</sup> which was adopted at the 15<sup>th</sup> Ordinary Meeting of the Contracting Parties to the Barcelona Convention in Almeria, Spain in January 2008. Climate change was one of the main agenda items of this meeting. The Almeria Declaration stresses the importance of accounting for climate change and its adverse effects on “coastal and marine ecosystems and the environment in general and the negative consequences for sustainable development, particularly for the developing countries in the Mediterranean Basin.” It also included agreement on the use of the ICZM Protocol as the basis to address practical responses to the impact of climate change on Mediterranean coastal ecosystems.
- **The Marrakech Declaration,**<sup>10</sup> adopted at the 16th Ordinary Meeting of the Conference of Parties (COP) to the Barcelona Convention in Marrakech, Morocco in November 2009 (UNEP (DEPI)/MED IG.19/8 Annex I). Ministerial discussions emphasised the need for enhanced knowledge and scientific assessment as tools for policy-makers to incorporate measures into

adaptation plans. The Marrakech Declaration stressed that adaptation to climate change in marine and coastal areas is a major priority for the Mediterranean region and that it requires regional guidance and co-ordination.

- **Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol) of the Barcelona Convention,**<sup>11</sup> which completes the set of protocols for the Protection of the Marine Environment and the Coastal Mediterranean Region. It was signed in Madrid on 21 January 2008 and entered into force on 23 March 2011. The ICZM Protocol will allow Mediterranean countries to better manage and protect their coastal zones and to deal with emerging coastal environmental challenges, such as climate change. In fact, the ICZM Protocol is the first regional ICZM legal instrument that deals extensively with the issue of climate change, both at the strategic level (by requesting countries to mainstream climate change issues into national ICZM strategies and plans) and the local level (by requesting countries to define, *inter alia*, the coastal setback zone). This protocol is a unique legal instrument on ICZM in the international community and could serve as a model for other regional seas.

According to the stock taking performed in the framework of the EU FP7 PEGASO Project (2014), seven Mediterranean countries (Algeria, Egypt, France, Israel, Spain, Tunisia and Turkey) have a framework law for coastal zones.<sup>12</sup> Croatia ratified the ICZM Protocol with its national law, and six more countries (Albania, Bosnia and Herzegovina, Italy, Montenegro, Morocco and Slovenia) are in the process of drafting or approving national legislation for ICZM.

Regarding Article 8.2 of the protocol (*Establishing a coastal setback zone*), 12 of the countries have or are setting up a 100-metre setback zone in which construction is banned. However, certain conditions allow the exploitation of the public maritime domain, mostly for public utilities or for maritime-related economic activities.

<sup>11</sup> <http://www.unepmap.org/index.php?module=news&action=detail&id=110>

<sup>12</sup> [http://www.pegasoproject.eu/images/stories/WP2/D2.2A\\_Final%20global%20results%20of%20the%20stock-taking.pdf](http://www.pegasoproject.eu/images/stories/WP2/D2.2A_Final%20global%20results%20of%20the%20stock-taking.pdf)

<sup>9</sup> <http://www.emwis.net/documents/PDF/Almeria%20Declaration>

<sup>10</sup> [http://unfccc.int/cop7/documents/accords\\_draft.pdf](http://unfccc.int/cop7/documents/accords_draft.pdf)

### Box 1.1: Articles of the ICZM Protocol that Address CV&C

- Taking risk into account in the implementation of ICZM (Art. 5e)  
*"The objectives of integrated coastal zone management are to: (...) prevent and/or reduce the effects of natural hazards and in particular of climate change, which can be induced by natural or human activities" (Art. 5e).*
- Integrating the "risk" dimension in the ICZM national strategy (Art. 22)  
*"Within the framework of national strategies for integrated coastal zone management, the Parties shall develop policies for the prevention of natural hazards" (Art. 22).*
- Part IV of the protocol addresses "Risks Affecting the Coastal Zone", calling on parties to take measures to prevent and mitigate natural hazards and climate change in particular, as well as coastal erosion (Art. 22 – 24).

### Tools for integrating risks in coast-related sectoral policies

- Establishing a coastal setback zone (Art. 8-2)
- Vulnerability and hazard assessments (Art. 22)
- Adopting prevention, mitigation and adaptation measures (Art. 22, 23-1)
- Respecting carrying capacity as a tool for preventing risk (Art. 6b)

Despite the lack of specific laws, most Mediterranean countries have at least some provisions to regulate construction in the coastal zone:

- In **Greece**, the general legislation on non-urban building rights (PD 270/D/ 1978) provides for a minimum distance of 30 m from the coastline for all construction and land use.
- In **Turkey**, legislation does not allow construction on the shore (beaches, dunes, wetlands, etc.) and in the first 50 m of the adjacent shore band.
- In **Egypt**, it is forbidden to construct any establishment within 200 m from the coastline without the permission of the competent administrative authority.
- In **Lebanon**, construction is also forbidden within a 200 m band starting from the highest level of seawater in winter, while free public access to the beach and public maritime areas is allowed.
- In **Tunisia**, a 25 m zone in which construction is banned has been established for areas covered by spatial plan, with a 100 m zone for sensitive areas and areas without a spatial plan.
- In **Morocco**, a law on the littoral - still in the process of being adopted - prohibits construction within a 100 m strip. However, as an exception, this no-build band can have projects "of particular economic interest" but

only with a permit whose terms are determined by the regulation.

- Since 1983, **Israel** has had a statutory setback of 100 m in which construction is not permitted unless specific permission is granted under exceptional circumstances.

## International and Mediterranean policy frameworks

Many organizations have worked extensively to produce policy documents, principles and guidelines that explicitly address the impact of climate change on coastal management and co-operation. This section presents the policy frameworks that currently exist at the international, regional, and Mediterranean levels and it addresses the links between climate change and coastal management in the context of climate-related threats.

## Current policy framework and related adaptation efforts

### United Nations Environment Programme (UNEP) - Regional Seas Programme: The Mediterranean Action Plan (MAP)

In 1975, the MAP became the first plan adopted as a Regional Seas Programme under the UNEP umbrella. Although the initial focus of the MAP was on marine pollution control, it gradually shifted to include integrated coastal zone planning and management as the most effective way to improve

the ecological state of the sea and to help coastal communities adapt to climate change. Implemented by the Barcelona Convention, MAP introduced integrated coastal zone management in the mid-1980s in response to the growing development pressure in coastal areas.

A series of policy documents, recommendations, programmes and projects, such as Coastal Area Management Programmes (CAMPs),<sup>13</sup> and tools and instruments have been developed and implemented through the six MAP Regional Activity Centres (RACs) based in Mediterranean countries. Each of the centres offers its own environmental and developmental expertise. The Mediterranean Commission on Sustainable Development (MCSDD) is an advisory body to the MAP Contracting Parties. The MCSDD co-ordinated preparation of the Mediterranean Strategy on Sustainable Development (MSSD), which was adopted in 2005 and is now being revised.

### The European Commission - EU strategies and policy efforts

EU policies and instruments include:

- The *Integrated Maritime Policy* (and action plan), which permits the sustainable development of maritime-related activities. Its environmental pillar, the *Marine Strategy Framework Directive* aims to deliver a “good environmental status” of the marine environment by 2020. In addition, the Common Fisheries Policy is being reformed to achieve sustainable fisheries.
- The *Water Framework and Floods Directives*.<sup>14</sup> In coastal areas, the Water Framework Directive covers transitional and coastal waters up to one nautical mile from the territorial baseline of a member state for a Good Ecological Status and up to 12 nautical miles for a Good Chemical Status. As part of the implementation phase of this directive, almost half of river basin management plans address specific climate change adaptation measures. The Floods Directive devotes attention to the impact of coastal floods.
- The *Natura 2000, Habitats and Birds Directives*: The Natura 2000 network protects a large percentage of coastal and marine regions. In

2013, the European Commission produced “Guidelines on Climate Change and Natura 2000,”<sup>15</sup> which were intended for site managers and policy-makers. The guidelines focus on practical advice and the key principles involved in developing adaptive management for climate change. They also underline the benefits from Natura 2000 sites in mitigating the impacts of climate change, reducing vulnerability and increasing resilience, and explaining how the adaptation of management for species and habitats protected by Natura 2000 (such as green infrastructure and other ecosystem-based approaches) can be used to tackle the effects of climate change.

- The *EU Maritime Spatial Planning Directive*.<sup>16</sup> One of the most recent EU achievements is the Maritime Spatial Planning Directive. Launched on 12 March 2013, it was adopted in July 2014. This new initiative aims to establish a framework for maritime spatial planning in EU member states that will promote the sustainable growth of maritime activities and the sustainable use of coastal and marine resources. Climate change is mentioned in the preamble and in the objectives of the directive, stating member states will seek to improve the resilience to climate change impacts through their maritime spatial plans.
- The *EU Strategy on Adaptation to Climate Change*:<sup>17</sup> Following the “EU White Paper on Adaptation,”<sup>18</sup> the European Commission adopted a strategy on adaptation to climate change in April 2013. The strategy’s goal is to make Europe more climate resilient. Adaptation actions include mainstreaming of climate change (mitigation and adaptation) into EU sector policies and funds, including marine and inland water issues, forestry, agriculture, biodiversity, infrastructure and buildings, but also migration and social issues.

<sup>15</sup> <http://ec.europa.eu/environment/nature/climatechange/pdf/Guidance%20document.pdf>

<sup>16</sup> Directive Establishing a Framework for Maritime Spatial Planning (2014/89/EU)

<sup>17</sup> [http://ec.europa.eu/clima/policies/adaptation/what/documentation\\_en.htm](http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm)

<sup>18</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF>

<sup>13</sup> <http://www.pap-thecoastcentre.org/>

<sup>14</sup> Water Framework Directive (2000/60/EC)



- The *European Climate Adaptation Platform (Climate-ADAPT)*<sup>19</sup> is a partnership between the European Commission and the European Environment Agency. It is a publicly available, web-based platform launched in March 2012 and designed to support policy-makers at the EU, national, regional and local levels in the development of climate change adaptation measures and policies through several resources and tools. The EU is also providing guidelines on integrating climate into policies and investments and on how to use the instruments and funds provided by the Commission for climate change adaptation. For instance, *EU-Cities Adapt* is an initiative to train and exchange knowledge among stakeholders at the city level.

### **The Union for the Mediterranean (UfM) - The Mediterranean Climate Change Initiative**<sup>20</sup>

This initiative was designed in Athens in October 2010 as an autonomous political initiative and a projects-based initiative eligible for Union for the Mediterranean (UfM) branding. It seeks to accelerate the region's responses to the impacts of climate change. The proposed Priority Work Areas for the Initiative are:

- The *Mediterranean Climate Sensitive Development Charter*: Building on existing UNFCCC, EU and national strategies, this document will ensure that the extent of climate change impacts on the region are fully understood.
- *Sustainable Mediterranean Cities*: Cities, and how they can be a key part of the solution to climate change, will be a major component of the Mediterranean Climate Sensitive Development Charter.
- The *Mediterranean Climate Change Fund*: This initiative would attract funding from existing sources – the UN, the EU, central governments, development banks, and sovereign and infrastructure funds.
- The *Mediterranean Climate Change Service Network*: This network could build on the work of existing scientific research institutes in the

region to offer analyses of environmental, economic and social impacts at the regional and local levels, assure rapid response and facilitate efficient and timely cooperation.

### **Regional Adaptation Framework for Climate Change in the Mediterranean**

UNEP/MAP has been working on the issue of climate change impacts on marine and coastal zones since the 1990s. At the 16th Meeting of the Contracting Parties to the Barcelona Convention in 2009, the “Marrakech Declaration” adopted by the ministers of the environment and the heads of the delegations agreed to “Implement effective co-ordination to ensure the integration of climate change issues into development policies with the aim of achieving the Millennium Development Goals and the objectives of the MSSD, and ensure the strengthening of co-operation for the sharing of experience in the field of surveillance (early-warning systems) and the development and implementation of adaptation and risk-management strategies.”

In UNEP/MAP's Five-Year Strategic Programme of Work 2010-2014, climate change was one of the six themes. The Programme of Work (PoW) for 2014-15 contained several mitigation and adaptation actions, including the preparation of a framework and its review by the MCSD, following which it will be submitted for consideration by 19th Meeting of the Contracting Parties to the Barcelona Convention at the end of 2015.

Finally, the first Mediterranean Strategy for Sustainable Development (MSSD), adopted in 2005, included the mitigation of climate change and adaptation to its effects as one of its seven priority fields of action. The assessment of the implementation of the MSSD report (2011) suggested that the revised MSSD should put more emphasis on orientations, actions and indicators concerning emerging priorities, such as adaptation to climate change. The revision process of the MSSD currently under development has climate change as one of its six focus areas.

### **The Arab Climate Resilience Initiative (ACRI)**<sup>21</sup>

The overall objective of ACRI is to build the foundations for a regional platform to support Arab

<sup>19</sup> <http://climate-adapt.eea.europa.eu/>

<sup>20</sup> <http://www.medclimatechangeinitiative.org/sites/default/files/Joint-Declaration.pdf>

<sup>21</sup> [www.arabclimateinitiative.org](http://www.arabclimateinitiative.org)

countries as they acquire knowledge on climate change priorities, develop capacities to respond with strategic programmes and policies, and to establish partnerships and other forms of co-operation to address this challenge that has both local and global effects. The programming areas of the ACRI framework include:

1. Supporting institutional capacity to address the impacts of climate change.
2. Supporting local approaches to climate change adaptation.
3. Enhancing resilience in the three priority areas of water and food security, sea-level rise and coastal erosion, and sustainable energy.

### **The Southern and Eastern Neighbours Instrument**

The European Neighbourhood and Partnership Instrument (ENPI)<sup>22</sup> has been operational since 1 January 2007. The ENPI is the main source of funding for 17 partner countries.<sup>23</sup> Its main purpose is to create an area of shared values, stability and prosperity, enhanced co-operation and deeper economic and regional integration by covering a wide range of co-operation areas. Between 2004 and 2007, €120 million was allocated to climate change activities, focusing on the energy sector. The ENPI South Regional Initiative Programme 2011-13 carried out activities on climate change under its Priority Area Three – Sustainable Development for the Mediterranean.

### **The New Partnership for Africa's Development (NEPAD)<sup>24</sup>**

The Climate Change programme within NEPAD brings together all relevant regional and continental players to co-ordinate, share knowledge and encourage each other in addressing the threat of climate change. The objective of the programme is to assist countries in integrating climate change responses into their national development processes. The programme also wants to start collecting data and information on climate change mitigation and adaptation on the continent. The goal is to establish a database of

relevant climate change information and develop sub-regional climate change frameworks.

### **The Special Climate Change Fund (SCCF)**

The SCCF was established under the UNFCCC in 2001 to finance four programmes, including adaptation, which was given the highest priority at COP (Decision 7/CP.7). With regard to the SCCF adaptation programme, the COP identified Integrated Coastal Zone Management as a priority intervention. The project meets the eligibility criteria of the SCCF. By promoting an ICZM plan that takes into account climate change risks, the project involves long-term adaptation measures that create increased resilience of coastal development and socio-economic sectors. This approach fits with the strategic objective of the SCCF, which is to promote climate change resilient development.

### **Steps in the establishment process**

The above legal and policy framework provides a basis for the establishment phase. The assumption is that both the strategy and the plans should be comprehensive – covering all issues crucial for sustainable coastal development in the 21st century – and integrated – ensuring institutional co-ordination, co-ordination of national, regional and local authorities, the involvement of non-governmental organisations and other competent organisations and support of scientific institutions, as well as the integrity of sea and land areas. All partners should agree on the final status of the strategy or plan at this initial stage, particularly when the strategy or plan is being used to meet the statutory purposes of one or more sectors.

As far as climate change is concerned, the main task is to ensure institutional co-ordination with bodies responsible for climate adaptation and mitigation strategies and plans. All countries have an obligation to produce a report to the United Nations Framework Convention on Climate Change that details greenhouse gas emissions (GHGs) and provides vulnerability assessments and actions to adapt to climate change.<sup>25</sup> Any actions on

<sup>22</sup>[http://ec.europa.eu/europeaid/where/neighbourhood/overview/index\\_en.htm](http://ec.europa.eu/europeaid/where/neighbourhood/overview/index_en.htm)

<sup>23</sup> Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Lebanon, Libya, Moldova, Morocco, Occupied Palestinian Territory, Russia, Syria, Tunisia and the Ukraine.

<sup>24</sup>[www.nepad.org/](http://www.nepad.org/)

<sup>25</sup> For details see: [http://unfccc.int/national\\_reports/items/1408.php](http://unfccc.int/national_reports/items/1408.php). Annex One countries (i.e. those that have a target reduction of GHGs under the Kyoto Protocol) also have to provide information on policies and measures that have been introduced.

climate change under the ICZM should be co-ordinated with the national communication office of that country. In addition, local authorities in many coastal zones are already planning to introduce measures to respond to some of the expected impacts of climate change. It is essential that these authorities and their plans and procedures be brought into the ICZM process at this initial stage.

*These climate issues should be noted in the strategy, and plans for the ICZM should ensure that the conditions are met. The plans should also identify the key stakeholders.*

The scoping report, which is the output of this stage, should cover co-ordination mechanisms, boundary definition, governance context, initial drivers and pressures, key problems and issues, risk identification, stakeholder analysis, a vision proposal, a decision on strategic environmental assessment (SEA) and the work plan.

## 1.1 Establishing co-ordination mechanisms

Practice shows that an efficient co-ordination structure for ICZM includes three bodies – a steering group, a technical group and a consultative group. Addressing climate change will require:

- At least one representative from the national government or a competent senior-level local administration(s) should have familiarity with climate issues.
- The technical group requires at least one person with a working knowledge of adaptation to climate change.
- The consultative group should include someone from the national communication office and a representative from those sectors where climate issues are important at Stage 1.4 (Scoping).

## 1.2 Defining territorial scope

Climate change will have an impact on areas that do not respect the boundaries of a coastal zone as defined in the ICZM. For example, sea-level rise may affect areas outside the defined zone and extreme events could impact areas that extend

beyond the defined boundaries, yet they are part of an integrated area that includes the coastal zones.

The issue of boundary definition should be raised during the preparation of a national ICZM strategy. The ICZM Protocol proposes a seaward limit of the coastal zone as the external limit of the territorial sea; while the landward limit is the limit of the competent coastal units. Countries should decide on the competent coastal units when ratifying the protocol, and the national ICZM strategy is the time to reconfirm this decision. The “competent” coastal units should be reconciled with the ecosystem and economic, social and political criteria as appropriate.

Practicality is necessary when defining the territorial scope of the areas to be covered under the plan. The pragmatic view outlined above is the recommended approach. This also applies to maritime zones, where the economic and social criteria should be applied, including coastal tourism, culture, agriculture and other economic uses, including patterns of transport and accessibility and urbanisation. In general, it makes sense to retain administrative boundaries where possible to maintain the integrity of stakeholder accountability and recognition, policy conformity and statistical information. A pragmatic compromise between ecosystem features and administrative requirements should prevail.

When a national plan is being prepared, additional details should be provided on how to deal with conflicts between administrative definitions and ecological, economic, social and political zones. Resolution of these conflicts should be proposed in the national plan. Local plans should then work with the agreed upon boundary definitions.

## 1.3 Defining governance context

The institutional context for climate change planning is already well established. In addition to a national communication office, and local and regional governments that are considering actions to adapt to climate change, several ministries and departments may also be involved:

- Ministry of Agriculture because of potential impacts on crop yields;

- Ministry of Environment, especially the body responsible for water management and ecosystem health;
- Ministry of Health, for the consequences of heat waves, vector and water-borne diseases and the increased risk of food contamination from higher temperatures;
- Agencies responsible for land-use planning (local and central);
- Ministry of Tourism;
- Ministry of Physical Planning and Construction.

The private sector is also actively engaged in coastal areas. Individuals and companies with significant investments will be very aware of increased climate change risks and will be planning remedial measures. However, these measures will depend very much on what policies the government has in place, highlighting the strong connection in the actions by these two sets of actors. It is critical that the ICZM is aware of private sector plans to provide it with the right framework and incentives so that it can make a cost effective contribution to adapting to climate change.

The ICZM needs to liaise with the private sector to understand its position and, ideally, to coordinate efforts for the effective management of coastal zones. This can only be done if the ICZM is recognized by the private sector for its capacity to play this co-ordinating role.

The identification of the key institutional aspects of the ICZM should be made in the national ICZM strategy, including those addressing climate change. In the national and local plans these linkages should ensure that all important stakeholders are included in the preparation of the plan.

## 1.4 Scoping

The main problems arising from climate variability and change include damage to infrastructure from sea-level rise and flooding, declining agricultural yields, increased risks from heat waves and extreme weather events, possible declines in high season tourism, shorter tourist seasons due to changes in climate, water shortages because of changes in precipitation and possible saline contamination of groundwater, damage to

ecosystems from changes in temperature and water availability, and an increased risk of forest fires.

These are a general set of problems that should be noted in an ICZM strategy, but not all of them will apply in all coastal zones. When preparing local coastal plans, the issues that are most relevant to a particular area can be identified.

