Expert Analysis:

Environmental change, conflict, and human migration in the Mediterranean Basin

by MedEC

Mediterranean Experts on Climate and environmental Change

MEDITERRANEAN EXPERTS ON CLIMATE AND ENVIRONMENTAL CHANGE

ISBN: 978-2-493662-16-3 doi: 10.5281/zenodo.14800746

Disclaimer

The content and views expressed in this document are purely those of the authors and may not, in any circumstances, be interpreted as stating an official position of the supporting institutions, including UNEP/MAP. Neither the supporting institutions nor any person acting on their behalf may be held responsible for the use, which may be made of the information contained therein.

The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the MedECC and its supporting institutions concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Preferred citation

MedECC, 2026: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, pp. 238. doi: 10.5281/zenodo.14800746

Editors

Manfred A. LANGE *(Cyprus),* **Roula MAJDALANI** *(Lebanon),* **Wolfgang CRAMER** *(France),* **Joël GUIOT** *(France),* **Julie C. GATTACCECA** *(France),* **Katarzyna MARINI** *(France)*

Cover design and layout by **Zen-Studio** *(Marseille)*
Copy-editing by **Connected Language Services**
Photo credits **Adobe Stock Photos**

Supporting institutions

www.medecc.org
contact@medecc.org

Expert Analysis

Environmental change, conflict, and human migration in the Mediterranean Basin

Editors

Report Coordinators:
Manfred A. LANGE *(Cyprus)*, **Roula MAJDALANI** *(Lebanon)*

MedECC Coordinators:
Wolfgang CRAMER *(France)*, **Joël GUIOT** *(France)*

MedECC Scientific Secretariat:
Julie GATTACCECA *(France)*, **Katarzyna MARINI** *(France)*

by MedECC
Mediterranean Experts on Climate and environmental Change

Table of contents

Acknowledgements 9

Preface 11

List of figures, tables, and boxes 14

List of abbreviations, acronyms, and scientific units 16

Executive Summary 21

Chapter 1 43
Introduction and framing

Executive summary 45

1.1 Motivation to write the Expert Analysis 46
1.1.1 Why consider the relationships between environmental change, migration, and conflict? 47
1.1.2 Why focus on the Mediterranean region? 48
1.1.3 The environmental change-conflict-migration nexus 49
1.1.4 The environmental change-migration-conflict nexus in the policy context of the Mediterranean region 49

1.2 Main issues addressed and structure of the report 51
1.2.1 Scope and content of the report 51

1.3 Key issues and conclusions to be drawn 53

1.4 Background and report drafting process 55
1.4.1 Nature of the analysis as a synthesis of available literature and data 55
1.4.2 Selection of authors based on their expertise, with a consideration of gender and geographical balance 55
1.4.3 Neutrality and independence of the authors 55
1.4.4 Process of writing, editing, and reviewing the report 55

References 60

Chapter 2 63
Geographical and temporal scope and current setting

Executive summary 65

2.1 Definition of key terms 66
2.1.1 Human mobility and its different forms 66
2.1.2 Other important definitions 67

2.2 Spatio-temporal scopes of the report 69
2.2.1 Geographical scopes 69
2.2.2 Temporal scale and temporal scope of this report 71
2.3 Socio-economic and demographic trends: past, present, and future 72
2.4 Major trends of climate changes in the Mediterranean: past, present, and future 74
2.5 Past and current patterns and trends in migration and conflict 76
2.5.1 Diachronic responses to environmental change 76
2.5.2 Trends in migration and security and humanitarian challenges 77
2.6 Future projected trends in conflicts and migration 79
References 80

Chapter 3 87
Threats to human life and livelihoods from environmental change

Executive summary 90
3.1 Water 92
3.1.1 Introduction 92
3.1.2 Current state of water availability and spatial distribution 92
3.1.3 Human pressures and water management 95
3.2 Food 96
3.2.1 Historical and projected impacts of environmental changes on agriculture and fisheries sectors in the Mediterranean 96
3.2.2 Beyond direct impacts: indirect environmental effects and consequences 97
3.2.3 Implications for livelihoods, migration, and conflict 97
3.3 Health 99
3.3.1 Interconnections between conflict, human migration and environmental change, and impacts on public health 99
3.3.2 Current and future health pressures caused by environmental change, migration, and conflict in the Mediterranean 99
3.3.3 Intersectional vulnerability 101
3.4 Coasts 103
3.4.1 Impacts of environmental change 103
3.4.2 Current and future socio-economic pressures 103
3.4.3 Implications for conflict and migration 106
3.5 Ecosystems 108
3.5.1 Historical and projected climate trends and their impacts on Mediterranean ecosystems 108
3.5.2 Beyond direct climate change impacts: indirect climatic effects and consequences of non-climatic environmental change 110
3.5.3 Summary: implications for livelihoods, migration, and conflict 111

3.6 Energy 112
3.6.1 Environmental change impacts on the energy sector 112
3.6.2 Implications for livelihoods, migration, and conflict 113

3.7 Interactions between sectors 115

References 118

Chapter 4 131
Challenges for security: conflict and cooperation in the Mediterranean

Executive summary 133

4.1 Geopolitics, security risks, and conflicts in the Mediterranean region 134

4.2 The interaction between environmental change and conflict: empirical foundations 136

4.3 Climate and conflict projection 141

4.4 Conflict and migration 143

4.5 Conflict, climate hazards, vulnerability, and adaptation 145

4.6 Conflict resolution, climate governance, and environmental peacebuilding 148

References 151

Chapter 5 159
Understanding the environment-migration nexus in the Mediterranean

Executive summary 161

5.1 Central concepts and frameworks on environmental migration 162
5.1.1 Conceptual framework 162
5.1.2 Different types of environmental hazards and their impacts on populations 163
5.1.3 The role of contextual effects and co-stressors 164
5.1.4 The IPCC risk framework 165

5.2 Empirical evidence on environmental migration in the Mediterranean 166
5.2.1 North Africa and Sahel 166
5.2.2 The Middle East as part of the MENA region 167
5.2.3 Southeastern Europe 168
5.2.4 Southern Europe 170

5.3 Trajectories and destinations of mobile populations 171
5.3.1 Environmental changes and urbanisation processes 171
5.3.2 Regional migration towards the Mediterranean 172

5.4 Projecting environmental impacts on migration flows in the future 174
5.4.1 Projection types and methods 174
5.4.2 Projecting future migration due to environmental stress in the Mediterranean 175

References 176

Chapter 6 185
The environmental change-conflict-migration nexus and uneven challenges of adaptation

Executive summary 187

6.1 Complexity of interactions between environmental change, forced migration, and conflict 188
6.1.1 Limitations of available information, data, and sources on key dynamics for the nexus 188
6.1.2 Migration, adaptation, and the environmental change-conflict-migration nexus 190

6.2 Governance of environmental change, migration, and conflict in the Mediterranean 193

6.3 Legal frameworks and regimes to govern environmental migration 195

6.4 Migration and place-based vulnerabilities 196
6.4.1 Place-based vulnerabilities are central in the environment-migration-conflict nexus 196
6.4.2 Vulnerability varies across time and space 196

6.5 Migration, environment, and intersectional aspects 199

References 201

Chapter 7 207
Knowledge gaps and strategies to address them

Executive summary 209

7.1 Introduction 210

7.2 Mechanisms and pathways affecting the environment-migration-conflict nexus 212

7.3 Mediterranean challenges: diversity, instability, and the perils of securitisation 216

7.4 Methodological issue 220
7.4.1 Interdisciplinary and multidimensional research 220
7.4.2 Contextual complexities: multiple historical, regional, and cultural contexts and individual stories 220
7.4.3 From environmental conflict to environmental justice? 221
7.4.4 Data availability and reliability 222
7.4.5 Diverse methodologies and longitudinal and comparative studies 223

7.5 Conclusion: rethinking the environment-migration-conflict nexus 224

References 227

Annexes
Annex I: List of Contributors 232
Annex II: List of Expert Reviewers 235

Acknowledgements

The MedECC Expert Analysis is the result of extensive efforts by numerous individuals, supported by esteemed institutions. The editors wish to express their deepest appreciation to the Coordinating Lead Authors and Lead Authors for their invaluable expertise and dedication throughout the process. Their work was facilitated by the Contributing Authors who assisted in drafting the report. We are grateful to the expert reviewers whose insightful feedback on the drafts significantly enhanced the quality of the report. We would also like to acknowledge the support of the MedECC Steering Committee, for their oversight of the process.

We sincerely acknowledge the invaluable support of our institutional partners, particularly Plan Bleu, which hosts the MedECC Secretariat, the Union for the Mediterranean (UfM) with funding from the Swedish International Development Cooperation Agency (SIDA), and the United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP). Plan Bleu and the UfM Secretariat work in partnership to support MedECC within the framework of their cooperation agreements.

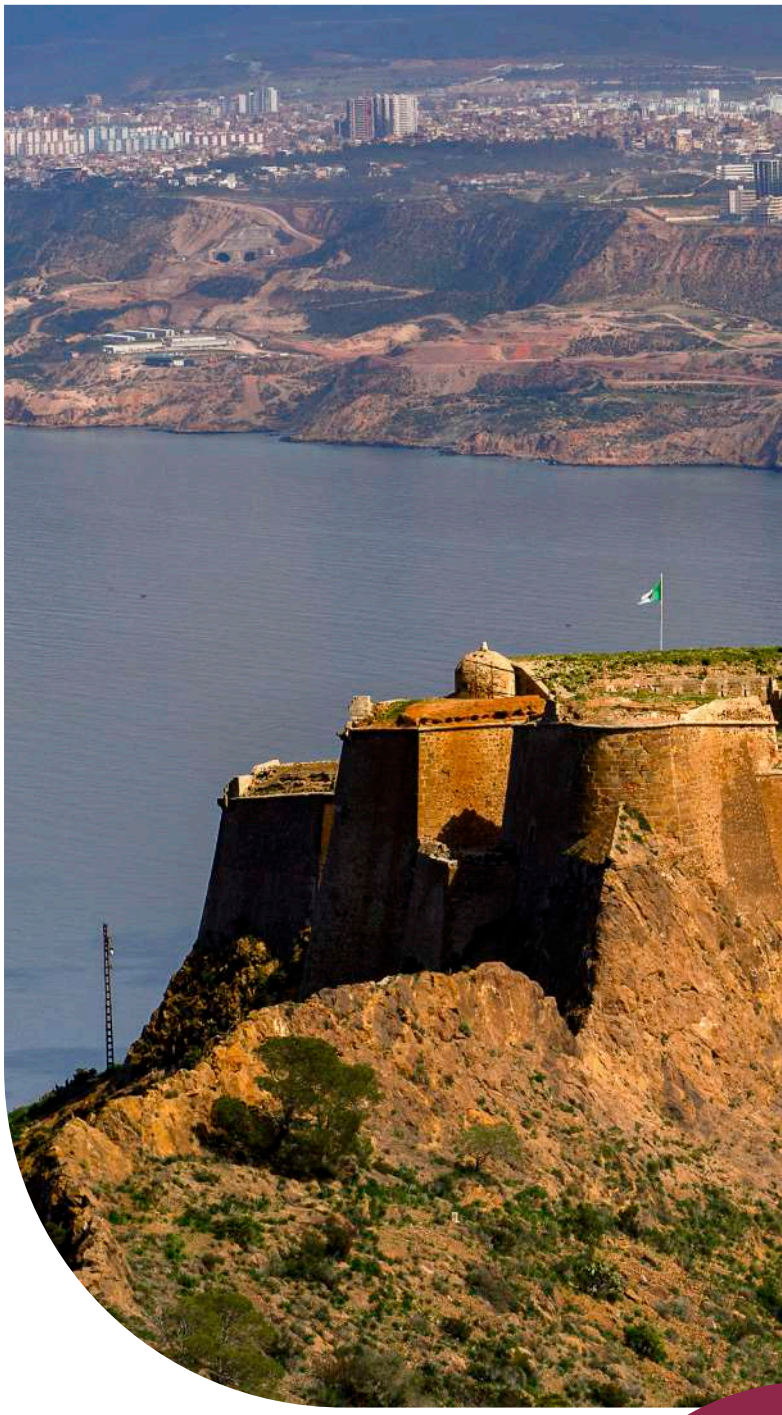
This analysis was developed within a Work Programme that benefited from funding by the French Ministry of Ecological Transition and Territorial Cohesion, the French Ministry for Europe and Foreign Affairs (MEAE), the Italian Ministry of Environment and Energy Security (MASE), the Mediterranean Trust Fund (MTF), and the Principality of Monaco. MedECC also receives support from the Advisory Council for the Sustainable Development of Catalonia (Government of Catalonia, Spain), the French Association Regional Group of Experts on Climate in the Southern Provence-Alpes-Côte d'Azur Region (GREC-SUD), and IT Department of OSU Pythéas (France).

We gratefully thank those who provided their invaluable help and assistance for the Coordinating Lead Authors in-person meeting, held in Barcelona (Spain) in June 2022.

We are grateful to those involved in communicating about MedECC and its reports, including the Plan Bleu and UfM communication teams.

We also extend our thanks to those who provided invaluable support with accounting and administrative matters within Plan Bleu and GREC-SUD.

Additionally, we wish to acknowledge the support from the graphic design and language services teams involved in the production of this report.



Preface

Mediterranean Experts on Climate and environmental Change (MedECC) is an open and independent international network of scientists founded in 2015, that specifically focuses on climate and environmental changes within the Mediterranean region. The objective of MedECC is to provide decision-makers, stakeholders, and citizens with assessments of available scientific knowledge on climate and environmental changes including associated risks and social aspects. MedECC reports aim to maintain neutrality regarding policy and to objectively address scientific, technical and socio-economic factors relevant to the application of policies. They are produced for use by policymakers and a broader audience and are developed on the basis of scientific criteria only.

Since 2015, more than 300 authors have contributed to MedECC reports, all in an individual capacity and without financial compensation. MedECC scientists are located in 35 countries, including 19 registered as Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) and 23 members of the Union for the Mediterranean (UfM).

The network is governed by Co-Coordinators, a Steering Committee, and an Advisory Board. Operations are managed by the MedECC Secretariat, which is officially hosted by Plan Bleu, a UNEP/MAP Regional Activity Centre in Marseille, France, as part of a partnership with the Secretariat of the UfM. The Mediterranean Action Plan of the United Nations Environment Program (UNEP/MAP) has also provided support since 2022, with MedECC activities integrated into the successive UNEP/MAP Work Programmes since 2020, the latest being approved during COP 24 (Cairo, Egypt, December 2025).

MedECC published the First Mediterranean Assessment Report (MAR1): *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future,* in November 2020. It includes a Summary for Policymakers (SPM) that was approved line-by-line during a plenary session attended by government representatives from Mediterranean countries in September 2020, ensuring its relevance to stakeholders. MedECC was awarded the prestigious North-South Prize 2020 of the Council of Europe for its efforts towards peace and democracy. The SPM was acknowledged as an important contribution of the scientific community to future climate and environmental action in the Mediterranean region, as stated in the Declaration adopted during the 2nd Ministerial Meeting on Climate and Environmental Action of the Union for the Mediterranean (4 October 2021, Cairo, Egypt), and by the 22nd meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) (COP 22, December 2021, Antalya, Türkiye). The findings of MAR1 have since been widely acknowledged and cited in strategic documents, establishing it as a foundational scientific source for climate and mitigation policies across the Mediterranean. The MAR1 report has also laid significant groundwork for other key deliverables and contributions for the Mediterranean region. MedECC contributed to the coordination of the climate change chapter of the State of the Environment and Development in the Mediterranean (SoED) report, published in 2020 by Plan Bleu. MedECC authors contributed to the IPCC Sixth Assessment Report (AR6-WG2) published in February 2022, through a cross-chapter paper focused specifically on the Mediterranean Basin, integrating regional aspects into the global assessment. In 2024, two MedECC Special Reports were published: *Interlinking climate change with the Water–Energy–Food–Ecosystems (WEFE) nexus in the Mediterranean Basin* and *Climate and environmental coastal risks in the Mediterranean.* The SPM of the climate and environmental coastal risks report was approved at COP23 (Decision IG.26/13, Portorož, 2023), while the SPM of the WEFE nexus report was endorsed at COP24 (Decision IG.27/10, Cairo, 2025).

This MedECC Expert Analysis

Scope of the Analysis

The ***MedECC Expert Analysis on environmental change, conflict, and human migration in the Mediterranean Basin*** responds to the MedECC Steering Committee's decision to provide scientific information regarding specific issues for the Mediterranean identified after the publication of MAR1, informed by both scientists and government representatives. It provides an assessment of the scientific, technical and socio-economic literature on the interdependency and numerous mutual linkages and feedback mechanisms between environmental change (including climate change), conflict and human migration. It builds on the MedECC MAR1 report, previous reports by the Intergovernmental Panel on Climate Change (IPCC), and other relevant local, regional, and national assessments, and draws on evidence from over 1000 scientific publications.

This Analysis examines the intricate connections between environmental change, conflict, and human migration in the Mediterranean Basin. It aims to improve the common understanding of the determinants, trends, patterns and impacts of human migration and displacement in order to assist in the development of policy measures designed to minimise human suffering, allocate resources effectively, and collectively support regional stability and well-being.

Structure of the Analysis

The Analysis consists of seven chapters and includes an Executive Summary, which presents key findings of the full Analysis in the form of headline statements and a synthesised narrative of the full Analysis. *Chapter 1 (Introduction and framing)* and *Chapter 2 (Geographical and temporal scope and current setting)* describe the methodology and process, context, background, and key dimensions of this assessment. *Chapter 3 (Threats to human life and livelihoods from environmental change)* provides an overview of the impact of environmental change including climatic drivers and non-climatic drivers, in a range of sectors, which may endanger human life and livelihoods and cause conflict and/or migration. *Chapter 4 (Key challenges for security: conflict and cooperation in the Mediterranean), Chapter 5 (Understanding the environment-migration nexus in the Mediterranean),* and *Chapter 6 (The environmental change-conflict-migration nexus and uneven challenges of adaptation)* then address the context-dependent migration patterns shaped by the interaction of environmental stressors with socio-economic and political factors. These core chapters aim to deepen the understanding of how environmental challenges influence conflict dynamics, migration flows, and adaptation strategies in the region. Finally, *Chapter 7 (Knowledge gaps and strategies to address them)* builds on the previous chapters and presents an overview of the knowledge gaps and some ways forward. The aim of this structure is to offer a coherent assessment of the risks and responses to efficiently guide policymakers and stakeholders toward a comprehensive understanding and effective policy responses that address the interconnected challenges of environmental change, security, and migration in the Mediterranean region.

The process

The MedECC Expert Analysis represents the collaborative efforts of a team of leading experts and scientists who volunteered their time and expertise without financial compensation. Its preparation followed the established principles of scientific assessments, similar to those applied for MAR1 and the IPCC, involving an open and rigorous process of author selection, external peer-review, and stakeholder consultation.

An open call for self-nominations of scientific experts was circulated in April 2021. The Scoping Meeting took place in November 2021, in which experts and scientists were consulted alongside governmental representatives and stakeholders. The framework and outline were reviewed and approved by the MedECC Steering Committee. The authors were selected and approved by the MedECC Steering Committee based on their expertise, their country, and the gender balance (56 authors from 17 countries). The Analysis detailed outline was developed during an in-person meeting in Barcelona, Spain, in June 2022. It was further refined in November 2022 following a consultation process in which the outline was shared with stakeholders, including the UfM Climate Change Expert Group (CCEG), UNEP/MAP and Plan Bleu Focal Points, and the Mediterranean Commission on Sustainable Development (MSCD).

The development of the MedECC Expert Analysis involved several stages of drafting, an open and transparent review and revision process, and consultation with stakeholders to ensure scientific accuracy and robustness, as well as strong policy-relevance. The initial draft (Zero Order Draft) underwent internal review between March and May 2023, receiving 203 comments from 12 reviewers. The First Order Draft Analysis and its Executive Summary underwent extensive peer review between October and December 2023. A total of 508 comments on the full Analysis and 147 comments on the Executive Summary were submitted by 34 reviewers and fully addressed by the authors in developing the final version, consolidated by the coordinators.

List of figures, tables, and boxes

Figures

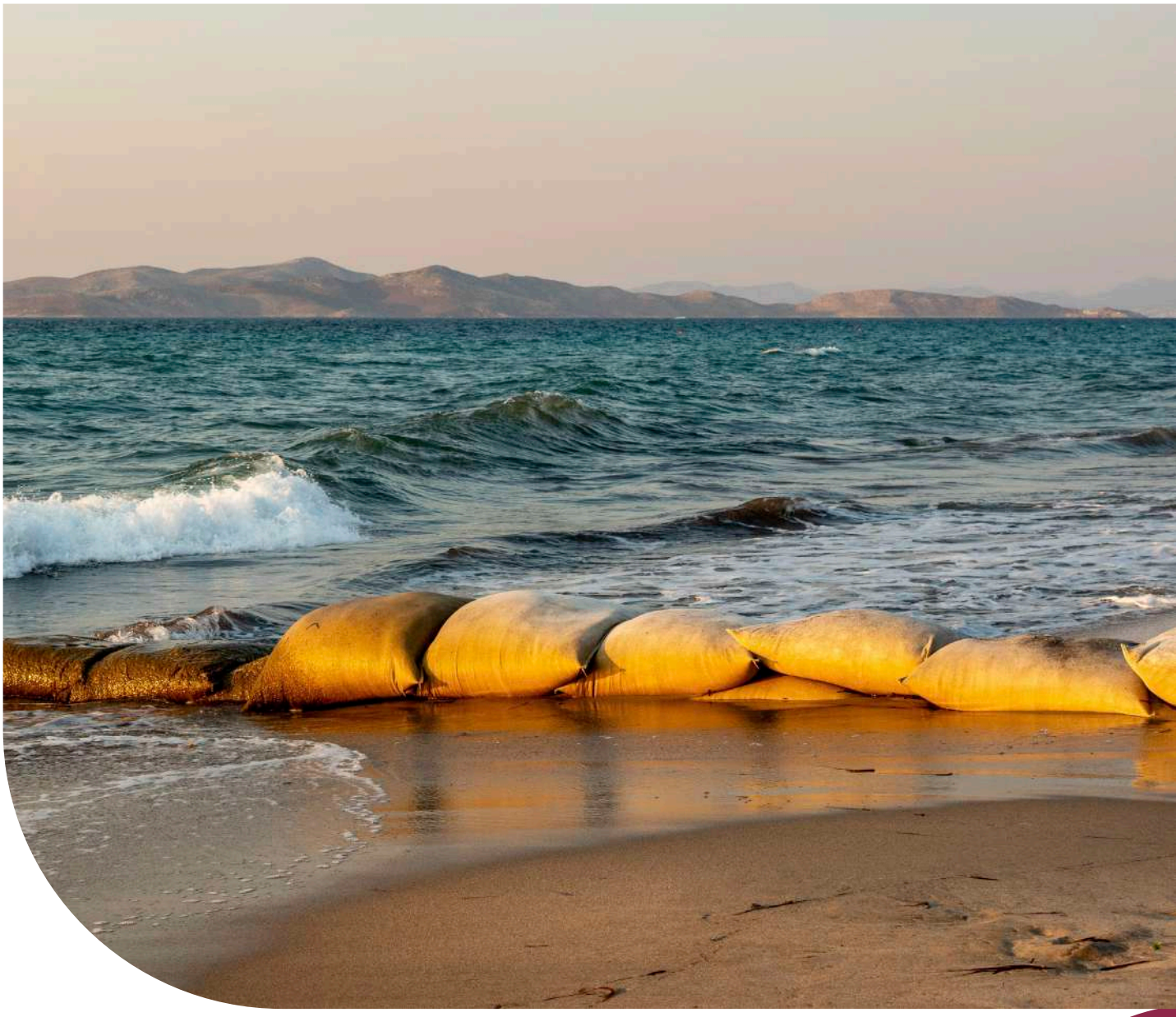
Figure ES1	Links between climate change and socio-economic changes and their consequences for the individual sectors	**32**
Figure ES2	Number of irregular border crossings by migrants in 2024	**35**
Figure ES3	Schematic representation of the conceptual framework showing the 'drivers' of migration and the influence of environmental change	**36**
Figure ES4	Conceptual diagram illustrating the 'vicious circle' which locks affected societies into a structure of violence, vulnerability, and the impacts of environmental change	**38**
Figure 1.1	Number of irregular border crossings by migrants in 2024 via the Western, Central, and Eastern Mediterranean Route, as well as other European migration movements.	**46**
Figure 1.2	A brief description of the report's structure and the main issues covered	**51**
Figure 2.1	Topography, bathymetry, major urban areas, container ports, and regional boundaries of the Mediterranean region	**69**
Figure 2.2	Spatial patterns and temporal evolution of economic and political indicators in the Mediterranean since 2002	**72**
Figure 2.3	Future demographic and socio-educational projections for the Mediterranean region from 2022 to 2100	**73**
Figure 2.4	Projected changes in temperature and precipitation across the Mediterranean region by the end of the 21st century	**74**
Figure 2.5	Share of international migration stock in Mediterranean countries as a percentage of the total population per country	**77**
Figure 2.6	International migration patterns by country	**78**
Figure 3.1	Infographic summarising the main results of the First Mediterranean Assessment Report (MAR1) published in 2020	**93**
Figure 3.2	Spatial distribution of mean annual precipitation values based on CRU gridded datasets	**93**
Figure 3.3	Total renewable water resources per capita in the Mediterranean in 2017	**94**
Figure 3.4	Climate risk assessment for fisheries in the Mediterranean Basin	**98**
Figure 3.5	Intersectional vulnerability and exposure in the Mediterranean city of Haifa (Israel)	**102**
Figure 3.6	Mean sea level rise projections for the Mediterranean Sea and six climate scenarios and the likely range	**104**
Figure 3.7	Population in Low Elevation Coastal Zone (LECZ) by geographical region and Shared Socioeconomic Pathways (SSPs)	**105**
Figure 3.8	Socio-economic challenges for climate change adaptation and mitigation	**106**
Figure 3.9	Meta-analyses of projected percentage changes in ecosystem service groups and categories provided by Mediterranean forest ecosystems under 21st-century climate change	**108**
Figure 3.10	Distribution of threatened marine species vulnerable to climate change throughout the Mediterranean Sea	**109**
Figure 3.11	Key risks in the Mediterranean and their location across the Mediterranean region for SSP5-RCP8.5 by 2100	**115**
Figure 3.12	Links between climate change and socio-economic changes and their consequences for the individual sectors	**116**
Figure 4.1	Number of battle-related deaths between 1989 and 2022 in the Mediterranean	**135**
Figure 4.2	Palmer Drought Severity Index (PDSI) (2005–2014) and location of armed conflict events (1989–2014)	**136**
Figure 4.3	Conceptual diagram illustrating the interlinkages between climate hazards, armed conflict, and societal vulnerability	**146**
Figure 5.1	A conceptual framework for understanding the migration-environment nexus	**162**
Figure 5.2	Environmental migration risk framework	**166**

Tables

Table 3.1	Distribution of water use for individual sectors and sub-regions of the Mediterranean Basin	**94**
Table 3.2	The energy cycle schematic, and the main areas of climate change impact on its operation	**114**
Table 3.3	Examples of climate change effects on the electricity	**114**
Table 4.1	Overview of the empirical studies that forecast/project future climate-related conflict risks	**143**
Table 6.1	Examples of climate adaptation measures in coastal, urban, and rural systems	**191**
Table 6.2	Climate migration in the context of adaptation strategies in the Mediterranean region	**197**

Boxes

Box 1.1	The role of science-policy interfaces for inclusive environmental governance	**56**
Box 3.1	The Shared Socioeconomic Pathways (SSPs)	**105**



List of abbreviations, acronyms, and scientific units

Abbreviations and acronyms

3S Initiative	Initiative for Sustainability, Stability and Security
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area
ACCORD	African Centre for the Constructive Resolution of Disputes
AFD	Agence Française de Développement
AR5	5th Assessment Report (of the IPCC)
AR6	6th Assessment Report (of the IPCC)
AU	African Union
BCE	Before Common Era
CARE-C	Climate and Atmosphere Research Center (Cyprus Institute)
CCEG	UfM Climate Change Expert Group
CA	Contributing Author
CBD	Convention on Biodiversity
CCP	Cross-Chapter Paper
CCT	Civil conflict transformation
CCVA	Climate Change Vulnerability and Adaptation
CL	Cutaneous Leishmaniasis
CLA	Coordinating Lead Author
CNA	Center for Naval Analyses
CO_2	Carbon dioxide
COP	Conference of the Parties
COVID-19	Coronavirus disease 2019
CP	Contracting Party
CRR	Conflict risk reduction
CRU TS	Climate Research Unit Time Series
DMCSEE	Drought Management Center for Southeast Europe
DRR	Disaster Risk Reduction
e.g.	exempli gratia or 'for example'
ECDC	European Centre for Disease Prevention and Control
EEA	European Environment Agency
EEAS	European External Action Service
EMME	Eastern Mediterranean and the Middle East
EnPax	Environmental Peacebuilding Association
EC	European Commission
ES	Executive Summary
ESCWA	Economic and Social Commission for Western Asia
et al.	et alii, or 'and others'
EU	European Union
EUAA	European Union Agency for Asylum
EVI	Enhanced Vegetation Index
FAO	Food and Agriculture Organisation
FOD	First Order Draft
G7	Group of Seven
GAP	Southeastern Anatolia Project (Turkish: Güneydoğu Anadolu Projesi, GAP)
GDP	Gross Domestic Product
GDP PC	Gross Domestic Product per capita
GED	Georeferenced Event Dataset
GERD	Grand Ethiopian Renaissance Dam
GFCM	General Fisheries Commission for the Mediterranean
GHG	Greenhouse gases
GMDAC	Global Migration Data Analysis Centre
GRID	Global Report on Internal Displacement
GWN	Good Water Neighbors
i.e.	id est, or 'that is' and means 'in other words'
IAI	Istituto Affari Internazionali (Italian Institute of International Affairs)
ICARDA	International Center for Agricultural Research in the Dry Areas (Lebanon)
ICG	International Crisis Group
ICMPD	International Centre for Migration Policy Development
ICZM	Integrated Coastal Zone Management
IDDRI	Institute for Sustainable Development and International Relations (Institut du développement durable et des relations internationales)
IDMC	Internal Displacement Monitoring Center
IDP	Internally displaced person
IEA	International Energy Agency
IEMed	European Institute of the Mediterranean
IEP	Institute for Economics and Peace
IGOs	Inter-Governmental Organisations
ILO	International Labour Organization
INGO	International Non-Governmental Organisation
IOM	International Organization for Migration
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISS	Institute for Security Studies
ITPS	Intergovernmental Technical Panel on Soils
IUCN	International Union for Conservation of Nature
KNOMAD	Global Knowledge Partnership on Migration and Development
LA	Lead Authors
LDCs	Least Developed Countries
LECZ	Low Elevation Coastal Zone
MAP	Mediterranean Action Plan
MAR1	First Mediterranean Assessment Report
MCSD	Mediterranean Commission on Sustainable Development
MED	Mediterranean
MedECC	Mediterranean Experts on Climate and environmental Change
MELUND	Ministerium für Energiewende, Umwelt, Natur und Digitalisierung des Landes Schleswig-Holstein (Ministry for Energy Transition, Environment, Nature and Digitalization of Schleswig-Holstein, Germany)
MENA	Middle East and North Africa
MPA	Marine Protected Area
MSSD	Mediterranean Strategy for Sustainable Development
NATO	North Atlantic Treaty Organization
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
OSCE	Organization for Security and Co-operation in Europe
PDSI	Palmer Drought Severity Index
PEA	Political economy analyses
PIK	Potsdam Institute for Climate Impact Research
PM	Particulate Matter
PM10	Particulate Matter with diameter below 10 µm
PRIO	Peace Research Institute Oslo
PTSD	Post-Traumatic Stress Disorder
PV	Photovoltaics
RAC	Regional Activity Center
RCP	Representative Concentration Pathways
RES	Renewable energy sources
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SIDS	Small Island Developing States
SIPRI	Stockholm International Peace Research Institute
SoED	State of the Environment and Development in the Mediterranean
SPA	Shared Policy Assumptions
SPEI	Standardised precipitation-evapotranspiration index
SPI	Science-policy interface
SPM	Summary for Policymakers
SSP	Shared Socioeconomic Pathway
UAE	United Arab Emirates
UCDP	Uppsala Conflict Data Program
UDHR	Universal Declaration of Human Rights
UfM	Union for the Mediterranean
UK	United Kingdom
UN	United Nations
UN CRC	UN Convention on the Rights of the Child
UN DESA	UN Department of Economic and Social Affairs
UNDP	UN Development Programme
UNDPPA	UN Department of Political and Peacebuilding Affairs
UNDRR	UN Office for Disaster Risk Reduction
UNEP	UN Environment Programme
UNESCO	UN Educational, Scientific and Cultural Organisation
UNFCCC	UN Framework Convention on Climate Change
UNHCR	UN High Commissioner for Refugees
UNIDO	UN Industrial Development Organization
UNOCHA	UN Office for the Coordination of Humanitarian Affairs
UNOHCHR	UN Office of the High Commissioner Human Rights
UNODC	UN Office on Drugs and Crime
UNOSCDS	UN Office of the Special Coordinator for Development in the Sahel
UNRWA	UN Nations Relief and Works Agency
US(A)	United States (of America)
USAID	US Agency for International Development
USDA	US Department of Agriculture
US DoD	US Department of Defense
vs.	versus (against)
WEFE	Water-Energy-Food-Ecosystems
WGI/II/III	Working Group I/II/III of the IPCC
WHO	World Health Organization
WMO	World Meteorological Organization
WWI/WWII	World War I/II
ZOD	Zero Order Draft

Scientific units

Physical Quantity / Concept	Unit Name	Symbol	Definition / Notes
SI base units			
Length	metre	m	-
Mass	kilogram	kg	-
Time	second	s	-
Thermodynamic temperature	kelvin	K	-
SI derived			
Area	square meter	m^2	-
Energy	joule	J	$kg\ m^2\ s^{-2}$
Power	watt	W	$kg\ m^2\ s^{-3} = J\ s^{-1}$
Temperature	degree Celsius	°C	t/°C = T/K – 273.15
Volume	cubic meter	m^3	-
Non-SI units			
Area	hectare	ha	1 ha = 10,000 m^2
Currency	euro, dollar, US dollar	€, $, USD	-
Time	year	yr	-
Percentage	(dimensionless, 1/100)	%	-
Mass	tonne	t	1 t = 103 kg

SI Prefixes (fraction and multiples)

Factor	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10^{1}	deca	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	µ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Expert Analysis: Environmental change, conflict, and human migration in the Mediterranean Basin

Executive Summary

Drafting Authors

Manfred A. LANGE *(Cyprus)*, **Roula MAJDALANI** *(Lebanon)*, **Eda ACARA** *(Türkiye)*, **Audrey BROUILLET** *(France)*, **Çağdaş DEDEOĞLU** *(Canada)*, **Andrea DESSÌ** *(Italy)*, **Roman HOFFMANN** *(Austria)*, **Vally KOUBI** *(Switzerland/Greece)*, **Lena REIMANN** *(The Netherlands)*, **Jürgen SCHEFFRAN** *(Germany)*, **Ourania TZORAKI** *(Greece)*, **Jan WILKENS** *(Germany)*

Editors

Manfred A. LANGE *(Cyprus)*, **Roula MAJDALANI** *(Lebanon)*, **Wolfgang CRAMER** *(France)*, **Joël GUIOT** *(France)*, **Salpie DJOUNDOURIAN** *(Lebanon)*, **Piero LIONELLO** *(Italy)*, **Julie GATTACCECA** *(France)*, **Katarzyna MARINI** *(France)*

This document should be cited as:

MedECC, 2026: Executive Summary [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Djoundourian, S., Lionello, P., Gattacceca, J.C., Marini, K. (eds.)]. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, pp. 21-41. doi: 10.5281/zenodo.17734238

Table of contents

Key highlights 25

A. Introduction 29

B. Drivers and their impacts on migration 30

C. Basic facts on migration 34

D. The environmental change-migration-conflict nexus 36

E. Knowledge gaps and future outlook 41

List of figures

ES1 Links between climate change and socio-economic changes and their consequences for the individual sectors 32

ES2 Number of irregular border crossings by migrants in 2024 via the Western, Central, and Eastern Mediterranean Route, as well as other European migration movements 35

ES3 Schematic representation of the conceptual framework showing the 'drivers' of migration and the influence of environmental change 36

ES4 Conceptual diagram illustrating the 'vicious circle', which locks affected societies into a structure of violence, vulnerability, and the impacts of environmental change 38

Key highlights

Background and general framework

Human mobility and the search for better or safer living conditions for individuals, communities, and substantial segments of the population have been common throughout much of the history of the Mediterranean (and elsewhere). The number of people crossing the Mediterranean Sea[1] and arriving in host countries, primarily on the northern shores, has fluctuated a great deal over the last decade, between a maximum of about 1 million in 2015 and a minimum of around 95,000 in 2020[2]. In 2023, approximately 270,000 people arrived in the Mediterranean Basin[3], coming mainly from the African continent and the Middle East and Western Asia. However, most migrants from these regions move internally within a given country, from rural areas to towns and cities (internal migration). When moving across borders to neighbouring or more distant states (external migration), migrants also prefer to seek shelter in urban settings. The variation in arrival numbers is due to a number of factors, including the general political situation in the region that is the ability of migrants to move away from their home country without restriction, and to cross national borders before reaching the main points of departure for Europe. Recently introduced strict border controls on the European Union's southern flank are important obstacles to migrants aiming to enter Europe. This includes bilateral and multilateral agreements between receiving European Union (and other) countries and origin or transit countries along both the North African and Eastern Mediterranean routes, from where migrants embark on their journeys towards Europe[4]. Migrants who manage to reach the Mediterranean coast often aim to reach a European country, despite the life-threatening conditions associated with crossing the Mediterranean Sea in largely unseaworthy boats. Between 2014 and 2024, more than 30,000 people have been recorded dead or missing at sea[5]. This represents a humanitarian tragedy that calls for urgent political measures and action from decision-makers at national, international, and European Union levels.

The reasons for migration and the fate of migrants[6] in the Mediterranean and its rim countries have been a matter of debate at national and international levels for the last few decades. Understanding the underlying reasons and motivations that compel people to take such risks may lead to a more rational basis for government policies and regulations.

Environmental and climate change[7] in countries of origin have often been cited among the many potential drivers for migration, including consequences on basic aspects of livelihoods, such as access to water and food security. Such deteriorating living conditions may leave individuals and communities little choice but to abandon their homes.

Conflicts and disputes over land and natural resources that turn violent, and politically driven conflicts in general, represent equally important driving forces for migration. Additionally, social and economic hardships, often interrelated with the aforementioned drivers, play important roles in prompting people to leave their homes.

1 Although outside the Mediterranean Basin, numbers reported include movements from West African countries towards the Spanish Canary Islands as part of Mediterranean migration statistics.

2 Mediterranean Refugees/Migrants Data Portal, United Nations High Commissioner for Refugees (UNHCR), https://data.unhcr.org/en/situations/europe-sea-arrivals. Accessed 1 March 2025.

3 The Mediterranean Basin comprises the semi-enclosed Mediterranean Sea and the countries and regions bordering it in Africa, Asia, and Europe.

4 See, for example, McAuliffe & Oucho (eds.), World Migration Report 2024 (IOM, Geneva). https://publications.iom.int/books/world-migration-report-2024

5 See: https://missingmigrants.iom.int/region/mediterranean

6 The term 'migrant' is used in this report to refer collectively to individuals and groups who voluntarily or involuntarily leave their homes to find new homes in either their country of origin (internal migrants), or in a country across borders (cross-border or external migrants), including asylum seekers and refugees, terms that are not mutually exclusive, but may overlap strongly.

7 In this Analysis, the term 'environmental change', if not explicitly stated otherwise, is used to refer to changes in terrestrial and marine ecosystems as well as changes in climate conditions at local, regional or global scales.

Objective and scope of the Analysis

The core objective of this Analysis is to achieve a more comprehensive understanding of the nexus between environmental change, conflict, and migration, both presently and in the near future. The numerous linkages and feedback mechanisms between each of these drivers and migration are complex. Unravelling and determining verifiable and concrete relationships between all elements of the nexus remains a major challenge from both a conceptual and applied perspective.

The Analysis provides an updated review of environmental changes with an emphasis on their impacts on water, food and energy security, human health, and the environmental integrity of the Mediterranean region. Environmental changes are frequently quoted as primary causes of migration and the terms 'environmental or climate migrants/ refugees' are used to depict people thus affected. However, this Analysis highlights that other drivers frequently play a more important role in (primarily external) migration than environmental changes and their impacts. These include, in particular, conflicts and their devastating consequences, various socio-economic factors, different degrees of vulnerability of affected populations, as well as governance issues in a given country. The current scope of the Analysis has therefore been expanded to include these factors and achieve a more comprehensive understanding of the environmental change-conflict-migration nexus.

This Analysis assesses the current state of scientific knowledge in order to better understand the experiences and challenges of migrants in the Mediterranean, with the goal of supporting decision-makers in creating effective policies aimed at improving the lives of those affected by migration and minimising the adverse consequences of human (im-)mobility in the Mediterranean. The Analysis applies the concept of the environmental change-migration-conflict nexus in order to develop integrated policy measures, which are derived through multi-stakeholder engagements. However, deficiencies in quantifying the linkages between the elements of this nexus result in significant challenges to devising appropriate response mechanisms.

Despite numerous new advances in our understanding of the environmental change-conflict-migration nexus, a number of questions remain open. The complexity of the subject, driven by human desires, fears, and motivations that are difficult to quantify, poses a significant challenge. However, the Analysis offers several lessons intended to inform decision-makers in devising policies and programmes that address the root causes of the problems emanating from the environmental change-conflict-migration nexus rather than their symptoms. At the same time, avenues for future research that address climate science, social and economic behaviour, impacts of foreign interventions, and geopolitics through a multi-disciplinary lens are proposed.

Results and conclusions

The complex interplay between climate change, conflict, and place-based vulnerability is particularly evident in the Mediterranean region[8], a well-documented hotspot of environmental stress and geopolitical instability.

First, the region faces multiple risks associated with environmental changes. Anthropogenic disturbances have severely affected the environmental integrity of marine and terrestrial ecosystems, as well as the well-being of local communities. Of particular concern is the issue of water stress, defined as water availability of less than 500 to 1000 m^3 per inhabitant per year, a situation already experienced in all the southern and eastern Mediterranean countries. Anticipated changes in climate conditions will likely transform the region into a global 'drought hotspot', with substantial adverse consequences for food security. Furthermore, rising sea levels, in combination with enhanced seawater intrusion, will render coastal aquifers unsuitable for human consumption and significantly reduce agricultural activities in countries that depend on them. The deterioration of Mediterranean freshwater, coastal, marine, and terrestrial ecosystems will result in a declining provision of a number of ecosystem services and therefore adversely affect human well-being.

Second, the region has historically been a hotspot for geopolitical conflict. The legacy of repeated foreign interventionism in the Middle East and North Africa (MENA) region since World War I, as well as more recent events and changes in political

[8] Although this Analysis focuses primarily on the Mediterranean region, it also draws on data from the Mediterranean Basin (see footnote 3), the Eastern Mediterranean and Middle East (EMME), and the broader Middle East and North Africa (MENA) region (also referred to as Southern and Eastern Mediterranean Countries (SEMC). In this Analysis, the MENA region refers specifically to countries bordering or closely connected to the Mediterranean Sea.

and socio-economic conditions since the end of the Cold War, have resulted in significant numbers of migrants fleeing their homes in search of safer shelter. The past two decades alone have seen the 2003 invasion and occupation of Iraq, the wave of popular uprisings known as the 'Arab Spring' in 2010 and 2011, and ongoing and violent conflicts in Libya, Syria, Yemen, and Palestine. The depth of the security and political challenges facing these states and societies have often overshadowed environmental disruptions, resulting in reduced attention and action to reduce the impacts of environmental changes in the region. Migrants from Syria, as well as Iraq, Afghanistan, and Sudan, represent a large proportion of the migrant flows towards neighbouring countries (Jordan, Lebanon, Türkiye) and the European Union. Persisting instability in Libya has contributed to turning the country into a major departure point for people from large parts of the African continent attempting to reach Europe. Conflicts directly cause migration by creating intolerable levels of threat to the well-being of local residents. Indirect effects of conflicts, including reduced economic opportunities and the resulting lack of sufficient income, compel many individuals or families to relocate.

Conflicts increase the vulnerability of exposed societies to future environmental hazards and can lead to detrimental impacts on societal development in a given locale. It has been observed that conflicts often turn these hazards into disasters by amplifying risks and vulnerabilities across multiple institutional and temporal scales. Conversely, variations in environmental conditions, such as changes in climate conditions combined with more severe and frequent extreme events, may cause competition for natural resources between neighbouring regions that can turn to extreme violence. Increased scarcity of natural resources, and particularly water and food, can thereby amplify already existing challenges.

The current lack of effective governance structures, limited cross-border cooperation, and unsustainable policies add to this challenge. Developing and implementing effective adaptation plans and initiatives may help reduce the consequences of environmental changes on natural resources, food security, general livelihood, and health, and reduce the potential for economic loss. Such plans can also be instrumental to alleviating the risk of conflict, thereby addressing the linkages between the elements of the environmental change-conflict-migration nexus. Intersectional structural inequalities that already permeate Mediterranean societies and economies also need to be considered. These include significant economic disparities between Mediterranean Basin countries, differences in mobility between rural and urban areas, as well as the position and role of women in society. These factors largely shape the complex realities of environmental vulnerability, migration, and conflict in the Mediterranean.

Insufficient empirical data, methodological shortcomings, and difficulties in accessing relevant data and conducting empirical work represent significant obstacles. To develop realistic and effective policy measures, further interdisciplinary and cross-sectoral studies are indispensable. Effective governance needs to address a set of specific challenges to identify pathways towards sustainable adaptation. Involuntary migration in the Mediterranean as a form of adaptation to environmental changes has been identified as a coping mechanism of affected communities. However, coping strategies alone, instead of efficient adaptation measures, may increase risks and vulnerabilities to the impacts of environmental changes for migrants in the long run.

The narrative of migration and displacement induced by environmental change as a linear cause-effect relationship needs to be revisited. It is crucial to acknowledge region-specific push factors and diverse motivations for migration, which differ not only from one region to another but also amongst various groups of people and communities. The differences between internal and external migration are shaped by distinct socio-economic conditions and geopolitical forces. Furthermore, the decision to leave one's home, livelihood, history, and culture is also shaped by the dangers involved in the journey (or at least a perception of them), its legality, and the risks migrants are prepared to take. A nuanced understanding of these complexities is crucial for research and policy domains, ensuring that the problem is approached with the necessary attention to its intricacies.

There is also an urgent need to shift the narrative around the environmental change-conflict-migration nexus from a security-focused frame of reference to one that emphasises opportunities for development and cooperation. A development-focused approach based on the engagement of all stakeholders can enhance social cohesion and reduce the tensions that may arise from competition over scarce resources.

Empirical evidence has established that the Mediterranean Basin is a climate change hotspot. Climate action in the Mediterranean, particularly in the southern and eastern countries, should therefore prioritise adaptation strategies and programmes to build

the resilience of vulnerable communities and develop climate-resilient solutions that enhance livelihoods, promote social equity, and mitigate vulnerability to climate impacts. From this perspective, exploring the potential of investments in green infrastructure, the water-energy-food nexus, and sustainable agriculture could contribute to job creation and local economic growth. Yet significant knowledge gaps remain in understanding and systematically developing evidence-based policies that link climate action with economic opportunities. This is particularly evident in marginalised communities that are often hit hardest by environmental change and extreme weather events. Limited fiscal resources, governance structures, and institutional capacities can make it difficult for these communities to cope with recurring and intensifying climate-related challenges, potentially influencing migration decisions.

Since the completion of the revisions of this expert assessment in 2024, various devastating conflicts have continued to affect the Mediterranean region with far-reaching humanitarian and environmental consequences. New analyses and data on their environmental consequences (destruction of agricultural lands, soil contamination, and damage to vital ecosystems) and forced displacement of populations are becoming available and will require updates of this assessment. We hope the MedECC Second Mediterranean Assessment Report (MAR2) and other assessments will depict the rapidly evolving realities and their cumulative impacts on the region's environment, human security and well-being.

More in-depth qualitative research is needed to explore how community-driven climate initiatives and collaboration on joint management of scarce natural resources as common public goods can foster peaceful coexistence and shared prosperity, while building resilience to environmental change. There are a growing number of success stories documenting how community-driven climate projects can engage stakeholders to efficiently address local needs and build local capacities, which in turn enhances livelihoods, promotes social equity, and mitigates vulnerability to climate change.

Additional collaborative research is needed at the regional scale and across sectors and disciplines in the Mediterranean, bringing together environmental scientists, economists, sociologists, and local practitioners to develop an evidence-based regional vision on how the environmental change-migration nexus is contextualised in different sub-regions of the Basin. This interdisciplinary approach can enhance understanding of the development impacts of environmental change within the broader framework of the UN 2030 Agenda for Sustainable Development.

Regional collaboration among Mediterranean countries, inter-governmental bodies, and Basin-level initiatives across the Mediterranean cannot be overemphasised. They represent an important avenue for building a coherent approach to managing the climate, socio-economic, political, and developmental challenges around the Basin. Existing multi-stakeholder platforms enable joint initiatives and projects, which promote dialogue and collaboration on climate, environment, and migration.

A. Introduction

A.1 Background

A.1.1 Human mobility and the search for better or safer living conditions for individuals, communities and substantial segments of the population have been common throughout much of the history of the Mediterranean (and elsewhere). {5.1}[9]

A.1.2 The Mediterranean represents an important transit and destination region for migrants from the African continent as well as from the Middle East and other parts of Western Asia. The number of people crossing the Mediterranean Sea and arriving in host countries, primarily on the northern shores, has fluctuated a great deal over the last decade. The variation in arrival numbers is due to a number of factors, including the general political situation in the region that is the ability of migrants to move away from their home country without restriction and to cross national borders before reaching the main points of departure towards Europe. Stricter border controls and increased surveillance, as well as cooperation with countries of origin and transit (for example the EU–Türkiye agreement), represent important obstacles for migrants aiming to enter Europe. {2.5}

A.1.3 Most environmental migration is internal and over short distances, often from rural areas to towns and cities, although migration over longer distances and across national borders is observed. Most migrants from these regions move internally within a given country, from rural areas to towns and cities (internal migration). When moving to neighbouring or more distant states (external migration), migrants also prefer to seek shelter in urban settings. Large inflow of migrants into host countries may reduce their adaptive capacity and put pressures on already stressed societies of the host countries. {1.1; 5.1}

A.1.4 There are numerous reasons for people or entire communities to migrate and leave their homelands. Sudden or persistent changes in environmental conditions, including extreme events and their consequences, and the impacts on livelihood and the availability of essential resources (e.g. water, food) represent important drivers for migration, particularly for internal displacements (*medium* to *high confidence*). (See also *Section D.1*) {1.1}

A.1.5 Emerging or existing conflicts and threats to well-being and physical integrity are important and lead to mostly involuntary conflict-induced displacements. People often move for economic, social and political reasons hoping to improve their economic prospects and living standards *(medium confidence).* (See also *Section C.1*) {1.1; 5.1}

A.1.6 The southern and eastern Mediterranean countries and the Arab region represent a particularly relevant case for conflict-induced displacements *(medium confidence).* {1.2}

A.2 Motivation and goals

A.2.1 This Analysis seeks to deepen understanding of the complex relationships between environmental change and migration in the Mediterranean region, by analysing their dynamics, trends, patterns, drivers and impacts through the nexus approach. It aims to inform policy measures that minimise suffering, allocate resources effectively, and support the well-being of people and communities considering leaving their homes, voluntarily or involuntarily. This Analysis also identifies and assesses the policy dimensions, gaps, and challenges related to migrants and migration in the Mediterranean Basin. (See *Introduction*)

A.2.2 The interdependency and numerous mutual linkages and feedback loops between environmental change, conflict, and human migration make it very difficult to establish convincing and verifiable quantitative relationships between them. This presents a significant challenge for achieving a comprehensive understanding and for specifying policy guidelines and strategies. These interconnections are captured and analysed within the framework of the environmental change-conflict-migration nexus in the Mediterranean Basin. A better and more comprehensive understanding of this nexus represents the core focus of this Analysis. (See *Introduction*)

[9] This Analysis applies the calibrated terms that were adopted transversally by the Intergovernmental Panel on Climate Change (IPCC) since the 5th Assessment Report in order to communicate the robustness and certainty of assessment findings either qualitatively or quantitatively. The calibrated terms quantify confidence and likelihood. Each assessment finding is based on an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, for example, *'medium confidence'*. The following terms have been used to indicate the assessed likelihood of an outcome or result: virtually certain (99–100% probability); very likely (90–100%); likely (66–100%); about as likely as not (33–66%); unlikely (0–33%); very unlikely (0–10%); and exceptionally unlikely (0–1%). Assessed likelihood is typeset in italics, for example, *'very likely'*. The scientific evidence for each key finding is found in the chapters of the underlying report and referred to in curly brackets {}.

B. Drivers and their impacts on migration

B.1 The changing environment

B.1.1 In line with global trends, the Mediterranean region has warmed substantially over the last century, with higher and accelerated mean temperature trends over the last four decades, particularly in the eastern parts of the Basin. All Mediterranean sub-regions have warmed by up to 1.5°C and above, sometimes exceeding a 2°C increase since the pre-industrial era, which is significantly higher than the global rate *(high confidence)*. {2.4}

B.1.2 In the Mediterranean, heat waves and droughts are expected to intensify in a warmer climate. For heat waves, increases in severity, frequency and duration are a robust outcome across scenarios, modelling approaches and definitions. The region is also identified as a global hotspot for future droughts, with more frequent and severe events projected. In contrast, projections of extreme precipitation are less robust, with lower agreement across models, although individual rainfall events can reach unprecedented magnitudes. Observed increases in heat extremes can be attributed to human influence *(high confidence).* {2.4}

B.1.3 Extreme events affect the well-being of Mediterranean societies by causing casualties, property losses and having substantial impacts on ecosystems, agriculture, food production and water resources. They also affect socio-economic sectors such as labour productivity, transportation, energy production and tourism *(high confidence)*. {2.4}

B.1.4 Surface temperatures of the Mediterranean Sea increased by about 1.5°C between 1982 and 2018, with particularly strong warming in the Adriatic, Aegean, and Levantine Seas. This represents some of the fastest warming sea surface temperatures. Climate change also causes increases in the magnitude and frequency of marine heat waves *(medium confidence),* with strong ecological consequences including risks of extinction and shifts in species distributions *(medium confidence).* {3.5.1}

B.1.5 Projected trends in rainfall are less robust than temperature projections in the Mediterranean, which is characterised by high interannual variability of rainfall. Although it is difficult to detect long-term precipitation trends, there is clear evidence of a transition to drier conditions in the eastern parts of the Mediterranean as well as in northwestern Africa during the current century, driven by increasing evapotranspiration *(medium confidence).* {2.4}

B.1.6 Drought, aridity, and human-induced land degradation represent important environmental hazards in the Mediterranean region. They may potentially lead to more permanent forms of involuntary migration *(medium confidence).* {5.2.1}

B.2 Impacts of environmental changes

B.2.1 Water availability and water security

B.2.1.1 Water scarcity is a prevailing condition in many Mediterranean countries. Available water resources per capita vary significantly between Mediterranean countries. However, all of the southern and eastern countries suffer from water scarcity (i.e. <500 m^3 $capita^{-1}$ yr^{-1}) or water stress (i.e. <500–1000 m^3 $capita^{-1}$ yr^{-1}). Ongoing and anticipated changes in climate conditions are *likely* to exacerbate this challenge in the Mediterranean, which is projected to become a global 'drought hotspot'. The mean annual total renewable water availability per person amounts to 629 m^3 $capita^{-1}$ yr^{-1} for the Middle East and North Africa Region (MENA region), a value falling within the water stress limit of 500–1000 m^3 $capita^{-1}$ yr^{-1}. However, the geographical distribution of water availability varies significantly between individual countries in the Mediterranean. This is because western and central Mediterranean countries are characterised by markedly higher precipitation values than those in the southern and eastern parts of the Basin *(high confidence).* {3.1.1}

B.2.1.2 On average, agricultural irrigation represents the predominant consumer (76–79%) of the few available water resources in eastern and southern Mediterranean countries, while domestic use and industry represent 4–13% and 6–20%, respectively. The anticipated decrease in water available for irrigation will have direct consequences on agricultural productivity and food security in some Mediterranean countries particularly, if suitable remedies (e.g. smart irrigation, cultivation of drought-tolerant crops, etc.) are not applied. The reduced amount of environmental water may contribute to accelerated desertification in semi-arid and arid parts of the Basin. Both impacts will *likely* enhance the pressure on local communities and may lead to involuntary migration within and beyond national borders *(medium confidence).* {3.1.2}

B.2.2 Food security

B.2.2.1 The expected sea level rise in the Mediterranean Sea could have adverse consequences for coastal communities and for near-coastal agriculture, for example in the Nile Delta with

direct impacts on regional food security. Increased warming and drying throughout the region, combined with declining soil fertility and growing water scarcity will reduce production and threaten food security at national and regional levels *(medium confidence).* {3.2.1}

B.2.2.2 Higher water temperatures and increasing marine heat waves will have adverse consequences for marine ecosystems and fisheries in the Mediterranean. By 2050, more than 20% of exploitable fish and marine invertebrates are projected to become extinct in the region. Reduced landings and lower fisheries revenues, in combination with non-climatic drivers of change, exacerbate risks to food security throughout the Mediterranean Basin, with the greatest challenges expected for eastern and southern Mediterranean countries *(high confidence).* {3.2.1}

B.2.3 Human health

B.2.3.1 Environmental changes in the Mediterranean Basin will have adverse consequences on public health as well as implications for the health of migrating population groups. Consequences include, for example, a rise in respiratory and heart illnesses, the emergence of new vector-borne diseases and water- and food-related illnesses *(high confidence).* {3.3.2}

B.2.3.2 The initiation and exacerbation of existing political conflicts, driven by political instabilities or rivalry within or between countries, will have adverse consequences for the health of population groups involved. This has the potential to force communities to abandon their homes, which, in turn, can have profound implications for the health of migrating population groups and of the indigenous population *(medium confidence).* {3.3}

B.2.3.3 Most immigrants and refugees suffer unusually high levels of poverty, hardship and inadequate living conditions in the countries to which they immigrate. This includes substandard housing, low-quality food and water, and insufficient healthcare facilities. The precarious conditions prevalent on migration routes and in refugee camps, coupled with environmental degradation such as land degradation, food insecurity and water pollution, as well as environmental change-induced events, further enhance the vulnerability of the immigrant population's health. Limited access to healthcare services poses a significant health determinant for migrants, with national or local health systems often ill equipped to address these challenges. Poor mental health is increasingly becoming a significant health consequence of environmental change, conflict, and migration *(medium confidence).* {3.3.1}

B.2.3.4 While climatic and environmental change, conflict, and migration – together with other factors – lead to negative consequences on the physical, mental and social health of the public, certain population groups are more vulnerable than others. This includes the elderly, the chronically ill, people who work outdoors, and economically deprived populations including those suffering from energy, food or water poverty *(high confidence).* {3.3.3}

B.2.4 The coastal zone

B.2.4.1 The impacts of environmental changes on the Mediterranean coastal zone are manifold. Rising sea levels will enhance seawater intrusion of coastal aquifers, thereby endangering freshwater supplies for agriculture and human consumption. Increasing human-induced groundwater extraction is accelerating the subsidence of delta systems and exacerbating the exposure of populations to flooding. Such delta systems frequently support substantial socio-economic activities of local communities. Mean sea level rise will also aggravate ongoing beach loss in the Mediterranean. Beach erosion due to mean sea level rise will be further magnified during temporal storm events *(medium confidence).* {3.4.1}

B.2.4.2 The Mediterranean coastal zone is densely populated, with more than a third of the total Mediterranean population, roughly 155 million people, living within 20 kilometres of the coast. As of 2010, approximately 10% of this population, about 47 million, live in areas with elevations of no more than 10 metres above sea level (known as Low Elevation Coastal Zone) *(high confidence).* The concentration of population in coastal zones is currently more pronounced in the western Mediterranean, the western shore of the Adriatic Sea, the eastern shore of the Aegean-Levantine region, and the Nile Delta. {3.4.2}

B.2.4.3 The impacts of environmental change related to sea level rise will depend heavily on the socio-economic development of coastal communities, including aspects such as population growth, urban expansion and the development of critical infrastructure. However, the concrete relationships between these factors have rarely been explored in recent research. Current studies primarily focus on the biophysical aspects of sea level rise, while neglecting the social and economic dimensions. A more comprehensive understanding

of these relationships is crucial for developing effective adaptation strategies and ensuring equitable outcomes for coastal communities. Feedback between environmental change and socio-economic development in coastal locations shows a high potential for conflict and migration in the region. Sea level rise can disrupt livelihoods, damage infrastructure, and erode land, leading to economic hardship and social unrest. In turn, these socio-economic factors can hinder access to resources and limit options for adaptation to sea level rise *(medium confidence).* {3.4.3}

B.2.5 Ecosystems

B.2.5.1 Under anthropogenic environmental change, increased drought and heat stress are expected to adversely affect terrestrial and marine ecosystems throughout the Mediterranean Basin. In forest ecosystems, this will *likely* result in a higher frequency and intensity of wildfires, and vulnerability to pests. The damage caused is therefore expected to hinder the delivery of ecosystem services from forest ecosystems throughout the Mediterranean. For freshwater ecosystems, climate change will reduce precipitation and increase evaporation rates and thus water availability. This will lead to temporary or permanent dry-out of lakes and ponds, and to a decline of flow in intermittent rivers and ephemeral streams *(medium confidence).* {3.5.1}

B.2.5.2 Rising sea surface temperatures and marine heat waves in the Mediterranean Sea enhance risks of disruption of the marine food chain and a significant decline in species variability. These risks have further been confirmed by declining fisheries landings, as already reported throughout the region with respect to the 1980s and 1990s period, which are increasingly threatening the fisheries sector in the Mediterranean. The occurrence of new tropical, invasive, species is furthermore projected to increase in the region under increased temperatures, with negative repercussions for marine ecosystems, fish populations and the economic conditions of the fisheries sector *(medium confidence).* {3.5.2}

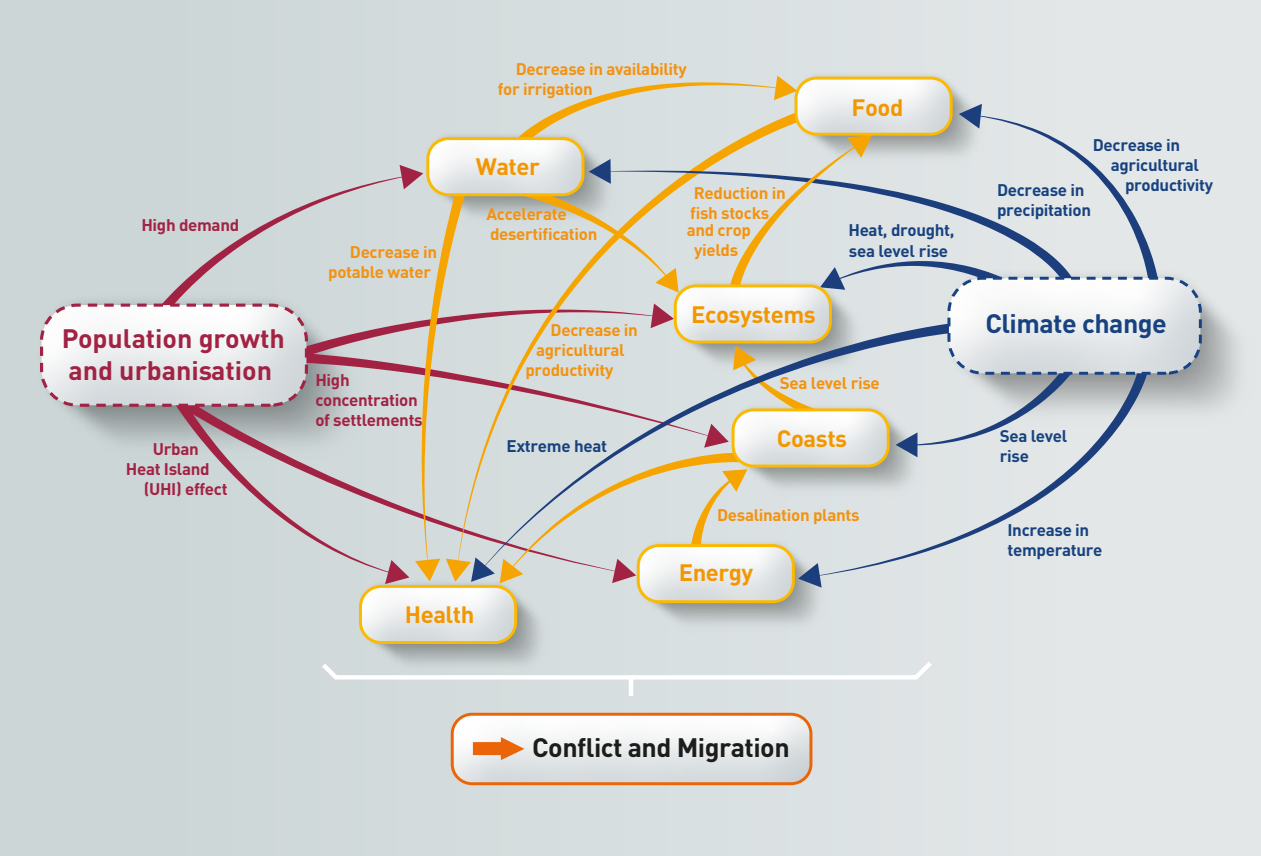


Figure ES1 | Links between climate change and socio-economic changes and their consequences for the individual sectors. The figure aims to illustrate qualitatively some of the linkages between the elements of the environmental change-migration-conflict nexus and the sectors assessed in the report. {*Figure 3.12* in *Section 3.7*}

B.2.5.3 An environmental change-induced deterioration to the state of the Mediterranean's freshwater, coastal, marine, and terrestrial ecosystems is further exacerbated by additional anthropogenic activities, especially associated with intensive agriculture, the development of industry, transport, and fisheries exploitation. These processes will result in a reduced supply of a number of ecosystem services, and therefore in adverse impacts to human well-being. Depending on the severity of the impacts, adaptive capacities of environments and communities, and opportunities for livelihood diversification, these trends have the potential to result in permanent forms of displacement as people are forced to seek alternative livelihood opportunities *(medium confidence).* {3.5.3}

B.2.6 Energy

B.2.6.1 Extreme weather conditions as well as other processes related to climate change, such as slow onset events, may affect conventional and renewable energy production operations. Water-cooled power plants will have to be adjusted to operate at different temperature levels with decreasing efficiencies, and hydropower plants may run out of water. Environmental change is also expected to have a bearing on electricity networks, such as overhead cables and pylons for electricity transport as well as the transport of conventional fuels. {3.6}

B.2.6.2 Climate change will particularly affect local to regional living conditions, and lead to an increased need for space cooling with growing demand for electricity. Reduced energy security for a significant part of the population in a given region and of local communities may lead to deteriorating living conditions and involuntary migration *(medium confidence).* {3.6}

B.2.7 Interactions between sectors

B.2.7.1 Environmental change and socio-economic changes such as population growth and urbanisation impact a variety of sectors, including water availability, food production, ecosystems, the coastal zone, public health, and the energy sector, in multiple ways. These impacts are highly interconnected and therefore constitute a complex system of environmental and socio-economic pressures that may result in increased conflict and migration *(high confidence). (Figure ES1)* {3.7}

C. Basic facts on migration

C.1 Forms of migration

C.1.1 Human mobility and migration occur across three dimensions: (1) the decision to move, on a spectrum from fully voluntary to involuntary (forced); (2) space, in terms of the distance migrants travel within their own countries or the borders they cross; and (3) the duration of their stay away from their home location, whether seasonal, temporary or permanent. {2.1.1}

C.1.2 Disaggregating movement along the voluntary to involuntary continuum is complex. Such movement requires determining the degree of pressure to which individuals or households have been subjected because of the altered conditions, as well as the degree of freedom in making a decision to move. The terms usually associated with environmental and climate-related migration include environmentally induced migration, climate-change-induced migration, climate migrants, ecological or environmental refugees, climate displacement, distress migration, and climate refugees. {2.1.1}

C.1.3 In terms of spatial scales of migration, a distinction is made between internal migration and external migration[10]. Internal migration refers to a change of residence within national boundaries, such as between states, provinces, cities, or municipalities. External migration refers to a change of residence across national borders. International migrants can be further classified into regular immigrants who move with the permission of the receiving state, irregular immigrants who move without permission, and refugees who cross international boundaries to escape persecution. {2.1.1}

C.1.4 In terms of the duration of stay in the host region or country, permanent migration should be distinguished from temporary and seasonal migration. In the climate change context, the Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) distinguishes three types of human movement: migration, a predominantly voluntary movement, displacement, predominantly involuntary, and planned relocation, voluntary or involuntary depending on circumstances. {2.1.1}

C.1.5 In the context of environmental change, there is an increasing focus on 'trapped populations', referring to individuals who wish to move but face constraints that prevent them from doing so. In contrast, some individuals are 'voluntarily' immobile, choosing to remain in their current location despite the adverse effects of environmental change because of factors such as a strong attachment to their home location or cultural reasons. {5.1.1}

C.1.6 Migration across the Mediterranean involves individuals from Africa, the Middle East, and parts of (Western) Asia, as well as movement between (mostly) southern European Mediterranean countries. Corresponding flows are usually described and classified as 'migration routes' *(Figure ES2)* {2.2.1.1}:

- The Western African and Western Mediterranean route: from Morocco, Mauritania, Senegal, and Gambia toward the Canary Islands and mainland Spain, including also overland routes to Melilla and Ceuta.
- The Central Mediterranean route: from North Africa across the Mediterranean Sea to Italy and Malta.
- The Eastern Mediterranean and Balkans route: mostly from Afghanistan, Iraq, Pakistan, Palestine, Somalia, Syria, and Türkiye to Bulgaria, Cyprus, and Greece.
- The East African Route: from North Africa and the Middle East to Greece and Italy.

[10] While the term 'international migration' is frequently used, the term 'external migration' is used in the report.

C.2 Migration as an adaptation strategy

C.2.1 Migration is considered an adaptation strategy that reduces the risks and consequences of climatic and non-climatic stressors to populations when it is voluntary, safe, and orderly. This strategy takes place at local, national, regional, and international scales. In coastal systems, different adaptation pathways have been identified to distinguish between sustainable and unsustainable adaption to environmental change *(medium confidence).* {6.1.1}

C.2.2 Certain adaptation pathways may become counterproductive, when practices or processes make people more, instead of less, vulnerable to environmental change. In the Mediterranean region this risk is particularly relevant in the case of displacement and involuntary (forced) migration *(medium confidence).* {6.1.1}

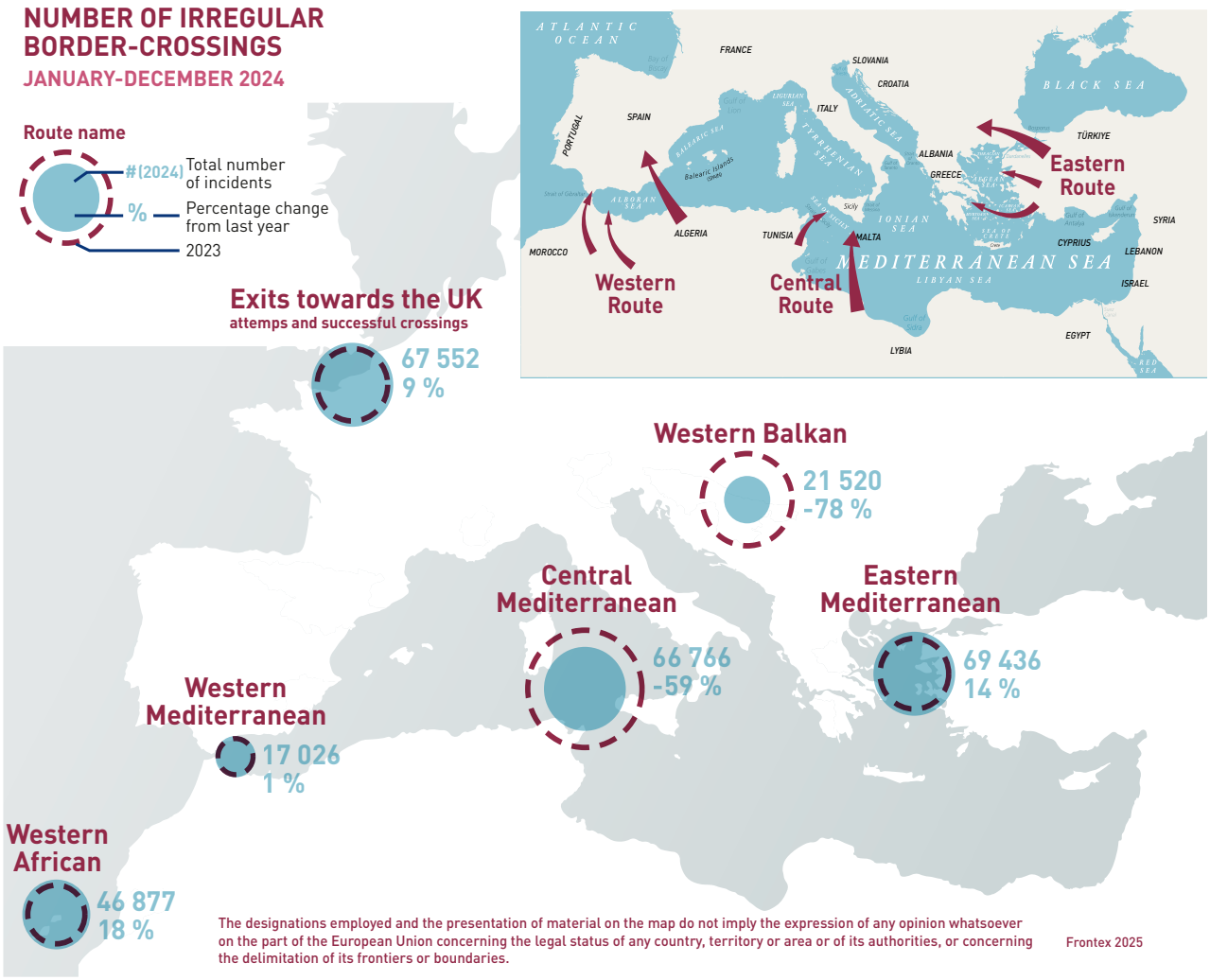


Figure ES2 | Number of irregular border crossings by migrants in 2024 via the Western, Central, and Eastern Mediterranean Route, as well as other European migration movements. Source: FRONTEX[11]; the insert (upper right) represents schematically the major Mediterranean migration routes; source: Migration Policy Institute[12]. {1.1, *Figure 1.11*}

[11] https://www.frontex.europa.eu/what-we-do/monitoring-and-risk-analysis/migratory-routes/migratory-routes

[12] https://www.migrationpolicy.org/article/asylum-seeker-and-migrant-flows-mediterranean-adapt-rapidly-changing-conditions

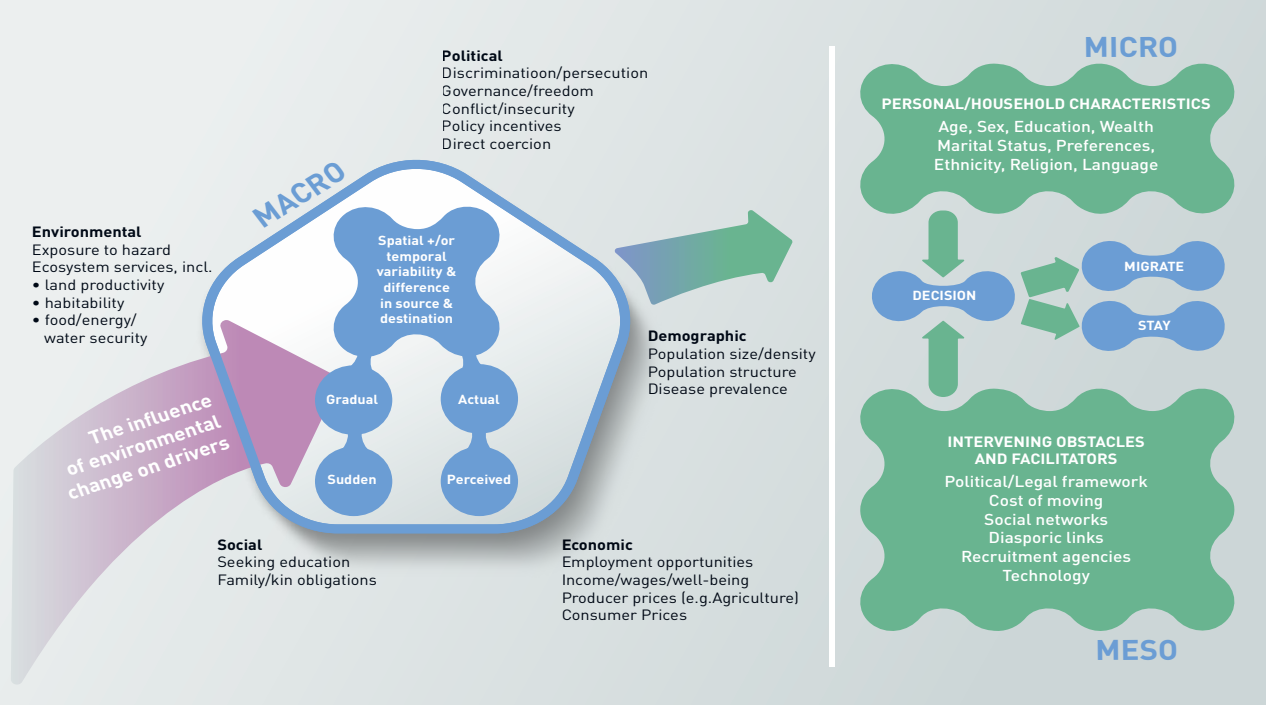


Figure ES3 | Schematic representation of the conceptual framework showing the 'drivers' of migration and the influence of environmental change. Source: Foresight, Migration and Global Environmental Change 2011[13]. {5.1.1}

D. The environmental change-migration-conflict nexus

D.1 Environmental change and migration

D.1.1 Linkages between changing environmental conditions and migration in the Mediterranean are complex and non-linear. No single theoretical framework currently provides a comprehensive understanding of the role of the environment in human migration. The links between environmental changes and migration are highly context-dependent and strongly influenced by local socio-economic and political conditions, as well as other co-stressors *(high confidence).* {5.1.1}

D.1.2 According to the Foresight (2011) framework[13], the decision to migrate is influenced by five broad categories of drivers, namely environmental, social, economic, demographic, and political drivers, which constitute the macro-level factors. *(Figure ES3)* {5.1.1}

D.1.3 Migration decisions are shaped not only by the complex interplay of macro drivers, but also by intervening meso-level factors, such as social networks, legal frameworks, and technology, as well as by personal and household characteristics, including age, gender, education and wealth. {5.2; 5.3}

D.1.3.1 The complexity of the issues involved, and the lack of adequate data, make it difficult to empirically assess environmental impacts on migration and to project future mobility under environmental change. Available evidence points to nuanced links between environmental and climate changes and migration in the Mediterranean region. The specific forms of these changes, that is, slow versus sudden onset events[14] or the effects of cumulative stressors, play a decisive role on the response of affected populations. The vulnerability of each group or community plays a decisive role in shaping the impacts of environmental changes. Often, a significant part of an affected population remains immobile, some because they do

13 https://www.gov.uk/government/publications/migration-and-global-environmental-change-future-challenges-and-opportunities

14 While the term 'rapid onset event' has been used at places in the underlying report, the preferred term is 'sudden onset events'. Sudden onset events represent a sub-group of rapid onset events and take place at a much faster rate of years to a few decades, which is more appropriate than the longer timescales of decades to several centuries that apply to rapid onset events.

not want to leave, others because they lack resources to move, resulting in potential entrapment *(medium confidence).* {5.1.1} (See also *Section C.1*)

D.1.3.2 Empirical evidence of environmental migration on a regional scale in the Mediterranean includes North Africa and the Sahel Zone, where drought and desertification processes, together with resulting land degradation, represent considerable risk factors, particularly for the North African dryland regions *(medium confidence).* {5.2.1}

D.1.3.3 In the Middle East and North Africa (MENA), conflict and violence are the immediate causes of displacement. While a close relationship between environmental change and conflicts has been suggested, the hypothesis that environmental change contributes directly to instability is not supported by the currently available information. Instead, environmental factors act as additional stressors within broader socio-political contexts, where conditions such as poverty, institutional challenges, and state capacity contribute to instability. This highlights the fact that the predominant drivers leading to conflicts are existing socio-political tensions. Future environmental changes and hazards could lead to increased poverty and social instability, thereby further destabilising the region and contributing to major out-migration *(medium confidence).* {5.2.2}

D.1.3.4 In southeastern Europe and the Balkans, environmental changes are projected to have significant impacts on agricultural production and food security, which may increase both internal and external migration. Important drivers are prolonged droughts, increased forest fires and land degradation, heavy precipitation and flooding events *(high confidence).* {5.2.3}

D.1.3.5 Climate and environmental factors are not only relevant for mobility within the Mediterranean but can also shape mobility to the region *(high confidence).* {5.3.2}

D.2 Environmental change and conflicts

D.2.1 The Mediterranean region, including Southern Europe and major parts of the MENA region, has historically been a hotspot for geopolitical conflicts at the intersection of three continents – Europe, Africa, and Asia. Environmental changes act as a risk multiplier, interwoven with the region's geopolitical dimensions, posing additional stress on vital infrastructure and key economic sectors in the region *(medium confidence)*. {4.1}

D.2.2 Research on the linkages between environmental conditions and conflicts in the Mediterranean region is limited and has resulted in contradictory findings. Water scarcity (and possible resultant conflicts) is often linked to environmental variability and change, but may be driven more significantly by population pressure, agricultural productivity, and economic development. However, environmental changes could increase intercommunal violence, such as between herders and farmers, and among pastoralists, by affecting their coping strategies for access to water and foliage. Examination of the connections between extreme weather events, such as storms, floods or droughts, and conflicts, concludes that a direct association between such events and armed conflict remains contested. Studies which examine whether climatic events can increase the probability of inter-state conflict by reducing the supply of water in transboundary river basins lead to the conclusion that shrinking shared water resources do not necessarily lead to armed conflicts or wars. However, environmental change may contribute to tensions, threats, and even some violent episodes between local communities and riparian states. Results of several studies have shown that environmental changes could either increase inter-state conflicts or enhance cooperation, depending on the ability of the existing institutional frameworks to accommodate these changes *(medium confidence).* {4.2}

D.2.3 While current evidence of direct causal links remains contested, future climate change could still heighten conflict risks, although projections are subject to major uncertainties. However, because of methodological and data limitations, long-term conflict projections cannot incorporate the complexity and feedback loops that characterise the environment-conflict relationship *(medium confidence).* Simplistic modelling assumptions may distort estimates of conflict risk, in some cases driving them down. {4.3}

D.2.4 Conflicts drive migration decisions. Most research on involuntary migration concludes that displacement is an obvious consequence of emerging or ongoing conflicts, as they cause local residents to perceive an intolerable level of threat to safety and well-being, leaving no other option than to leave their homes. Conflicts can also indirectly affect migration by reducing economic opportunities. Given the resulting prospects of having to deal with insufficient income, many individuals or families choose to move. Thus, physical and economic insecurity are strong drivers of conflict-induced migration, since they entail both motivation and opportunity *(high confidence).* {4.4}

D.3 Vulnerability and adaptation in the vicious circle

D.3.1 Changes in environmental conditions and ongoing or emerging conflicts together increase the vulnerability of exposed societies to future environmental hazards. Conflicts have several detrimental impacts on societal development, and may thus amplify environmental risks and vulnerabilities across multiple institutional and temporal scales. Three interrelated processes constitute a 'vicious circle', which locks affected societies into a structure of violence, vulnerability, and the impacts of environmental change *(Figure ES4)*:

1. Community vulnerability determines the level of risk from environmental hazards and climate change.
2. Environmental-change impacts increase armed conflict risks.
3. Armed conflicts heighten vulnerability to future environmental hazards.

On a more general level, it has been concluded that the compound effects of conflicts and environmental hazards are likely to amplify the vulnerability of exposed societies. This may lead to a cascade of temporally- and spatially-dependent risks, which might mutually reinforce and increase societal vulnerability to future hazards *(medium confidence).* {4.5}

D.3.2 Effective adaptation plans and initiatives can help to reduce conflict risks by countering the effects of environmental changes on natural resources, food and water security, livelihoods, and economic stability. Adaptation and mitigation policies may reduce the conflict potential of climate variability and environmental change, but they carry the risk of unintended negative effects, which need to be addressed in advance. Environmental adaptation initiatives may foster cooperation between states, but they may increase the risk of conflict between them, if poorly designed or if critical competing interests are not adequately considered. For instance, infrastructure projects such as dams or dykes may affect relationships between upstream and downstream states, as in the Nile River basin, where both cooperative and conflicting interactions have occurred *(medium confidence).* {See also *Section C.2)* {4.5}

D.4 Environmental change - migration - conflicts

D.4.1 Current evidence does not support a strong direct causal link between environmental change, conflict, and migration. Lack of coordinated and supportive governance structures for migration and adaptation is a key factor driving the relationships between environmental hazards, the impacts of environmental change, conflict, and migration.

Figure ES4 | Conceptual diagram illustrating the 'vicious circle', which locks affected societies into a structure of violence, vulnerability, and the impacts of environmental change. {*Figure 4.2* in *Section 4.5*}

While interactions and dynamics that constrain effective policies operate on various scales, the most relevant and effective response mechanisms consist in community-based and location-specific measures *(medium confidence).* {6.1}

D.4.2 While migration is increasingly discussed as a form of adaptation to environmental change, current evidence highlights that it tends not to be a sustainable adaptation strategy, but rather a coping mechanism at best. Migration is a highly socially demanding process, and not a mere functional option for people facing environmental change and conflicts. Depending on the existing political and economic institutions, the influx of migrants may also increase conflict risks and lower the adaptive capacity of host communities and countries, by intensifying resource scarcity, socio-political unrest, and turning climate into a security issue (securitisation)[15] *(medium confidence).* {6.1}

D.4.3 International human rights law does not expressly recognise any environmental or climate-related reasons for migration that would result in legal protection. Consequently, individuals forced to leave their home country because of the unbearable impacts of environmental change are rejected by potential host countries. This follows the contention by host communities that migrants should not be considered under international legal regimes, including the Convention relating to the Status of Refugees, and they therefore lack legal protection. Despite various initiatives and a few rulings connecting migration, environmental risks, and human rights, the prospects of providing legal protection for migrants (e.g. climate refugees) remain dim *(high confidence)*. {6.3}

D.4.4 Place-based vulnerabilities of communities and individuals are central to the environmental change-migration-conflict nexus. For vulnerable communities that lack adaptive capacity, migration might not be an available option and may instead lead to (involuntary) immobility *(medium confidence).* (See also *Section C.1*) {6.4}

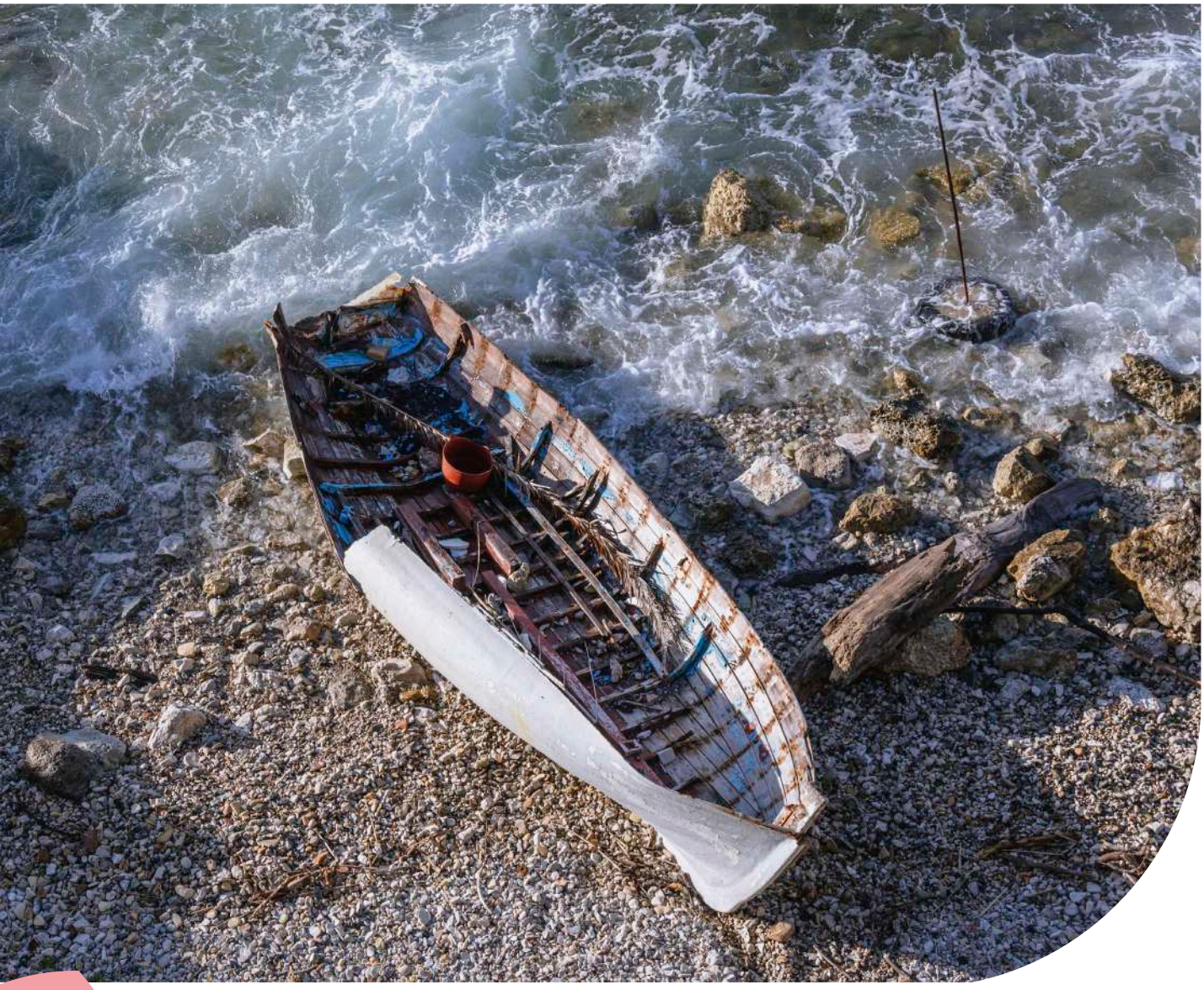
15 The concept of "securitisation" is used in this Analysis as defined in international relations and political science, particularly within the framework of the Copenhagen School (Buzan et al., 1998). Securitisation refers to the process through which an issue is constructed as an immediate and existential threat by a powerful actor—such as a government or political leader—through a speech act. This construction must be accepted by a relevant audience to legitimise the use of extraordinary measures beyond normal political procedures. As used in this Analysis, securitisation concerns the construction of issues as security threats, not the financial meaning of the term (i.e. the pooling and repackaging of assets into tradable securities). {6.2}

D.4.5 Intersectional structural inequalities that already permeate Mediterranean societies and economies also shape the complex realities of the environmental vulnerability-migration-conflict nexus. These inequalities, which are distributed unevenly across northern and southern Mediterranean countries, are restructured by environmental change based on ethnicities, racialised groups, gender identities, age groups, abilities, and classes, both within and between communities *(medium confidence).* {6.5}

Intersectional structural inequalities in the context of environmental variability shape the:

1. likelihood of mobility and immobility as a result of environmental change;
2. routes and conditions of mobility;
3. adaptive capacity associated with mobility and/or immobility.

D.4.6 There is a rural to urban migration trend, which is exacerbated by climate-induced water scarcity *(medium confidence).* Gender and age inequalities shape this process: women and the elderly in rural areas are often left behind, a pattern referred to as the 'masculinisation of migration'. However, there are also cases of women migrating in the face of climate change. Housing opportunities at the destination and land tenure, alongside education, determine migration prospects and routes for men and women. {6.5}



E. Knowledge gaps and future outlook

E.1 Knowledge gaps

E.1.1 While environmental change has been characterised as a 'threat multiplier', quantifiable and direct relationships between environmental change, conflict, and migration are complex and nonlinear, making it a challenge to identify causality across the nexus *(high confidence).* {7.1; 7.5.1}

E.1.2 Multiple and direct causal relationships between conflict and migration have been established for the Mediterranean Basin (and beyond). However, a more comprehensive understanding of the relationship between environmental change and conflict is still lacking, as the relationship is more complex and lacks quantifiable data to establish direct causality *(high confidence).* {7.3}

E.1.3 The lack of sufficient empirical studies and interdisciplinary dialogue, combined with methodological shortcomings and difficulties accessing data, limit our understanding and a quantifiable description of the complexity of the environmental change-migration-conflict nexus *(medium confidence).* {7.3}

E.1.4 The breadth of variables, combined with wide socio-economic, political, and institutional disparities across Mediterranean Basin states, as well as the long timeframe and large spatial and temporal scales needed to quantify and test causality across the environmental change-migration-conflict nexus, add methodological complexity in specifying realistic and effective policy measures for the Mediterranean Basin. Given this diversity, sub-regional approaches may be preferable (i.e. East Mediterranean, West Mediterranean) compared to broader frameworks seeking to apply 'one-size-fits-all' approaches to the whole Mediterranean Basin *(high confidence).* {7.3}

E.2 Way forward

E.2.1 The complexity of the issues addressed requires a broad multidisciplinary approach, involving the natural and human sciences on an equal footing, in order to gain a more comprehensive understanding of the environmental change-migration-conflict nexus *(high confidence).* {7.4.1}

E.2.2 In order to better understand the current impacts of environmental change on migration and to project future mobility under similar conditions, it is crucial to significantly improve the empirical database, enhance interdisciplinary collaboration, and strengthen the science-policy interface (and possibly science-diplomacy) across all relevant fields and sectors *(high confidence).* {7.4.4}

E.2.3 Greater involvement of local civil society in developing and implementing place-based research is fundamental. Communicating scientific data and results through an effective science-policy interface is essential in addressing the challenges of the environmental change-migration-conflict nexus *(high confidence).* {7.4.2}

E.2.4 Addressing the root causes of the socio-economic and political vulnerability of states and societies in the Mediterranean Basin is fundamental to improving adaptive capacity and promoting transformative strategies for communities and regions. This includes a direct focus on human rights, good governance, and developmental practices across states and societies in the Mediterranean Basin. {7.4.1}

Introduction and framing

1

Coordinating Lead Authors
Manfred A. LANGE *(Cyprus)*, **Roula MAJDALANI** *(Lebanon)*

Lead Authors
Julien LE TELLIER *(Lebanon)*

This chapter should be cited as:
Lange, M.A., Majdalani, R., Le Tellier, J., 2026: Introduction and framing. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, pp. 43-61 doi: 10.5281/zenodo.18784499

Chapter 1
Introduction and framing

Executive summary 45

1.1 Motivation to write the Expert Analysis 46
1.1.1 Why consider the relationships between environmental change, migration, and conflict? 47
1.1.2 Why focus on the Mediterranean region? 48
1.1.3 The environmental change-conflict-migration nexus 49
1.1.4 The environmental change-migration-conflict nexus in the policy context of the Mediterranean region 49

1.2 Main issues addressed and structure of the report 51
1.2.1 Scope and content of the report 51

1.3 Key issues and conclusions to be drawn 53

1.4 Background and report drafting process 55
1.4.1 Nature of the analysis as a synthesis of available literature and data 55
1.4.2 Selection of authors based on their expertise, with a consideration of gender and geographical balance 55
1.4.3 Neutrality and independence of the authors 55
1.4.4 Process of writing, editing, and reviewing the report 55

Box 1.1 The role of science-policy interfaces for inclusive environmental governance 56

References 60

Information about the authors 61

Executive summary

Human migration[16] has today assumed spatial and temporal scales of exceptional magnitude *(Section 1.1)*. It involves conflict– and disaster-induced displacement of individuals and communities. The term 'disaster-induced displacement' does not only refer to displacement due to natural events, such as natural hazards, extreme weather events, or climate-related impacts, but may also include socio-economic hardships, human disturbances and political pressures *(Section 1.1).*

While shaped by a number of generic key aspects that are valid in other contexts worldwide, the Mediterranean region deserves special attention when considering the environmental change[17]-conflict-migration nexus because of its climatic, economic and societal setting (*medium confidence; Section 1.2*).

Abandoning their original settlements because of the severe consequences of environmental change may be seen as a frequently applied adaptation strategy for affected communities *(medium confidence; Section 1.3).* It is critically important to consider that voluntary or involuntary migration is usually the result of a variety of drivers *(Section 1.3).* Contrary to commonly quoted convictions, environmental change represents just one factor among others in the decision to migrate. Other drivers, particularly conflicts and their devastating consequences, various general socio-economic factors, as well as governance issues in a given country, frequently constitute more important drivers of migration than environmental change and its impacts. The number of conflict-induced displacements in 2021 was the highest ever recorded with 14.4 million migrants worldwide *(high confidence; Section 1.3).*

The southern and eastern Mediterranean countries and the Arab region are particularly relevant cases for conflict-induced displacement because they are affected by complex and violent armed struggles (*medium confidence; Section 1.2.3*). The impacts of environmental change may lead to enhanced competition over scarce resources and exacerbate conflicts and migration (*medium confidence; Section 1.2.3*). Environmental change may also aggravate structural inequalities between southern and eastern Mediterranean countries, on the one hand, and northern Mediterranean countries and Europe, on the other (*medium confidence; Section 1.2.3*).

This Analysis comprises seven chapters and is structured as shown in *Figure 1.2 (Section 1.2.1).* An important aspect of the science-policy context of this Analysis is a well-organised Science-Policy Interface (SPI) for the Mediterranean, which is briefly introduced *(Section 1.2.2)* and described more in detail in *Box 1.1.*

The drafting of this Analysis follows the practices and processes established by the Mediterranean Experts on Climate and environmental Change (MedECC) network in the context of the First Mediterranean Assessment Report (MAR1) (MedECC 2020a). Preparation of the report involved contributions from thirty-nine authors representing twenty-one countries. *(Section 1.4, Annex 1).*

[16] In this Analysis, 'migration' or 'migrants' is adopted to collectively refer to individuals and groups who voluntarily or involuntarily leave their homes to find new homes in either their country of origin (internal migrants), or in a country across the borders (cross-border or external migrants), encompassing asylum seekers and refugees, terms that are not mutually exclusive and may overlap strongly.

[17] In this Analysis, the term 'environmental change', if not explicitly mentioned, includes changes in terrestrial and marine ecosystems as well as changes in climate conditions at local, regional, or global scales.

1.1 Motivation to write the Expert Analysis

Human migration, whether voluntary or involuntary, is caused by events and circumstances that frequently leave individuals or groups of individuals no other choice than to move. Migration has been part of human history for millennia and may involve relocations on a moderate scale, within a given region or country, or movements that lead to much more distant relocations to other countries or even other continents. The number of forcibly displaced individuals in the world amounted to around 82 million by the end of 2020 (UNHCR 2021) and is expected to reach over 130 million displaced people in 2024 (UNHCR 2024). Considered to be one of the 'most congested human migration routes' *(Figure 1.1)*, the Mediterranean Basin recorded approximately 160,000 arrivals in 2022 (UNHCR 2022).

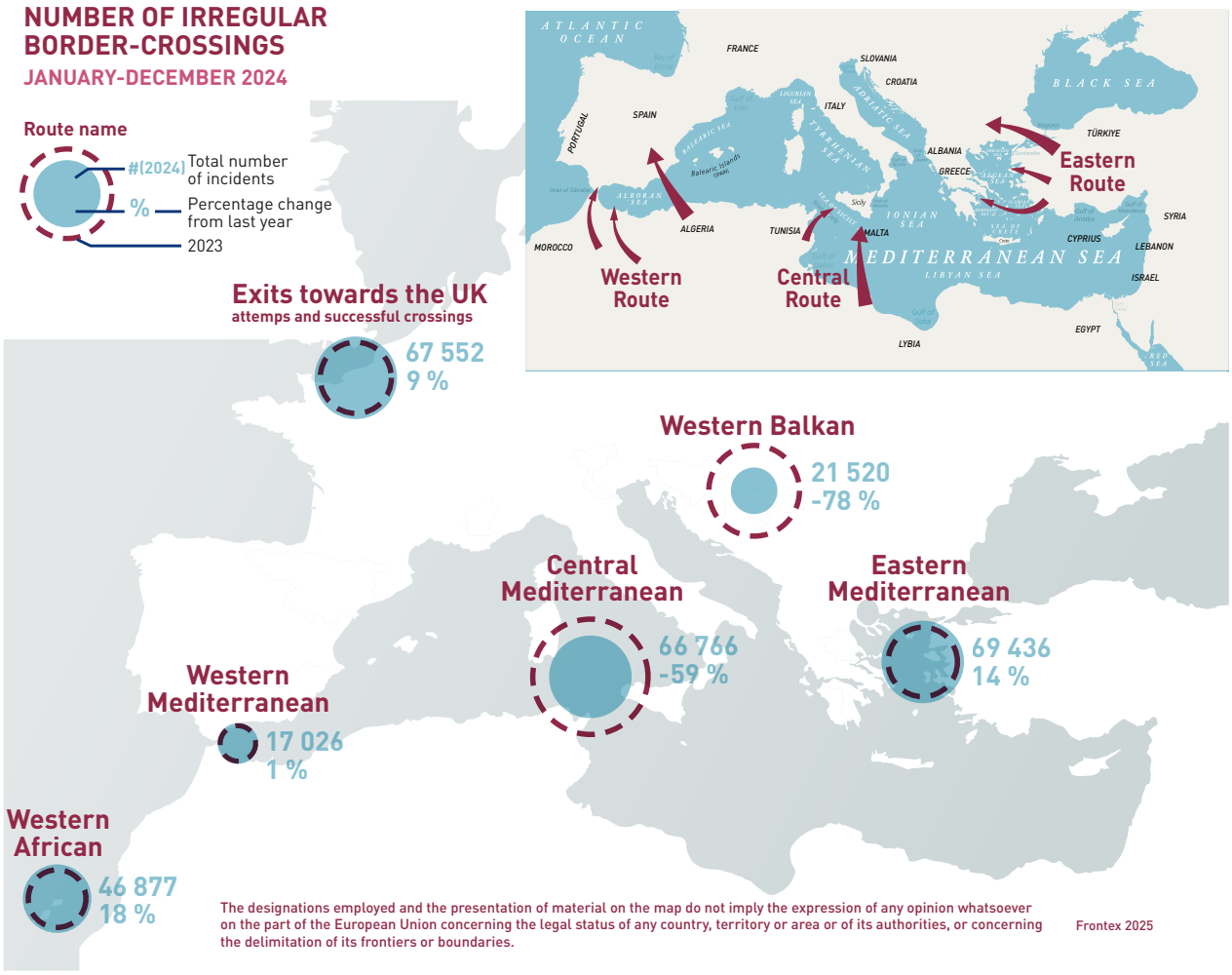


Figure 1.1 | Number of irregular border crossings by migrants in 2024 via the Western, Central, and Eastern Mediterranean Route, as well as other European migration movements. Source: FRONTEX[18]; the insert (upper right) represents schematically the major Mediterranean migration routes; source: Migration Policy Institute[19].

[18] https://www.frontex.europa.eu/what-we-do/monitoring-and-risk-analysis/migratory-routes/migratory-routes/

[19] https://www.migrationpolicy.org/article/asylum-seeker-and-migrant-flows-mediterranean-adapt-rapidly-changing-conditions

A distinction is usually made between conflict-induced and disaster-induced displacement or migration[20]. The former term refers to displacement caused by wars and acts of aggression, including violent human activities and politically motivated oppression. The latter denotes displacement to avoid the adverse consequences of climate change-induced natural hazards, such as extreme weather events like floods and landslides, and repeated periods of drought. It also includes fleeing the devastation caused by natural disasters such as earthquakes and volcanic eruptions. A closer look, however, reveals that the distinctions between conflict-induced and disaster-induced displacement/migration may often be blurred in practice. Conflicts may escalate due to disputes over natural resources that are strained because of environmental changes, while human activities may amplify the impact of natural disasters, which can lead to migration.

The studies referenced in MAR1 (Koubi et al. 2020) and more recently by Lange et al. (2022) have addressed the relationships between climate and environmental change, migration, and conflicts in the Mediterranean in general terms.

1.1.1 Why consider the relationships between environmental change, migration, and conflict?

The interdependency and numerous mutual linkages and feedback mechanisms between environmental change, conflict and human migration present significant challenges for a comprehensive understanding and the definition of policy guidelines. These challenges are central to this report, which is guided by the following key questions:

1. What are the major structural inequalities, uneven development and socio-economic challenges, and their relations to environmental change that are pervasive in the Mediterranean?

2. How can threats to human life and livelihoods posed by environmental change be described and possibly quantified, given the fact that the Mediterranean Basin is considered a climate change 'hotspot'? (see Giorgi 2006; Cramer et al. 2018).

3. What are the major impacts of environmental change on food and water security, economic activities, and human and environmental health in urban and rural settings?

4. Environmental change may increase conflict risks in relation to poverty, weak institutions, and limited capacities, specifically but not exclusively in the eastern and southern Mediterranean countries. Can causal relationships between changes in environmental conditions and conflicts be directly identified and described?

5. How can diverse patterns of human mobility, that is either sudden onset events and their direct consequences, or gradual slow onset events leading to more permanent types of mobility, be recognised and described?

6. To what extent does environmental change exacerbate the intersectional inequalities and challenges that already exist in governance structures in Mediterranean countries, and how are they related to human mobility and conflict?

7. What steps are needed to overcome the lack of empirical studies, methodological shortcomings, and difficulties in accessing data needed to understand the complexity of the environmental change-conflict-migration nexus in the Mediterranean Basin?

8. What collective and collaborative efforts are specifically required in the Mediterranean region to address the issues mentioned above?

While these key questions may be considered generic and valid for many regions in the world, the Mediterranean Basin deserves special attention regarding the environmental change-conflict-migration nexus. Individual chapters of this Analysis provide evidence for this (see *Section 1.2.1* and below).

[20] It is very important to distinguish between displacement and migration. Individuals who are displaced may later become migrants, but this is not inevitable if they return to their place of origin. Whether someone is classified as a 'displaced person' or a 'migrant' depends on the specific circumstances of the event.

This report adopts a forward-looking perspective to explore suitable options and anticipatory actions for mitigation and adaptation. It aims to improve the common understanding of the determinants, trends, patterns, and impacts of human migration and displacement. This may assist in the development of policy measures designed to minimise suffering, allocate resources where they are most urgently needed, and collectively support human well-being.

1.1.2 Why focus on the Mediterranean region?

The Mediterranean Basin, the largest semi-enclosed sea in the world, is surrounded by countries across three continents sharing a coastline of about 46,000 km (EEA 2015). The population of these countries is around 512 million (UNEP/MAP and Plan Bleu 2020), with 70% of them living in urban settings and one third of those in coastal zones. Intensive development and tourism have increased the fragmentation of landscapes and disrupted their ecological integrity. Population growth, urbanisation, and rising living standards have led to unsustainable patterns of consumption and production, with a heavy environmental footprint, putting food and water security at risk.

The Mediterranean region is facing increasing cumulative environmental and climate risks, including strong warming (up to 6°C by 2100) and drying, accelerating sea level rise (currently 4 mm yr^{-1}), and increasing air and water pollution (Cramer et al. 2018; Cherif et al. 2020; Ali et al. 2022). The resulting drier and hotter conditions, in combination with enhanced coastal flooding, will affect local communities directly because of increased exposure. This represents hazards and high risks for human societies as well as terrestrial and marine ecosystems in the foreseeable future.

Climate change also leads to an increase in the frequency and intensity of extreme events. These events, such as long-lasting hot spells, extreme precipitation events, extended periods of drought, wildfires, and sandstorms, have caused severe impacts that have adversely affected the livelihoods of local communities (Vafeidis et al. 2020).

The Mediterranean region is a biodiversity hotspot with the highest rate of endemic species in the world. Pressures on ecosystems from anthropogenic activities, pollution, and climate change will lead to irreversible environmental damage and loss of biodiversity (Valavanidis and Vlachogianni 2013; IUCN 2022). Ecosystems face various threats, especially in the south and east of the Mediterranean Basin. This includes land degradation, as well as the loss of half of the wetlands over the course of the 21st century, overfishing (20% of fish species at risk of extinction by 2050), unsustainable agriculture, wildfires (burnt area may double by 2100) and the invasion of non-indigenous species.

Because of their high vulnerability, the adaptive capacity of ecosystems and human systems in the Mediterranean is likely to reach or exceed their limits. This may cause serious and lasting consequences for human health and livelihoods and may lead to involuntary migration of local communities to places where water, food, and other resources are perceived to be more readily available and accessible. This was described in detail in MAR1 (MedECC 2020a). Additional information is provided in the State of the Environment and Development (SoED) in the Mediterranean report published by Plan Bleu, a Regional Activity Centre of the United Nations Environment Programme's Mediterranean Action Plan (UNEP/MAP and Plan Bleu 2020). Both reports shed light on the hefty toll that the triple global crisis of climate change, biodiversity loss, and pollution is taking on Mediterranean ecosystems.

The Sustainable Development Goals (SDGs) were universally agreed by the United Nations (UN) in 2015 under the framework of the 2030 Agenda for Sustainable Development. Efforts undertaken in Mediterranean countries since 2015 have resulted in positive developments. However, these have fallen short of achieving the SDGs by 2030 and are not enough to reduce the most significant pressures on the environment, and to safeguard the Mediterranean Basin for present and future generations while meeting human development needs (UNEP/MAP and Plan Bleu 2020).

According to the latest Sustainable Development Report, the Mediterranean is also a region of divisions (Sachs et al. 2023). Most countries of the Middle East and North Africa (MENA) belonging to the wider Mediterranean fail to achieve up to nine of the SDGs in the absence of transformative policies, awareness-raising campaigns, and specific education programmes. Due to more relevant policies and more adequate funding, the Mediterranean EU member states have demonstrated greater progress in achieving the SDGs, such as France, Italy and Cyprus, with only two, three, and four of the goals not achieved, respectively.

1.1.3 The environmental change-conflict-migration nexus

A well-defined and quantifiable causal link between individual high-impact environmental changes and subsequent (involuntary) migration is highly complex. While environmental changes may frequently be the primary factor leading individuals, families or entire communities to move (IOM 2014), it is critically important to keep in mind that, in most situations, people choose or are forced to migrate as a result of more than one driver. Disasters in general triggered more than 60% of the new internal displacements recorded in 2021, accounting globally for 23.7 million migrants. Of those, 94% were driven by climate-change related extreme events, such as storms, extended droughts, or flooding. Moving away from one's original homeland in response to such disasters is not the only reason for migration. Migration is often also understood as an adaptation measure for communities affected by increasingly extreme weather and climate conditions.

Globally, the number of conflict-induced internal displacements in 2021 was the highest ever recorded, at 14.4 million. The overwhelming majority of displacements were caused by armed conflicts. However, communities fled repeatedly as conflict frontlines shifted. Camps hosting internally displaced people (IDPs)[21] were frequently attacked in some countries, forcing people to move again (IDMC 2022).

Achieving a more comprehensive understanding of the nexus between environmental change, conflict, and migration, both now and in the near future, is the core focus of this report. The linkages and feedback mechanisms between each of these two drivers and migration are complex. This applies similarly to the relationships between environmental change and conflict. Unravelling and determining verifiable and concrete relationships between all elements of the nexus remains a major challenge from both a conceptual and applied perspective.

1.1.4 The environmental change-migration-conflict nexus in the policy context of the Mediterranean region

The Southern and Eastern Mediterranean countries and the MENA region are at the epicentre of both a global climate change hotspot and the world's involuntary (and forced) migration crisis. The MENA region is home to 5.8% of the world's population. However, 38% of its population, or 173 million people, live in conflict-affected areas (see UNDP 2022).

The MENA region is home to just 5.8% of the world's population, yet it bears a disproportionate burden of conflict and displacement. As of 2022, 38% of the region's population — approximately 173 million people — live in conflict-affected areas (UNDP 2022). In the Eastern Mediterranean, 77 million people across four countries — Lebanon, Libya, Palestine, and Syria — are in need of humanitarian assistance. These countries are among the seven conflict-affected countries in the broader Arab region, which also includes Iraq, Iran, and Israel. In 2023, the MENA region was the origin of 14.8 million refugees, representing around 40.5% of the global refugee population. At the same time, it hosted 9.4 million refugees under UNHCR and UNRWA mandates — 25.4% of the global total. Notably, over 6.5 million refugees have originated from Syria alone. Around 19 million internally displaced persons (IDPs), more than a third of all conflict-induced IDPs globally (UN ESCWA 2024), are found in the Eastern Mediterranean and Middle Eastern region.

Conflicts have devastating impacts and long-term security, humanitarian, and development implications, and give rise to involuntary displacement (Abu-Ismail et al. 2021). They have accelerated the pace of migration from and into the MENA, including trans-border movement of refugees, especially in Jordan and Lebanon, but also in Cyprus, Greece, and Türkiye. This has resulted in significant pressures on the host countries' economic and social infrastructure.

Conflicts and migration can be exacerbated by the impacts of environmental change, which increase competition over scarce resources and reinforce potential struggles. Extreme weather and climate events, as well as gradual environmental changes (e.g. coastal erosion or sea level rise) aggravate socio-economic, health, and safety challenges. In addition, increasing temperatures, water scarcity, soil salinisation, and land degradation, driven largely by environmental changes and affecting agricultural productivity and food security, may

[21] According to the Guiding Principles on Internal Displacement (UN 1998), internally displaced persons (IDPs) are 'persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized border.' See also: https://www.ohchr.org/en/special-procedures/sr-internally-displaced-persons/about-internally-displaced-persons

lead an increasing number of people to migrate. Conversely, environmental-change driven migration can be reinforced by violence and conflict.

Structural inequalities in the Mediterranean region, such as national and sub-regional demographic dynamics exacerbate, the already existing North-South divide. While fertility rates equal to or greater than two children per woman are observed in the southern and sastern Mediterranean countries, fertility rates fall below the critical threshold of two children per woman in the western and northern countries. Population numbers in the latter region are expected to stagnate or decrease. However, the currently observed considerable flow of migrants from the conflict areas of countries in parts of the MENA region to Europe may alter the population dynamics of the western and northern Mediterranean countries (Le Tellier and de Miras 2017).

This report gathers and analyses existing evidence on environmental change-induced migration to address remaining policy and knowledge gaps. The environmental change-conflict-migration nexus in the Mediterranean represents an interesting, yet challenging, topic from the perspective of a science-policy interface (SPI) because (1) there are knowledge gaps, as well as (2) a lack of consensus among scientists, regarding the underlying relationships and interdependencies between the elements of this nexus. This report will therefore consider and address the following policy dimensions, gaps, and challenges:

- Apart from any natural drivers, the extent to which environmental change will continue to influence migration will depend on whether emissions of greenhouse gases (GHG) can be reduced, as well as on the adaptation capacities of the impacted sub-regions and countries.

- Since the population affected needs assistance to adapt to the impacts of environmental change, there is a need for adaptation measures, climate risk management, and disaster risk reduction, including early warning systems.

- There is a need for development assistance to promote adaptation to climate change or the reduction of poverty and livelihood disruptions caused by desertification, drought, and crop failure.

- There is a need to address political crises in some Mediterranean countries. This primarily concerns the southern and eastern countries that are part of the MENA region, where an increasingly young and often well-educated population is faced with bleak economic prospects and unemployment.

- Additional research on migration dynamics and the impacts of climate and environmental change on the well-being and integrity of communities is also needed. Comprehensive information, including data on labour migration caused by climate change and urban issues, particularly with regard to rural inhabitants moving into cities, slums, and informal settlements, should be collected and analysed.

- There is an urgent requirement for a gender-responsive approach because environmental change and migration affect women and men differently.

1.2 Main issues addressed and structure of the report

A brief description of the report's structure *(Figure 1.2)* and the main issues covered therein are provided below.

1.2.1 Scope and content of the report

The overall scope of the report and the environmental setting in the Mediterranean Basin are briefly described in the current chapter and in more detail in *Chapter 2* (*Geographical and temporal scope and current setting). Chapter 2* also addresses socio-economic and demographic trends, and major developments in environmental and climate conditions, and provides a brief overview of the past, current and future state of migration and conflict in the Mediterranean region.

Chapter 3 (Threats to human life and livelihoods from environmental change) offers insights into pressures and challenges to human life and livelihoods caused by environmental changes such as decreasing precipitation, heat waves and sea level rise, which may in turn lead to conflict and/or migration. In addition, the chapter considers the impacts of non-climatic drivers, such as overfishing, environmental pollution, and land use changes, and addresses threats to human life and livelihoods by examining the following sectors: water and food security, human health, coastal processes and conditions, degradation of terrestrial and marine ecosystems, and the energy sector.

Chapter 4 (Key challenges for security: conflict and cooperation in the Mediterranean) considers the current status of conflicts in the region and their geopolitical root causes. Subsequent sections of the chapter address interactions between environmental change and conflict, on the one hand, and the relationships between conflict and migration, on the other.

Chapter 5 (Understanding the environment-migration nexus in the Mediterranean) aims to explain various basic concepts of human mobility in the context of the environmental change-conflict-

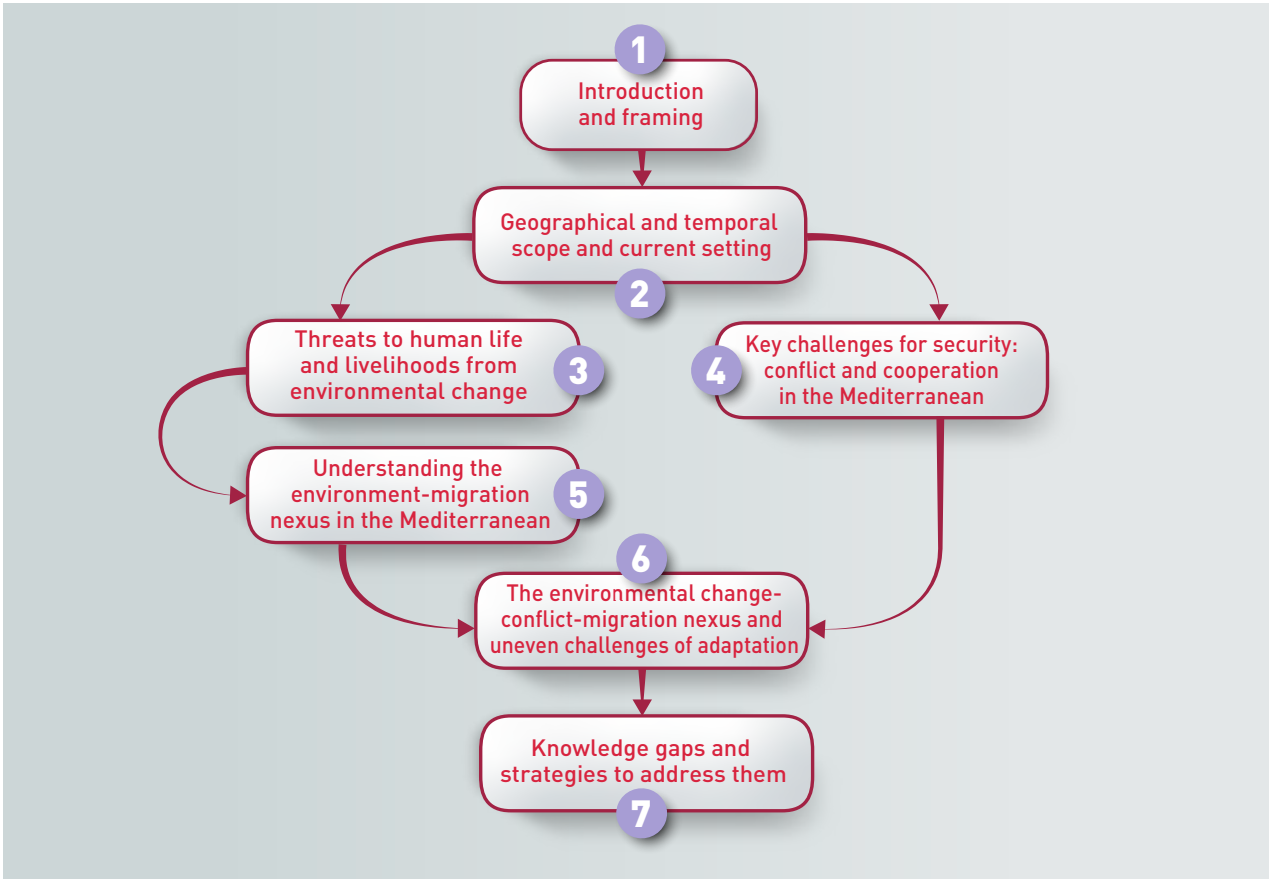


Figure 1.2 | A brief description of the report's structure and the main issues covered. Numbers in the figure denote chapter numbers.

migration nexus. These concerns relate to different forms of human mobility. The chapter provides definitions and explanations regarding human mobility, various factors that trigger movement at different scales away from home communities and the spatial extent of such movements across regional and national borders. It considers the societal challenges that arise once mobile populations arrive at their new destinations. It also deals with the diversity of the spatial and temporal patterns of migration, including the fate of population groups that remain immobile at their locales, despite environmental changes. Finally, the chapter addresses the consequences of environmental migration, specifically regarding adaptation and maladaptation of the migrants to the local conditions of the new place of settlement.

Chapter 6 (The environmental change-conflict-migration nexus and uneven challenges of adaptation) provides a synthesis of the issues addressed in the previous chapters. After looking into the complexity of interactions between environmental change, migration, and conflict, the chapter addresses governance issues, including legal frameworks and regimes related to the environmental change, conflict, and migration nexus in the Mediterranean region. The chapter also covers the challenges associated with migration and place-based vulnerabilities of communities, as well as those related to the environmental and intersectional aspects of migration.

Finally, *Chapter 7 (Knowledge gaps and strategies to address them)* focuses on knowledge gaps associated with the facts and ideas proposed and discussed in the previous chapters and offers approaches to address them. This includes strategies to enable a better understanding of the mechanisms affecting the links between environmental change, migration, and conflict.

The science-policy approach for this report can be found in *Box 1.1.*

1.3 Key issues and conclusions to be drawn

Migratory movements of people in the Mediterranean Basin are growing to a level that far surpasses human movements to and within the Mediterranean in the recent past. The great suffering and loss of life among migrants deserve special attention from scholars and policymakers alike.

An individual's or community's decision to move is based on numerous circumstances. Changes in environmental conditions, as well as conflicts and their devastating consequences for the livelihood of affected communities, enhance their vulnerability and represent powerful drivers of migration.

In order to shed light on the environmental change-conflict-migration nexus, the relationships between environmental change and migration, and those between conflict and migration, are analysed separately. The combined consequences of climatic and non-climatic drivers on migration are considered in the context of vulnerability and adaptation of affected communities. These interactions have been captured by the concept of a 'vicious circle', which locks affected societies into a structure of violence, vulnerability, and environmental and climate change impacts (see *Chapter 4*).

While changing environmental conditions may be a relevant driver of migration, leaving one's home may be considered an adaptation strategy for affected communities. However, environmental changes and resulting migration may also increase conflict risks. The influx of large numbers of migrants into host countries may reduce their adaptive capacity because of, for example, increasing resource scarcity, socio-political unrest, and cultural differences in already stressed societies. The fate of migrants in the Mediterranean region is therefore significantly influenced by the absorptive capacity of host countries, and this needs to be taken into consideration. Moreover, pre-existing concerns associated with migration can lead to or amplify unfair criticism and stigmatisation of migrants. This is particularly important, since this challenge is often treated as a security issue and not a human rights question.

Contrary to commonly quoted convictions that environmental changes are directly causing migrant flows (the terms 'environmental or climate migrants' are used to depict people so affected), the report comes to a different important conclusion. We find that other drivers, and in particular conflicts and their devastating consequences, various general socio-economic factors, and governance issues in a given country, frequently constitute more important drivers of migration than environmental changes and their impacts. This applies particularly to cross-border migration.

Achieving a more comprehensive understanding of the nexus between environmental change, conflict, and migration, both now and in the near future, represents the core focus of this report. However, direct and quantifiable causal links between environmental change, conflict, and migration are complex and hard to unravel. This represents a significant gap in our understanding that needs to be bridged urgently. Unravelling the methodological complexity in specifying realistic and effective policy measures through interdisciplinary and cross-sectoral studies will be indispensable. The knowledge gap underscores the need for additional research to comprehensively understand the root causes of migration. Embracing a multifaceted approach is essential to finding solutions to these challenges. Active involvement from the development, natural sciences and humanitarian research communities, bringing together environmental scientists, economists, sociologists, and local practitioners, will be essential to develop an evidence-based regional vision on how the environment-migration nexus is contextualised in different sub-regions of the Basin. This kind of interdisciplinary approach can enhance our understanding of the developmental aspects of environmental change impacts within the broader framework of the 2030 Sustainable Development Goals (SDGs).

The existing literature suggests that conflicts are a cause of involuntary and voluntary migration. However, the uncertainty and complexity of linkages between developing and ongoing conflicts on the one hand, and migratory movements on the other, significantly complicate matters. Devising appropriate and efficient response mechanisms therefore remains a challenge, especially when conflicts and vulnerabilities emerge due to the absence of effective governance structures, limited cross-border cooperation, or unsustainable policies. Given this challenge, developing and implementing effective adaptation measures and initiatives, for both migrant and host communities, represents an essential strategy for reducing the risk of exacerbating existing conflicts.

Despite numerous advances in our understanding of the environmental change-conflict-migration nexus, questions remain open. However, some additional lessons from the report could inform decision-makers in devising policies and programmes that

address the root causes of the problems associated with the nexus, rather than their symptoms. This also includes proposals for future research that address climate science, social and economic behaviour, and geopolitics through a multidisciplinary lens, as mentioned above.

The narrative of environment-induced migration and displacement as a linear cause-effect relationship needs to be revisited. The push factors and motivations to move are numerous and differ from one region to another, and from one group of people and community to another. Both research and policy domains therefore need to understand that migration from rural to urban areas and across borders differ considerably. They are shaped by different socio-economic conditions and geopolitical forces at play in countries of origin as well as in host countries. The drive to leave one's home and livelihood, history and culture is also shaped by the risk involved in the journey (or at least a perception of it), its legality, and the routes migrants are prepared to take.

The narrative around the environmental change-conflict-migration nexus needs to be shifted urgently from a security-focused frame of reference to one that emphasises opportunities for development and cooperation. A development-focused approach based on engagement of all stakeholders can enhance social cohesion and reduce tensions that may arise from competition over scarce resources.

Because the Mediterranean has been identified as a 'climate change hotspot', climate actions, should prioritise adaptation strategies and programmes, particularly in southern and eastern countries. This will help building the resilience of vulnerable communities and develop climate-resilient solutions that enhance livelihoods, promote social equity, and mitigate vulnerability to climate impacts.

In order to build resilience to environmental change, more in-depth qualitative research is needed to explore how community-driven environmental initiatives and collaboration on joint management of scarce natural resources as common public goods can foster peaceful coexistence and shared prosperity. There are a growing number of success stories documenting how such environmental projects can engage stakeholders to efficiently address local needs and build local capacities. This in turn will enhance livelihoods, promote social equity, and mitigate vulnerability to environmental change in a given community.

Finally, the importance of regional collaboration among Mediterranean countries, inter-governmental bodies, and Basin-level initiatives across the Mediterranean cannot be over emphasised. These represent important avenues for building a coherent approach to managing the environmental, socio-economic, political and developmental challenges around the Basin. This may be achieved through existing multi-stakeholder platforms, joint initiatives and projects that promote dialogue and collaboration on climate, environment, and migration.

1.4 Background, methodology, and drafting process

This Expert Analysis draws on the expertise of the MedECC network and builds on the First Mediterranean Assessment Report (MAR1, MedECC 2020a). It responds to the motivation to provide deeper analysis of several critical issues identified in MAR1 each focusing on (1) the climate and environmental coastal risks (MedECC 2024a); (2) the interlinkages between climate and water–energy–food–ecosystems (WEFE) nexus (MedECC 2024b); and (3) the interdependencies, linkages, and feedbacks between environmental change, conflict, and human migration (this Analysis).

1.4.1 Nature of the analysis as a synthesis of available literature and data

This Analysis represents a collective and iterative review, synthesis, and assessment of available openly published literature. MedECC has carried out no new or additional research, and all findings of the assessment are supported by scientific references. It is primarily based on peer-reviewed literature (in English or other languages), selected non-peer reviewed literature has also been considered, such as institutional or government reports, national statistics, etc. It builds on the MAR1 (MedECC 2020a), previous reports by the Intergovernmental Panel on Climate Change (IPCC), and other relevant local, regional, and national assessments, and draws on evidence from over 1000 scientific publications. The preparation of this Expert Analysis follows an iterative drafting and review process, based on the approach used for the MAR1, ensuring scientific rigor, author independence, and balanced expertise.

1.4.2. Selection of authors based on their expertise, with a consideration of gender and geographical balance

The MedECC Scientific Steering Committee (SC) appointed the Coordinating Lead Authors (CLAs) and Lead Authors (LAs) taking into account a range of scientific, technical, and socio-economic views and backgrounds, as well as geographical and gender balance. A total of 39 CLAs, LAs, and Contributing Authors (CAs) contributed to this Expert Analysis *(Annex I)*. The selection process included efforts to ensure a balance in gender and geography between authors from the northern and western shores of the Mediterranean, and those from southern and eastern countries. The gender balance in this assessment is 38% men and 62% women. 28% of the authors are affiliated in institutions located in Northern Mediterranean Countries, 26% in Southern and Eastern Mediterranean Countries and 46% in other countries (see *Annex I*). This imbalance is due to a number of issues, including the fact that research on the environmental change-conflict-migration nexus or on selected features of the nexus (except the issue of climate change) is less prominently covered by Mediterranean scientists. It should also be noted that linkages between migration and conflict are highly sensitive politically in some Mediterranean countries, which creates significant obstacles to conducting and publishing research on these topics.

1.4.3 Neutrality and independence of the authors

The nature of this Analysis demands the highest possible neutrality and independence of CLAs, LAs, and CAs. Care was therefore taken to select only those scientific experts who fulfilled the criteria — that is primarily scientists from private or public universities and research institutions that carry out work on non-sensitive topics not directly associated with government or defence-related topics. Authors of the report carry out their work on a voluntary basis.

1.4.4 Process of writing, editing, and reviewing the report

Each chapter was drafted under the guidance and supervision of the CLAs, who coordinated content and supervised LAs and CAs. CLAs and LAs are responsible for the content of each chapter and draft specific sections based on their area of expertise. The CLAs oversee the process and are responsible for the coordination of the chapters. The Report Coordinators drive and oversee the entire process of completing the first and subsequent versions of the report, as well as the drafting of the Executive Summary.

This Analysis has gone through a two-stage review process. The Zero Order Draft (ZOD) of the report underwent an internal review by members of the MedECC Scientific Committee and MedECC authors. Following reviewers' comments, a First Order Draft (FOD), including the draft Executive Summary, was produced and underwent an external review process *(Annex II)*. Comments from both stages were incorporated into the final draft. The Executive Summary ensures clarity for decision-makers and facilitates a science-policy dialogue.

Box 1.1

The role of science-policy interfaces for inclusive environmental governance

A science-policy interface (SPI) is based on coordinated dialogue between scientists and policymakers in a problem-solving process and offers a structure or process that enhances the effectiveness of governance in improving the identification, formulation, and evaluation of policies (UNEP 2009). SPIs improve communication and information sharing and help to bridge the gap between scientists and policymakers through two-way and well-balanced communication channels.

Communication obstacles between scientists and policymakers can hinder stakeholder dialogue. The two spheres do not always 'speak the same language', and are not always addressing the same timeframes, among other barriers.

Timeframes — policy decisions must be taken in the short term (i.e. the term of political mandates), while scientists need much more time to establish sound and reliable knowledge.

Language — communication to policymakers should be based on short key messages and recommendations – a decision-maker makes his/her decision on a specific subject if, and only if, there is consensus among scientists (and it is even better if that consensus can be summarised in half a page). In a context of uncertainty, with complex environmental policy affairs, adaptive (or no-regret) policies should have the potential to be adjusted according to socio-economic contexts and the availability of new knowledge (or new scientific consensus).

SPIs go beyond a linear communication approach, where scientists work to pass on knowledge to policymakers, leaving them to decide subsequently what should be done and what actions should be implemented. 'Instead of just communicating information, scientists and policymakers interact and exchange ideas to understand problems together. In this arrangement, policymakers can inform scientists of their research needs and expectations, their analysis of issues and current policymaking processes, while scientists can clarify the scope of their research and the way it can be translated into recommendations and concrete measures' (Lemaitre-Curri et al. 2018, p.5).

Three criteria are fundamental to a robust SPI: credibility, relevance and legitimacy (Cash et al. 2003):

Credibility — the perceived validity of the information, methods and procedures used within an SPI.

Relevance — how closely the procedures and objectives of the SPI relate to the needs of the policymaking process.

Legitimacy — the fairness, accuracy and political balance perceived by the parties involved in the SPI.

SPIs facilitate evidence-based decision-making. They aim to jointly develop and use knowledge on specific issues for the definition, implementation, and follow-up of measures to this end (Young et al. 2013). The collective and structured work must enable the production of shared knowledge syntheses on various issues, expressed in an accessible and balanced language, and adapted if necessary to the diplomatic constraints inherent in multilateral processes (IDDRI and AFD 2017). SPIs can take various forms, from informal discussions between scientists and policymakers to intergovernmental bodies or research projects, involving deliberate interactions between science and policy to serve governance purposes.

Several SPIs have been established or are drawn on by multilateral environmental agreements and international and regional fora addressing environmental issues, allowing scientific experts, policymakers and other stakeholders to network and influence decision-making processes. As an exemplary case, the United Nations Environment Programme (UNEP) and the World

Meteorological Organization (WMO)[22] established the Intergovernmental Panel on Climate Change (IPCC)[23] in 1988. Based on current knowledge on climate change, IPCC synthesis reports specifically address policymakers and provide them with a reliable scientific basis for formulating climate policy. IPCC experts are appointed by their member states, who approve the synthesis reports line-by-line through negotiation and consensus. Formally established in 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[24] is the independent intergovernmental body for biodiversity and ecosystem services. It includes innovative aspects regarding platform members and stakeholders engaged in the consultation process, where not only scientists and policymakers, but also special interest groups such as members of civil society, among others, are represented.

Multi-stakeholder dialogue and environmental governance in the Mediterranean region

Keeping track of the Mediterranean through rigorous monitoring has been one of the core functions of the UN Environment Programme / Mediterranean Action Plan – Barcelona Convention system (UNEP/MAP) since its creation five decades ago. This normative framework set up under the auspices of UNEP in the 1970s as a regional multilateral environmental agreement and UN treaty unites 21 Mediterranean countries and the European Union (EU) within a unique legally binding framework for policy and implementation.[25] A framework with three dimensions: institutional, regulatory, implementation – in a nutshell, governance and action, to support the definition and implementation of regional and national environment policies, from the identification of needs expressed by policymakers to partnerships, including with academia.

Scientists, policymakers, and other stakeholders in the Mediterranean region have long been interacting. The scientific community has played a key role in building the Mediterranean environmental governance framework. 'In his article on epistemic communities, Professor Peter Haas (1990) argues that the Mediterranean Action Plan (...) was partly born out of the action of a community of scientists who shared common convictions (Haas 1990). To a certain extent, the MAP has benefited from the contribution of scientific communities involved in a global context that highlighted the need to strengthen scientific knowledge, long before the current concept of SPI had been identified' (Lemaitre-Curri et al. 2018).