The main pressures from climate change include sea-level rise, precipitation changes (leading to lower water availability in some areas and during some seasons and floods in other areas and other seasons), increased frequency of extreme weather events (hurricanes, floods, heat waves, etc.) and increased risks of vector and water borne diseases. At this stage the identification of these pressures, and an idea of where and when they are likely to be most serious, is required. As noted in the Guidelines for the Preparation of NICZM Strategies, these pressures will depend on future plans for land use, which is a key determinant of the impacts that result from the climate-related factors above. The climate drivers will also depend on policies for water and land management that are in place or likely to be introduced.

A national ICZM strategy should note the important climatic drivers and pressures. At the national planning stage national level data will be collected and at the local planning stage further relevant data will be assembled. There are also data sources that provide information with some degree of spatial disaggregation (see the websites listed at the end of this report).

For further information on the likely pressures, a downscaling exercise may be required, but this can be undertaken at a later stage of the process. The scoping stage, including risk identification, is primarily a desk exercise in conjunction with key stakeholders and technical experts from relevant sectors. As noted in the Guidelines for the Preparation of NICZM Strategies, risk vulnerability is conventionally categorised according to:

- the nature of the risk and its consequences;
- the magnitude of possible adverse consequences from each risk; and
- the probability of the occurrence of each risk.



In the case of climate change, objective probabilities cannot be defined in most cases. However, broad probability categories based on modelling and expert judgement are available for some pressures and impacts. These categories may predict when an event such as a temperature increase is "likely" (if the probability of it being exceeded is less than 50%) or "unlikely" (if the probability of it being exceeded is less than 10%). At this stage, the exercise should determine which of the key impacts identified in the previous stage have the highest probability.

This information is likely to be available for extreme events, sea-level rise, temperature increase, and perhaps changes in precipitation levels. Together with the data on key problems, such information will help at the later stage when the analysis of options is carried out.

The nature of risk identification and its relevance to the ICZM should be noted during the preparation of the national ICZM strategy. The collection of probability data at the national level should be collected for the national ICZM plan and at the local level for the local plans. However, the latter may require some downscaling of the models that predict the potential impacts.

## 1.5 Engaging stakeholders

Stakeholder participation in strategy and plan preparation is essential. Key groups must be informed of major climate changes, the likely consequences of those changes and the increased risks they represent. This can be done without providing too much technical detail. The groups that need to be involved will include local communities, government agencies, scientific institutions, NGOs, business, media and opinion makers, tourism service providers, private developers, and people working in agriculture and fisheries. Based on consultations with these groups, options for action can be drawn up. The role of stakeholders is discussed in greater detail in Section 3.

The same groups must be consulted once these options have been technically evaluated to get their feedback. The final plan will be based on the consensus of these key stakeholders.

A simple communications strategy should be devised during or shortly after the establishment stage. It should outline how these different participatory activities will be carried out and what other communications will be made. The national ICZM strategy will include the preparation of a broad communication strategy and the identification of key stakeholders. The details of the communication strategy and the groups or individuals to be invited will be spelled out in the plan.

## 1.6 Proposing a vision

The vision is prepared at this stage with the objective of ensuring the smooth running of the project and a common understanding of the time constraints, and to allocate resources efficiently during the period of the strategy or plan. There is not much to add here about integrating climate change into the vision, which will give rise to specific actions and activities that will form a part of the overall structure.

Some of the analytical measures identified may give rise to outsourcing studies that will provide technical material to be integrated into the main planning framework. This may also be the case with some other components of the ICZM. All such studies must be seen as part of the overall input into the preparation of the plan and there has to be enough expertise among the core team to be able to understand the results of the studies and to use them in drawing up the main ICZM plan.

## 1.7 Decision on a strategic environmental assessment (SEA)

As defined in the Guidelines for the Preparation of NICZM Strategies, a strategic environmental assessment is "a systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives to ensure that they are fully included and appropriately addressed at the earliest stage of decision-making, on a par with economic and social considerations." A number of countries have a statutory requirement to carry out a strategic environmental assessment (SEA) when a major project or policy change is being considered. This tool can be useful when

actions are proposed across a number of sectors, or when actions in one sector are likely to have an impact across several sectors. It can also be useful when the time frames for actions are different, for example, some land-use measures may conflict in the short term with climate adaptation objectives in the long term.

If a decision is made to carry out an SEA for the entire ICZM, then it will include any policies and measures for the climate component. It should be noted that the exercise is a complicated one because it entails examining a combination of policies across a range of sectors for their impacts on environmental resources. It can only really be done for the ICZM and it will require considerable

resources and time. Ultimately, it is a decision that the steering group must take in light of the national policy for SEAs.

Even if an SEA is not made, an assessment of the cross effects of the different policies will be needed. Development programmes that expand land use in coastal areas have to be undertaken with future consequences on climate costs in mind. An expansion of tourism that does not account for the impacts of climate change on visitors or of changes in water availability could result in failure.

A decision on an SEA should be taken at the strategy stage. Its application will be within the national plan since it is unlikely that local plans have sufficient resources to prepare an SEA.

## 2 Analysis and Futures

### 2.1 Background and building the evidence

The two stages in this section of the ICZM are: (a) building the evidence and (b) identifying the futures. The aim of the first stage is to establish an operational foundation for the preparation of the strategy or plan and its implementation. From a climate viewpoint the key tasks are:

- to identify the main elements of climate variability and change in the short- (10-20 years), mid- (30-40 years), and long-term (60+ years); and
- to assess the impacts of this variability on key sectors and the risks associated with them.

The second stage involves identifying policies and priorities for action. The climate change factors to be discussed are of varying importance, depending on which sector or area of policy is under consideration. This section presents those policy areas in which climatic factors play an important role. It will assess the range of policies and options and discuss possible pilot projects and funding sources. The selection of the actual policies options will be made when drawing up the national and local plans (depending on whether the policies and options are national or local). It is followed by the elaboration of pilot projects and funding sources.

To assist policy-makers, we provide below the key climate information that is needed and discuss how it can be used to develop a list of overall policies and priorities. We begin by providing a brief introduction to the state of climate science and what it tells us about impacts in coastal zones. This is followed by a description of coastal zones in the Mediterranean region. The final section discusses how this information is used to prepare future policies and actions.

#### Introduction to climate science and its impacts

The state of knowledge about climate change and its impacts is updated every six to seven years by the International Panel for Climate Change (IPCC), an international body that consists of scientists

from all countries around the world. It is divided into three working groups (WGs): climate science (WG I), impacts of climate change (WG II), and policies and measures to reduce greenhouse gas emissions (WG III). The Fifth Report of the IPCC was published in 2014. Its main findings from these working groups are provided below.

We know that the planet has previously experienced variations in CO<sub>2</sub> concentrations and global average temperature. However, these variations never before occurred so quickly, depriving living organisms with the opportunity to adapt. In particular, global atmospheric concentrations of greenhouse gases (primarily carbon dioxide, methane and nitrous oxide) have increased significantly since 1750. The main cause of these increases has been human activity and there is very high confidence that the effect of that activity has been global warming.

Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850). The linear warming trend over the last 50 years (0.13°C [0.10°C to 0.16°C] per decade) is nearly twice that for the last 100 years. The total temperature increase from 1850–1899 to 2001–2005 is 0.76°C [0.57°C to 0.95°C]<sup>26</sup>.

Global average sea level rose at an average rate of 1.8 [1.3 to 2.3] mm per year from 1961 to 2003. The rate was faster from 1993 to 2003, about 3.1 [2.4 to 3.8] mm per year. Whether the faster rate from 1993 to 2003 reflects decadal variability or an increase in the longer term trend is unclear. There is *high confidence* that the rate of observed sea-level rise increased from the 19<sup>th</sup> to the 20<sup>th</sup> century. The total rise in the 20<sup>th</sup> century is estimated to be 0.17 [0.12 to 0.22] m.

Numerous long-term changes have been observed at continental, regional and ocean basin scales. These include changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and different aspects of extreme weather, including droughts, heavy

<sup>26</sup> Intervals given in the report are 90% uncertainty intervals unless otherwise stated.

precipitation, heat waves and the intensity of tropical cyclones.

Long-term trends from 1900 to 2005 have been observed in precipitation amounts over many large regions. Significantly greater precipitation has been observed in the eastern parts of North and South America, northern Europe and northern and central Asia. Drying conditions have been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.

More intense and longer droughts have been noted over wider areas since the 1970s, particularly in

tropical and sub-tropical regions. Higher temperatures and decreased precipitation has contributed to more frequent and longer droughts. Changes in sea surface temperatures, wind patterns and decreased snowpack and snow cover have also been linked to droughts.

These observations of climate trends are uncertain, which is reflected in the careful wording of the report and its findings. Table 2.1 summarises the current state of knowledge about these trends with some explanatory statements about its degree of certainty.

*Table 2.1: Recent trends, assessment of human influence on trends, and projections of future extreme events for which late 20<sup>th</sup> century trends have been observed.*

Phenomenon <sup>a</sup> and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend <sup>b</sup>	Likelihood of future trends based on projections for 21st century using SRES scenarios
Warmer and fewer cold days and nights over most land areas	<i>Very likely<sup>c</sup></i>	<i>Likely<sup>d</sup></i>	<i>Virtually certain<sup>d</sup></i>
Warmer and more frequent hot days and nights over most land areas	<i>Very likely<sup>e</sup></i>	<i>Likely (nights)<sup>d</sup></i>	<i>Virtually certain<sup>d</sup></i>
Warm spells/heat waves. Frequency increases over most land areas	<i>Likely</i>	<i>More likely than not<sup>f</sup></i>	<i>Very likely</i>
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	<i>Likely</i>	<i>More likely than not<sup>f</sup></i>	<i>Very likely</i>
Area affected by droughts increases	<i>Likely in many regions since 1970s</i>	<i>More likely than not</i>	<i>Likely</i>
Intense tropical cyclone activity increases	<i>Likely in some regions since 1970</i>	<i>More likely than not<sup>f</sup></i>	<i>Likely</i>
Increased incidence of extreme high sea level (excludes tsunamis) <sup>g</sup>	<i>Likely</i>	<i>More likely than not<sup>g,h</sup></i>	<i>Likely<sup>i</sup></i>

*Note: The terms are used as follows: virtually certain (99-100% probability); very likely (90-100% probability); likely (66-100% probability); as likely as not (33-66% probability); more likely than not (50-100% probability). See: <http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf>. Source: IPCC (2014a).*

In terms of attribution, the report states that the increases in global temperatures are very likely due to an observed increase in anthropogenic greenhouse gas concentrations. The degree of confidence (90-100%) is greater than in previous years. Human influences now extend to other

aspects of the climate, such as ocean warming, temperature extremes and wind patterns.

In terms of future projections, the fifth IPCC assessment concludes that a warming of about 0.2°C per decade will occur for the next two decades under a range of socio-economic



emissions scenarios. Even if the concentrations of all greenhouse gases and aerosols is kept at the levels of the year 2000, a further warming of about 0.1°C per decade can be expected.

Continued greenhouse gas emissions at or above current rates will cause further warming and induce many changes in the global climate system during

the 21<sup>st</sup> century that would *very likely* be larger than those observed during the 20<sup>th</sup> century. The report provides projections of temperature increases as a function of likely changes in greenhouse gas emissions. These are shown in Table 2.2. The scenarios to which the table refers are described at the end of this chapter.

*Table 2.2: Projected increases in water temperature and sea-level rise under different scenarios*

Scenario	Emissions of CO <sub>2</sub> GtC/Yr.		Cumulative Carbon Budget GtC 1990-2100	Temp. increase and range °C 2090-99 relative to 1980-99	Sea-Level Rise M 2090- 99 relative to 1980-99
	2050	2100			
B1	11.3	4.2	983	1.8 (1.1-2.9)	0.18-0.38
B2	11.0	13.3	1,164	2.4(1.4-3.8)	0.20-0.43
A2	15.4	28.7	1,862	3.4 (2.0-5.4)	0.23-0.51
A1F1	23.9	28.2	2,189	4.0 (2.4-6.4)	0.26-0.59

*Note: In 1990 emissions of CO<sub>2</sub> from fossil fuels and land use were 7.1 GtC  
Sources: <https://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf> IPCC (2014a).*

The likely increase in temperature and sea-level rise depends on future emissions. To achieve a stabilisation of temperatures in the region of 2°C, emissions must fall to about 11 GtC by 2050. This goal has been set after discussions on the risks of climate change and from what is feasible given the existing commitment to lower GHG emissions and the costs of reducing such gases in the future. Unfortunately, current trends do not indicate that this will happen. The current total annual energy-related emissions are just over 30 GtCO<sub>2</sub> and rising, a carbon “burn rate” that would deplete the carbon budget for the entire century within the next 20 years. The IPCC has warned that our current trajectory will lead to a warming estimated between 3.7 – 4.8°C during the 21<sup>st</sup> century with significant climate impacts.

Against this backdrop of gloom, the decarbonisation results reported in this year’s Low Carbon Economy Index (LCEI) bring some hope, with growth in absolute emissions of only 1.8%, the slowest rate of emissions growth since 2008-2009, when carbon emissions fell as a result of the global recession.<sup>27</sup> The reduction in carbon intensity (tons CO<sub>2</sub> per million dollars of GDP) is also the highest since 2008, standing at 1.2%, compared to 0.8% in 2012. Nevertheless, it is still only one-fifth of the required

decarbonisation rate. Currently, the LCEI shows that **the global economy will need to cut its carbon intensity by 6.2% per year every year from now until 2100**, more than five times its current rate. Figure 2.1 shows the required rates of decline in carbon intensity to attain the B1 scenario.<sup>28</sup> As far as adaptation planning for climate change is concerned, the implication of this situation is that a potential increase in temperature of up to 4°C by 2100 is a real possibility and should be considered in the formulation of the appropriate measures.<sup>29</sup>

<sup>27</sup> <http://www.pwc.co.uk/sustainability-climate-change/publications/low-carbon-economy-index.jhtml>.

<sup>28</sup> The scenarios used by the climate science WGI report are a little different from those used by the other IPCC AR5 reports. The reference in the LCEI study is to the WGII and WGIII reports, but the differences in terms of emissions reductions is not significant.

<sup>29</sup> There is a simple link between temperature increases and concentrations of GHGs in parts per million (PPM). A 2° C increase means limiting greenhouse gas concentrations in the atmosphere to about 450 ppm CO<sub>2</sub> equivalents. The current value is about 400 ppm CO<sub>2</sub>. A concentration of 550 ppm would result in increases of closer to 4°C.

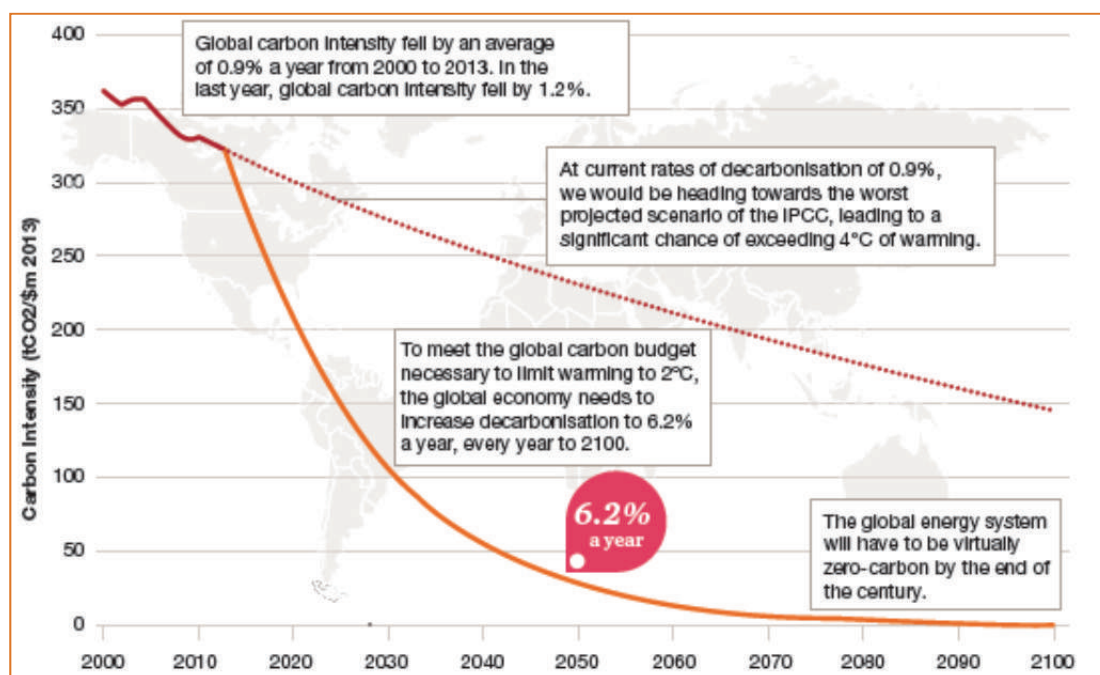


Figure 2.1: Pathways to a 2°C stabilisation. Source: LCEI, 2014

## Coastal zones in the Mediterranean

In this section we look at the possible impacts of the climate changes described above on the coastal zones of the Mediterranean.

Coastal zones are the most appealing assets of the Mediterranean. However, they are exposed to enormous pressures from land-based and marine pollution, urban development, fishing, aquaculture, tourism, extraction of materials, and marine biological invasions. With global warming and sea rise, these pressures will increase. In particular, many coastal systems will experience increased inundations and storm flooding, accelerated coastal erosion, seawater contamination of fresh groundwater, encroachment of tidal waters into estuaries and river systems, and elevated sea surface and ground temperatures. Other impacts may include changes in chemical (ocean acidification) and physical characteristics (thermal stratification) of marine systems, increased harmful algal blooms, the spread of invasive species, habitat loss (especially coastal wetlands), species migrations, and changes in population dynamics among marine and coastal species. These biogeophysical effects will, in turn, have a direct and indirect socio-economic impact on tourism, human settlements, agriculture, freshwater supply and quality, fisheries, financial services, and human

health in the coastal zone (Nicholls, 2004; Nicholls et al., 2011).

With the release of the IPCC's Fifth Assessment Report (AR5), climate change has again been identified as an important driver of change. The countries of the Mediterranean region, one of the main climate change hot-spots (Giorgi, 2006), are already witnessing the effects of CV&C in coastal zones and watersheds, which include water stress, desertification, biodiversity decline and extreme climate events, such as floods and droughts that cause significant loss and damage. In the coming decades, climate change will inflict even greater damage, especially on developing countries that are particularly vulnerable to the adverse effects of climate change. Therefore, it is critically important to understand and investigate further the impact that CV&C will have on coastal zone populations, activities, natural resources, and the marine and coastal biodiversity of the Mediterranean.

This section provides an overview of the observed and projected impacts of climate change on key economic sectors in the Mediterranean region.

### The impact of CV&C on agriculture

Climate change is already making an impact on agriculture in the Mediterranean region (Peltonen-

Sainio et al., 2010; Olesen et al., 2011). Projected climate changes are expected to continue to affect agriculture in the future through direct effects on water resources and irrigation requirements, crop growth conditions, crop productivity and distribution, agricultural pests and diseases, and the conditions for livestock production. These impacts will generate altered land-use patterns and will trigger widespread economic effects.

The most obvious negative impacts of climate change on agriculture coming out of the literature (Climate Water Project<sup>30</sup>; WASSERMED project<sup>31</sup>; EEA Report, 2010; Iglesias et al., 2011; Olesen et al., 2011) review are:

- Climate change is projected to improve the suitability for crop production in northern Europe and to reduce crop productivity in large parts of the southern Mediterranean. Projections based on different climate models agree on the direction of the change but with some variation in its magnitude.
- The extension of the areas suitable for cultivation into the northern latitudes and higher altitudes and the overall lengthening of the cultivation season could especially bring benefits to the northern Mediterranean countries.
- Increased water requirements are expected to be most acute in southern Europe and the southern Mediterranean, where the suitability for rain-fed agriculture is projected to decrease and irrigation requirements are projected to increase.
- Changes in crop phenology have been observed, such as the advancement of flowering and harvest dates in cereals. These changes are expected to continue in many regions, leading to reductions in grain yield.
- The frequencies of drought may become regular, and not only in semi-arid countries. As part of a causal chain, drought leads to further negative effects on agriculture, such as loss of crops and animal stock, loss of arable land and

desertification, which is already affecting several countries.

- Recent heat waves and droughts have greatly reduced some crop yields. The projected increase in the occurrence of such events would be especially detrimental to crop production in central and southern Europe and the southern Mediterranean, where such events will occur even more frequently and add to current stresses.
- Extreme climatic events, including droughts and heat waves, have negatively affected crop productivity in the first decade of this century, and they are expected to increase yield variability further as the climate changes.
- Climate change, and especially higher air temperatures, will create conditions suitable for the invasion of weeds, pests and diseases that are adapted to warmer climatic conditions.
- Increasing temperatures may also increase the risk of livestock diseases by supporting the dispersal of insects, enhancing the survival of viruses from one year to the next, and by improving conditions for new insect vectors that are now limited by colder temperatures.
- Loss of arable lands due to salinization caused by sea water intrusion due to sea-level rise and increased use of irrigation is expected to increase in the future.