With its ecological complexity, socio-economic disparities, numerous international agreements, and particularly strong pressures on the environment, the Mediterranean is both a showcase and a testing ground for global environmental governance. An array of international agreements requiring Mediterranean states to preserve the region's natural resources has been in place for several decades. These include among others the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, the General Fisheries Commission for the Mediterranean (GFCM)[26] under the auspices of the UN Food and Agriculture Organization (FAO)[27], and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS)[28].

The Contracting Parties to the Barcelona Convention adopted decisions calling for a stronger science-policy interface, including through the Mediterranean Strategy for Sustainable Development (MSSD)[29], the Regional Climate Change Adaptation Framework programme, and the Integrated Monitoring and Assessment Programme

[22] https://wmo.int/

[23] https://www.ipcc.ch/

[24] https://www.ipbes.net/

[25] https://www.unep.org/unepmap/who-we-are

[26] https://www.fao.org/gfcm/en/

[27] https://www.fao.org/home/en

[28] https://accobams.org/

[29] https://www.unep.org/unepmap/what-we-do/mediterranean-strategy-sustainable-development-mssd

(IMAP)[30] of the Mediterranean Sea and Coast. This requirement to strengthen the science-policy interface also features in the biannual UNEP/MAP programme of work.

Within the UNEP/MAP – Barcelona Convention system, a network of National Focal Points, scientific experts and other stakeholders co-operate through steering and advisory committees that support policymaking processes. This is done through MED POL[31], the regional scientific programme of pollution monitoring and assessment, and the Regional Activity Centres (RACs), which represent the UNEP/MAP components that mobilise scientific expertise on specific environmental themes.

The UN 2030 Agenda for sustainable development acknowledges the importance of the regional and sub-regional dimensions, regional economic integration and interconnectivity in sustainable development (UN General Assembly 2015). Regional and sub-regional frameworks are recognised as facilitating the effective translation of global sustainable development policies into concrete action at national level. The 2030 Agenda welcomes the cooperation of regional and sub-regional commissions and organisations for follow-up and review, and it encourages states to identify the most suitable regional fora in which to engage. The UNEP/MAP Mediterranean Commission on Sustainable Development (MCSD) is a case in point. It was created in 1995 in the aftermath of the Rio Conference (1992) as the multi-stakeholder advisory body of the Parties to the Barcelona Convention.[32] The Commission has been instrumental as a forum for experience sharing and peer learning by gathering not only government representatives, but also stakeholders from various categories on an equal footing. This includes representatives of local authority networks, civil society/non-governmental organisations (NGOs), socio-economic actors, inter-governmental organisations (IGOs), the scientific community, and parliamentarians. MedECC is a member of the MCSD under the group of scientists.[33]

The MCSD was instrumental in integrating the principles of the 2030 Agenda into the MSSD, which was adopted by all Mediterranean countries at the 19th Meeting of the Parties to the Barcelona Convention (COP 19) (Athens, Greece, 9-12 February 2016)[34], as a strategic guiding document for all stakeholders and partners to translate the SDGs at the regional, sub-regional and national levels. The MSSD identifies, under its Objective 4 'Addressing Climate Change as a Priority Issue for the Mediterranean', and as a regional Flagship Initiative, the establishment of 'a regional science-policy interface mechanism (...) with a view to preparing consolidated regional scientific assessments and guidance on climate change trends, impacts and adaptation and mitigation options'. MedECC corresponds to this MSSD Flagship Initiative, and the UNEP/MAP Medium-Term Strategy 2022-2027 confirms 'support to MedECC as a voluntary science policy interface platform of Mediterranean climate scientists'.

The case study of MedECC's First Mediterranean Assessment Report (MAR1)

MedECC is an open and independent international scientific network of experts founded in 2015 responding to these needs for a regional-level SPI in the Mediterranean, in the context of the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, France, in 2015. The network aims at gathering, updating, and consolidating the best available scientific knowledge on climate and environmental change and associated risks in the Mediterranean basin to render it accessible to policymakers, stakeholders, and citizens. Since

[30] https://www.unep.org/unepmap/what-we-do/monitoring-and-assessments

[31] https://www.unep.org/unepmap/fr/who-we-are/institutional-set/med-pol

[32] https://www.unep.org/unepmap/who-we-are/governing-and-subsidiary-bodies

[33] https://www.unep.org/unepmap/who-we-are/governing-and-subsidiary-bodies/mcsd-members

[34] Decision IG.22/2: https://wedocs.unep.org/bitstream/handle/20.500.11822/6084/16ig22_28_22_02_eng.pdf

2018, the Plan Bleu/RAC[35] of UNEP/MAP has hosted the MedECC Scientific Secretariat. MedECC is also supported by the Union for the Mediterranean (UfM), a regional, institutional intergovernmental platform gathering all EU member states and Southern and Eastern Mediterranean countries. MedECC published MAR1 in 2020 responding to the need for a comprehensive synthesis and assessment of recent trends climate and environmental change in the Mediterranean region including the likely future development of the region and the consequences of environmental change for natural systems, the economy, and human well-being.

The development of MedECC reports follows an iterative drafting and review process, similar to the approaches used by the IPCC and the IPBES. The UNEP/MAP and UfM Secretariats organised a consultation between their policymakers and the MedECC coordinators and CLAs. These consultations included an online review of the draft SPM (April – June 2020)[36] followed by a one-day plenary session held remotely on 22 September 2020. The consultation was attended by members of the MCSD Steering Committee, Plan Bleu Focal Points, members of the UfM Climate Change Expert Group (CCEG) and of the UfM Environment Task Force, the MedECC Secretariat, Steering Committee, and Coordinating Lead Authors, as well as UNEP/MAP, Plan Bleu and UfM Secretariat representatives. The aim of these consultations was to ascertain that MAR1 findings, as presented in the draft SPM, were fully comprehensible, unambiguous, and that the assessment of literature was transparent, objective, and complete. Attended by approximatively 100 participants, this plenary stakeholder consultation constituted an important step in reinforcing the science-policy dialogue.

The MedECC MAR1 SPM (MedECC 2020b) was formally endorsed by the Contracting Parties of the COP 22 of the Barcelona Convention and reflected in the Antalya Ministerial Declaration (Türkiye, December 2021) (UNEP/MAP 2021a, 2021b). It was also recognised as an important contribution of the scientific community to future climate and environmental actions in the Mediterranean region in the Ministerial Declaration of the Second UfM Ministerial Conference on Environment and Climate Action (Cairo, Egypt, October 2021) (UfM 2021).

In addition, MedECC contributed to the IPCC Sixth Assessment Report (AR6), with a cross-chapter paper dedicated to the Mediterranean for the first time (Ali et al. 2022). This chapter was prepared under the co-leadership of one of the MedECC coordinators, and several MedECC MAR1 authors contributed to it, ensuring a strong synergy across the two assessment reports.

It is worth mentioning that the 2020 North-South Prize of the Council of Europe was awarded to MedECC for its efforts to address climate change and biodiversity conservation in the Mediterranean, in particular by elaborating the first-ever scientific assessment on climate and environmental change impacts in the Mediterranean Basin[37]. The jury stated that MedECC constitutes a concrete example of the vision of the Mediterranean Sea as a shared space for peace, development, and human rights. The ceremony took place on 9 December 2021 in Lisbon, Portugal.

[35] https://planbleu.org/en

[36] The MedECC Secretariat received 453 comments on the draft SPM from 21 governments, decision-makers and partner organisations. In addition, 196 comments were received on the MAR1 draft full report.

[37] https://rm.coe.int/decision-jury-nsp2020/1680a0b27f

References

Abu-Ismail K., Chaitani Y., and Nehme M. (2021). *Domestic conflict: a proposed index and its implications for Arab States*. E/ESCWA/CL6.GCP/2021/TP.6. Beirut: United Nations Economic and Social Commission for Western Asia. https://www.unescwa.org/sites/default/files/pubs/pdf/domestic-conflict-proposed-index-implications-arab-states-english.pdf

Ali E., Cramer W., Carnicer J., Georgopoulou E., Hilmi N. J. M., Le Cozannet G., and Lionello P. (2022). Cross-Chapter Paper 4: Mediterranean Region. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 2233–2272). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009325844.021

Cash D. W., Clark W. C., Alcock F., Dickson N. M., Eckley N., Guston D. H., Jäger J., and Mitchell R. B. (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences*, *100*(14), 8086–8091. doi: 10.1073/pnas.1231332100

Cherif S., Doblas-Miranda E., Lionello P., Borrego C., Giorgi F., Iglesias A., Jebari S., Mahmoudi E., Moriondo M., Pringault O., Rilov G., Somot S., Tsikliras A., Vilà M., and Zittis G. (2020). Chapter 2: Drivers of Change. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 59–180). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7100601

Cramer W., Guiot J., Fader M., Garrabou J., Gattuso J.-P., Iglesias A., Lange M. A., Lionello P., Llasat M. C., Paz S., Peñuelas J., Snoussi M., Toreti A., Tsimplis M. N., and Xoplaki E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change*, *8*(11), 972–980. doi: 10.1038/s41558-018-0299-2

EEA (2015). Mediterranean BRief The European environment – state and outlook 2015. In *SOER 2015 — The European environment — state and outlook 2015* (pp. 225–229). European Environment Agency, Copenhagen.

Giorgi F. (2006). Climate change hot-spots. *Geophysical Research Letters*, *33*(8), L08707. doi: 10.1029/2006gl025734

Haas P. M. (1990). *Saving the Mediterranean: the politics of international environmental cooperation*. Columbia University Press, 303 pp.

IDDRI, and AFD (2017). *Basing public policy on science and knowledge*. A Planet for life. The fabric of sustainable future. Institute for Sustainable Development and International Relations and Agence Française de Développement, 34 pp. Basing public policy on science and knowledge | IDDRI

IDMC (2022). Global Report on Internal Displacement 2022 (GRID 2022). Internal Displacement Monitoring Center (IDMC). https://disasterdisplacement.org/resource/2022-global-report-on-internal-displacement-grid/ https://disasterdisplacement.org/resource/2022-global-report-on-internal-displacement-grid/

IOM (2014). *IOM Outlook on Migration, Environment and Climate Change*. International Organization for Migration, 144 pp.

IUCN (2022). *Mediterranean Red List.* International Union for the Conservation of Nature. https://www.iucnredlist.org/regions/mediterranean-red-list

Koubi V., Behnassi M., Elia A., Grillakis M., and Turhan E. (2020). Human security. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 515–538). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7216161

Lange M. A. (2022). Climate Change and the Water-Energy Nexus in the MENA Region. In V. Naddeo, K.-H. Choo, & M. Ksibi (Eds.), *Water-Energy-Nexus in the Ecological Transition* (pp. 93–98). Springer International Publishing. doi: 10.1007/978-3-031-00808-5_22

Le Tellier J., and de Miras C. (2017). Le Plan Bleu : une interface multiple entre développement durable et gouvernance pour la Méditerranée. In A. Iraki & C. de Miras (Eds.), *Interroger les gouvernances urbaines : entre fragmentation et contrat territorial* (pp. 283–309). Karthala.

Lemaitre-Curri E., Lavoux T., and Futhazar G. (2018). *Science-policy interfaces for environmental governance in the mediterranean*. Marseille: Plan Bleu. https://planbleu.org/en/publications/science-policy-interfaces-for-environmental-governance-in-the-mediterranean/

MedECC (2020a). *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (W. Cramer, J. Guiot, & K. Marini, Eds.). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp. doi: 10.5281/zenodo.4768833

MedECC (2020b) Summary for Policymakers. In: *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* [Cramer W, Guiot J, Marini K (eds.)]. Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp. 11-40, doi: 10.5281/zenodo.5513887

MedECC (2024a)*: Climate and Environmental Coastal Risks in the Mediterranean*. [Djoundourian, S., Lionello, P., Llasat, M.C., Guiot, J., Cramer, W., Driouech, F., Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, 306 pp. doi: 10.5281/zenodo.13754020

MedECC (2024b): Interlinking climate change with the Water-Energy-Food-Ecosystems (WEFE) nexus in the Mediterranean Basin. [Drobinski, P., Rivera-Ferre, M.G., Abdel Monem, M., Driouech, F., Cramer, W., Guiot, J., Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, 264 pp. doi: 10.5281/zenodo.13365388

Sachs J. D., Lafortune G., Fuller G., and Drumm E. (2023). *Implementing the SDG Stimulus. Sustainable Development Report 2023*. Paris: Paris: Sustainable Development Solutions Network, Dublin: Dublin University Press. doi: 10.25546/102924

UfM (2021). *Declaration from 2nd Union for the Mediterranean Ministerial Conference on Environment and Climate Action*. Union for the Mediterranean. https://ufmsecretariat.org//wp-content/uploads/2021/10/UfM-ministerial-declaration-ENV-CA_final-1-1.pdf

UN (1998). *Guiding Principles on Internal Displacement (E/CN.4/1998/53/Add.2)*. https://docs.un.org/en/E/CN.4/1998/53/Add.2

UN ESCWA (2024). *Arab Sustainable Development Report 2024*. (E/ESCWA/CL5.SDGS/2024/1). United Nations Economic and Social Commission for Western Asia. https://www.unescwa.org/publications/arab-sustainable-development-report-2024

UNDP (2022). *New Threats to Human Security in the Anthropocene: Demanding Greater Solidarity*. United Nations Development Programme, New York.

UNEP/MAP (2021a). Antalya Ministerial Declaration. In *Report of the 22nd Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols. UNEP/MED IG.25/27* (pp. 103–108). United Nations Environment Programme/Mediterranean Action Plan, Athens. https://wedocs.unep.org/bitstream/handle/20.500.11822/37129/21ig25_27_2507_eng.pdf

UNEP/MAP (2021b). Decision IG.25/4: Assessment Studies. In *Report of the 22nd Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols. UNEP/MED IG.25/27* (UNEP/MED IG.25/27; pp. 233–268). UNEP/MAP, Athens. https://www.unep.org/unepmap/meetings/cop-decisions/cop22-outcome-documents

UNEP/MAP, and Plan Bleu (2020). *State of the Environment and Development in the Mediterranean*. Nairobi.

UNHCR (2021). *Global Trends - Forced Displacement in 2020*. Geneva: United Nations High Commissioner for Refugees. https://www.unhcr.org/publications/global-trends-2021

UNHCR (2022). *Global report 2022*. Geneva: United Nations High Commissioner for Refugees. https://www.unhcr.org/media/global-report-2022

UNHCR (2024). *Global appeal 2024*. Geneva: United Nations High Commissioner for Refugees. https://www.unhcr.org/media/global-appeal-2024

Vafeidis A. T., Abdulla A. A., Bondeau A., Brotons L., Ludwig R., Portman M., Reimann L., Vousdoukas M., and Xoplaki E. (2020). Managing future risks and building socio-ecological resilience. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 539–588). Union for the Mediterranean, Plan Bleu. doi: 10.5281/zenodo.7101119

Valavanidis A., and Vlachogianni T. (2013). Ecosystem and Biodiversity Hotspots in the Mediterranean Basin: Threats and Conservation Efforts. *Science Advances on Environment, Toxicology & Ecotoxicology Issues*, *10*, 1-24. https://www.researchgate.net/publication/236231013_Ecosystem_and_Biodiversity_Hotspots_in_the_Mediterranean_Basin_Threats_and_Conservation_Efforts

Young J. C., Watt A. D., van den Hove S., and and the SPIRAL project team. (2013). *Effective interfaces betweenscience, policy and society: the SPIRAL project handbook*. https://oppla.eu/resource/spiral-project-handbook-effective-interfaces-between-science-policy-and-society

Information about the authors

Coordinating Lead Authors

Manfred A. LANGE, Energy, Environment and Water Research Center (EEWRC), The Cyprus Institute, *Cyprus*

Roula MAJDALANI, International Center for Agricultural Research in the Dry Areas, Consultative Group on International Agricultural Research (ICARDA-One CGIAR), *Lebanon*

Lead Author

Julien LE TELLIER, United Nations Economic and Social Commission for Western Asia (UN-ESCWA), *Lebanon*

Geographical and temporal scope and current setting

2

Coordinating Lead Authors
Audrey BROUILLET *(France)*

Lead Authors
Lucas KLUGE *(Germany)*, **George ZITTIS** *(Cyprus)*

Contributing Authors
Tuba BIRCAN *(Belgium)*, **Efthymia NIKITA** *(Cyprus)*, **Dilek YILDIZ** *(Austria)*

This chapter should be cited as:
Brouillet, A., Kluge, L., Zittis, G., 2026: Geographical and temporal scope and current setting. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, pp. 63-85. doi: 10.5281/zenodo.17984865

Chapter 2
Geographical and temporal scope and current setting

Executive summary 65

2.1 Definition of key terms 66
2.1.1 Human mobility and its different forms 66
2.1.2 Other important definitions 67

2.2 Spatio-temporal scopes of the report 69
2.2.1 Geographical scopes 69
2.2.1.1 The Mediterranean Basin and migration routes 69
2.2.1.2 Routes of migration flows, and countries of origin 70
2.2.1.3 Mediterranean destination countries 70
2.2.2 Temporal scale and temporal scope of this report 71

2.3 Socio-economic and demographic trends: past, present, and future 72

2.4 Major trends of climate changes in the Mediterranean: past, present and future 74

2.5 Past and current patterns and trends in migration and conflict 76
2.5.1 Diachronic responses to environmental change 76
2.5.2 Trends in migration and security and humanitarian challenges 77

2.6 Future projected trends in conflicts and migration 79

References 80

Information about the authors 85

Executive summary

The Mediterranean region covered in this Expert Analysis comprises the semi-enclosed Mediterranean Sea and its bordering countries, which belong to Europe, Asia and Africa. The current population is estimated between 480 and 520 million. The region comprises a variety of climate zones.

This Analysis aims to synthesise past and present observed trends in human mobility and migration, as well as future projections in all the related drivers, including changes in climate, environment, ecosystems, conflicts and security.

Due to its geographical continuity and diverse cultural, political, and economic settings, the Mediterranean region exhibits significant socio-economic disparities between northern and southern countries. These inequalities increase the region's vulnerability to environmental challenges.

All Mediterranean subregions have warmed substantially during the last century. Observed warming now exceeds 1.5°C since the pre-industrial era. The region is therefore warming significantly faster than what is being observed globally.

Observed and projected precipitation trends are less robust than temperature trends. Interannual climate variability is considered the dominant driver of rainfall anomalies in the Mediterranean. The magnitude, direction and significance of trends vary between Mediterranean locations, except for consistent evidence of ongoing drying in the eastern parts of the Basin.

Climate-related extreme events, particularly heat waves and droughts, are expected to intensify in a continuously warming Mediterranean region.

Ongoing political instability and conflicts in North Africa and the Middle East are expected to continue to affect mobility patterns in the Mediterranean region. Despite increasing border controls, current migration flows are expected to increase in the coming decades.

2

2.1 Definition of key terms

Environmental changes resulting from anthropogenic activities have affected and influenced all terrestrial and marine ecosystems of the Mediterranean Basin in recent decades (MedECC 2020b; Ali et al. 2022). Major manifestations of these impacts include changes in climate variables, that is, temperature, precipitation, extreme events, atmospheric circulation, as well as sea level rise, and changes in the physical and chemical properties of the sea. In addition, an ongoing increase in human population, enhanced terrestrial and marine pollution, as well as an unsustainable use of land and sea areas have added stress to environmental and human systems in the Mediterranean. Livelihoods are therefore significantly affected by these changes, for example, the lack of sufficient precipitation for rain-fed agriculture. Their impacts result in reduced predictability and higher uncertainties with regard to the availability of major resources, which may pose challenges to food security and livelihoods, and affect social structures and human health of communities and countries. This may encourage voluntary as well as involuntary human mobility and migration. Uncertainties in the magnitude and spatial distribution of climate change and its impacts in the individual sub-regions of the Mediterranean may also lead to tipping points being crossed[38]. The consequences of passing tipping points will challenge community integrity, leadership and traditional conflict resolution mechanisms.

The following provides definitions of key notions and terms used and described throughout this Expert Analysis.

2.1.1 Human mobility and its different forms

Human mobility occurs across three dimensions:

1. the choice of the movement of an individual or a group of individuals, on a spectrum from fully voluntary to involuntary (forced) (de Haas 2021);
2. spatial scales, in terms of the distance migrants travel inside the borders of their own countries or the borders they cross; and
3. the temporal scale and duration of their stay away from their home location, whether seasonal, temporary or permanent.

Disaggregating movement along the voluntary to involuntary continuum is quite complex. It requires determining the degree to which a person/household has come under pressure from altered conditions, as well as the degree of freedom they have in making a mobility decision. Usually, voluntary movement entails some element of freedom of choice, whereas displacement or involuntary relocation implies constraints on the degree of freedom. Terms usually associated with environmental and climate migration therefore include environmentally-induced involuntary migration, climate change-induced migration, climate migrants, ecological or environmental refugees, climate displacement, distress migration, and climate refugees. While the latter is a popular term, it is also considered somewhat problematic, since 'refugee' is used as a legal category, limited to people fleeing persecution owing to factors such as their race, ethnicity, or political beliefs.

Migration can also be split into two major types of 'spatial scaled' migration: internal migration and *international/external* migration, whose processes, causes and consequences often differ significantly. Internal migration refers to a change of residence within national boundaries, such as between states, provinces, cities, or municipalities. It mostly includes a four-way classification: (1) rural-to-rural migration; (2) rural-to-urban migration; (3) urban-to-rural migration; and (4) urban-to-urban migration.

Although it strongly varies among countries, the prevalent form of internal migration appears to be rural-to-urban migration (Lucas 2015). Due to factors such as economic opportunities concentrated in urban areas and industrialisation, individuals from rural areas are often attracted by employment prospects, better livelihoods, education, and other amenities. As a result, rural-to-urban migration is the dominant form of internal migration in many countries undergoing significant economic and social transformations.

International migration refers to a change of residence across national borders. International migrants can be further classified into legal immigrants who move with the legal permission of the receiving state, undocumented immigrants

[38] In climate science, a tipping point is a critical threshold that, when crossed, leads to large, accelerating and often irreversible changes in the climate system (Lenton et al. 2019).

who move without legal permission, and refugees who cross an international boundary to escape persecution.

In terms of the duration of stay, migration can be classified into three types: permanent, temporary, and seasonal/circular migration (although these three categories might not necessarily be exhaustive). The migrant's intention to permanently change their residence distinguishes permanent migration from temporary/seasonal migration. In permanent migration, the usual place of residence of a migrant changes and the likelihood of returning home is small. In the case of temporary and seasonal migration, however, migrants continue to remain usual members of the household and tend to move circularly between the places of origin and destination.

In the context of climate change, the Conference of the Parties (COP 16) to the United Nations Framework Convention on Climate Change (UNFCCC) highlighted three types of human movement in December 2010: (1) migration; (2) displacement; and (3) planned relocation (UNFCCC 2011; Black et al. 2013).

While migration is generally regarded as a predominantly voluntary movement, displacement is mostly understood to refer to a predominantly forced movement. Planned relocation describes a process in which individuals or groups are physically relocated from their homes and settled permanently in a new location; it may be involuntary or voluntary, depending on the circumstances. Migration, displacement, and (planned) relocation, however, are not the only categories that need to be understood.

In the context of environmental change, increasing attention has also focused on so-called 'trapped populations' (Black et al. 2011; Adger et al. 2015). That is, people who, although they would like to move, are unable to do so because of mobility constraints. Examples of such constraints include old age or disability, lack of economic or social capital, or legal formalities (Carling 2002; Wiegel et al. 2019; Schewel 2020). In contrast, there are also 'voluntarily' immobile people who choose to remain in place despite the adverse effects of environmental change. This may result from a close attachment to the home location or cultural reasons, such as the ancestral links people have with their land (Adams 2016; Farbotko et al. 2020; Zickgraf 2021).

These complex and different forms of mobility can be broadly summarised using the definition of the International Organization for Migration (IOM): 'Migration includes the movement of a person or a group of persons, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees, displaced persons, economic migrants, and persons moving for other purposes, including family reunification' (IOM 2018). Accordingly, IOM defines a migrant as 'any person who is moving or has moved across an international border or within a State away from their habitual place of residence, regardless of (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; or (4) what the length of the stay is'.

2.1.2 Other important definitions

Climate adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC 2023).

Climate change: The United Nations Framework Convention on Climate Change defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and which is in addition to natural climate variability observed over comparable time periods' (UN General Assembly 1994, Article 1, para 2). The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes (IPCC 2023).

Climate migrants: The term 'climate migrants' is often debated in literature and is considered a misleading label, as it suggests a direct causal and exclusive relationship between climate and migration. The literature shows that many key factors such as governance and socio-economic vulnerability (unrelated to climate modifications) drive migration, along with other environmental factors (e.g. pollution). A dynamic combination of variables is at play over time, often dictating choices even when conditions are dire.

Conflict: A conflict is broadly defined in this report as collective actions of varying levels of intensity driven by diverging political interests, ranging from protest to non-lethal riot events, civil conflict

and war. Conflicts can be inter-state (conflicts between two or more governments), or intra-state, that is, conflicts between a government and a non-governmental party, with no interference from other countries.

Disaster: A serious disruption of the functioning of a community or society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts (UNDRR 2017).

Environmental change: 'Environmental change is a change or disturbance of the environment through natural ecological processes' (Johnson et al. 1997).

Environmental migrants: Based on the three above-mentioned dimensions, the IOM defines environmental migrants as 'persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment...[including but not limited to climate]...that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad' (IOM 2007, para 6).

Exposure: The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. According to the United Nations Office for Disaster Risk Reduction (UNDRR), exposure is 'the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas' (UNDRR 2017).

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socio-natural in origin. Natural hazards are predominantly associated with natural processes and phenomena. Anthropogenic hazards, or human-induced hazards, are induced entirely or predominantly by human activities and choices. Several hazards are socio-natural, as they are associated with a combination of natural and anthropogenic factors, including environmental degradation and climate change (UNDRR 2017).

Human rights: Human rights are rights inherent to all human beings, regardless of race, sex, nationality, ethnicity, language, religion, or any other status (e.g UN General Assembly 1948; UN General Assembly 1989). Human rights include the right to life and liberty, freedom from slavery and torture, freedom of opinion and expression, the right to work and education, freedom of movement and residence, right to seek and enjoy asylum from persecution in other countries, and many more. Everyone is entitled to these rights, without discrimination.

Livelihood: The resources used, and the activities undertaken in order for people to live. The entitlements and assets to which people have access usually determine livelihoods. Such assets can be categorised as human, social, natural, physical or financial.

Resilience: The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC 2023).

Risk: The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of environmental change, risks can arise from potential impacts of climate change as well as human responses to environmental change. Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species (IPCC 2023).

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. See also Exposure and Risk. (IPCC 2023).

2.2 Spatio-temporal scopes of the report

2.2.1 Geographical scopes

2.2.1.1 The Mediterranean Basin and migration routes

While the Mediterranean Sea is a well-defined water body bounded by the Strait of Gibraltar, the Dardanelles Strait, and the Suez Canal *(Figure 2.1)*, several definitions are used to describe the land boundaries of the Mediterranean Basin. It comprises the semi-enclosed Mediterranean Sea with bordering countries, which belong to Africa, Asia, and Europe, at the crossroads of three continents. The Mediterranean region is known for its great environmental and socio-cultural richness and is characterised by unique ecological and physiographic features, as well as its historical and cultural heritage (Abulafia 2011).

Due to human activities, the Mediterranean Basin has undergone continuous modifications of its environment and socio-economic conditions over several millennia. For instance, only 23.7% of the Mediterranean population lived in southern countries in 1950, while this proportion was 46.3% in 2020 (MedECC 2020a).

In political terms, the United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) covers 21 countries, which are Contracting Parties (CPs) to the Barcelona Convention. This excludes Jordan and Portugal, which do not border the Mediterranean, as well as Gibraltar (United Kingdom) and Palestine, which hold observer

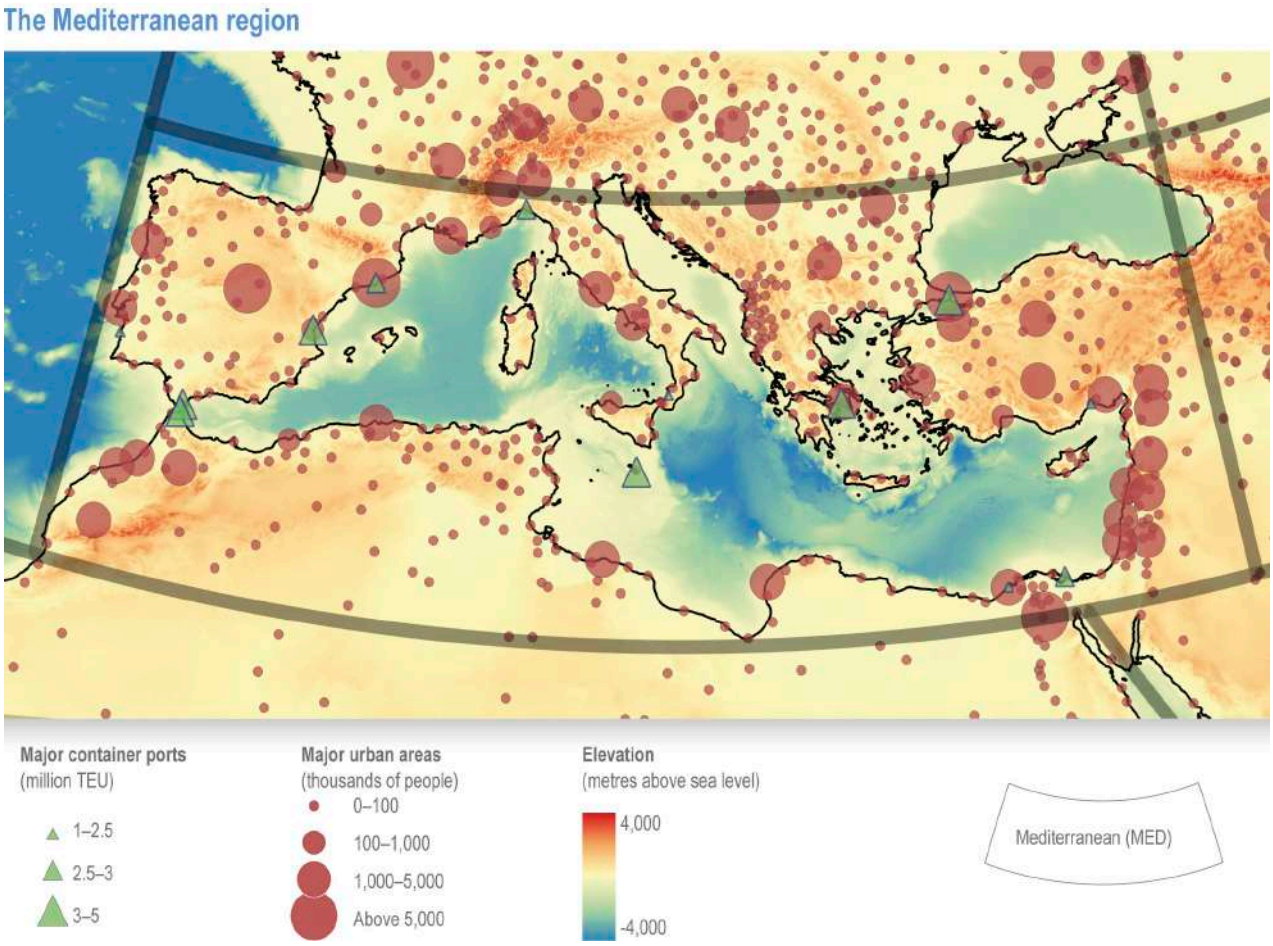


Figure 2.1 | Topography, bathymetry, major urban areas, container ports, and regional boundaries of the Mediterranean region. Map showing topography and bathymetry (colour bar in metres), main urban areas (population in thousands for 2020, from www.naturalearthdata.com), container ports (millions of TEU [twenty-foot container equivalent units] for 2017, from International Association of Ports and Harbours), and the borders of the Mediterranean region used in WGI AR6 Chapter 10 (Doblas-Reyes et al. 2021). Source: Figure CCP4.1 in Ali et al. (2022).

status. The population of the Mediterranean region, as defined here, totals approximately 480 million inhabitants (EEA 2019). However, taking a larger geographical area into account and considering the above-mentioned countries (i.e. Jordan, Palestine, Gibraltar/UK, and Portugal), the population of the Mediterranean Basin is estimated at about 540 million people (UN DESA 2019).

Approximately one third of the Mediterranean population is concentrated in its coastal zones, and about 250 million people are in coastal hydrological basins. Moreover, a large proportion of the industrial infrastructure and urban settlements are located near the sea. This includes extensive harbour, shipbuilding and dockyard facilities, since the Mediterranean Sea represents one of the busiest shipping routes globally. Since the Mediterranean region is also the world's leading tourist destination, a significant number of international tourists have visited Mediterranean countries in recent years. In the future, the Mediterranean population could increase to 657 million by 2050 and 694 million by 2100, with 55.5% and 64.6% of the population living in southern countries in 2050 and 2100, respectively (UN DESA 2019).

Following the earlier physical assessment by MedECC (MedECC 2020a), the geographical scope of this report comprises a regular latitude-longitude box (29°N to 47.5°N and 10°W to 39°E). This box includes regions with non-Mediterranean climates, including the Alps, the Eastern Balkans, and part of the Sahara. This definition of the Mediterranean region is slightly larger than the MED zone adopted in IPCC-AR5 (IPCC 2013) and quite similar to the MED zone adopted in the cross-chapter on the Mediterranean in IPCC-AR6 (Ali et al. 2022) *(Figure 2.1)*.

2.2.1.2 Routes of migration flows, and countries of origin

Migration through the Mediterranean involves individuals from various countries in Africa, the Middle East, and parts of Asia (Pace and Monnet 2016). Data on refugees travelling through the Mediterranean are collected by the European Union Agency for Asylum (EUAA)[39], and data on migration flows are collected by the International Organization for Migration (IOM)[40]. Corresponding migration fluxes are usually described and classified as 'migration routes'.

The Western African and Western Mediterranean route corresponds to migrations via the Mediterranean Sea to mainland Spain and by land to the Spanish enclaves of Melilla and Ceuta in North Africa (European Council: Council of the European Union 2023). Migrants mostly depart from Morocco, Mauritania, Senegal and Gambia, and then sail along the West African coast to reach the Canary Islands. Migrants and asylum seekers also use the Central Mediterranean route to enter the EU. They embark on journeys from North Africa, and Türkiye, crossing the Mediterranean Sea to reach Italy and Malta. Countries of origin using this migration route include mainly Bangladesh, Côte d'Ivoire, Egypt, Guinea, and Pakistan. The Eastern Mediterranean and the Balkans route mostly refers to migrations through Bulgaria, Cyprus, and Greece. Large numbers of refugees seeking shelter originate mostly from Afghanistan, Iraq, Pakistan, Palestine, Somalia, Syria, and Türkiye.

Specific countries of origin of migrants vary over time due to political, economic, and social factors. As an example, migration by sea in the Mediterranean region was characterised by a massive increase in the number of refugees seeking shelter from the Syrian civil war in 2015, but these fluxes were 98% lower in 2020 due to EU measures to tackle migrant smugglers.[41]

2.2.1.3 Mediterranean destination countries

Most individuals follow the previously described migration routes to seek refuge, economic opportunities, or better living conditions. Major corresponding destination countries in the Mediterranean region thus include many European countries including, but not limited to: Italy (Sicily, southern mainland coast), Spain (Andalusia, the Canary Islands), Greece and the Cyclades, Malta, Cyprus, and France (e.g. Crawley et al. 2016; IOM 2018, 2019, 2021).

Many states in North Africa also play important and varying roles in Mediterranean migration dynamics,

[39] https://euaa.europa.eu/asylum-knowledge/data-analysis-and-research

[40] https://gmdac.iom.int/data-and-resources

[41] https://www.consilium.europa.eu/en/policies/eu-migration-policy/#routes

including serving as departure points, transit countries, and in some cases, destinations for migrants (ICMPD 2017; IOM 2021). These countries include Libya (despite its own internal conflicts and challenges), Tunisia, and Algeria (although the Algerian government has implemented measures to curb irregular migration). However, due to the nature of migration patterns and geopolitical factors, European countries remain the primary destinations for many migrants crossing the Mediterranean (Crawley et al. 2016; Hanson and McIntosh 2016).

2.2.2 Temporal scale and temporal scope of this report

In this section, we refer mainly to scales and scopes associated with past and present climate conditions, and to future projections of climate variables.

In climate sciences, different periods and time frames are used to assess climate modifications throughout Earth's history, mostly depending on data availability (IPCC 2007, 2013, 2021). For instance, instrumental observations of temperature can be found from the second half of the 18th century, but only in some European countries. Precipitation monitoring is also largely heterogeneous in both temporal and spatial scales within the Mediterranean region. This is the result of insufficient data stemming from old networks in early recordings in some countries, or from incoherent observations over a short period (Morbidelli et al. 2020). Palaeoclimate proxy information provides the basis for reconstructing climates before the instrumental period. Past climate information for the Mediterranean is preserved in natural archives, such as marine and lacustrine sediments, corals, tree rings, loesses, and cave deposits (speleothems), as well as various sources of documentary evidence (Zittis et al. 2022).

Projected future changes are typically described relative to a recent period, which serves as a baseline reference. This is typically a recent 20 to 30-year long period that covers the end of the 20th and/or the beginning of the 21st century. Current and upcoming decades are very important transitional periods for prioritising and taking action to mitigate and/or adapt to environmental changes. In this Expert Analysis, the proposed future climate projections follow the IPCC-AR6 scenario approach and consider various possible climate policy and socio-economic pathways.

2.3 Socio-economic and demographic trends: past, present, and future

The Mediterranean region comprises complex socio-political settings. For millennia, the Mediterranean has been a unique geographical space, but it has been a politically, economically, and culturally divided region (except for the time of the Roman Empire). The modes of government in countries and regions have been continuously changing, whereas the geographical scope of the Mediterranean has remained unchanged over the past 5000 years of human history (Brauch 2010). These long-standing divisions are reflected in contemporary socio-economic and political conditions across the region *(Figure 2.2).*

The variety of cultures, policies and governance approaches, and the diversity of social systems have also led to very different levels of socio-economic development between northern and southern Mediterranean countries (IPCC 2014; Rigaud et al. 2018; MedECC 2020a; Ali et al. 2022; IDMC 2023). Per capita income levels are three to five times higher in southern European countries (France, Italy, and Spain, in particular), compared to countries on the southern and eastern shores of the Mediterranean Sea. While significant progress has been made in the southern and eastern countries over the last twenty years, instability and significant inequalities persist.

This socio-economic gradient between northern and southern Mediterranean countries lies at the heart of the region's vulnerability to environmental and climate change issues, since it exacerbates imbalances and leads to greater impacts of environmental changes on less-developed countries (which have limited capacity to deal with these impacts and to devise possible adaptation measures).

In the future, Mediterranean regions are expected to experience decreasing population growth along with other regions in the world, except for Europe *(Figure 2.3).* In Southern Europe, after a slight reduction during the century, population growth is set to increase from 2070. Improved healthcare and declining fertility rates may lead to an ageing population, which could pose challenges in terms of healthcare, pension systems, and labour productivity (UN DESA 2022).

The Mediterranean has been a major route for migration, and this trend is likely to continue in the coming years. Factors such as economic disparities, political instability, authoritarian regimes, conflict and climate change will contribute to increased migration flows (including educated and skilled people, with the consequent brain drain), affecting both destination countries and migrants themselves. Managing migration and addressing the root causes of displacement will remain key challenges.

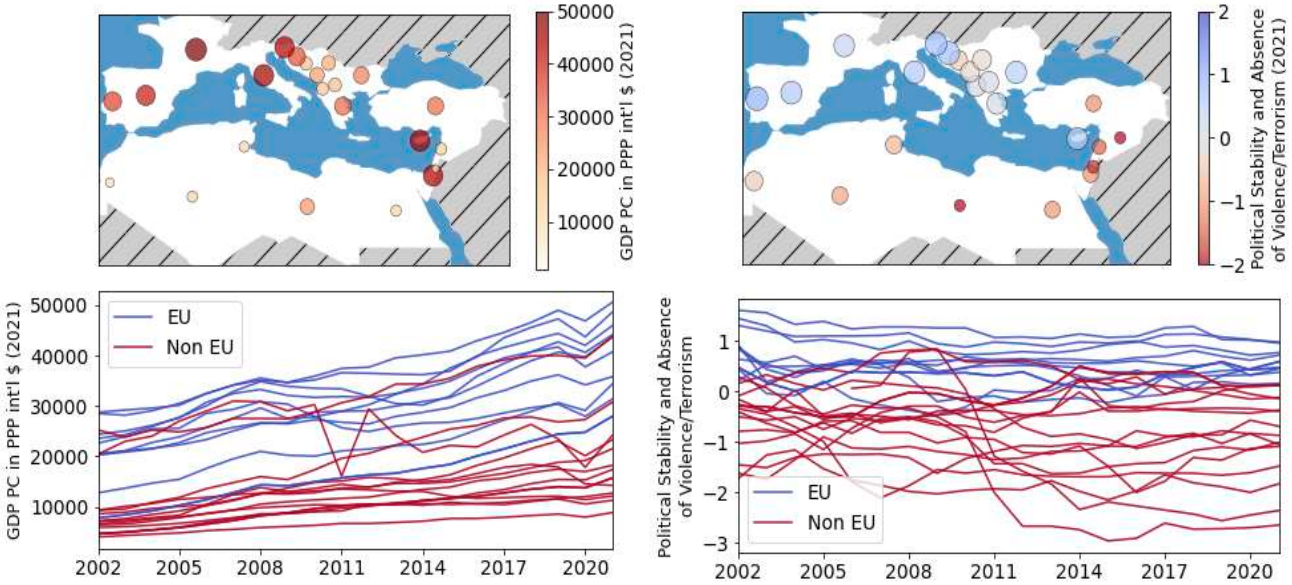


Figure 2.2 | Spatial patterns and temporal evolution of economic and political indicators in the Mediterranean since 2002. Spatial distribution within Mediterranean regions and temporal trends of gross domestic product per capita (GDP PC), expressed in constant international dollars adjusted for purchasing power parities (PPPs) (left panel), and the Political Stability and Absence of Violence/Terrorism Index (right panel). Maps show spatial patterns, while time-series plots illustrate country-level trends; each curve in the lower panels represents one Mediterranean country. Source: World Bank data (https://data.worldbank.org/).

Future trends may involve a shift towards knowledge-based industries, technology, renewable energy, and the digital economy (Randone et al. 2017). Efforts to attract foreign investment and develop innovative sectors could drive economic diversification and create new employment opportunities. Urbanisation is also expected to rise continuously, with the growth of megacities and coastal urban centres. This trend may lead to increased pressure on infrastructure, public services, and resources. Innovative urban planning, sustainable development and investment in smart cities will be crucial to address the challenges associated with rapid urbanisation.

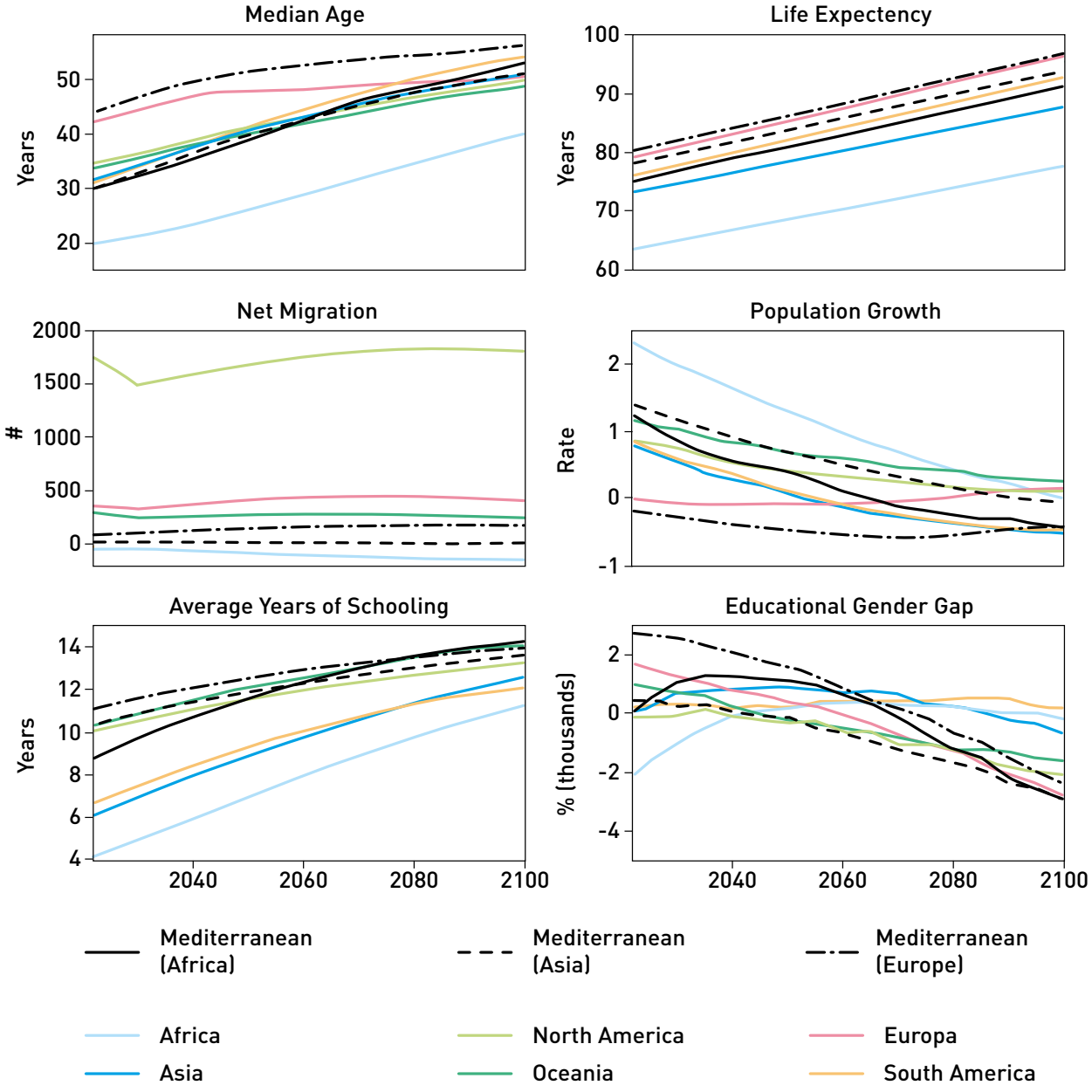


Figure 2.3 | Future demographic and socio-educational projections for the Mediterranean region from 2022 to 2100. Future projections for the Mediterranean include median age (top left), life expectancy (top right), net migration (in thousands, middle left), population growth (middle right), average years of schooling (bottom left) and educational gender gap (difference between the proportion of females and the proportion of males by level of educational attainment for the population over 15 years of age, bottom right). Data obtained through the Wittgenstein Centre Human Capital Data Explorer (https://dataexplorer.wittgensteincentre.org/wc-de-v2/; European Commission: Joint Research Centre (2018)).

2.4 Major trends of climate changes in the Mediterranean: past, present, and future

The broader Mediterranean region includes a variety of climate zones ranging from temperate (e.g. northern Mediterranean coast) to semi-arid and arid (e.g. North Africa and the Middle East) or even colder regimes in the higher mountain zones, such as the mountainous areas of the Alps (Beck et al. 2018). Overall, the region is characterised by temperate, wet winters and warm to hot, dry summers (Seager et al. 2019).

Following global trends, the region has warmed substantially during the last century, with higher and accelerating mean temperature trends over the last four decades, particularly in the eastern parts of the Basin (Cramer et al. 2018; MedECC 2020a; Zittis et al. 2022). This regional warming has already reached the 1.5°C level since the pre-industrial era (Cramer et al.

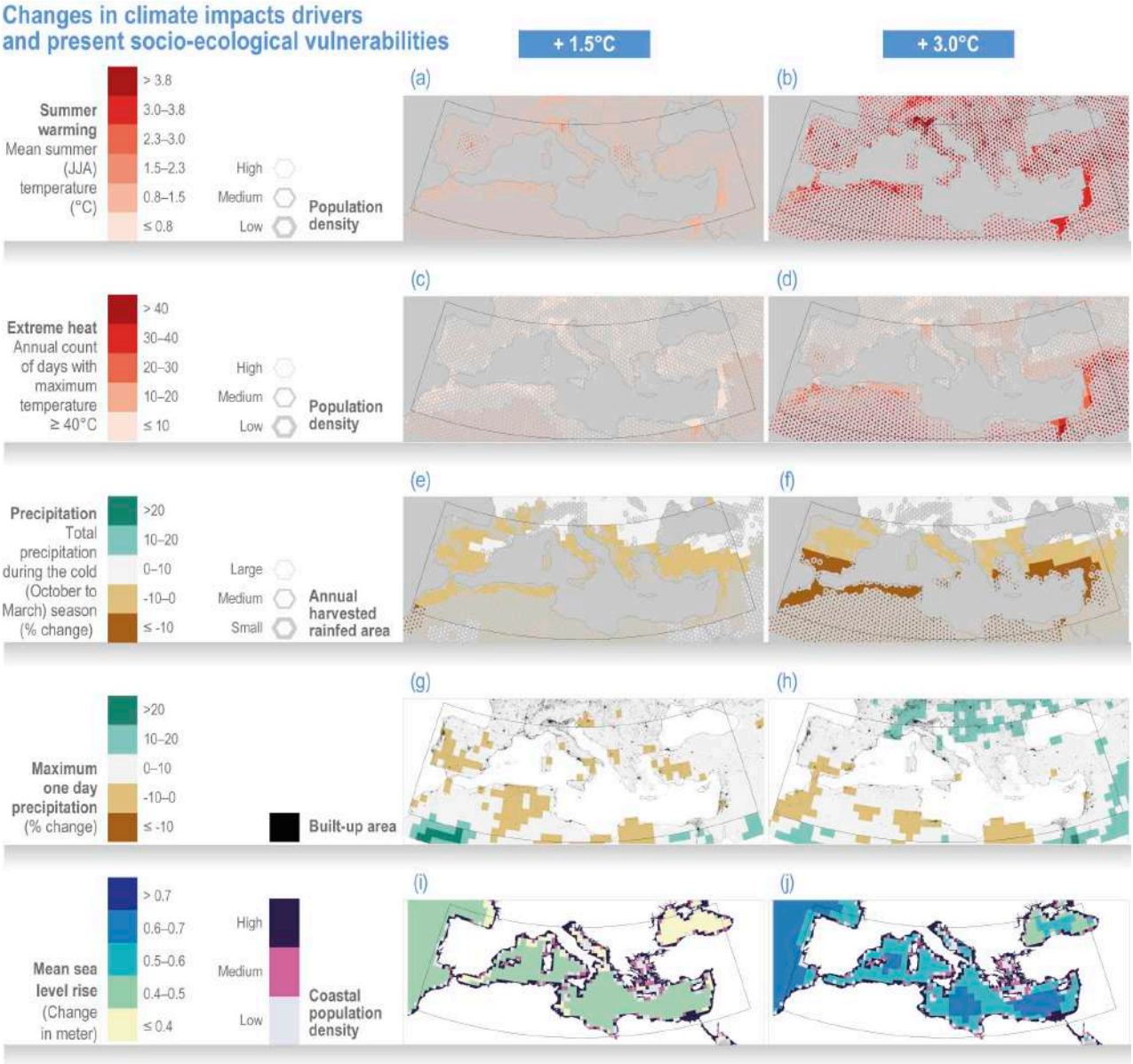


Figure 2.4 | Projected changes in temperature and precipitation across the Mediterranean region by the end of the 21st century. Spatial distribution of projected changes in extreme temperature and total precipitation by the end of the 21st century with respect to the 1995–2014 period for +1.5°C (left column) and +3°C (right column) global warming: mean summer (June to August) temperature (°C, a, b), number of days with maximum temperature above 40°C (days, c, d), total precipitation during the cold season (October to March) (%, e, f). Source: Figure CCP4.2 in Ali et al. (2022).

2018). In addition to mean temperatures, an increase in the frequency and intensity of heat extremes has also been observed (Donat et al. 2014; Perkins-Kirkpatrick and Lewis 2020; Erlat et al. 2021). There is *high confidence* in attributing these trends to human causes (IPCC 2021). The temperature of the Mediterranean waters has also increased (Darmaraki et al. 2019; Castellanos et al. 2021), posing additional challenges to marine ecosystems and facilitating the intrusion of alien species (MedECC 2020a).

Rainfall trends are less robust, and interannual climate variability is still among the dominant drivers of precipitation anomalies in the Mediterranean (Tanarhte et al. 2012; Caloiero al. 2018a; Zittis 2018; MedECC 2020a). The magnitude, signs, and significance of trends can vary according to location, season, and period of focus (Bartolini et al. 2018; Serrano–Notivoli et al. 2018; Zittis 2018; Scorzini and Leopardi 2019). Nevertheless, particularly in the eastern parts of the Mediterranean, there is evidence of a transition to drier conditions (Cook et al. 2016; Deitch et al. 2017; Caloiero et al. 2018b; Mathbout et al. 2018).

Extreme weather events can affect the well-being of Mediterranean societies by causing casualties, property loss and substantial impacts on agriculture, food and water resources. However, extreme weather can also impact other socio-economic activities such as labour productivity, transportation, energy production, and tourism (Waha et al. 2017; Lange 2019; García–León et al. 2021; Hochman et al. 2022). Such disruptive weather events relevant to the region include heat waves, droughts, extreme precipitation, and windstorms.

The region is considered a climate change hotspot because it is warming faster than global rates, particularly over the last four decades. This regional acceleration is driven by soil moisture depletion and declining aerosol trends (Urdiales-Flores et al. 2023). In addition, temperature and precipitation are changing and expected to change further in opposite directions (increasing and declining trends, respectively), a combination that amplifies the impacts on societies and ecosystems. In addition, significant changes in the variability of precipitation and temperature are also expected in the future (Giorgi 2006; Zittis et al. 2019). Extreme events, particularly heat waves and droughts, are expected to intensify in a warmer world (Almazroui et al. 2021; Coppola et al. 2021; Hochman et al. 2022). Since parts of the region are already hot during summers, future heat extremes of increased severity, frequency and duration will be one of the major challenges for the Mediterranean. This is a robust outcome for all scenarios, modelling approaches and heat wave definitions (Lelieveld et al. 2016; Zittis et al. 2016; Bador et al. 2017; Varela et al. 2020; Zittis et al. 2021b). Regions that are *likely* to be affected by extreme heat events also include countries in Sub-Saharan Africa, western Asia or other origin countries of migration. *(Figure 2.4).*

Due to the combined warming and drying effect, the region is considered to be a global hotspot for future droughts, even under intermediate forcing scenarios (Spinoni et al. 2020, 2021). More frequent and severe events will further challenge several sectors including food production, energy and water resource management, and human health. These impacts may also accumulate in time and space across sectors, amplifying the adverse climate-related risks for populations (Byers et al. 2018; Brouillet and Sultan 2023). In the Mediterranean, the combination of increasing extreme temperatures and sufficiently high humidity will result in and amplify heat stress on people (Diffenbaugh et al. 2007; Brouillet and Joussaume 2019).

As already mentioned, projections of extreme precipitation are less robust, in contrast to projected temperature developments, and the inter-model agreement of future trends is lower than, for example, extreme heat or droughts. This is partially due to the short duration and local nature that characterises such events. However, individual rainfall events that could occur at any time and location in the Mediterranean can be of unprecedented magnitude (Donat et al. 2019; Zittis et al. 2021a). Particularly for the predominantly arid territories of northern Africa, such torrential events can account for more than half of annual precipitation totals, posing additional challenges to water management, agriculture, and urban environments.

The physicochemical properties of the waters of the Mediterranean Sea are also being impacted. There is increasing evidence that Mediterranean water masses are becoming warmer, with observed trends ranging from +0.29 to +0.44°C per decade (Cherif et al. 2020). The mean sea level in the Mediterranean is currently rising at a rate of 2.8 ± 0.1 mm yr^{-1}, which is consistent with a global sea level rise of 3.1 ± 0.4 mm yr^{-1}. Ocean acidification is an additional serious consequence of climate change with complex organism-to-ecosystem effects (Hassoun et al. 2015, 2022) and negative impacts related to ecosystem services such as food provision or carbon sequestration. These trends will *likely* continue in the future, exacerbating impacts on ecosystems, critical infrastructure and coastal aquifers (Cherif et al. 2020).

2.5 Past and current patterns and trends in migration and conflict

2.5.1 Diachronic responses to environmental change

Archaeology, history and paleoenvironmental sciences can provide a deep-time, cross-cultural understanding of human-environment relations as they shed light on short- and long-term human responses to environmental change (Schug 2020; Baby-Collin et al. 2021). The impact of climate on the rise and decline of civilisations, human migration, and violent conflict throughout history has been the object of debate between climate (neo)determinists and sceptics (Brauch and Scheffran 2012). In light of contemporary concerns about global warming, reflections on past environmental hazards and disasters and associated human responses have gained momentum, and the catastrophic approach has become increasingly popular (Budja 2015).

Regarding the Mediterranean, ample evidence supports complex patterns of environmental variation and change at different temporal and regional scales from prehistoric times (Lionello 2012). Numerous recent case studies, employing diverse paleoenvironmental and paleoclimatological proxies, have shown that past human societies in the Mediterranean have adapted to climatic variation and change in different ways. This emphasises their dynamic character and inventiveness, as well as the effectiveness of alternative adaptive strategies. In the central Sahara, human groups adapted to a climate transition from moist and stable conditions to an unstable and arid climate during the 4th millennium BCE. To do so, they increasingly relied on transhumance[42], an adaptive strategy of limited effectiveness when the climate turned hyper-arid in the lowlands. In contrast, an emphasis on sedentism[43] in oasis areas and sheep and goat husbandry in upland areas proved durable under these circumstances (Clarke et al. 2016).

The impact of the 4th millennium aridification has been the subject of another study. Roberts et al. (2011) examined increasing aridification during the 4th, 3rd, and 2nd millenia BCE, and its potential association with major transitions in the eastern Mediterranean archaeological record: Chalcolithic/Early Bronze Age, Early Bronze Age/Middle Bronze Age, and Late Bronze Age/Iron Age. The last two of these transitions were characterised by population decline and political collapse. However, the Chalcolithic/Early Bronze Age transition witnessed the emergence of Dynastic Egypt, the earliest Mesopotamian city states, and other major cultural transformations, without a collapse of pre-existing social structures. Even for the other two transitions, climate change appears to have merely acted as an external factor, which accentuated internal societal tensions, especially in centralised states. Indeed, highly specialised societies in certain territories (e.g. northeastern Syria during the Akkadian Empire) faced major socio-economic crises, eventually resulting in societal collapse. In contrast, other territories (e.g. most of the Middle Euphrates valley) continued to flourish at the end of the 3rd millennium BCE, likely because their social structure was less rigid, enabling them to adapt to changing circumstances, but also because they resided close to permanent water resources. The study by Roberts et al. (2011) therefore illustrates the diverse impact that climatic phenomena had even in the same regions during different periods, but also within the same period across neighbouring sites.

In a more recent context, Preiser-Kapeller (2016) demonstrated that deterministic models of climatic impact on political and economic developments cannot fully capture the complex interplay between environmental parameters and social structures in mediaeval Mediterranean history. The author found that a 'Collapse' across the Eastern Mediterranean and Near East in the 11th century cannot be supported by written, archaeological and natural scientific evidence. Instead, this period was characterised by high regional variation. Even when an economic/demographic decline and/or political change is visible (e.g. in parts of Iran or Fatimid Egypt), climate-induced stress may have played a role, but these developments were still driven mostly by context-specific environmental, socio-economic and political dynamics. Moreover, Byzantium and Fatimid Egypt are examples of relative 'resilience', as both witnessed severe internal conflict and loss of territories in the 11th century, but core political and religious power structures survived.

[42] Transhumance is the action or practice of moving livestock from one grazing ground to another in a seasonal cycle, typically to lowlands in winter and highlands in summer.

[43] Sedentism is the practice of living in one place for a long time.

The above examples represent only a minuscule part of human-environment research conducted by historians, archaeologists, and other specialists in the Mediterranean. However, they demonstrate the need to avoid oversimplified and deterministic interpretations of human behaviour, which assume that deteriorating environmental conditions have to lead to migration and conflict. Human societies in diverse environments have shown resilience to long- and short-term episodes of climate change. When collapse occurred, it was the result of multiple stress factors and their interplay — environmental, but also political, economic and sociocultural (Knapp and Manning 2016).

2.5.2 Trends in migration and security and humanitarian challenges

The Mediterranean region continues to witness mixed migration flows involving refugees, asylum seekers, economic migrants, and irregular migrants. As mentioned earlier, countries in North Africa, such as Algeria, Libya, and Tunisia serve as departure points for many migrants attempting to reach Europe through the Mediterranean Sea (IOM 2018).

The so-called 'Central Mediterranean route' that spans from North Africa to Italy and Malta is considered one of the most challenging migration routes in the world (Malakooti and Fall 2020). Migrants commonly

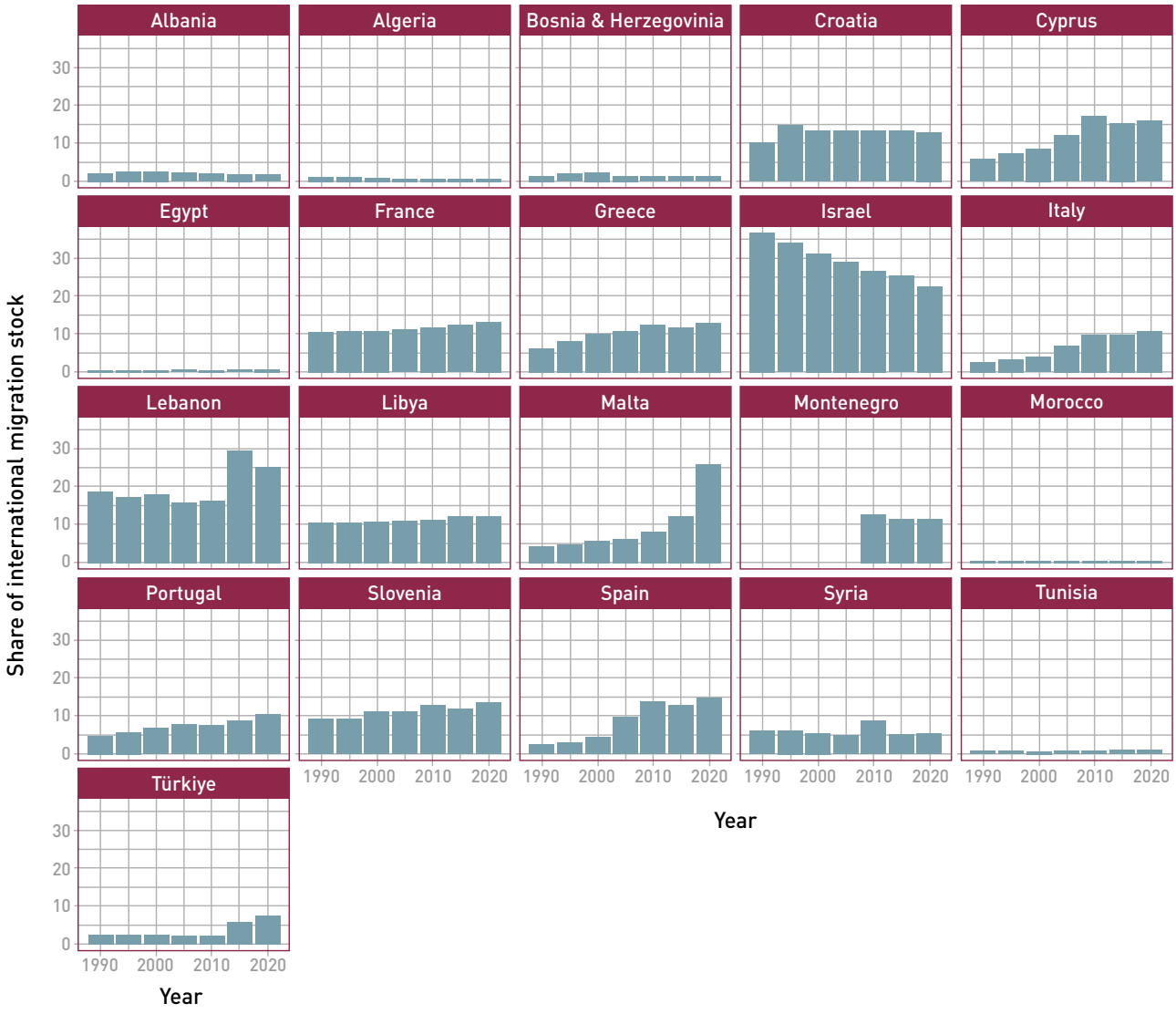


Figure 2.5 | Share of international migration stock in Mediterranean countries as a percentage of the total population per country. Source: UN DESA, Population Division (2020).

undertake perilous journeys on overcrowded and unseaworthy boats, leading to numerous deaths. Nevertheless, migration routes can change based on various factors, including weather conditions, political developments, border controls, and the activities of smuggling networks (UNODC 2018). For instance, a decrease in the number of migrants taking the Eastern Mediterranean route (from Türkiye to Greece) has been observed due to the EU-Türkiye agreement and increased border security measures.

Due to the above factors, the influx of migrants results in significant security and humanitarian challenges within (and around) Mediterranean countries (Del Guercio 2019). Countries like Cyprus, Greece, Italy, Malta, and Spain have faced the strain of accommodating and processing large numbers of migrants (*Figures 2.5* and *2.6*), often resulting in strained resources and overcrowded reception centres.

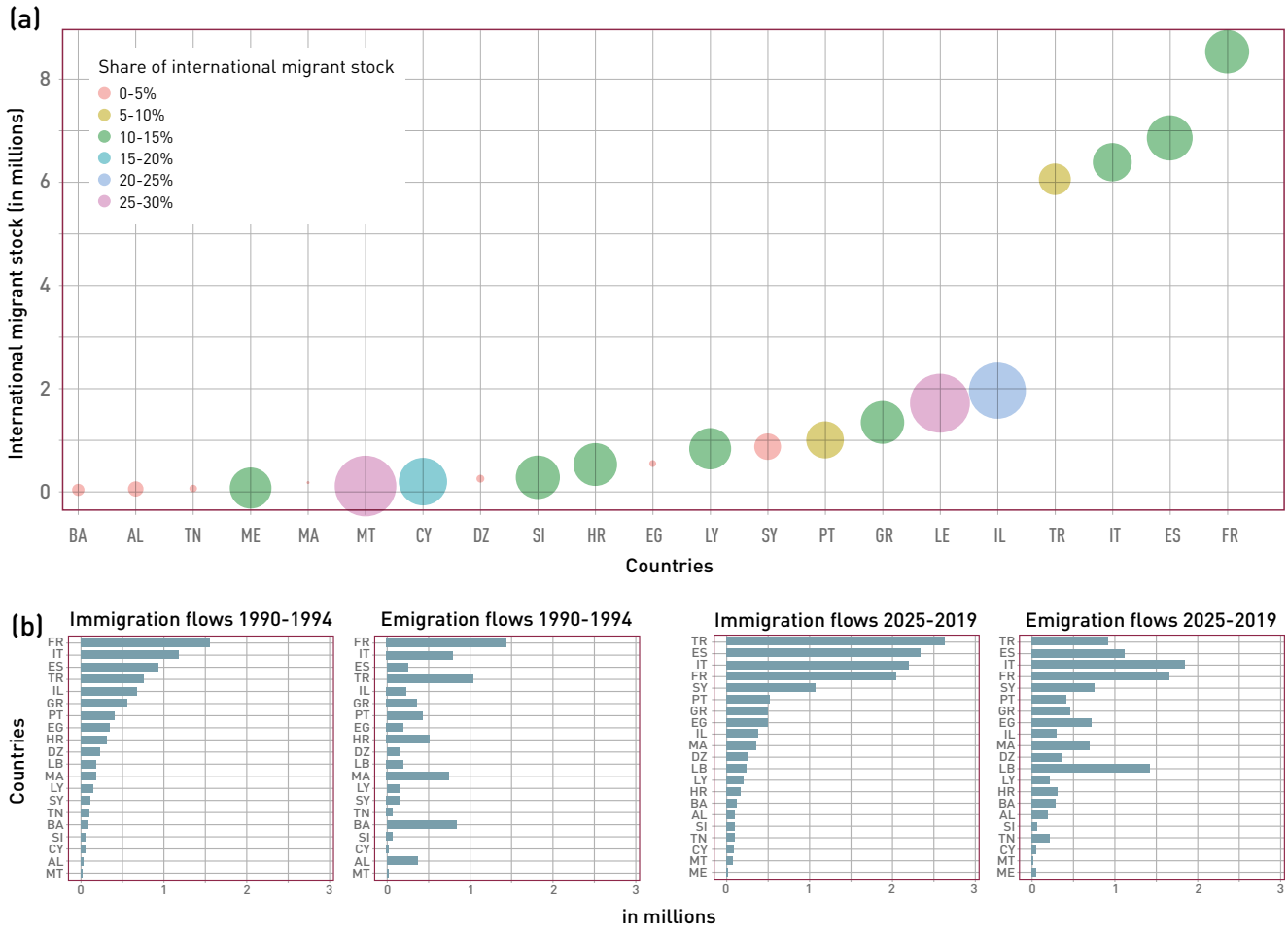
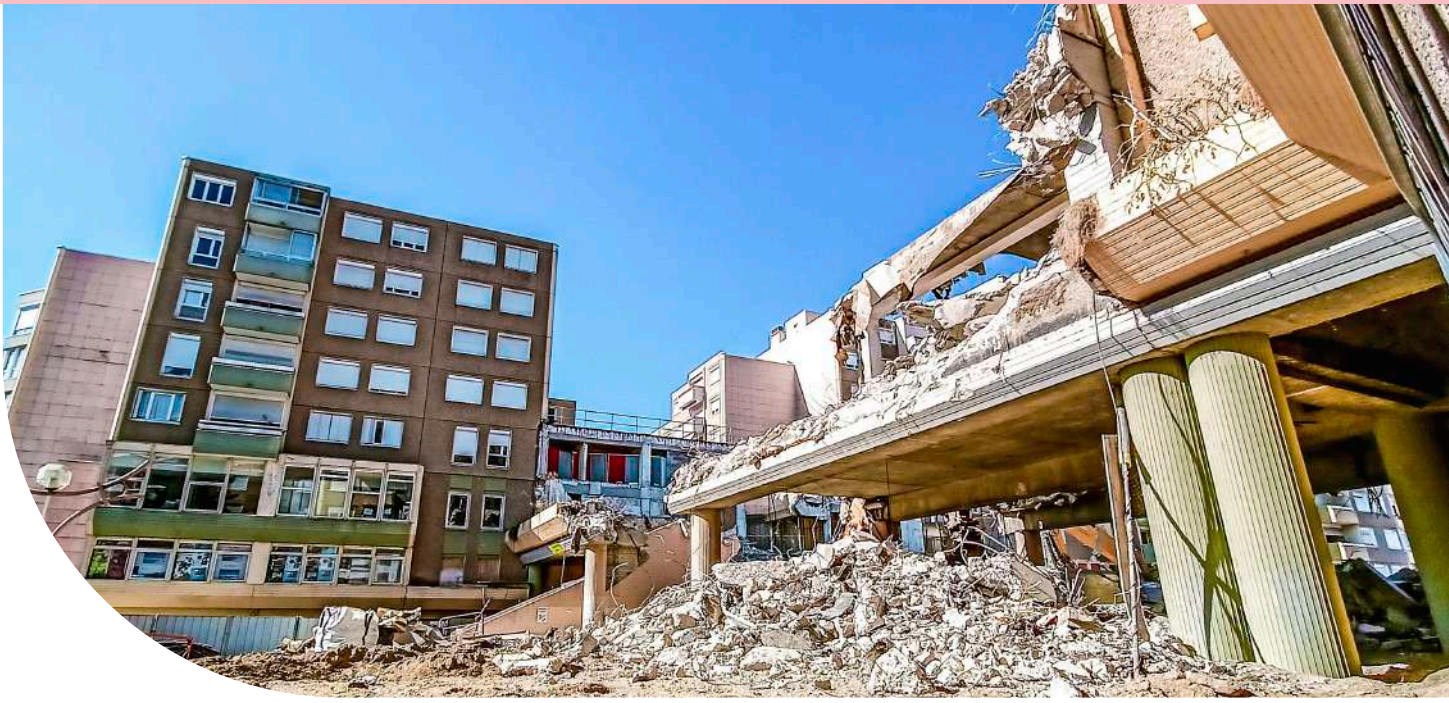


Figure 2.6 | International migration patterns by country. (a) International migrant stock and percentage of migrant stock in population in 2020 per country (UN DESA, Population Division 2020). (b) International migration flows. Source: Abel and Yildiz (2022).

Country codes

AL	Albania
BA	Bosnia and Herzegovina
CY	Cyprus
DZ	Algeria
EG	Egypt
ES	Spain
FR	France
GR	Greece
HR	Croatia
IL	Israel
IT	Italy
LB	Lebanon
LY	Libya
MA	Morocco
ME	Montenegro
MT	Malta
SI	Slovenia
SY	Syrian Arab Republic
TN	Tunisia
TR	Türkiye



2.6 Future projected trends in conflicts and migration

In the context of global warming, resulting impacts and consequent additive pressure will play a crucial role in driving future migration patterns. Rising sea levels, extreme weather events, and resource scarcity may lead to increased displacement, particularly in vulnerable regions like North Africa and the Middle East (Waha et al. 2017; Daoudy et al. 2022). Higher numbers of people attempting to cross the Mediterranean in search of safety and better livelihoods are thus expected in the coming years.

Ongoing conflicts and political instability in the Middle East and North Africa are also likely to continue to affect migration patterns in the Mediterranean (McKee et al. 2017). The resolution of conflicts, such as the Syrian civil war and the Libyan crisis, will have a significant impact on the number of people seeking refuge or economic opportunities in Europe.

Social and economic factors attract migrants to European countries, and include employment opportunities, better shelter, and higher standards of living (Bouoiyour et al. 2019; Zanabazar et al. 2021). Host countries also need cheap and young labour forces to work for ageing societies and fill the gaps in the workforce. Some synthesis reports state that immigration could be seen as one of the strategic instruments to enable the European Union to cope with ageing and demographic imbalances (Apap 2002; Bijak et al. 2008).

European countries are also expected to continue implementing policies to manage migration and protect their borders. This may involve stricter border controls and enhanced surveillance, as well as cooperation with countries of origin and transit to prevent irregular migration. Such policies may influence the routes taken by migrants and the methods employed by smuggling networks (UNODC 2018).

The humanitarian response to migration in the Mediterranean is likely to evolve, with a possible focus on 'burden- and responsibility-sharing' among countries (UN 2018; Del Guercio 2019). This concept refers to a more equitable sharing of the responsibility and burden of hosting and supporting the world's refugees among states (e.g. Suhrke, 1998; Dowd and McAdam, 2017; Luecke and Schneiderheinze, 2017; UN 2018). It also takes into account existing contributions and differing capacities and resources among host countries. Nevertheless, this burden-sharing approach has not yet been made operational, with only six associated pledges from three states since 2019.[44]

Discussions on fair distribution of responsibility, resettlement programmes, and improved reception conditions may shape future policies to address the needs of migrants and alleviate the strain on frontline countries.

[44] Dashboard of the Global Refugee Forum consulted on 12 March 2024: https://globalcompactrefugees.org/pledges-contributions

References

Abel G. J., and Yildiz D. (2022). Closing disparities between European sending and receiving international migration flow data. *Regional Studies, Regional Science, 9*(1), 523–525. doi: 10.1080/21681376.2022.2096478

Abulafia D. (2011). *The great sea: a human history of the Mediterranean.* Oxford University Press. doi: 10.1093/oso/9780195323344.001.0001

Adams R. L. (2016). Big animals and big stones: an ethnoarchaeological exploration of the social dynamics of livestock use in Megalithic societies of eastern Indonesia. In C. Jeunesse, P. Le Roux, & B. Boulestin (Eds.), *Mégalithismes vivants et passés: approches croisées* (pp. 97–116). Archaeopress Publishing Ltd. doi: 10.2307/j.ctvxrq101.10

Adger W. N., Arnell N. W., Black R., Dercon S., Geddes A., and Thomas D. S. G. (2015). Focus on environmental risks and migration: causes and consequences. *Environmental Research Letters, 10*(6), 060201. doi: 10.1088/1748-9326/10/6/060201

Ali E., Cramer W., Carnicer J., Georgopoulou E., Hilmi N. J. M., Le Cozannet G., and Lionello P. (2022). Cross-Chapter Paper 4: Mediterranean Region. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 2233–2272). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009325844.021

Almazroui M., Saeed F., Saeed S., Ismail M., Ehsan M. A., Islam M. N., Abid M. A., O'Brien E., Kamil S., Rashid I. U., and Nadeem I. (2021). Projected Changes in Climate Extremes Using CMIP6 Simulations Over SREX Regions. *Earth Systems and Environment, 5*(3), 481–497. doi: 10.1007/s41748-021-00250-5

Apap, J. (2002). Shaping Europe's Migration Policy New Regimes for the Employment of Third Country Nationals: A Comparison of Strategies in Germany, Sweden, the Netherlands and the UK. *European Journal of Migration and Law, 4*(3), 309-328. doi: 10.1163/157181602322768920

Baby-Collin V., Bouffier S., and Mourlane S. (dir.) (2021). *Atlas des migrations en Méditerranée de l'Antiquité à nos jours.* Arles: Actes Sud, 284 p. https://actes-sud.fr/catalogue/atlas-des-migrations-en-mediterranee-002249

Bador M., Terray L., Boé J., Somot S., Alias A., Gibelin A.-L., and Dubuisson B. (2017). Future summer mega-heatwave and record-breaking temperatures in a warmer France climate. *Environmental Research Letters, 12*(7), 074025. doi: 10.1088/1748-9326/aa751c

Bartolini G., Grifoni D., Magno R., Torrigiani T., and Gozzini B. (2018). Changes in temporal distribution of precipitation in a Mediterranean area (Tuscany, Italy) 1955–2013. *International Journal of Climatology, 38*(3), 1366–1374. doi: 10.1002/joc.5251

Beck H. E., Zimmermann N. E., McVicar T. R., Vergopolan N., Berg A., and Wood E. F. (2018). Present and future Köppen-Geiger climate classification maps at 1-km resolution. *Scientific Data, 5*(1), 180214. doi: 10.1038/sdata.2018.214

Bijak, J., Kupiszewska, D., and Kupiszewski, M. Replacement Migration Revisited: Simulations of the Effects of Selected Population and Labor Market Strategies for the Aging Europe, 2002–2052. *Population Research and Policy Review, 27,* 321–342. doi: 10.1007/s11113-007-9065-2

Black R., Adger W. N., Arnell N. W., Dercon S., Geddes A., and Thomas D. (2011). The effect of environmental change on human migration. *Global Environmental Change: Human and Policy Dimensions, 21*, S3–S11. doi: 10.1016/j.gloenvcha.2011.10.001

Black R., Arnell N. W., Adger W. N., Thomas D., and Geddes A. (2013). Migration, immobility and displacement outcomes following extreme events. *Environmental Science & Policy, 27,* S32–S43. doi: 10.1016/j.envsci.2012.09.001

Bouoiyour J., Miftah A., and Selmi R. (2019). *The economic impact of migrants and refugees on Europe.* FEMISE Med Brief n°24. doi: 10.13140/rg.2.2.34373.40165

Brauch H. G. (2010). Four phases of research on environment and security. *Peace Studies, Public Policy and Global Security,* 141–185.

Brauch H. G., and Scheffran J. (2012). Introduction: Climate Change, Human Security, and Violent Conflict in the Anthropocene. In J. Scheffran, M. Brzoska, H. Brauch, P. Link, & J. Schilling (Eds.), *Climate Change, Human Security and Violent Conflict. Hexagon Series on Human and Environmental Security and Peace, vol 8* (pp. 3–40). Springer, Berlin, Heidelberg. doi: 10.1007/978-3-642-28626-1_1

Brouillet A., and Joussaume S. (2019). Investigating the Role of the Relative Humidity in the Co–Occurrence of Temperature and Heat Stress Extremes in CMIP5 Projections. *Geophysical Research Letters, 46*(20), 11435–11443. doi: 10.1029/2019gl084156

Brouillet A., and Sultan B. (2023). Livestock exposure to future cumulated climate-related stressors in West Africa. *Scientific Reports, 13*(1), 2698. doi: 10.1038/s41598-022-22544-y

Budja M. (2015). Archaeology and rapid climate changes: from the collapse concept to a panarchy interpretative model. *Documenta Praehistorica, 42*, 171–184. doi: 10.4312/dp.42.11

Byers E., Gidden M., Leclère D., Balkovic J., Burek P., Ebi K., Greve P., Grey D., Havlik P., Hillers A., Johnson N., Kahil T., Krey V., Langan S., Nakicenovic N., Novak R., Obersteiner M., Pachauri S., Palazzo A., ... Riahi K. (2018). Global exposure and vulnerability to multi-sector development and climate change hotspots. *Environmental Research Letters, 13*(5), 055012. doi: 10.1088/1748-9326/aabf45

Caloiero T., Caloiero P., and Frustaci F. (2018a). Long-term precipitation trend analysis in Europe and in the Mediterranean basin. *Water and Environment Journal, 32*(3), 433–445. doi: 10.1111/wej.12346

Caloiero T., Veltri S., Caloiero P., and Frustaci F. (2018b). Drought Analysis in Europe and in the Mediterranean Basin Using the Standardized Precipitation Index. *Water, 10*(8), 1043. doi: 10.3390/w10081043

Carling J. (2002). Migration in the age of involuntary immobility: Theoretical reflections and Cape Verdean experiences. *Journal of Ethnic and Migration Studies, 28*(1), 5–42. doi: 10.1080/13691830120103912

Castellanos M., García M. Á., Pérez I. A., Sánchez M. L., Pardo N., and Fernández-Duque B. (2021). Measuring temperature trends in the Mediterranean basin. *Journal of Atmospheric and Solar-Terrestrial Physics, 222*, 105713. doi: 10.1016/j.jastp.2021.105713

Cherif S., Doblas-Miranda E., Lionello P., Borrego C., Giorgi F., Iglesias A., Jebari S., Mahmoudi E., Moriondo M., Pringault O., Rilov G., Somot S., Tsikliras A., Vilà M., and Zittis G. (2020). Chapter 2: Drivers of Change. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 59-180). MedECC Reports. Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7100601

Clarke J., Brooks N., Banning E. B., Bar-Matthews M., Campbell S., Clare L., Cremaschi M., di Lernia S., Drake N., Gallinaro M., Manning S., Nicoll K., Philip G., Rosen S., Schoop U.-D., Tafuri M. A., Weninger B., and Zerboni A. (2016). Climatic changes and social transformations in the Near East and North Africa during the 'long' 4th millennium BC: A comparative study of environmental and archaeological evidence. *Quaternary Science Reviews, 136*, 96–121. doi: 10.1016/j.quascirev.2015.10.003

Cook B. I., Anchukaitis K. J., Touchan R., Meko D. M., and Cook E. R. (2016). Spatiotemporal drought variability in the Mediterranean over the last 900 years. *Journal of Geophysical Research: Atmospheres, 121*(5), 2060–2074. doi: 10.1002/2015jd023929

Coppola E., Raffaele F., Giorgi F., Giuliani G., Xuejie G., Ciarlo J. M., Sines T. R., Torres-Alavez J. A., Das S., di Sante F., Pichelli E., Glazer R., Müller S. K., Abba Omar S., Ashfaq M., Bukovsky M., Im E.-S., Jacob D., Teichmann C., … Rechid D. (2021). Climate hazard indices projections based on CORDEX-CORE, CMIP5 and CMIP6 ensemble. *Climate Dynamics, 57*(5–6), 1293–1383. doi: 10.1007/s00382-021-05640-z

Cramer W., Guiot J., Fader M., Garrabou J., Gattuso J.-P., Iglesias A., Lange M. A., Lionello P., Llasat M. C., Paz S., Peñuelas J., Snoussi M., Toreti A., Tsimplis M. N., and Xoplaki E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change, 8*(11), 972–980. doi: 10.1038/s41558-018-0299-2

Crawley H., McMahon S., Jones K., Duvell F., and Sigona N. (2016). *Destination Europe? Understanding the dynamics and drivers of Mediterranean migration in 2015.* Centre for Trust, Peace and Social Relations, Coventry University. https://pure.coventry.ac.uk/ws/portalfiles/portal/11554038/MEDMIG_research_brief_2_eastern_med.pdf

Daoudy M., Sowers J., and Weinthal E. (2022). What is climate security? Framing risks around water, food, and migration in the Middle East and North Africa. *WIREs Water, 9*(3), e1582. doi: 10.1002/wat2.1582

Darmaraki S., Somot S., Sevault F., and Nabat P. (2019). Past Variability of Mediterranean Sea Marine Heatwaves. *Geophysical Research Letters, 46*(16), 9813–9823. doi: 10.1029/2019gl082933

de Haas H. (2021). A theory of migration: the aspirations-capabilities framework. *Comparative Migration Studies, 9*(1), 8. doi: 10.1186/s40878-020-00210-4

Deitch M., Sapundjieff M., and Feirer S. (2017). Characterizing Precipitation Variability and Trends in the World's Mediterranean-Climate Areas. *Water, 9*(4), 259. doi: 10.3390/w9040259

Del Guercio A. (2019). Cross-border movement and human rights within the framework of European asylum policy. In M. Perlik, G. Galera, I. Machold, & A. Membretti (Eds.), *Alpine Refugees: Immigration at the Core of Europe: Vol. Alpine Refugees* (pp. 18–27). Cambridge Scholars Publishing.

Diffenbaugh N. S., Pal J. S., Giorgi F., and Gao X. (2007). Heat stress intensification in the Mediterranean climate change hotspot. *Geophysical Research Letters, 34*(11). doi: 10.1029/2007gl030000

Doblas-Reyes F. J., Sörensson A. A., Almazroui M., Dosio A., Gutowski W. J., Haarsma R., Hamdi R., Hewitson B., Kwon W.-T., Lamptey B. L., Maraun D., Stephenson T. S., Takayabu I., Terray L., Turner A., and Zuo Z. (2021). Linking global to regional climate change. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, Ö. Yelekçi, R. Yu, & B. Zhou (Eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1363–1512). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. doi: 10.1017/9781009157896.012

Donat M. G., Angélil O., and Ukkola A. M. (2019). Intensification of precipitation extremes in the world's humid and water-limited regions. *Environmental Research Letters, 14*(6), 065003. doi: 10.1088/1748-9326/ab1c8e

Donat M. G., Peterson T. C., Brunet M., King A. D., Almazroui M., Kolli R. K., Boucherf D., Al-Mulla A. Y., Nour A. Y., Aly A. A., Nada T. A. A., Semawi M. M., Al Dashti H. A., Salhab T. G., El Fadli K. I., Muftah M. K., Dah Eida S., Badi W., Driouech F., … Al Shekaili M. N. (2014). Changes in extreme temperature and precipitation in the Arab region: long-term trends and variability related to ENSO and NAO. I*nternational Journal of Climatology, 34*(3), 581–592. doi: 10.1002/joc.3707

Dowd R, and McAdam J. (2017) International Cooperation and Responsability-sharing to Protect Refugees: What, why and how? *International and Comparative Law Quarterly. 66*(4), 863-892. doi: 10.1017/S0020589317000343

EEA (2019). *The European environment: state and outlook 2020: knowledge for transition to a sustainable Europe.* Luxembourg: Publications Office of the European Union. doi: 10.2800/96749

Erlat E., Türkeș M., and Aydin-Kandemir F. (2021). Observed changes and trends in heatwave characteristics in Turkey since 1950. *Theoretical and Applied Climatology, 145*(1–2), 137–157. doi: 10.1007/s00704-021-03620-1

European Commission: Joint Research Centre (2018). *Demographic and human capital scenarios for the 21st century – 2018 assessment for 201 countries* (W. Lutz, N. Stilianakis, M. Stonawski, A. Goujon, & K. Samir, Eds.). Luxembourg: Publications Office of the European Union. doi: 10.2760/835878

European Council: Council of the European Union (2023). *EU migration and asylum policy.* https://www.consilium.europa.eu/en/policies/eu-migration-policy/

Farbotko C., Dun O., Thornton F., McNamara K. E., and McMichael C. (2020). Relocation planning must address voluntary immobility. *Nature Climate Change, 10*(8), 702–704. doi: 10.1038/s41558-020-0829-6

García-León D., Casanueva A., Standardi G., Burgstall A., Flouris A. D., and Nybo L. (2021). Current and projected regional economic impacts of heatwaves in Europe. *Nature Communications, 12*(1), 5807. doi: 10.1038/s41467-021-26050-z

Giorgi F. (2006). Climate change hot–spots. *Geophysical Research Letters, 33*(8), L08707. doi: 10.1029/2006gl025734

Hanson G., and McIntosh C. (2016). Is the Mediterranean the New Rio Grande? US and EU Immigration Pressures in the Long Run. *Journal of Economic Perspectives, 30*(4), 57–82. doi: 10.1257/jep.30.4.57

Hassoun A. E. R., Bantelman A., Canu D., Comeau S., Galdies C., Gattuso J.-P., Giani M., Grelaud M., Hendriks I. E., Ibello V., Idrissi M., Krasakopoulou E., Shaltout N., Solidoro C., Swarzenski P. W., and Ziveri P. (2022). Ocean acidification research in the Mediterranean Sea: Status, trends and next steps. *Frontiers in Marine Science, 9*, 892670. doi: 10.3389/fmars.2022.892670

Hassoun A. E. R., Gemayel E., Krasakopoulou E., Goyet C., Abboud-Abi Saab M., Guglielmi V., Touratier F., and Falco C. (2015). Acidification of the Mediterranean Sea from anthropogenic carbon penetration. *Deep Sea Research Part I: Oceanographic Research Papers, 102*, 1–15. doi: 10.1016/j.dsr.2015.04.005

Hochman A., Marra F., Messori G., Pinto J. G., Raveh-Rubin S., Yosef Y., and Zittis G. (2022). Extreme weather and societal impacts in the eastern Mediterranean. *Earth System Dynamics, 13*(2), 749–777. doi: 10.5194/esd-13-749-2022

ICMPD (2017). *Making migration better: Annual report 2017.* Austria: International Centre for Migration Policy Development. https://www.icmpd.org/file/download/50455/file/2017%2520Annual%2520Report%2520ICMPD.pdf

IDMC (2023). *Global Report on Internal Displacement.* Internal Displacement Monitoring Centre. https://www.internal-displacement.org/global-report/grid2023/

IOM (2007). *Discussion Note: Migration and the Environment (94th session- MC/INF/288).* International Organization for Migration. https://www.iom.int/sites/g/files/tmzbdl486/files/jahia/webdav/shared/shared/mainsite/about_iom/en/council/94/MC_INF_288.pdf

IOM (2018). *Mixed migration flows in the Mediterranean.* International Organization for Migration. https://eca.iom.int/sites/g/files/tmzbdl661/files/documents/flows_compilation_report_december_2018.pdf

IOM (2019). *Mixed migration flows in the Mediterranean.* International Organization for Migration. https://dtm.iom.int/sites/g/files/tmzbdl1461/files/reports/FCR%20December%202019-6_published.pdf

IOM (2021). *DTM Europe - 2021 info sheet: Mixed migration flows to Europe.* https://malta.iom.int/sites/g/files/tmzbdl1101/files/documents/dtm-med-2021-info-sheet.pdf

IPCC (2007). *Climate Change 2007. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC.* Cambridge University Press, Cambridge, New York. https://www.ipcc.ch/report/ar4/wg1/

IPCC (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, & P. M. Midgley, Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. doi: 10.1017/CBO9781107415324

IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White, Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou, Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi: 10.1017/9781009157896

IPCC (2023). Annex I: Glossary [Reisinger, A., D. Cammarano, A. Fischlin, J.S. Fuglestvedt, G. Hansen, Y. Jung, C. Ludden, V. Masson-Delmotte, R. Matthews, J.B.K Mintenbeck, D.J. Orendain, A. Pirani, E. Poloczanskaa, and J. Romero (eds.)]. In Core Writing Team, H. Lee, & J. Romero (Eds.), *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* IPCC, Geneva, Switzerland, pp. 119-130. doi: 10.59327/IPCC/AR6-9789291691647.002

Johnson D. L., Ambrose S. H., Bassett T. J., Bowen M. L., Crummey D. E., Isaacson J. S., Johnson D. N., Lamb P., Saul M., and Winter-Nelson A. E. (1997). Meanings of Environmental Terms. *Journal of Environmental Quality, 26*(3), 581–589. doi: 10.2134/jeq1997.00472425002600030002x

Knapp A. B., and Manning S. W. (2016). Crisis in Context: The End of the Late Bronze Age in the Eastern Mediterranean. *American Journal of Archaeology, 120*, 99–149. doi: 10.3764/aja.120.1.0099

Lange M. A. (2019). Impacts of Climate Change on the Eastern Mediterranean and the Middle East and North Africa Region and the Water–Energy Nexus. *Atmosphere, 10*(8), 455. doi: 10.3390/atmos10080455

Lelieveld J., Proestos Y., Hadjinicolaou P., Tanarhte M., Tyrlis E., and Zittis G. (2016). Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century. *Climatic Change, 137*(1–2), 245–260. doi: 10.1007/s10584-016-1665-6

Lenton T. M., Rockström J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., and Schellnhuber H. J. (2019). Climate tipping points — too risky to bet against. *Nature, 575*(7784), 592–595. doi: 10.1038/D41586-019-03595-0

Lionello, P. (Ed.). (2012). *The Climate of the Mediterranean Region.* Elsevier. doi: 10.1016/C2011-0-06210-5

Lucas R. E. B. (2015). *Internal Migration in Developing Economies: An Overview.* KNOMAD Working Paper. KNOMAD Trust Fund Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/099412408232434668

Luecke M., and Schneiderheinze C. (2017). More financial burden-sharing for developing countries that host refugees. *Economics: The Open-Access, Open-Assessment E-Journal, 11*(2017-24), 1–11. doi: 10.5018/economics-ejournal.ja.2017-24

Malakooti A., and Fall C. (2020). *Migration Trends Across the Mediterranean: Piecing Together the Shifting Dynamics.* Global Initiative Against Transnational Organized Crime and Clingendael: Netherlands Institute of International Relations. https://globalinitiative.net/wp-content/uploads/2020/11/Migration-Trends-Across-the-Mediterranean-Piecing-Together-the-Shifting-Dynamics.pdf

Mathbout S., Lopez-Bustins J. A., Royé D., Martin-Vide J., Bech J., and Rodrigo F. S. (2018). Observed Changes in Daily Precipitation Extremes at Annual Timescale Over the Eastern Mediterranean During 1961–2012. *Pure and Applied Geophysics, 175*(11), 3875–3890. doi: 10.1007/s00024-017-1695-7

McKee M., Keulertz M., Habibi N., Mulligan M., and Woertz E. (2017). Demographic and Economic Material Factors in the Mena Region. *MENARA Working Paper.* https://api.semanticscholar.org/CorpusID:216932911

MedECC (2020a). *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (W. Cramer, J. Guiot, & K. Marini, Eds.). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp. doi: 10.5281/zenodo.4768833

MedECC (2020b). Summary for Policymakers. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report.* Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, pp 11-40. doi: 10.5281/zenodo.5513887

Morbidelli R., García-Marín A. P., Mamun A. Al, Atiqur R. M., Ayuso-Muñoz J. L., Taouti M. B., Baranowski P., Bellocchi G., Sangüesa-Pool C., Bennett B., Oyunmunkh B., Bonaccorso B., Brocca L., Caloiero T., Caporali E., Caracciolo D., Casas-Castillo M. C., G.Catalini C., Chettih M., … Saltalippi C. (2020). The history of rainfall data time-resolution in a wide variety of geographical areas. *Journal of Hydrology, 590,* 125258. doi: 10.1016/j.jhydrol.2020.125258

Pace R., and Monnet J. (2016). Migration in the Mediterranean: Origins and Characteristics. In *IEMed. Mediterranean Yearbook* (pp. 91–97). Institut Europeu de la Mediterrania. https://www.iemed.org/publication/migration-in-the-mediterranean-origins-and-characteristics/

Perkins-Kirkpatrick S. E., and Lewis S. C. (2020). Increasing trends in regional heatwaves. *Nature Communications, 11*(1), 3357. doi: 10.1038/s41467-020-16970-7

Preiser-Kapeller J. (2016). A collapse of the Eastern Mediterranean? New results and theories on the interplay between climate and societies in Byzantium and the Near East, ca. 1000–1200 AD. (with seven appendices, including three tables and 33 figures). *Jahrbuch Der Österreichischen Byzantinistik, 1,* 195–242. doi: 10.1553/joeb65s195

Randone M., Di Carlo G., Costantini M., Tzanetti T., Haferkamp D., Portafaix A., Smits M., Antoniades V., Kachaner N., and Osborne A. (2017). *Reviving the economy of the Mediterranean Sea: actions for a sustainable future.* WWF Mediterranean Marine Initiative, Rome, Italy. 64 pp. https://wwfeu.awsassets.panda.org/downloads/reviving_mediterranean_sea_economy_full_rep_lowres.pdf

Rigaud K. K., de Sherbinin A., Jones B., Bergmann J., Clement V., Ober K., Schewe J., Adamo S., McCusker B., Heuser S., and Midgley A. (2018). *Groundswell: Preparing for Internal Climate Migration*. World Bank, Washington, DC. doi: 10.1596/29461

Roberts N., Eastwood W. J., Kuzucuoğlu C., Fiorentino G., and Caracuta V. (2011). Climatic, vegetation and cultural change in the eastern mediterranean during the mid-holocene environmental transition. *Holocene, 21*(1), 147–162. doi: 10.1177/0959683610386819

Schewel K. (2020). Understanding Immobility: Moving Beyond the Mobility Bias in Migration Studies. *International Migration Review, 54*(2), 328–355. doi: 10.1177/0197918319831952

Schug, G. R. (Ed.) (2020). *The Routledge Handbook of the Bioarchaeology of Climate and Environmental Change. Routledge.* doi: 10.4324/9781351030465

Scorzini A. R., and Leopardi M. (2019). Precipitation and temperature trends over central Italy (Abruzzo Region): 1951–2012. *Theoretical and Applied Climatology, 135*(3–4), 959–977. doi: 10.1007/s00704-018-2427-3

Seager R., Osborn T. J., Kushnir Y., Simpson I. R., Nakamura J., and Liu H. (2019). Climate Variability and Change of Mediterranean-Type Climates. *Journal of Climate, 32*(10), 2887–2915. doi: 10.1175/jcli-d-18-0472.1

Serrano-Notivoli R., Beguería S., Saz M. Á., and de Luis M. (2018). Recent trends reveal decreasing intensity of daily precipitation in Spain. *International Journal of Climatology, 38*(11), 4211–4224. doi: 10.1002/joc.5562

Spinoni J., Barbosa P., Bucchignani E., Cassano J., Cavazos T., Cescatti A., Christensen J. H., Christensen O. B., Coppola E., Evans J. P., Forzieri G., Geyer B., Giorgi F., Jacob D., Katzfey J., Koenigk T., Laprise R., Lennard C. J., Kurnaz M. L., … Dosio A. (2021). Global exposure of population and land-use to meteorological droughts under different warming levels and SSPs: A CORDEX-based study. *International Journal of Climatology, 41*(15), 6825–6853. doi: 10.1002/joc.7302

Spinoni J., Barbosa P., Bucchignani E., Cassano J., Cavazos T., Christensen J. H., Christensen O. B., Coppola E., Evans J., Geyer B., Giorgi F., Hadjinicolaou P., Jacob D., Katzfey J., Koenigk T., Laprise R., Lennard C. J., Kurnaz M. L., Li D., … Dosio A. (2020). Future Global Meteorological Drought Hot Spots: A Study Based on CORDEX Data. *Journal of Climate, 33*(9), 3635–3661. doi: 10.1175/jcli-d-19-0084.1

Suhrke A. (1998), Burden-sharing during Refugee Emergencies: The Logic of Collective versus National Action, *Journal of Refugee Studies, 11*(4), 396–415. doi: 10.1093/jrs/11.4.396

Tanarhte M., Hadjinicolaou P., and Lelieveld J. (2012). Intercomparison of temperature and precipitation data sets based on observations in the Mediterranean and the Middle East. *Journal of Geophysical Research: Atmospheres, 117*, D12102. doi: 10.1029/2011jd017293

UN DESA (2019). *World Population Prospects 2019: Highlights.* (ST/ESA/SER.A/423). United Nations Department of Economic and Social Affairs. https://population.un.org/wpp/

UN DESA, Population Division (2020). *International migrant stock 2020* (POP/DB/MIG/Stock/Rev.2020). United Nations Department of Economic and Social Affairs. https://www.un.org/development/desa/pd/content/international-migrant-stock

UN General Assembly (1948). *The Universal Declaration of Human Rights (UDHR).* New York: United Nations General Assembly. https://www.un.org/en/about-us/universal-declaration-of-human-rights

UN General Assembly (1989). *Convention on the Rights of the Child.* United Nations, Treaty Series, vol. 1577, p. 3. United Nations. https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-child

UN General Assembly (1994). *United Nations Framework Convention on Climate Change: Resolution A/RES/48/189.* Adopted 20 January 1994. New York: United Nations General Assembly. https://unfccc.int/cop4/conv/ftconv.html

UN General Assembly (2018). *Global Compacts on Refugees.* New York: United Nations General Assembly. https://www.unhcr.org/media/global-compact-refugees-booklet

UNDRR (2017). *The Sendai Framework Terminology on Disaster Risk Reduction.* Geneva, Switzerland: United Nations Office for Disaster Risk Reduction. https://www.undrr.org/terminology/residual-risk

UNFCCC (2011). *The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention.* Decision 1/CP.16, FCCC/CP/2010/7/Add.1. United Nations Framework Convention on Climate Change. https://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf

UNODC (2018). *Global Study on Smuggling of Migrants 2018.* United Nations publication, Sales No. E.18.IV.9. United Nations Office on Drugs and Crime. https://www.unodc.org/unodc/en/data-and-analysis/glosom.html

Urdiales-Flores D., Zittis G., Hadjinicolaou P., Osipov S., Klingmüller K., Mihalopoulos N., Kanakidou M., Economou T., and Lelieveld J. (2023). Drivers of accelerated warming in Mediterranean climate-type regions. *Npj Climate and Atmospheric Science, 6*(1), 97. doi: 10.1038/s41612-023-00423-1

Varela R., Rodríguez-Díaz L., and deCastro M. (2020). Persistent heat waves projected for Middle East and North Africa by the end of the 21st century. *PLOS ONE, 15*(11), e0242477. doi: 10.1371/journal.pone.0242477

Waha K., Krummenauer L., Adams S., Aich V., Baarsch F., Coumou D., Fader M., Hoff H., Jobbins G., Marcus R., Mengel M., Otto I. M., Perrette M., Rocha M., Robinson A., and Schleussner C.-F. (2017). Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. *Regional Environmental Change, 17*(6), 1623–1638. doi: 10.1007/s10113-017-1144-2

Wiegel H., Boas I., and Warner J. (2019). A mobilities perspective on migration in the context of environmental change. *WIREs Climate Change, 10*(6), e610. doi: 10.1002/wcc.610

Zanabazar A., Kho N. S., and Jigjiddorj S. (2021). The Push and Pull Factors Affecting the Migration of Mongolians to the Republic of South Korea. *SHS Web of Conferences, 90*, 01023. doi: 10.1051/shsconf/20219001023

Zickgraf C. (2021). Theorizing (im)mobility in the face of environmental change. *Regional Environmental Change, 21*(4), 126. doi: 10.1007/s10113-021-01839-2

Zittis G. (2018). Observed rainfall trends and precipitation uncertainty in the vicinity of the Mediterranean, Middle East and North Africa. *Theoretical and Applied Climatology, 134*(3–4), 1207–1230. doi: 10.1007/s00704-017-2333-0

Zittis G., Almazroui M., Alpert P., Ciais P., Cramer W., Dahdal Y., Fnais M., Francis D., Hadjinicolaou P., and Howari F. (2022). Climate change and weather extremes in the Eastern Mediterranean and Middle East. *Reviews of Geophysics, 60*(3), e2021RG000762. doi: 10.1029/2021RG000762

Zittis G., Bruggeman A., and Lelieveld J. (2021a). Revisiting future extreme precipitation trends in the Mediterranean. *Weather and Climate Extremes, 34*, 100380. doi: 10.1016/j.wace.2021.100380

Zittis G., Hadjinicolaou P., Almazroui M., Bucchignani E., Driouech F., El Rhaz K., Kurnaz L., Nikulin G., Ntoumos A., Ozturk T., Proestos Y., Stenchikov G., Zaaboul R., and Lelieveld J. (2021b). Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa. *Npj Climate and Atmospheric Science, 4*(1), 20. doi: 10.1038/s41612-021-00178-7

Zittis G., Hadjinicolaou P., Fnais M., and Lelieveld J. (2016). Projected changes in heat wave characteristics in the eastern Mediterranean and the Middle East. *Regional Environmental Change, 16*(7), 1863–1876. doi: 10.1007/s10113-014-0753-2

Zittis G., Hadjinicolaou P., Klangidou M., Proestos Y., and Lelieveld J. (2019). A multi-model, multi-scenario, and multi-domain analysis of regional climate projections for the Mediterranean. *Regional Environmental Change, 19*(8), 2621–2635. doi: 10.1007/s10113-019-01565-w

Information about the authors

Coordinating Lead Authors

Audrey BROUILLET, ESPACE-DEV, Institut de Recherche pour le Développement (IRD), *France* / Potsdam Institute for Climate Impact Research (PIK), *Germany*

Lead Authors

Lucas KLUGE, Potsdam Institute for Climate Impact Research (PIK), *Germany*

George ZITTIS, Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute, *Cyprus*

Contributing Authors

Tuba BIRCAN, Vrije Universiteit Brussel (VUB), *Belgium*

Efthymia NIKITA, Science and Technology in Archaeology and Culture Research Center (STARC), The Cyprus Institute, *Cyprus*

Dilek YILDIZ, International Institute for Applied Systems Analysis (IIASA), *Austria*

Threats to human life and livelihoods from environmental change

3

Coordinating Lead Authors
Lena REIMANN *(The Netherlands)*, **Ourania TZORAKI** *(Greece)*

Lead Authors
Dias HARALAMBOPOULOS *(Greece)*, **Manfred A. LANGE** *(Cyprus)*, **Maya NEGEV** *(Israel)*, **Alejandra RODRIGUEZ ENRIQUEZ** *(USA/the Netherlands)*, **Cecilia ZAGARIA** *(The Netherlands)*

Contributing Authors
Tuba BUCAK *(Denmark)*, **Shlomit PAZ** *(Israel)*, **Ignacio PITA-VACA** *(France)*

This chapter should be cited as:
Reimann, L., Tzoraki, O., Haralambopoulos, D., Lange, M.A., Negev, M., Rodriguez Enriquez, A., Zagaria, C., 2026: Threats to human life and livelihoods from environmental change In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. [eds.]]. MedECC Secretariat, Marseille, France, pp. 87-129. doi: 10.5281/zenodo.17902795

Chapter 3
Threats to human life and livelihoods from environmental change

Executive summary 90

3.1 Water 92
3.1.1 Introduction 92
3.1.2 Current state of water availability and spatial distribution 92
3.1.3 Human pressures and water management 95

3.2 Food 96
3.2.1 Historical and projected impacts of environmental changes on agriculture and fisheries sectors in the Mediterranean 96
3.2.2 Beyond direct impacts: indirect environmental effects and consequences 97
3.2.3 Implications for livelihoods, migration, and conflict 97

3.3 Health 99
3.3.1 Interconnections between conflict, human migration and environmental change, and impacts on public health 99
3.3.2 Current and future health pressures caused by environmental change, migration, and conflict in the Mediterranean 99
3.3.3 Intersectional vulnerability 101

3.4 Coasts 103
3.4.1 Impacts of environmental change 103
3.4.2 Current and future socio-economic pressures 103

Box 3.1 The Shared Socioeconomic Pathways (SSPs) 105

3.4.3 Implications for conflict and migration 106

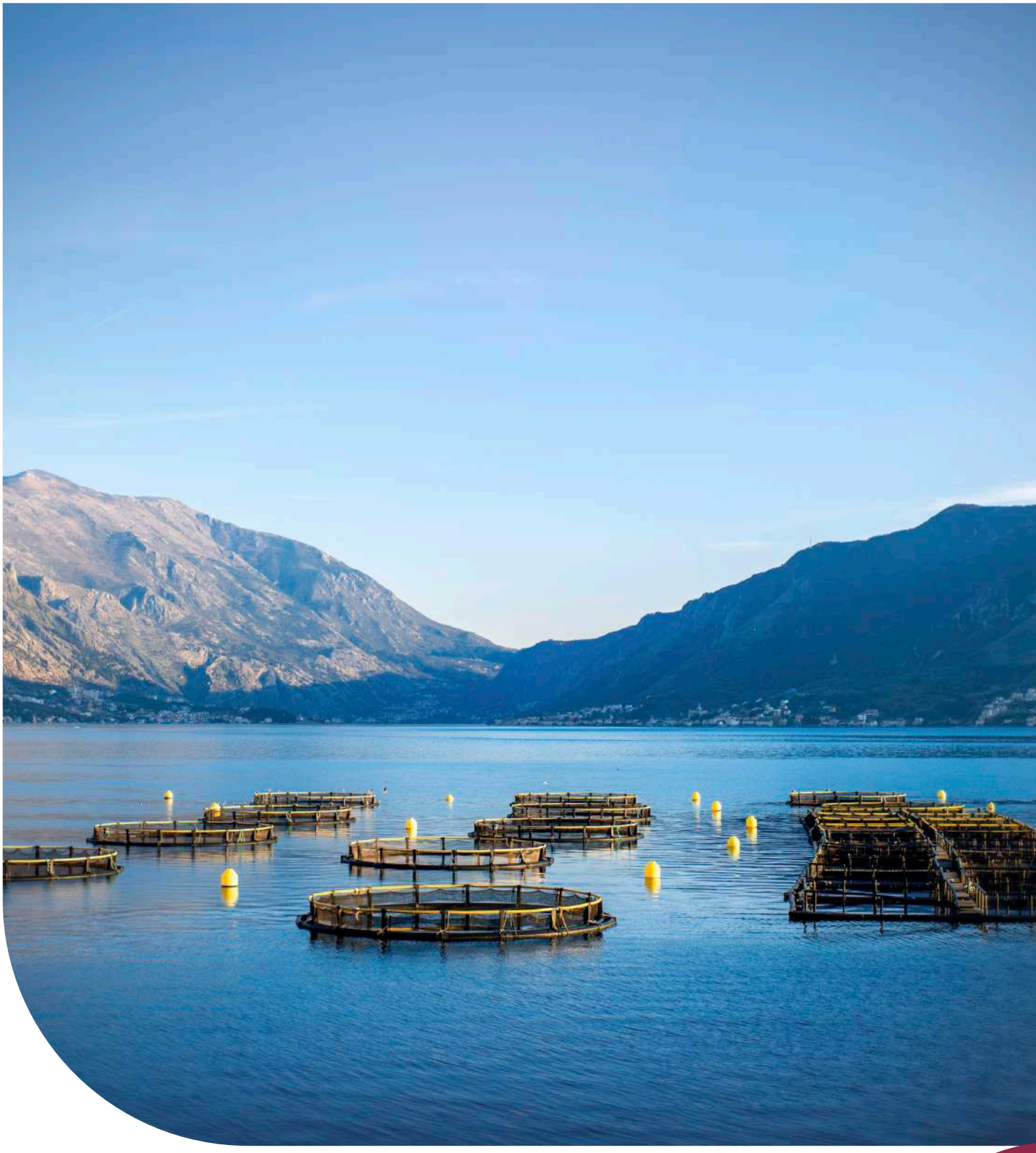
3.5 Ecosystems 108
3.5.1 Historical and projected climate trends and their impacts on Mediterranean ecosystems 108
3.5.2 Beyond direct climate change impacts: indirect climatic effects and consequences of non-climatic environmental change 110
3.5.3 Summary: implications for livelihoods, migration, and conflict 111

3.6 Energy 112
3.6.1 Environmental change impacts on the energy sector 112
3.6.2 Implications for livelihoods, migration, and conflict 113

3.7 Interactions between sectors 115

References 118

Information about the authors 129



Executive summary

Water: Water scarcity is a prevailing condition in many Mediterranean countries, while ongoing and anticipated changes in climate conditions are likely to exacerbate this challenge. The western and central Mediterranean countries are characterised by markedly higher water availability than in the southern and eastern parts of the Basin where water for agriculture is the dominant consumer of available water (up to around 80%). The Mediterranean region has become highly urbanised, and urban structures face particularly severe challenges including increased warming compared to surrounding rural areas caused by the 'heat island effect' and increased demand for potable water for human consumption and the upkeep of green spaces in cities. Effective adaptation measures at the local to regional level are necessary to address these difficulties and lower the likelihood of local communities being forced to migrate *(medium to high confidence)*. {3.1}

Food: Environmental change will induce adverse impacts on the agriculture and fisheries sectors. This will mainly be caused by longer-lasting and increasingly intense marine and terrestrial heat waves, as well as droughts and floods on land (*medium* to *high confidence*). These impacts will *likely* involve reduced farm and fisheries productivity and, in combination with non-climatic drivers of change, an exacerbation of risks to food security (domino effect). These trends apply to the entire Mediterranean Basin, with greatest challenges foreseen for southern and eastern Mediterranean countries *(high confidence).* {3.2}

Health: Conflicts and human migration, driven by a combination of climate-related and non-climate related factors, have significant implications for public health in the Mediterranean Basin. Conflicts beyond the Mediterranean region (i.e. Ukraine) can have indirect consequences for the health of Mediterranean populations, for example with regard to the provision of food or other essential daily life items. People living in conflict zones in the Mediterranean (such as Gaza or Syria), as well as refugees and immigrants arriving at their destination in Mediterranean countries from inside and outside the Mediterranean, experience disproportionately high rates of poverty and endure inadequate living conditions. This includes substandard housing, contaminated water, and insufficient healthcare facilities. Such poor conditions result in risks to human health and represent hotspots for outbreaks of infectious diseases. People living in conflict zones, as well as refugees and migrants, are also vulnerable to poorer mental health. The treatment of mental illnesses among both adult and child refugees, together with child malnutrition, are frequently neglected. The elderly, the chronically ill, people who work outdoors, and those from low-income backgrounds are particularly susceptible. {3.3}

Coasts: Sea level rise will increase the frequency and intensity of already existing coastal hazards such as flooding due to extreme sea levels, beach erosion and saltwater intrusion into soils and aquifers *(high confidence).* The impacts of these hazards will be exacerbated by future socio-economic developments in the coastal zone (e.g. population growth or decline, urbanisation levels and expansion, asset and critical infrastructure development) *(high confidence).* {3.4}

Ecosystems: The Mediterranean's terrestrial, marine, and freshwater ecosystems are predicted to be adversely affected by environmental change. Forests are expected to experience increased drought, heat stress, wildfires, and pest vulnerability, while forecasts for freshwater ecosystems suggest that they will encounter declining water availability and the drying out of lakes. In marine ecosystems, increased sea-surface temperatures are likely to affect plankton availability and favour the occurrence of tropical invasive species, hence disrupting food chains. These impacts will be exacerbated by additional anthropogenic activities, including intensive agriculture, industrial development, and fisheries exploitation. Provisioning ecosystem services, including those associated with timber and non-timber forest products and fisheries, will decline. These trends have the potential to result in displacement, as communities may need to seek alternative livelihood opportunities (*medium* to *high confidence*). {3.5}

Energy: Extreme weather conditions affect conventional energy production operations such as coal mining and oil and natural gas exploitation.

Power plants may need to be modified to run at lower temperatures with lower efficiency if they rely on water bodies for their cooling needs. Extreme weather conditions also alter and affect the renewable energy production of solar photovoltaic systems, wind turbines, hydroelectric plants, and biomass production. Transportation networks, including those for electricity and conventional fuels, are expected to be impacted by climate change. Rising temperatures and erratic wind patterns are a clear threat to overhead cables and pylons used in the transmission of power. Environmental change will therefore have an impact on living conditions at the local to regional level, potentially resulting in decreased energy security for the vast majority of local populations due to increased needs for space cooling or devastating storm events. {3.6}

Interactions between sectors: Several sectors (i.e. water, food, health, coasts, ecosystems and energy) are affected by both environmental changes and socio-economic changes across the Mediterranean region *(high confidence).* The impacts on these sectors are highly interconnected *(Figure 3.11)*, therefore resulting in compounding stresses on human livelihoods. The interaction of impacts across sectors, and their compounding effects, may potentially trigger conflict and migration across the region *(medium confidence).* {3.7}

3

Introduction

The overall aim of *Chapter 3* is to provide an overview of the impact of environmental change, including climatic drivers (e.g. extreme precipitation, heat waves, sea level rise) and non-climatic drivers that are not directly related to climate change (e.g. overfishing, pollution, dams, urbanisation, governance challenges), on a range of sectors that may endanger human life and livelihoods and cause conflict and/or migration. The findings for the sectors considered build on the main results of the First Mediterranean Assessment Report (MedECC 2020) *(Figure 3.1). Sections 3.1–3.6* therefore discuss the impacts of environmental change on the respective sectors, how non-climatic factors exacerbate the pressures caused by environmental change, and the potential effect of these developments on conflict and migration. Whenever possible, each section additionally covers a number of cross-cutting themes, such as differences in urban versus rural areas, the interaction of climatic and non-climatic drivers in worsening environmental stresses, as well as regional differences across the Mediterranean Basin. *Section 3.7* summarises and examines interconnections among all sectors in light of their potentially magnifying implications for migration and conflict.

3.1 Water

3.1.1 Introduction

Large parts of the Mediterranean have long struggled with water scarcity, but resourceful local populations have found innovative ways to efficiently manage this scarce resource. The amount of precipitation for a given region depends on ever-changing climate conditions and the occurrence of extreme events. Since the industrial revolution in the late 19th century, changes in climatic conditions have resulted in significant warming, clearly impacting water availability in the Mediterranean Basin. Looking at the recent past, *Figure 3.2* presents the spatial distribution of mean annual precipitation values based on CRU TS[45] gridded datasets (Climatic Research Unit gridded Time Series, Harris et al. 2014) for 1951–2009. It can be clearly seen that annual precipitation values for southern and eastern parts of the region amount to less than 800 mm yr^{-1}, while the values for the northern part of the region lie mainly below 1000 mm yr^{-1} (Philandras et al. 2011). The trend for the number of rainy days for the period 1951–2010 is decreasing for the western and central Mediterranean and slightly increasing for the eastern Mediterranean (Philandras et al. 2011).

The mean total annual renewable water availability per person amounts to 629 m^3 $capita^{-1}$ yr^{-1} for the MENA region, a value well below the water stress limit of 1000 m^3 $capita^{-1}$ yr^{-1} (Table 1 in Lange 2023). However, there is significant geographical variation between individual countries, with western and central parts of the Basin characterised by markedly higher values than those in the southern and eastern parts *(Figure 3.3)*.

The rise in annual mean temperatures in the Mediterranean has already reached the 1.5°C level since the pre-industrial era (Cramer et al. 2018; *Chapter 2, Section 2.4*). Moreover, the frequency and intensity of extreme events (heat waves, droughts, heavy rainfall) have also markedly increased over the last few decades and are expected to continue to rise (e.g. Perkins-Kirkpatrick and Lewis 2020; Zittis et al. 2021). All these observations demonstrate a pronounced drying trend throughout the Mediterranean, with a particular emphasis on and increase in the risk of higher water scarcity in the eastern and southern parts of the region (see *Figure 2.8* in Cherif et al. 2020). While not explicitly covered here, changes in environmental conditions, for example industrial pollution or the use of fertilisers and pesticides and their effects on surface and groundwater quality also significantly affect water availability.

3.1.2 Current state of water availability and spatial distribution

In most Mediterranean countries, agriculture is the dominant consumer of available water. On average, 64% is used for irrigation, 11% for domestic use, and 25% for industry in the Mediterranean (Blinda

[45] CRU TS series of data sets (CRU TS = Climatic Research Unit Time Series) contain gridded monthly fields of precipitation, daily maximum and minimum temperatures, cloud cover, and other variables covering Earth's land areas: https://crudata.uea.ac.uk/cru/data/hrg/

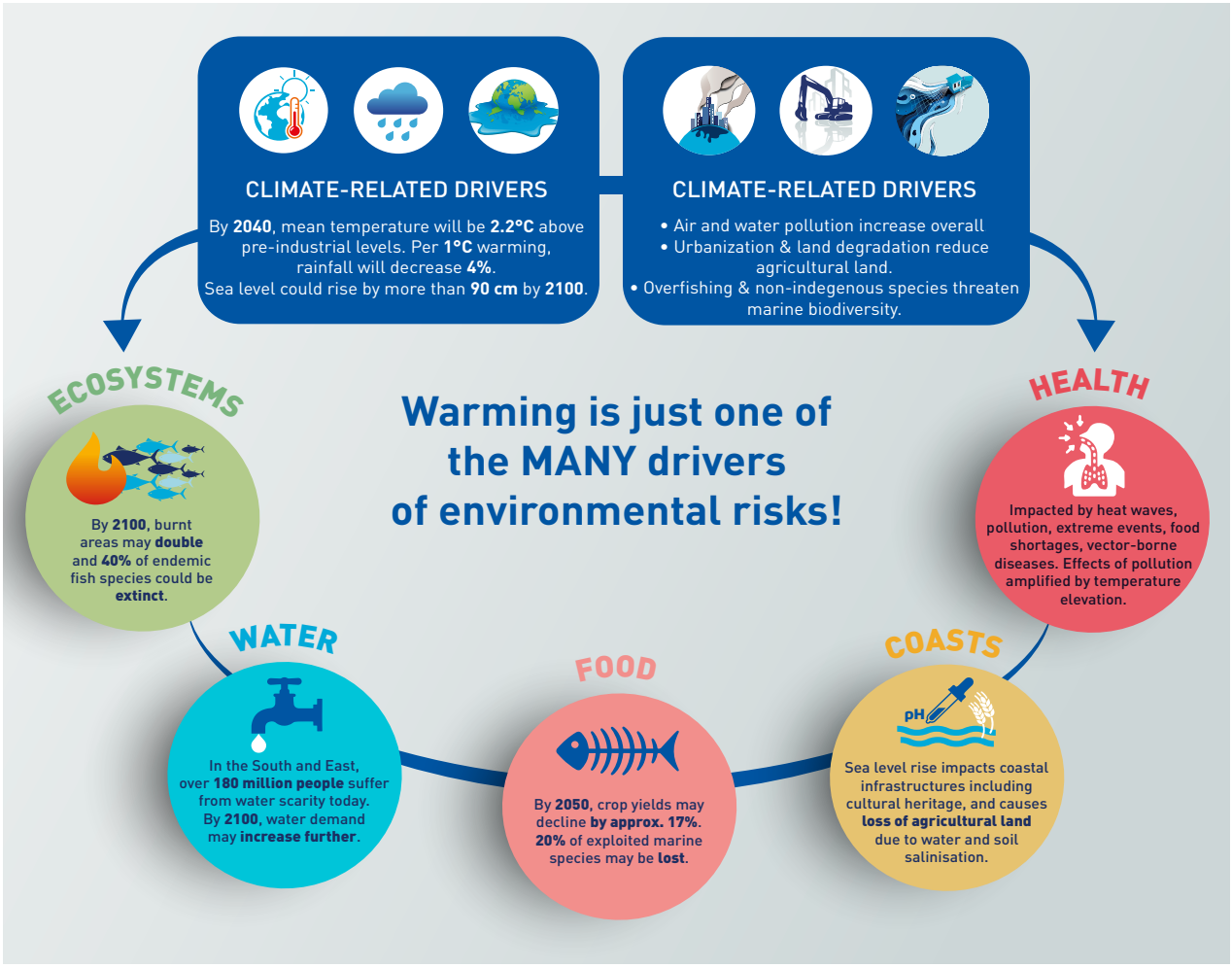


Figure 3.1 | Infographic summarising the main results of the First Mediterranean Assessment Report (MAR1) published in 2020. Source: MedECC (2020).

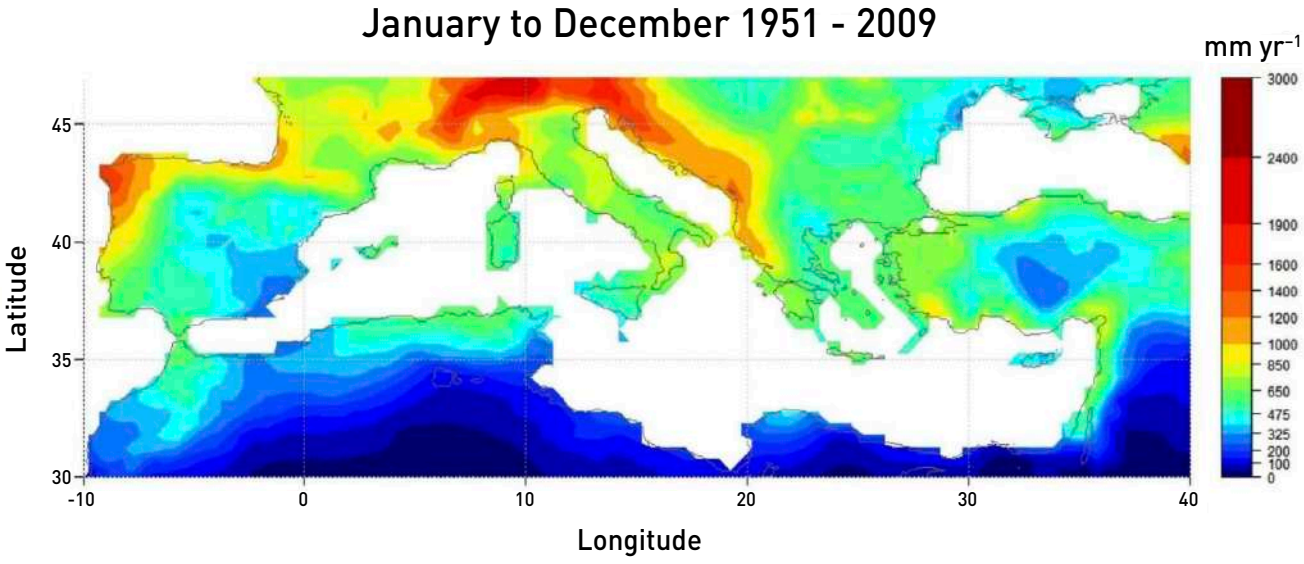


Figure 3.2 | Spatial distribution of mean annual precipitation values based on CRU gridded datasets. Source: Philandras et al. (2011).

2008; Mandi 2014; Fader et al. 2020; García-Vila et al. 2024). The Mediterranean Basin's available water resources of between 1060 km³ yr⁻¹ and 1452 km³ yr⁻¹ are unevenly distributed, with the northern countries holding 72 to 84%, while the eastern and southern countries receive the remaining 16 to 28% of the available water (EC 2007; Ferragina 2010). There is therefore a great deal of variation between Mediterranean sub-regions regarding the proportion of water consumed by various sectors *(Table 3.1)*.

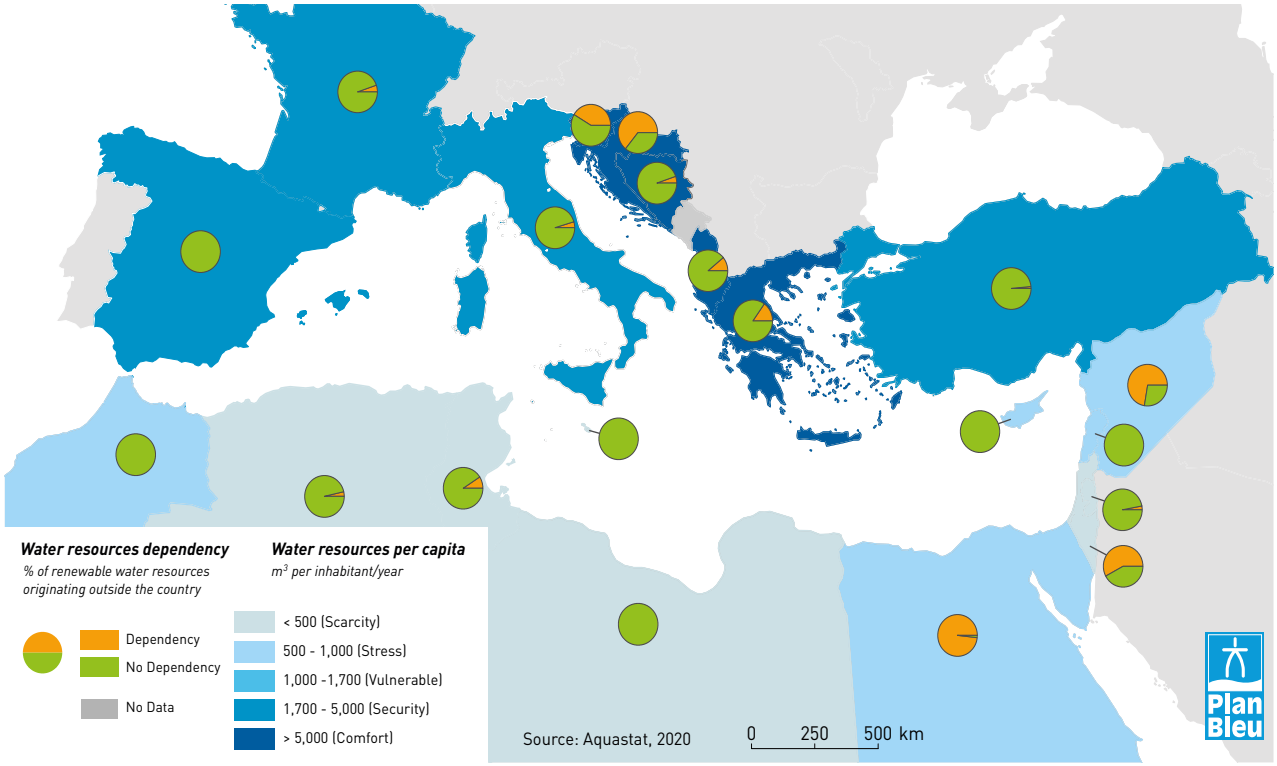


Figure 3.3 | Total renewable water resources per capita in the Mediterranean in 2017. Source: UNEP/MAP and Plan Bleu (2020).

Table 3.1 | Distribution of water use for individual sectors and sub-regions of the Mediterranean Basin. Source: Fader et al. (2020).

Mediterranean sub-region	Water use for sector, %		
	Agriculture	Industry	Domestic
Northern Mediterranean	36	48	16
Southern Mediterranean	76	20	4
Eastern Mediterranean	79	6	13

Given anticipated changes in climate up to the end of the century, reduced precipitation and extreme events (e.g. extended dry spells) will increase the risks of severe water scarcity (see *Figures 2.10* and *2.11* in Cherif et al. 2020) in large parts of the Mediterranean Basin, transforming it into a global 'drought hotspot' (Spinoni et al. 2020).

A decrease in the water available for irrigation will have direct consequences for agricultural productivity and food security in some Mediterranean countries. It will also reduce the amount of environmental water, that is water needed to maintain healthy terrestrial ecosystems, and may lead to accelerated desertification in semi-arid and arid parts of the Basin. Both impacts will likely enhance pressure on local communities and may lead to forced mobility within and beyond national borders.

The Mediterranean is characterised by a high degree of urbanisation (e.g. Lange 2019), which is likely to increase over the next few decades. As a result of climate change, cities will suffer significantly enhanced warming compared to the surrounding countryside, caused by the 'heat island effect' (for more details, see Lange 2019). The resulting extreme conditions will not only affect human health and the indoor comfort of the urban population; they will also lead to rising demand for potable water and for water to maintain cities' green spaces. Extreme heat will also require increased space cooling in public and private buildings. Both issues will increase water and energy needs in the context of the water-energy nexus (Lange 2019, 2022). Growing pressure on urban inhabitants may also give rise to increased migration away from the unbearably hot conditions of cities in the Mediterranean.

3.1.3 Human pressures and water management

The consequences of ongoing climate change and increasing water scarcity described above increase the pressure to develop effective adaptation strategies at the local to regional level. Water management in several Mediterranean countries is characterised by low efficiency and the decentralisation of responsibilities to various governmental institutions. Demand side management and the provision of incentives to reduce consumption are largely missing. In addition, many urban distribution networks are plagued by significant leakage problems (ageing and the use of steel pipes), which reduce available potable water for city inhabitants.

Although technically feasible, advanced irrigation technologies combined with smart agricultural practices are still only rarely implemented in many Mediterranean countries. Moreover, the choice of crops and fruits cultivated in a given country should be adjusted to reduce agricultural water needs and minimise the inappropriate export of virtual water[46] to other countries.

There is an urgent need to effectively adapt to the expected increase in water scarcity, particularly in the southern and eastern countries of the Mediterranean Basin, in order to reduce the risk of further forced migration of local communities (more details on effective mitigation and adaptation strategies are provided in Lange 2019, 2022). Given the prospect of continued decreases in precipitation, alternative water sources will have to be utilised. Seawater desalination, already practised in some Mediterranean countries (e.g. in Algeria, Cyprus, Greece) and likely to be introduced in others, is only an option of limited viability. This is mainly because of the significant energy demand of desalination, and the resultant relatively high cost of desalinated water. Using renewable energy sources offers promising alternatives to provide the energy needed for desalination. Given the conditions in the southern and eastern parts of the Mediterranean Basin, solar or wind energy, or a hybrid solution involving both (or more) renewable energies are therefore feasible alternatives to using ground- and surface water under enhanced climate change-induced water scarcity.

[46] The term 'virtual water' refers to the water consumed at every step in a value chain of a given good, service or process. This water must therefore be 'expended' to grow fruits or vegetables throughout the entire production process (see Graham et al. (2020)).

3.2 Food

3.2.1 Historical and projected impacts of environmental changes on agriculture and fisheries sectors in the Mediterranean

Recent temperature increases and enhanced dry periods in the Mediterranean region have been most severe in the summer months, a crucial phenological stage for crops, with implications for agricultural production (Vogel et al. 2021). Examples of impacts identified include significant yield losses for wheat (up to –20% in Italy) and barley throughout the period between 1989 and 2009 (Moore and Lobell 2015). The livestock sector has also been adversely affected by increased thermal stress, especially within intensive, indoor production systems more prevalent in the northern Mediterranean. Indirect effects include land degradation (e.g. in the Algerian steppes, see Mouhous 2005), reduced grassland productivity, limited water availability, and increased occurrence of pathogens and vectors (Lacetera et al. 2013; Blanco-Penedo et al. 2020). Past evidence throughout the region shows a link between an increase in temperature and the temperature-humidity index and increased mortality rates among dairy cows and sheep (Vitali et al. 2009), alongside declines in milk quality (Blanco-Penedo et al. 2020) and yields (Ramón et al. 2016; Hempel et al. 2019).