A recent overview of the main problems resulting from climate change that will affect agricultural production in the Mediterranean area (Skuras and Psaltopoulos, 2012) showed that yields will be subjected to the combined effects of changes in temperature, rainfall and atmospheric CO<sub>2</sub> concentration. Future climate change can lead to yield decreases or increases, depending on crop type and with considerable regional differences across the Mediterranean.

In rainy areas, which in certain regions of North Africa represent more than 90% of total agricultural land, crop yields are expected to fluctuate more widely over time and to converge on a significantly lower long-term average. Recent studies estimate that agricultural output in the Mediterranean region as a whole will decrease (in value terms) 21% by 2080, with peaks of an almost 40% decrease in countries like Morocco and Algeria.

<sup>30</sup> <http://www.climatewater.org/> Bridging the gap between adaptation strategies of climate change impacts and European water policies.

<sup>31</sup> WASSERMED – Water Availability and Security in Southern Europe and the Mediterranean.

In the southern Mediterranean increases in CO<sub>2</sub> will help to reduce the loss in yields because of a warmer and drier climate, but it will not be possible to recover the losses completely. However, this likely “fertilization” impact of increased CO<sub>2</sub> concentrations still has not been verified and is subject to debate.

In areas with significant productivity losses, such as the south Mediterranean, and with the agricultural sector still playing a significant role in the overall economy, changes in gross domestic product (GDP) are expected to be negative and significant, especially under the A2 scenario (Figure 2.2).

The WB - Morocco study on the impact of climate change on the agricultural sector (Gommes et al., 2009) showed that the impact of climate change on rain-fed durum wheat yield (without technological trends) will be moderate until 2030 but severe beyond, according to scenario A2 (Figure 2.2).

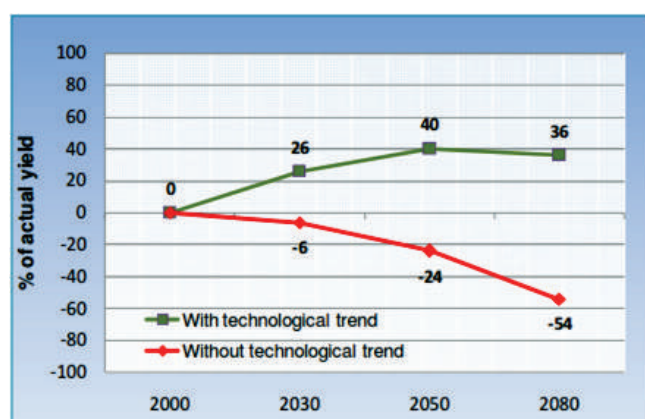


Figure 2.2: Impact of climate change on rain-fed durum wheat yield in Morocco according to scenario A2 (Gommes et al., 2009)

### Impact of CV&C on fisheries

This section gives an overview of the observed and projected impacts of climate change on fisheries and aquaculture from published reports (FAO, IUCN, MedPan, EEA, IPCC AR5, Circle-Med project<sup>32</sup>, MedSea project<sup>33</sup>) and papers. Key impacts are summarized in Box 2.1 that follows.

It is extremely difficult to predict how climate change may affect fish stocks and the fishing industry, particularly given the present stresses on fish stocks. Wild fish stocks seem to be responding

to warming conditions both physiologically and ecologically. Warming waters are expected to affect fish distribution, migration patterns, phenology (timing), food availability and recruitment. In response, the geographical distribution and productivity of fish stocks could be changing (Simpson et al., 2011). On a global scale, projections of changes in total catch of marine fish and invertebrates as a consequence only of climate warming has shown the possibility of a large-scale redistribution of global catch potential with an increase in high latitude regions and a decline in the tropics. However, the effects of climate change, in particular sea warming, on wild fish distribution are difficult to distinguish from those of high exploitation rates or technological developments. In the Mediterranean fisheries are already overfished (89% of stocks) or fully exploited. Increases in salinity and seawater temperatures and the spread of invasive species will further affect these fisheries.

According to the International Union for the Conservation of Nature (IUCN) and MedPan (2012), the increase in sea temperature detected in the last three decades in the Mediterranean (about 1°C in the NW Mediterranean) is driving profound and large-scale changes in coastal fish assemblages. Typical southern species<sup>34</sup> are now spreading northward into the coldest parts of the Mediterranean. It seems that by the end of the century, the coldest areas of the Mediterranean Sea (the Adriatic Sea and the Gulf of Lyon) are likely to become the only refuges for cold-water species and, in the worst-case scenario, they could become a dead end, driving endemic species to extinction.

<sup>32</sup> Circle -Med Project : <http://www.circle-med.net/>

<sup>33</sup> <http://medsea-project.eu/>

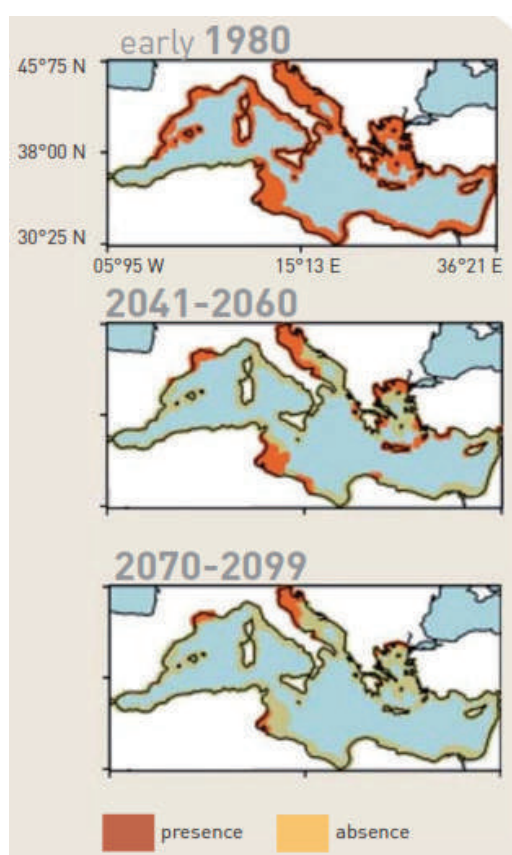
<sup>34</sup> Such as the ornate wrasse *Thalassoma pavo*, the Mediterranean parrotfish *Sparisoma cretense* and the barracuda *Sphyraena viridensis* (Source: IUCN/MedPan, 2012).



### Box 2.1: Impact of climate change on fisheries and aquaculture

The key findings from the recently released Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) reveal the growing threat of climate change to fisheries and aquaculture.

- Climate change and acidification are altering ocean ecosystems in profound ways, with consequent impacts on fisheries and aquaculture.
- Projected impacts of climate change on fisheries and aquaculture are negative on a global scale.
- Major impacts include displacement of stocks and, for aquaculture, mortality of shellfish from acidic water. Impacts of climate change and ocean acidification are generally exacerbated by other factors such as overfishing, habitat loss and pollution.
- This is contributing to an increase in the number of “dead zones” in the ocean, as well as to an increase in harmful algal blooms.
- Coral reef ecosystems are declining rapidly, with the risk of potential collapse of some coastal fisheries. Incidences of coral bleaching are likely to increase.
- Aquaculture may be affected through reduced catches of feed-fish and increasing severity of tropical storms and flooding.



Based on a physical oceanographic simulation published in Somot et al. (2006), Ben Rais Lasram et al. (2010) mapped the evolution of the potential habitats of 75 essentially coastal endemic species in the Mediterranean to the year 2100. Figure 2.3 shows their results. In the case of the IPCC's A2 scenario for the skadback (*A. kessleri*), a species of fish that today can be found throughout the Mediterranean, the data shows that by 2099, 90% of its favorable habitats will have gradually disappeared. Under the same A2 scenario, the superficial water temperature will have risen by 3.1 degrees in the period from 2070 to 2099. The habitats will be reduced for 50 of the endemic species under consideration and 14 of them will most likely disappear.

Figure 2.3: Evolution of the range of the skadback (*Arnoglossus kessleri*) in the Mediterranean through the 21<sup>st</sup> century in scenario A2 (Ben Rais Lasram et al., 2010). From CIRCLE-MED.

In addition, with the proliferation of non-indigenous invasive species, certain native species may be outcompeted or replaced. The latest reviews of Mediterranean species list more than 140 non-indigenous fishes, including both Atlantic species that have entered through the Strait of Gibraltar and Lessepsian species that have come from the Red Sea through the Suez Canal.

It is also speculated that ocean acidification may eventually have an impact on the lowest levels of the food web, which ensures availability of food for fish, and hence have an impact on fish productivity. Before 2100, the surface waters of the Mediterranean Sea will suffer sharp reductions in carbonate ion concentrations (– 37%).

Global warming also reduces the supply of nutrients to superficial waters by reinforcing the water column's stratification. This nutritional weakening limits the primary production processes in the column and encourages the spread of "ocean deserts" (Polovina et al., 2008). The decrease in oxygen concentration in sea waters could aggravate the effects of the eutrophication of coastal waters to the point of anoxia (Diaz and Rosenberg, 2008).

Nevertheless, not all climate change impacts will necessarily be negative. Redistribution of fish stocks may mean that one country's loss is another's gain and that markets would have to explore other target species rather than those currently sold. However, these trends, along with modifications of the life cycles of target fishes, are already threatening traditional fishing practices.

On the other hand, climate change may create new opportunities for marine aquaculture, in particular by raising warm-water species in previously unsuitable locations (EEA, 2012). However, aquaculture depends on coastal habitats that will be potentially affected by climate change, such as extreme weather events, which may pose a risk to infrastructures and to sea-level rise-induced changes in shoreline morphology that may change the location of habitats suitable for the industry. Coastal aquaculture will also be exposed to major economic losses from red tides the frequency and severity of which are likely to increase (Roessig et al., 2004).

### **Impact of CV&C on coastal tourism**

The Mediterranean region is by far the largest global tourism destination, attracting almost a third of the world's international tourists and generating more than a quarter of international tourism receipts, which is estimated to contribute about 10% of GDP and employment (Magnan et al., 2012). According to United Nations World Tourism Organization (UNWTO, 2013), the Mediterranean region will reach 500 million international tourist arrivals by 2030 and for the period 2010–2030 the tourism sector in Mediterranean Africa (4.6% a year), the Middle East (4.5%) and the emerging economies of Europe (4.1%) is expected to significantly outgrow the advanced economies of Europe (1.6%). Tourism in the Mediterranean is predominantly concentrated along the coastal strip

(40% of which is built up), and peaks during the summer season.

The tourist industry is by nature very fragile and dependent on political, economic and social changes and the probability of climate change adds another element of uncertainty to the planning of future development. The Mediterranean region is considered as a tourism vulnerability hotspot (Figure 2.4). Tourism in this region is particularly vulnerable to global climate change since climate is one of the most important natural assets in this region.

All tourism destinations are climate sensitive and can be affected positively or negatively by CV&C that brings heat waves, unseasonable cold, drought, storms, and heavy rain. These weather conditions can affect not only tourist comfort and safety, but also the coastal ecosystems that attract tourists (e.g., coral reefs, beaches and dunes, lagoons and estuaries) or deter them (e.g., infectious disease, wildfires, storm surges, heat waves, insect and water-borne pests). CV&C also influences various facets of tourism operations (e.g., water supply and quality, particularly on islands and in more arid coastal areas, heating-cooling costs, food supply through agriculture) and activities (diving, fishing). Unexpected algal and jellyfish blooms can also affect tourism preventing swimming and other water activities and can be dangerous to human health.

In the long term, coastal erosion, flooding and habitat loss due sea-level rise could significantly affect tourist access to beaches, which often drive tourism demand, calling for long-term planning solutions. Given that many coastal ecosystems and coastal destinations already face substantial human pressure, it is of great importance to integrate these expected changes into coastal planning.<sup>35</sup>

The Fourth Assessment Report of the IPCC stated that "higher summer temperatures may lead to a gradual decrease in summer tourism in the Mediterranean" (Parry et al., 2007). But otherwise increased temperature could extend tourist seasons and opportunities to other coastal destinations.

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<sup>35</sup>"Coastal Tourism in the Mediterranean: Adapting to Climate Change" seminar. Cagliari (Sardinia), Italy, 8-10 June 2009.

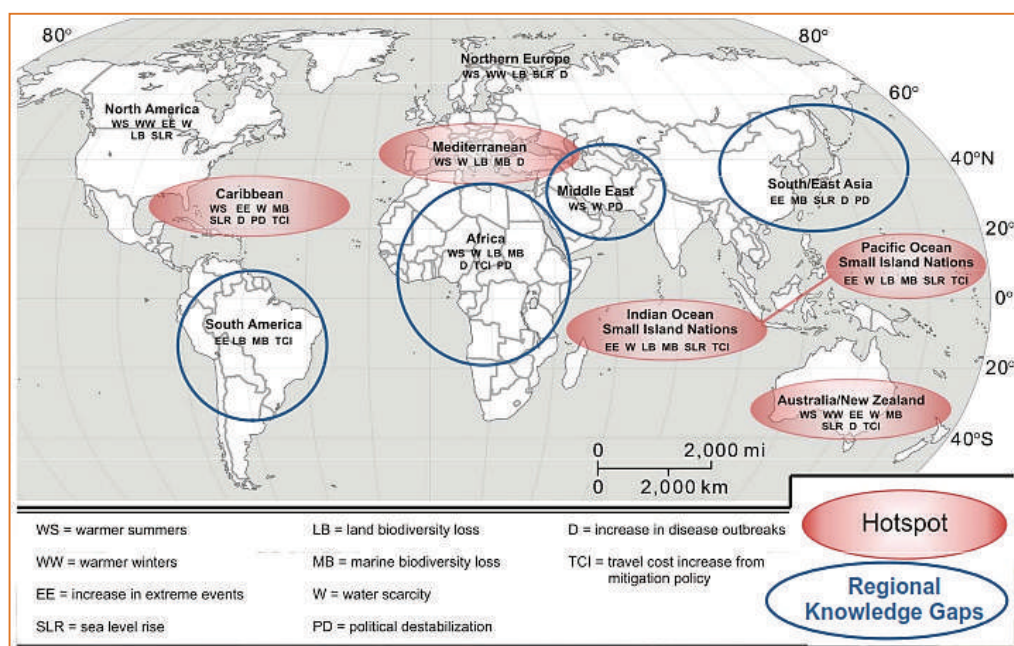


Figure 2.4: Tourism vulnerability “hotspots” (Source: UNWTO/UNEP, 2006)

Most of the analysis that examined the suitability for tourism of current and future climatic conditions in the Mediterranean is based on the use of the Tourism Climatic Index (TCI), devised by Mieczkowski (1985). This index is a composite measure for systematically assessing the climatic elements that are most relevant to the quality of the tourism experience for the “average” summer tourist. It uses a weighted aggregate of several climate variables (maximum and mean daily temperature, humidity, precipitation, sunshine and wind) to assess human comfort for general outdoor activities.

Existing studies (Amelung and Moreno, 2009, 2012; Ciscar et al., 2009) indicate that there will be a regional and seasonal shift in tourism flows, resulting in an alternative distribution of tourism-generated income. The CIRCE Project<sup>36</sup> addressed to some extent the vulnerability of coastal tourism in the southern Europe (Magnan et al., 2012). The findings suggest that projected climate change will decrease tourism flows from the north to the south of Europe and increase flows within the north of Europe. Climate change may generate positive effects for tourism in most northern Mediterranean countries, at least in the medium term. The reason

is because much of the tourism in the area is related to outdoor activities in the summer, which actually benefit from higher temperatures and reduced precipitations.

Results from WASSERMed project indicate that conditions will remain favourable for outdoor activities in the Mediterranean basin. However, a change in seasonality is foreseen, as there is an improvement in TCI values in the spring and autumn and a deterioration in the summer. In particular, negative impacts for summer tourism are predicted for the southern Mediterranean countries, while the situation is different for northern countries, where an improvement in TCI values is noticed throughout the year.

In the recent CLIM-RUN project,<sup>37</sup> the mean TCI was calculated for nine different models in summer for the period 2021-2050 and compared to the 1971-2000 period (Figures 2.5 and 2.6). The results suggest that in the near future (2021-2050), the TCI will on average increase north of 45°N and will decrease further south (Fig. 2.5). The change in the TCI (Fig. 2.6) is weak and does not show any gain in the number of days greater than 70 north of 45°N. On the other hand, the number of days greater than 70 is decreasing south of 45°N with the strongest decrease in northern Africa. The change in the summer TCI in the period 2021-2050

<sup>36</sup> The CIRCE project: “Climate Change and Impact Research: the Mediterranean Environment”. <http://www.iefc.unibocconi.it/wps/wcm/connect/7ed0e897-59bc-49e7-8f45-f812e76c53c3/Roson+22+marzo.pdf?MOD=AJPERES>

<sup>37</sup> CLIM-RUN Project (2011-2014) <http://www.climrun.eu/>



compared with 1971-2000 (averaged over nine models) indicates a decrease in the TCI around the Mediterranean basin and North Africa in the future. An increase in the TCI is found in northern Europe.

Another study (Rutty and Scott, 2013) surveyed the climatic preferences of potential travellers from northern Europe for summer tourism at 10 beach and urban destinations to the Mediterranean. The study suggests that only in the medium (2046–2065) and long term (2080–2099) would destinations gradually become “unacceptably hot” during the peak summer months for this target group. It also indicates that in the long term there is a potential for a much longer warm weather tourism season as the selected destinations would no longer be considered as “unacceptably cool” during the Mediterranean’s current shorter seasons of spring and autumn.

On the economic level, the impact of climate change on tourism will be beneficial for the eight countries located on the northern side of the Mediterranean. In contrast, the other 14 countries will lose (up to 31% for Cyprus) (Bigano et al., 2008). According to a 2012 EEA report, the economic effects of climate change on tourism depend very much on whether holiday seasons in Europe remain fixed or would possibly shift. With a more flexible timing of travelling, climate change could benefit the tourist industry in the Mediterranean by evening out demand, reducing the summer peak while increasing occupancy in the spring and autumn, which become climatically more suitable. However, without such adjustments the European and Mediterranean tourist industries are projected to be very negatively affected by climate change.

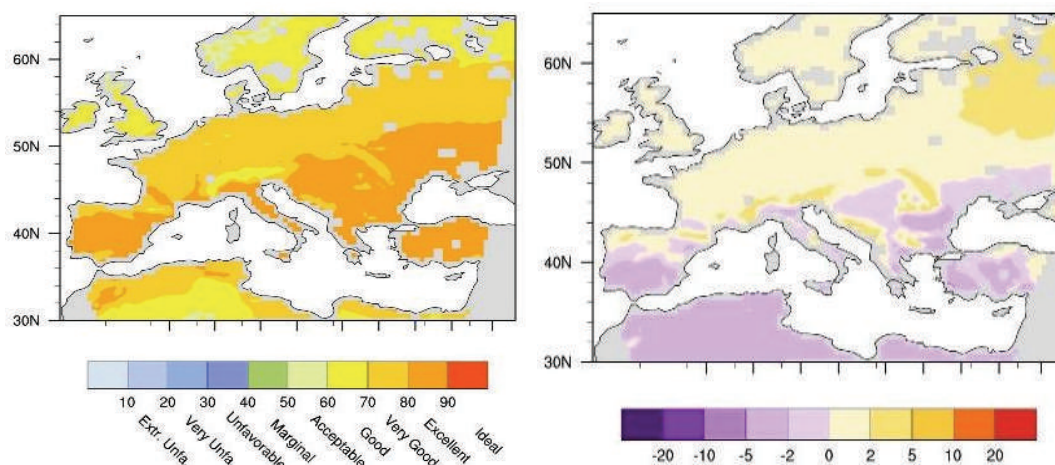


Figure 2.5: Left: TCI calculated for the ENSEMBLES mean for the period 1971-2000 in the summer season. Right: Number of days when the TCI was greater than 70 in the summer season for the period 1971-2000

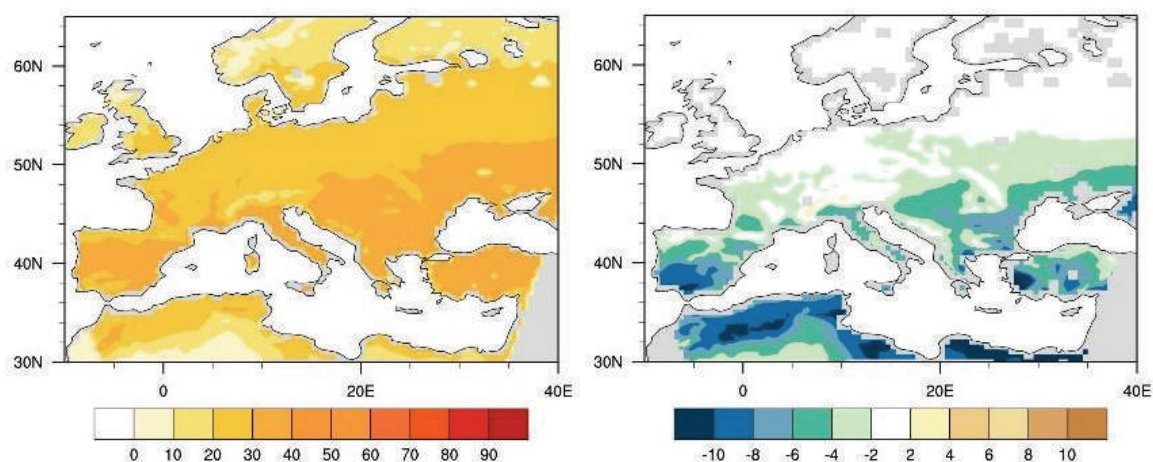


Figure 2.6: Left: Change of the TCI for the period 2021-2050 compared to the 1971-2000 period (Ensemble mean). Right: Change in the number of days with a TCI greater than 70 in the summer season for the period 2021-2050 compared to the 1971-2000 period.