The Mediterranean Basin has been identified as a climate change 'hotspot' (see Cherif et al. 2020; Lionello and Scarascia 2020; Ali et al. 2022), with future climate change projections indicating continued intensification of warming under a range of emissions scenarios. By 2100, 4°C warming has been projected to result in severe drought-induced economic losses throughout Europe, particularly in the Mediterranean agricultural sector — potentially reducing its economic output by 10% (Naumann et al. 2021). In general, the greatest yield reductions are forecast for the southern Mediterranean. This will have particularly severe consequences for agricultural employment, which suffers from limited adaptive capacity (Aguilera et al. 2020). Crop growth models and land suitability studies have been carried out for a number of regionally important products. The lowest yield reductions are foreseen for maize (Olesen et al. 2011), especially in comparison to winter wheat, which will primarily be affected in rain-fed areas (Moriondo et al. 2011; Saadi et al. 2015; Schilling et al. 2020). Significant Mediterranean-wide reductions in sunflower yields have also been forecast due to the crop's exposure to hot summer months, where the greatest increases in extremes are anticipated (Moriondo et al. 2011; Cramer et al. 2018; Abd-Elmabod et al. 2020). Rain-fed tomatoes and horticultural crops are furthermore expected to be adversely impacted (Saadi et al. 2015; Aguilera et al. 2020). Declines in productivity are also expected for (rain-fed) olive and grapevines, not only as a result of increases in heat stress and drought but also from additional extremes, notably heavy rainfall, frost, and hail (Olesen et al. 2011; Tanasijevic et al. 2014; Aguilera et al. 2020). For grapevines, these changes are reported to exacerbate adverse impacts on product quality (Ferrise et al. 2013; Cramer et al. 2018). Northern Mediterranean regions are on the other hand projected to see an increase in suitability for a number of crops, including winter wheat, tomatoes, and olives (Saadi et al. 2015; Aguilera et al. 2020, García-Vila et al. 2024).

Attribution studies indicate that anthropogenic climate change has increased the frequency and intensity of extreme heat wave events in the Mediterranean. In addition to enhanced heat stress, increases in extreme rainfall events and the risk of wildfires (Clarke et al. 2022) are *likely*. The 2003 summer heat wave contributed to an increase in fire risk and the occurrence of mega-fires in France and Portugal. The severity of these events was significantly higher than previously observed, as fire conditions in France had formerly been observed at a probability of occurrence of less than 0.2% (Barbero et al. 2020; Clarke et al. 2022). There is evidence of direct adverse impacts of wildfires on agricultural production in the Mediterranean region in recent years, as witnessed in affected coastal agricultural lands in Greece in 2004–2005 (Stougiannidou and Zafeiriou 2022). However, more indirect effects have also been reported, such as reduced grape quality from wildfire smoke exposure in Italy (Brunori et al. 2021). Flooding has also caused adverse impacts on the agricultural sector (e.g. Gil-Guirado et al. 2019), including livestock mortality and failed harvests (especially in conjunction with landslides; Amengual and Borga 2020). Additionally, waterlogging from flooding has reduced plant growth and yields, particularly in sensitive crops such as olives and avocados (Kourgialas 2021).

Infrastructure has also suffered from climate change impacts, particularly with regard to irrigation,

drainage systems, and soil conservation structures, resulting in increasing vulnerabilities of the agricultural sector to concurrent drought risk, as evidenced in Tunisia (Dahri and Abida 2020).

The spread of invasive agricultural weeds, pests and diseases is furthermore affected by climate change (e.g. through the spread of the olive fruit fly; Skuras and Psaltopoulos 2012; Ponti et al. 2014). Impacts on livestock vary distinctly between mixed production systems (primarily characterising the northern basin), where farmers benefit from production diversification, and open rangelands or industrial livestock systems (Cramer et al. 2018). Projections for the bovine sector include increased losses in monthly income throughout summer months because of changes to temperature and humidity (Hempel et al. 2019), and declines in milk productivity (Lacetera et al. 2013), potentially increasing reliance on imports (Sraïri et al. 2013).

An additional impact of major concern to food production is sea level rise (*Section 3.4.1*) — particularly in the Nile Delta, where 25% of the land area lies at or below current sea levels, and where fertile agricultural areas are at risk of flooding and saltwater intrusion (Zittis et al. 2022).

The fisheries sector has been impacted by rising temperatures and more extreme summer heat waves. Mass mortalities first identified throughout the 1980s have since become a recurring feature, and were particularly severe in 1999, 2003, and 2008 (Darmaraki et al. 2019; Garrabou et al. 2019). Climate change projections point towards an increase in the severity of marine heat waves (i.e. with regard to duration and intensity) in the Mediterranean Sea under mid- and high-end climate change scenarios (RCP4.5 and RCP8.5; *Section 3.5.1*). These events are forecast to become up to 42 times more severe than at present (Darmaraki et al. 2019). Opportunities for species to adapt by moving to higher latitudes are limited within the semi-enclosed Mediterranean Sea (Ben Rais Lasram et al. 2010; Albouy et al. 2012), and the region, like most of the world, is projected to see a further decline in catches and fisheries revenues (Lam et al. 2016). By 2050, more than 20% of exploited fish and marine invertebrates are forecast to become extinct in the region (Cramer et al. 2018).

3.2.2 Beyond direct impacts: indirect environmental effects and consequences

A number of additional processes are resulting in increased pressure and/or the deterioration of scarce resources in the Mediterranean region. These may either be independent from, or indirectly driven or exacerbated by climate change. Across the Middle East and North Africa, population numbers are expected to exceed 1 billion by the end of the century (Zittis et al. 2022), with smaller increases projected for northern and eastern Mediterranean countries (Malek et al. 2018). This trend, alongside tourism development, is intensifying pressure on freshwater resources (Zittis et al. 2022) and is further driving the urbanisation of coastal areas and the sealing and loss of agricultural land, with important implications for flood risk (Malek et al. 2018; Tramblay et al. 2019; Ferreira et al. 2022). Further concerns involve regional land degradation. Across Europe, the highest rates of soil erosion and loss of soil organic matter are found in Mediterranean countries (Ferreira et al. 2022). In Slovenia, 41% of agricultural land is estimated to be severely eroded, resulting in high economic losses associated with foregone yields, a trend that is also pronounced in Spain, Italy, and Greece (Panagos et al. 2018; Ferreira et al. 2022). Erosion is primarily driven by agricultural intensification — a process that is also driving the loss of organic matter (e.g. via intensive tillage), as well as soil pollution (e.g. nitrate contamination from livestock production, or pollution from excessive use of fertilisers and fungicides; Ferreira et al. 2022). In Morocco and Tunisia, land degradation is estimated to result in a 0.5% decrease in Gross Domestic Product. Additional soil degradation issues are associated with salinisation, exacerbated by groundwater abstraction, affecting crop yields (Ferreira et al. 2022). In Egypt, 90% of agricultural land is affected by salinisation and waterlogging (FAO and ITPS 2015).

The Mediterranean Sea is furthermore at risk of pollution from coastal activities (as it is home to numerous refineries and chemical plants), seaborne traffic, and (micro)plastics (Trincardi et al. 2023). Furthermore, few areas within the Mediterranean Sea are considered to represent sustainable fisheries, with the Adriatic Sea showing the highest levels of exploitation of commercial species and the EU Mediterranean displaying declining landings and overall negative economic trends (Colloca et al. 2017). These trends are furthermore hampered by an increase in invasive species favoured by warming conditions, particularly in the eastern Mediterranean Sea and in connection with the Suez Canal (Cramer et al. 2018).

3.2.3 Implications for livelihoods, migration, and conflict

Other impacts of adverse environmental changes include limited capacities for adaptation. This explains the high spatial variability in climate risk assessment for fisheries throughout the

Figure 3.4 | Climate risk assessment for fisheries in the Mediterranean Basin. Source: Pita et al. (2021).

Mediterranean Basin, with countries in North Africa displaying the highest risk scores (Pita et al. 2021) *(Figure 3.4).* Marine Protected Areas have been identified as an effective means of increasing fish biomass within rocky reefs of the Mediterranean Sea, but they need to take into account future changes in climatic gradients to ensure long-term conservation (Frid et al. 2023). The Mediterranean region has also seen an increase in aquaculture production, mitigating some of the declines in fisheries landings (Hilmi et al. 2021).

Uneven adaptation capacities have similarly been identified for Mediterranean croplands, with areas of greatest exposure to increased drought and heat stress also displaying lower adaptation potential (Zagaria et al. 2023). Core adaptation enablers have been identified as greater market accessibility and water/irrigation availability, higher land ownership rates, lower poverty levels, and suitable soil and slope conditions for resilient crop production (Zagaria et al. 2023).

Varying degrees of climate risk within the agriculture and fisheries sectors imply varying degrees of impact on Mediterranean livelihoods which, to a significant extent, are dependent on the type of environmental impact experienced. Sudden onset events (e.g. storms, floods) limit the potential for reactive adaptation and may result in immediate destructive outcomes through loss of land and infrastructure. They are therefore more likely to cause a loss of livelihoods, employment, and food security within subsistence agricultural households. These impacts are more often associated with temporary and short-distance forms of migration. With regard to slower-onset environmental change processes (including drought and land degradation from erosion and increased salinity), impacts on yields, produce quality, and fisheries landings are more often gradual. In these situations, migration is more likely to be identified as a 'voluntary' adaptation strategy – despite the limited potential for other forms of adaptation (MedECC 2020a). In such cases, the motivations for migration are primarily perceived as economic, and often occur along a rural-urban gradient (e.g. Fernández et al. 2019; Sobczak-Szelc and Fekih 2020), associated with an increase in poverty and a decrease in employment linked to declining suitability of farming and fishing. Environmental change may therefore be interpreted as an important intermediary or secondary factor for migration (Cai et al. 2016). This is particularly the case in contexts of pre-existing vulnerability (Fargues et al. 2020; Cundill et al. 2021) where food insecurity is one of several contributors to political instability (Ali et al. 2022).

3.3 Health

3.3.1 Interconnections between conflict, human migration and environmental change, and impacts on public health

Public health, environmental change, conflict, and associated displacement and involuntary migration are all interrelated. Environmental changes have a profound direct impact on public health and also generate and exacerbate political conflicts and human migration. Migrants and refugees, in particular, face significant risks to their health and well-being, as they constitute a vulnerable population that is disproportionately impacted by conflicts (Matlin et al. 2018; Negev et al. 2019). Within the Mediterranean Basin, and mainly in the southern and eastern countries, factors such as severe drought, water shortages, and pollution *(Section 3.1),* food insecurity *(Section 3.2),* lack of adaptive capacity, and increased climatic risks all intensify political conflicts and aggravate regional disputes (Gleick 2014; Al-Delaimy 2020; Paz et al. 2021). Furthermore, extreme weather events and sea level rise *(Section 3.4)* force inhabitants to migrate (see *Section 5.1.4* regarding the climate-mobility association). Conflicts and migration therefore serve as determinants of both physical and mental illness.

Immigrants and refugees experience disproportionately high rates of poverty and endure inadequate living conditions, including substandard housing, contaminated water, and insufficient healthcare facilities. The precarious conditions along migration routes, at destinations, and in refugee camps, along with environmental degradation such as land erosion, food insecurity, and water pollution, as well as climate change-induced events like extreme heat waves, cold spells, wildfires, and droughts, increase the vulnerability of immigrant populations. These conditions heighten the risk of malnutrition, infectious diseases, heat- and cold-related morbidity and mortality, and mental health disorders, including post-traumatic stress disorder, depression, anxiety, and physical injuries during migration or in unsafe camps (Berry et al. 2018; Hayes et al. 2018; Bellizzi et al. 2020). Migration also leads to short- or long-term lack of access to essential determinants of health, including education, job security, and social networks. This exacerbates poverty, social stratification, social isolation, and loneliness among migrants.

Additionally, limited access to healthcare services poses a significant challenge for the health of migrants, with national or local health systems often ill-equipped to address these needs (Paz et al. 2021). In destination countries, refugees and immigrants typically have limited access to healthcare services, primarily relying on emergency care and immunisations, along with maternal and child preventive care. Healthcare coverage is largely inadequate, and language barriers and cultural differences further complicate access to healthcare, leading to a deterioration in health. Moreover, the treatment of mental illnesses among both adults and children is frequently neglected, despite poor mental health increasingly becoming a significant health consequence of environmental change, conflict, and migration (Al-Delaimy 2020).

3.3.2 Current and future health pressures caused by environmental change, migration, and conflict in the Mediterranean

The relationship between low socio-economic development, environmental change, conflict, and their impact on public health is complex and multidimensional. Climate change is a factor that can contribute to the risk of armed conflicts within countries. However, in general, its influence is relatively low compared to other drivers, and the mechanisms linking climate to conflicts remain uncertain (Mach et al. 2019).

Conflicts and human migration, driven by various combinations of climate-related and non-climate related factors, have significant implications for public health in the Mediterranean Basin. The influence of climate change relative to other factors is debated in the literature. For example, studies on the Syrian war showed that environmental change, including the most severe recorded drought (Kelley et al. 2015), persistent multi-year crop failures, and associated economic deterioration, all played an important role in contributing to political instability in Syria. This in turn led to displacement of people, food insecurity, higher unemployment, and increased violence (Gleick 2014; Kelley et al. 2015; Lal 2021). On the other hand, Selby et al. (2017) argued that the evidence linking environmental change to the conflict in Syria is unreliable, and that the scale of the migration caused by the drought was small. According to their study, migration was caused more by economic liberalisation than by the prevailing drought.

Migration itself poses various health risks influenced by a complex interplay of factors, including an individual's pre-departure health, socio-economic and environmental conditions, local disease patterns, risk behaviours, cultural norms, and access to preventive or curative therapies

throughout the migration process (Abubakar et al. 2018). Migrant populations often bear a significant burden of diseases such as tuberculosis, hepatitis B and C, and vaccine-preventable illnesses (Vearey et al. 2020). Despite the recognition of the many migration-related health risks, mobile populations often encounter punitive border policies, arbitrary detention, abuse, extortion, and limited access to healthcare services (Abubakar et al. 2018). For instance, in Greece, poor living conditions, communication difficulties, exclusion from services, and instances of racism and xenophobia have detrimental effects on the health of asylum seekers, refugees, and immigrants (Fouskas et al. 2019).

Furthermore, conflicts beyond the Mediterranean region can have indirect consequences on the health of Mediterranean populations. For example, the war in Ukraine led to a surge in wheat prices, potentially affecting food security and nutrition in Mediterranean countries heavily reliant on imported wheat, such as Egypt, which imports 82% of its wheat from Russia and Ukraine (FAS USDA 2022).

Environmental changes in the Mediterranean also affect human health through changes in the dispersion pathways of atmospheric pollutants and the concentrations of particulate matter (PM). Particulate matter originates primarily from Saharan dust intrusions and advected smoke from wildfires (Linares et al. 2020). The human health effects of dust storms range from respiratory disorders (such as asthma, pneumonia, and allergic rhinitis) to cardiovascular disorders (including strokes), conjunctivitis, skin irritations, and injuries related to transport accidents (Goudie 2014). Health risks associated with wildfires include direct risks from exposure to fires, as well as risks from heavy wildfire smoke (Xu et al. 2020). Indeed, alongside the increasing frequency and extent of wildfires, especially in the European parts of the Mediterranean region (Peñuelas et al. 2017), an increase in PM10 concentrations in the eastern Mediterranean is linked to dust storms, which are *likely* attributed to changes in synoptic-scale conditions driven by climate (Krasnov et al. 2016).

Additional health and environmental emergencies also pose a risk to human health in the Mediterranean. In late 2019, COVID-19, the illness caused by SARS-CoV-2, emerged and spread very quickly across the globe, with 760 million cases and a death toll of nearly 7 million people (WHO 2023). Mediterranean countries experienced varied impacts, resulting in different durations and stringencies of lockdowns and public health restrictions. Italy was the first country in the region to report a major outbreak, with over 35,000 deaths in 2020 and more than 100,000 cumulative deaths by early 2021 during another major wave of infections. Multiple waves occurred in Spain as well, while Greece reported fewer total fatalities.[47] In less developed Mediterranean countries (i.e. Algeria and Egypt) the spread of COVID-19 exposed gaps in epidemic preparedness and health system capacity (Paz et al. 2021).

On 4 August 2020, a large explosion occurred at the port of Beirut, Lebanon, caused by the detonation of approximately 2750 tons of improperly stored ammonium nitrate. The explosion resulted in over 200 fatalities, and injured around 6000 people, with approximatively 300,000 individuals temporarily displaced, with severe impacts on their health. The disaster also rendered three hospitals non-functional, severely damaged two others, and destroyed 17 containers of essential medical supplies (Devi 2020).

Health service delivery in armed conflict areas faces multiple challenges. For example, in Syria, health services have been heavily disrupted as a result of the crisis, while attacks have left health centres damaged and, in some cases, non-functional, significantly reducing access to essential health services for affected populations (Bozo et al. 2019). This complex situation increases the risk of common infectious diseases, which are highly sensitive to climate variability, as warmer temperatures and altered rainfall patterns can create more hospitable environments for both vectors and pathogens (Hess et al. 2020). Vector-, food-, and water-borne diseases tend to be more prevalent in vulnerable areas, including some developing countries within the Mediterranean region, where exposure risks are amplified by factors such as poor sanitation and inadequate infrastructure. Poor conditions such as

[47] European Centre for Disease Prevention and Control (ECDC): https://www.ecdc.europa.eu/en/covid-19/data

those in refugee camps and in high density cities with poor water infrastructure, whether due to low socio-economic status or conflict, may contribute to increasing the density of infectious agents and reduced disease control (WHO 2018). Migration driven by climate change may increase the incidence of communicable diseases among both migrants and host populations, and increase the rate of non-communicable diseases in the migrant population (Spearman et al. 2023). An alarming example is the increase in cutaneous leishmaniasis (CL) by tens of thousands of cases in Syria in early 2013, in places that are not historical hotspots of CL, a change that might be attributed to the massive human displacement within Syria. Additionally, CL has begun to emerge in neighbouring countries (Jordan, Lebanon, and Türkiye), where displaced Syrians and disease reservoirs coexist, in parallel with ecological disruption of sandfly habitats (Al-Salem et al. 2016). In September 2022, the UN warned that a cholera outbreak in Syria, which has not reported cholera since 2009, poses a 'serious threat' to the region, with more than 1000 suspected cases and eight reported deaths, while the true numbers are likely to be under-reported. The outbreak's source was thought to be unsafe water from the Euphrates River used for drinking and to irrigate crops, leading to food contamination.

The civil war has damaged two-thirds of Syrian water treatment plants, half of its pumping stations, and a third of its water towers. Almost half of the population relies on alternative sources of water, such as water trucks, which are often unsafe, while at least 70% of sewage is untreated. Currently, the UN estimates that 14.6 million people in Syria need humanitarian assistance, half a million children are chronically malnourished, and many health facilities remain damaged amid a severe shortage of health professionals (Devi 2022).

Poor water quantity and quality in refugee camps in Algeria, including onsite health institutions, is another example of microbiological contamination and consequential health risks. In Egypt, Saad-Hussein et al. (2014) suggested that bilharzial cancer cases were emerging among farmers displaced from their agricultural land due to sea level rise.

In addition to water insecurity, migrants and refugees are at risk of food insecurity. Despite governmental and international efforts, refugees face limited access to adequate food in terms of quantity, quality, and diversity (Vakos et al. 2021). In addition, severe personal identity traumas such as physical and sexual violence against women, have been observed among Syrian refugees, while the rate of post-traumatic stress disorder (PTSD) and depression have also been high (Al Ibraheem et al. 2017). In Gaza, the continuous conflict with Israel, comprising strict siege conditions and destruction of infrastructure, together with poor health infrastructure, a high urbanisation rate, and low socio-economic status, exacerbated by climate change, rising temperatures, and lack of safe water, all lead to deteriorating physical and mental health (Efron et al. 2018).

Special attention should be paid to the child population. In Türkiye, the country hosting the largest number of Syrian refugees in the world (3.6 million), 46% of them are under the age of 18. These children face a variety of risks to their health and well-being, including communicable and non-communicable diseases, PTSD, depression, and family violence, as well as child labour and child marriage. It was found that malnutrition is a key issue for Syrian refugee children, and it is more prevalent compared to Turkish children (Sahin et al. 2021). Environmental stressors also contribute to the migration from Africa to Europe, across the Mediterranean Sea. Between 2015 and 2023, every year thousands of people were defined as 'dead' or 'missing' with the lowest number (1510) in 2019 and the highest (5096) in 2016[48]. In 2023, 35,200 refugee and migrant children arrived in Bulgaria, Cyprus, Greece, Italy, Malta, and Spain, via sea and land, mainly from the eastern, central, and western Mediterranean and North Africa, 41% more than the total number in 2021. Of these, 67% were unaccompanied or separated from both their parents. Health systems should address the effects of environmental change on migration and health, including early warning systems, vaccination programmes, capacity building of healthcare professionals, and protection of migration corridors and displaced people (Spearman et al. 2023).

3.3.3. Intersectional vulnerability

While environmental change, conflict, and migration have adverse impacts on the physical, mental, and social health of the general public, certain population groups are even more vulnerable. This includes the

[48] UNHCR Operational Data Portal, Europe Sea Arrivals: https://data.unhcr.org/en/situations/mediterranean

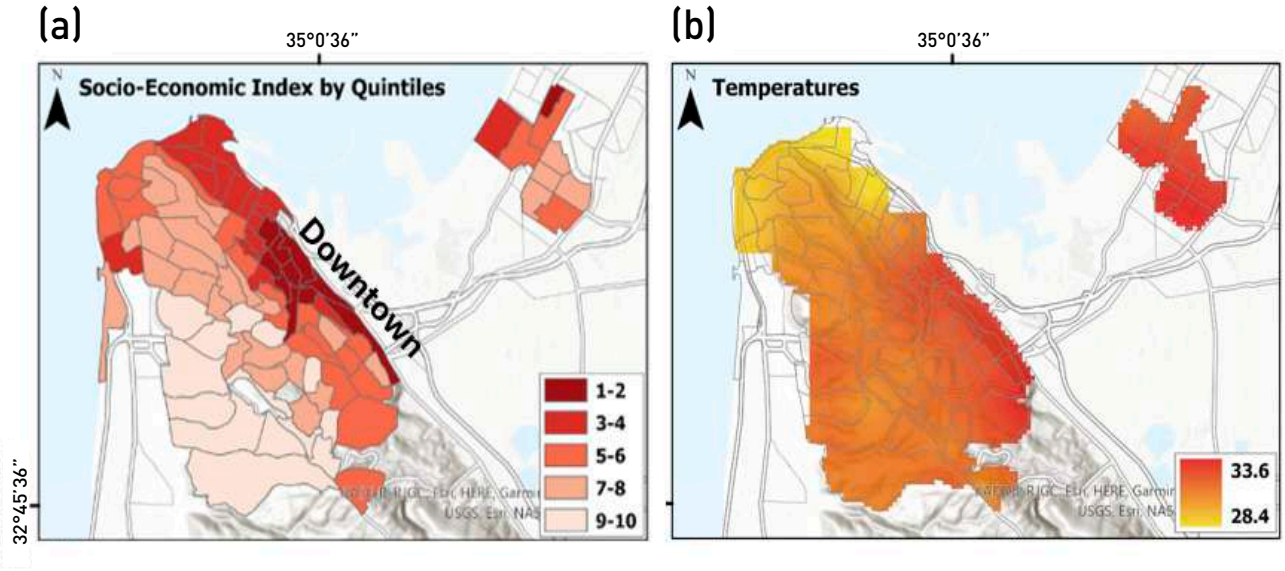


Figure 3.5 | Intersectional vulnerability and exposure in the Mediterranean city of Haifa (Israel). (a) Socio-economic status and (b) Average temperature on excessively hot days in August between 2010 and 2019. The downtown population is subject to intersecting vulnerabilities and exposure – belonging to the lowest socio-economic quintile and living in the hottest area in summer. Source: Negev et al. (2022).

elderly, the chronically ill, women, children, people who work outdoors, and economically deprived populations, including those suffering from energy, food, or water poverty. In addition, those who suffer intersectional vulnerability (people who encounter vulnerability in two or more dimensions — that is, the elderly who are chronically ill, or women who are economically deprived) and/or are exposed to intersectoral stressors, are disproportionately vulnerable (IPCC 2022). For example, city-dwellers may be more exposed to heat stress due to the urban heat island effect. Urban structures are warmer (and more polluted) than surrounding rural areas. Moreover, certain areas within cities may be exposed to even higher heat stress due to urban morphology, including a high density of buildings, vegetation, land cover, land use, etc. (Ellena et al. 2020). Urban temperatures are unequally distributed within cities. For example, a study conducted in Cairo, Egypt, showed that people in marginalised, informal districts are highly exposed to heat and less capable of protecting themselves, putting their health at increased risk (Khalil et al. 2018). Another study conducted in Haifa, Israel, showed that the lowest socio-economic neighbourhoods (Socio-Economic Index <2) are also the most exposed to high temperatures in summer *(Figure 3.5)* (Negev et al. 2022). People with intersectional social vulnerability who are also more exposed to environmental stressors are therefore facing higher health risks than others, and are often less able to adapt to environmental change than other groups of inhabitants.

3.4 Coasts

3.4.1 Impacts of environmental change

The mean sea level of the Mediterranean Sea has, on average, risen by 1.4±0.2 mm yr^{-1} during the 20th century (Wöppelmann and Marcos 2012). This rate increased to 2.4±0.5 mm yr^{-1} for 1993 to 2012 (Bonaduce et al. 2016). By the end of the 21st century, mean sea level will increase by between 0.43 m and 0.87 m relative to 1995–2014, depending on the greenhouse gas emission scenario considered (*Figure 3.6*; Ali et al. 2022). Impacts of relative mean sea level variations comprise submersion and permanent coastline retreat; seawater intrusion into freshwater aquifers; higher groundwater tables; and degradation of marine ecosystems. These impacts constitute a major threat to coastal communities, not only with regard to the near-coastal ecosystem, but also because of adverse consequences on coastal infrastructure and economic activities in coastal regions (Oppenheimer et al. 2019).

To compensate for current rainfall scarcity, groundwater has been extensively used for agricultural irrigation in the Mediterranean (Nixon et al. 2003). Groundwater aquifers are at risk due to low recharge because of projected decreasing precipitation volumes, rising temperatures and increased water demand. Consequently, seawater intrusion is of particular concern in the Mediterranean region, since a significant proportion of agricultural land is located along the coast. Many coastal aquifers already suffer from seawater intrusion (Mas-Pla et al. 2014; Telahigue et al. 2020), and this is projected to increase in the future. Although mean sea level rise has a lower impact on groundwater salinity than groundwater recharge reduction, it can still worsen seawater intrusion (Pisinaras et al. 2021). In the Nile Delta, a 1 m rise in mean sea level would result in a 15% reduction in fresh groundwater (Sefelnasr and Sherif 2014). In the Po Delta, rising sea levels and decreasing river discharge could cause an increase of up to 80% in seawater intrusion by the end of the 21st century (Bellafiore et al. 2021).

Delta systems are low-elevation land areas that support substantial socio-economic activities. Subsidence rates in the larger Mediterranean deltas range between 1.4 and 10 mm yr^{-1} (Stanley 1997; Besset et al. 2017; Belivermis et al. 2024). An example is the Ebro Delta, where 73% of permanent land loss is expected under a relative mean sea level rise of 0.67 m, resulting from the RCP8.5 emission scenario (van Vuuren et al. 2014) by the end of the century (Sayol and Marcos 2018). Subsidence also affects cities in the Mediterranean, exacerbating the exposure of coastal populations to flooding. Groundwater abstraction in the Po Delta has accelerated the natural long-term subsidence in the Venice lagoon, contributing to about half of the historical relative mean sea level rise in Venice (Zanchettin et al. 2021). The city of Alexandria is subsiding due to its location in the Nile Delta, at a rate of up to 2 mm yr^{-1} (Wöppelmann et al. 2013), and has therefore been considered one of the most exposed cities to coastal flooding.

In addition to mean sea level, changes in other components of sea levels (astronomical tides, waves, storm surges) exacerbate coastal erosion and flooding. Extreme waves and surges will exacerbate erosion and flood risks along the coast, as mean sea level defines the baseline level from which extreme events propagate. Extending the example above, the 73% land loss in the Ebro Delta will increase to between 89.4% and 90.5% when accounting for extreme waves and surges (Sayol and Marcos 2018). Mean sea level rise and extreme sea levels will further exacerbate ongoing beach retreat (Enríquez et al. 2017, 2019; Belivermis et al. 2024). Nearly 50% of the sandy coastline in the Mediterranean and Black Sea regions experienced erosion between 1980 and 2000 (www.eurosion.org; Marcos et al. 2016). Mean sea level rise is estimated to result in an average beach loss of 65.5% on 869 beaches in the Balearic Islands by the end of the century, increasing to 86.3% during a storm event (Agulles et al. 2021). Similar results have been obtained for Greece (Tzoraki et al. 2018; Andreadis et al. 2021) and, although site-specific studies are required, analogous outcomes are anticipated in other Mediterranean coastal zones. These coastal changes are of particular significance considering that beaches serve as vital natural barriers for coastal protection against marine storms and are also significant contributors to the region's sun-and-beach tourism industry (Enríquez and Bujosa Bestard 2020).

3.4.2 Current and future socio-economic pressures

The consequences of environmental changes on human lives and livelihoods in coastal areas, in particular those caused by sea level rise, are largely driven by socio-economic developments in the Mediterranean coastal zone. Historically, settlements have developed in the direct coastal zone due to the low tidal range and steep topography in the adjacent hinterland (Benoit and Comeau 2005; UNEP/MAP 2017; Lange et al. 2020). Ancient civilisations therefore developed in the region, and

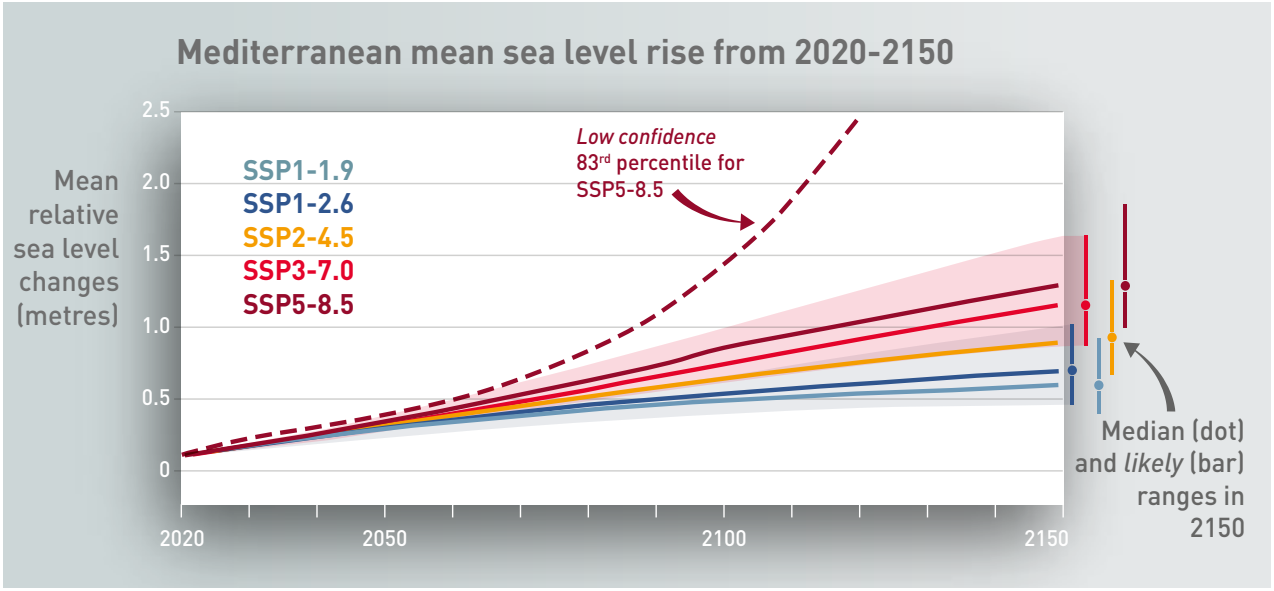


Figure 3.6 | Mean sea level rise projections for the Mediterranean Sea and six climate scenarios and the *likely* range. Source: Ali et al. (2022).

their remnants are now often listed on UNESCO's World Heritage list, with a high concentration of UNESCO World Heritage sites located in the immediate coastal zone (Cazenave 2014; Reimann et al. 2018b). Similarly, the Mediterranean coastal zone is densely populated, with almost one third of the total Mediterranean population (roughly 150 million people) living within 20 km of the coast, and approximately 10% (about 47 million) in the Low Elevation Coastal Zone (LECZ)[49] in 2010 (Reimann et al. 2021). Further, slightly more than half of the population in the LECZ lives in urban areas; however, these patterns differ considerably between Northern Mediterranean countries[50] (~77% urban) and Southern and Eastern Mediterranean countries[51] (~43% urban) (Reimann et al. 2021). Infrastructure such as ports, roads, and railways are therefore also concentrated in coastal locations (Piante and Ody 2015; Lagarias and Stratigea 2022).

The Mediterranean coastal zone has experienced rapid socio-economic growth in recent decades (EEA 2006; EEA and UNEP/MAP 2014; Piante and Ody 2015). This has been driven by the shipping, fishing and tourism industries, but also by lifestyle choices, with a high share of second home ownership in the region (Reimann et al. 2018a). With progressing urbanisation and continued attractiveness of the coastal zone for human settlements, the LECZ population is expected to grow between 10% (SSP4) and 130% (SSP3) by 2100 (compared to 2010), depending on the socio-economic scenario (Shared Socioeconomic Pathway, SSP; *Box 1*) (Reimann et al. 2021). However, if stringent coastal zone management is pursued, the LECZ population may decrease by 18% by 2100 (SSP1) (Reimann et al. 2018a). Future coastal population growth will differ substantially between the northern Mediterranean and southern and eastern Mediterranean countries *(Figure 3.7a)*, with an increase compared to 2010 in the LECZ population in the southern and eastern parts by 100 million under all SSPs. Furthermore, a large proportion of the future coastal population is expected to live in urban areas, with a substantial increase projected in the southern and eastern countries over the course of the 21st

[49] The LECZ covers all land up to 10 m elevation in hydrological connection to the sea (McGranahan et al. 2007; MacManus et al. 2021).

[50] Andorra, Croatia, Cyprus, France, Greece, Italy, Malta, Monaco, San Marino, Slovenia, Spain, the Vatican.

[51] Algeria, Albania, Bosnia and Herzegovina, Egypt, Israel, Lebanon, Libya, Montenegro, Morocco, Palestine, Syria, Tunisia, Türkiye.

century *(Figure 3.7b)* (Reimann et al. 2021). Moreover, urban areas are expected to undergo considerable expansion between 2012 and 2100. According to various urban development projections, the urban footprint in low-lying coastal areas (below 20 m) is expected to increase significantly, ranging from 67% for Italy to 104% for the Mediterranean coast of France (Wolff et al. 2020).

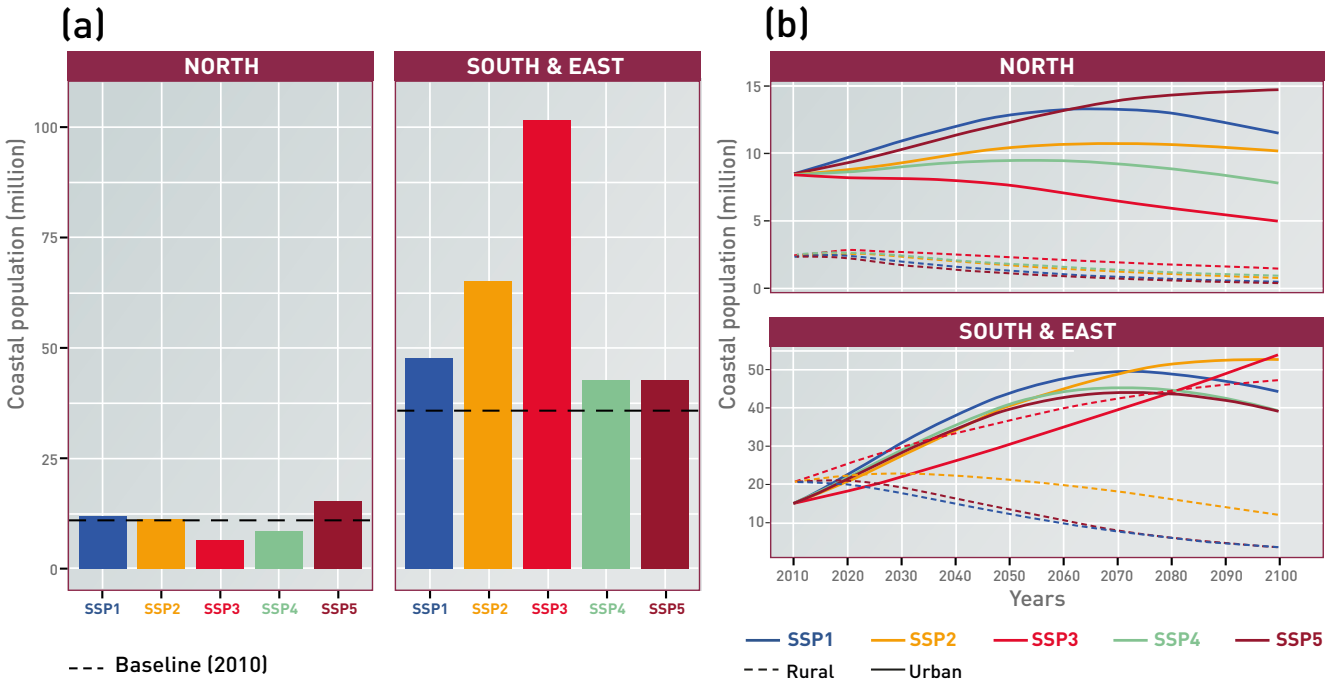


Figure 3.7 | Population in Low Elevation Coastal Zone (LECZ) by geographical region and Shared Socioeconomic Pathways (SSPs). (a) Population in 2100 relative to 2010; (b) Urban and rural population changes from 2010 to 2100. Figure adapted with minor adjustments from Reimann et al. (2021).

Box 3.1

The Shared Socioeconomic Pathways (SSPs)

The Shared Socioeconomic Pathways (SSPs) are one component of the current scenario framework in climate change research, which consists of climate scenarios (Representative Concentration Pathways, RCPs), socio-economic scenarios (SSPs), and climate policy scenarios (Shared Policy Assumptions, SPAs) (van Vuuren et al. 2014; O'Neill et al. 2020).

Five SSPs describe plausible alternative trends in global-scale societal development in the course of the 21st century based on their socio-economic challenges for climate change mitigation and adaptation (O'Neill et al. 2014). Each SSP has an underlying narrative that qualitatively describes a broad range of socio-economic developments in the form of a storyline (O'Neill et al. 2017). In SSP1, challenges are low as society develops sustainably; in SSP2, historic patterns in socio-economic development continue, leading to moderate challenges; SSP3 has high challenges due to resurgent nationalism and limited global cooperation; SSP4 has high adaptation challenges as inequalities are high within and across countries; and SSP5 is characterised by rapid economic growth based on fossil fuels, which leads to high challenges for mitigation *(Figure 3.8)*.

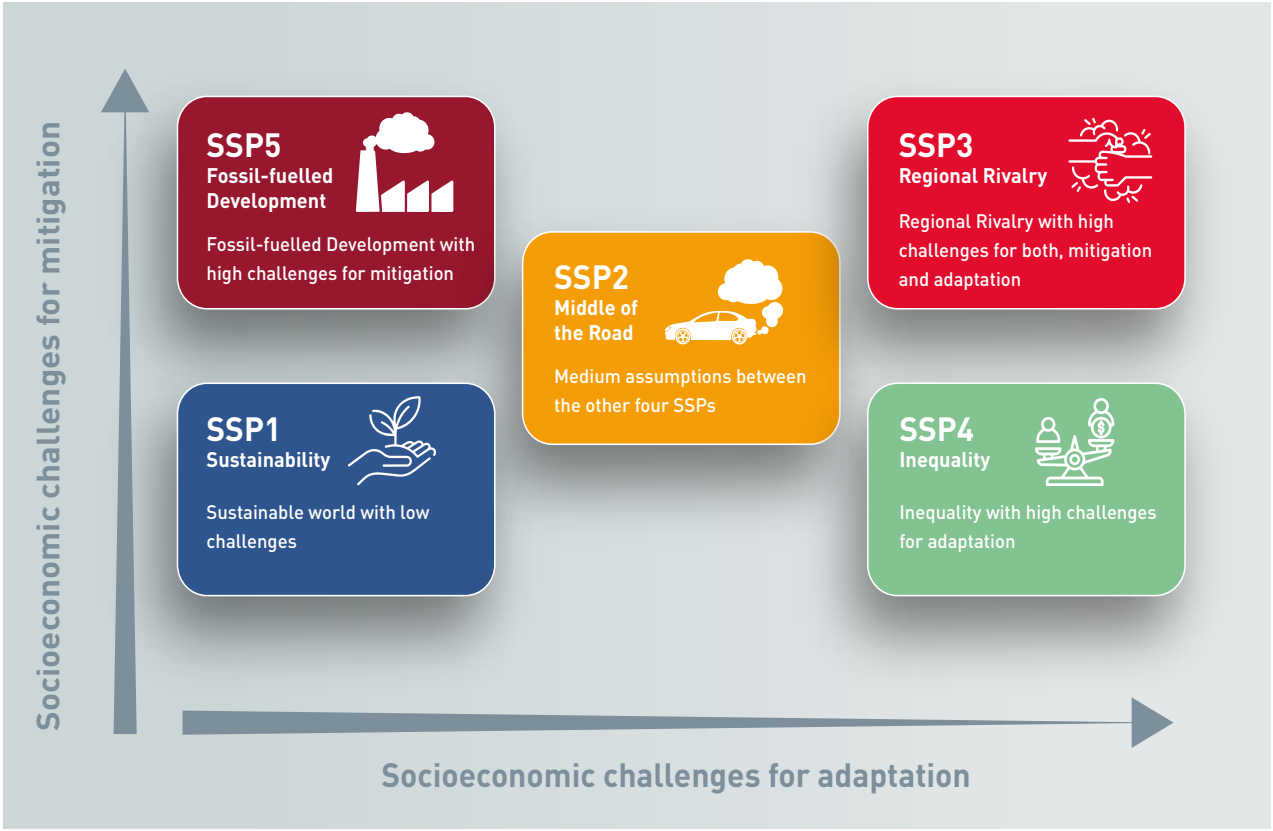


Figure 3.8 | Socio-economic challenges for climate change adaptation and mitigation. Figure modified from Reimann et al. (2023b).

3.4.3 Implications for conflict and migration

Socio-economic development will be a major driver of environmental change impacts on lives and livelihoods in coastal locations in the future (Reimann et al. 2023b), but current knowledge of this kind of feedback is still too limited. A recent study projects up to 20 million internal migrants by 2100 due to sea level rise if no adaptation strategies are implemented (Reimann et al. 2023a). In particular in the arid southern parts of the Mediterranean region, habitability is expected to decrease, putting pressure on population and settlements from two sides: the coast (due to sea level rise) and inland areas (due to desertification) (Reimann et al. 2018a; Clement et al. 2021). Furthermore, coastal flooding due to extreme sea levels may result in loss of life, temporary displacement, and permanent migration away from the coast as flooding becomes more frequent and intense, for example threatening the livelihoods of people due to a reduction in agricultural yields through saltwater intrusion *(Section 3.4.1)*. While few settlements will be directly threatened by progressing coastal erosion, coastal residents recognise the impact of coastal erosion on their daily lives and understand the anthropogenic causes of coastal erosion problems including change impacts (Tourlioti et al. 2021). Coastal erosion will *likely* have a considerable effect on the attractiveness of Mediterranean beaches for tourism purposes. Currently, about 80% of regional employment is directly related to the tourism sector (Manca and Santarossa 2016) and annual tourist arrivals are currently increasing, especially in North Africa and Europe (Mejjad et al. 2022).

Environmental change impacts on lives and livelihoods such as the examples discussed above are further exacerbated by considerable differences in governance and adaptive capacity across northern, eastern, and southern parts of the region (EEA and UNEP/MAP 2014; UNEP/MAP 2016; Cramer et al. 2018). While coastal adaptation planning is part of the Mediterranean Action Plan and the Integrated

Coastal Zone Management (ICZM) protocol in the Mediterranean[52], implementation has so far been limited and fragmented across the region, leaving poorer population groups vulnerable to climate change impacts in coastal areas, especially in the southern and eastern Mediterranean (Cramer et al. 2018). Future socio-economic development in the 21st century (i.e. SSPs) will considerably influence adaptation practices and coastal management. However, adaptive capacity is *likely* to continue to vary across northern, southern, and eastern parts of the region (Reimann et al. 2018a, 2021, 2023a). Additionally, coastal urban settings are more *likely* to be protected from the impacts of sea level rise due to the cost-effectiveness of protection measures in these locations (Lincke and Hinkel 2018). Coastal residents perceive beaches as a public common good but show an unwillingness to pay for coastal zone restoration and protection (Tourlioti et al. 2021). These examples of potential feedback between climate change and socio-economic development in coastal locations present a high potential for conflict and migration in the region.

[52] https://www.unep.org/unepmap/who-we-are/contracting-parties/iczm-protocol

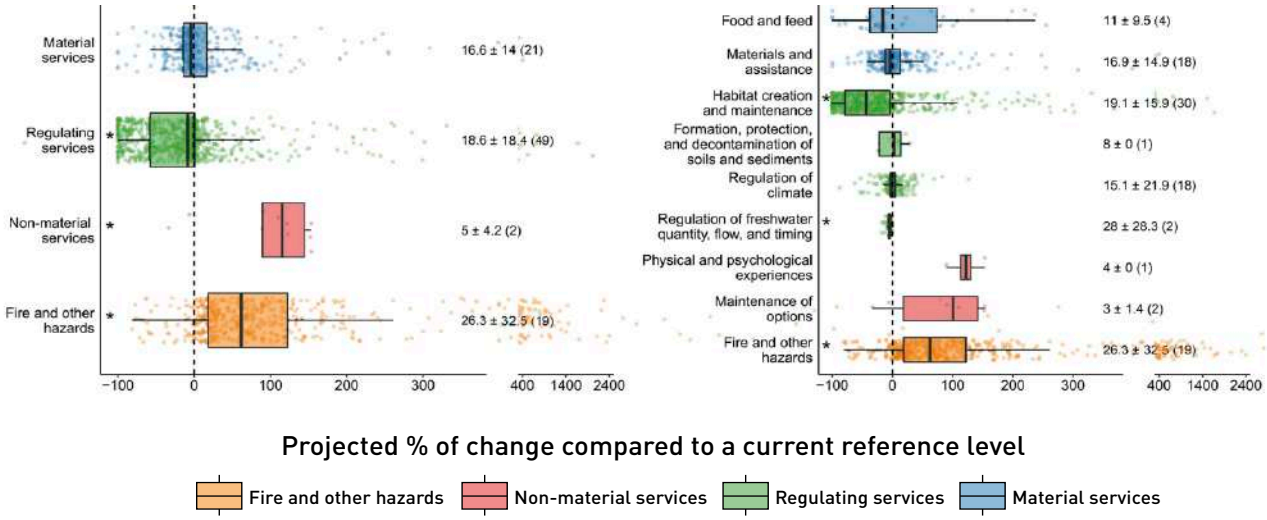


Figure 3.9 | Meta-analyses of projected percentage changes in ecosystem service groups and categories provided by Mediterranean forest ecosystems under 21st-century climate change. Numbers at the end of each box indicate the mean observations per study, standard deviation, and number of studies in the respective ecosystem service group (left) or category (right). Asterisks indicate that the median projected trend differs significantly from zero following the Wilcoxon signed-rank test. Figure adapted from Morán–Ordóñez et al. (2021).

3.5 Ecosystems

3.5.1 Historical and projected climate trends and their impacts on Mediterranean ecosystems

Mediterranean ecosystems (forest, freshwater, coastal, and marine) are vulnerable to environmental change. Within forest ecosystems, increased drought and heat stress arising from climate change are expected to particularly affect broadleaf and drought-sensitive tree species (e.g. *Fagus sylvatica, Castanea sativa,* and *Pinus nigra*) (Ochoa-Hueso et al. 2017; Morán–Ordóñez et al. 2021). In combination with a number of other direct or indirect climate change impacts, especially increases in the occurrence and intensity of wildfires (see also *Sections 1.1.2, 3.2.1, 3.3.1, 3.3.2*) and vulnerability to pests, such changes are therefore expected to hinder the delivery of a number of ecosystem services from forest ecosystems throughout the Mediterranean, especially regulating ecosystem services *(Figure 3.9)* (Morán–Ordóñez et al. 2021).

For freshwater ecosystems, climatic changes are predicted to impact water quantity in the Mediterranean region through significant declines in precipitation and runoff, low flows, and enhanced evaporation rates (Molina-Navarro et al. 2014; Bucak et al. 2017; Green et al. 2017; Coppens et al. 2020). Many freshwater ecosystems are *likely* to face temporary or permanent dry-out risks (e.g. within intermittent-flow rivers and ephemeral streams) (Nabih et al. 2021). In Greece, these changes will result in declining riverine flora and fauna due to reduced freshwater and sediment flows (López-Ballesteros et al. 2020). For wetlands, high-end climate change projections indicate a sharp decline in ecological status due to the impacts of drought, with only 26% of Mediterranean wetlands expected to remain in good ecological status by 2100 (Lefebvre et al. 2019). A decreased hydraulic load can lead to a reduction in nutrient loads and an increase in salinisation (Jeppesen et al. 2015; Yılmaz et al. 2021). In other locations, increased temperature and internal nutrients are likely to cause eutrophication and deteriorating water quality. Increased temperatures can furthermore enhance the ability of invasive species to colonise and outcompete native species and disrupt ecosystem functioning and integrity (Green et al. 2017; Carosi et al. 2021). An increased frequency of other extreme events (floods and heat waves) is also *likely* to affect fish fauna (Santiago et al. 2016; Jarić et al. 2019) and aquatic insects (Conti

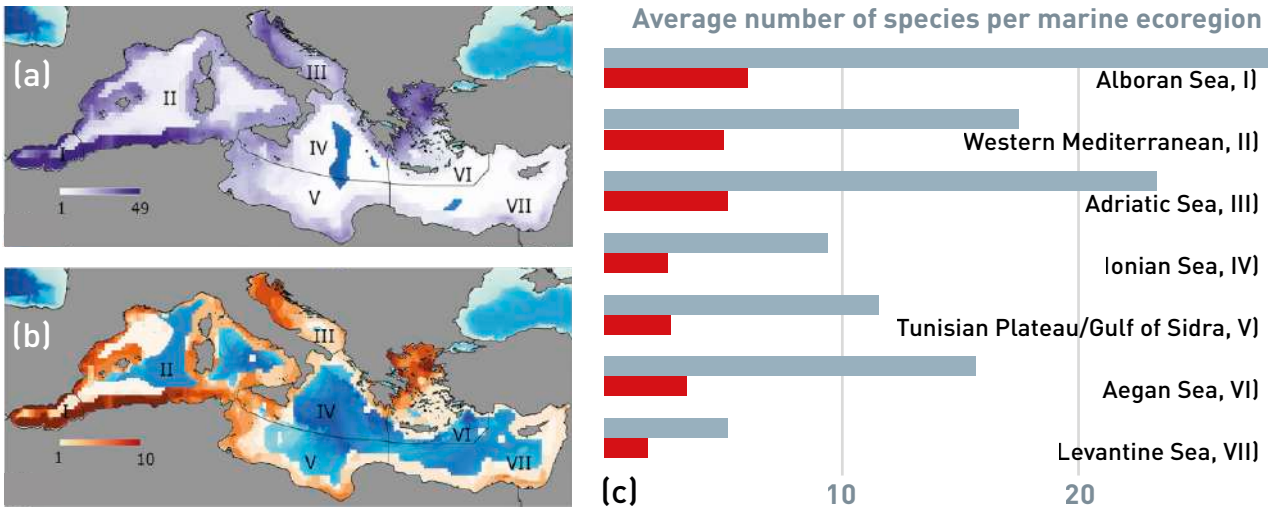


Figure 3.10 | Distribution of threatened marine species vulnerable to climate change throughout the Mediterranean Sea. Panel (a) highlights species with high climatic vulnerability, while panel (b) shows species that are highly exposed to ocean warming. The bar chart indicates the average number of species per region with high vulnerability (grey) and high exposure (red). Source: Chatzimentor et al. (2022).

et al. 2014). Furthermore, declines in the richness of African-Eurasian migratory and breeding waterbird species are forecast throughout the Mediterranean (Nagy et al. 2022). Overall, there is evidence of changing freshwater species ranges under climate change, and future projections foresee a shrinking of freshwater habitats (Pörtner et al. 2022).

Coastal ecosystems are vulnerable to a number of climate change stressors including increased heat stress, sea level rise, and salinisation *(Section 3.4)* (Santos et al. 2014; Erostate et al. 2020). Projections expect 60% of Mediterranean coastal areas to lose fish species by 2040, especially within the western Mediterranean, following increased sea surface temperatures (Clark et al. 2020). Substantial impacts are being additionally projected for subtidal seagrasses (and especially *Posidonia oceanica*). By 2100, seagrasses in the Mediterranean are at risk of functional extinction, with important repercussions for ecosystem services including carbon storage, habitat provisioning, and coastal protection (Chefaoui et al. 2018). Acidification of seawater due to anthropogenic climate change is further expected to contribute to coral bleaching and mortality (Santos et al. 2014).

The Mediterranean Sea has been identified as having one of the fastest changing sea surface temperatures globally, having already increased by 1.48°C over the 1982–2018 period (Azzurro et al. 2019). Beyond increasing average sea surface temperatures, climate change is also resulting in increases in the magnitude and frequency of marine heat waves, thereby disrupting the marine food chain (Moraitis et al. 2019) *(Section 3.2.1).* Risks of extinction and shifting species distributions are both projected for the region (Garrabou et al. 2021). This is due to increased temperatures affecting species growth, survival, and reproduction, and pushing some species to migrate both into and away from the Mediterranean Sea (Azzurro et al. 2019).

Species declines are being reported throughout the region with respect to the 1980s/1990s period (e.g. in coralligenous assemblages, cold-water species, and zooplankton) and have further been confirmed by declining fisheries landings (Kim et al. 2019; Garrabou et al. 2021; Chatzimentor et al. 2022). Importantly, 93 of 104 threatened species in the Mediterranean are experiencing species decline, largely occurring within the Alboran Sea, Adriatic Sea, and Western Mediterranean *(Figure 3.10)* (Chatzimentor et al. 2022). This is of particular significance given the high proportion of species endemism in the Mediterranean region (25–30%) (Garrabou et al. 2021), and the dependence of marine species on the survival of endemic reefs (Gómez–

Gras et al. 2021). More sessile species are expected to adapt and migrate as a consequence of climate change (Azzurro et al. 2019). The occurrence of new (tropical) species is predicted to increase in the region as a result of increased warming (Benedetti et al. 2019).

3.5.2 Beyond direct climate change impacts: indirect climatic effects and consequences of non-climatic environmental change

Terrestrial ecosystems across the Mediterranean have a long history of human alteration, which has more recently combined with and exacerbated climate change impacts. This is the case for air pollution and land degradation from nitrogen deposition and tropospheric ozone arising from activities associated with industry, agriculture, and transport (Ochoa-Hueso et al. 2017). Beyond pollution, changing land use and management in Mediterranean agroecosystems, and particularly agricultural abandonment resulting in shrub encroachment, also represent an important driver of increased fire risk in the region, and have been found to further amplify the effects of drought (Rolo and Moreno 2019; Elsen et al. 2022). Additionally, policy targets are altering forest management to ensure the delivery of services including carbon sequestration, bioenergy production, habitat provisioning, climate adaptation, and erosion regulation. The achievement of some or all of these targets is *likely* to induce more profound changes in Mediterranean forests than those ensuing from the impacts of environmental changes (Morán-Ordóñez et al. 2020).

Freshwater ecosystems have been, and are *likely* to be, adversely affected by anthropogenic drivers of environmental change beyond climate change, including water abstraction for irrigation and subsequent increases in salinisation. This may result in temporary or permanent habitat loss for freshwater species (Green et al. 2017), yet in some regions there is evidence that climate change has a greater effect on freshwater ecosystems than land use change dynamics (Bucak et al. 2017). Increased construction of dams and reservoirs has similar adverse implications for freshwater ecosystems as a result of reduced water quantity, sediment accumulation, and increased salinity downstream (Taylor et al. 2021). Pollution has an additional negative impact, including from nutrient enrichment associated with agriculture and urban pollution from suboptimal sewage treatment (Paredes et al. 2021; Pereda et al. 2021). These impacts all pose a threat to freshwater biodiversity in the Mediterranean and its endemic fish species, which are reported to have undergone declines in the past few decades (Meke et al. 2012; Yeğen et al. 2015; Küçük et al. 2016; MWO 2018).

Mediterranean coastal ecosystems are impacted by a range of non-climatic drivers of environmental change due to the high population density and anthropogenic activity within coastal regions, and climate change is therefore largely exacerbating pre-existing pressures and risks (*Section 3.4*; Santos et al. 2014). Over-development of coastal Mediterranean regions is placing pressure on coastal lagoons and aquifers both via reduced water availability and through increased pollution, each stemming from often unregulated residential, industrial, and agricultural withdrawals and emissions (Drius et al. 2019; Erostate et al. 2020; Llorca et al. 2020). River discharge is also an increasing source of pollution, and the primary cause of eutrophication in coastal waters, resulting in algal blooms and hypoxia, especially within the Adriatic and Aegean seas, with adverse impacts on endemic species (Macias et al. 2018; Ontoria et al. 2019). Two additional important pressures on coastal ecosystems are the increased presence of invasive species, in particular from the Red Sea (Zamir et al. 2018), and overfishing (Albouy et al. 2013). Drivers of change are also situated upstream of coastal areas, where dams for irrigation or hydropower generation are reducing sediment flow to the coastline with implications for deltas and coastal zones.

Increases in the number of non-indigenous species in the Mediterranean are also the result of marine traffic (primarily through the Suez Canal), aquaculture, and the aquarium trade (Azzurro et al. 2019). Further drivers of marine ecosystem change in the region are overfishing, eutrophication, and ship collisions (Garrabou et al. 2021; Chatzimentor et al. 2022). While Marine Protected Areas (MPA) across the Mediterranean have been found to be effective in safeguarding marine ecosystems, concerns have been raised over a lack of monitoring, and more rigorous consideration of the impacts of environmental change. This should be taken into consideration in addition to expanding the MPA network beyond the north-western Mediterranean (Benedetti et al. 2019;

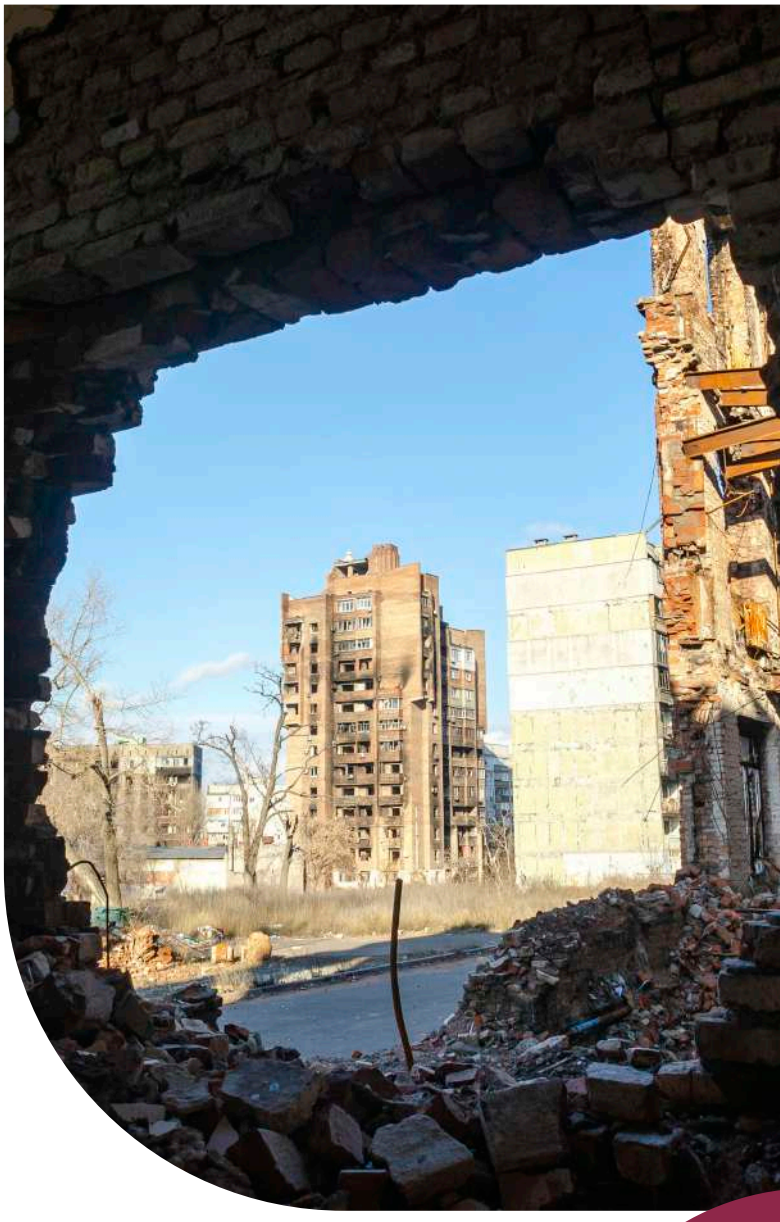
Garrabou et al. 2021). Climatic and non-climatic impacts on Mediterranean marine ecosystems are likely to affect regional livelihoods, not only through maintaining food provisioning, but also through impacts on tourism and coastal protection (Garrabou et al. 2021).

3.5.3 Summary: implications for livelihoods, migration, and conflict

A deterioration in the state of freshwater, coastal, marine, and terrestrial ecosystems of the Mediterranean will result in a reduced supply of ecosystem services, and therefore lead to adverse impacts on human well-being. Some of these impacts will lead to lost incomes and livelihoods, primarily as a result of declining agricultural yields (including from increased coastal salinisation and declining irrigation capabilities), reduced forest productivity due to the deteriorating health and growth rate of trees, declining fish stocks, disrupted port operations, and reduced tourism opportunities across all ecosystems, and in coastal areas in particular (Ali et al. 2022). Depending on the severity of the impact, existing options for ecosystem resilience through adaptation, and opportunities for livelihood diversification, these trends have the potential to result in permanent forms of displacement as people are forced to seek alternative livelihood opportunities.

Because of this variation in adaptation capacities and vulnerabilities (in addition to the scale of environmental pressures), implications for livelihoods are not uniform throughout the Mediterranean region. A key area of concern is the Nile Delta in Egypt, where sea level rise and increased desertification are gradually eroding some of the region's most productive ecosystems (Warner et al. 2010). In some cases, regions facing this kind of gradually progressing ecosystem deterioration have started exploring possibilities for relocation (e.g. to upland metropolitan areas, as discussed for coastal regions in Spain in Fatorić et al. (2017)). This is usually perceived as a last-resort option by vulnerable populations, including those at greatest risk of livelihood loss, residential damage, and health effects (Fatorić et al. 2017). Displacement and migration are also likely to occur in regions at high risk of ecosystem disruption from destructive hazards, including flooding and wildfire.

Assessing the impacts of climate and environmental change through an ecosystem services lens makes it possible to identify dependencies of multiple functions and (economic) sectors on key ecosystem properties, and therefore reveals areas of potential competition and conflict. Competing claims on Mediterranean wetlands have, for example, been identified in terms of biodiversity conservation, flood protection, hydropower generation, and irrigated agriculture (Pulido-Velazquez et al. 2023). When situated across transboundary areas, these claims can furthermore become a cause of international tension (Taylor et al. 2021). Coastal areas are similarly under pressure to deliver multiple ecosystem services as a result of a high concentration of people and economic activity, and may therefore also see increased competition and conflict following a deterioration in their ecological state (Fatorić et al. 2017).



3.6 Energy

3.6.1 Environmental change impacts on the energy sector

Environmental changes are expected to impact the energy sector, including production, transportation, distribution, and final end use *(Table 3.2).* Furthermore, increasing temperatures and extreme weather conditions will increase the dependency on ever increasing energy consumption to improve indoor environmental conditions.

The use of energy represents by far the largest source of greenhouse gas emissions from human activities, as three-quarters of global greenhouse gas emissions are linked to burning fossil fuels for energy used for various purposes. Climate change puts energy security at risk, as it affects many facets of the energy cycle including production. This is particularly relevant with regard to the energy demand for space cooling in buildings and industry to maintain acceptable indoor conditions. In addition, the entire infrastructure of the energy industry — power plants, grids, transport facilities, etc. — is put under stress due to increasing temperatures and extreme weather conditions. Finally, climate change can alter energy generation potential, because, for example, changes in the water cycle affect the ability to generate hydropower, and the effective cooling of nuclear power plants.

Thermoelectric plants burn hydrocarbons (coal, oil, natural gas) or utilise nuclear fuels to operate the thermodynamic cycle of power production. These plants require large amounts of water for electricity generation, mainly for cooling purposes, making their performance and cooling capacity strongly dependent on and highly sensitive to reduction in water availability as a result of environmental change (Förster and Lilliestam 2010; Attia 2015; Lee et al. 2018; Petrakopoulou et al. 2020). Renewable energy sources (RES) (solar, wind, geothermal, biomass, and hydro) are also significantly affected by climate change. Not only do long-term variations in solar and wind energy availability need to be reassessed under changing climate conditions, but the actual operation of solar photovoltaics, wind turbines, and other RES plants is also affected (Yang et al. 2022).

While the efficiency of solar panels decreases with increasing ambient temperature, hampering their energy output, increasing solar irradiance is expected to partly compensate for this effect (Dubey et al. 2013; Panagea et al. 2014; Jerez et al. 2015).

Wind turbines may experience unforeseen pressures from climate change-induced extreme wind situations and consequently suffer from a loss of structural stability and resilience. Atmospheric conditions enter into the design and operation of wind turbines and wind farms, and, for example, a small variation in wind speed usually has a sizeable impact on energy output (Pryor and Barthelmie 2010).

Geothermal energy is practically independent of climate factors. Simulation results however indicate that about 10% of operating hours may require additional technical measures, like peak source support, smart management, and buffers to limit pumping ramp rate (Ciapała et al. 2021). Management of geothermal energy production can therefore utilise modern techniques to smooth production in accordance with demand fluctuations.

Bioenergy has been promoted as a renewable energy policy component offering an alternative to fossil fuels, with climate change mitigation benefits. However, these benefits have come under scrutiny, and research has focused on the long payback times for forest-based bioenergy, and indirect effects on land use and food production, biodiversity loss, and land degradation (Koponen et al. 2018). Various attempts to quantify the environmental-change effects of bioenergy systems have been made, and results vary due to the different treatment of biogenic carbon fluxes and other considerations (Brandão et al. 2019). Increases in ambient temperatures may increase biomass forest production, especially in northern latitudes. However, for the Mediterranean Basin, the expected decrease in precipitation will reduce, if not reverse, any positive effects (Poudel et al. 2011; Peñuelas et al. 2017).

Hydropower is a renewable, low-emission source of electricity, and it contributes significantly to the reduction of GHG emissions and energy supply security. However, as it relies on sufficient and predictable surface water flows, environmental changes are likely to alter river discharges, impacting water availability and ultimately hydropower generation (Berga 2016) . The impacts of climate change on hydropower development are

complex, and their effects depend on factors such as local hydrological conditions and geographic features (Shu et al. 2018; Wasti et al. 2022). Extended droughts in an area like the Mediterranean Basin (Ozkaya and Zerberg 2019; Altın et al. 2020) are likely to lead to decreasing hydropower generation and a complete collapse, if reservoir levels fall below intake structures.

Battery storage systems are needed, because renewable energy, especially solar and wind, are not always available, and demand can outpace supply. A power grid (which is an extensive system), and the need for efficient storage of vast amounts of electrical energy entails significant investments in electricity storage, that is in battery units (Jones et al. 2020).

Examples of sector-specific impacts

Coal mining. Climate hazards such as heavy precipitation, drought, and heat induced by climate change will become more frequent and intense, increasing the physical challenges to mining operations, altering the water supply to mining sites, and disrupting operations. Mining regions not accustomed to water stress are projected to become increasingly vulnerable. Flooding from extreme rains can also cause operational disruptions, including mine closure, washed-out roads, and unsafe water in tailing dams. Extreme weather combined with sea level rise can damage processing or transportation infrastructure located near coastlines. Widespread decarbonisation efforts across industries could create major shifts in commodity demand for the mining industry (Rüttinger and Sharma 2016).

Petroleum operations. Oil and gas infrastructure, especially near coasts and offshore, face increasing challenges and impacts from environmental change and extreme weather conditions, which also increases the risk of associated oil spills. The key climate change drivers in coastal and offshore regions can be characterised as air and water temperature, precipitation, sea level rise, and extreme storm events (Dong et al. 2022).

Grid infrastructure. Changing environmental operating conditions impact infrastructure utilisation and performance *(Table 3.3).* Climate trends will transform the performance and risk exposure of grid assets. Building a system that could operate reliably in any possible climate future may imply prohibitive costs and prove unnecessary. Certain risks should therefore be accepted (Sathaye et al. 2013; Panteli and Mancarella 2015; Brockway and Dunn 2020).

Energy demand. Electricity is set to become the main energy carrier, accounting for over 50% of total final energy consumption by 2050 in the 1.5°C scenario. Renewable energy deployment, improvements in energy efficiency, and the electrification of end-use sectors are expected to contribute to this shift. In addition, modern biomass and hydrogen are both likely to play more significant roles, providing 16% and 14% of total final energy consumption by 2050, respectively (IRENA 2023). The energy consumption of buildings accounts for over 40% of energy demand in the EU, and climate change impacts pose a number of challenges for the building sector. It is primarily the increase in ambient temperature, and the subsequent need for increased air-conditioning usage, that is considered the main challenge and impact on demand for electricity (Angeles et al. 2018; Bazazzadeh et al. 2021; Colelli et al. 2022).

3.6.2 Implications for livelihoods, migration, and conflict

The pursuit of improved living conditions leads to increasing energy consumption, with an ever-increasing demand for wet appliances (washing machines, dishwashers, etc.), cold appliances (fridges, freezers, air conditioners, etc.), consumer electronics, lighting, and cooking. Climate change, with its soaring temperatures and frequent extreme weather conditions, is going to have an even greater impact on energy needs, especially in areas of the southern Mediterranean Sea, which already face strong migration pressures. These pressures are expected to increase. While the generation of sufficient electricity has to be seen in the context of the energy-water nexus, the stable provision of energy to the consumers will depend on a functional energy infrastructure. Consequently, these objectives may be associated with potential conflict among populations striving to obtain energy and water resources (Lucca et al. 2023)

The IEA World Energy Outlook 2023 shows an ever-present risk of disruption in energy supply, due to the unsettled global economy. Russia's invasion of Ukraine and conflicts in the Middle East make

for a world energy situation that runs counter to a smooth energy transition process, while geopolitics focuses on the energy markets, especially for oil and natural gas. This is counterbalanced to some extent by the lowering of photovoltaic prices, the green hydrogen economy, and the efforts of many countries to implement a strategy to break away from fossil fuel subsidies. A new, clean energy economy seems to be emerging, with solar PV, electric vehicles, and subsequent investment in clean energy technologies on the rise. In addition, green hydrogen has the potential to act as a catalyst for sustainable development in developing countries (UNIDO et al. 2024).

Table 3.2 | The energy cycle schematic, and the main areas of climate change impact on its operation.

THE ENERGY CYCLE			
SUPPLY SIDE	**PRODUCTION**	**TRANSPORT**	**DEMAND SIDE**
Coal, Oil, Natural gas, Nuclear	Power stations, PV parks, Wind parks	Electricity grid, Oil tankers, Pipelines	Buildings, Transport, Industry
Solar energy, Wind energy, Geothermal, Biomass, Hydraulic			
CLIMATE CHANGE AREAS OF IMPACT			
Construction, Mining, Drilling, Fuel transport	Power operation, Land use, Water use, Maintenance	Grid operation, Shipping, Maintenance	Operation, Maintenance, Replacing

Table 3.3 | Examples of climate change effects on the electricity.

GENERATION	TRANSMISSION	DISTRIBUTION
Decreasing availability of water may affect the generation of hydroelectricity, the efficiency of PV farms, and the operation of thermal power stations	Warmer temperatures and heat waves can reduce the transmission capacity of lines and put pressure on substations	Heat waves and more frequent and intense wildfires can damage distribution lines, transformers, and substations

3.7 Interactions between sectors

There are strong linkages between migration, water availability, food production, coastal ecosystems and development, public health, the energy sector, and environmental change. Climate change affects water availability, food security, and therefore human health through the increased occurrence of climate hazards such as drought, floods, and heat waves *(Figure 3.11)*. The effects of such processes are more apparent in the Mediterranean's southern and eastern regions, where lower precipitation and less advanced irrigation technologies make it difficult to meet agricultural needs and rising demands for food and water. Population is projected to increase in these regions up to 2100 under all socio-economic scenarios (SSPs) compared to 2010. The coastal Mediterranean region's high level of urbanisation will worsen conditions in cities because of the 'urban heat island effect'. This will result in increased demand for water to maintain green spaces in cities. In addition, more energy will be needed for space cooling in order to maintain acceptable indoor living conditions, particularly for the most vulnerable populations — the elderly, the sick, pregnant women, and children. Marine heat waves, which persist longer and become hotter, are predicted to put the fishing industry at medium to high risk, since they reduce productivity and revenue.

Over-development of coastal Mediterranean regions is placing pressure on coastal lagoons and aquifers both via reduced water availability, and through increased pollution, each stemming from often unregulated residential, industrial, and agricultural withdrawals and emissions. Land losses in coastal deltas are projected to be intensified by mean sea level rise. Increases in the number of invasive species in the Mediterranean are only partly the result of climate change disruptions to sea temperatures, and are more significantly linked to marine traffic.

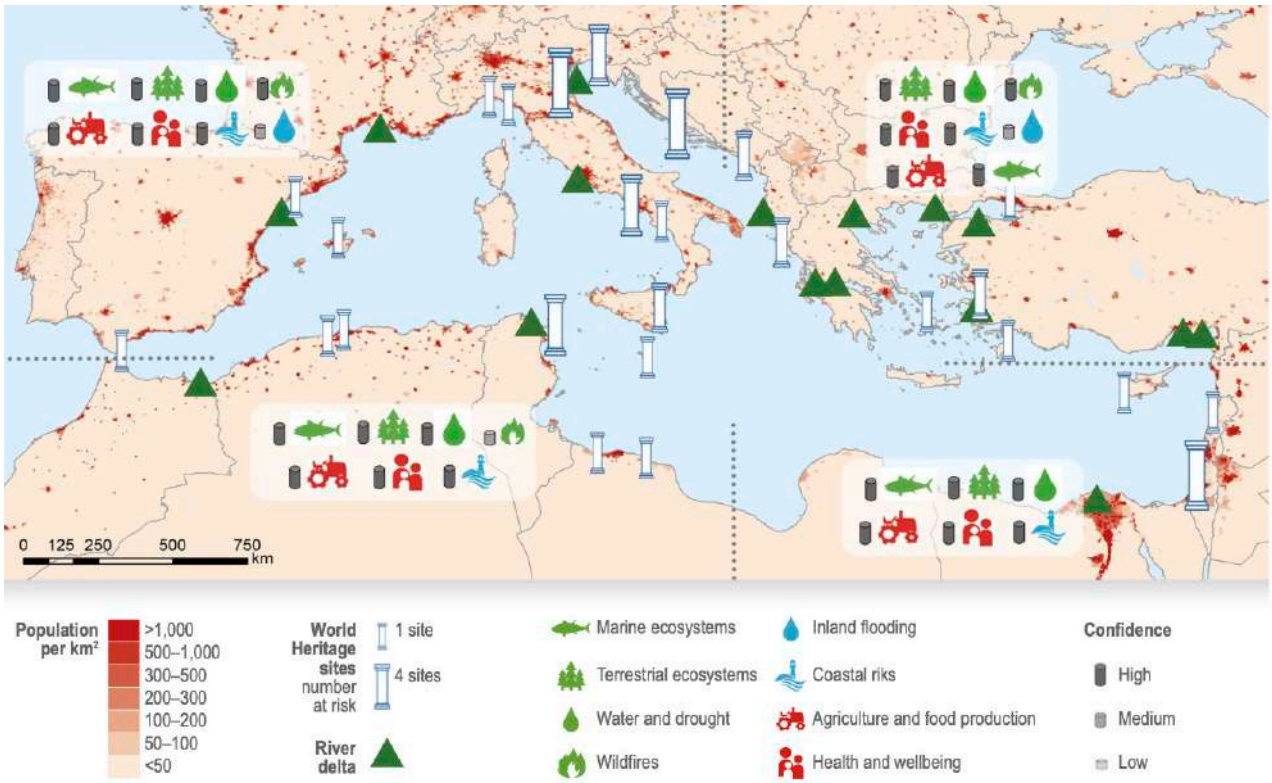


Figure 3.11 | Key risks in the Mediterranean and their location across the Mediterranean region for SSP5-RCP8.5 by 2100. Source: Figure CCP4.7 from Ali et al. (2022), based on: Reimann, Merkens, et al. 2018; Reimann, Vafeidis, et al. 2018; Wolff et al. 2018 (see Sections CCP4.3.2–6 and Tables SMCCP4.2a and b in Ali et al. 2022 for details). Risks to World Cultural Heritage sites from flooding or erosion due to sea level rise in multiple locations (Section CCP4.3.5 in Ali et al. 2022), and Mediterranean river deltas are hotspots of vulnerability to climate change (Section CCP4.3.2 in Ali et al. 2022). The population exposed to risks is mapped for an SSP5-RCP8.5 pathway. Adaptation can reduce these risks (Section CCP4.4 in Ali et al. 2022).

Relative sea level rise will not only affect coastal populations and ecosystems due to the gradual submergence of low-lying land but will also result in more frequent and intense coastal flooding and erosion due to extreme sea levels (Burak et al. 2024). Habitability is predicted to decline, particularly in the dry southern Mediterranean region. This will put pressure on people and settlements from both the coast (because of sea level rise) and inland areas (due to desertification). Furthermore, as coastal flooding increases in frequency and intensity due to extreme sea levels, it may lead to human deaths, temporary displacement, and permanent population movement away from the coast. Seawater intrusion into coastal aquifers and soils associated with sea level rise may affect around 30% of irrigated farmlands. Several delta areas are already considered to have salt-affected soils, and coastal aquifers may be salinised, which could endanger people's livelihoods by lowering agricultural yields, restricting access to safe drinking water, and decreasing profits from the tourism industry.

Extreme weather conditions affect conventional energy production operations such as coal mining and oil and natural gas drilling. Power plants, which depend on substantial amounts of cooling water, are *likely* to have to be adjusted to operate at different temperature levels with reduced efficiency. Also, extreme weather conditions alter and affect the renewable energy production of solar photovoltaics, wind turbines, hydroelectricity plants (rivers, lakes, dams), and biomass production. Environmental changes are expected to impact transport networks, including electricity networks, and also the transport of conventional fuels. Overhead cables and pylons for electricity transmission are particularly vulnerable to increasing temperatures and erratic wind conditions. At the user end, climate change will, among other things, alter weather conditions in many areas around the planet, increasing temperatures and changing wind conditions and precipitation patterns. This will affect living conditions and therefore energy dependence for the vast majority of the population.

Conflicts and human migration, driven by a combination of climate-related and non-climate related factors, have significant implications for public health in the Mediterranean Basin. Conflicts

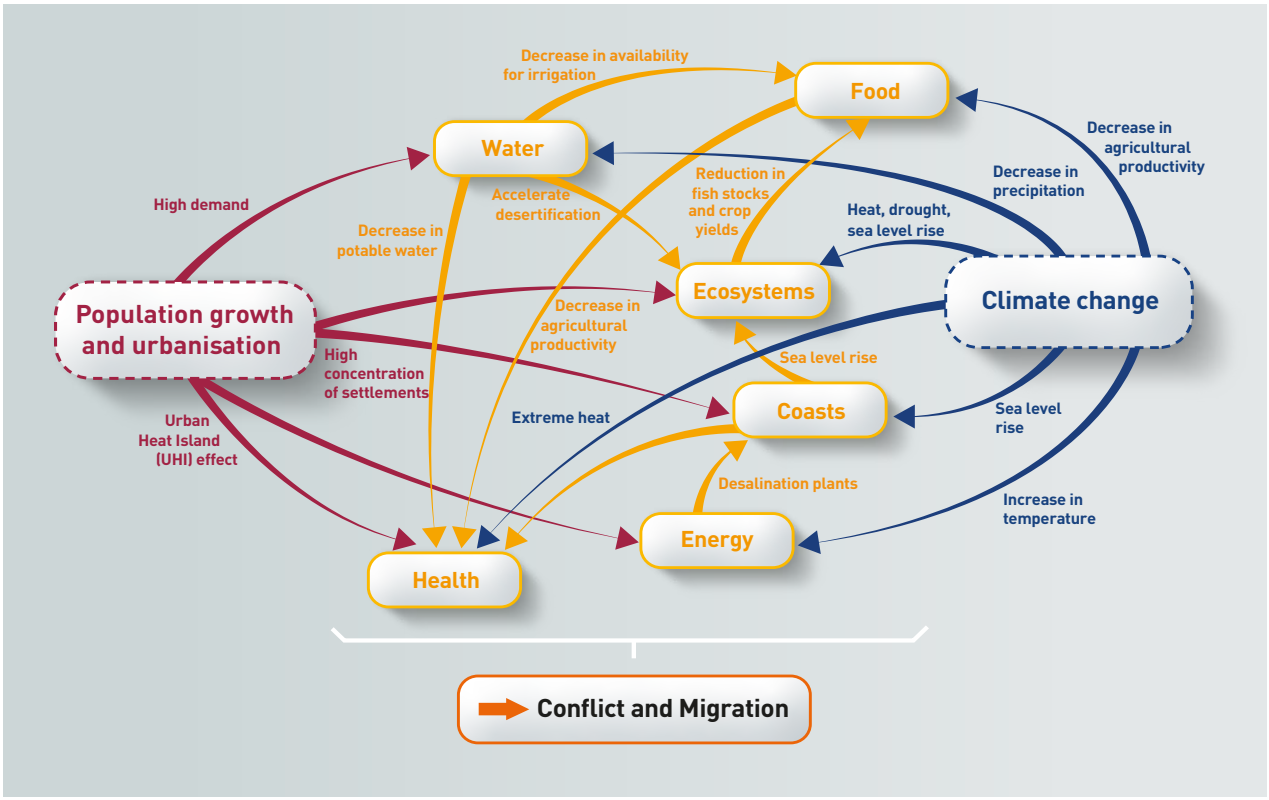


Figure 3.12 | Links between climate change and socio-economic changes and their consequences for the individual sectors.

beyond the Mediterranean region (for example the Ukraine war) can have indirect consequences for the health of Mediterranean populations. Immigrants and refugees face disproportionately high rates of poverty and inadequate living conditions in their destination countries. The elderly, the chronically ill, people who work outdoors, and those from low-income backgrounds are particularly susceptible.

In summary, the different sectors discussed in this chapter are affected by both environmental changes and socio-economic changes across the Mediterranean region. The impacts on these sectors are highly interconnected *(Figure 3.12)*, therefore resulting in compounding stresses on human livelihoods. The interaction of impacts across sectors, and their compounding effects, have the potential to become triggers for conflict and migration across the region.

References

Abd-Elmabod S. K., Muñoz-Rojas M., Jordán A., Anaya-Romero M., Phillips J. D., Jones L., Zhang Z., Pereira P., Fleskens L., and van Der Ploeg M. (2020). Climate change impacts on agricultural suitability and yield reduction in a Mediterranean region. *Geoderma*, *374*, 114453. doi: 10.1016/j.geoderma.2020.114453

Abubakar I., Aldridge R. W., Devakumar D., Orcutt M., Burns R., Barreto M. L., Dhavan P., Fouad F. M., Groce N., Guo Y., Hargreaves S., Knipper M., Miranda J. J., Madise N., Kumar B., Mosca D., McGovern T., Rubenstein L., Sammonds P., … Zhou S. (2018). The UCL–Lancet Commission on Migration and Health: the health of a world on the move. *The Lancet*, *392*(10164), 2606–2654. doi: 10.1016/S0140-6736(18)32114-7

Aguilera E., Díaz-Gaona C., García-Laureano R., Reyes-Palomo C., Guzmán G. I., Ortolani L., Sánchez-Rodríguez M., and Rodríguez-Estévez V. (2020). Agroecology for adaptation to climate change and resource depletion in the Mediterranean region. A review. *Agricultural Systems*, *181*, 102809. doi: 10.1016/j.agsy.2020.102809

Agulles M., Jordà G., and Lionello P. (2021). Flooding of Sandy Beaches in a Changing Climate. The Case of the Balearic Islands (NW Mediterranean). *Frontiers in Marine Science*, *8*, 760725. doi: 10.3389/fmars.2021.760725

Ahmed S., Saad-Hussein A., Feel A., and Hamed M. (2014). Time series trend of Bilharzial bladder cancer in Egypt and its relation to climate change: A study from 1995-2005. *International Journal of Pharmaceutical and Clinical Research*, *6*, 46–53. https://www.researchgate.net/publication/281104879_Time_series_trend_of_Bilharzial_bladder_cancer_in_Egypt_and_its_relation_to_climate_change_A_study_from_1995-2005

Al Ibraheem B., Kira I. A., Aljakoub J., and Al Ibraheem A. (2017). The health effect of the Syrian conflict on IDPs and refugees. *Peace and Conflict: Journal of Peace Psychology*, *23*(2), 140–152. doi: 10.1037/pac0000247

Albouy C., Guilhaumon F., Araújo M. B., Mouillot D., and Leprieur F. (2012). Combining projected changes in species richness and composition reveals climate change impacts on coastal Mediterranean fish assemblages. *Global Change Biology*, *18*(10), 2995–3003. doi: 10.1111/j.1365-2486.2012.02772.x

Albouy C., Guilhaumon F., Leprieur F., Lasram F. B. R., Somot S., Aznar R., Velez L., Le Loc'h F., and Mouillot D. (2013). Projected climate change and the changing biogeography of coastal Mediterranean fishes. *Journal of Biogeography*, *40*(3), 534–547. doi: 10.1111/jbi.12013

Al-Delaimy W. K. (2020). Vulnerable Populations and Regions: Middle East as a Case Study. In W. Al-Delaimy, V. Ramanathan, & M. Sánchez Sorondo (Eds.), *Health of People, Health of Planet and Our Responsibility* (pp. 121–133). Springer, Cham. doi: 10.1007/978-3-030-31125-4_10

Ali E., Cramer W., Carnicer J., Georgopoulou E., Hilmi N. J. M., Le Cozannet G., and Lionello P. (2022). Cross-Chapter Paper 4: Mediterranean Region. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 2233–2272). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009325844.021

Al-Salem W. S., Pigott D. M., Subramaniam K., Haines L. R., Kelly-Hope L., Molyneux D. H., Hay S. I., and Acosta-Serrano A. (2016). Cutaneous Leishmaniasis and Conflict in Syria. *Emerging Infectious Diseases*, *22*(5), 931–933. doi: 10.3201/eid2205.160042

Altın T. B., Sarış F., and Altın B. N. (2020). Determination of drought intensity in Seyhan and Ceyhan River Basins, Turkey, by hydrological drought analysis. *Theoretical and Applied Climatology*, *139*(1–2), 95–107. doi: 10.1007/s00704-019-02957-y

Amengual A., and Borga M. (2020). Hydrometeorological analysis of an extreme flash-flood: the 28 September 2012 event in Murcia, south-eastern Spain. In W. Leal Filho, G. Nagy, M. Borga, P. Chávez Muñoz, & A. Magnuszewski (Eds.), *Climate Change, Hazards and Adaptation Options: Handling the Impacts of a Changing Climate* (pp. 3–26). Springer, Cham. doi: 10.1007/978-3-030-37425-9_1

Andreadis O., Chatzipavlis A., Hasiotis T., Monioudi I., Manoutsoglou E., and Velegrakis A. (2021). Assessment of and adaptation to beach erosion in islands: An integrated approach. *Journal of Marine Science and Engineering*, *9*(8), 859. doi: 10.3390/jmse9080859

Angeles M. E., González J. E., and Ramírez N. (2018). Impacts of climate change on building energy demands in the intra-Americas region. *Theoretical and Applied Climatology*, *133*(1–2), 59–72. doi: 10.1007/s00704-017-2175-9

Attia S. I. (2015). The influence of condenser cooling water temperature on the thermal efficiency of a nuclear power plant. *Annals of Nuclear Energy*, *80*, 371–378. doi: 10.1016/j.anucene.2015.02.023

Azzurro E., Sbragaglia V., Cerri J., Bariche M., Bolognini L., Ben Souissi J., Busoni G., Coco S., Chryssanthi A., and Fanelli E. (2019). Climate change, biological invasions, and the shifting distribution of Mediterranean fishes: A large-scale survey based on local ecological knowledge. *Global Change Biology*, *25*(8), 2779–2792. doi: 10.1111/gcb.14670

Barbero R., Abatzoglou J. T., Pimont F., Ruffault J., and Curt T. (2020). Attributing increases in fire weather to anthropogenic climate change over France. *Frontiers in Earth Science*, *8*, 104. doi: 10.3389/feart.2020.00104

Bazazzadeh H., Nadolny A., and Safaei S. S. H. (2021). Climate Change and Building Energy Consumption: A Review of the Impact of Weather Parameters Influenced by Climate Change on Household Heating and Cooling Demands of Buildings. *European Journal of Sustainable Development*, *10*(2), 1–12. doi: 10.14207/ejsd.2021.v10n2p1

Bellafiore D., Ferrarin C., Maicu F., Manfè G., Lorenzetti G., Umgiesser G., Zaggia L., and Levinson A. V. (2021). Saltwater Intrusion in a Mediterranean Delta Under a Changing Climate. *Journal of Geophysical Research: Oceans*, *126*, e2020JC016437. doi: 10.1029/2020jc016437

Belivermis, M., Camuffo, D., Caiola, N., Ferrari, C., Mhammdi, N., Romero, E., Wolff, C., 2024: Drivers and their Interactions. In S. Djoundourian, P. Lionello, M. C. Llasat, J. Guiot, W. Cramer, F. Driouech, J. C. Gattacceca, & K. Marini (Eds.), *Climate and environmental coastal risks in the Mediterranean* (pp. 71–130). MedECC Reports. MedECC Secretariat, Marseille, France. doi: 10.5281/zenodo.15096232

Bellizzi S., Lane C., Elhakim M., and Nabeth P. (2020). Health consequences of drought in the WHO Eastern Mediterranean Region: hotspot areas and needed actions. *Environmental Health*, *19*(1), 114. doi: 10.1186/s12940-020-00665-z

Ben Rais Lasram F., Guilhaumon F., Albouy C., Somot S., Thuiller W., and Mouillot D. (2010). The Mediterranean Sea as a 'cul-de-sac' for endemic fishes facing climate change. *Global Change Biology*, *16*(12), 3233-3245. doi: 10.1111/j.1365-2486.2010.02224.x

Benedetti F., Ayata S., Irisson J., Adloff F., and Guilhaumon F. (2019). Climate change may have minor impact on zooplankton functional diversity in the Mediterranean Sea. *Diversity and Distributions*, *25*(4), 568–581. doi: 10.1111/ddi.12857

Benoit G., and Comeau A. (Eds.) (2005). *A sustainable future for the Mediterranean*. Routledge, London. doi: 10.4324/9781849770323

Berga L. (2016). The Role of Hydropower in Climate Change Mitigation and Adaptation: A Review. *Engineering*, *2*(3), 313–318. doi: 10.1016/j.eng.2016.03.004

Berry P., Enright P. M., Shumake-Guillemot J., Villalobos Prats E., and Campbell-Lendrum D. (2018). Assessing Health Vulnerabilities and Adaptation to Climate Change: A Review of International Progress. *International Journal of Environmental Research and Public Health*, *15*(12), 2626. doi: 10.3390/ijerph15122626

Besset M., Anthony E. J., and Sabatier F. (2017). River delta shoreline reworking and erosion in the Mediterranean and Black Seas: The potential roles of fluvial sediment starvation and other factors. *Elementa: Science of the Anthropocene*, *5*, 54. doi: 10.1525/elementa.139

Blanco-Penedo I., Velarde A., Kipling R. P., and Ruete A. (2020). Modeling heat stress under organic dairy farming conditions in warm temperate climates within the Mediterranean basin. *Climatic Change*, *162*(3), 1269–1285. doi: 10.1007/s10584-020-02818-y

Blinda M. (2008). Resources and Water Demand. Forecasts for the Future of Water in the Mediterranean. In *IEMed Mediterranean Yearbook* (pp. 71–80). European Institute of the Mediterranean. https://www.iemed.org/publication/resources-and-water-demand-forecasts-for-the-future-of-water-in-the-mediterranean

Bonaduce A., Pinardi N., Oddo P., Spada G., and Larnicol G. (2016). Sea-level variability in the Mediterranean Sea from altimetry and tide gauges. *Climate Dynamics*, *47*(9–10), 2851–2866. doi: 10.1007/s00382-016-3001-2

Bozo M., Khudari H., and Mohammad M. (2019). Scale-up of malnutrition screening by the World Health Organization in Syria. *Field Exchange*, *61*, 57–61. https://www.ennonline.net/fex/61/en/scale-malnutrition-screening-world-health-organization-syria

Brandão M., Kirschbaum M. U. F., Cowie A. L., and Hjuler S. V. (2019). Quantifying the climate change effects of bioenergy systems: Comparison of 15 impact assessment methods. *Global Change Biology Bioenergy*, *11*(5), 727–743. doi: 10.1111/gcbb.12593

Brockway A. M., and Dunn L. N. (2020). Weathering adaptation: Grid infrastructure planning in a changing climate. *Climate Risk Management*, *30*, 100256. doi: 10.1016/j.crm.2020.100256

Brunori E., Biasi R., Maesano M., Moresi F. V, Bellincontro A., and Mencarelli F. (2021). Precision viticulture and wildfire emergencies: Effects of smoke on the vine and localization of damage. *International Journal of Enology and Viticulture*, *8*, 001–003. https://hdl.handle.net/11568/1114200

Bucak T., Trolle D., Andersen H. E., Thodsen H., Erdoğan Ş., Levi E. E., Filiz N., Jeppesen E., and Beklioğlu M. (2017). Future water availability in the largest freshwater Mediterranean lake is at great risk as evidenced from simulations with the SWAT model. *Science of the Total Environment*, *581*, 413–425. doi: 10.1016/j.scitotenv.2016.12.149

Burak, Z.S., Hilmi, N., Jiménez, J.A., Ali, E., Balzan, M.V., Bonazza, A., Dechraoui-Bottein, M.-Y., Demirel, N. Farahmand, S., González, M., Montserrat, S., Pulido-Velázquez, D., Safa, A., Vacchi, M., 2024: Impacts and Risks. In S. Djoundourian, P. Lionello, M. C. Llasat, J. Guiot, W. Cramer, F. Driouech, J. C. Gattacceca, & K. Marini (Eds.), *Climate and environmental coastal risks in the Mediterranean* (pp. 131–208). MedECC Reports. MedECC Secretariat, Marseille, France. doi: 10.5281/zenodo.15096247

Cai R., Feng S., Oppenheimer M., and Pytlikova M. (2016). Climate variability and international migration: The importance of the agricultural linkage. *Journal of Environmental Economics and Management*, *79*, 135–151. doi: 10.1016/j.jeem.2016.06.005

Carosi A., Ghetti L., and Lorenzoni M. (2021). The role of climate changes in the spread of freshwater fishes: Implications for alien cool and warm-water species in a Mediterranean basin. *Water*, *13*(3), 347. doi: 10.3390/w13030347

Cazenave A. (2014). Anthropogenic global warming threatens world cultural heritage. *Environmental Research Letters*, *9*(5), 051001. doi: 10.1088/1748-9326/9/5/051001

Chatzimentor A., Doxa A., Katsanevakis S., and Mazaris A. D. (2022). Are Mediterranean marine threatened species at high risk by climate change? *Global Change Biology*, *29*(7), 1809–1821. doi: 10.1111/gcb.16577

Chefaoui R. M., Duarte C. M., and Serrão E. A. (2018). Dramatic loss of seagrass habitat under projected climate change in the Mediterranean Sea. *Global Change Biology*, *24*(10), 4919–4928. doi: 10.1111/gcb.14401

Cherif S., Doblas-Miranda E., Lionello P., Borrego C., Giorgi F., Iglesias A., Jebari S., Mahmoudi E., Moriondo M., Pringault O., Rilov G., Somot S., Tsikliras A., Vilà M., and Zittis G. (2020). Drivers of Change. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 59–180). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7100601

Ciapała B., Jurasz J., Janowski M., and Kępińska B. (2021). Climate factors influencing effective use of geothermal resources in SE Poland: the Lublin trough. *Geothermal Energy*, *9*(1), 3. doi: 10.1186/s40517-021-00184-1

Clark N. J., Kerry J. T., and Fraser C. I. (2020). Rapid winter warming could disrupt coastal marine fish community structure. *Nature Climate Change*, *10*(9), 862–867. doi: 10.1038/s41558-020-0838-5

Clarke B., Otto F., Stuart-Smith R., and Harrington L. (2022). Extreme weather impacts of climate change: an attribution perspective. *Environmental Research: Climate*, *1*(1), 12001. doi: 10.1088/2752-5295/ac6e7d

Clement V., Rigaud K. K., De Sherbinin A., Jones B., Adamo S., Schewe J., Sadiq N., and Shabahat E. (2021). Groundswell Part 2: Acting on internal climate migration. World Bank, Washington, DC. doi: 10.1596/36248

Colelli F. Pietro, Emmerling J., Marangoni G., Mistry M. N., and De Cian E. (2022). Increased energy use for adaptation significantly impacts mitigation pathways. *Nature Communications*, *13*(1), 4964. doi: 10.1038/s41467-022-32471-1

Colloca F., Scarcella G., and Libralato S. (2017). Recent trends and impacts of fisheries exploitation on Mediterranean stocks and ecosystems. *Frontiers in Marine Science*, *4*, 244. doi: 10.3389/fmars.2017.00244

Conti L., Schmidt-Kloiber A., Grenouillet G., and Graf W. (2014). A trait-based approach to assess the vulnerability of European aquatic insects to climate change. *Hydrobiologia*, *721*(1), 297–315. doi: 10.1007/s10750-013-1690-7

Coppens J., Trolle D., Jeppesen E., and Beklioğlu M. (2020). The impact of climate change on a Mediterranean shallow lake: insights based on catchment and lake modelling. *Regional Environmental Change*, *20*, 1–13. doi: 10.1007/s10113-020-01641-6

Cramer W., Guiot J., Fader M., Garrabou J., Gattuso J.-P., Iglesias A., Lange M. A., Lionello P., Llasat M. C., Paz S., Peñuelas J., Snoussi M., Toreti A., Tsimplis M. N., and Xoplaki E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change*, *8*(11), 972–980. doi: 10.1038/s41558-018-0299-2

Cundill G., Singh C., Adger W. N., Safra de Campos R., Vincent K., Tebboth M., and Maharjan A. (2021). Toward a climate mobilities research agenda: Intersectionality, immobility, and policy responses. *Global Environmental Change*, *69*, 102315. doi: 10.1016/j.gloenvcha.2021.102315

Dahri N., and Abida H. (2020). Causes and impacts of flash floods: case of Gabes City, Southern Tunisia. *Arabian Journal of Geosciences*, *13*, 1–15. doi: 10.1007/s12517-020-5149-7

Darmaraki S., Somot S., Sevault F., Nabat P., Cabos Narvaez W. D., Cavicchia L., Djurdjevic V., Li L., Sannino G., and Sein D. V. (2019). Future evolution of Marine Heatwaves in the Mediterranean Sea. *Climate Dynamics*, *53*(3), 1371–1392. doi: 10.1007/s00382-019-04661-z

Devi S. (2020). Lebanon faces humanitarian emergency after blast. *The Lancet*, *396*(10249), 456. doi: 10.1016/s0140-6736(20)31750-5

Devi S. (2022). War driving cholera in Syria. *The Lancet*, *400*(10357), 986. doi: 10.1016/s0140-6736(22)01836-0

Dong J., Asif Z., Shi Y., Zhu Y., and Chen Z. (2022). Climate Change Impacts on Coastal and Offshore Petroleum Infrastructure and the Associated Oil Spill Risk: A Review. *Journal of Marine Science and Engineering*, *10*(7), 849. doi: 10.3390/jmse10070849

Drius M., Bongiorni L., Depellegrin D., Menegon S., Pugnetti A., and Stifter S. (2019). Tackling challenges for Mediterranean sustainable coastal tourism: An ecosystem service perspective. *Science of the Total Environment*, *652*, 1302–1317. doi: 10.1016/j.scitotenv.2018.10.121

Dubey S., Sarvaiya J. N., and Seshadri B. (2013). Temperature Dependent Photovoltaic (PV) Efficiency and Its Effect on PV Production in the World – A Review. *Energy Procedia*, *33*, 311–321. doi: 10.1016/j.egypro.2013.05.072

EC (2007). *Communication from the Commission to the European Parliament and the Council: Addressing the challenge of water scarcity and droughts in the European Union. COM(2007) 414 final*. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52007DC0414

EEA (2006). *The changing faces of Europe's coastal areas*. Copenhagen: European Environment Agency. http://www.eea.europa.eu/publications/eea_report_2006_6

EEA (2014). *Horizon 2020 Mediterranean report: toward shared environmental information systems.* EEA Technical report 6/2014. EEA-UNEP/MAP joint report. Copenhagen: European Environment Agency. doi: 10.2800/13326

Efron S., Fischbach J., Blum I., Karimov R., and Moore M. (2018). *The Public Health Impacts of Gaza's Water Crisis: Analysis and Policy Options*. Santa Monica, CA: RAND Corporation. doi: 10.7249/rr2515

Ellena M., Breil M., and Soriani S. (2020). The heat-health nexus in the urban context: A systematic literature review exploring the socio-economic vulnerabilities and built environment characteristics. *Urban Climate*, *34*, 100676. doi: 10.1016/j.uclim.2020.100676

Elsen P. R., Saxon E. C., Simmons B. A., Ward M., Williams B. A., Grantham H. S., Kark S., Levin N., Perez-Hammerle K.-V., and Reside A. E. (2022). Accelerated shifts in terrestrial life zones under rapid climate change. *Global Change Biology*, *28*(3), 918–935. doi: 10.1111/gcb.15962

Enríquez A. R., and Bujosa Bestard A. (2020). Measuring the economic impact of climate-induced environmental changes on sun-and-beach tourism. *Climatic Change*, *160*(2), 203–217. doi: 10.1007/s10584-020-02682-w

Enríquez A. R., Marcos M., Álvarez-Ellacuría A., Orfila A., and Gomis D. (2017). Changes in beach shoreline due to sea level rise and waves under climate change scenarios: application to the Balearic Islands (western Mediterranean). *Natural Hazards and Earth System Sciences*, *17*(7), 1075–1089. doi: 10.5194/nhess-17-1075-2017

Enríquez A. R., Marcos M., Falqués A., and Roelvink D. (2019). Assessing Beach and Dune Erosion and Vulnerability Under Sea Level Rise: A Case Study in the Mediterranean Sea. *Frontiers in Marine Science*, *6*, 4. doi: 10.3389/fmars.2019.00004

Erostate M., Huneau F., Garel E., Ghiotti S., Vystavna Y., Garrido M., and Pasqualini V. (2020). Groundwater dependent ecosystems in coastal Mediterranean regions: Characterization, challenges and management for their protection. *Water Research*, *172*, 115461. doi: 10.1016/j.watres.2019.115461

Fader M., Giupponi C., Burak S., Dakhlaoui H., Koutroulis A., Lange M. A., Llasat M. C., Pulido-Velazquez D., and Sanz-Cobeña A. (2020). Water. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 181–236). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7101074

FAO, and ITPS (2015). Status of the World's Soil Resources (SWSR) – Main Report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy. https://openknowledge.fao.org/handle/20.500.14283/i5199e

Fargues, P., Rango, M., Borgnäs, E., & Schöfberger, I. (Eds.). (2020). *Migration in West and North Africa and across the Mediterranean: trends, risks, development and governance*. Geneva: International Organization for Migration. https://publications.iom.int/books/migration-west-and-north-africa-and-across-mediterranean

FAS USDA (2022). *Egypt Makes its Largest Wheat Purchase in More than a Decade*. Report Number EG2022-0017. United States Department of Agriculture / Foreign Agricultural Service, Global Agricultural Information Network. https://www.fas.usda.gov/data/egypt-egypt-makes-its-largest-wheat-purchase-more-decade

Fatorić S., Morén-Alegret R., Niven R. J., and Tan G. (2017). Living with climate change risks: stakeholders' employment and coastal relocation in mediterranean climate regions of Australia and Spain. *Environment Systems and Decisions*, *37*(3), 276–288. doi: 10.1007/s10669-017-9629-6

Fernández C., Sierra-Huedo M. L., and Chinarro D. (2019). Climate change-induced migration in Morocco: Sub-Saharian and Moroccan migrants. In M. Paradiso (Ed.), *Mediterranean Mobilities: Europe's Changing Relationships* (pp. 177–195). Springer, Cham. doi: 10.1007/978-3-319-89632-8_15

Ferragina E. (2010). The Water Issue in the Mediterranean. In M. Scoullos & E. Ferragina (Eds.), *10 papers for Barcelona 2010 - Environmental and Sustainable Development in the Mediterranean* (pp. 53–78). IEMed and ISS. https://www.researchgate.net/publication/265012608_The_Water_Issue_in_the_Mediterranean_in_Environmental_and_Sustainable_Development_in_the_Mediterranean

Ferreira C. S. S., Seifollahi-Aghmiuni S., Destouni G., Ghajarnia N., and Kalantari Z. (2022). Soil degradation in the European Mediterranean region: Processes, status and consequences. *Science of The Total Environment*, *805*, 150106. doi: 10.1016/j.scitotenv.2021.150106

Ferrise R., Moriondo M., Trombi G., Miglietta F., and Bindi M. (2013). Climate change impacts on typical mediterranean crops and evaluation of adaptation strategies to cope with. In A. Navarra & L. Tubiana (Eds.), *Regional Assessment of Climate Change in the Mediterranean* (Vol. 51, pp. 49–70). Springer, Dordrecht. doi: 10.1007/978-94-007-5772-1_4

Förster H., and Lilliestam J. (2010). Modeling thermoelectric power generation in view of climate change. *Regional Environmental Change*, *10*(4), 327–338. doi: 10.1007/s10113-009-0104-x

Fouskas T., Sidiropoulos S., and Vozikis A. (2019). Leaving no one out? Public health aspects of migration: Health risks, responses and accessibility by asylum seekers, refugees and migrants in Greece. *International Journal of Health Research and Innovation*, *7*, 13–28. https://www.researchgate.net/publication/343917202_Leaving_no_one_out_Public_health_aspects_of_migration_Health_risks_responses_and_accessibility_by_asylum_seekers_refugees_and_migrants_in_Greece

Frid O., Malamud S., Di Franco A., Guidetti P., Azzurro E., Claudet J., Micheli F., Yahel R., Sala E., and Belmaker J. (2023). Marine protected areas' positive effect on fish biomass persists across the steep climatic gradient of the Mediterranean Sea. *Journal of Applied Ecology*, *60*, 638–649. doi: 10.1111/1365-2664.14352

García-Vila, M., Rivera Ferre, M.G., Chfadi, T., El Kenawy, A., Branquinho, C., Lorenzo-Lacruz. J., Menichetti, E., Mohammed, S., Sanz-Cobena A., 2024: Drivers of change and their impacts on the WEFE nexus in the Mediterranean region. In P. Drobinski, M. G. Rivera Ferre, M. Abdel Monem, F. Driouech, W. Cramer, J. Guiot, J. C. Gattacceca, & K. Marini (Eds.), *Interlinking climate change with the Water-Energy-Food-Ecosystems (WEFE) nexus in the Mediterranean Basin* (pp. 57–139). MedECC Reports. MedECC Secretariat, Marseille, France. doi: 10.5281/zenodo.13378622

Garrabou J., Gómez-Gras D., Ledoux J.-B., Linares C., Bensoussan N., López-Sendino P., Bazairi H., Espinosa F., Ramdani M., Grimes S., Benabdi M., Souissi J. Ben, Soufi E., Khamassi F., Ghanem R., Ocaña O., Ramos-Esplà A., Izquierdo A., Anton I., … Harmelin J. G. (2019). Collaborative Database to Track Mass Mortality Events in the Mediterranean Sea. *Frontiers in Marine Science*, *6*. doi: 10.3389/fmars.2019.00707

Garrabou J., Ledoux J.-B., Bensoussan N., Gómez-Gras D., and Linares C. (2021). Sliding Toward the Collapse Collapse of Mediterranean Coastal Marine Rocky Ecosystems. In J. G. Canadell & R. B. Jackson (Eds.), *Ecosystem Collapse and Climate Change* (pp. 291–324). Springer, Cham. doi: 10.1007/978-3-030-71330-0_11

Gil-Guirado S., Pérez-Morales A., and Lopez-Martinez F. (2019). SMC-Flood database: a high-resolution press database on flood cases for the Spanish Mediterranean coast (1960–2015). *Natural Hazards and Earth System Sciences*, *19*(9), 1955–1971. doi: 10.5194/nhess-19-1955-2019

Gleick P. H. (2014). Water, Drought, Climate Change, and Conflict in Syria. *Weather, Climate, and Society*, *6*(3), 331–340. doi: 10.1175/wcas-d-13-00059.1

Gómez-Gras D., Linares C., Dornelas M., Madin J. S., Brambilla V., Ledoux J., López-Sendino P., Bensoussan N., and Garrabou J. (2021). Climate change transforms the functional identity of Mediterranean coralligenous assemblages. *Ecology Letters*, *24*(5), 1038–1051. doi: 10.1111/ele.13718

Goudie A. S. (2014). Desert dust and human health disorders. *Environment International*, *63*, 101–113. doi: 10.1016/j.envint.2013.10.011

Graham N. T., Hejazi M. I., Kim S. H., Davies E. G. R., Edmonds J. A., and Miralles-Wilhelm F. (2020). Future changes in the trading of virtual water. *Nature Communications*, *11*(1), 3632. doi: 10.1038/s41467-020-17400-4

Green A. J., Alcorlo P., Peeters E. T., Morris E. P., Espinar J. L., Bravo-Utrera M. A., Bustamante J., Diaz-Delgado R., Koelmans A. A., Mateo R., Mooij W. M., Rodriguez-Rodriguez M., van Nes E. H., and Scheffer M. (2017). Creating a safe operating space for wetlands in a changing climate. *Frontiers in Ecology and the Environment*, *15*(2), 99–107. doi: 10.1002/fee.1459

Harris I., Jones P. D., Osborn T. J., and Lister D. H. (2014). Updated high-resolution grids of monthly climatic observations – the CRU TS3.10 Dataset. *International Journal of Climatology*, *34*(3), 623–642. doi: 10.1002/joc.3711

Hayes K., Blashki G., Wiseman J., Burke S., and Reifels L. (2018). Climate change and mental health: risks, impacts and priority actions. *International Journal of Mental Health Systems*, *12*(1), 28. doi: 10.1186/s13033-018-0210-6

Hempel S., Menz C., Pinto S., Galán E., Janke D., Estellés F., Müschner-Siemens T., Wang X., Heinicke J., and Zhang G. (2019). Heat stress risk in European dairy cattle husbandry under different climate change scenarios–uncertainties and potential impacts. *Earth System Dynamics*, *10*(4), 859–884. doi: 10.5194/esd-10-859-2019

Hess J., Boodram L. L. G., Paz S., Stewart Ibarra A. M., Wasserheit J. N., and Lowe R. (2020). Strengthening the global response to climate change and infectious disease threats. *BMJ*, *371*, m3081. doi: 10.1136/bmj.m3081

Hilmi N., Farahmand S., Lam V. W. Y., Cinar M., Safa A., and Gilloteaux J. (2021). The Impacts of Environmental and Socio-Economic Risks on the Fisheries in the Mediterranean Region. *Sustainability*, *13*(19), 10670. doi: 10.3390/su131910670

IPCC (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama, Eds.). Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp. doi: 10.1017/9781009325844

IRENA (2023). *World Energy Transitions Outlook 2023: 1.5°C Pathway* (Vol. 1). Abu Dhabi: International Renewable Energy Agency. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Jun/IRENA_World_energy_transitions_outlook_2023.pdf

Jarić I., Lennox R. J., Kalinkat G., Cvijanović G., and Radinger J. (2019). Susceptibility of European freshwater fish to climate change: Species profiling based on life-history and environmental characteristics. *Global Change Biology*, *25*(2), 448–458. doi: 10.1111/gcb.14518

Jeppesen E., Brucet S., Naselli-Flores L., Papastergiadou E., Stefanidis K., Noges T., Noges P., Attayde J. L., Zohary T., and Coppens J. (2015). Ecological impacts of global warming and water abstraction on lakes and reservoirs due to changes in water level and related changes in salinity. *Hydrobiologia*, *750*, 201–227. doi: 10.1007/s10750-014-2169-x

Jerez S., Tobin I., Vautard R., Montávez J. P., López-Romero J. M., Thais F., Bartok B., Christensen O. B., Colette A., Déqué M., Nikulin G., Kotlarski S., van Meijgaard E., Teichmann C., and Wild M. (2015). The impact of climate change on photovoltaic power generation in Europe. *Nature Communications*, *6*(1), 10014. doi: 10.1038/ncomms10014

Jones C., Gilbert P., and Stamford L. (2020). Assessing the Climate Change Mitigation Potential of Stationary Energy Storage for Electricity Grid Services. *Environmental Science & Technology*, *54*(1), 67–75. doi: /10.1021/acs.est.9b06231

Kelley C. P., Mohtadi S., Cane M. A., Seager R., and Kushnir Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3241–3246. doi: 10.1073/pnas.1421533112

Khalil H. A. E. E., Ibrahim A., Elgendy N., and Makhlouf N. (2018). Could/should improving the urban climate in informal areas of fast-growing cities be an integral part of upgrading processes? Cairo case. *Urban Climate*, *24*, 63–79. doi: 10.1016/j.uclim.2018.01.007

Kim G.-U., Seo K.-H., and Chen D. (2019). Climate change over the Mediterranean and current destruction of marine ecosystem. *Scientific Reports*, *9*(1), 18813. doi: 10.1038/s41598-019-55303-7

Koponen K., Soimakallio S., Kline K. L., Cowie A., and Brandão M. (2018). Quantifying the climate effects of bioenergy – Choice of reference system. *Renewable and Sustainable Energy Reviews*, *81*, 2271–2280. doi: 10.1016/j.rser.2017.05.292

Kourgialas N. N. (2021). Hydroclimatic impact on mediterranean tree crops area–Mapping hydrological extremes (drought/flood) prone parcels. *Journal of Hydrology*, *596*, 125684. doi: 10.1016/j.jhydrol.2020.125684

Krasnov H., Katra I., and Friger M. (2016). Increase in dust storm related PM10 concentrations: A time series analysis of 2001–2015. *Environmental Pollution*, *213*, 36–42. doi: 10.1016/j.envpol.2015.10.021

Küçük F., Gülle I., and Güçlü S. S. (2016). Pseudophoxinus iconii, a new species of spring minnow from Central Anatolia (Teleostei: Cyprinidae). *Ichthyological Exploration of Freshwaters*, *27*(3), 283–288. https://www.pfeil-verlag.de/wp-content/uploads/2017/04/ief27_3_08.pdf

Lacetera N., Segnalini M., Bernabucci U., Ronchi B., Vitali A., Tran A., Guis H., Caminade C., Calvete C., and Morse A. (2013). Climate induced effects on livestock population and productivity in the Mediterranean area. In A. Navarra & L. Tubiana (Eds.), *Regional Assessment of Climate Change in the Mediterranean: Volume 2: Agriculture, Forests and Ecosystem Services and People* (pp. 135–156). Advances in Global Change Research, vol 51. Springer, Dordrecht. doi: 10.1007/978-94-007-5772-1_7

Lagarias A., and Stratigea A. (2022). Coastalization patterns in the Mediterranean: a spatiotemporal analysis of coastal urban sprawl in tourism destination areas. *GeoJournal*, *88*, 2529–2552. doi: 10.1007/s10708-022-10756-8

Lal P. (2021). Ten years since the crises in Syria: lessons for planetary and public health. *Public Health Action*, *11*(3), 110–111. doi: 10.5588/pha.21.0045

Lam V. W. Y., Cheung W. W. L., Reygondeau G., and Sumaila U. R. (2016). Projected change in global fisheries revenues under climate change. *Scientific Reports*, *6*, 32607. doi: 10.1038/srep32607

Lange M. A. (2019). Impacts of Climate Change on the Eastern Mediterranean and the Middle East and North Africa Region and the Water–Energy Nexus. *Atmosphere*, *10*(8), 455. doi: 10.3390/atmos10080455

Lange M. A. (2022). Climate Change and the Water-Energy Nexus in the MENA Region. In V. Naddeo, K.-H. Choo, & M. Ksibi (Eds.), *Water-Energy-Nexus in the Ecological Transition* (pp. 93–98). Springer International Publishing. https://link.springer.com/10.1007/978-3-031-00808-5_22

Lange M. A. (2023). Climate change, heat waves and their consequences in the MENA region - Orient Online. *German Journal for Politics, Economics and Culture of the Middle East*, *1*, 36–47. https://orient-online.com/shop/articles/climate-change-heat-waves-and-their-consequences-in-the-mena-region/

Lange M. A., Llasat M. C., Snoussi M., Graves A., Le Tellier J., Queralt A., and Vagliasindi G. M. (2020). Introduction. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp. 41–58). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. doi: 10.5281/zenodo.7100592

Lee U., Han J., Elgowainy A., and Wang M. (2018). Regional water consumption for hydro and thermal electricity generation in the United States. *Applied Energy*, *210*, 661–672. doi: 10.1016/j.apenergy.2017.05.025

Lefebvre G., Redmond L., Germain C., Palazzi E., Terzago S., Willm L., and Poulin B. (2019). Predicting the vulnerability of seasonally-flooded wetlands to climate change across the Mediterranean Basin. *Science of the Total Environment*, *692*, 546–555. doi: 10.1016/j.scitotenv.2019.07.263

Linares C., Díaz J., Negev M., Martínez G. S., Debono R., and Paz S. (2020). Impacts of climate change on the public health of the Mediterranean Basin population - Current situation, projections, preparedness and adaptation. *Environmental Research*, *182*, 109107. doi: 10.1016/j.envres.2019.109107

Lincke D., and Hinkel J. (2018). Economically robust protection against 21st century sea-level rise. *Global Environmental Change*, *51*, 67–73. doi: 10.1016/j.gloenvcha.2018.05.003

Lionello P., and Scarascia L. (2020). The relation of climate extremes with global warming in the Mediterranean region and its north versus south contrast. *Regional Environmental Change*, *20*(1), 1–16. doi: 10.1007/s10113-020-01610-z

Llorca M., Álvarez-Muñoz D., Ábalos M., Rodríguez-Mozaz S., Santos L. H., León V. M., Campillo J. A., Martínez-Gómez C., Abad E., and Farré M. (2020). Microplastics in Mediterranean coastal area: Toxicity and impact for the environment and human health. *Trends in Environmental Analytical Chemistry*, *27*, e00090. doi: 10.1016/j.teac.2020.e00090

López-Ballesteros A., Senent-Aparicio J., Martínez C., and Pérez-Sánchez J. (2020). Assessment of future hydrologic alteration due to climate change in the Aracthos River basin (NW Greece). *Science of The Total Environment*, *733*, 139299. doi: 10.1016/j.scitotenv.2020.139299

Mach K. J., Kraan C. M., Adger W. N., Buhaug H., Burke M., Fearon J. D., Field C. B., Hendrix C. S., Maystadt J.-F., O'Loughlin J., Roessler P., Scheffran J., Schultz K. A., and von Uexkull N. (2019). Climate as a risk factor for armed conflict. *Nature*, *571*(7764), 193–197. doi: 10.1038/s41586-019-1300-6

Macias D., Garcia-Gorriz E., and Stips A. (2018). Major fertilization sources and mechanisms for Mediterranean Sea coastal ecosystems. *Limnology and Oceanography*, *63*(2), 897–914. doi: 10.1002/lno.10677

MacManus K., Balk D., Engin H., McGranahan G., and Inman R. (2021). Estimating population and urban areas at risk of coastal hazards, 1990–2015: how data choices matter. *Earth System Science Data*, *13*(12), 5747–5801. doi: 10.5194/essd-13-5747-2021

Malek Ž., Verburg P. H., Geijzendorffer I. R., Bondeau A., and Cramer W. (2018). Global change effects on land management in the Mediterranean region. *Global Environmental Change*, *50*, 238–254. doi: 10.1016/j.gloenvcha.2018.04.007

Manca E., and Santarossa L. (2016). *Tourism and sustainable development in the Mediterranean: key facts and trends*. Plan Bleu. https://planbleu.org/sites/default/files/publications/tourism_and_sustainability_june2016.pdf

Mandi L. (2014). Water resources in the Mediterranean: quantity and quality. *Conference: EuroMEDCooperation. Inland and Marine Water Challenges*. doi: 10.13140/2.1.1662.8806

Marcos M., Jorda G., and Le Cozannet G. (2016). Sea level rise and its impacts on the Mediterranean. In J.-P. Moatti & S. Thiébault (Eds.), *The Mediterranean Region under Climate Change. A Scientific Update* (pp. 265–275). IRD Éditions. doi: 10.4000/books.irdeditions.23454

Mas-Pla J., Ghiglieri G., and Uras G. (2014). Seawater intrusion and coastal groundwater resources management. Examples from two Mediterranean regions: Catalonia and Sardinia. *Contributions to Science*, *10*, 171–184. doi: 10.2436/20.7010.01.201

Matlin S. A., Depoux A., Schütte S., Flahault A., and Saso L. (2018). Migrants' and refugees' health: towards an agenda of solutions. *Public Health Reviews*, *39*(1), 27. doi: 10.1186/s40985-018-0104-9

McGranahan G., Balk D., and Anderson B. (2007). The rising tide. *Environment and Urbanization*, *19*(1), 17–37. doi: 10.1177/0956247807076960

MedECC (2020a). *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (W. Cramer, J. Guiot, & K. Marini, Eds.). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp. doi: 10.5281/zenodo.4768833

MedECC (2020b). *Risks and impacts of environmental change in the Mediterranean Basin*. MedECC Secretariat, Marseille, France. https://www.medecc.org/outputs/infographic-mar1-main-results-2020/

Mejjad N., Rossi A., and Pavel A. B. (2022). The coastal tourism industry in the Mediterranean: A critical review of the socio-economic and environmental pressures & impacts. *Tourism Management Perspectives*, *44*, 101007. doi: 10.1016/j.tmp.2022.101007

Meke T., Küçükkara R., Çınar Ş., Çavdar N., Babar B., and Yener O. (2012). Beyşehir Gölü balık faunası için yeni bir kayıt: istilacı bir tür: Pseudorasbora parva (Temminck & Schlegel, 1846). *V. Limnology Symposium*.

Molina-Navarro E., Trolle D., Martínez-Pérez S., Sastre-Merlín A., and Jeppesen E. (2014). Hydrological and water quality impact assessment of a Mediterranean limno-reservoir under climate change and land use management scenarios. *Journal of Hydrology*, *509*, 354–366. doi: 10.1016/j.jhydrol.2013.11.053

Moore F. C., and Lobell D. B. (2015). The fingerprint of climate trends on European crop yields. *Proceedings of the National Academy of Sciences*, *112*(9), 2670–2675. doi: 10.1073/pnas.1409606112

Moraitis M. L., Valavanis V. D., and Karakassis I. (2019). Modelling the effects of climate change on the distribution of benthic indicator species in the Eastern Mediterranean Sea. *Science of The Total Environment*, *667*, 16–24. doi: 10.1016/j.scitotenv.2019.02.338

Morán-Ordóñez A., Ameztegui A., De Cáceres M., De-Miguel S., Lefèvre F., Brotons L., and Coll L. (2020). Future trade-offs and synergies among ecosystem services in Mediterranean forests under global change scenarios. *Ecosystem Services*, *45*, 101174. doi: 10.1016/j.ecoser.2020.101174

Morán-Ordóñez A., Ramsauer J., Coll L., Brotons L., and Ameztegui A. (2021). Ecosystem services provision by Mediterranean forests will be compromised above 2– warming. *Global Change Biology*, *27*(18), 4210–4222. doi: 10.1111/gcb.15745

Moriondo M., Giannakopoulos C., and Bindi M. (2011). Climate change impact assessment: The role of climate extremes in crop yield simulation. *Climatic Change*, *104*, 679–701. doi: 10.1007/s10584-010-9871-0

Mouhous A. (2005). *Les Causes de la dégradation des parcours steppiques cas de la wilaya de Laghouat, commune de Hadj Méehri Azeddine Mouhous*. (Doctoral dissertation, Institut National Agronomique). http://catalogue.ensa.dz/bib/19584

MWO (2018). *Mediterranean Wetlands Outlook 2: Solutions for sustainable Mediterranean Wetlands*. Tour du Valat, France. https://medwet.org/fr/publications/med-wetlands-outlook-2-2018/

Nabih S., Tzoraki O., Zanis P., Tsikerdekis T., Akritidis D., Kontogeorgos I., and Benaabidate L. (2021). Alteration of the Ecohydrological Status of the Intermittent Flow Rivers and Ephemeral Streams due to the Climate Change Impact (Case Study: Tsiknias River). *Hydrology*, *8*(1), 43. doi: 10.3390/hydrology8010043

Nagy S., Breiner F. T., Anand M., Butchart S. H. M., Flörke M., Fluet-Chouinard E., Guisan A., Hilarides L., Jones V. R., Kalyakin M., Lehner B., Pearce-Higgins J. W., and Voltzit O. (2022). Climate change exposure of waterbird species in the African-Eurasian flyways. *Bird Conservation International*, *32*(1), 1–26. doi: 10.1017/S0959270921000150

Naumann G., Cammalleri C., Mentaschi L., and Feyen L. (2021). Increased economic drought impacts in Europe with anthropogenic warming. *Nature Climate Change*, *11*(6), 485–491. doi: 10.1038/s41558-021-01044-3

Negev M., Teschner N., Rosenthal A., Levine H., Lew-Levy C., and Davidovitch N. (2019). Adaptation of health systems to climate-related migration in Sub-Saharan Africa: Closing the gap. *International Journal of Hygiene and Environmental Health*, *222*(2), 311–314. doi: 10.1016/j.ijheh.2018.10.004

Negev M., Zohar M., and Paz S. (2022). Multidimensional hazards, vulnerabilities, and perceived risks regarding climate change and Covid-19 at the city level: An empirical study from Haifa, Israel. *Urban Climate*, *43*, 101146. doi: 10.1016/j.uclim.2022.101146

Nixon S., Trent Z., Marcuello C., and Lallana C. (2003). *Europe's water: an indicator-based assessment*. EEA. https://www.eea.europa.eu/publications/topic_report_2003_1

Ochoa-Hueso R., Munzi S., Alonso R., Arróniz-Crespo M., Avila A., Bermejo V., Bobbink R., Branquinho C., Concostrina-Zubiri L., Cruz C., Cruz de Carvalho R., De Marco A., Dias T., Elustondo D., Elvira S., Estébanez B., Fusaro L., Gerosa G., Izquieta-Rojano S., … Theobald M. R. (2017). Ecological impacts of atmospheric pollution and interactions with climate change in terrestrial ecosystems of the Mediterranean Basin: Current research and future directions. *Environmental Pollution*, *227*, 194–206. doi: 10.1016/j.envpol.2017.04.062

Olesen J. E., Trnka M., Kersebaum K. C., Skjelvåg A. O., Seguin B., Peltonen-Sainio P., Rossi F., Kozyra J., and Micale F. (2011). Impacts and adaptation of European crop production systems to climate change. *European Journal of Agronomy*, *34*(2), 96–112. doi: 10.1016/j.eja.2010.11.003

O'Neill B. C., Carter T. R., Ebi K., Harrison P. A., Kemp-Benedict E., Kok K., Kriegler E., Preston B. L., Riahi K., Sillmann J., van Ruijven B. J., van Vuuren D., Carlisle D., Conde C., Fuglestvedt J., Green C., Hasegawa T., Leininger J., Monteith S., and Pichs-Madruga R. (2020). Achievements and needs for the climate change scenario framework. *Nature Climate Change*, *10*(12), 1074–1084. doi: 10.1038/s41558-020-00952-0

O'Neill B. C., Kriegler E., Ebi K. L., Kemp-Benedict E., Riahi K., Rothman D. S., van Ruijven B. J., van Vuuren D. P., Birkmann J., Kok K., Levy M., and Solecki W. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, *42*, 169–180. doi: 10.1016/j.gloenvcha.2015.01.004

O'Neill B. C., Kriegler E., Riahi K., Ebi K. L., Hallegatte S., Carter T. R., Mathur R., and van Vuuren D. P. (2014). A new scenario framework for climate change research: the concept of shared socioeconomic pathways. *Climatic Change*, *122*(3), 387–400. doi: 10.1007/s10584-013-0905-2

Ontoria Y., Gonzalez-Guedes E., Sanmartí N., Bernardeau-Esteller J., Ruiz J. M., Romero J., and Pérez M. (2019). Interactive effects of global warming and eutrophication on a fast-growing Mediterranean seagrass. *Marine Environmental Research*, *145*, 27–38. doi: 10.1016/j.marenvres.2019.02.002

Oppenheimer M., Glavovic B.C., Hinkel J., van de Wal R., Magnan A.K., Abd-Elgawad A., Cai R., Cifuentes-Jara M., DeConto R.M., Ghosh T., Hay J., Isla F., Marzeion B., Meyssignac B., and Sebesvari Z. (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* (pp. 321–445). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157964.006

Ozkaya A., and Zerberg Y. (2019). A 40-Year Analysis of the Hydrological Drought Index for the Tigris Basin, Turkey. *Water*, *11*(4), 657. doi: 10.3390/w11040657

Panagea I. S., Tsanis I. K., Koutroulis A. G., and Grillakis M. G. (2014). Climate Change Impact on Photovoltaic Energy Output: The Case of Greece. *Advances in Meteorology*, *2014*, 1–11. doi: 10.1155/2014/264506

Panagos P., Standardi G., Borrelli P., Lugato E., Montanarella L., and Bosello F. (2018). Cost of agricultural productivity loss due to soil erosion in the European Union: From direct cost evaluation approaches to the use of macroeconomic models. *Land Degradation & Development*, *29*(3), 471–484. doi: 10.1002/ldr.2879

Panteli M., and Mancarella P. (2015). Influence of extreme weather and climate change on the resilience of power systems: Impacts and possible mitigation strategies. *Electric Power Systems Research*, *127*, 259–270. doi: 10.1016/j.epsr.2015.06.012

Paredes I., Ramírez F., Aragonés D., Bravo M. Á., Forero M. G., and Green A. J. (2021). Ongoing anthropogenic eutrophication of the catchment area threatens the Doñana World Heritage Site (South-west Spain). *Wetlands Ecology and Management*, *29*(1), 41–65. doi: 10.1007/s11273-020-09766-5

Paz S., Majeed A., and Christophides G. K. (2021). Climate change impacts on infectious diseases in the Eastern Mediterranean and the Middle East (EMME)—risks and recommendations. *Climatic Change*, *169*(3–4), 40. doi: 10.1007/s10584-021-03300-z

Peñuelas J., Sardans J., Filella I., Estiarte M., Llusià J., Ogaya R., Carnicer J., Bartrons M., Rivas-Ubach A., Grau O., Peguero G., Margalef O., Pla-Rabés S., Stefanescu C., Asensio D., Preece C., Liu L., Verger A., Barbeta A., … Terradas J. (2017). Impacts of Global Change on Mediterranean Forests and Their Services. *Forests*, *8*(12), 463. doi: 10.3390/f8120463

Pereda O., von Schiller D., Garcia-Baquero G., Mor J.-R., Acuna V., Sabater S., and Elosegi A. (2021). Combined effects of urban pollution and hydrological stress on ecosystem functions of Mediterranean streams. *Science of the Total Environment*, *753*, 141971. doi: 10.1016/j.scitotenv.2020.141971

Perkins-Kirkpatrick S. E., and Lewis S. C. (2020). Increasing trends in regional heatwaves. *Nature Communications*, *11*(1), 3357. doi: 10.1038/s41467-020-16970-7

Petrakopoulou F., Robinson A., and Olmeda-Delgado M. (2020). Impact of climate change on fossil fuel power-plant efficiency and water use. *Journal of Cleaner Production*, *273*, 122816. doi: 10.1016/j.jclepro.2020.122816

Philandras C. M., Nastos P. T., Kapsomenakis J., Douvis K. C., Tselioudis G., and Zerefos C. S. (2011). Long term precipitation trends and variability within the Mediterranean region. *Natural Hazards and Earth System Sciences*, *11*(12), 3235–3250. doi: 10.5194/nhess-11-3235-2011

Piante C., and Ody D. (2015). *Blue Growth in the Mediterranean Sea: the Challenge of Good Environmental Status*. MedTrends Project. WWF-France. 192 pages. http://www.medtrends.org/reports/MEDTRENDS_REGIONAL.pdf

Pisinaras V., Paraskevas C., and Panagopoulos A. (2021). Investigating the effects of agricultural water management in a mediterranean coastal aquifer under current and projected climate conditions. *Water*, *13*, 108. doi: 10.3390/w13010108

Pita I., Mouillot D., Moullec F., and Shin Y.-J. (2021). Contrasted patterns in climate change risk for Mediterranean fisheries. *Global Change Biology*, *27*(22), 5920–5933. doi: 10.1111/gcb.15814

Ponti L., Gutierrez A. P., Ruti P. M., and Dell'Aquila A. (2014). Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers. *Proceedings of the National Academy of Sciences*, *111*(15), 5598–5603. doi: 10.1073/pnas.1314437111

Poudel B. C., Sathre R., Gustavsson L., Bergh J., Lundström A., and Hyvönen R. (2011). Effects of climate change on biomass production and substitution in north-central Sweden. *Biomass and Bioenergy*, *35*(10), 4340–4355. doi: 10.1016/j.biombioe.2011.08.005

Pryor S. C., and Barthelmie R. J. (2010). Climate change impacts on wind energy: A review. *Renewable and Sustainable Energy Reviews*, *14*(1), 430–437. doi: 10.1016/j.rser.2009.07.028

Pulido-Velazquez D., Baena-Ruiz L., Mayor B., Zorrilla-Miras P., López-Gunn E., de Dios Gómez-Gómez J., de la Hera-Portillo Á., Collados-Lara A.-J., Moreno M. M., Aróstegui J. L. G., and Alcalá F. J. (2023). Integrating stakeholders' inputs to co-design climate resilience adaptation measures in Mediterranean areas with conflicts between wetland conservation and intensive agriculture. *Science of The Total Environment*, *870*, 161905. doi: 10.1016/j.scitotenv.2023.161905

Ramón M., Díaz C., Pérez-Guzman M. D., and Carabaño M. J. (2016). Effect of exposure to adverse climatic conditions on production in Manchega dairy sheep. *Journal of Dairy Science*, *99*(7), 5764–5779. doi: 10.3168/jds.2016-10909

Reimann L., Jones B., Bieker N., Wolff C., Aerts J. C. J. H., and Vafeidis A. T. (2023a). Exploring spatial feedbacks between adaptation policies and internal migration patterns due to sea-level rise. *Nature Communications*, *14*(1), 2630. doi: 10.1038/s41467-023-38278-y

Reimann L., Jones B., Nikoletopoulos T., and Vafeidis A. T. (2021). Accounting for internal migration in spatial population projections—a gravity-based modeling approach using the Shared Socioeconomic Pathways. *Environmental Research Letters*, *16*(7), 74025. doi: 10.1088/1748-9326/ac0b66

Reimann L., Merkens J.-L., and Vafeidis A. T. (2018a). Regionalized Shared Socioeconomic Pathways: narratives and spatial population projections for the Mediterranean coastal zone. *Regional Environmental Change*, *18*(1), 235–245. doi: 10.1007/s10113-017-1189-2

Reimann L., Vafeidis A. T., Brown S., Hinkel J., and Tol R. S. J. (2018b). Mediterranean UNESCO World Heritage at risk from coastal flooding and erosion due to sea-level rise. *Nature Communications*, *9*(1), 4161. doi: 10.1038/s41467-018-06645-9