## Impact of CV&C on coastal population and land

Human settlement has long been drawn to coastal areas, which provide many resources and trading opportunities but also expose residents to a range of hazards, including coastal flooding (Small and Nicholls, 2003). Both urban disasters and environmental hot spots are already located in low-lying coastal areas (Diley et al., 2005). Climate change will increase the risk of both. In particular, rising sea levels will increase the risk of floods, and stronger storms may further increase the flood risk (Small and Nicholls, 2003).

Science-based climate scenarios (like those of the IPCC) suggest that with the current predictions, climate change will probably result in more flood events combined with erosion in many regions. Without adaptation, a rise in sea level will inundate and displace wetlands and lowlands, erode shorelines, exacerbate coastal storm flooding, increase the salinity of estuaries, threaten freshwater aquifers, and otherwise have an impact on water quality and infrastructure. Areas most at risk would be tidal deltas, low-lying coastal plains, beaches, islands (including barrier islands), coastal wetlands and estuaries.

The population of Mediterranean countries has been steadily increasing over the last 50 years. It doubled from 240 million in 1960 to 480 million in 2010 and is expected to reach 529 million by 2025. More than one-third of this population lives in coastal administrative units that cover less than 12% of the surface area of the Mediterranean countries.

The population of the coastal regions grew from 95 million in 1979 to 143 million in 2000 and could reach 174 million by 2025 (UNEP/MAP, 2012). The concentration of people in coastal cities is heaviest in the western Mediterranean, the western shore of the Adriatic Sea, the eastern shore of the Levantine region, and the Nile Delta. In the southern Mediterranean countries the concentration of population in the coastal zone varies from one country to another ranging from more than 1,000 people/km<sup>2</sup> in the Nile Delta to fewer than 20 people/km<sup>2</sup> along parts of the Libyan coast (See Figure 2.7). The coastal urban population is expected to increase by 33 million (30 million of that increase in the south and east) between 2000 and 2025 and (UNEP/MAP, 2012).

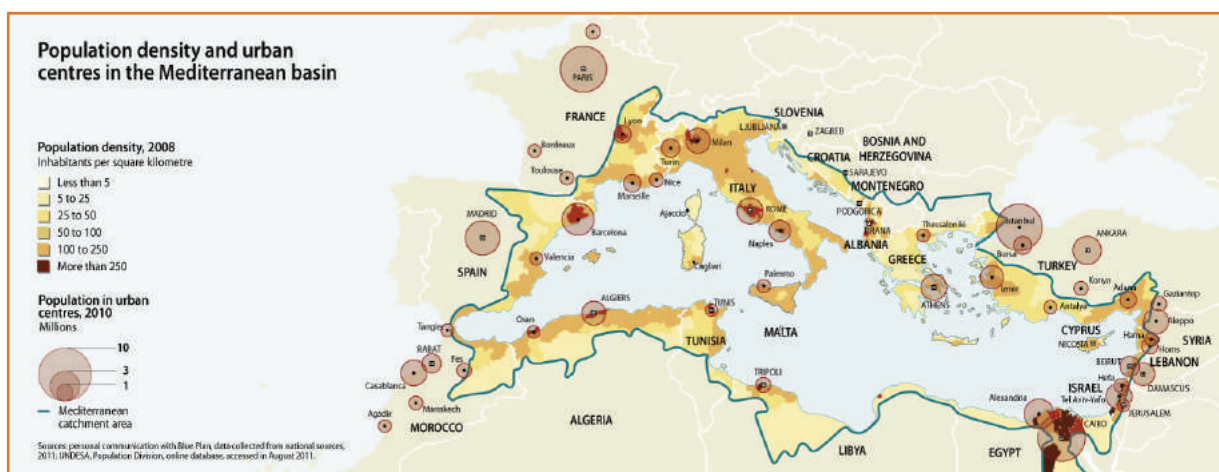


Figure 2.7: Population density and urban centres in the Mediterranean basin (Source: UNEP/MAP, 2012)

Mediterranean coastal areas are already under strong pressures from urbanization, coastward migration of people, tourism, intensive irrigated agriculture, dam building, industries, and port facilities. Human-induced drivers are the primary means of change in coastal aquifers, lagoons, estuaries, deltas, and wetlands, but climate-

induced drivers are likely to aggravate existing problems and to create new risks.

The PESETA project<sup>38</sup> estimated that up to an additional 1.6 million people each year in the northern Mediterranean, and northern and

<sup>38</sup> <http://peseta.jrc.ec.europa.eu/>

western Europe will experience coastal flooding by 2080 under the SRES A1FI scenario, unless additional adaptation measures are undertaken. The number of people affected by coastal flooding in the EU ranges between 775,000 to 5.5 million people, depending on the emissions scenario (Ciscar et al., 2011).

Simulations for sea-level rise (SLR) conducted in the North African countries (in Tolba and Saab, 2009) showed that under the 1 m SLR scenario,

approximately 41,500 km<sup>2</sup> of the territory and at least 37 million people (11%) would be directly affected by the rise of the sea level. In the extreme case of 5m SLR, such an impact will be at its highest, as it is estimated that up to 113,000 km<sup>2</sup> (0.8%) of coastal territory would be inundated by seawater. However, the potential impacts of SLR are not uniformly distributed across the region. See Figures 2.8 and 2.9.

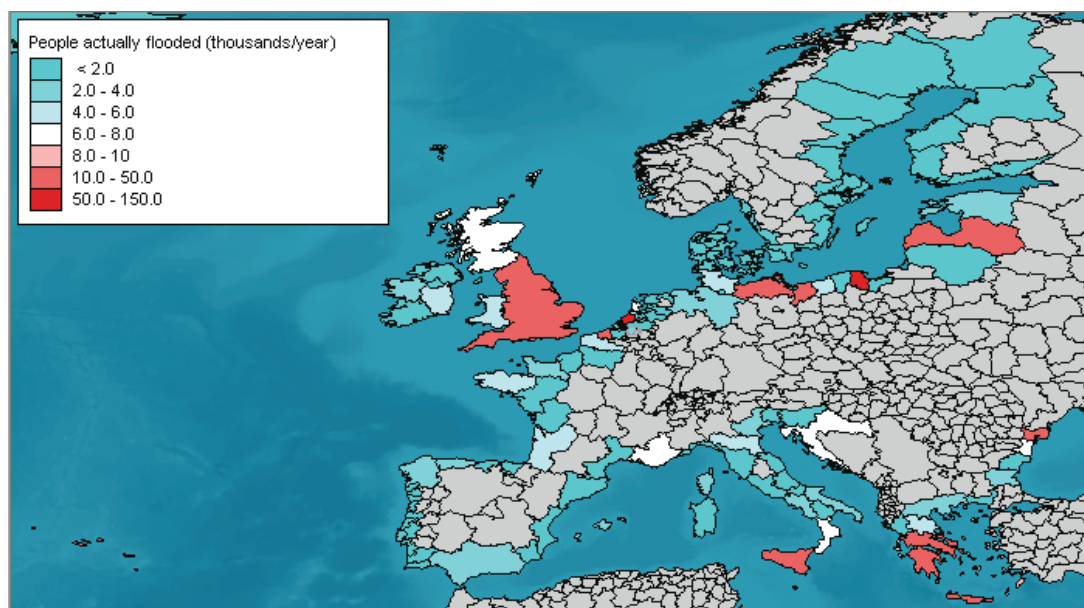


Figure 2.8: People actually flooded (thousands/year) across Europe, for the A2 scenario, 2080s (ECHAM4), without adaptation (UE, 2009)

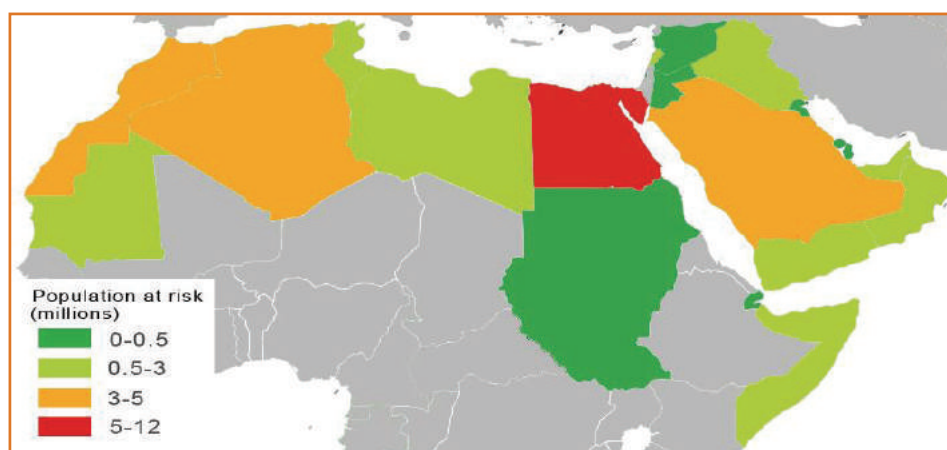


Figure 2.9: Population at risk at an extreme five-metre sea-level rise (Tolba and Saab, 2009)

According to the study “Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes” carried out by the Organization for Economic Co-operation and Development (Nichols et al., 2008), 14 Mediterranean port cities with more than 1 million inhabitants are considered at increasing risk from severe storm-surge flooding,

rising sea levels and local land subsidence. The risk is also increased by poorly planned development, which often brings more people into vulnerable areas. More than 1.5 million people living in Mediterranean port cities are exposed to a once in a century coastal flood event. The top six Mediterranean cities in terms of exposed

population are estimated to be Alexandria – by far the most exposed with more than 1.3 million people at risk – Istanbul, Benghazi, Casablanca, Izmir and Algiers. The UNHABITAT State of Arab Cities (2012) Report<sup>39</sup> also highlighted climate change-induced extreme weather and sea-level rise as key challenges for southern and eastern Mediterranean cities.

The analysis carried out by Dasgupta et al. (2009a) on the potential impacts of increasing frequencies and severities of storm surges in the MENA region (Table 2.3), indicated that, while the land area of the MENA region would be less impacted by SLR than the developing world generally (0.25% vs. 0.31% with a 1 m SLR), all other indicators suggest more severe impacts of SLR in this region. In particular, with a 1 m SLR, 3.2% of its population would be impacted (vs. 1.28% worldwide), 1.49% of its GDP (vs. 1.30% worldwide), 1.94% of its urban population (vs. 1.02% worldwide), and 3.32% of its wetlands (vs. 1.86% worldwide).

The increased impact on agricultural areas is significant for the MENA region primarily because the amount of Egyptian and Algerian cropland in

surge zones would increase from the existing estimated 212 km<sup>2</sup> to approximately 900 km<sup>2</sup> with SLR and intensified storm surges. The percentage increase in surge regions for MENA countries is shown in Figure 2.10.

Overall, by the end of the century, coastal flooding in the south Mediterranean is expected to worsen as sea levels rise (Brown et al., 2011). In Egypt, sea-level rise of 1 m combined with more intense storm surges could affect 15% of the country's coastal population (Dasgupta et al., 2009a). The impact of coastal flooding may be particularly severe around the Nile, where 25% of the delta could be inundated (Fitzgerald et al., 2008; Dasgupta et al., 2009b). Even a smaller sea-level rise of 0.5 m is likely to mean severe coastal flooding in Egypt, particularly in the Nile delta (Dasgupta et al., 2009b; El-Raey 2011; EEA 2010). See Figure 2.11.

Finally, climate change will manifest itself in altered regimes of natural hazard occurrence, and therefore can be conceptualised as a disaster management issue. Strategic land-use planning is a critical tool to mitigate and adapt to hazardous events.

*Table 2.3: Impacts of sea-level rise: Middle East and North Africa region (Dasgupta et al. 2009b)*

	1m	2m	3m	4m	5m
<b>Area (Total = 10,050,556 sq. km.)</b>					
Impacted area	24,654	33,864	43,727	53,615	63,120
% of total area	0.25	0.34	0.44	0.53	0.63
<b>Population (Total = 259,396,000)</b>					
Impacted population	8,307,472	10,912,744	13,684,993	16,454,655	19,439,678
% of total population	3.20	4.21	5.28	6.34	7.49
<b>GDP (Total = 1,404,470 million USD)</b>					
Impacted GDP (USD)	20,870	30,365	39,037	46,209	54,853
% of total GDP	1.49	2.16	2.78	3.29	3.91
<b>Urban extent (Total = 190,030 sq. km.)</b>					
Impacted area	3,679	5,037	6,529	7,951	9,384
% of total area	1.94	2.65	3.44	4.18	4.94
<b>Agricultural extent (Total = 354,294 sq. km.)</b>					
Impacted area	4,086	6,031	8,007	9,819	11,451
% of total area	1.15	1.70	2.26	2.77	3.23
<b>Wetlands area (Total = 342,185 sq. km.)</b>					
Impacted area	11,361	14,758	18,224	21,417	24,277
% of total area	3.32	4.31	5.33	6.26	7.09

<sup>39</sup> <http://www.citiesalliance.org/sites/citiesalliance.org/files/SOAC-2012.pdf>

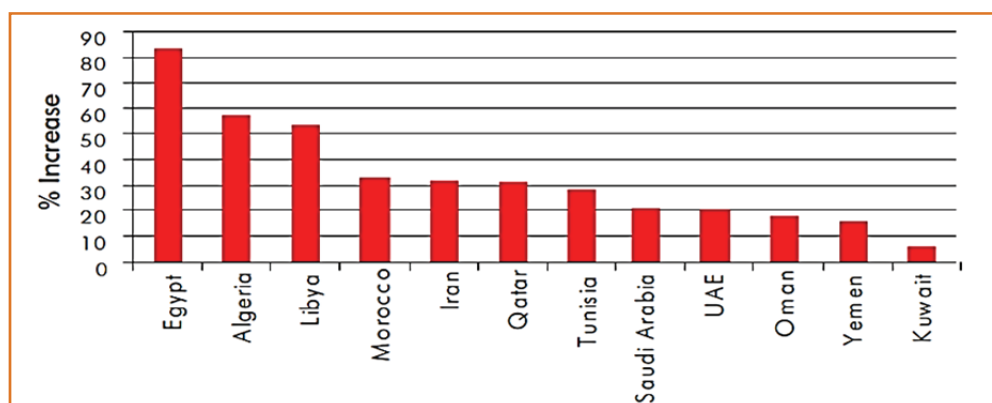


Figure 2.10: Percentage increase of impact of storm surges in the coastal zone of Arab countries (Dasgupta et al., 2009)

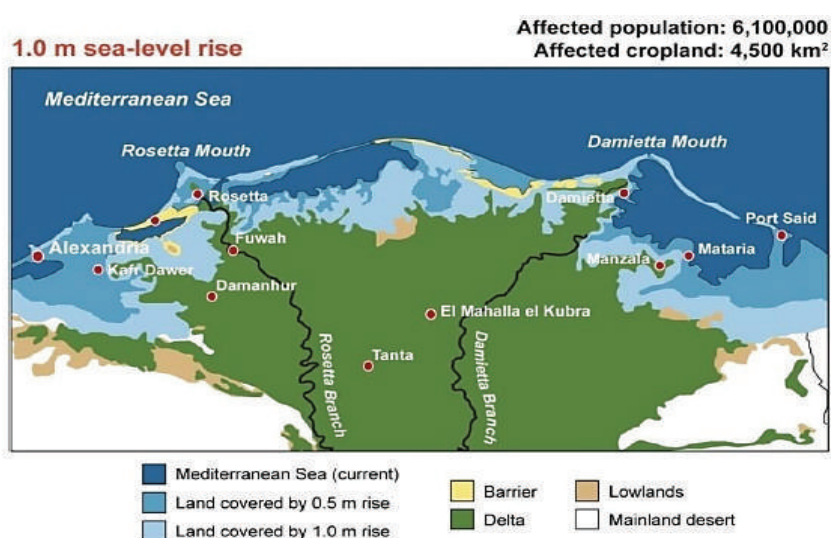


Figure 2.11: Potential direct inundation of the Nile Delta region with two scenarios for sea-level rise indicating vulnerable cities of the delta (Fitzgerald et al., 2008)

## 2.2 Building the future

This section has laid out the relevant information on the impacts of CV&C in coastal zones in some detail. We now discuss below how this information will be used.

Policies and priorities for actions that will be taken based on the above information will take into account their effects on all three pillars of sustainable development: economic, environmental and social. The range of policies and options will be identified in the strategy, along with possible pilot actions and sources of funding. The selection of the actual policies and options will be made when drawing up the national and local plans (depending on whether the policies and options are local or national). At this stage, the elaboration of the pilot actions and sources of funding will be made.

The climate change factors to be discussed are of varying importance, depending on which sector or

area of policy is under consideration. We present those policy areas where climatic factors play an important role.

### Agriculture

The impacts on agriculture are of wider interest and relevance than just to a coastal community. Adaptation measures undertaken will include research and development on crop varieties better suited to the new climate, improved irrigation, where appropriate, and extension and other support to farmers to assist them to adapt to climatic changes. In coastal zones where water is already at a premium appropriate adaptation plans may differ from other areas and it is probably best that those responsible for ICZM participate actively in national agricultural adaptation programmes as well as in the planning for water allocation and management.



## Infrastructure

Sea-level rise and changes in extreme events have a direct bearing on coastal infrastructure. Fortunately, this is an area that is the most developed in terms of tools to assess the appropriate responses. In particular, the DIVA model has been used to estimate the required investment in coastal protection for different parts of the European coastline (Richards and Nicholls, 2009). The model looks at (i) the direct impacts of erosion, (ii) increased flood risk and inundation, (iii) coastal wetland loss and change, and (iv) salinisation. It estimates the best responses based on their costs and benefits. The responses include flood defences and beach nourishment but not all the softer options, such as insurance. The model has been applied to most of the European coastline, including the Mediterranean, but not to the Mediterranean countries of North Africa, the Middle East and parts of the Balkans. A detailed application of the model for a given coastal zone is presented in Section 5.

## Health

As with agriculture, this is an issue wider than just coastal zones, although the latter could be especially affected if there is an increase in vector borne diseases. Impacts of climate on health through contaminated food and water will require stricter controls on vendors. The ICZM needs to review its regulations and look at ways to improve health safety where required.

## Water

Adaptation to changes in water supply will take the form of reducing demand (measures that promote more efficient use, increases in water charges) and increases in storage and available supply. The latter could involve the building of reservoirs, runoff management capacities, plans for water allocation in periods of drought and even the transfer of water from surplus to deficit areas. There is also the option of building desalinisation facilities to meet water deficits. In coastal areas all of these could be relevant and need to be considered in the context of the ICZM, including the demand for water created by any plans to increase activities such as tourism. Tourism creates additional demands for water and energy. It is important to

anticipate that energy produced from hydropower in the future may decrease in the summer months, exactly when tourist zones need the most energy.

## Extreme Events

Increased risks of flooding and damage from heavy rains and winds have been identified in Stage 2.1 Building the Evidence. We are already witnessing more communities being affected by flash floods and storm surges. Although not all of these events can be attributed to climate change, their increased frequency is a good indicator of climatic effects. Appropriate actions will include land-use changes, improved flood and hurricane protection, and better insurance to provide coverage against damage. Many of these actions will also be considered at the national level, so plans should be drawn up in collaboration with national authorities. Current thinking on this issue is summarized in the Box 2.2 below (Henocque, 2011). It is worth noting that as a response to the Cairo overarching principle, the coastal setback zones stipulated under Article 8.2 of the Mediterranean ICZM Protocol is part of the “broader goal of preventing natural risks and adapting to climate change, and is a major tool to achieve this goal.”

## Tourism

For most coastal zones tourism is a key sector and the impacts of climate change on visitor numbers is critical information for planning and management in these areas. Studies have now been conducted on this topic. For a useful survey of the literature see Fischer (2007). The studies provide estimates of changes in numbers under different scenarios. For the Mediterranean the summary states that the region will be too hot during summer, but climatic conditions will improve during spring and autumn.

Considering the improving summer temperatures in northern Europe, it is likely that the Mediterranean and its related tourism industry will encounter a decrease (a dramatic decrease is forecast for Spain) in international tourist arrivals in summer and an increase during the spring and autumn, especially in Spain, Greece and Turkey, and the winter season will become more attractive in North Africa. More detailed figures are available in the references cited in this survey article.

In terms of planning, the data will determine the nature of the facilities and the volumes of visitors that can be expected. It will be a direct input into strategies for the kind of developments that are appropriate for each coastal zone. A number of models have been used to try and predict changes in tourism flows by country and season due to climate change. The results are varied, with some

models showing significant decreases in the Mediterranean region while others indicate the opposite. What is clear, however, is that there will be more competition from Northern Europe, where summers will be warmer and it will be more attractive for visitors to come to the Mediterranean in the shoulder seasons of April and October. Planning should take account of such changes.

#### *Box 2.2: Extreme Events and Climate Change in Coastal Zones*

In the aftermath of the 2004 tsunami in the Indian Ocean, UNEP/GPA (Global Programme of Action for the Protection of the Marine Environment from Land-based Activities) convened a meeting in February 2005 in Cairo (Egypt) to discuss post-tsunami reconstruction, coastal zone rehabilitation and management in the affected countries. The meeting adopted 12 guiding principles which were initially drafted by integrated coastal management practitioners. To a large extent, they encapsulate the approaches that seek to reduce coastal area vulnerability to both man-made and natural hazards. These principles were endorsed by senior government officials from tsunami-affected countries, representatives from the UNEP Regional Seas Programmes, and other UN agencies including FAO and IOC-UNESCO, and by international institutions such as IUCN, the World Bank and the WWF.

The 12 principles are:

1. Overarching principle: Reduce the vulnerability of coastal communities to natural hazards by establishing a regional early warning system, applying construction setbacks, greenbelts and other no-build areas in each nation, founded on a scientifically mapped "reference line."
2. Promote early resettlement with provisions for safe housing, debris clearance, potable water, sanitation and drainage services; and access to sustainable livelihood options.
3. Enhance the ability of the natural system to act as a "bioshield" to protect people and their livelihoods by conserving, managing and restoring wetlands, mangroves, spawning areas, sea grass beds and coral reefs; and by seeking alternative sustainable sources of building materials, with the aim of keeping coastal sand, coral, mangroves and rocks in place.
4. Promote design that is cost-effective, appropriate and consistent with best practices and placement of infrastructure away from hazard and resource areas, favouring innovative and soft engineering solutions to coastal erosion control.
5. Respect traditional public access and uses of the shoreline, and protect religious and cultural sites.
6. Adopt ecosystem-based management measures; promote sustainable fisheries management in over-fished areas, and encourage low-impact aquaculture.
7. Promote sustainable tourism that respects setback lines and carrying capacity, benefits local communities and applies adequate management practices.
8. Secure commitments from governments and international organizations to abide to these Principles and build on and strengthen existing institutional arrangements where possible.
9. Ensure public participation through capacity building and the effective utilization of all means of communication to achieve outcomes that meet the needs and realities of each situation.
10. Make full use of tools such as strategic environmental assessment, spatial planning and environmental impact assessment, to identify trade-offs and options for a sustainable future.
11. Develop mechanisms and tools to monitor and periodically communicate the outcomes of the reconstruction through indicators that reflect socio-economic change and ecosystem health.
12. Widely disseminate good practices and lessons learned as they emerge.

## Ecosystems

The impacts on ecosystems are very location specific. Studies under the CIRCE Project identify low flows in rivers as an important impact, but consequences on marine systems and fisheries can also be expected. This is an area where those responsible for the ICZM should undertake a local assessment, drawing, of course, on the existing literature.

Information collected at the analysis stage will influence the measures that must be introduced. Some downscaling of impact assessment using models will probably be required. Funding for this effort may be available from global funds. For rivers, low flow alleviation may be required to avoid loss of recreation services and risks to species. For marine areas, protection of new areas may be advisable and some measures may be needed to protect fisheries.

The information about future scenarios is divided into giving story lines B1, B2, etc. and giving more recent socio-economic scenarios. As both are used in the literature, we provide a description of each. The storylines B1, B2, etc. are referred to in Table 2.2.

### The A-B Storylines

**B1.** The B1 storyline and scenario family describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

**B2.** The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

**A2.** The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in a continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

**A1.** The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil-intensive (A1FI), non-fossil energy sources (A1T) or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

### The Socio-economic Scenarios - Shared Socio-economic Pathway (SSP)

Each Shared Socio-economic Pathway (SSP) is made up of a qualitative narrative associated with quantified measures of development. Five SSP narratives (Figure 2.12) were developed: sustainability, middle of the road, fragmentation, inequality and conventional development pathways.<sup>40</sup> The different narratives span the space of possible futures in terms of the evolution of society and natural system in the coming century.

SSP 1 (Sustainability), SSP 3 (Fragmentation) and SSP 5 (Conventional Development) have been selected as scenarios in WISE up as they cover a broad and representative range of possible futures.

- **SSP 1 Sustainability** – This pathway is characterised by reduced inequalities globally and within countries as low income countries

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<sup>40</sup> O'Neill, et al., 2012

develop at a rapid rate and a high level of education is achieved globally. Low global population growth is associated with consumption oriented toward low energy intensity goods and low animal product consumption. This is partly enabled by a fast-paced and environmentally-friendly technological development. Reduced fossil fuel dependency and rapid, clean energy technological development is concurrent with a high level of environmental awareness. Environmental governance is successful at achieving global and implemented agreements. The Millennium Development Goals are achieved within the next decade or two.

- **SSP 2 Middle of the road** – Current trends continue with some progress towards the Millennium Development Goals, lower energy and material intensity consumption and lower fossil fuel dependency. There is an unequal development rate between low income countries and a persistence of global and in-country inequalities. Low level of investment in education prevents low population growth. Global governance achieves an intermediate level of environmental protection.
- **SSP 3 Fragmentation** – This world is fragmented into marginalised and poor regions, countries struggling to maintain their living standards and pockets of moderate wealth. There is little progress towards achieving the Millennium Development Goals, lower energy and material intensity consumption and lower fossil fuel dependency. Inequalities are increasing. There is a low level of investment in education and clean technologies along with policies oriented towards security and barriers to trade that slow economic growth. Population growth is high and drives up unmitigated emissions. Global governance is weak and international aid is low leaving some populations vulnerable to climate change.
- **SSP 4 Inequality** – This world is characterised by high inequalities globally and within

countries. A small, wealthy elite is responsible for most emissions and has a low incentive to mitigate them, while the larger poor population is vulnerable to climate change impacts, especially since global institutions are ineffective. There is no clean technology development.

- **SSP 5 Conventional Development** – This pathway illustrates a world where conventional development (economic growth and pursuit of self-interest in a liberalised world) is perceived as the solution to social and economic challenges. As a result, fossil fuel dependency deepens and mitigation challenges are high. The Millennium Development Goals are attained and robust economic growth, engineered solutions and highly managed ecosystems provide a certain level of adaptive capacity.

Each of these pathways comprises three drivers quantified at the national scale and at a five-year interval. **These drivers are population growth, urban population growth and economic growth.** The starting year for all projections is 2015 – the year 2010 corresponds to historic data. These parameters vary per SSP narrative and country up to the year 2100. The IIASA database provides estimates for projections of the five SSPs by country for all three drivers from different sources: IIASA, OECD and the UN.

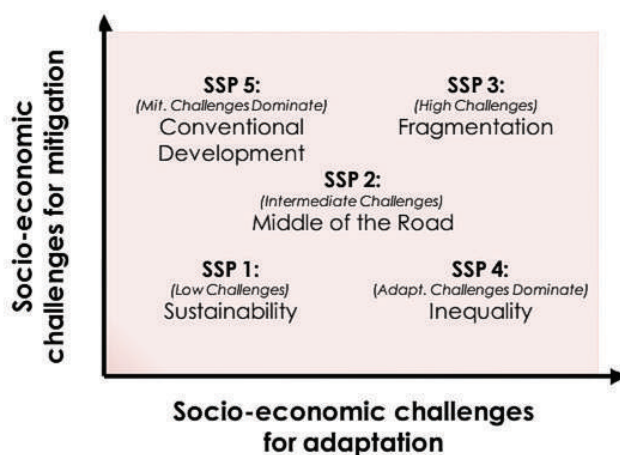


Figure 2.12: Socio-economic scenarios



## 3 Setting the Vision

The aim of this stage is to engage stakeholders in setting the priorities and agreeing on the key policies and measures that should be considered in the analysis stage.

### 3.1 Building consensus

#### Introduction to inclusive governance

The point of departure for this stage is the scoping report, which was prepared at the establishment stage. This report is discussed with stakeholders and amended in light of their reactions. Stakeholder consultations are also used to determine priorities.

Because of climate change's long-term and uncertain nature, responding to it may be particularly complex and contentious compared to other, more tangible modern environmental problems. For this reason coastal adaptation must be carried out as an inclusive, strategic and adaptive process for the assessment of climate change impacts, planning, implementation, and evaluation. A broad range of stakeholders including governments, private business, scientists and civil society organizations should be engaged at the start of the process to ensure ownership of adaptation interventions. They should be kept maintained not only during the project, but also afterwards through the appropriate long-term organizational and institutional arrangements to ensure more effective implementation and sustainability.

Such inclusive governance is based on the assumption that all stakeholders have something to contribute to the process of coastal adaptation through the ICZM process and that mutual communication and an exchange of ideas, will smooth the conflicts and improve the final decisions rather than impeding the decision-making process or compromising the legitimacy of policies. The benefits of widening participation to all interests involved in making a decision include improving local "ownership" of strategies and ensuring decisions meet the needs of citizens (Fletcher, 2003).

For instance, Article 14 of the ICZM Protocol devotes an entire section to the participatory process, envisioning the involvement of all stakeholders in the formulation and implementation of coastal and marine strategies, plans, programmes or projects to guarantee efficient governance of the ICZM process (Box 3.1).

Likewise, the climate protocols also emphasize the importance of inclusive processes to arrive at effective actions (Box 3.2).

Only if all these groups of actors are actively involved in a participatory manner can the process efficiently address the challenges of CV&C in coastal management and the development of successful community-based solutions. Concepts of good governance are important aspects in this regard through the provision of legal security, transparency, accountability and the freedom to express one's views (McLennan et al., 2014).

#### Box 3.1: "Participation" in the ICZM Protocol

Article 14 of the ICZM Protocol states that:

*"the Parties shall take the necessary measures to ensure the appropriate involvement in the phases of the formulation and implementation of coastal and marine strategies, plans and programmes or projects, as well as the issuing of the various authorizations, of the various stakeholders, including:*

- territorial communities and public entities concerned,
- economic operators,
- non-governmental organizations,
- social actors,
- the concerned public."

#### Box 3.2: Participation in the Cancun Declaration

The Conference of the Parties (COP) in Article 1.7 recognises the need to engage a broad range of stakeholders at the global, regional, national and local levels, be they government, including sub-national and local government, private business or civil society, including youth and persons with disability, and that gender equality and the effective participation of women and indigenous peoples are important for effective action on all aspects of climate change.

Inclusive governance is crucial to current practice in coastal management and will require the development and strengthening of the current institutional setup and the improvement of the governance system, enabling a more democratic and participatory decision-making process, whereby the interests of all relevant stakeholders are properly addressed, to ensure that the adaptive capacity of coastal communities and ecosystems is improved under various climate change scenarios (Ballinger and Rhisiart, 2011).

For instance, the application of the participative “Climagine” method in the preparation of the coastal plan for the Šibenik-Knin County in Croatia (within the CV&C project), or the participation programme in the Collaborative Application Sites (CASES) of the PEGASO project<sup>41</sup> (2010-2014), were fundamental pillars of the process of ICZM

development and a cross-cutting component of the integrated PEGASO toolbox (e.g., indicators, scenarios). Participatory consultation is required at all steps of the ICZM process as depicted in the following scheme (Fig. 3.1) adapted from the PEGASO project (Soriani et al., 2014).

Each step in the planning process provides opportunities for stakeholder participation. There are many methods and techniques that can be used to facilitate this critical part of the planning effort. They include, but are not limited to, charrettes, focus groups, open houses, workshops, and public meetings. There is no “one size fits all” solution for stakeholder participation. You will need to review and choose those methods and techniques that are most likely to result in effective and efficient stakeholder participation in your state (NOAA, 2007).

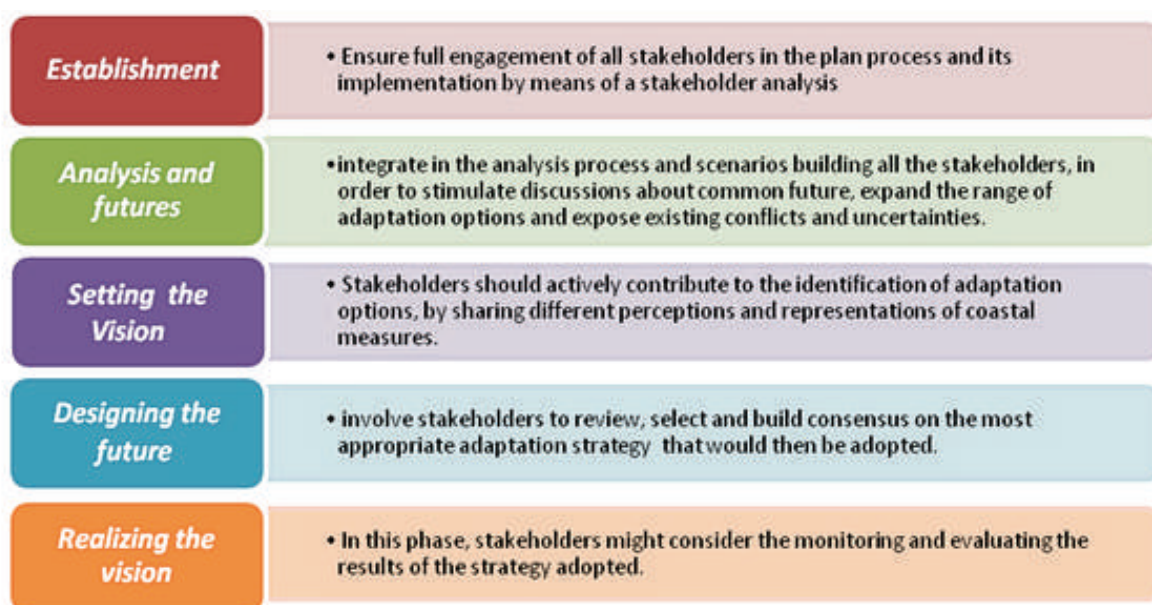


Figure 3.1: Participation in the five phases of the ICZM process

<sup>41</sup> <http://www.pegasoproject.eu/>

## Resilience-building approaches and initiatives for coastal communities

### Introduction

As discussed in previous sections, coastal communities and ecosystems are already seriously stressed in many areas of the Mediterranean. The reasons include intense coastal development, overpopulation, poverty, internal conflict, fragmentation and loss of habitat, over-fishing, pollution, and the spread of invasive species. These non-climate stressors will impair the resilience of ecosystems, i.e., their ability to maintain their integrity and to continue to provide critical goods and services to coastal communities in the midst of climate change. Therefore, healthy coastal ecosystems will play a major part in helping coastal communities to adapt to climate change. According to Costanza et al. (1997), coastal ecosystems are highly resilient because of the diversity of their functions and the linkages between these functions. In the same manner, they argue that coastal economies are more diverse and that they are inherently more resilient because of the resilience of the ecosystems upon which they depend (Adger, 2005). Reducing non-climate anthropogenic stressors can therefore help to foster ecological resilience to climate change within the coastal environment (Colls *et al.*, 2009) (see Box 3.3).

The resilience of a coastal community can be built by the adoption of ecosystems based adaptation (EbA) to climate change, meaning restoration, enhancement, conservation and wise use of natural resources with the active engagement of local communities to enable the ecosystems to function properly and to deliver services for the benefits of nature and local livelihoods, which in turn build societal resilience to the impacts of climate change.

The concept of “coastal resilience” is a new way of thinking about how to protect coastal communities better from climate-related hazards. Proponents of this concept suggest that planning for resilience can proactively reduce hazard risk and vulnerability. Indeed, resilient communities understand the hazards they face, take specific and coordinated actions to reduce their vulnerability, and develop responses and recovery plans to facilitate a quick response and effective long-term recovery should a disaster occur. Coastal resilience is now being

#### Box 3.3: What is resilience?

**Resilience** – from the Latin *resilio*, meaning “to spring back”.

IPCC: Resilience “*is the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions*” (Lavell et al., 2012).

UNISDR (2009)<sup>42</sup>: Resilience is “*the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner including through the preservation and restoration of its essential basic structures and functions*”.

NOAA<sup>43</sup>: **Coastal resilience** means building the ability of a community to “bounce back” after hazardous events such as hurricanes, coastal storms, and flooding – rather than simply reacting to impacts.

actively promoted as a management strategy by several organizations and agencies (IOC/UNESCO, 2012).<sup>44</sup> Thus, taking into account the specificity and diversity of the socio-economic conditions in the Mediterranean basin, together with the fact that this region is considered to be a climate change hotspot, building a resilience strategy is a priority, “no regret” action.

### The “Climagine” approach

Within the framework of the MedPartnership sister project<sup>45</sup> “Integration of Climate Variability and Change into National ICZM Strategies” (ClimVar & ICZM), Plan Bleu and PAP/RAC are working together to develop and test a participatory method that addresses the specific challenges of CV&C in coastal zones in two selected demonstration cases: Tunisia and Croatia. This method, called “**Climagine**,” is an adaptation of “*Imagine*”<sup>46</sup> developed by Plan Bleu in collaboration with the Bayswater Institute (UK) in the year 2000 to address sustainable coastal zone management needs in the Mediterranean (see Figure 3.2).

<sup>42</sup> [http://www.unisdr.org/files/7817\\_UNISDRTerminology\\_English.pdf](http://www.unisdr.org/files/7817_UNISDRTerminology_English.pdf)

<sup>43</sup> <http://oceanservice.noaa.gov/facts/resilience.html>

<sup>44</sup> Intergovernmental Oceanographic Commission of UNESCO. 2012. Coastal Management Approaches for Sea-level Related Hazards: Case Studies and Good Practices. IOC Manuals and Guides, 60. 25 pp.

<sup>45</sup> <http://www.themedpartnership.org/>

<sup>46</sup> <http://planbleu.org/fr/outils-et-methodes/methode-imagine>


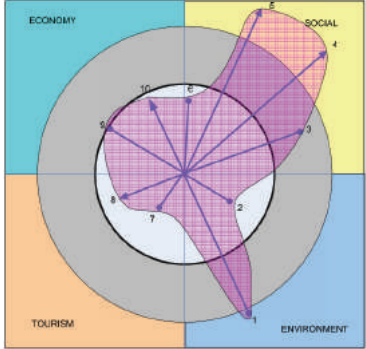

'Climagine'	Workshop Objectives	Workshop Description
	<b>WS1</b> Understanding the eco-socio-system context	<ul style="list-style-type: none"> <li>▪ Description of the coastal eco-socio-system and the CV&amp;C-related threats based on the DPSIR approach</li> <li>▪ Drawing of freehand 'Rich pictures' to express the coastal zone situation as perceived by the stakeholders</li> <li>▪ Consensual identification of the main drivers and priority issues of CV&amp;C impacts from a territorial and environmental shared diagnosis</li> </ul>
	<b>WS2</b> Selection of indicators based on issues and definition of the assumptions behind the scenarios	<ul style="list-style-type: none"> <li>▪ Selection of a core set of indicators in the list proposed by the local team and based on issues already selected, and definition of the belt of sustainability for each indicator</li> <li>▪ Scenario assumptions and pathways intended to guide strategy in the light of trend and alternative pictures of the future</li> </ul>
	<b>WS 3</b> Recommendations and discussion of the results	<ul style="list-style-type: none"> <li>▪ Presentation of the scenario results and discussion with stakeholders to set the first priorities for an action plan</li> </ul>

Figure 3.2: *Climagine* process (Adapted from Lafitte, A. 2013)

The “*Imagine*” method is a participation-based tool to support “territorial managers” and local decision-makers in implementing prospective analysis tools (Coudert and Larid, 2006). This allows them to shape possible futures (based on past and current trends), and subsequently to help them to define action plans to move towards more desirable and sustainable futures. “*Imagine*” has proved particularly suitable to local ICZM initiatives in the Mediterranean, where it was tested in many Coastal Area Management Programmes (CAMPs). Indeed, local participatory workshops provided a unique opportunity to discuss and debate common issues, breaking the barriers of communication between the different stakeholders, and encouraging them to work together to define a common sustainable future.

“*Climagine*” is the “*Imagine*” method with a CV&C dimension. It is a framework for local governance to prepare an ICZM plan in an integrative way and in a participative manner, taking into account physical and socio-economic impacts on coastal environment.

### The “Community-based Risk Screening Tool-Adaptation and Livelihoods”<sup>47</sup> (CRiSTAL) Tool

CRiSTAL is a planning tool that helps users design activities that support climate adaptation at the community level. It was developed by four international non-governmental organizations (the International Union for the Conservation of Nature, the International Institute for Sustainable

<sup>47</sup> <https://www.iisd.org/cristaltool/>



Development, the Stockholm Environment Institute and Helvetas Swiss Intercooperation) in response to the outcomes of the first phase of the Livelihoods and Climate Change Initiative, which demonstrated how ecosystem management and restoration and/or sustainable livelihood projects contribute to risk reduction and climate change adaptation.

The CRiSTAL approach relies on a combination of primary information gathered through participatory methods (stakeholder consultations, project team discussions) and secondary information gathered by desk-based research (Box 3.4).