Reimann L., Vafeidis A. T., and Honsel L. E. (2023b). Population development as a driver of coastal risk: Current trends and future pathways. *Cambridge Prisms: Coastal Futures*, *1*, e14. doi: 10.1017/cft.2023.3

Rolo V., and Moreno G. (2019). Shrub encroachment and climate change increase the exposure to drought of Mediterranean wood-pastures. *Science of the Total Environment*, *660*, 550–558. doi: 10.1016/j.scitotenv.2019.01.029

Rüttinger L., and Sharma V. (2016). *Climate Change and mining: A Foreign Policy Perspective*. Adelphi. https://climate-diplomacy.org/magazine/environment/climate-change-and-mining-foreign-policy-perspective

Saadi S., Todorovic M., Tanasijevic L., Pereira L. S., Pizzigalli C., and Lionello P. (2015). Climate change and Mediterranean agriculture: Impacts on winter wheat and tomato crop evapotranspiration, irrigation requirements and yield. *Agricultural Water Management*, *147*, 103–115. doi: 10.1016/j.agwat.2014.05.008

Santiago J. M., Garcia de Jalon D., Alonso C., Solana J., Ribalaygua J., Pórtoles J., and Monjo R. (2016). Brown trout thermal niche and climate change: Expected changes in the distribution of cold-water fish in central Spain. *Ecohydrology*, *9*(3), 514–528. doi: 10.1002/eco.1653

Santos F. D., Stigter T. Y., Faysse N., and Lourenço T. C. (2014). Impacts and adaptation to climate change in the Mediterranean coastal areas: the CIRCLE-MED initiative. *Regional Environmental Change*, *14* (Suppl 1), 1–3. doi: 10.1007/s10113-013-0551-2

Sathaye J. A., Dale L. L., Larsen P. H., Fitts G. A., Koy K., Lewis S. M., and de Lucena A. F. P. (2013). Estimating impacts of warming temperatures on California's electricity system. *Global Environmental Change*, *23*(2), 499–511. doi: 10.1016/j.gloenvcha.2012.12.005

Sayol J. M., and Marcos M. (2018). Assessing Flood Risk Under Sea Level Rise and Extreme Sea Levels Scenarios: Application to the Ebro Delta (Spain). *Journal of Geophysical Research: Oceans*, *123*(2), 794–811. doi: 10.1002/2017jc013355

Schilling J., Hertig E., Tramblay Y., and Scheffran J. (2020). Climate change vulnerability, water resources and social implications in North Africa. *Regional Environmental Change*, *20*, 15. doi: 10.1007/s10113-020-01597-7

Sefelnasr A., and Sherif M. (2014). Impacts of Seawater Rise on Seawater Intrusion in the Nile Delta Aquifer, Egypt. *Groundwater*, *52*(2), 264–276. doi: 10.1111/gwat.12058

Selby J., Dahi O. S., Fröhlich C., and Hulme M. (2017). Climate change and the Syrian civil war revisited. *Political Geography*, *60*, 232–244. doi: 10.1016/j.polgeo.2017.05.007

Shu J., Qu J. J., Motha R., Xu J. C., and Dong D. F. (2018). Impacts of climate change on hydropower development and sustainability: a review. *IOP Conference Series: Earth and Environmental Science*, *163*, 012126. doi: 10.1088/1755-1315/163/1/012126

Skuras D., and Psaltopoulos D. (2012). A broad overview of the main problems derived from climate change that will affect agricultural production in the Mediterranean area. In A. Meybeck, J. Lankoski, S. Redfern, N. Azzu, & V. Gitz (Eds.), *Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a Joint FAO/OECD Workshop* (pp. 217–260). FAO/OECD Rome. https://www.fao.org/fileadmin/templates/agphome/documents/faooecd/skuras.pdf

Sobczak-Szelc K., and Fekih N. (2020). Migration as one of several adaptation strategies for environmental limitations in Tunisia: evidence from El Faouar. *Comparative Migration Studies*, *8*(1), 8. doi: 10.1186/s40878-019-0163-1

Spearman C. W., Ramadan H. K.-A., Sonderup M., and Saad-Hussein A. (2023). Impact of Migration on Gastrointestinal and Liver Diseases in Africa. In A. Saad-Hussein, R. Elwakil, & K. Khomsi (Eds.), *Impact of Climate Change on Health in Africa* (pp. 153–194). Springer, Cham. doi: 10.1007/978-3-031-39466-9_7

Spinoni J., Barbosa P., Bucchignani E., Cassano J., Cavazos T., Christensen J. H., Christensen O. B., Coppola E., Evans J., Geyer B., Giorgi F., Hadjinicolaou P., Jacob D., Katzfey J., Koenigk T., Laprise R., Lennard C. J., Kurnaz M. L., Li D., … Dosio A. (2020). Future Global Meteorological Drought Hot Spots: A Study Based on CORDEX Data. *Journal of Climate*, *33*(9), 3635–3661. doi: 10.1175/jcli-d-19-0084.1

Sraïri M. T., Benyoucef M. T., and Kraiem K. (2013). The dairy chains in North Africa (Algeria, Morocco and Tunisia): from self sufficiency options to food dependency? *SpringerPlus*, *2*(162). doi: 10.1186/2193-1801-2-162

Stanley, J. D. (1997). Mediterranean deltas: subsidence as a major control of relative sea-level rise. *Bulletin de Institut Oceanographique, Monaco, Science Series*, *3*, 35–62. https://repository.si.edu/bitstream/handle/10088/7447/JD_stanley_2.pdf?sequence=1

Stougiannidou D., and Zafeiriou E. (2022). Wildfire economic impact assessment: an empirical model-based investigation for Greek agriculture. *Modeling Earth Systems and Environment*, *8*, 3357–3371. doi: 10.1007/s40808-021-01306-1

Tanasijevic L., Todorovic M., Pereira L. S., Pizzigalli C., and Lionello P. (2014). Impacts of climate change on olive crop evapotranspiration and irrigation requirements in the Mediterranean region. *Agricultural Water Management*, *144*, 54–68. doi: 10.1016/j.agwat.2014.05.019

Taylor N. G., Grillas P., Al Hreisha H., Balkız Ö., Borie M., Boutron O., Catita A., Champagnon J., Cherif S., Çiçek K., Costa L. T., Dakki M., Fois M., Galewski T., Galli A., Georgiadis N. M., Green A. J., Hermoso V., Kapedani R., ... Sutherland W. J. (2021). The future for Mediterranean wetlands: 50 key issues and 50 important conservation research questions. *Regional Environmental Change*, *21*(2), 33. doi: 10.1007/s10113-020-01743-1

Telahigue F., Mejri H., Mansouri B., Souid F., Agoubi B., Chahlaoui A., and Kharroubi A. (2020). Assessing seawater intrusion in arid and semi-arid Mediterranean coastal aquifers using geochemical approaches. *Physics and Chemistry of the Earth*, *115,* 102811. doi: 10.1016/j.pce.2019.102811

Tourlioti P. N., Portman M. E., Tzoraki O., and Pantelakis I. (2021). Interacting with the coast: Residents' knowledge and perceptions about coastal erosion (Mytilene, Lesvos Island, Greece). *Ocean & Coastal Management*, *210*, 105705. doi: 10.1016/j.ocecoaman.2021.105705

Tramblay Y., Mimeau L., Neppel L., Vinet F., and Sauquet E. (2019). Detection and attribution of flood trends in Mediterranean basins. *Hydrology and Earth System Sciences*, *23*(11), 4419–4431. doi: 10.5194/hess-23-4419-2019

Trincardi F., Francocci F., Pellegrini C., d'Alcalà M. R., and Sprovieri M. (2023). The Mediterranean Sea in the Anthropocene. In K. Schroeder & J. Chiggiato (Eds.), *Oceanography of the Mediterranean Sea* (pp. 501–553). Elsevier. doi: 10.1016/b978-0-12-823692-5.00013-3

Tzoraki O., Monioudi I. N., Velegrakis A. F., Moutafis N., Pavlogeorgatos G., and Kitsiou D. (2018). Resilience of Touristic Island Beaches Under Sea Level Rise: A Methodological Framework. *Coastal Management*, *46*(2), 78–102. doi: 10.1080/08920753.2018.1426376

UNEP/MAP (2016). *Mediterranean strategy for sustainable development 2016-2025*. Plan Bleu, Regional Activity Centre. https://wedocs.unep.org/handle/20.500.11822/7097

UNEP/MAP (2017). *Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas*. Athens: United Nations Environment Programme / Mediterranean Action Plan. https://wedocs.unep.org/20.500.11822/17500

UNEP/MAP, and Plan Bleu (2020). *State of the Environment and Development in the Mediterranean*. Nairobi. https://planbleu.org/en/soed-2020-state-of-environment-and-development-in-mediterranean/

UNIDO, IRENA, and IDOS (2024). *Green hydrogen for sustainable industrial development. A policy toolkit for developing countries*. United Nations Industrial Development Organization; International Renewable Energy Agency; Institute for Development and Sustainability. https://www.irena.org/Publications/2024/Feb/Green-hydrogen-for-sustainable-industrial-development-A-policy-toolkit-for-developing-countries

Vakos A., Khalil N., Kumar A., Menezes L., and Ahson M. (2021). Assessment of Growth in Pediatric Syrian Refugee Populations in Jordan. *Avicenna Journal of Medicine*, *11*(04), 167–171. doi: 10.1055/s-0041-1736544

van Vuuren D. P., Kriegler E., O'Neill B. C., Ebi K. L., Riahi K., Carter T. R., Edmonds J., Hallegatte S., Kram T., Mathur R., and Winkler H. (2014). A new scenario framework for Climate Change Research: scenario matrix architecture. *Climatic Change*, *122*(3), 373–386. doi: 10.1007/s10584-013-0906-1

Vearey J., Hui C., and Wickramage K. (2020). Migration and health: Current issues, governance and knowledge gaps. In *World Migration Report 2020* (Vol. 2020, Issue 1, pp. 209–228). International Organization for Migration. doi: 10.18356/9ea52c60-en

Vitali A., Segnalini M., Bertocchi L., Bernabucci U., Nardone A., and Lacetera N. (2009). Seasonal pattern of mortality and relationships between mortality and temperature-humidity index in dairy cows. *Journal of Dairy Science*, *92*(8), 3781–3790. doi: 10.3168/jds.2009-2127

Vogel J., Paton E., Aich V., and Bronstert A. (2021). Increasing compound warm spells and droughts in the Mediterranean Basin. *Weather and Climate Extremes*, *32*, 100312. doi: 10.1016/j.wace.2021.100312

Warner K., Hamza M., Oliver-Smith A., Renaud F., and Julca A. (2010). Climate change, environmental degradation and migration. *Natural Hazards*, *55*(3), 689–715. doi: 10.1007/s11069-009-9419-7

Wasti A., Ray P., Wi S., Folch C., Ubierna M., and Karki P. (2022). Climate change and the hydropower sector: A global review. *WIREs Climate Change*, *13*(2), e757. doi: 10.1002/wcc.757

WHO (2018). *Report on the health of refugees and migrants in the WHO European Region: No public health without refugee and migrant health*. World Health Organization. Regional Office for Europe. https://www.who.int/publications/i/item/report-on-the-health-of-refugees-and-migrants-in-the-who-european-region-no-public-health-without-refugee-and-migrant-health

WHO (2023). *World health statistics 2023: monitoring health for the SDGs, Sustainable Development Goals*. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789240074323

Wolff C., Nikoletopoulos T., Hinkel J., and Vafeidis A. T. (2020). Future urban development exacerbates coastal exposure in the Mediterranean. *Scientific Reports*, *10*(1), 14420. doi: 10.1038/s41598-020-70928-9

Wolff C., Vafeidis A. T., Muis S., Lincke D., Satta A., Lionello P., Jimenez J. A., Conte D., and Hinkel J. (2018). A Mediterranean coastal database for assessing the impacts of sea-level rise and associated hazards. *Scientific Data*, *5*(1), 180044. doi: 10.1038/sdata.2018.44

Wöppelmann G., Le Cozannet G., De Michele M., Raucoules D., Cazenave A., Garcin M., Hanson S., Marcos M., and Santamaría-Gómez A. (2013). Is land subsidence increasing the exposure to sea level rise in Alexandria, Egypt? *Geophysical Research Letters*, *40*(12), 2953–2957. doi: 10.1002/grl.50568

Wöppelmann G., and Marcos M. (2012). Coastal sea level rise in southern Europe and the nonclimate contribution of vertical land motion. *Journal of Geophysical Research: Oceans*, *117*(C1). doi: 10.1029/2011jC007469

Xu R., Yu P., Abramson M. J., Johnston F. H., Samet J. M., Bell M. L., Haines A., Ebi K. L., Li S., and Guo Y. (2020). Wildfires, Global Climate Change, and Human Health. *New England Journal of Medicine*, *383*(22), 2173–2181. doi: 10.1056/nejmsr2028985

Yang Y., Javanroodi K., and Nik V. M. (2022). Climate Change and Renewable Energy Generation in Europe—Long-Term Impact Assessment on Solar and Wind Energy Using High-Resolution Future Climate Data and Considering Climate Uncertainties. *Energies*, *15*(1), 302. doi: 10.3390/en15010302

Yeğen V., Uysal R., Yağcı A., Cesur M., Çetinkaya S., Bilgin F., Bostan H., and Yağcı M. (2015). New records for distribution of invasive topmouth gudgeon (Pseudorasbora parva Temminck & Schlegel, 1846) in Anatolia. *Journal of Limnology and Freshwater Fisheries Research*, *1*(1), 57–61. https://dergipark.org.tr/en/download/article-file/181164

Yılmaz G., Çolak M. A., Özgencil İ. K., Metin M., Korkmaz M., Ertuğrul S., Soyluer M., Bucak T., Tavşanoğlu Ü. N., and Özkan K. (2021). Decadal changes in size, salinity, waterbirds, and fish in lakes of the Konya Closed Basin, Turkey, associated with climate change and increasing water abstraction for agriculture. *Inland Waters*, *11*(4), 538–555. doi: 10.1080/20442041.2021.1924034

Zagaria C., Schulp C. J. E., Malek Ž., and Verburg P. H. (2023). Potential for land and water management adaptations in Mediterranean croplands under climate change. *Agricultural Systems*, *205*, 103586. doi: 10.1016/j.agsy.2022.103586

Zamir R., Alpert P., and Rilov G. (2018). Increase in weather patterns generating extreme desiccation events: implications for Mediterranean rocky shore ecosystems. *Estuaries and Coasts*, *41*, 1868–1884. doi: 10.1007/s12237-018-0408-5

Zanchettin D., Bruni S., Raicich F., Lionello P., Adloff F., Androsov A., Antonioli F., Artale V., Carminati E., Ferrarin C., Fofonova V., Nicholls R. J., Rubinetti S., Rubino A., Sannino G., Spada G., Thiéblemont R., Tsimplis M., Umgiesser G., ... Zerbini S. (2021). Sea-level rise in Venice: Historic and future trends (review article). *Natural Hazards and Earth System Sciences*, *21*(8), 2643–2678. doi: 10.5194/nhess-21-2643-2021

Zittis G., Almazroui M., Alpert P., Ciais P., Cramer W., Dahdal Y., Fnais M., Francis D., Hadjinicolaou P., and Howari F. (2022). Climate change and weather extremes in the Eastern Mediterranean and Middle East. *Reviews of Geophysics*, *60*(3), e2021RG000762. doi: 10.1029/2021rg000762

Zittis G., Hadjinicolaou P., Almazroui M., Bucchignani E., Driouech F., El Rhaz K., Kurnaz L., Nikulin G., Ntoumos A., Ozturk T., Proestos Y., Stenchikov G., Zaaboul R., and Lelieveld J. (2021). Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa. *Npj Climate and Atmospheric Science*, *4*(1), 20. doi: 10.1038/s41612-021-00178-7

Information about the authors

Coordinating Lead Authors

Lena REIMANN, Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, *The Netherlands.* Department of Built Environment, School of Engineering, Aalto University, *Finland*
Ourania TZORAKI, Marine Sciences Department, School of the Environment, University of the Aegean, *Greece*

Lead Author

Dias HARALAMBOPOULOS, Department of the Environment, School of the Environment, University of the Aegean, *Greece*
Manfred A. LANGE, Energy, Environment and Water Research Center (EEWRC), The Cyprus Institute, *Cyprus*
Maya NEGEV, School of Public Health, University of Haifa, *Israel*
Alejandra RODRIGUEZ ENRIQUEZ, Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, *The Netherlands*. Coastal Risks and Engineering Lab, University of Central Florida, *USA*. School of Geosciences, University of South Florida, *USA*
Cecilia ZAGARIA, Institute for Environmental Studies, Vrije Universiteit Amsterdam / Farming Systems Ecology Group, Wageningen University & Research, *The Netherlands*

Contributing Authors

Tuba BUCAK, Aarhus University, *Denmark*
Shlomit PAZ, School of Environmental Sciences, University of Haifa, *Israel*
Ignacio PITA-VACA, MARine Biodiversity, Exploitation & Conservation (UMR MARBEC), Université de Montpellier, *France*

Key challenges for security: conflict and cooperation in the Mediterranean

4

Coordinating Lead Authors
Vally KOUBI *(Switzerland/Greece)*, **Jürgen SCHEFFRAN** *(Germany)*

Lead Authors
Paola VESCO *(Norway)*

This chapter should be cited as:
Koubi, V., Scheffran, J., Vesco, P., 2026. Key challenges for security: conflict and cooperation in the Mediterranean. In: *Environmental change, conflict, and human migration in the Mediterranean Basin* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Reports. MedECC Secretariat, Marseille, France, pp. 131-157. doi: 10.5281/zenodo.14800694

Chapter 4
Key challenges for security: conflict and cooperation in the Mediterranean

Executive summary 133

4.1 Geopolitics, security risks, and conflicts in the Mediterranean region 134

4.2 The interaction between environmental change and conflict: empirical foundations 136

4.3 Climate and conflict projection 141

4.4 Conflict and migration 143

4.5 Conflict, climate hazards, vulnerability, and adaptation 145

4.6 Conflict resolution, climate governance, and environmental peacebuilding 148

References 151

Information about the authors 157

Executive summary

Environmental change[53] contributes to intra-state conflict risk in specific contexts including poverty, institutions, and poor state capacity.

Environmental changes could increase inter-state conflicts or cooperation, depending on the ability and resources of the existing institutional frameworks to accommodate these changes.

The compound effects of conflict and climate hazards may lead to a vicious circle of temporally- and spatially-dependent risks that amplify the vulnerability of exposed societies and further increase the likelihood of conflict.

Climate adaptation initiatives may foster cooperation if carefully planned but may also increase the risk of conflict if poorly designed.

[53] The term 'environmental change', if not explicitly stated otherwise, is used to refer to changes in terrestrial and marine ecosystems as well as changes in climate conditions at local, regional or global scales.

4

4.1 Geopolitics, security risks, and conflicts in the Mediterranean region

This chapter reviews existing empirical studies focusing on the relationship between environmental change (including changes in climatic conditions) and conflict in the Mediterranean, with linkages to migration and geopolitics. Conflict is broadly defined as collective actions of varying levels of intensity driven by diverging political interests, from low-intensity or social conflict, such as protest and non-lethal riot events, to civil conflict and war, to inter-state war. In line with the existing literature on climate and conflict, climate is here understood as encompassing three categories of phenomena: (1) climate change, defined as gradual changes in average weather conditions occurring over multiple decades and centuries (IPCC 2023); (2) climate variability, that refers to short-term changes in weather patterns, such as variations in temperature and precipitation; (3) extreme weather and climate events whose frequency and intensity are affected by climate change, such as droughts, floods, and storms (see *Chapter 2* for more details).

The Mediterranean region, including Southern Europe, and parts of the Middle East and North Africa (MENA), has from ancient times been a hotspot of geopolitical conflict at the intersection of three continents: Africa, Asia, and Europe. The Mediterranean Sea connected and separated the spheres of influence of major powers and their power projections, as witnessed during both World Wars, the Cold War, and in the Israel-Hamas war and crisis in Gaza. In the 21st century, geopolitical landscapes and transformation processes have become increasingly complex, linking multiple scales, actors, and dimensions of extended securitisation (Ehteshami et al. 2017).

The Middle East as part of the MENA region[54] remains at the centre of some of the world's most intractable conflicts and security dilemmas and lacks effective regional security structures (Sørli et al. 2005). A quantitative study based on the Uppsala Conflict Data Program (UCDP) finds 347 'conflict years' in the Middle East from 1946 to 2018 (Deitch and Valensi 2020). Many of these conflicts show a high level of intensity and international involvement, complicating peaceful conflict resolution. From 2012, there has been a major increase of fatalities in the MENA region, mostly driven by the Syrian civil war (Dupuy et al. 2017) *(Figure 4.1).* These estimates are likely to grow due to the conflict between Israel and Palestine, which has caused 4470 battle-related deaths as of December 2023 (UCDP candidate event dataset v23.1: Hegre et al. 2020).

There are numerous entangled conflicts between state and non-state actors. They are rooted in colonial legacies, and their main causes are ethnic, ideological, and religious tensions, regional and global power competition, and the fragility of countries with low levels of democracy (Sørli et al. 2005). Prominent cases are the Israeli-Palestinian conflict; the Iran-Iraq War; the First (1991) and Second (2003) Gulf Wars; the violent civil wars in Syria, Libya, and Yemen; and the struggle between Saudi Arabia and Iran (Deitch and Valensi 2020). In Southern Europe, the Balkan civil wars of the 1990s and tensions between Greece and Türkiye should be noted. Violent acts by non-state actors have included terrorist attacks by Al-Qaeda and the Islamic State, among others, with consequences beyond the Mediterranean region. Other consequences of conflicts spilling over to neighbouring regions in Europe, the Sahel, and Western, Central, and Southern Asia include migration and involuntary displacement, economic and political destabilisation, and trade in goods and arms (Ehteshami et al. 2017).

Of particular importance were the popular uprisings of the Arab Spring in 2011. What started as a democratic movement triggered a cascade of conflict events in the following years that 'deepened regional instability, fanned existing conflicts, and sparked new turmoil' (Deitch and Valensi 2020), leading to the fall of political regimes in Tunisia, Egypt, Libya, and Yemen, and to a prolonged civil war in Syria. Other countries that did not directly experience turmoil (Bahrain, Iraq, Jordan, Lebanon) are facing ongoing instability and intractable conflict, making the MENA

[54] Although this Analysis focuses primarily on the Mediterranean region, it also draws on data from the Mediterranean Basin, the Eastern Mediterranean and Middle East (EMME), and the broader Middle East and North Africa (MENA) region (also referred to as Southern and Eastern Mediterranean Countries). In this Analysis, the MENA region refers specifically to countries bordering or closely connected to the Mediterranean Sea.

region a fragile, chaotic, and violent arena, sensitive to multiple security risks.

In addition to hard security threats involving violence, militarisation, and arms races, the Mediterranean region is experiencing 'soft security' risks associated with energy and climate change, environmental degradation and resource scarcity, population growth and migration, health, and development. Climate change has been described as a risk multiplier interwoven with the region's geopolitical dimensions (Scheffran 2021). Global warming poses additional stress on vital sectors (agriculture, forestry, fisheries, tourism, health, and electricity generation), especially in Mediterranean countries with high vulnerabilities and low adaptive capacities, diminishing agricultural production, income, and food security. The shrinking resource base undermines human livelihoods and development opportunities for a growing population, and contributes to unemployment, poverty, economic recession, weak governance, and political instability,

which are potential drivers of violence and conflict (Scheffran 2021). In the following, potential pathways between climate change and violent conflict are discussed based on empirical literature.

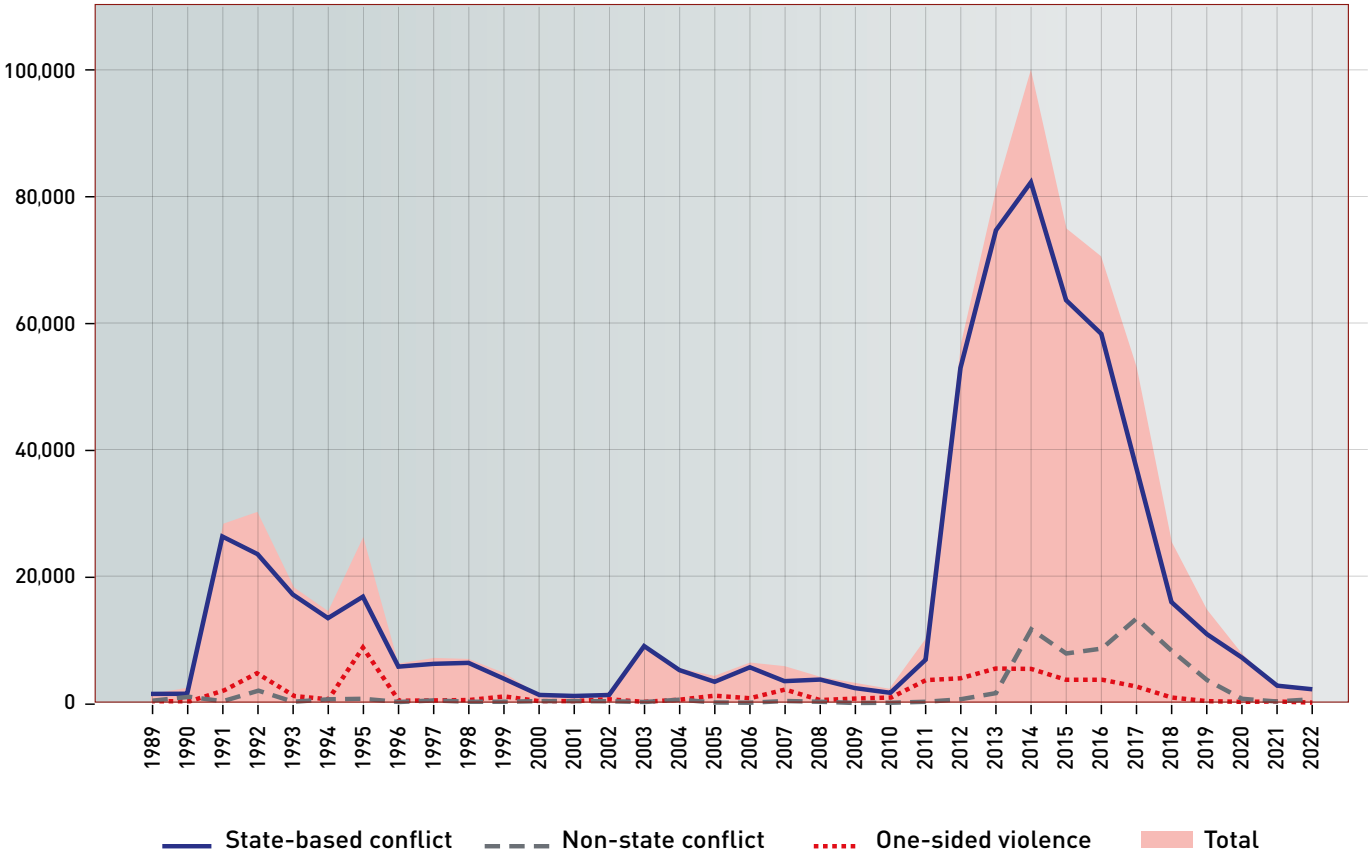


Figure 4.1 | Number of battle-related deaths between 1989 and 2022 in the Mediterranean. Source: Uppsala Conflict Data Program (UCDP), Davies et al. (2023).

4.2 The interaction between environmental change and conflict: empirical foundations

While climate and (civil) conflict appear to be correlated *(Figure 4.2),* the interactions between climate change and conflicts result in the most severe impacts in countries or regions that are poor and highly dependent on agriculture for income and food production (Koubi 2019).

Major changes in weather patterns, in particular drought conditions, have coincided with the collapse of several previously powerful civilisations in the Aegean and Eastern Mediterranean (Kaniewski et al. 2015), as well as of empires such as the Akkadian Empire (Weiss et al. 1993; Weiss 2017; Carolin et al. 2019; Watanabe et al. 2019), and the Ottoman Empire (Kaniewski et al. 2015). Moreover, several studies provide evidence for a climate-conflict relationship associated with reduced agricultural production across many centuries. The Little Ice Age appears to have been associated with more cases of political upheaval and warfare in the Ottoman (White 2011; Haldon et al. 2014) and Byzantine (Xoplaki et al. 2016) Empires. In particular, the Gelali rebellions between 1550 and 1603 were reactions to social and economic crises stemming in part from climatic hardship associated with the Little Ice Age (see *Chapter 2, Section 2.5.1*). This evidence from historic antecedents, however, cannot be taken to suggest that recent or future changes in climate would lead to large-scale political collapse, mainly due to globalisation in the contemporary world (Butzer 2012).

Most of the recent research on the connections between climate change and conflict focuses on the effects of climate variability — mainly temperature, precipitation, and, to a lesser extent, extreme weather events as proxies for the kinds of longer-term changes that might occur due to climate change — on inter-state and intra-state conflict. Examples include civil conflict and/or civil war, communal violence, and low intensity conflict such as demonstrations, protests, and riots (Koubi 2019; Buhaug et al. 2023). A meta-analysis based on 60 studies finds that deviations from mild temperatures and normal precipitation systematically increase conflict risk, often substantially (Hsiang et al. 2013; see also Hsiang and Burke (2014) for another

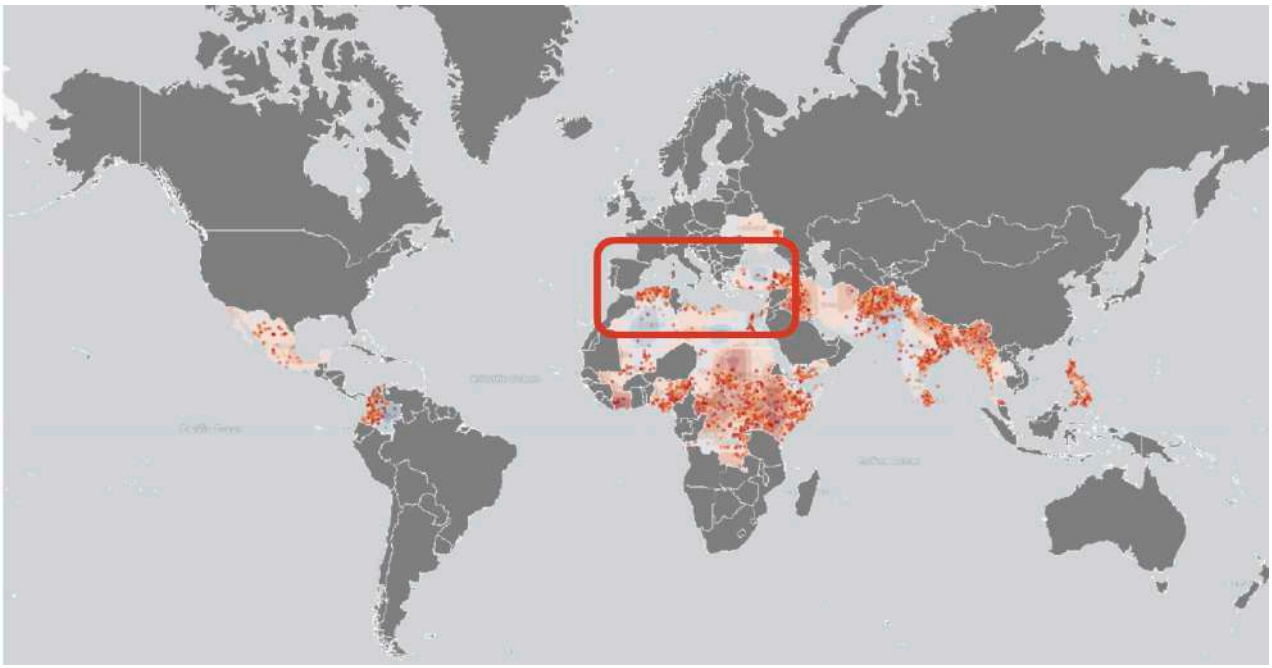


Figure 4.2 | Palmer Drought Severity Index (PDSI) (2005–2014) and location of armed conflict events (1989–2014). Results are screened for countries with more than one recorded armed conflict event per year. Red and blue shades represent drought and wet regions. Younger conflicts are shaded darker (red) than older conflicts (orange/yellow). Data: National Oceanic and Atmospheric Administration (NOAA) PDSI and Uppsala Conflict Data Program (UCDP) Georeferenced Event Dataset (GED). Adapted from Koubi (2019).

meta-analysis of 50 studies). However, this study has been criticised because its conclusion is misleading and at odds with recent empirical evidence (Buhaug et al. 2014). The UN Intergovernmental Panel on Climate Change Fifth and Sixth Assessment Reports (IPCC AR5; IPCC AR6) support the assessment of Buhaug et al. (2014) and assert that climatic changes can indirectly increase the risk of conflict by amplifying well-documented drivers such as socio-economic conditions. According to a global expert elicitation, major drivers for conflict risk include low socio-economic development, low state capabilities, intergroup inequality (e.g. ethnic differences), and recent history of violent conflict (Mach et al. 2019). Despite high uncertainty and the low ranking of climate as a conflict driver per se, growing climate variability and extreme climate events may exacerbate existing drivers of violent conflict. Abrupt climate-related events tend to have an indirect and conditional influence on conflict risk, for example through economic shocks, or by reducing the availability of natural resources, which in turn negatively affects agricultural productivity, food prices, and long-term socio-economic development (Mach et al. 2019, 2020).

Besides extreme weather events and environmental migration, potential indirect mechanisms and pathways linking climate and conflict include the degradation of natural resources. This includes the quality and availability of water and food, forests and biodiversity, and arable land and livestock, as well as combinations thereof, which are often locally constrained and associated with low-intensity farming (i.e. a low level of inputs used by the farm per unit of production factor) involving different land user groups (Buhaug et al. 2023). Exploring the complex linkages between climate variability, agricultural production, and the incidence of armed conflicts provides insights into how food resources affect violent conflict (Vesco et al. 2021). Long–term economic development and stability depend on access to and preservation of natural resources. These resources are vulnerable to climate-related hazards, with socio-economic and political consequences, which can spread across borders through spillover effects such as human displacement and social unrest (Scheffran et al. 2019). The situation is particularly critical in fragile and failing states, that is states characterised by agriculturally dependent and predominantly rural societies, social fragmentation, inadequate governance, and poor management capacities — typical of many Mediterranean countries.

There is, however, limited research on the climate-conflict nexus in the Mediterranean region, with contradictory results that differ according to the context under investigation, research design, methodological choice, and scope conditions used by the study. Different empirical cases help to understand the complexity of this relationship. For instance, climate variability measured as a deviation of the current level of precipitation and temperature from their past long-term levels did not affect the onset of armed conflict during the 1997–2009 period (Böhmelt et al. 2014). In addition, population pressure, agricultural productivity, and economic development were likely to have a stronger impact on water conflict risk than climate variability. The authors conclude that violent water conflicts are extremely rare, and that factors conducive to restraint, such as stable political conditions, may in fact stimulate cooperation. More recently, a study of civil conflicts in Africa and the Middle East for the 1992–2012 period finds that abnormally high temperatures decrease conflict risk in the Middle East, while they increase it in Africa. They also find that conflict risk peaks at about 32°C, which suggests that warm temperatures increase aggression to a certain point, beyond which they reduce it. In ad-dition, and more in line with expectations, more rainfall and above-average crop yields[55] decrease conflict risk (Helman et al. 2020). These heterogeneous findings led the authors to caution against broad conclusions regarding the climate-conflict links. Another study for countries in Africa and the Middle East region for the period between 1990 and 2017 finds that while long-term warming (trends and means) did not affect armed conflict, short-term changes either in temperature or precipitation (annual deviations) increased political instability and/or violent conflict. The authors conclude that their findings show that projected warming and increasing temperature

[55] In this study, crop yield production is proxied by the EVI2 vegetation index during the growing season. EVI is a satellite-based indicator of vegetation cover.

variability may increase violence in these regions, yet there is a need to understand the mechanisms of climate-conflict relationships (Helman and Zaitchik 2020).

Another study examines the relationship between climate change and political instability in 18 MENA countries for the period 1985–2016, using monthly data (Sofuoğlu and Ay 2020). It shows that abnormally warm years increased political instability and violence in countries already experiencing conflict, thus supporting the notion that climate change acts as a threat multiplier in MENA countries. A very recent study aims to identify the impact of rainfall variability on conflict incidence and onset, using a global panel dataset for the years 1989–2020 — including countries from the MENA region. This study shows that an increase in monthly rainfall decreases the risk of conflict incidence, but annual rainfall variability is not significantly linked to either conflict incidence or outbreak (Coulibaly and Managi 2022).

Climatic changes could also increase inter-communal violent events, such as conflict between herders and farmers or among pastoralists, by affecting their coping strategies to secure water and foliage. Given that most farming and pastoralism in Africa, including in the MENA region, are highly dependent on rainfall, reduced precipitation and resultant lower groundwater levels may contribute to an increased likelihood of conflict. In a common narrative, drought is pushing pastoralists to the farmlands of sedentary communities in search of forage, triggering dispute, violence, and conflict especially in areas lacking functioning conflict management. Detges (2014) shows that fighting is more likely to occur close to well sites in northern Kenya. Similarly, Döring (2020a) examines the impact of precipitation and groundwater access on violent communal conflict in the Middle East and Africa for the 1990–2014 period. The author finds that a lack of access to groundwater increases the likelihood of communal violence, and this effect is conditioned by precipitation levels and population density. Moreover, state presence and the provision of public goods dampen the effect of difficult groundwater access on conflict.

Regarding low-intensity conflict, Ide et al. (2020a) examine the effect of drought on the onset of non-violent, water-related conflict in the MENA region between 1996 and 2009. They report that conflicts over water cannot generally be linked to drought, because their findings show that pre-existing social divisions combined with either autocratic political systems or the reduction of public water supply are crucial factors in distinguishing between peaceful and conflictual locations, while economic development is less relevant.

A growing body of research examines the connections between extreme weather events, such as storms, floods, or droughts, and conflict (Schleussner et al. 2016; Ide et al. 2020b). These events can cause or worsen scarcity, by damaging public and private infrastructure, destroying crops, and killing livestock, subsequently leading to conflict. The direct association between natural disasters and armed conflict is contested. On the one hand, Vestby (2019) analyses Afrobarometer[56] data in which respondents were asked about their participation in politically-motivated violence, as well as how their living conditions had changed over the past year (using the Standardised Precipitation Evapotranspiration Index (SPEI)[57]). The study finds that individuals who had experienced a deterioration in living conditions due to droughts are more likely to use force or violence for a political cause. On the other, Feitelson and Tubi (2017) examine the effect of the extreme 2007–2010 drought on armed conflict in the Euphrates and lower Jordan River basins and find that, except for Syria, and the consequent spillover into Iraq, droughts do not constitute a main driver of armed conflict in the Middle East. They conclude that droughts may lead to conflict when more fundamental factors, especially adaptive capacity, have been compromised.

There is also some evidence that widespread disasters generate solidarity and cooperation rather than conflict. For instance, Tubi and Feitelson (2016) examine conflictual and cooperative

[56] https://www.afrobarometer.org/

[57] https://spei.csic.es/

interactions between Muslim Bedouin herders and Jewish agricultural settlements in Israel's semi-arid northern Negev region during the drought between 1957 and 1963. They find that while the interactions between these two groups ranged from violent clashes to extensive cooperation and assistance, conflict was limited. The measures taken by state institutions to directly reduce friction and provide relief assistance were central to the overall limited level of conflict. Finally, Döring (2020b) uses disaggregated event data covering the Mediterranean area and the greater MENA regions for the period between 1997 and 2009 to examine the effect of water scarcity on incidences of domestic water cooperation. He finds that low groundwater tables increase the chance of both conflictual and cooperative events over water, as well as state- and non-state-initiated cooperative events, with effects being more pronounced for the water scarce Arab region. Moreover, the effect of groundwater in fostering non-state-initiated cooperative events holds only in regimes characterised by lower political participation, while state-initiated cooperative events are more likely in areas that have recently experienced an armed conflict. Finally, precipitation and agricultural droughts are found to have a negligible and insignificant effect on water-related interactions (conflictual, neutral or cooperative), as well as state- and non-state-initiated water cooperation.

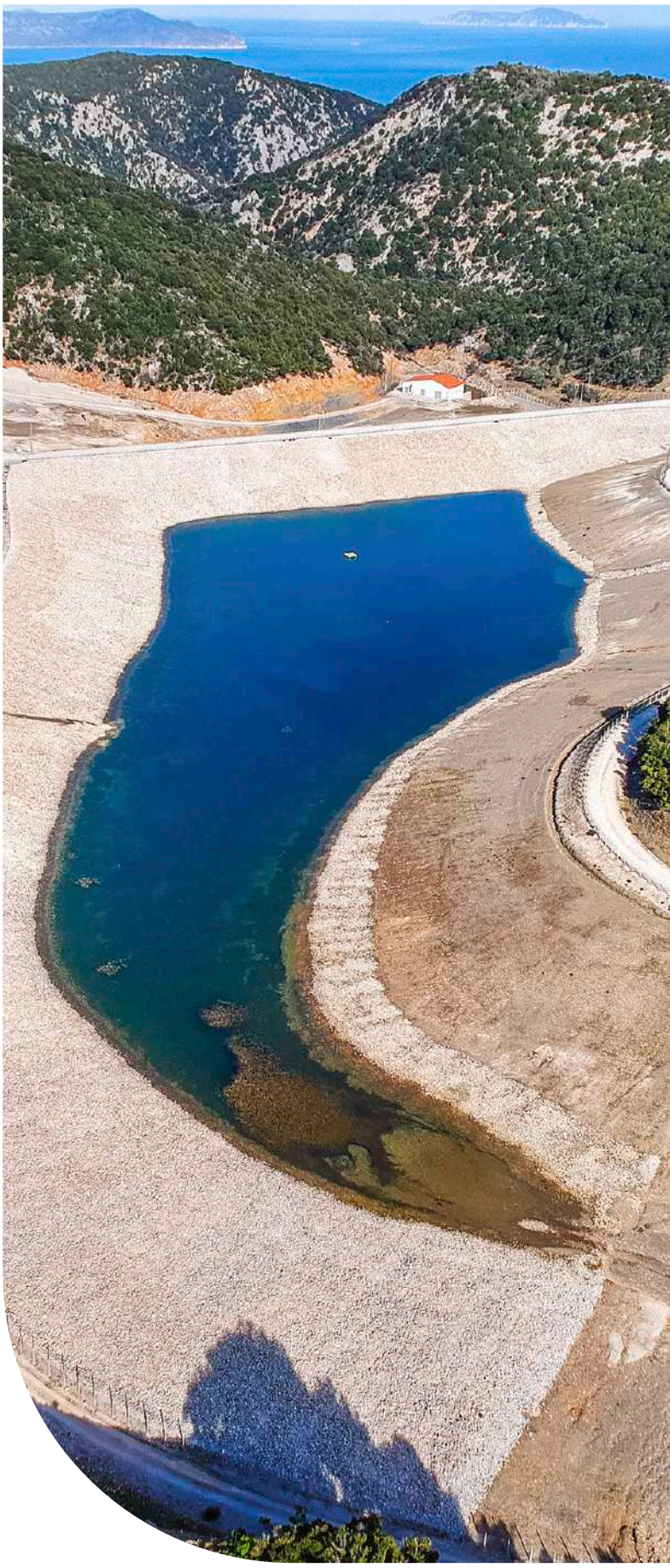
Several recent studies identify a causal link between higher food prices, caused by climate-induced changes to agricultural production, and social unrest in Africa (Berazneva and Lee 2013; Raleigh et al. 2015), while Buhaug et al. (2015) do not find support for such a relationship. Rising food prices associated with extreme weather events in crop producing regions (notably in China and Russia) are considered to have played a significant role in fomenting the Arab Spring unrest across North Africa and the Middle East in 2011 (Sternberg 2012; Newman 2018) where protests and riots led to political change in Egypt, Libya, and Tunisia (Sottilotta 2015). However, others show that such forms of violence are triggered more by a complex set of political and economic factors combined with government failures than by single factors such as higher food prices (Sneyd et al. 2013; Devarajan and Ianchovichina 2018; Al-Shammari and Willoughby 2019). Food security policies adopted by a specific government helped to avert revolution, as seen in Morocco compared to Egypt and Syria (Soffiantini 2020).

More controversial is the Syrian civil war, where there is no consensus on the role of climate as a contributing factor. Before the Syrian rebellion started in 2011, a prolonged drought hit the Fertile Crescent region (2007 to 2009). The drought exacerbated the vulnerability of rural populations, increased agricultural losses, and forced deprived farmers to move from rural areas to the capital, thereby elevating tensions and pressures on an autocratic system with poor management and governance. The role of climate variability in the Syrian conflict is therefore disputed. Some studies highlight the catalytic effect of the drought on the conflict (Gleick 2014; Kelley et al. 2015), while others contest the drought's impact and instead blame failed government policies for the escalation of tensions (Selby et al. 2017; Daoudy 2020). Reviewing the evidence, Ide (2018) concludes that there is poor understanding of whether large economic losses or rural-urban migration were relevant in the urban unrest. While environmental factors may have played a role in the early phase, political factors, such as the repressive response by the regime, were more clearly associated with the protests and escalation. Other destabilising drivers were the US invasion of Iraq in 2003, the Arab Spring, regional power rivalries, and the emergence of the 'Islamic State'. In fact, neighbouring countries like Jordan, which also suffered from the drought, did not experience a civil war. These competing claims indicate that compounding and cascading effects in both natural and social processes preclude simple statements on dominant or even single causal mechanisms in the Syrian or conflict, or others. Eklund et al. (2022) show that an agricultural collapse cannot be substantiated, as croplands in Syria experienced a fast recovery after the 2007–2009 drought, questioning the drought-migration-conflict narrative for the Syrian civil war.

Finally, some studies examine whether climatic events can increase the probability of inter-state conflict by reducing the supply of water in transboundary river basins. Despite the threat of 'water wars' prominently featured in the media and policy discourse since the early 1990s, shrinking shared water resources, while potentially contributing to tensions, threats, and even some localised violent episodes, are unlikely to lead to

war (Wolf 2007). In fact, joint precipitation scarcity is found to reduce the likelihood of inter-state militarised dispute (Devlin and Hendrix 2014), as water scarcity enhances the incentives of riparian states to cooperate, rather than to fight (Dinar et al. 2011). In addition, research shows that the risk of conflict is further mitigated by the liberal institutional and economic structures of riparian states (Feitelson and Tubi 2017), commercial treaties (Dinar et al. 2015), the behaviour of upper riparian states (Feitelson and Tubi 2017) and upstream-downstream relations (Munia et al. 2016), the existence of transboundary treaties (Tir and Stinnett 2012), the number of agreements between riparians states (Dinar et al. 2019), the specific design of international water agreements (Dinar et al. 2015), and institutional frameworks for flexible but specific water allocation mechanisms (Dinar et al. 2015; Oktav 2017).

While research shows that in the context of transboundary freshwater resources, the prevailing response is cooperation, non-violent conflict is nevertheless quite frequent (Bernauer and Böhmelt 2020). Conflict is possible within a basin in the absence of transboundary institutional mechanisms able to manage the effects of rapid or extreme change to physical or institutional systems (Wolf et al. 2003). Dams and water infrastructure, while able to help manage water variability and provide water in times of drought, or dampen the effects of floods, can also substantially change the hydrological function of the basin where they are built (see also *Section 4.5*). Overall, hydrological disputes in the Euphrates, Jordan, Nile, and Tigris River basins are more often seen as part of territorial security and development-related concerns than as a genuine water issue (Link et al. 2016). However, climate change may affect future inter-state relations and undermine the stability of existing water institutions where they are incapable of accommodating change (Dinar et al. 2015; Ide et al. 2016; De Stefano et al. 2017). A systematic review of empirical research on the complex relationship between abrupt climate events and violent conflict in the MENA region suggests several avenues for future research, including the implications of floods and heat waves, non-agricultural sectors such as the critical oil and gas sector, society's ability to cope with weather extremes, and prior governmental mismanagement of land, water, and conflict dynamics (Kim and Garcia 2023).



4.3 Climate and conflict projection

Although climate has not had a straightforward impact on the risk of conflict in the Mediterranean thus far, a future characterised by increasing temperature and more severe and frequent extreme climate events may increase the likelihood of conflict. A growing body of literature aims to predict the extent to which climate change will affect conflict in the decades to come. The most relevant projection studies for the region of interest are summarised in *Table 4.1*. An increasing number of these analyses rely on machine learning tools, which are sufficiently flexible to avoid parametric assumptions, while also accounting for the interactive effects that characterise the climate-conflict nexus (Ge et al. 2022; Xie et al. 2022).

Among existing studies that predict the impact of climate on conflict, only a handful focus on short-term predictions for one to five years ahead, while the majority investigates long-term, multi-decadal impacts throughout the 21st century, using climate and socio-economic scenarios in line with the RCP-SSP framework developed by the IPCC (2021). Existing short-term forecasting studies report that climate and environmental variables marginally contribute to predicting armed conflict, and their role is modest compared to poverty, agricultural dependence, population density, level of socio-economic development, ethnic fractionalisation, and other drivers of societal vulnerability (Theisen et al. 2021). This is in line with empirical research showing that climate only has a contextual and indirect influence on the risk of conflict, which is highly dependent on the vulnerability of the affected population (Buhaug and von Uexkull 2021). Similarly, the final report of the Sahel Predictive Analytics initiative led by UNHCR lists societal vulnerability to climate hazards, and especially climate-driven challenges to food and livelihoods, as a main driver of conflict risk in the short-term future (Blocher et al. 2022). Such studies are also relevant for the wider MENA region.

Long-term projections largely confirm a minimal and indirect contribution of climatic drivers to predicting conflict risk in the region. For example, using an open-source machine-learning model, Hoch et al. (2021) find that the importance of hydro-climatic indicators is limited compared to socio-political and historical conflict predictors. However, the influence of climatic indicators is expected to vary according to different climate scenarios and across locations.

Simulations generally find the African part of the Mediterranean to remain at low risk of violence (Busby et al. 2014; Hoch et al. 2021) relative to conflict-ridden Sahel and Sub-Saharan Africa (Hendrix and Glaser 2007; Witmer et al. 2017; Petrova et al. 2023). In the North African region, Hoch et al. (2021) predict that the provinces of El Oued and Ouargla in Algeria, and southwestern areas of Morocco bordering West Sahara, have the highest probability of climate-related conflict in North Africa. This is seen particularly under pessimistic climate scenarios, which assume a global temperature increase of between 2.7°C and 3.6°C by the end of the century. Increased temperatures by the end of the century are expected to negatively impact agricultural production. This could, in turn, contribute to rising food prices and food insecurity, leading to protests and riots against the government (see also Waha et al. 2017; Scheffran et al. 2019).

Due to the strong dependence of North African countries on agriculture for their Gross Domestic Product (GDP) and employment, climate change can undermine food security, economic stability, resilience, and overall livelihood prospects in the region, indirectly contributing to social instability. A possible strategy to mitigate climate change impacts on security is therefore to reduce economic and livelihood dependence on rain-fed agriculture, strengthen sustainable land use practices, and increase adaptive capacity and regional cooperation (Schilling et al. 2020). Although climate change may increase the risk of violence in some parts of Algeria and Morocco within North Africa (Schilling et al. 2020; Hoch et al. 2021), the overall region will continue to be more stable than Sub-Saharan Africa and the Sahel: Morocco and Tunisia are predicted to experience lower risks of climate-related conflicts than other African countries by 2050 (Busby et al. 2014). Projections show that Africa as a whole is likely to continue to be burdened by conflict throughout the century. For example, Burke et al. (2009) project that a 1°C temperature increase across the continent will lead to a 54% rise in the average likelihood of conflict in Sub-Saharan Africa, corresponding to a total of additional 393,000 battle deaths by 2030. However, Buhaug (2010) shows that this result is not robust to alternative model specifications, and finds that climate variability, measured as interannual growth

and deviation from annual mean precipitation and temperature, is a poor predictor of civil conflict. These contradictory findings not only reflect the complexity of the relationship between climate change and conflict; they may also be driven by the uncertainties that characterise long-term projections of complex social phenomena, especially due to data limitations and challenges in the validation and testing of model results.

Projections for the Middle East similarly point to a higher risk of climate-related conflict than for North Africa. Combining a literature review with simulations of regional climate impacts, Waha et al. (2017) find that under a 4°C warming scenario, the decline in agricultural productivity and resulting pressure on food and water resources are likely to induce rural to urban migration and trigger social unrest in the Mashreq and Maghreb regions.

An analysis of the compound effects of temperature and precipitation projections for the Middle East (Dezfuli et al. 2022) points to Tigris-Euphrates headwaters as a hotspot of future climate impacts in the region, due to a combination of high temperature, reduced precipitation, and increased rainfall variability. The authors highlight that in a situation of changing climate, the potential for water-related conflicts and migration is especially considerable around the southeastern Anatolia Project irrigation initiative, due to threats to project viability and impacts on downstream water security.

However, projections of conflict risk may be optimistic, and fail to incorporate the complexity and feedback loops that characterise the climate-conflict relationship, due to methodological challenges and data-related limitations. For long-term conflict projections, simplistic modelling assumptions may drive estimates of conflict risk down. For example, simulating armed conflict and economic growth simultaneously throughout the 21st century, Petrova et al. (2023) find that adjusting current economic projections by taking into account possible conflict impacts leads to 25% lower estimates of global average GDP growth, compared to existing economic projections that do not account for the negative effects of conflict on economic growth. As GDP is both a fundamental driver of armed conflict (see Collier 1998; Ward et al. 2010) and may be negatively affected by climate change, these findings suggest that current projections of conflict risk may be underestimated.

Table 4.1 | Overview of the empirical studies that forecast/project future climate-related conflict risks. The overview only includes studies from the region of interest.

Reference	Time horizon	Spatial scope	Methods	Conflict drivers	Conflict predictions in the Mediterranean region
Blocher et al. (2022)	2022	The Sahel	Machine learning models	Political, socio-economic and demographic variables	Low risk of conflict in Gambia, Guinea, Mauritania, and Senegal
Busby et al. (2014)	2060	Africa	Composite vulnerability modelling	—	The Nile Delta, and few hotspots in Morocco
Hoch et al. (2021)	2050	Africa	Machine learning models	The importance of climate indicators is limited compared to non-climatic predictors	El Oued and Ouargla in Algeria, southwestern areas of Morocco bordering Western Sahara, and Mauritania
Waha et al. (2017)	2090	MENA region	Combination of literature review and simulations of climate impacts	Pressure on resources could contribute to social unrest in the MENA region	Algeria and the Nile Delta

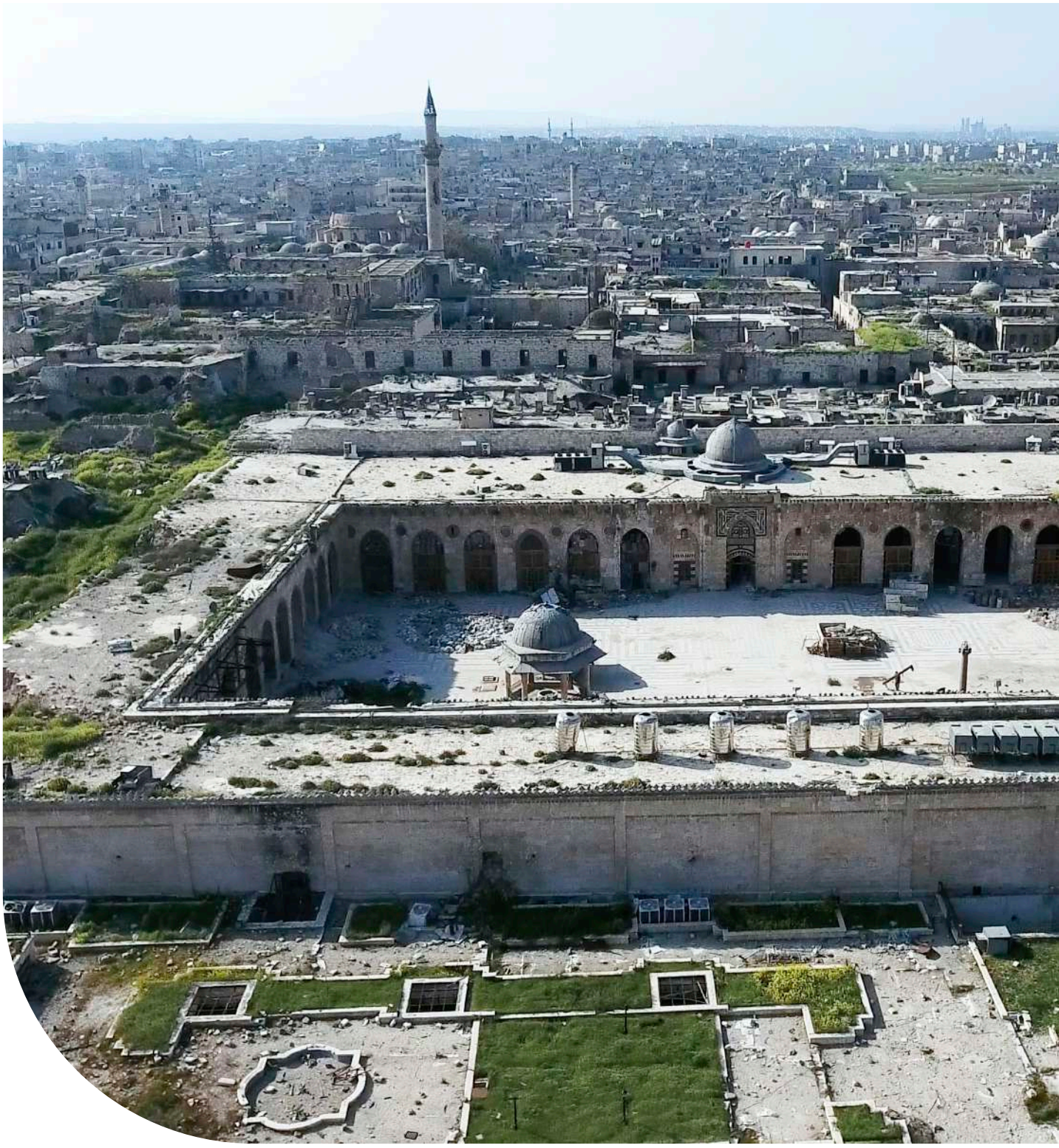
4.4 Conflict and migration

Existing research emphasises the role of conflicts in driving human migration decisions. In addition, most research on involuntary migration tends to conclude that displacement is an obvious consequence of conflict, and that people flee because they have no choice. The Internal Displacement Monitoring Centre (IDMC) of the Norwegian Refugee Council estimated that an unprecedented 53.2 million people were living in internal displacement because of conflict and violence at the end of 2021, across 59 countries and territories. Conflict and violence triggered one million internally displaced persons (IDPs)[58] in the MENA region in 2021, less than half of the 2.1 million recorded in the previous year, and the lowest figure for the region in a decade. The decrease was mainly the result of de-escalation conflict in Iraq, Libya, and Syria. While these countries continued to experience instability, conflict reignited in Gaza in May 2021, triggering more than 117,000 displacements, as well as small-scale displacements in Lebanon and Israel. In 2022, conflict in Syria and Yemen resulted in the displacement of 450,000 people. Across the region, the number of people living in displacement at the end of 2022 because of conflict and violence reached 12.7 million.

Conflict influences migration in direct and indirect ways. It can directly affect migration by causing civilians to perceive a higher level of threat than they are willing to tolerate. When faced with significant dangers and

[58] According to the Guiding Principles on Internal Displacement (UN 1998), internally displaced persons (IDPs) are 'persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized border.' See also: https://www.ohchr.org/en/special-procedures/sr-internally-displaced-persons/about-internally-displaced-persons

ongoing adversities associated with armed conflicts, many have no other option but to leave their homes (Davenport et al. 2003; Moore and Shellman 2004, 2006; Adhikari 2012). Conflict can also indirectly affect migration by reducing economic opportunities, since without sufficient income, many civilians choose to move (Betts 2013). Notwithstanding the debate over whether human migration is fundamentally different when violence or economics are the direct causes of migration, physical and economic insecurity are strong drivers of conflict-induced migration since they entail both motivation and opportunity (Schon 2019).



4.5 Conflict, climate hazards, vulnerability, and adaptation

The relationship between conflict, climate hazards, and vulnerability is inherently endogenous: both climate-related impacts and conflicts increase the vulnerability of exposed societies to future climate hazards (Buhaug and von Uexkull 2021). Conflicts have been associated with a number of detrimental impacts on societal development: they deteriorate livelihood and food security, impair physical and psychological health, and the well-being of exposed individuals, deteriorate access to freshwater, harm economic growth, and weaken educational attendance (Gates et al. 2012). Conflicts may thus turn climate hazards into disasters through amplifying risks and vulnerabilities across multiple institutional and temporal scales (Peters 2022). As illustrated in *Figure 4.3,* climate hazards and conflict might compound each other in a vicious circle, which traps affected societies in a spiral of recurring violence, increased vulnerability, and harmful climate impacts (Buhaug and von Uexkull 2021). Climate hazards and conflicts may both increase societal vulnerability to future hazards, but the effect of compound risks can be even more detrimental to exposed societies. Combined exposure to socio-political crises and extreme climate events can lead to a cascade of temporally- and spatially-dependent risks (Zscheischler et al. 2018), which may mutually reinforce and increase societal vulnerability to future hazards. As disasters are a product of social constructs beyond the natural event itself, the devastation induced by violence can contribute to shaping climate hazards into disasters (Peters 2022). The compound effect of violence and climate-related disasters may be more detrimental to societal vulnerability than the occurrence of a single event: it is not a coincidence that the most severe humanitarian crises occur in areas exposed to a combination of human and natural hazards (von Uexkull and Busby 2018).

However, studies of the impacts of conflict and climate hazards on vulnerability remain limited, and further efforts are necessary to better understand the 'human dimension' of the climate risk and conflict nexus (Augsten et al. 2022). Peters (2022) carried out in-depth interviews with Disaster Risk Reduction (DRR) experts in 25 conflict-affected countries, including in the Middle East, and found that conflicts exacerbate existing vulnerabilities and reduce coping capacities. This is caused by harming the physical and psychosocial well-being and health of affected households, disrupting and destroying livelihoods, destroying and damaging infrastructure, and forcing people to migrate. Similarly, Marktanner et al. (2015) use a cross-sectional time-series analysis on disaster deaths to assess how conflicts shape the impact of climate hazards. They find that the death toll from a disaster is, on average, 40% higher when it is followed by a conflict, and suggest that the legacy of a conflict casts a long shadow over a country's climate adaptive capacity.

Developing and implementing adaptation plans and initiatives may be a strategy for alleviating disaster and conflict risks (Tänzler et al. 2010). A regionally specific assessment of climate risks is a precondition for containing vicious circles of insecurity, violent conflict and forced migration (Cramer et al. 2018). Adaptation projects can help counter the effects of climate change on natural resources, food security, livelihoods, and the potential for economic loss (Pörtner et al. 2022), and as a result, reduce the conflict potential of climate variability. Nevertheless, existing empirical research has mostly disregarded the role of adaptation to climate as a component of human security (Babcicky 2013; Biagini et al. 2014). Most of these studies have implicitly assumed that by reducing climate change impacts, adaptation would reduce the risk of conflict (Tänzler et al. 2010). However, poorly designed adaptation, especially when inefficient, may also contribute to an increased potential for conflict. In this context, some theoretical studies have highlighted that since conflicts are not caused by climate change itself, but by human reactions to it (Babcicky 2013), adaptation projects might carry their own conflict potential independently of climate impacts (Scartozzi 2020). These studies have theorised that adaptation can cause unintentional changes to power structures, raise issues of distributive and procedural justice, and trigger resource competition, overall opening up new opportunities for armed conflict as well as for cooperation (Tänzler et al. 2010).

Adaptation may disproportionately affect some socio-economic, age, ethnic, or gender groups, trigger changes in resource availability or access to resources, and lead to shifting power structures and institutional changes (Biagini et al. 2014; Scartozzi 2020). The impact of external financial help to support adaptation projects may also contribute to rent-seeking and other forms of corruption in receiving countries, especially in systems characterised by

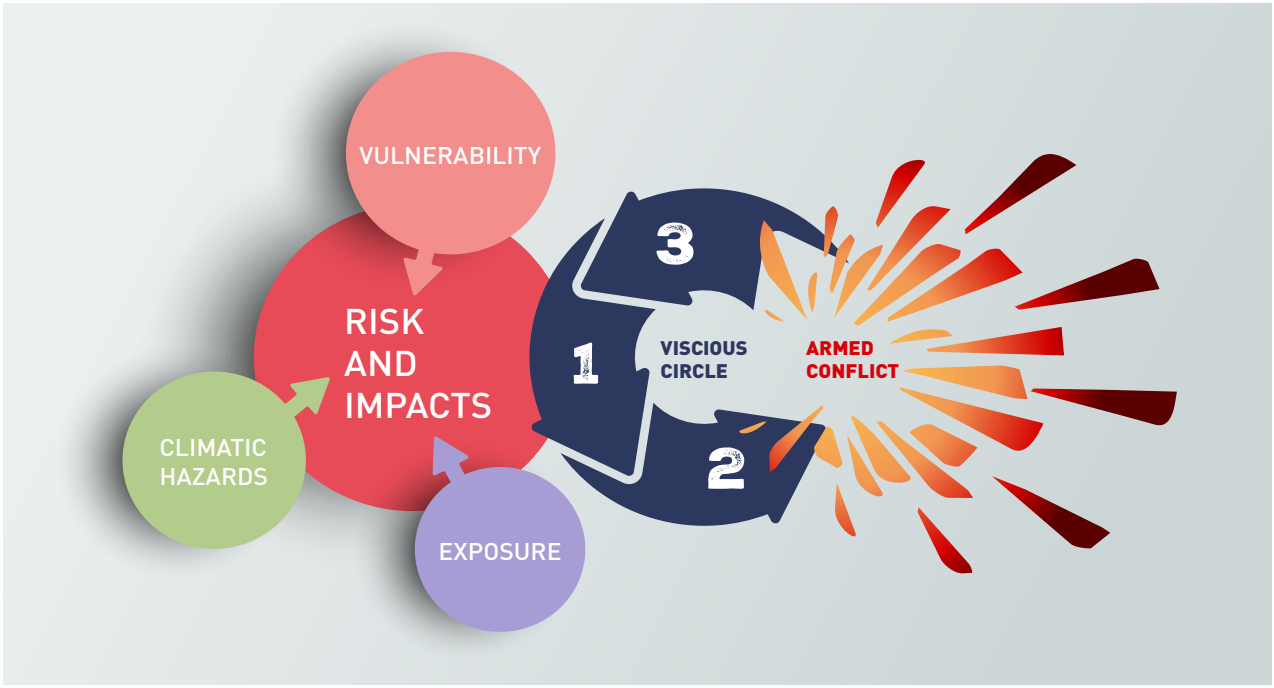


Figure 4.3 | Conceptual diagram illustrating the interlinkages between climate hazards, armed conflict, and societal vulnerability. Source: Buhaug and von Uexkull (2021).

weak governance. By and large, initiatives to adapt to the effects of climate change may have a destabilising potential, especially if critical competing interests are not taken into account during the planning process. It is therefore not unlikely that adaptation would lead to unexpected forms of conflict (Yanda and Bronkhorst 2011). For example, infrastructure projects such as dams or dykes may affect relationships between riparian states, as the construction of a dam may reduce the availability of water for downstream countries while benefiting upstream states. The construction of large dams in upstream riparian states without an agreement in place was found to be one of the strongest indicators of a basin's potential hydro-political tension (Wolf et al. 2003). The Nile river basin area is a case in point, showing evidence of both cooperative and conflictual relations across states, while hydro-politics in the region have generally fostered transboundary cooperation, as epitomised by the Nile Basin Initiative[59] (Homer-Dixon and Deligiannis 2009). The Ethiopian plan for a 'Grand Ethiopian Renaissance Dam' (GERD) in 2011 escalated tensions with Egypt around water security, adding to a climate of dispute between upstream and downstream states that had characterised negotiations in the early 2000s around the Nile River Basin Framework Agreement[60] (Tayie 2016). News of the GERD construction was greeted by violent protests in Egypt and strong rhetoric from Egyptian politicians (Gebreluel 2014). Similarly, the Turkish GAP project[61], involving the construction of 22 dams and 19 hydropower plants along the Euphrates River, spurred tension between Türkiye and downstream countries, Syria and Iraq, further aggravated by competition for leadership in the area (El-Fadel et al. 2002).