#### Box 3.4: Overview of CRiSTAL

**Objectives:** CRiSTAL helps users to understand:

- How current and potential future climate hazards affect/may affect a project area and local livelihoods.
- How men and women respond to the current and potential future impacts of these climate hazards.
- Which livelihood resources are most affected by current climate hazards and which ones are most important for the response strategies.
- How project activities affect access to, or the availability of, these critical livelihood resources.
- Which project adjustments (revision of existing activities and/or design of new activities) can be made to support climate adaptation and reduce climate risk.

**Target user:** CRiSTAL targets project planners and managers working at the local or community level. However, a wide range of other actors may also use the tool (including policymakers and decisionmakers).

**Approach:** CRiSTAL relies on information collected from desk-based review and stakeholder consultations at the local level (community and other local experts) using participatory methods.

**Key outputs:** Applying CRiSTAL leads to three main outputs:

1. List of livelihood resources that are most affected by climate hazards and most important for responding to climate impacts.
  2. Proposed adjustments to existing projects and new activities to support climate adaptation.
  3. List of desired adaptation outcomes and important influencing factors to be monitored.
- (Source: [www.cristaltool.org](http://www.cristaltool.org)).

CRiSTAL was one of the first community-based climate risk screening tools. From 2007 until 2012, CRiSTAL was applied in over 20 countries in Asia, Africa and Latin America by various institutions and development professionals. Since its launch in 2007, CRiSTAL has been updated to incorporate user needs and priorities as well as the latest thinking in the field of climate change adaptation. The current and completely revised version of CRiSTAL was developed between 2010 and 2012 based on extensive user experience and feedback.

### Community-Based Adaptation (CBA) projects<sup>48</sup>

Recognizing that small communities are often the most severely affected by climate change impacts, yet the least equipped to cope and adapt, UNDP, in collaboration with the GEF Small Grants Programme (SGP), has designed the CBA project to achieve the goal of reducing vulnerability, increasing adaptive capacity to the adverse effects of climate change, and building the resilience of communities, ecosystems, and resource-dependent livelihoods in the face of climate change.

CBA projects are based on a bottom-up approach. Effective CBA requires an integrated approach that combines traditional knowledge with innovative strategies that not only address current vulnerabilities, but also build the resilience of people to face new challenges. It also aims to protect and sustain the ecosystems that people depend on for their livelihoods.

All these initiatives have more or less common objectives including:

- Promoting participatory consultations and dialogue between coastal stakeholders, giving priority to “bottom-up” approaches by involving the stakeholders from the outset of the process.
- Promoting no-regret/low-regret and win-win measures that reduce vulnerability and build the resilience of coastal communities.
- Promoting long-term planning with an on-going process for revising and improving adaptation strategies.

<sup>48</sup> <http://www.undp-alm.org/projects/spa-community-based-adaptation-project>



These and other measures are discussed more in the next section. The future resilience of Mediterranean coastal communities to climate change-related impacts will depend to a large extent on the successful implementation of a combination of measures.

### 3.2 Setting the direction

The vision statement, which is the aim of this sub-section, is a general statement that defines broad priorities. As the [Guidelines for the Preparation of National ICZM Strategies Required by the ICZM Protocol for the Mediterranean](#) note, the objectives that arise from the vision statement can be complex, consisting of High Level Objectives (or Goals) and clusters of Sub-Objectives. In addition, some objectives will be predetermined in existing international, national and sub-national policies, such as "Horizon 20-20," the Water Framework Directive and other water quality standards. The vision statement has to be made at the strategy stage and carried over to the plan stage (both national and local).

On the climate front a clear statement is needed of the importance given to adaptation to climate change as a high level objective. This may be followed by a list of the areas in which action is required and the cross sectoral priorities (e.g., adaptation to climate versus short term development imperatives).

Climate change priorities will have to be drawn from a range of possible actions. As an initial screening, the measures can be classified as:

- **Low regret or No-regrets measures:** These are measures that can be introduced now to adapt to climate change, incurring little or no cost and generating a range of benefits. Examples include improved efficiency in water use, the development of early warning systems that inform affected parties of extreme weather events, improved monitoring of climate data to better predict impacts from higher temperatures and changes in rainfall patterns. Also included in this category are measures to address the "adaptation deficit."<sup>49</sup> An adaptation deficit arises when the current

infrastructure is inadequate to cope with the present climatic variations (e.g., current flood defences are inadequate to cope with present flooding). Action to correct this situation can possibly be justified even without reference to future climate change, although it may still not be the top priority.

- **Action vs. Postponement:** The literature on adaptation notes the benefits in some cases of postponing decisions, for example on the height of a sea defence, until more information is available on the likely risks. This can be done through an analytical method known as Real Options Analysis.<sup>50</sup>
- **Hard vs. Soft Options:** Too often adaptation to climate change is thought of in terms of engineering solutions. Yet, these may not be the most effective and certainly not the least costly. Examples are restoration of wetlands that can be less costly and as effective in protecting some coastal areas and sea walls, or demand management measures for water that can be less costly than building additional reservoirs. These soft measures are often ignored because they involve policy changes requiring administrative coordination across different departments.
- **Long term vs. Short term:** Many climate impacts are relatively long term, involving actions now to protect coastal areas and their inhabitants ten or more years in the future. However, these impacts can be exacerbated by short- to medium-term measures introduced for other reasons (e.g., economic expansion and growth). For example, allowing settlement in an area that may be more prone to flooding may yield benefits now but will impose heavy costs later. The different options should be laid out for each of the areas where some action is required and the pros and cons of each discussed with stakeholders. The aim at this stage is not to make a final selection but to indicate broad priorities from which sets of options can be drawn and evaluated in Stage 4 (Designing the Future).

<sup>49</sup> For further discussion on the adaptation deficit see Parry et al. (2009).

<sup>50</sup> For an example of Real Options Analysis see the assessment for the Thames defences, summarised in Ranger et al. (2010).

The national ICZM strategy should describe how key problems will be analysed and how priorities will be set. For climate change it should note some of the choices that are open to the policy-makers (as outlined above). During the stage of preparing the national and local plans, the options will be further elaborated and the priorities will be determined.

### 3.3 Measuring success

The IMF document provides a fairly detailed description of the indicators that will track whether the plan's interventions are achieving their intended objectives. Consequently, they need to be aligned with these objectives and, more precisely, they have to be linked to the output or outcome being measured.

These guidelines propose three types of indicators:

1. Sustainability Indicators that show how the strategy or plan is being realised;
2. Impact Indicators that measure how well the strategy or plan outputs are being achieved; and
3. Performance Indicators that measure how well the projected activities are being implemented.

In addition, a distinction is made between Headline Indicators that provide information to the general public and Specific Indicators that are designed to assist in the technical monitoring of the strategy or plan. An indicator matrix is provided, which

establishes a link between the broad objectives and the indicators that show the progress in achieving these objectives.

From a climate change perspective the relevant broad objectives are sustainable development of the region and the protection of human life and natural and physical capital in the face of climate change. Each of these is likely to be affected by climate change. The problem with developing indicators in this context is that the threat from climate change is in the future and an assessment must be made of its magnitude, given plans for development, etc. Thus, estimating the relevant climate indicators will require considerable analytical work. This can be done, but it will require regular monitoring over the life of the ICZM. However, this effort is worthwhile since it keeps this dimension of the problem in the public's mind.

Table 3.1 provides a list of possible climate indicators, using the same broad categories of indicators, as provided in the IMF document. Each indicator will need further clarification and refinement before it can be estimated and used.

The structure of the indicators is laid out in the strategy, with the criteria they should fulfil. The selection of the specific indicators is made during the preparation of the plan. Ideally, the same indicators should be used to allow for some comparability, but the plan may also include or omit some other indicators.

Table 3.1: Possible climate-related indicators that complement others for ICZM

		Climate Related Indicators for Selected Years					
Broad Indicator	Sub Objective	Pop. at Flood Risk	Pop. at Heat Risk	Property at Risk	Water Balance	Ecosystem Stress	Tourist Visitors
A. Healthy & Productive Economy	Maximising Economic Development	X		X	X	X	X
	Increasing Employment						X
	Foster Diversification						X
B. Healthy & Productive Environment	Minimize Habitat Destruction					X	X
	Reduce volume of all pollutants					X	
C. Public Health & Safety	Protect human life and property	X	X	X			
D. Social Cohesion	Maintain a sense of equity and social justice	X		X			

## 4 Designing the Future

### 4.1 Formulating ICZM strategies, plans and programmes

At this stage, strategies, plans and programmes will have specific climate-related elements. They will include measures related to sea-level rise, such as sea defences, changes in land-use regulations, and measures designed for agriculture, tourism, health, water and ecosystems, primarily in conjunction with national policies in these areas. Issues related to funding will be specific to climate change. External funds should be available from the Global Adaptation Fund, which is being established and which will publish guidelines for the documentation required to receive funding. Much of the information that is recommended to be collected for the ICZM should also be of great value in preparing such proposals, although further data may be required.

### 4.2 Establishing management structure

This stage consists of setting up inter-sectoral management, long-term facilitation and consultation structures, and the post-plan period, which ultimately will have an impact on coastal governance performance. The solutions developed in the Stage 1.3. (Defining the governance context through the strategy or plan formulation) should now be reconsidered with a view toward long-term, permanent solutions for the integration of sectors.

### 4.3 Embedding

At this stage, the indicators identified in Section 3.3 must to be estimated and provided. As the strategy or plan is implemented, changes in the indicators should also be estimated. This does not need to be done too frequently since the indicators will not change that frequently. For climate indicators, calculations at five-year intervals should be sufficient. The estimation of indicators is made as part of the implementation of the strategy or plan.



*Photo 4.1: Lindos, Rhodes (Source: Marko Prem, PAP/RAC, October 2011)*

## 5 Realizing the Vision

### 5.1 Implementation

#### Instruments for Implementation

ICZM has a wide range of instruments to implement the strategy. A central pillar is land-use regulation and the limitation on the use of certain areas on environmental grounds. Also important is the adoption of standards for the construction, energy and other sectors that provide goods and services. In addition, it is increasingly important to use fiscal instruments to promote certain actions that are considered desirable. Such instruments serve several purposes. First, they are more flexible than direct physical control over the person whose actions are being influenced. Second, if the instrument is in the form of a charge, it allows the authorities to raise much needed financial resources that can provide essential public goods. Third, as long as a charge is in place, it provides a continued incentive for greater efficiency, which is not the case with the use of physical controls.

Areas in which fiscal instruments can be used specifically to address some of the climate change impacts that have been discussed are:

- Transferable development rights, where an individual whose rights have been taken away in one location can have them reallocated in another location. Such rights make the introduction of new regulations easier and allow a market for these rights to develop (Markandya et al, 2008).
- The use of charges that better reflect the cost of services, particularly related to water.
- The development of insurance markets to provide coverage against the risks of flooding, etc. To the extent that they bear at least part of the costs, this encourages the private sector and individuals to modify their behaviour and not take excessive risks, as they tend to do when the cost of all damages are covered by public funds.
- Charges to tourists to cover their additional burden on public services as a source of financing environmental protection.

- The use of direct controls under which banks and other financial institutions will not finance projects located in vulnerable coastal zones.

The range of instruments to be used in the ICZM should be identified in the strategy, along with some priorities indicating which instruments are preferred from a national viewpoint. The actual selection, however, will be made at the planning stage, national or local as appropriate.

#### Examples of Good Practice

Learning from experiences of others can provide important information on specific and successful adaptation approaches for coastal areas. Listed below are some examples of the key principles that should guide communities as they build national or local adaptation strategies for sea-level rise. They are drawn from the growing number of adaptation studies in coastal zones around the world and in the Mediterranean.

- The USAID Guidebook on Adapting to Coastal Climate Change (2009), in particular, lists good practices for successful and sustained coastal adaptation that have proven effective in coastal management worldwide and that can help overcome resistance to mainstreaming coastal adaptation.
- The Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use (Grannis, 2011) of the Georgetown Climate Centre is a comprehensive tool on how governments can use land-use practices to adapt to sea-level rise.
- In the EU, Climate-ADAPT<sup>51</sup>, the European Climate Adaptation Platform (2012), has been developed to share information on adaptation case studies throughout the EU and on potential adaptation options to help users develop their own climate change adaptation policies.
- The OURCOAST database is a comprehensive compilation of hundreds of summaries of successful cases of integrated coastal management throughout Europe, including many cases focusing particularly on climate

<sup>51</sup> <http://climateadapt.eea.europa.eu>



change adaptation information and communication systems, planning and land management instruments, and institutional co-ordination mechanisms.

- The EU Framework Programme (FP) projects, INTERREG projects, and ESPON projects also contribute to developing EU-wide information on the implementation of adaptation actions.

In general, adaptation responses can be categorized as (1) reactive<sup>52</sup> or planned<sup>53</sup> responses and (2) structural or non-structural responses. Reactive responses traditionally utilize structural solutions, while planned or proactive measures use non-structural measures to protect against risks. Proactive non-structural solutions are often the more cost effective over the long term and less environmentally damaging than reactive responses (Grannis, 2011).

### **Climate Risks to Coastal Zones: The Use of the DIVA Model**

One of the most important impacts of climate change in coastal areas is sea-level rise and storms. The Dynamic and Interactive Vulnerability Assessment (DIVA) model and database was constructed to aid the assessment of such impacts and to help decisionmakers decide where and in what form to provide protection to coastal assets. DIVA is an integrated, global research model for assessing the biophysical and socio-economic consequences of sea-level rise and associated extreme water levels under different physical and socio-economic scenarios by considering various adaptation strategies. ([www.diva-model.net](http://www.diva-model.net); Hinkel and Klein, 2009). It is a modular model that assesses several impacts of sea-level rise.

In this section we will apply DIVA to an analysis of the impacts of climate change on the coast of Croatia and Tunisia.

### **The Use of the DIVA Model in Croatia**

The model is used to assess:

- increased coastal flood risk in terms of the expected annual damages from extreme sea level events (storm surges), to assets (buildings,

infrastructure) and number of people affected; and

- dry land loss due to increased coastal erosion and to sea-level rise and the resulting damages (forced migration).

The study was recently undertaken as the first such an assessment for Croatia (Hinkel et al., 2014). It also went further than any previous work in quantifying the costs of adaptation strategies. The various steps in the assessment included:

- i. The region being analysed was divided into coastal segments of variable lengths and according to principal geographic features: (i) administrative boundaries, (ii) the geomorphic structure of the coastal environment, (iii) the expected morphological development of the coast given sea-level rise, and (iv) population density.
- ii. The above method was used to derive a dataset on the coastal morphology and geological characteristics of Croatia. This dataset was based on visual interpretation of Google Earth imagery based on the concepts described in (Scheffers et al., 2012). It also relied on the existing DIVA database and the use of location-tagged photographs from the web-service Panoramio (<http://www.panoramio.com>). In addition, a dataset on the location of beaches, provided by local land agencies, was used for validation. Population data was added to the database to derive a spatial dataset that included all coastal settlements. The result was a DIVA coastline database with 1,150 segments, covering 5,711 km.
- iii. Each segment was assessed for exposure to inundation using the Shuttle Radar Terrain Mission (SRTM) Digital Elevation Model (DEM).
- iv. An erosion factor was also estimated for each segment based on a dataset with coastal morphology. This ranged from 1 if the area was considered highly erodible, such as sandy beaches, to 0.3 if the areas consisted of rocky coasts with pebble beaches.
- v. Future impacts were determined based on sea level scenarios taken from climate models downscaled to the area of the Croatian coastline. The degree of sea-level rise (SLR) by 2050 and 2100 depends on future emissions. Three scenarios covering a range similar to the four

<sup>52</sup> Actions/changes in policy and behavior that a government takes *after* impacts have already occurred.

<sup>53</sup> Strategic and proactive that aims to address the full range of coastal climate change hazards in a way that meets societal objectives.



scenarios given in Table 2.2 were considered. The results were SLRs that ranged from 0.15 to 0.31 meters in 2050 and from 0.28 to 1.08 m in 2100.

- vi. Information on extreme water levels for different periods was also included in the DIVA database. Extreme water levels are displaced upwards with the rising sea level since there is no clear evidence that climate change will further alter the distributions. Analysis of global tides since 1970 has concluded that the water level that is exceeded on average once per year (H1) will increase from 0.83m to between 0.95 and 1.12 m in 2050 and between 1.08 and 1.89 m in 2100, depending on which sea level rise scenario occurs. The water level that is exceeded on average once every hundred years (H100) increases from 1.14 m now to between 1.26 and 1.43 meters in 2050 and between 1.39 and 2.2 m in 2100.
- vii. The above data are combined with socio-economic scenarios – Shared Socio-economic Pathways (SSPs) – that provide information on future incomes and population levels in the affected areas. This information was taken from work performed by IIASA and other research groups and is available at the national level for Croatia. Local level scenarios for the coastal segments were derived from a combination of national estimates and local information. There are five SSPs that reflect different demographics and economic growth up to the year 2100.
- viii. The last step is to estimate and give a value to the impacts, which are divided into three groups. The first group is erosion impacts, which are estimated in terms of (i) land loss, in km<sup>2</sup>/yr., (ii) migration cost in millions of US dollars/yr., valued at the cost of forced migration when it is required due to land loss, and (iii) nourishment costs in millions of US dollars/yr., when eroded sand is replaced through beach or shore nourishment. The model calculates the costs of beach nourishment only when it finds that damage avoided in terms of loss of migration or tourism is greater than the costs of nourishment.
- ix. The second set of impacts relates to flood damage and sea-level rise. The people affected are residents of areas in which the H100 water level is exceeded (while taking account of any existing dikes). In addition, property in such an

area is considered affected according to a damage function that assumes a given level of damage for each meter of flood in an area. These damages are, of course, probabilistic. The model also calculates the expected damages using the distribution of extreme water levels for different return periods.

The results of applying the model to Croatia are of considerable interest. First, the model calculates the area of coastline flooded due to a 1-in-a-100-year flood under different SLR scenarios. This area increases from less than 50 km<sup>2</sup> now to 280-340 km<sup>2</sup> in 2050 and to 320-390 km<sup>2</sup> in 2100. Next, the model calculates the assets affected by such a flood, which increase from less than \$10 billion at present to \$40-70 billion in 2050 and \$76-154 billion in 2100. In terms of people, the impacts are less severe. At present, there are 101,000 people in the H100 floodplain. In 2050, the model projects 102,000 (low SLR, SSP5) to 117,000 (high SLR, SSP3) people below H100, and in 2100 it projects 74,000 to 125,000 people living below H100. We note that the range of future estimates is not only the result of climate change but also that of population and economic growth.

The above can be used to estimate the costs of a sea-flood for all of Croatia. In 2010, the expected annual flood costs were around \$0.26 billion. Under the high sea-level rise scenario the annual damages by sea-floods range from \$4.4 to \$5.8 billion in 2050, and in 2100 the model projects average annual damages by sea-floods ranging from \$39 to \$58 billion. Under the low sea-level rise scenario the expected damages are much lower, ranging from \$1.6 to \$2.1 billion in 2050 and from \$6.0 billion to \$9.0 billion in 2100. All the above estimates assume no further action is taken to adapt the country to such a climate change.

There is also an increased risk to UNESCO World Heritage Sites (<http://whc.unesco.org/en/list/>), six of which lie in the Croatian Low Elevation Coastal Zone (LECZ; McGranahan et al., 2007). A site is characterised as exposed when it lies (even partially) below 10 m elevation. Under current conditions, both the Cathedral of St. James in Šibenik and Episcopal Complex of the Euphrasian Basilica in Poreč lie below the 100-year surge and thus are at risk under current climate variability. The Episcopal Complex of the Euphrasian Basilica in

Poreč, which is located directly on the coast is very vulnerable to sea-level rise (see the photo below). The other sites do not appear to be at immediate risk of flooding today or in the near future.

The model next looks at measures to reduce impacts through the construction of dikes. Although a wide range of measures for flood protection is available, including protection against flooding by restoring coastal ecosystems, flood-proofing houses and critical infrastructure, and retreat from the coastline, this analysis focuses on dikes because they are the most common and developed technology in coastal zones with heavy human use. But they do not have to be the sole measure applied. Which long-term strategy is selected to protect Croatia against sea-level rise is a decision that must be made by all stakeholders. The cost estimates generated here may be used in this process.

Dikes are built according to a formula in which the benefits of protecting the coast exceed the costs. The costs are given from technical data on construction and the benefits are estimated in terms of damage avoided, which depends on what assets and people are there and what the assets are worth. This kind of assessment is common in the economic appraisal of investments and is part of the model. When applied, the model shows that to adapt to current climate variability in 2010 dikes

with a total length of 4,800 km and an average height of 1.20 m would be needed to protect 85.3% of Croatia's coastline. Constructing these dikes would require an investment of \$6.8 billion. These costs represent what is called adaptation deficit in the literature (i.e. the money should be spent right now). Usually, these costs would be distributed over time. Assuming a planning and implementation horizon for coastal defences of 50 years would mean that \$140 million per year would have to be spent over 50 years.

Adapting to future climate change means upgrading existing and constructing new dikes to account for escalating risks. Annual costs will increase with sea-level rise. In 2050, and under the high SLR scenario, about \$55-60 million per year will have to be invested to upgrade dikes and \$90 million per year to maintain the total dike stock (i.e. about \$70 million to maintain the initial dike stock built in 2010 and \$20 million to maintain dikes built since 2010). In 2100, \$120 million per year will be needed for dike upgrades and \$135 million per year for maintenance, with an average dike height of about 2.4 m under the high sea-level rise scenario. Under the low SLR scenario the average dike height in 2100 is 1.6 m and \$17-19 million per year will be needed to upgrade dikes and \$90 million per year to maintain them.



*Photo 5.1: The Episcopal Complex of the Euphrasian Basilica in Poreč, located at sea-level. (Source: Integration of climatic variability and change into national strategies to implement the ICZM Protocol in the Mediterranean: National level assessments for Croatia, Final report. J. Hinkel, A. T. Vafeidis, D. Lincke, C. Wolf, 2012)*

While these adaptation costs are substantial, overall adaptation is cost-efficient because it reduces the impacts on an order of about two magnitudes. In 2100, annual sea-flood costs will be about \$0.6-0.8 billion under the high SLR scenario and \$0.2-0.3 billion under the low SLR scenario.

Only a small fraction of the Croatian coastline consists of erodible beaches. The study identified 189 segments that contain a fraction of erodible beach. The total length of erodible beaches in Croatia is 80.9 km. Under the high sea-level rise scenario and without adaptation, sea-level rise is projected to erode 8.6 km<sup>2</sup> of land from 2010 to 2100. Under the medium sea-level rise scenario 3.8 km<sup>2</sup> are lost and under the low sea-level rise scenario 2.1 km<sup>2</sup> are lost from 2010 to 2100.

This land loss leads to migration as people who live on the eroding land must leave. In the worst case scenario (high sea-level rise, SSP3) erosion forces 3,200 people to migrate from 2010 to 2100 with a migration cost of approximately \$350 million (not discounted).

Applying beach nourishment by following the cost-benefit approach will require 0.54-0.67 million m<sup>3</sup> of sand annually by 2100 at an annual cost of \$1.6-2.0 million. Under the medium- and low sea-level rise scenarios the annual costs will be \$0.20-0.25 million and \$0.49-0.60 million, respectively. Hence, beach nourishment is relatively cheap alternative compared to the costs of physically moving people from the area.

### The Use of the DIVA Model in Tunisia

Box 5.1 provides a brief description of the implementation of the DIVA model in Tunisia.

### Structural Measures

As the previously mentioned study for Croatia has shown, shoreline structural measures, often referred to as “hard protection,” “armouring,” or “grey infrastructure”, can be designed to decrease shoreline erosion or reduce coastal risks associated with wave damage and flooding. Common structures include levees, storm surge barrier gates and seawalls to reduce coastal flooding; and revetments, groins, and near shore breakwaters to reduce coastal erosion. All of these measures can

reduce storm wave damage to some extent.<sup>54</sup> However, while they may provide immediate remediation, they may not be sustainable in protecting coastal land in the long term. Many of these adaptation options may also have potential negative impacts on habitats and ecosystems, including wetland loss where migration is blocked by hard structures.

Moreover, shoreline hard techniques are costly to construct and maintain, even though they may be appropriate in some areas where expensive critical infrastructure or intensely developed areas are at risk. It is important to prioritize the areas for which specific measures will be implemented as part of an overall adaptation strategy. DIVA is one prioritization tool, but other information on local ecosystems and other assets will be required before making a decision on where to construct hard protection measures.

### Non-structural Measures

Non-structural measures are complete or partial alternatives to structural measures, including soft armouring, early warning systems, modifications in public policy, management practices, regulatory policy, and pricing policy. The following sections discuss some examples of such measures.

### Soft-Armouring

*Soft armouring* covers a variety of techniques that use natural resources to strengthen coastlines. Soft measures aim to develop living shorelines through beach nourishment, planting dune grasses, marsh creation, planting submerged aquatic vegetation or elevating land so that structures are less vulnerable to flooding, storm surge, and erosion. In general, except in intensely developed areas, adaptation options that favour ecosystem and living shoreline approaches are recommended over hard structures to stabilize the shoreline. However, the decision should be informed by the relative costs of each option and the extent to which it protects the coastal assets.

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<sup>54</sup> For more details on structural measures, see Grannis J. (2011), *Adaptation Tool Kit – Sea-Level Rise and Coastal Land Use: How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise*. Georgetown Climate Center, Georgetown Law, 600 New Jersey Ave. NW, Washington, DC 20001. [www.georgetownclimate.org](http://www.georgetownclimate.org)

### Box 5.1: DIVA Model Implementation in Tunisia

#### A. A downscaled DIVA approach at the national level in Tunisia

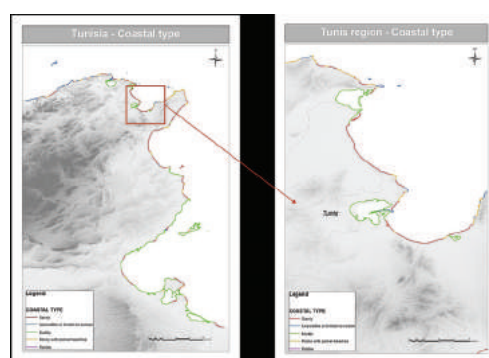
The general approach of the DIVA segmentation was applied to Tunisia's coasts:

- elements of coast line, such as coastal types: plain, river mouth and lagoon
- population density
- administrative units

The DIVA segmentation of the coasts includes a data base with more than 80 physical, ecological and socioeconomic parameters.

The preliminary results provided by the Global Climate Forum and the University of Kiel were based on open source and online available data (i.e., coastal type, coastal plain, river mouth, population, administration unit, lagoon). The following key inputs were used to define DIVA:

- Coast length: 2,151 km & erodible coast length: 486 km
- Current (2015) exposure below 2 m:
  - People: 384,785
  - Assets: 8.9 billion US\$
  - Area: 8,463 km<sup>2</sup>
- Current (2015) exposure below 100-year flood:
  - Average height of 100-year flood: 1.58 m
  - People: 304,732
  - Assets: 6.8 billion US\$
  - Area: 1,461 km<sup>2</sup>
- Coastal administrative Units: 78



DIVA Tunisia segmentation

#### B. Initial results of the assessment of the costs of climate variability and change to the Tunisian coast

In the initial global DIVA segmentation Tunisia had 35 segments; in the Tunisian DIVA segmentation a total of 564 segments were defined.

The preliminary results were presented in 2014 to a selected panel of Tunisian experts (i.e., segmentation, areas at risk, socio-economic estimation and evaluation of adaptation coasts, etc.). The conclusions of the preliminary results can be summarised as follows:

- Flooding is an issue in Tunisia:
  - Worst case in 2100: up to 524,000 people flooded annually, annual cost of up to 65 billion US\$
  - Damages will be mainly concentrated in Tunis, Sfax and Mahdia
  - Protection with dikes will not be very attractive for tourism
- Erosion is an issue in Tunisia:
  - Without adaptation: annual land loss of 165 soccer fields and annual migration of 760 people
  - Adaptation (beach nourishment) in 2100 would cost about 38.5 million US\$
  - Keeping the beaches used for tourism is relatively expensive

The partners agreed to push forward with the DIVA Tunisia modelling within the ClimVar & ICZM project in 2015. Further analysis will be based on the integration of more specific data forwarded by the Tunisian partners. A list of useful data to improve results was established:

Parameter	Format
Digital elevation model	Elevation in m
Population	Population density Population count Population projection for the next 30 years
Extreme water level /Surge height	Extreme water level above mean sea-level for the 1-in-1, 1-in-10, 1-in-100 and 1-in-1000 year event Height above mean sea level, in m (including high-water-level)
Coastal slope / Bathymetry	Sea bed slope in degrees
Tidal range	Tidal range in m
Geomorphology	Type of coastal landform Length of sandy beaches in m
Erosion	Observed coastline recession rates in mm per year
Land use	Type of land use, value of each land use Buildings and other infrastructure by age, type of use and value
GDP	GDP per capita in dollar per person per year
Coastal protection	Dike height above mean sea level Dike cost (Costs of raising a standard dike of 1km length by 1m(in million \$)) Dike maintenance cost for 1 km length Other protection infrastructure
Sea-level change	Local sea level change in m



*Living shorelines* refers to a management practice that addresses erosion by providing long-term protection, restoration or enhancement of vegetated shoreline habitats. This term is more popular in the Mid-Atlantic region, where it is used to stabilize the shore while maintaining natural processes. The design of living shorelines may also help accommodate the landward migration of wetlands that results from sea-level rise.

*Beach nourishment* requires public policy decisions that take an integrated approach across environmental, social and economic disciplines, and that should be managed like all other public infrastructure, i.e. by ensuring there is funding and monitoring to support on-going maintenance. It is normally only appropriate to high value amenity beaches or small pocket beaches. The success of a nourishment scheme should be enhanced by vegetation transplanting and fencing, and associated with hard structures that will reduce long-shore transport losses. The DIVA model shows

**Box 5.2: Beach nourishment as a successful measure against erosion – Rostock, Germany**

Located on the Baltic coast, Rostock is the largest city of the state Mecklenburg-Vorpommern in north-eastern Germany. It is one of Germany's major seaports. The average erosion at recession sites of the coast is about 34 m/100 years. In the 1970s, the construction of hard coastal protection turned out to be insufficient protection at certain locations. East of the Rostock harbour entrance nourishments were needed to maintain the coastline. Along the rest of the coastline the hard coastal measures had apparently succeeded in halting erosion. The nourishments have had to be repeated every 2-3 years at Hohe dune and every 10 years at Markgrafenheide. The nourishments have succeeded in stopping the coastline from receding.

Hard constructions for the protection of a highly dynamic coast have not been enough to prevent coastal erosion. Sand nourishment in combination with marram grass planting in the dunes and the maintenance of coastal forests behind the dunes was found to be an efficient way to protect the coast from further decline. Geo-textiles are used to increase protection at locations where dune ridges are narrow. Sand nourishments must be repeated depending on the frequency of erosion and storm surges, on average about every 6 years.

<http://ec.europa.eu/ourcoast/index.cfm?menuID=4&articleID=196>

when beach nourishment may be justified as an adaptation measure and how it can be included in the set of measures deployed to adapt the coast to climate change. Box 5.2 provides an example of the successful use of beach nourishment to reverse the impacts of erosion.

### Early warning systems

Providing coastal communities with early warning facilities is a key part of developing the preparedness of those communities for coping with the rapid onset of potentially catastrophic hazards.<sup>55</sup> In addition, early warning is highlighted as a major component of disaster risk reduction in the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.<sup>56</sup> Developing and implementing an effective early warning system requires the contribution and coordination of a wide range of individuals and institutions involved in coastal management and in CV&C adaptation strategies. Box 5.3 provides examples of two such systems.

### Policy and land-use regulations

It is widely recognised that land-use planning is an effective way to reduce risks associated with natural hazards (Burby, 1998). Coastal adaptation to CV&C will probably require new, and modifications to existing, plans, laws, and regulations. These measures can be incorporated into the adaptation planning process or that of an existing plan (e.g., Master Plan, hazard reduction, ICZM, IWRM, etc.).

*Planning tools* include coastal hazard mapping, risk management, cost benefit analysis, emergency planning and preparedness. The mapping of coastal areas at risk of flooding or susceptible to erosion is an essential tool for land-use planning with respect to SLR and can be essential to help determine the most appropriate response to coastal hazards. Development planning for undeveloped coasts offers some of the most concrete entry points for integrating climate change adaptation. The incorporation of adaptation issues in these processes can lead to the identification of new

<sup>55</sup> Hazard Awareness and Risk Mitigation in Integrated Coastal Management (ICAM). Intergovernmental Oceanographic Commission. IOC Manual and Guides No. 50, ICAM Dossier No. 5, Paris, UNESCO. 2009 (English).

<sup>56</sup> <http://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf>



#### Box 5.3: WMO Coastal Inundation Forecasting Demonstration Project (CIFDP)<sup>57</sup>

The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the WMO Commission for Hydrology (CHy) have initiated the CIFDP Project to meet the challenges of coastal community safety and socio-economic sustainability through the development of coastal inundation forecasting and warning systems at the regional level based on robust science and observations.

#### European Space Agency (ESA) Storm Surge Project, eSurge<sup>58</sup>

The JCOMM Expert Team on Wave and Coastal Hazard Forecasting Systems (ETWCH) has established collaborative arrangements with the European Space Agency (ESA) to support improved storm surge forecasting through Earth observation information. The ESA Storm Surge Project (*eSurge*) will develop a comprehensive open-access database with user tools for storm surge events, supporting satellite data and model outputs that can be used to enhance storm surge analysis and forecasting. In the Mediterranean region, the eSurge-Venice Project will provide a demonstration NRT service (eSurge-Venice live) of EO data products and services in support of operational and experimental forecasting and warning services.



Photo 5.2: Venice Acqua Alta 04-03-2014

(Source: © Laure Jaquemin)

(Source: [http://www.jcomm.info/index.php?option=com\\_content&view=article&id=135&Itemid=37](http://www.jcomm.info/index.php?option=com_content&view=article&id=135&Itemid=37))

development priorities, revised strategies, supporting by-laws, law enforcement mechanisms, and monitoring and evaluation frameworks. Challenges include the time and resources required for the process and for public consultation and education.<sup>59</sup>

*Regulatory tools* will ensure that land use is regulated through the establishment of appropriate zoning within areas that are subject to, or potentially subject to, coastal hazards from sea-level rise and extreme weather events. Zoning regulations can include a wide range of considerations, such as different land uses, land-use densities, the siting of buildings, setbacks, etc.

Setbacks create a buffer between shoreline development and the sea that provides some protection against the destructive effects of erosion or land loss resulting from accelerated sea-level rise or increased storm activity. Details are given in the Box 5.4.

#### Box 5.4: Setbacks in the ICZM Protocol (Article 8-2)

Under the Protocol the Parties:

- (a) shall establish in coastal zones, as from the highest winter waterline, a zone where construction is not allowed. Taking into account, inter alia, the areas directly and negatively affected by climate change and natural risks, this zone may not be less than 100 metres in width, subject to the provisions of subparagraph (b) below. Stricter national measures determining this width shall continue to apply.
- (b) may adapt, in a manner consistent with the objectives and principles of this Protocol, the provisions mentioned above:
  - 1) for projects of public interest;
  - 2) in areas having particular geographical or other local constraints, especially related to population density or social needs, where individual housing, urbanisation or development are provided for by national legal instruments;
- (c) shall notify the organization of their national legal instruments providing for the above adaptations.

<sup>57</sup> <http://www.storm-surge.info/>

<sup>58</sup> [http://www.jcomm.info/index.php?option=com\\_content&view=article&id=168](http://www.jcomm.info/index.php?option=com_content&view=article&id=168)

<sup>59</sup> For more information see Sea-Level Rise Adaptation Primer: A Toolkit to Build Adaptive Capacity on Canada's South Coasts (2013) <http://www.env.gov.bc.ca/cas/adaptation/pdf/SLR-Primer.pdf>

According to the USAID Guidebook, it is wise to use setbacks as an adaptation tool within an overarching integrated coastal management programme since its benefits are significant, it can meet multiple objectives, and it can be considered a precautionary measure, or a no-regrets approach to climate change. However, it is critical to reach a public consensus on setback policies, taking into consideration the need to balance public safety with private property rights.

Ultimately, an effective response to a wide array of climate change impacts requires combining the best complementary measures that can bring additional benefits in terms of CV&C adaptation and thus contribute to sustainable coastal management.

## 5.2 Investment and infrastructure

Some climate-related actions will involve investment in protective infrastructure, such as sea walls, dikes and desalinisation facilities. The ICZM should not give priority to such solutions, but it should look in the first instance for less expensive options that involve early warning systems, and the use of fiscal and other incentives, etc.

However, some investments will be needed and some investments that are part of the development plan will have to be modified in light of climate change. Examples of these changes include measures for buildings to withstand increased impacts from extreme weather events and transport systems that have to account for the increased risks of subsidence. Some of these investments will be in the public sector and some will be in the private sector. The DIVA model provides a first cut of the likely investments in infrastructure and the timing of these investments.

The ICZM should provide guidance to the private sector on how to address additional climate risks. There are various sources for this, such as the World Bank report of 1997.

For public sector investments, a key aspect is funding, which is discussed in the next section.

## 5.3 Finance for realizing the vision

Financing adaptation to climate variability and climate change comes from national and international sources and from the public and private sectors. There is a difference in the relative importance of finance from these different sources, depending on whether the country is a developing or a developed one. In the context of climate change financing, donor-supported funds are available for developing countries, which broadly speaking are the non-Annex I countries of the Kyoto Protocol.

### Public Finance for Adaptation in Developing Countries

The main providers of public adaptation finance for developing countries are:

- Development finance institutions (DFIs), including bilateral, multilateral, and national DFIs;
- Governments, through bilateral official development assistance (ODA) contributions; and
- Climate funds targeting adaptation, and operating through national, regional or multilateral organizations.

With the exception of national development finance institutions that raise and channel finance for adaptation investments (aimed at achieving domestic adaptation goals), the other entities grant or invest their resources to provide financial and technical support to developing countries and emerging economies, and/or co-ordinate support among their member countries.

Public adaptation-related non-domestic finance in developing countries, which include all non-Organization for Economic Cooperation and Development (OECD) countries and Chile and Mexico, is estimated to have been around \$22 billion in 2013 (Buchner et al., 2014). In the Mediterranean, the countries in this group are Albania, Algeria, Bosnia & Herzegovina, Egypt, Libya, Morocco, Montenegro, Tunisia, Lebanon and Syria.

The requirements for adaptation to climate change are estimated about \$70-100 billion per year (UNEP, 2014). In 2009, the Conference of Parties of the UNFCCC agreed that developed countries should

mobilize about \$100 billion by 2020, although this target was to support both mitigation and adaptation measures in developing countries. Given that current adaptation finance is in the range of US\$22 billion, we are well short of the target.

The current level of support for adaptation is a combination of ODA and non-ODA finance originating from developed and developing country governments, adaptation-dedicated multilateral climate funds and DFIs.

The breakdown of the \$22 billion from DFIs was about 34 percent from multilateral financial institutions such as the World Bank; 15 percent from bilateral donors, and 51 percent from national financial institutions (Buchner et al., 2014). Thus, the role of national sources is very important in financing adaptation to climate change. Both bilateral and multilateral funding sources also have a key role. In the case of bilateral sources, around 43 percent of climate-related finance comes from Japan, Germany and the EU.

Both bilateral and multilateral funding institutions channel part of their resources through specific funds and programmes (OECD, 2014b). In 2013, adaptation-dedicated climate funds committed \$0.6 billion to developing countries (Buchner et al., 2014, mainly based on the Climate Funds Update (ODI/HBF, 2014)). In regard to the structure of these funds, one part is financing that comes under the Financial Mechanism of the UNFCCC; the other part is funding outside that structure. The UNFCCC funds include those managed by the Global Environment Facility (GEF), which include the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF), the Adaptation Fund (AF) and the Green Climate Fund (GCF). The funds outside the UNFCCC structure include the Pilot Programme for Climate Resilience (PPCR) — an adaptation-targeted programme of the Climate Investment Funds — and the Global Climate Change Alliance of the EU, which also supports mitigation activities. A summary of the aims of each fund, including who is eligible and the finances that are available, are summarised in Table 5.1.

Great Britain, Germany, and the United States are the largest contributors to adaptation-dedicated

climate funds. The main aspects of these funds relevant to the Mediterranean and to coastal management are:

- (i) The LDCF is not open to countries from this region but the SCCF is open and may be a source of partial financing for protection of coastal areas against climate change.
- (ii) The Adaptation Fund is open to countries in the region and may be used to provide funds for the protection of low-lying areas.
- (iii) The GCF is just getting started, but it has great ambitions. It is by far the largest of the dedicated funds, with pledges already made of \$10 billion. It will aim for a balanced (50:50) allocation of its resources between mitigation and adaptation over time (GCF 2014) and is intended to be the main fund for global climate change finance by mobilizing \$100 billion by 2020. It is also important to note that many stakeholders can access the funds by obtaining accreditation. Thus, the GCF is an important future source of finance for including climate change in the ICZM programmes of developing countries in the region and ICZM managers should monitor its development carefully.
- (iv) The PPCR is one of two Trust Funds that comprise the Climate Investment Funds (CIF). It makes resources available for increasing resilience to climate change when such actions are part of a broader strategy for development and poverty reduction. No countries in the region currently access the fund but it may be possible to do so in the future.
- (v) Finance from these sources cannot cover all the costs of a given programme or investment; other sources will be needed particularly local finance from the government. In addition these funds often complement finance for development from bilateral and multilateral sources so that mainstreaming the climate resilience into development objectives more broadly (as the ICZM approach seeks to do) is important.

Table 5.1: Multilateral funds for adapting to climate change

Fund	Purpose	Eligibility	Funding
SCCF <sup>2</sup>	<p>Designed to finance activities, programs and measures related to climate change that are complementary to those funded through the climate change focal area of the GEF, under the four financing windows:</p> <ol style="list-style-type: none"> <li>1. Adaptation to climate change;</li> <li>2. Technology transfer;</li> <li>3. Mitigation in selected sectors; and</li> <li>4. Economic diversification.</li> </ol> <p>Of these adaptation has top priority.</p>	All non-Annex I countries are eligible. In the Mediterranean this includes: Albania, Algeria, Bosnia & Herzegovina, Egypt, Israel, Libya, Morocco, Montenegro, Tunisia, Lebanon and Syria.	As of 2012, pledges to the fund were \$227 million, of which \$20 million was uncommitted. Further financing is expected.
AF <sup>3</sup>	Finances concrete adaptation programmes aimed at addressing the adverse impacts of and risks posed by climate change. This includes: low-lying coastal and other small island countries, and countries with fragile mountainous ecosystems, arid and semi-arid areas, and areas susceptible to floods, drought and desertification.	Any developing countries that are parties to the Kyoto Protocol and particularly vulnerable to the adverse effects of climate change. Direct access possible for National Implementing Agency. In the Mediterranean Egypt has accessed funds.	Financed with a share of proceeds from the <u>clean development mechanism (CDM)</u> project activities and other sources of funding. As of 2014, it had a balance of \$277 million with annual commitments running at around \$75 million.
GCF <sup>4</sup>	A key role in channelling new, additional, adequate and predictable financial resources to developing countries for mitigation and adaptation. The fund will disburse grants, loans, equity and guarantees through accredited entities. The GCF will finance activities to enable and support adaptation, mitigation (including REDD+), technology development and transfer (including CCS), capacity-building and the preparation of national reports.	All developing country members of the UNFCCC are eligible. A range of entities can be accredited – government agencies, NGOs and private sector. 70 developing countries have so far designated a national authority or focal point as governmental counterpart of the fund.	In 2009, developed countries pledged \$30 billion for “fast start” climate financing for development, and a goal of mobilizing \$100 billion annually by 2020. In 2014, actual capital was \$10 billion. To date, disbursements have been very minor.
PPCR <sup>5</sup>	The PPCR is one of two trust funds that comprise the Climate Investment Funds (CIF) – a joint undertaking of multilateral development banks. It is administered by the World Bank. Approved in November 2008, the PPCR provides incentives for scaled-up action and transformational change in integrating climate resilience into national development planning consistent with poverty reduction and sustainable development goals in 9 countries and 2 regions.	Countries that are (a) eligible for official development aid (ODA) and (b) have an active country programme with one of the multilateral development institutions. In practice, there is a priori selection of PPCR target countries. None are in the Mediterranean.	As of June 2014, \$1.3 billion had been pledged and \$919 million received and \$784 approved for disbursement.



## Public Finance for Adaptation in Member States of the EU

For Member States of the European Union the new rule on EU funds allows and indeed encourages them to allocate a part of the investments for economic development to climate change compatible projects. In its Multi-annual Financial Framework (MFF) 2014-2020, the Commission has made mandatory a key indicator for climate action at EU Member State level: the share of ESIF support that will be used for climate change objectives. This relates to the target that climate related expenditure will correspond to at least 20 percent of the EU funds in the period 2014-2020. The indicative share envisaged for National Operational Programmes (NOPs) will be assessed against this objective and against the programme scope.

- <http://www.thegef.org/gef/ldcf>
- <http://www.thegef.org/gef/SCCF>
- <http://fiftrustee.worldbank.org/index.php?type=fund&ft=af>
- <http://www.gcfund.org/documents/in-session-documents.html>
- <http://www.adaptasiapacific.org/funds-compendium/33>

According to the individual Partnership Agreements, different amounts will be available under EU ESIF for the period 2014-2020. For example, Croatia has been allocated a total of around €10.6 billion euro. If the 20 percent rule of CC actions to be financed is respected, about 2 billion euro in Croatia should be dedicated to CC compatible mitigation and adaptation actions in relevant sectors (energy, transport, agriculture, water, etc.). These funds will be critical, especially for new member states to fulfil their EU mitigation targets **and** to invest in adaptation. Concerning agriculture the leverage effect in financing CC compatible actions could be even higher. For the Rural development programme, EAFR (second pillar of the CAP) there is “30%-rule” for the financing of CC actions. The percentage applies not only to the 2 billion that Croatia will receive through CAP but also to the mandatory 350 million euro of national co-financing. In total that means 30% of 2.35 billion euro have to be allocated to environmental and CC-relevant measures.

Today at the EU level, climate change adaptation is mainstreamed throughout sectoral policies – environment, agriculture, fisheries, regional

development, etc. Financing climate change actions in a member state is possible via five European structural and investment funds (ESI funds): the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD), and the European Maritime and Fisheries Fund (EMFF). Between 20 and 30 percent of funds under the individual programmes must be dedicated to climate change mitigation or adaptation measures.

In addition, other EU financial instruments exist that will promote research and development on climate change adaptation. These include Horizon 2020, the LIFE+ instrument, which finances a wide range of projects on the environment and climate mitigation and adaptation<sup>60</sup> and the EU Solidarity Fund for natural disasters (ex post funding for drought and flood events).

Finally, climate adaptation is integrated into funding and loans by the European Investment Bank and the European Bank for Reconstruction and Development, and it is a major factor for insurance and other cross-cutting issues in the private sector.

## Private Finance

Information on the amount the private sector spends on adaptation to climate change is very limited, although many private sector entities are certainly allocating resources to ensure their investments are climate resilient. The private sector is also providing climate risk insurance as part of the process of planning economic activities and making investment decisions. There are many risk management options that insurance may incentivize, such as flood proofing for buildings and property or retrofitting houses. For businesses, the link between an insurance product and a risk reduction incentive appears to be significant – the size of an insurance premium makes risk reduction activities with premium discounts more attractive.

Recent experience has shown that there is a role for public sector support in mobilizing private finance. This support can be provided by ensuring that private partners are better informed about the risks and have the technical capability to undertake

<sup>60</sup> In the 2014-2020 MFF, a specific LIFE+ climate change fund with 800 million euros has been created.



the appropriate adaptation measures. In the case of insurance, public-private partnerships have been successful in providing coverage when a private company would not have been able to do so.

In coastal zones the private sector has a major role in investment in facilities that provide services such as recreation, tourism, housing, etc. When such investments face an increased risk from climate change, private investors will need to provide financing for adaptation to the extent that they directly benefit from it. The fact that some investments fulfil a “public good” (a sea wall may protect the property of more than one investor) shows that we need a combination of public and private financing to ensure that the correct investments are made.

At the same time, situations exist in which public funds are not available for “public good” investments, while the private sector, which has the financial wherewithal, will not undertake the investment on its own. Innovative governance structures such as partnerships can stimulate private sector co-financing (Tompkins and Eakin, 2012). Public-private partnerships (PPPs) arose as a way to share capabilities and risks between the public and private sectors (Schroeder et al., 2013). The role of the municipality in PPPs consists of facilitating project development by removing barriers, while the private sector assumes part of the risk, provides funding and manages the project. For further details see Markandya et al., 2015.

### Conclusions on Financing

This section has shown that adaptation-related finance has increased since the beginning of this decade (see Buchner et al., 2013, 2014, and UNFCCC, 2011). Furthermore, there are clear indications that climate change considerations are now more frequently mainstreamed into development cooperation practices (OECD, 2014d). However, the section also highlights that scaling up adaptation financing to address current climate variability and projected climate change remains a pressing priority. As noted in the beginning of the section, a more comprehensive overview of adaptation financing flows would require the inclusion of private financing flows and domestic spending on adaptation.

## 5.4 Acting

The lessons learned should be shared across the ICZM community and used to improve future plans. They apply especially in the climate area, where there is not much experience with the implementation of actual policies and measures, and where such lessons are constantly being learned.

## 5.5 Monitoring and Review

It is critical that planners continuously track information on climate impacts since new data is appearing all the time. This data may affect proposed adaptation actions, which should be revisited periodically to incorporate any new knowledge.

For all aspects of ICZM it is also important to monitor the success of any actions taken in achieving their goals, and what the impact has been of introducing relevant measures. The critical steps in plan implementation are described in the strategy. The main guidelines set out a fairly detailed description of the indicators that will track if a plan’s interventions are achieving their intended objectives. The interventions must be aligned with these objectives or, more precisely, they must be linked to the output or outcome being measured.

The Guidelines for the Preparation of NICZM Strategies propose three types of indicators: **Sustainability Indicators** that show how the plan is realised; **Impact Indicators** that measure how well the plan’s outputs are being achieved; and **Performance Indicators** that measure how well the project activities are being implemented. In addition, a distinction is made between Headline Indicators that provide information to the general public and Specific Indicators that assist in the technical monitoring of the plan. An indicator matrix is provided. It establishes a link between the broad objectives (see Section 3.2 on “Setting the direction”) and possible indicators that inform us of the progress in achieving these objectives.

From a climate change perspective the broad objectives are: sustainable development of the region and the protection of human life and natural and physical capital in the face of climate change. Each of these objectives is likely to be affected by climate change. The problem with developing indicators in this context is that the threat from climate change is in the future and an estimate

must be made of its magnitude so that plans for development can be formulated. **Hence, the relevant climate indicators will need considerable analytical work.** Furthermore, the results of this analysis will require regular monitoring over the life of the ICZM. However, it is worth the effort as it keeps this dimension of the problem in the public's mind.

Table 3.1 provides the broad categories of indicators that monitor climate impacts in coastal zones. The best starting point for such indicators is the national communication by the country, which should at least provide national estimates of the main climate change impacts in regard to temperature increase, sea-level rise, precipitation and extreme events. By the very nature of the problem,<sup>61</sup> such a data cannot consist of point

estimates, but must be provided in the form of ranges. Thus, they will take a form that makes it appropriate to adopt a risk-based assessment at future stages of the process. Tables 5.2 and 5.3 describe the data that is typically provided. Other countries may not have quite the same level of geographical detail; if the impacts are likely to be significant it may be worth asking a specialised agency such as the UK Met Office or the Danish Climate centre to customise projections for specific coastal regions. This is likely to involve some outlays, which may be recoverable from international institutions supporting the preparation of the programme.

Box 5.5 provides a description of the type of data available for a mature economy, such as the UK.

*Table 5.2: Data provided on a downscaled basis for making a risk assessment*

Variables Over Land Areas	Units	Temporal Averaging
Mean Temperature	°C	Month, season, year
Mean daily maximum temperature	°C	Month, season, year
Mean daily minimum temperature	°C	Month, season, year
Warmest day of the season	°C	Season
Coolest day of the season	°C	Season
Warmest night of the season	°C	Season
Coldest night of the season	°C	Season
Precipitation rate	mm/day	Month, season, year
Wettest day of the season	mm/day	Season
Specific humidity	g/kg	Month, season, year
Relative humidity	%	Month, season, year
Total cloud	Fraction	Month, season, year
Net surface long wave flux <sup>1</sup>	W/m <sup>-2</sup>	Month, season, year
Net surface short wave flux <sup>2</sup>	W/m <sup>-2</sup>	Month, season, year
Total downward short wave flux <sup>3</sup>	W/m <sup>-2</sup>	Month, season, year
Mean sea level pressure	hPa	Month, season, year
<b>Variables Over Marine Areas</b>		
Mean air temperature	°C	Month, season, year
Precipitation Rate	Mm/day	Month, season, year
Total cloud	Fraction	Month, season, year
Mean sea level pressure	hPa	Month, season, year

Source: UK Climate Projections Briefing Report, 2009.

**Note:**

1. Net surface long-wave flux is a measure of the total amount of longwave radiation that flows through a unit area per unit time at the Earth's surface.
2. Net surface shortwave flux is a measure of the total amount of shortwave radiation that flows through a unit area per unit time at the Earth's surface.
3. Total downward surface shortwave flux is a measure of the amount of shortwave radiation received by a unit area per unit time at the Earth's surface.

<sup>61</sup> One important reason is that future emissions and concentrations of greenhouse gases are not known and depend on the policies that are adopted to control them. However, other sources of uncertainty also exist.

Table 5.3: Typical data reported from climate models projections for the English coasts in 2050.

Source: UK Climate Projections Briefing Report, 2009.

Climate Variable	Very likely to be more than	Central estimate	Very unlikely to be more than
Mean annual temperature	+1.7°C	+2.7°C	+4.0°C
Mean summer temperature	+1.4°C	+3.1°C	+5.1°C
Mean annual precipitation	-6%	0%	+6%
Mean summer precipitation	+8%	-20%	-45%
Mean winter precipitation	+3%	+18%	+41%
Relative sea level	+13 cm	+27 cm	+41 cm

Note: Comparisons are relative to the 1960-1990 climate average.

#### Box 5.5: Impacts data Available for Coastal Zones in the UK

Data are available for a range of future socio-economic scenarios and allowing for different probabilities of climatic outcomes. For example, in the UK the following kinds of data are available for 25x25 km grids on a probabilistic basis. The 20 variables for which data are given are listed in Table 1. Projections are averaged for each of seven future overlapping 30 year time periods: 2010-2039; 2020-2049; 2030-2059; 2040-2069; 2050-2079; 2060-2089; 2070-2099. All changes are expressed relative to a modeled 30-year baseline period of 1961-1990.

Some information is also available in probabilistic terms, which provides a **central estimate** (e.g., 50% probability of not being more than a given increase in temperature), and **very unlikely events** (e.g., a 10% probability of being less than a given increase in mean temperature value or more than a given increase in mean temperature). These are based on 3 emissions scenarios plus other uncertain parameters.

For marine areas the information available includes, as noted in Table 1, the sea-level rise (with the probabilistic information as indicated above for mean temperature rise).

In addition the marine projections include information on projected storm surges. The last gives the projected elevation of the projected high tide under different return levels (e.g., 50 year return levels). Figures are available with different confidence intervals.

A third piece of climate information that is projected is changes in offshore waves. This gives changes in winter mean wave height but uncertainties in this variable cannot be expressed in probabilistic terms.

# Conclusions

This set of guidelines has taken the reader through the different stages of ICZM, showing how climate change is relevant to that stage, what kinds of actions are needed to address climatic effects, and what information is available in the literature on these effects, especially in the Mediterranean region. It has also laid out the lessons learned from the management of CV&C in specific locations in the region and elsewhere.

A great deal of research has established that climate change is a matter of concern because of increasing temperatures, sea-level rise and the increased frequency and intensity of extreme events (droughts, floods, storm surges). Some of these effects are already evident and they are projected to become even more serious over the rest of this century.

Coastal zones are especially vulnerable to sea-level rise and storm surges, and flooding in estuaries and deltas. They are also affected by changes in the level and pattern of demand for tourism, land for residential purposes, and fisheries and shipping.

This report has laid out the expected effects in the Mediterranean in these areas. Its key considerations are: (a) investment in vulnerable areas may prove to be unwise if assets are subject to damages from the effects of climate change, (b) private agents will have to be given the right information and incentives in order to make the best decisions. The report also lays out different

ways in which the various instruments that it discusses can be combined for this purpose.

The analysis of the location of vulnerable areas and what actions are justified to protect them has become a key part of mainstreaming climate change into ICZM. We have provided examples of this effort from Croatia, Tunisia and other countries.

Adaptation to climate change is a major activity in all countries and resources are available from different sources to finance it. The report provides details of these sources for EU members and other countries in the Mediterranean region. Appropriate adaptation policies and measures are first and foremost those which can be established as "no regrets". It is surprising how many climate adaptation measures have benefits other than those related to reducing climate impacts. They include lesser impacts from the current variability of climate and better management of land and other natural resources from a sustainability perspective.

Lastly, our knowledge of climate change is expanding all the time, but we are still making decisions in a framework of uncertainty. Hence, it is important that the ICZM system be flexible and open to new information. Methods for decision making with incomplete and dynamic information must be part of the tool kit that planners have at their disposal.

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## Websites

Major European and other projects on climate change impacts and adaptation can best be accessed from their websites. Some of the important ones of relevance are:

<http://www.circeproject.eu/>

The CIRCE Integrated Project, funded under the European Commission's Sixth Framework Programme, aims to reach this objective, highlighting impacts and possible adaptation actions of the climate change in the Mediterranean region that includes Europe, North Africa and the Middle East.

<http://www.climatecost.cc/reportsandpublications.html>

Using detailed disaggregated, bottom-up approaches, combined with top-down aggregated analysis, this project aims to provide a comprehensive and consistent analysis of the full costs of climate change. It covers the member states of the EU as well as India and China.

<http://peseta.jrc.ec.europa.eu/results.html>

The objective of the PESETA project (Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis) is to make a multi-sectoral assessment of the impacts of climate change in Europe for the 2011-2040 and 2071-2100 time horizons.

[http://ec.europa.eu/research/environment/pdf/env\\_health\\_projects/climate\\_change/clccashh.pdf](http://ec.europa.eu/research/environment/pdf/env_health_projects/climate_change/clccashh.pdf)

The cCASHh project is a combination of impact and adaptation assessment for three climate-related health outcomes: \*health effects of heat and cold; \*health effects of extreme weather events; \*infectious diseases transmitted by insects and ticks, e.g., tick-borne encephalitis, malaria (vector borne and rodent borne diseases)

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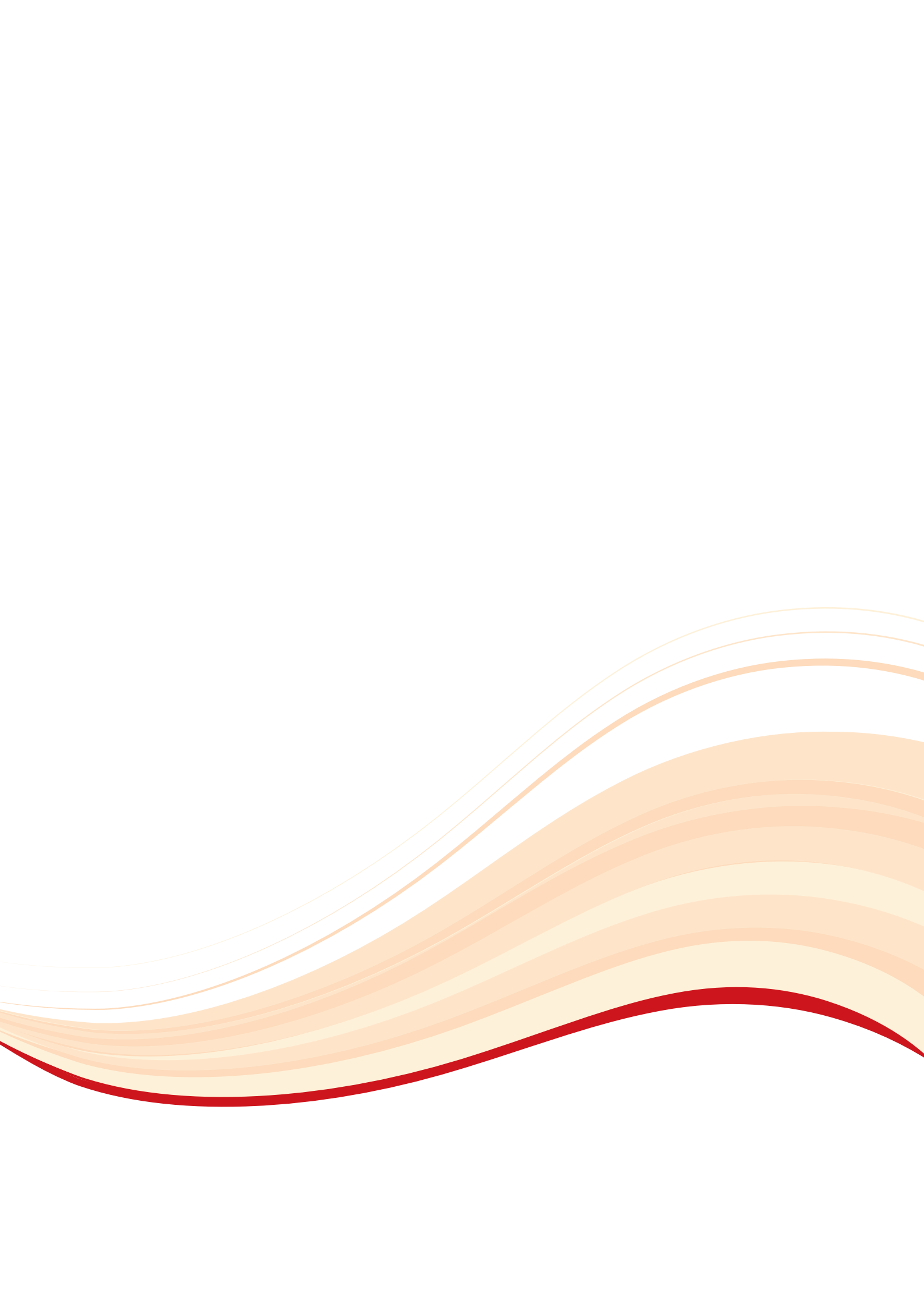
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PAP/RAC is established in 1977 in Split, Croatia, as a part of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP). PAP/RAC's mandate is to provide support to Mediterranean countries in the implementation of the Barcelona Convention and its Protocols, and in particular of the Protocol on Integrated Coastal Zone Management. PAP/RAC is oriented towards carrying out of the activities contributing to sustainable development of coastal zones and strengthening capacities for their implementation. Thereby, it co-operates with the national, regional and local authorities, as well as with a large number of international organisations and institutions.



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