The risk of unintended negative effects in fragile contexts therefore needs to be addressed in the implementation of climate adaptation and mitigation policies. Successful transformation requires climate-sensitive and conflict-sensitive mitigation and

[59] https://nilebasin.org/

[60] https://nilebasin.org/about-us/cooperative-framework-agreement

[61] https://en.gap.gov.tr/page/about-gap/whats-gap/

adaptation that minimise the potential for conflict and resistance (Nadiruzzaman et al. 2022, 2023). Examples include land use conflicts with local communities over bioenergy (e.g. palm oil plantations), wind and hydro power, carbon capture and geoengineering, strategic metals, or construction of dams (Scheffran and Cannaday 2013). The challenge is to avoid these side-effects and to realise potential co-benefits and synergies between different institutions and frameworks towards integrated approaches. Sectoral organisations and multilateral institutions can facilitate access to climate finance mechanisms and implement integrated initiatives for resilience-building and humanitarian assistance, conflict prevention and environmental peacebuilding. Although adaptation remains underfunded, parties to UNFCCC COP 28 signalled renewed ambition for the Loss and Damage Fund and agreed on new funding arrangements for supporting developing countries that are particularly vulnerable to the negative impacts of climate change. These agreements represent a promising development in financing adaptation initiatives in the most vulnerable countries, and may encourage positive changes in the Mediterranean region.

4.6 Conflict resolution, climate governance, and environmental peacebuilding

Although the Mediterranean region lacks formal cooperative security institutions, avoiding climate-related instability and conflict is a high priority to prevent already fragile states from sliding into further conflict or instability. This is especially important in fragile countries that often have low adaptive capacity and climate finance, such as Syria, Lebanon, Libya, Iraq, and Egypt in the Mediterranean (according to the Fragile States Index) (Nasri et al. 2021).

The environmental peace literature investigates how environmental cooperation can contribute to peace, transforming conflict through building trust, confidence, and the participation of stakeholders, for example through equitable sharing of common goods and natural resources, such as water (Ide 2018; Swain and Öjendal 2018; Ide et al. 2021). Effective interventions break the links between climate impacts and conflict risks in intergovernmental, national, and local contexts (Mach et al. 2019). In particular, climate-conflict resolution can combine socio-ecological and conflict transformation, risk reduction, climate change adaptation, sustainable development, humanitarian aid, and peacebuilding — strengthening resilience to climate-fragility risks and realising significant co-benefits.

Addressing these challenges involves a number of strategies and approaches. First, sustainable development aiming for an equitable balance of natural resources and human needs can be an essential contribution to cooperative conflict prevention and resolution (Scheffran 2016). Appropriate institutional mechanisms and legal regimes can leverage synergies and design integrated solutions from different policy fields in the climate-conflict nexus. To this end, a sufficient amount of traditional investment in hard security needs to be shifted to soft security, particularly in climate mitigation and adaptation (Brock et al. 2020). Climate mitigation and emission reductions are essential to prevent climate security risks, conflicts, and instabilities. Risk minimisation and management aim to contain and minimise threats, while anticipation and adaptation support actions that seek to avoid, minimise, and respond to potential climate impacts. 'Conflict-proofing' of climate adaptation plans diminishes conflict potential by minimising risks, limiting threats, and preparing societies against adverse climate impacts. In order to improve local coping capacities and resilience, while minimising vulnerabilities to climate impacts, governments in the Mediterranean could benefit from increased international cooperation to break down barriers and obstacles to climate diplomacy, by turning climate into a security issue (securitisation)[62], insufficient financing, and a lack of cooperation.

Second, a fair and just transition to low-carbon energy production and use can take into consideration existing inequalities between southern and northern Mediterranean countries, indicated by different measures of well-being, economic development, government effectiveness, and social networks (Moneer 2020). Marginalised individuals and groups have lower capacities for absorbing new economic shocks, which implies that some countries or regions are more affected than others. In line with the 'Polluter Pays' principle, industry needs to pay a fair share of environmental costs and damages (Healy and Barry 2017). International financial assistance can help countries that are more vulnerable to climate change risks and have lower adaptive capacity and less responsibility for historical greenhouse gas emissions (Muttitt and Kartha 2020). This counteracts climate change as a driver of conflict, constrains the conflict-sensitivity of societies, and strengthens sustainable peace and environmental peacebuilding.

Moreover, including established procedures of conflict prevention, civil conflict management, and conflict resolution in peace and security policies

[62] The concept of 'securitisation' is used in this Analysis as defined in international relations and political science, particularly within the framework of the Copenhagen School (Buzan et al., 1998). Securitisation refers to the process through which an issue is constructed as an immediate and existential threat by a powerful actor—such as a government or political leader—through a speech act. This construction must be accepted by a relevant audience to legitimise the use of extraordinary measures beyond normal political procedures. As used in this Analysis, securitisation concerns the construction of issues as security threats, not the financial meaning of the term (i.e. the pooling and repackaging of assets into tradable securities). See also *Chapter 6, Section 6.2.*

contributes to reducing conflict risks and improving human security. Collective efforts to address climate change can be an opportunity not only for socio-ecological transformations, but also for civil conflict transformation (Pastoors et al. 2022). Since climate conflicts are often based on power inequalities, addressing and dismantling environmental injustice is one of the central steps in conflict transformation towards environmental peacebuilding (Holifield et al. 2020), which critically exposes and constructively changes power inequalities. To manage conflicts, a negotiation process involves key stakeholders negotiating their interests, resources and means available, and the strategies to balance them. Conflict transformation includes constructive conflict resolution, peacebuilding, and violence prevention measures in crisis and conflict regions, such as round tables, facilitation and dialogue forums, mediation and conciliation, diplomacy, human rights monitoring, conflict-sensitive journalism, remembrance work, and psychosocial support (Pastoors et al. 2022). As an example of environmental peacebuilding, EcoPeace Middle East[63] aims to promote cooperative efforts to protect the shared environmental heritage of Israel, Jordan and Palestine, by bringing communities of the three countries together to work on common issues in a highly politicised environment (Schilling et al. 2017). Ecopeace's Good Water Neighbors (GWN)[64] project works with communities and municipalities across the three borders to develop a regional understanding of the problems, raise awareness of the shared water reality, create political will for transboundary cooperation, and build trust in order to solve issues of water pollution and allocation. In the Regional Water Data Banks Project, regional countries work together, while being supported by technical and financial assistance from the European Union (EU), France, the Netherlands, and the United States Agency for International Development (USAID). The Nile Basin Initiative[65] is an intergovernmental partnership of ten Nile Basin countries, to achieve sustainable socio-economic development through the equitable use of, and benefit from, common Nile Basin water resources. The Nile Basin Discourse[66], a network of civil society organisations within the Nile Basin region, runs alongside this, offering a complementary public platform for dialogue (Carius 2007).

Cooperative platforms, interagency frameworks and multi-institutional processes are beneficial for bridging diverse interests across the region and establishing rapid response mechanisms. Climate diplomacy practices are implemented by a broad range of actors, including national and local governments involved in policymaking, international organisations, such as the United Nations (UN) and the EU, Non-Governmental Organisations (NGOs), and donor funding projects. Regional partnerships and initiatives can connect global and local actions, jointly address climate-fragility risks, and improve resilience, engaging with existing networks, fora, and conferences (Scheffran 2021).

Multilateral dialogue providing frameworks for climate diplomacy already coexists at different levels (European External Action Service (EEAS), North Atlantic Treaty Organization (NATO), Organization for Security and Co-operation in Europe (OSCE), UN, but with little interaction between them. More improvement is needed, and synergies need to be utilised. While multilateral efforts could achieve progress in regional contexts, constructive engagement by key powers outside the Mediterranean (China, Iran, Russia, Saudi Arabia, the USA) could increase the chances of stability. This requires a shift away from geopolitical conflict to cooperative pathways in North-South or South-South frameworks (Ehteshami et al. 2017). In this context, migrant social networks can serve as a transformative force for building social resilience, climate adaptation, sustainable co-development, and conflict transformation (Scheffran et al. 2012; Adger et al. 2024).

Multi-issue regimes among Mediterranean states include the Barcelona Declaration of 1995

[63] https://ecopeaceme.org/

[64] https://panorama.solutions/sites/default/files/gwn_project_overview_updated_july_2015_1.pdf

[65] https://nilebasin.org/

[66] https://www.nilebasindiscourse.org/

establishing a Euro-Mediterranean partnership and its 2008 successor, the Union for the Mediterranean. Both instruments and frameworks have faced substantial challenges in promoting Euro-Mediterranean cooperation and integration (Scheffran and Brauch 2014). These regimes provide frameworks for discussing issues of common concern (e.g. migration and health, food, energy and water, climate, environmental and civil protection, employment, and security), but have struggled due to pre-existing political and geopolitical fractures among Mediterranean states, as well as perennial intra-EU divisions over policy priorities and interests.

Various institutional frameworks can be used for promoting climate diplomacy in the Mediterranean (see Scheffran 2021). For example, a Mediterranean New Deal could offer a framework for cooperation and joint initiatives. Together with the EU Green Deal (EC 2021c) and the Fit for 55 initiative (EC 2021a), the New Agenda for the Mediterranean (EC 2021b) offers an ambitious and innovative framework for relaunching and strengthening the strategic partnership between the EU and Southern Neighbourhood partners, including a dedicated Economic and Investment Plan to spur long-term socio-economic recovery. To support MENA states, including the southern and eastern Mediterranean countries with shared benefits and technology transfer, development aid could be combined with co-development and co-production. The 2011 New Deal for Engagement in Fragile States[67] has endorsed a number of principles for better understanding and responding to relevant compound risks associated with climate fragility (Hingorani 2015).

[67] https://capacity4dev.europa.eu/groups/public-fragility/info/new-deal-engagement-fragile-states_en

References

Adger W. N., Fransen S., Safra de Campos R., and Clark W. C. (2024). Scientific frontiers on migration and sustainability. *Proceedings of the National Academy of Sciences*, *121*(3), e2321325121. doi: 10.1073/pnas.2321325121

Adhikari P. (2012). The Plight of the Forgotten Ones: Civil War and Forced Migration1. *International Studies Quarterly*, *56*(3), 590–606. doi: 10.1111/j.1468-2478.2011.00712.x

Ali E., Cramer W., Carnicer J., Georgopoulou E., Hilmi N. J. M., Le Cozannet G., and Lionello P. (2022). Cross-Chapter Paper 4: Mediterranean Region. In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 2233–2272). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009325844.021

Al-Shammari N., and Willoughby J. (2019). Determinants of political instability across Arab Spring countries. *Mediterranean Politics*, *24*(2), 196–217. doi: 10.1080/13629395.2017.1389349

Augsten L., Gagné K., and Su Y. (2022). The human dimensions of the climate risk and armed conflict nexus: a review article. *Regional Environmental Change*, *22*(2). doi: 10.1007/s10113-022-01888-1

Babcicky P. (2013). A Conflict-Sensitive Approach to Climate Change Adaptation. *Peace Review*, *25*(4), 480–488. doi: 10.1080/10402659.2013.846131

Berazneva J., and Lee D. R. (2013). Explaining the African food riots of 2007–2008: An empirical analysis. *Food Policy*, *39*, 28–39. doi: 10.1016/j.foodpol.2012.12.007

Bernauer T., and Böhmelt T. (2020). International conflict and cooperation over freshwater resources. *Nature Sustainability*, *3*(5), 350–356. doi: 10.1038/s41893-020-0479-8

Betts A. (2013). *Survival Migration: Failed Governance and the Crisis of Displacement*. Cornell University Press. http://www.jstor.org/stable/10.7591/j.ctt32b5cd

Biagini B., Bierbaum R., Stults M., Dobardzic S., and McNeeley S. M. (2014). A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility. *Global Environmental Change*, *25*, 97–108. doi: 10.1016/j.gloenvcha.2014.01.003

Blocher J., Destrijcker L., Fischer B., Gleixner S., Gornott C., Hegre H., Jansen L., Jones B., Kjaerum A., Lindqvist-McGowan A., Von Loeben S., Manger N., Mayer T., Tomalka J., Vesco P., Vinke K., Wesch S., and Zvolsky A. (2022). *Moving from Reaction to Action: Anticipating Vulnerability Hotspots in the Sahel. A synthesis report from the Sahel Predictive Analytics project in support of the United Nations Integrated Strategy for the Sahel (UNISS)* (S. von Loeben, J. Birner, K. Vinke, & C. Gornott, Eds.). United Nations Office of the Special Coordinator for Development in the Sahel (OSCDS) & United Nations High Commissioner for Refugees (UNHCR). https://www.unhcr.org/media/moving-reaction-action-anticipating-vulnerability-hotspots-sahel-0

Böhmelt T., Bernauer T., Buhaug H., Gleditsch N. P., Tribaldos T., and Wischnath G. (2014). Demand, supply, and restraint: Determinants of domestic water conflict and cooperation. *Global Environmental Change*, *29*, 337–348. doi: 10.1016/j.gloenvcha.2013.11.018

Brock S., Alex B., Barrett O.-L., Femia F., Fetzek S., Goodman S., Loomi D., Middendorp T., Rademaker M., van Schaik L., Tasse J., and Werrell C. (2020). *The World Climate and Security Report 2020* (F. Femia & C. Werrell, Eds.). Product of the Expert Group of the International Military Council on Climate and Security. The Center for Climate and Security, an institute of The Council on Strategic Risks. https://imccs.org/report2020/

Buhaug H. (2010). Climate not to blame for African civil wars. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(38), 16477–16482. doi: 10.1073/pnas.1005739107

Buhaug H., Benjaminsen T. A., Gilmore E. A., and Hendrix C. S. (2023). Climate-driven risks to peace over the 21st century. *Climate Risk Management*, *39*, 100471. doi: 10.1016/j.crm.2022.100471

Buhaug H., Benjaminsen T. A., Sjaastad E., and Magnus Theisen O. (2015). Climate variability, food production shocks, and violent conflict in Sub-Saharan Africa. *Environmental Research Letters*, *10*(12), 125015. doi: 10.1088/1748-9326/10/12/125015

Buhaug H., Nordkvelle J., Bernauer T., Böhmelt T., Brzoska M., Busby J. W., Ciccone A., Fjelde H., Gartzke E., Gleditsch N. P., Goldstone J. A., Hegre H., Holtermann H., Koubi V., Link J. S. A., Link P. M., Lujala P., O'Loughlin J., Raleigh C., … von Uexkull N. (2014). One effect to rule them all? A comment on climate and conflict. *Climatic Change*, *127*(3–4), 391–397. doi: 10.1007/s10584-014-1266-1

Buhaug H., and von Uexkull N. (2021). Vicious Circles: Violence, Vulnerability, and Climate Change. *Annual Review of Environment and Resources*, *46*(1), 545–568. doi: 10.1146/annurev-environ-012220-014708

Burke M. B., Miguel E., Satyanath S., Dykema J. A., and Lobell D. B. (2009). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(49), 20670–20674. doi: 10.1073/pnas.0907998106

Busby J. W., Cook K. H., Vizy E. K., Smith T. G., and Bekalo M. (2014). Identifying hot spots of security vulnerability associated with climate change in Africa. *Climatic Change*, *124*(4), 717–731. doi: 10.1007/s10584-014-1142-z

Butzer K. W. (2012). Collapse, environment, and society. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(10), 3632–3639. doi: 10.1073/pnas.1114845109

Carius A. (2007). Environmental Peacebuilding: Conditions for Success. In *Environmental Change and Security Program Report* (Issue 12, pp. 59–75). Washington DC: Woodrow Wilson International Center for Scholars. https://www.wilsoncenter.org/sites/default/files/media/documents/publication/CariusEP12.pdf

Carolin S. A., Walker R. T., Day C. C., Ersek V., Sloan R. A., Dee M. W., Talebian M., and Henderson G. M. (2019). Precise timing of abrupt increase in dust activity in the Middle East coincident with 4.2 ka social change. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(1), 67–72. doi: 10.1073/pnas.1808103115

Collier P. (1998). On economic causes of civil war. *Oxford Economic Papers*, *50*(4), 563–573. doi: 10.1093/oep/50.4.563

Coulibaly T. Y., and Managi S. (2022). Identifying the impact of rainfall variability on conflicts at the monthly level. *Scientific Reports*, *12*(1), 18162. doi: 10.1038/s41598-022-23079-y

Cramer W., Guiot J., Fader M., Garrabou J., Gattuso J.-P., Iglesias A., Lange M. A., Lionello P., Llasat M. C., Paz S., Peñuelas J., Snoussi M., Toreti A., Tsimplis M. N., and Xoplaki E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change*, *8*(11), 972–980. doi: 10.1038/s41558-018-0299-2

Daoudy M. (2020). *The Origins of the Syrian Conflict*. Cambridge University Press. doi: 10.1017/9781108567053

Davenport C., Moore W., and Poe S. (2003). Sometimes You Just Have to Leave: Domestic Threats and Forced Migration, 1964-1989. *International Interactions*, *29*(1), 27–55. doi: 10.1080/03050620304597

Davies S., Pettersson T., and Öberg M. (2023). Organized violence 1989–2022, and the return of conflict between states. *Journal of Peace Research*, *60*(4), 691–708. doi: 10.1177/00223433231185169

De Stefano L., Petersen-Perlman J. D., Sproles E. A., Eynard J., and Wolf A. T. (2017). Assessment of transboundary river basins for potential hydro-political tensions. *Global Environmental Change*, *45*, 35–46. doi: 10.1016/j.gloenvcha.2017.04.008

Deitch M., and Valensi C. (2020). Violent Conflicts in the Middle East: A Quantitative Perspective. *Strategic Assessment - A Multidisciplinary Journal on National Security*, *23*(1), 20–39.

Detges A. (2014). Close-up on renewable resources and armed conflict. *Political Geography*, *42*, 57–65. doi: 10.1016/j.polgeo.2014.06.003

Devarajan S., and Ianchovichina E. (2018). A Broken Social Contract, Not High Inequality, Led to the Arab Spring. *Review of Income and Wealth*, *64*, S5-S25. doi: 10.1111/roiw.12288

Devlin C., and Hendrix C. S. (2014). Trends and triggers redux: Climate change, rainfall, and interstate conflict. *Political Geography*, *43*, 27–39. doi: 10.1016/j.polgeo.2014.07.001

Dezfuli A., Razavi S., and Zaitchik B. F. (2022). Compound Effects of Climate Change on Future Transboundary Water Issues in the Middle East. *Earth's Future*, *10*(4), e2022EF002683. doi: 10.1029/2022ef002683

Dinar S., Dinar A., and Kurukulasuriya P. (2011). Scarcity and Cooperation along International Rivers: An Empirical Assessment of Bilateral Treaties1. *International Studies Quarterly*, *55*(3), 809–833. doi: 10.1111/j.1468-2478.2011.00671.x

Dinar S., Katz D., De Stefano L., and Blankespoor B. (2015). Climate change, conflict, and cooperation: Global analysis of the effectiveness of international river treaties in addressing water variability. *Political Geography*, *45*, 55–66. doi: 10.1016/j.polgeo.2014.08.003

Dinar S., Katz D., De Stefano L., and Blankespoor B. (2019). Do treaties matter? Climate change, water variability, and cooperation along transboundary river basins. *Political Geography*, *69*, 162–172. doi: 10.1016/j.polgeo.2018.08.007

Döring S. (2020a). Come rain, or come wells: How access to groundwater affects communal violence. *Political Geography*, *76*, 102073. doi: 10.1016/j.polgeo.2019.102073

Döring S. (2020b). From Bullets to Boreholes: A Disaggregated Analysis of Domestic Water Cooperation in Drought-prone Regions. *Global Environmental Change*, *65*, 102147. doi: 10.1016/j.gloenvcha.2020.102147

Dupuy K., Gates S., Nygård H. M., Rudolfsen I., and Rustad S. A. (2017). *Trends in Armed Conflict, 1946–2016*. Oslo, Prio. https://www.prio.org/publications/10599

EC (2021a). *'Fit for 55': Delivering the EU's 2030 climate target on the way to climate neutrality (COM (2021) 550 final)*. https://eur-lex.europa.eu/legal-content/ENTXT/?uri=CELEX:52021DC0550

EC (2021b). *Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Renewed partnership with the Southern Neighbourhood: A new Agenda for the Mediterranean. (JOIN(2021) 2 final)*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021JC0002

EC (2021c). *The European Green Deal*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

Ehteshami A., Huber D., and Paciello M. C. (Eds) (2017). The Mediterranean reset: Geopolitics in a New Age. *Global Policy*. John Wiley. https://www.iai.it/sites/default/files/2017_globalpolicy-medreset.pdf

Eklund L., Theisen O. M., Baumann M., Forø Tollefsen A., Kuemmerle T., and Østergaard Nielsen J. (2022). Societal drought vulnerability and the Syrian climate-conflict nexus are better explained by agriculture than meteorology. *Communications Earth & Environment*, *3*, 85. doi: 10.1038/s43247-022-00405-w

El-Fadel M., Sayegh Y. El, Ibrahim A. A., Jamali D., and El-Fadl K. (2002). The Euphrates-Tigris Basin: A Case Study in Surface Water Conflict Resolution. *Journal of Natural Resources and Life Sciences Education*, *31*(1), 99–110. doi: 10.2134/jnrlse.2002.0099

Feitelson E., and Tubi A. (2017). A main driver or an intermediate variable? Climate change, water and security in the Middle East. *Global Environmental Change*, *44*, 39–48. doi: 10.1016/j.gloenvcha.2017.03.001

Gates S., Hegre H., Nygård H. M., and Strand H. (2012). Development Consequences of Armed Conflict. *World Development*, *40*(9), 1713–1722. doi: 10.1016/j.worlddev.2012.04.031

Ge Q., Hao M., Ding F., Jiang D., Scheffran J., Helman D., and Ide T. (2022). Modelling armed conflict risk under climate change with machine learning and time-series data. *Nature Communications*, *13*(1), 2839. doi: 10.1038/s41467-022-30356-x

Gebreluel G. (2014). Ethiopia's Grand Renaissance Dam: Ending Africa's Oldest Geopolitical Rivalry? *The Washington Quarterly*, *37*(2), 25–37. doi: 10.1080/0163660x.2014.926207

Gleick P. H. (2014). Water, Drought, Climate Change, and Conflict in Syria. *Weather, Climate, and Society*, *6*(3), 331–340. doi: 10.1175/wcas-d-13-00059.1

Haldon J., Roberts N., Izdebski A., Fleitmann D., McCormick M., Cassis M., Doonan O., Eastwood W., Elton H., Ladstätter S., Manning S., Newhard J., Nicoll K., Telelis I., and Xoplaki E. (2014). The Climate and Environment of Byzantine Anatolia: Integrating Science, History, and Archaeology. *The Journal of Interdisciplinary History*, *45*(2), 113–161. doi: 10.1162/jinh_a_00682

Healy N., and Barry J. (2017). Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition." *Energy Policy*, *108*, 451–459. doi: 10.1016/j.enpol.2017.06.014

Hegre H., Croicu M., Eck K., and Högbladh S. (2020). Introducing the UCDP Candidate Events Dataset. *Research & Politics*, *7*(3). doi: 10.1177/2053168020935257

Helman D., and Zaitchik B. F. (2020). Temperature anomalies affect violent conflicts in African and Middle Eastern warm regions. *Global Environmental Change*, *63*, 102118. doi: 10.1016/j.gloenvcha.2020.102118

Helman D., Zaitchik B. F., and Funk C. (2020). Climate has contrasting direct and indirect effects on armed conflicts. *Environmental Research Letters*, *15*(10), 104017. doi: 10.1088/1748-9326/aba97d

Hendrix C. S., and Glaser S. M. (2007). Trends and triggers: Climate, climate change and civil conflict in Sub-Saharan Africa. *Political Geography*, *26*(6), 695–715. doi: 10.1016/j.polgeo.2007.06.006

Hingorani Y. (2015). The New Deal for Engagement in Fragile States: Where are We Now? *Journal of Peacebuilding & Development*, *10*(2), 87–93. doi: 10.1080/15423166.2015.1054860

Hoch J. M., de Bruin S. P., Buhaug H., Von Uexkull N., van Beek R., and Wanders N. (2021). Projecting armed conflict risk in Africa towards 2050 along the SSP-RCP scenarios: a machine learning approach. *Environmental Research Letters*, *16*(12), 124068. doi: 10.1088/1748-9326/ac3db2

Holifield R., Chakraborty J., and Walker G. (2020). *The Routledge Handbook of Environmental Justice* (R. Holifield, J. Chakraborty, & G. Walker, Eds.). Routledge. doi: 10.4324/9781315678986

Homer-Dixon T., and Deligiannis T. (2009). Environmental scarcities and civil violence. In H. Brauch, Ú. Oswald Spring, J. Grin, C. Mesjasz, P. Kameri-Mbote, N. Behera, B. Chourou, & H. Krummenacher (Eds.), *Facing Global Environmental Change: Hexagon Series on Human and Environmental Security and Peace* (pp. 309–323). Springer, Berlin, Heidelberg. doi: 10.1007/978-3-540-68488-6_20

Hsiang S. M., and Burke M. (2014). Climate, conflict, and social stability: what does the evidence say? *Climatic Change*, *123*(1), 39–55. doi: 10.1007/s10584-013-0868-3

Hsiang S. M., Burke M., and Miguel E. (2013). Quantifying the Influence of Climate on Human Conflict. *Science*, *341*(6151). doi: 10.1126/science.1235367

Ide T. (2018). Climate War in the Middle East? Drought, the Syrian Civil War and the State of Climate-Conflict Research. *Current Climate Change Reports*, *4*(4), 347–354. doi: 10.1007/s40641-018-0115-0

Ide T., Bruch C., Carius A., Conca K., Dabelko G. D., Matthew R., and Weinthal E. (2021). The past and future(s) of environmental peacebuilding. *International Affairs*, *97*(1), 1–16. doi: 10.1093/ia/iiaa177

Ide T., Brzoska M., Donges J. F., and Schleussner C.-F. (2020). Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk. *Global Environmental Change*, *62*, 102063. doi: 10.1016/j.gloenvcha.2020.102063

Ide T., Lopez M. R., Fröhlich C., and Scheffran J. (2020). Pathways to water conflict during drought in the MENA region. *Journal of Peace Research*, *58*(3), 568–582. doi: 10.1177/0022343320910777

Ide T., Michael Link P., Scheffran J., and Schilling J. (2016). The Climate-Conflict Nexus: Pathways, Regional Links, and Case Studies. In H. Brauch, Ú. Oswald Spring, J. Grin, & J. Scheffran (Eds.), *Handbook on Sustainability Transition and Sustainable Peace. Hexagon Series on Human and Environmental Security and Peace, vol 10* (pp. 285–304). Springer, Cham. doi: 10.1007/978-3-319-43884-9_12

IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou, Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. USA, 2391 pp. doi: 10.1017/9781009157896

IPCC (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama, Eds.). Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp. doi: 10.1017/9781009325844

IPCC (2023): *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp. doi: 10.59327/IPCC/AR6-9789291691647

Kaniewski D., Guiot J., and Van Campo E. (2015). Drought and societal collapse 3200 years ago in the Eastern Mediterranean: a review. *WIREs Climate Change*, *6*(4), 369–382. doi: 10.1002/wcc.345

Kelley C. P., Mohtadi S., Cane M. A., Seager R., and Kushnir Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3241–3246. doi: 10.1073/pnas.1421533112

Kim K., and Garcia T. F. (2023). Climate Change and Violent Conflict in the Middle East and North Africa. *International Studies Review*, *25*(4). doi: 10.1093/isr/viad053

Koubi V. (2019). Climate Change and Conflict. *Annual Review of Political Science*, *22*(1), 343–360. doi: 10.1146/annurev-polisci-050317-070830

Link P. M., Scheffran J., and Ide T. (2016). Conflict and cooperation in the water-security nexus: a global comparative analysis of river basins under climate change. *WIREs Water*, *3*(4), 495–515. doi: 10.1002/wat2.1151

Mach K. J., Adger W. N., Buhaug H., Burke M., Fearon J. D., Field C. B., Hendrix C. S., Kraan C. M., Maystadt J.-F., O'Loughlin J., Roessler P., Scheffran J., Schultz K. A., and von Uexkull N. (2020). Directions for Research on Climate and Conflict. *Earth's Future*, *8*(7), e2020EF001532. doi: 10.1029/2020ef001532

Mach K. J., Kraan C. M., Adger W. N., Buhaug H., Burke M., Fearon J. D., Field C. B., Hendrix C. S., Maystadt J.-F., O'Loughlin J., Roessler P., Scheffran J., Schultz K. A., and von Uexkull N. (2019). Climate as a risk factor for armed conflict. *Nature*, *571*(7764), 193–197. doi: 10.1038/s41586-019-1300-6

Marktanner M., Mienie E., and Noiset L. (2015). From armed conflict to disaster vulnerability. *Disaster Prevention and Management*, *24*(1), 53–69. doi: 10.1108/dpm-04-2013-0077

Moneer A. (2020). Rethinking the Response to Climate Change Threats in the Mediterranean: Lessons from the Coronavirus Emergency. In *Mediterranean Yearbook 2020* (pp. 145–152). IEMed. https://www.iemed.org/publication/rethinking-the-response-to-climate-change-threats-in-the-mediterranean-lessons-from-the-coronavirus-emergency/

Moore W. H., and Shellman S. M. (2004). Fear of Persecution. *Journal of Conflict Resolution*, *48*(5), 723–745. doi: 10.1177/0022002704267767

Moore W. H., and Shellman S. M. (2006). Refugee or Internally Displaced Person? *Comparative Political Studies*, *39*(5), 599–622. doi: 10.1177/0010414005276457

Munia H., Guillaume J. H. A., Mirumachi N., Porkka M., Wada Y., and Kummu M. (2016). Water stress in global transboundary river basins: significance of upstream water use on downstream stress. *Environmental Research Letters*, *11*(1), 014002. doi: 10.1088/1748-9326/11/1/014002

Muttitt G., and Kartha S. (2020). Equity, climate justice and fossil fuel extraction: principles for a managed phase out. *Climate Policy*, *20*(8), 1024–1042. doi: 10.1080/14693062.2020.1763900

Nadiruzzaman M., Scheffran J., Shewly H. J., and Kley S. (2022). Conflict-Sensitive Climate Change Adaptation: A Review. *Sustainability*, *14*(13), 8060. doi: 10.3390/su14138060

Nadiruzzaman Md., John S., Muehlberger V., and Scheffran J. (2023). From a climate–security nexus to conflict-sensitive climate actions for peacebuilding and human security. *International Development Planning Review*, *45*(4), 469–478. doi: 10.3828/idpr.2023.16

Nasri P., Fiertz N., Haken N., Sample E., Wilson W., Woodburn D., Cockey S., Deleersnyder A.-E., Diop A., Batterman D., Reger K., Smith K., Hoduski N., and Kramer O. (2021). *Fragile States Index Annual Report 2021*. The Fund for Peace. https://fragilestatesindex.org/wp-content/uploads/2021/05/fsi2021-report.pdf

Newman E. (2018). Hungry, or Hungry for Change? Food Riots and Political Conflict, 2005–2015. *Studies in Conflict & Terrorism*, *43*(4), 300–324. doi: 10.1080/1057610x.2018.1454042

Oktav O. (2017). Turkey's Water Policy in the Euphrates-Tigris Basin. In M. Behnassi & K. McGlade (Eds.), *Environmental Change and Human Security in Africa and the Middle East* (pp. 239–255). Springer, Cham. doi: 10.1007/978-3-319-45648-5_13

Pastoors D., Drees L., Fickel T., and Scheffran J. (2022). 'Frieden verbessert das Klima' – Zivile Konfliktbearbeitung als Beitrag zur sozial-ökologischen Transformation. *Zeitschrift Für Außen- Und Sicherheitspolitik 15,* 283-305. doi: 10.1007/s12399-022-00911-x

Peters L. E. R. (2022). Disasters as Ambivalent Multipliers: Influencing the Pathways from Disaster to Conflict Risk and Peace Potential Through Disaster Risk Reduction. *Journal of Peacebuilding & Development*, *17*(2), 151–172. doi: 10.1177/15423166221081516

Petrova K., Olafsdottir G., Hegre H., and Gilmore E. A. (2023). The 'conflict trap' reduces economic growth in the shared socioeconomic pathways. *Environmental Research Letters*, *18*(2), 024028. doi: 10.1088/1748-9326/acb163

Raleigh C., Choi H. J., and Kniveton D. (2015). The devil is in the details: An investigation of the relationships between conflict, food price and climate across Africa. *Global Environmental Change: Human and Policy Dimensions*, *32*, 187–199. doi: 10.1016/j.gloenvcha.2015.03.005

Scartozzi C. M. (2020). Reframing Climate-Induced Socio-Environmental Conflicts: A Systematic Review. *International Studies Review*, *23*(3), 696–725. doi: 10.1093/isr/viaa064

Scheffran J. (2016). *From a Climate of Complexity to Sustainable Peace: Viability Transformations and Adaptive Governance in the Anthropocene* (pp. 305–346). doi: 10.1007/978-3-319-43884-9_13

Scheffran J. (2021). Environmental Security and Climate Diplomacy in the Mediterranean. In *Peacebuilding and Climate Change. Report of the Bologna Peacebuilding Forum, 18-19 May 2021* (Issue 25, pp. 28–44). Agency for Peacebuilding. https://www.iai.it/en/pubblicazioni/bologna-peacebuilding-forum-2021-peacebuilding-and-climate-change

Scheffran J., and Brauch H. G. (2014). Conflicts and Security Risks of Climate Change in the Mediterranean Region. In *The Mediterranean Sea* (pp. 625–640). Springer Netherlands. doi: 10.1007/978-94-007-6704-1_39

Scheffran J., and Cannaday T. (2013). Resistance against climate change policies: the conflict potential of non-fossil energy paths and climate engineering. In A. Maas, B. Bodó, C. Burnley, I. Comardicea, & R. Roffey (Eds.), *Global environmental change: new drivers for resistance, crime and terrorism?* (pp. 261–292). Baden-Baden: Nomos. https://www.rifs-potsdam.de/en/output/publications/2013/global-environmental-change-new-drivers-resistance-crime-and-terrorism

Scheffran J., Link P. M., and Schilling J. (2019). Climate and Conflict in Africa. In *Oxford Research Encyclopedia of Climate Science*. Oxford University Press. doi: 10.1093/acrefore/9780190228620.013.557

Scheffran J., Marmer E., and Sow P. (2012). Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. *Applied Geography*, *33*, 119–127. doi: 10.1016/j.apgeog.2011.10.002

Schilling J., Hertig E., Tramblay Y., and Scheffran J. (2020). Climate change vulnerability, water resources and social implications in North Africa. *Regional Environmental Change*, *20*(1), 15. doi: 10.1007/s10113-020-01597-7

Schilling J., Nash S. L., Ide T., Scheffran J., Froese R., and von Prondzinski P. (2017). Resilience and environmental security: towards joint application in peacebuilding. *Global Change, Peace & Security*, *29*(2), 107–127. doi: 10.1080/14781158.2017.1305347

Schleussner C.-F., Donges J. F., Donner R. V, and Schellnhuber H. J. (2016). Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(33), 9216–9221. doi: 10.1073/pnas.1601611113

Schon J. (2019). Motivation and opportunity for conflict-induced migration: An analysis of Syrian migration timing. *Journal of Peace Research*, *56*(1), 12–27. doi: 10.1177/0022343318806044

Selby J., Dahi O. S., Fröhlich C., and Hulme M. (2017). Climate change and the Syrian civil war revisited. *Political Geography*, *60*, 232–244. doi: 10.1016/j.polgeo.2017.05.007

Sneyd L. Q., Legwegoh A., and Fraser E. D. G. (2013). Food riots: Media perspectives on the causes of food protest in Africa. *Food Security*, *5*(4), 485–497. doi: 10.1007/s12571-013-0272-x

Soffiantini G. (2020). Food insecurity and political instability during the Arab Spring. *Global Food Security*, *26*, 100400. doi: 10.1016/j.gfs.2020.100400

Sofuoğlu E., and Ay A. (2020). The relationship between climate change and political instability: the case of MENA countries (1985:01–2016:12). *Environmental Science and Pollution Research*, *27*(12), 14033–14043. doi: 10.1007/s11356-020-07937-8

Sørli M. E., Gleditsch N. P., and Strand H. (2005). Why Is There So Much Conflict in the Middle East? *Journal of Conflict Resolution*, *49*(1), 141–165. doi: 10.1177/0022002704270824

Sottilotta C. E. (2015). Political Risk Assessment and the Arab Spring: What Can We Learn? *Thunderbird International Business Review*, *57*(5), 379–390. doi: 10.1002/tie.21689

Sternberg T. (2012). Chinese drought, bread and the Arab Spring. *Applied Geography*, *34*, 519–524. doi: 10.1016/j.apgeog.2012.02.004

Swain, A., & Öjendal, J. (Eds.). (2018). *Routledge Handbook of Environmental Conflict and Peacebuilding*. Routledge. doi: 10.4324/9781315473772

Tänzler D., Maas A., and Carius A. (2010). Climate change adaptation and peace. *WIREs Climate Change*, *1*(5), 741–750. doi: 10.1002/wcc.66

Tayie M. S. (2016). The Hydropolitics of the Nile River Basin. In A. Negm (Ed.), *The Nile River. The Handbook of Environmental Chemistry* (Vol. 56, pp. 599–654). Springer International Publishing. doi: 10.1007/698_2016_106

Theisen O., Hegre H., Buhaug H., Döring S., Jansen R., Lindqvist-McGowan A., Rudolfsen I., Vesco P., Salido Marcos J., Acaf Y., Nahabedian P., and Ismail L. (2021). *Understanding the Potential Linkages between Climate Change and Conflict in the Arab Region.* UN ESCWA. https://www.unescwa.org/sites/default/files/pubs/pdf/understanding-potential-linkages-climate-change-conflict-arab-region-english.pdf

Tir J., and Stinnett D. M. (2012). Weathering climate change: Can institutions mitigate international water conflict? *Journal of Peace Research*, *49*(1), 211–225. doi: 10.1177/0022343311427066

Tubi A., and Feitelson E. (2016). Drought and cooperation in a conflict prone area: Bedouin herders and Jewish farmers in Israel's northern Negev, 1957–1963. *Political Geography*, *51*, 30–42. doi: 10.1016/j.polgeo.2015.11.009

UN (1998). *Guiding Principles on Internal Displacement (E/CN.4/1998/53/Add.2)*. Geneva: United Nations Office for the Coordination of Humanitarian Affairs. https://docs.un.org/en/E/CN.4/1998/53/Add.2

Vesco P., Kovacic M., Mistry M., and Croicu M. (2021). Climate variability, crop and conflict: Exploring the impacts of spatial concentration in agricultural production. *Journal of Peace Research*, *58*(1), 98–113. doi: 10.1177/0022343320971020

Vestby J. (2019). Climate variability and individual motivations for participating in political violence. *Global Environmental Change*, *56*, 114–123. doi: 10.1016/j.gloenvcha.2019.04.001

von Uexkull N., and Busby J. W. (2018). Climate Shocks and Humanitarian Crises: Which Countries Are Most at Risk? *Foreign Affairs*. https://www.foreignaffairs.com/world/climate-shocks-and-humanitarian-crises

Waha K., Krummenauer L., Adams S., Aich V., Baarsch F., Coumou D., Fader M., Hoff H., Jobbins G., Marcus R., Mengel M., Otto I. M., Perrette M., Rocha M., Robinson A., and Schleussner C.-F. (2017). Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. *Regional Environmental Change*, *17*(6), 1623–1638. doi: 10.1007/s10113-017-1144-2

Ward M. D., Greenhill B. D., and Bakke K. M. (2010). The perils of policy by p-value: Predicting civil conflicts. *Journal of Peace Research*, *47*(4), 363–375. doi: 10.1177/0022343309356491

Watanabe T. K., Watanabe T., Yamazaki A., and Pfeiffer M. (2019). Oman corals suggest that a stronger winter shamal season caused the Akkadian Empire (Mesopotamia) collapse. *Geology*, *47*(12), 1141–1145. doi: 10.1130/g46604.1

Weiss H. (2017). Megadrought, collapse, and causality. In H. Weiss (Ed.), *Megadrought and collapse: From early agriculture to Angkor* (pp. 1–32). Oxford Academic. doi: 10.1093/oso/9780199329199.003.0001

Weiss H., Courty M.-A., Wetterstrom W., Guichard F., Senior L., Meadow R., and Curnow A. (1993). The Genesis and Collapse of Third Millennium North Mesopotamian Civilization. *Science*, *261*(5124), 995–1004. doi: 10.1126/science.261.5124.995

White S. (2011). *The Climate of Rebellion in the Early Modern Ottoman Empire*. Cambridge University Press. doi: 10.1017/cbo9780511844058

Witmer F. D. W., Linke A. M., O'Loughlin J., Gettelman A., and Laing A. (2017). Subnational violent conflict forecasts for sub-Saharan Africa, 2015–65, using climate-sensitive models. *Journal of Peace Research*, *54*(2), 175–192. doi: 10.1177/0022343316682064

Wolf A. T. (2007). Shared Waters: Conflict and Cooperation. *Annual Review of Environment and Resources*, *32*(1), 241–269. doi: 10.1146/annurev.energy.32.041006.101434

Wolf A. T., Yoffe S. B., and Giordano M. (2003). International waters: identifying basins at risk. *Water Policy*, *5*(1), 29–60. doi: 10.2166/wp.2003.0002

Xie X., Hao M., Ding F., Helman D., Scheffran J., Wang Q., Ge Q., and Jiang D. (2022). Exploring the direct and indirect impacts of climate variability on armed conflict in South Asia. *iScience*, *25*(11), 105258. doi: 10.1016/j.isci.2022.105258

Xoplaki E., Fleitmann D., Luterbacher J., Wagner S., Haldon J. F., Zorita E., Telelis I., Toreti A., and Izdebski A. (2016). The Medieval Climate Anomaly and Byzantium: A review of the evidence on climatic fluctuations, economic performance and societal change. *Quaternary Science Reviews*, *136*, 229–252. doi: 10.1016/j.quascirev.2015.10.004

Yanda P., and Bronkhorst S. (2011). Climate Change and Conflict: Conflict-Sensitive Climate Change Adaptation in Africa. In *Conflict-sensitive climate change adaptation in Africa*. (Vol. 14). Durban: The African Centre for the Constructive Resolution of Disputes (ACCORD). https://www.files.ethz.ch/isn/137666/policy_practice14.pdf

Zscheischler J., Westra S., van den Hurk B. J. J. M., Seneviratne S. I., Ward P. J., Pitman A., AghaKouchak A., Bresch D. N., Leonard M., Wahl T., and Zhang X. (2018). Future climate risk from compound events. *Nature Climate Change*, *8*(6), 469–477. doi: 10.1038/s41558-018-0156-3

Information about the authors

Coordinating Lead Authors

Vally KOUBI, Department of Humanities, Social and Political Sciences, ETH Zurich, *Switzerland/Greece*

Jürgen SCHEFFRAN, Institute of Geography & Research Group Climate Change and Security (CLISEC), University of Hamburg, *Germany*

Lead Authors

Paola VESCO, Peace Research Institute Oslo (PRIO), *Norway*

Understanding the environment-migration nexus in the Mediterranean

5

Coordinating Lead Authors
Roman HOFFMANN *(Austria)*, **Vally KOUBI** *(Greece/Switzerland)*

Lead Authors
Abdelslam BADRE *(Morocco)*, **Helene BENVENISTE** *(USA)*,
Merve Suzan ILIK BILBEN *(Türkiye)*, **Barbara ŠEDOVÁ** *(Germany)*

This chapter should be cited as:
Hoffmann, R., Koubi, V., Badre, A., Benveniste, H., Ilik Bilben, M.S., Šedová, B., 2026: Understanding the environment and migration nexus in the Mediterranean. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Secretariat, Marseille, France, pp. 159-183. doi: 10.5281/zenodo.17974655

Chapter 5
Understanding the environment-migration nexus in the Mediterranean

Executive summary 161

5.1 Central concepts and frameworks on environmental migration 162
5.1.1 Conceptual framework 162
5.1.2 Different types of environmental hazards and their impacts on populations 163
5.1.2.1 Slow and sudden onset events 163
5.1.2.2 Cumulative stressors 163
5.1.2.3 Cascading and compound risks 164
5.1.3 The role of contextual effects and co-stressors 164
5.1.3.1 Differences in mobility responses to environmental hazards 164
5.1.3.2 Channels of influence 165
5.1.3.3 Social tipping points and thresholds 165
5.1.4 The IPCC risk framework 165

5.2 Empirical evidence on environmental migration in the Mediterranean 166
5.2.1 North Africa and Sahel 166
5.2.2 The Middle East as part of the MENA region 167
5.2.3 Southeastern Europe 168
5.2.4 Southern Europe 170

5.3 Trajectories and destinations of mobile populations 171
5.3.1 Environmental changes and urbanisation processes 171
5.3.2 Regional migration towards the Mediterranean 172

5.4 Projecting environmental impacts on migration flows in the future 174
5.4.1 Projection types and methods 174
5.4.2 Projecting future migration due to environmental stress in the Mediterranean 175

References 176

Information about the authors 183

Executive summary

The links between environmental factors and migration are complex and characterised by non-linearities and high context-dependency. Environmental migration is strongly influenced by local socio-economic and political conditions, and other co-stressors.

Most environmental migration is internal and over short distances, although migration over longer distances and across national borders is observed. Changes in temporary forms of mobility are common in response to environmental changes.

The complexity of the issues and the insufficiency of data make it difficult to empirically assess environmental impacts on migration, and to project future mobility under environmental change.[68]

Existing evidence points to nuanced links between environmental factors and migration in the Mediterranean region. Different areas and sub-populations are affected to different extents.

Vulnerability to environmental hazards plays a decisive role in shaping the impacts of environmental changes. A large proportion of populations affected by environmental change remain immobile. While some are not motivated to leave their home, others may lack resources to do so, resulting in potential entrapment.

Drought, aridity, and land degradation are important environmental hazards in the Mediterranean region, with major implications for human mobility. They can potentially lead to more permanent forms of movement.

Environmental factors are not only relevant for mobility within the Mediterranean, but they can also shape mobility to the region. The Mediterranean is an important transit and destination region with most migrants moving to urban areas.

[68] In this Analysis, the term 'environmental change', if not explicitly stated otherwise, is used to refer to changes in terrestrial and marine ecosystems as well as changes in climate conditions at local, regional or global scales.

5.1 Central concepts and frameworks on environmental migration

5.1.1 Conceptual framework

The link between the environment and migration is as old as humankind (see *Chapter 2*). People have always moved in search of better living conditions for themselves and for their families, or to escape environmental hardship or hazards in their homeland. While these two drivers constitute the fundamentals of the simple 'push and pull' theory (Massey et al. 1993), migration decisions in the context of environmental change are typically more complex. There is no single theoretical framework that provides a comprehensive understanding of the role of environmental conditions in human migration (de Sherbinin et al. 2022).

Given the complexity and interactions of the various drivers of migration with environmental change factors, a framework that encapsulates broader dimensions of the migration process is required. This chapter adopts the Foresight (2011) framework, which stipulates that the decision to move is influenced by five broad categories of drivers, namely environmental, social, economic, demographic, and political drivers, which constitute the macro-level factors *(Figure 5.1).* By affecting the macro-level drivers, the impacts of environmental change are likely to vary with country-level characteristics, such as the level of economic development and the political capacity of the government to effectively address environmental problems (Adger et al. 2009).

Migration decisions are not only shaped by the complex interplay of macro drivers, but also by intervening factors at the meso-level (e.g. social networks, legal framework, technology) as well as personal and household characteristics (e.g. age, gender, education, wealth) (Black et al. 2011; Hunter et al. 2015). In line with the IPCC's risk framework (IPCC 2022), non-environmental characteristics affect people's vulnerability, which in combination with their exposure to different types of environmental hazards *(Section 5.1.2)*, determines the overall environmental risk, affecting their adaptation options and therefore also the decision to migrate *(Section 5.1.4).* Overall, recognising that environmental migration is highly contextual *(Section 5.1.3),* and that not all affected households or individuals will migrate is very important for understanding the nexus between environmental change and migration.

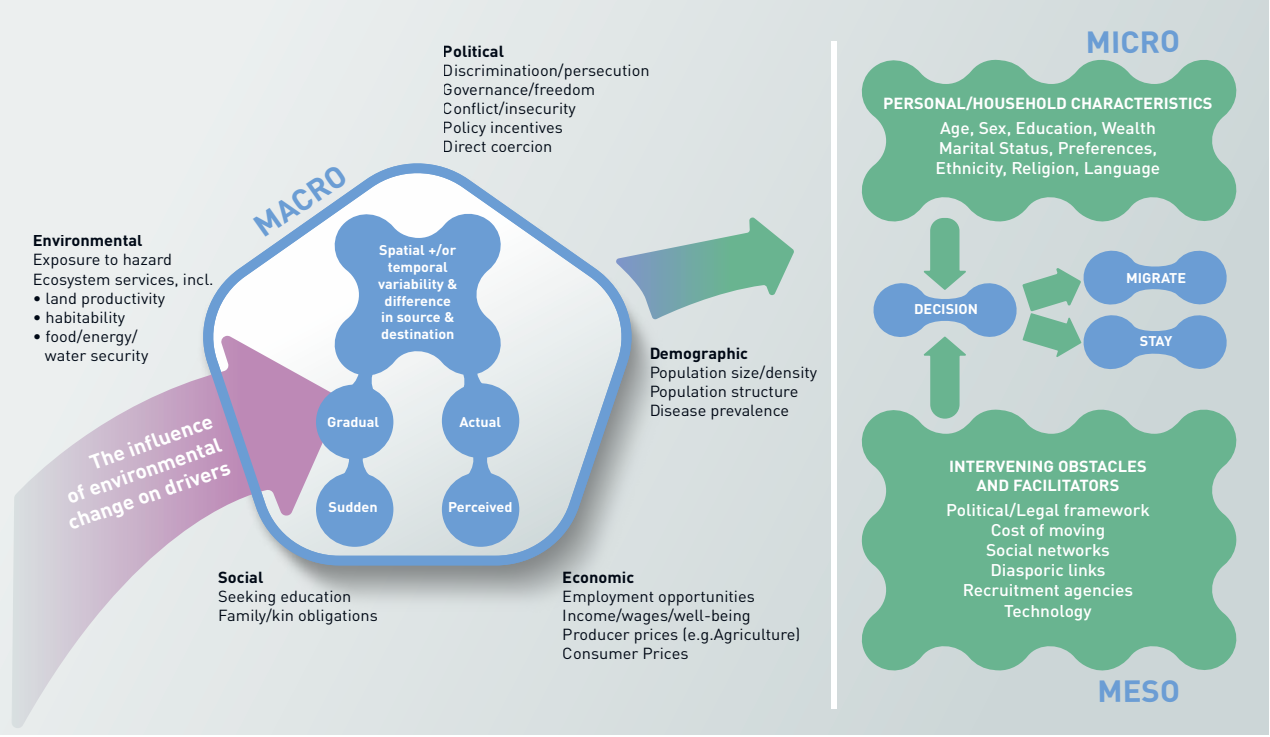


Figure 5.1 | A conceptual framework for understanding the migration-environment nexus. Source: Foresight, Migration and Global Environmental Change (2011).

The International Organization for Migration defines environmental migrants as 'persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to leave their habitual home, or choose to do so, either temporarily or permanently, and who move either within their country or abroad' (IOM 2007; see *Chapter 2, Section 2.1.2*). A complementary concept is that of 'climate mobilities', which emphasises the multiple forms of human movement, from permanent and seasonal movement to immobility in the context of climate change, as well as the transformative character of mobility and its impact on places of origin, transit, and destination (Boas et al. 2019; Wiegel et al. 2019).

Public debates around the issue of environmental migration often follow a simplistic and deterministic narrative, neglecting the diverse nature of human movements in the context of environmental change (Tschakert and Neef 2022). Often, the focus is placed on adaptive and involuntary migration, and the organised relocation of populations, as opposed to both voluntary and forced immobility, which have so far received less attention in research and policymaking (Cissé et al. 2022). While some groups may not have a motivation or incentive to migrate even when confronted with environmental hazards, others may not have the necessary resources to do so *(see Chapter 2, Section 2.1.2)* (Black and Collyer 2014; Adger et al. 2015). These 'trapped populations' are characterised by high levels of vulnerability and may find themselves in a vicious cycle of increasingly deteriorating environmental conditions, poverty, and immobility (Zickgraf 2018; Cundill et al. 2021; Benveniste et al. 2022). Immobile populations may need government support to remain in areas exposed to environmental hazards, or to relocate elsewhere. However, planned relocation has been linked to significant emotional, social, and economic costs (Cissé et al. 2022).

5.1.2 Different types of environmental hazards and their impacts on populations

5.1.2.1 Slow and sudden onset events

The existing literature on the links between climate change, the environment, and migration often distinguishes between slow and sudden onset events (Koubi et al. 2016b; Cattaneo et al. 2019; Hoffmann et al. 2021; IPCC 2022). Sudden onset events, such as hurricanes, floods, and wildfires tend to have severe, immediate consequences for the well-being, safety and health of individuals by inflicting injuries and casualties as well as causing economic disruption and food insecurity (Wallemacq and House 2018). In such cases, 'people must flee from a sudden onset environmental event to save their lives' (Warner et al. 2010). The resulting displacements tend to be temporary and over short distances (McLeman and Gemenne 2018), with the majority of those who are displaced returning as soon as possible to rebuild their homes and lives. Consequently, sudden onset events typically cause internal and not international migration.

Slow onset events such as drought, desertification, and water/soil salinity are usually not considered triggers of migration as their impacts unfold only gradually over time. The literature provides conflicting evidence of how these events affect human mobility. On the one hand, there are many cases of mass movements in response to drought, particularly in Africa (Sahel), South America (Argentina, Brazil), the Middle East (Iran, Syria), Central Asia, and Southern Asia (Piguet and Laczko 2013; Miyan 2015). On the other hand, studies have shown that people are unlikely to move in the presence of slow onset events (Koubi et al. 2016a; Cottier and Salehyan 2021). Slow onset events have also been shown to lead to reductions in both internal and international/external migration due to their impacts on migration capacities, including financial (liquidity constraints) and human (lack of education) capital (Cattaneo and Peri 2016; Koubi et al. 2022).

5.1.2.2 Cumulative stressors

The recent literature shows that it is not only the occurrence of a single event that has important impacts on people's livelihoods, including migration decisions, but also the occurrence of repeated events over a certain period of time (Devkota et al. 2017; Kim and Marcouiller 2018). The impact of a succession of such events can be very different from the impact of a single event, irrespective of their intensity (Berlemann and Steinhardt 2017). Due to a lack of appropriate data, only a few studies have been able to quantify the specific impact of repeated climate events on population movements (Bohra-Mishra et al. 2014; Safra de Campos et al. 2017).

5.1.2.3 Cascading and compound risks

Extreme environmental events can interact with other hazards and with human systems in important ways (Kruczkiewicz et al. 2021; Jehn et al. 2022; Thalheimer 2023). For example, rising global temperatures can affect agricultural productivity, and at the same time increase the frequency and severity of extreme events, that is floods and droughts, which may be occurring simultaneously. It is therefore analytically difficult to take into account how hazards can trigger other hazards and cause cascading impacts — and responses — in human systems (Zscheischler et al. 2018).

The IPCC (2018) acknowledges the difficulty of incorporating compounded and cascading impacts of multiple events in its analyses. In its special report on 1.5°C of warming, it observed that '[t]he literature on compound as well as interacting and cascading risks at warming of 1.5°C and 2.0°C is limited' (IPCC 2018, p. 245), and that 'risks across energy, food, and water sectors could overlap spatially and temporally, creating new and exacerbating current hazards, exposures, and vulnerabilities that will affect increasing numbers of people and regions.'(IPCC 2018, p. 10). Still, evidence shows that the simultaneous occurrence of extreme events on a large spatial and temporal scale can have cascading impacts on human systems, locally and globally.

An example of cascading and compounded events is the food security crisis of 2010–2011 and the Arab Spring (*see Chapter 4, Sections 4.1* and *4.2*). In early 2010, the Russian Federation experienced an unprecedented heat wave, which attribution analysis suggests was made five times more likely as a result of climatic warming (Rahmstorf and Coumou 2011). Such extremely hot and dry weather triggered widespread wildfires, which destroyed 20% of the Russian wheat crop. The same drought struck Ukraine and eastern China as well, causing major reductions in their wheat harvests (Sternberg 2012). Floods destroyed one million tonnes of grain reserves in Pakistan between August and October 2010. Unusual torrential rains shrunk wheat yields by nearly a quarter in Canada and reduced the quality of much of the crops to fodder in Australia and northwestern Europe (Holland 2012). Over the course of 2010, this combination of impacts contributed to a 40% increase in world food prices (Holland 2012), which, in turn, led China to make a large-scale wheat purchase to secure its domestic supply and Russia to levy an export ban for the same reason. This subsequently caused a spike in food prices in Egypt and elsewhere in the MENA region, where it became a major factor in the Arab Spring (Ciezadlo 2011; Bellemare 2015). Protesters in Tunisia brandished baguettes, while in Egypt they demanded 'bread, freedom and social justice'. By the end of 2011, popular revolts broke out in many Arab countries, including Egypt, Libya, Syria, Tunisia, and Yemen (Soffiantini 2020).

5.1.3 The role of contextual effects and co-stressors

The growing scientific evidence documenting environmental migration has produced a mixed collection of findings. While it is acknowledged that environmental factors can influence patterns of human mobility, questions often remain as to when, how, and why different forms of climate mobility emerge (Cattaneo et al. 2019; Hoffmann et al. 2021).

5.1.3.1 Differences in mobility responses to environmental hazards

Environmental factors can affect communities and human mobility both directly and indirectly. Extreme weather events such as storms and floods may force people to flee to survive (see above regarding sudden onset events). A direct impact may also occur in the context of slow onset events, where, for instance, sea level rise forces inhabitants of coastal areas to relocate. On the other hand, environmental factors can impact mobility indirectly by influencing another driver, such as income from agriculture or fishing. This can lead to heterogeneity in the migration response across different population groups, as some may be more affected by environmental hazards than others. Taken together, while the direct effects help us to understand whether climatic events affect mobility, the heterogeneous (i.e. contextual) effects help us to understand when climate mobility emerges (Berlemann and Steinhardt 2017; Cattaneo et al. 2019; Hoffmann et al. 2021).

There is ample evidence that mobility outcomes of environmental events differ depending on various factors at the micro-, meso-, and macro-levels (see *Figure 5.1*), reflecting the diverging vulnerabilities to environmental pressures of different population groups (Black et al. 2011; Cattaneo et al. 2019). A concrete example of such heterogeneous impacts is

the well-established inverted U-shape association between wealth and environmental migration. As environmental shocks can increase both the pressure to move and liquidity constraints, poor people might become immobile in the aftermath of adverse events, while middle-income populations might move at increased rates (Cattaneo and Peri 2016; Benveniste et al. 2022). The literature further provides evidence on heterogeneous effects in interaction with, for example, gender (see Dillon et al. 2011; Thiede et al. 2016; Becerra-Valbuena and Millock 2021), education (see Drabo and Mbaye 2015; Šedová et al. 2020), and agricultural dependence (see Dillon et al. 2011; Šedová et al. 2020). However, many gaps remain in our systematic understanding of when environmental migration emerges (Cattaneo et al. 2019).

5.1.3.2 Channels of influence

By affecting migration drivers (e.g. economic, social, or political factors), environmental hazards change the manifestation of human mobility, whereby the drivers act as mechanisms linking these two phenomena. Thus far, the evidence shows that economic (e.g. income differential between origin and destination, income variability) and political (e.g. onset and incidence of violent conflicts) factors are potential mechanisms explaining environmental migration (Berlemann and Steinhardt 2017; Cattaneo et al. 2019). As for the political factors, there is evidence that adverse climate impacts may increase the likelihood of violent conflict (Hsiang et al. 2013), which could then lead to forced displacement both within countries, but also internationally (Missirian and Schlenker 2017; Abel et al. 2019). Overall, more evidence on the role of different mechanisms in the link between climate and mobility is needed (Cattaneo et al. 2019).

5.1.3.3 Social tipping points and thresholds

Tipping points and thresholds are important for understanding environmental impacts on human mobility. Migration often takes place after a threshold has been crossed, beyond which risks or effects are too substantial to sustain (Meze-Hausken 2008; McLeman 2018; McLeman et al. 2021). The literature has identified the following six steps that play a role in the context of environmental impacts on mobility: (1) adaptation becomes necessary; (2) adaptation becomes ineffective; (3) substantive changes in land use/livelihoods become necessary; (4) in situ adaptation fails, migration ensues; (5) migration rates become non-linear; and (6) migration rates cease to be non-linear (McLeman 2018). These thresholds are a product of multiple factors, including climatic conditions or events in question, individual and household decisions, as well as larger group mobility dynamics. These processes are affected by people's perceptions, actions of influential individuals or groups, and changes in key infrastructure, services, or other community assets (Bardsley and Hugo 2010; McLeman 2018; Adams and Kay 2019; Horton et al. 2021).

5.1.4 The IPCC risk framework

In the context of the IPCC's Sixth Assessment Report, McLeman et al. (2021) developed a conceptual framework, which considers environmental migration from a climate change risk perspective *(Figure 5.2).* It shows how environmental migration may emerge from the interactions of both environmental and non-environmental factors, and what the potential outcomes could be. Accordingly, risks in the context of environmental change are a function of a particular climatic hazard, as well as the exposure and vulnerability of non-environmental factors (e.g. people, resources, and systems) to such a hazard.

Adaptation to an environmental hazard typically starts with in situ measures. If these are successful, they can lower the risk, and migratory patterns remain unchanged. However, if the local, context-specific thresholds are crossed and in situ adaptation becomes insufficient to address the risk, changes in the mobility strategy can be used to adapt by those with the capacities to do so. The mobility outcomes are uncertain and may both increase or decrease risk, depending on the different conditions including the political, socio-economic, and demographic situation. Typically, mobility with higher agency leads to better outcomes, as migrants have more control over their destination choices, and make decisions based on economic and security prospects (Adger et al. 2015; Jacobson et al. 2019). People who cannot afford to move and whose *in situ* adaptation fails typically experience increased risk and vulnerability (McLeman et al. 2021; IPCC 2022).

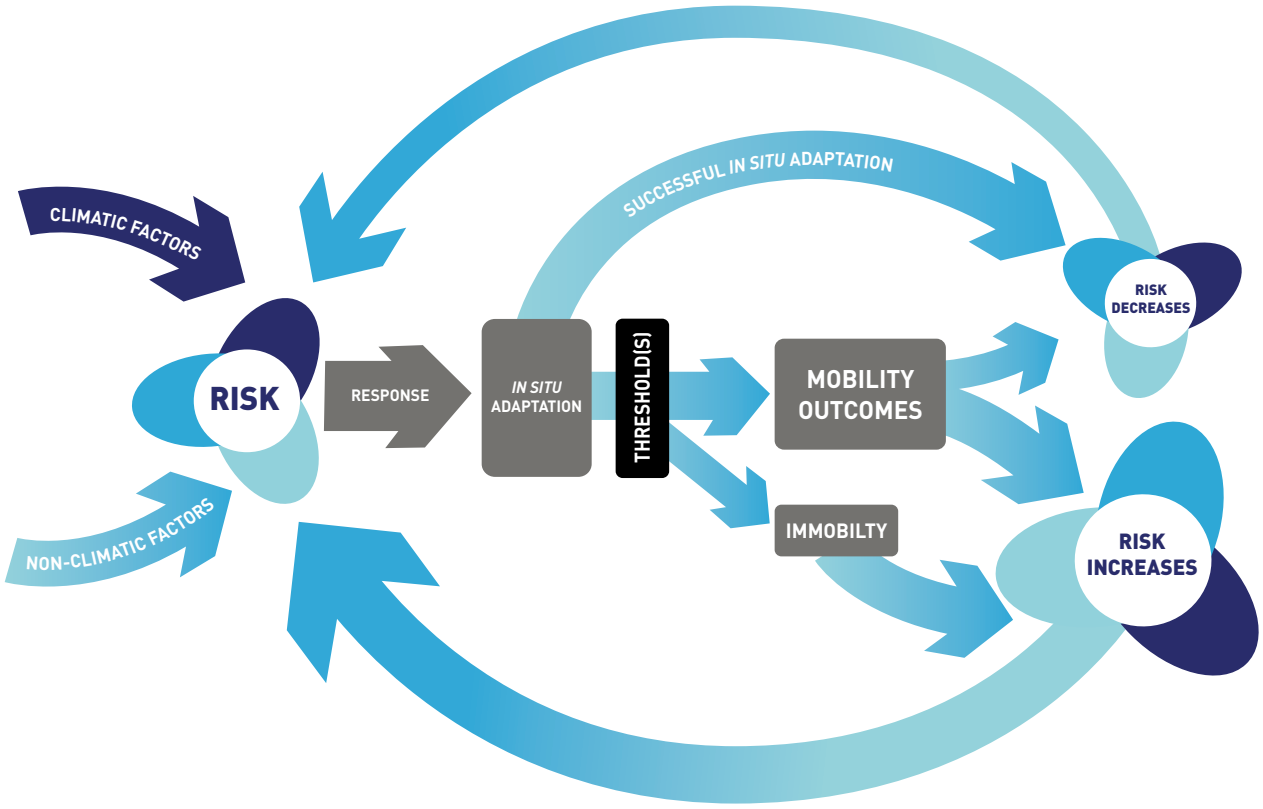


Figure 5.2 | Environmental migration risk framework. Source: McLeman et al. (2021).

5.2 Empirical evidence on environmental migration in the Mediterranean

5.2.1 North Africa and Sahel

In the Mediterranean, all North African countries — Algeria, Egypt, Libya, Morocco, and Tunisia — have historically been, and remain, significant countries for migrant destination, transit, and departure (de Haas 2011). Mixed migration patterns are observable in the region with economic conditions, environmental changes, and political instabilities contributing to migration dynamics. According to the seventh Afrobarometer carried out between 2017 and 2018, high migration intentions are observed in Tunisia (23%) and Morocco (13%), the two North African countries covered by the survey. Among all interviewed respondents, 47% indicated Europe as their preferred destination (Appiah-Nyamekye Sanny et al. 2019).

While environmental factors influence migration in the region, particularly for short-term and internal moves, political and economic conditions and social networks are more significant drivers (Hunter et al. 2015; Sow et al. 2016). In particular, economic shifts, urbanisation, demographic changes, rising education levels, and cultural transformations have all contributed to increased mobility, including rural-to-urban migration and emigration to Europe (de Haas 2011; Borderon et al. 2019).

Households in North African countries often do not directly attribute environmental hazards as the main cause of migration. However, they mention indirect factors such as insufficient agricultural revenue, a lack of agricultural employment, and better employment opportunities in destination areas. These indirect channels can be significantly influenced by adverse weather shocks and environmental change processes (Nguyen and Wodon 2014; Wodon et al. 2014). According to International Labour Organization (ILO) estimates for 2021, the agricultural sector employs a substantial proportion of the population in Sudan (41%), Morocco (35%), Egypt (20%), Libya (16%), Tunisia (14%), and Algeria (10%).

Rural communities that rely heavily on the environment for their livelihoods, such as pastoralists and agro-pastoralist communities are particularly susceptible to the impacts of environmental change (Hoffmann et

al. 2022; Wolde et al. 2023). The shrinkage of grazing areas over past decades has severely affected these communities, prompting some mobile populations in the region to travel longer distances. Additionally, sedentary farmers experience challenges due to delays in rainy season onset, mid-season heat waves, and heavy rains, resulting in crop loss and diminished yields (Connolly-Boutin and Smit 2016).

Drought and desertification processes as well as resulting land degradation represent considerable risk factors for North African dryland regions (Waha et al. 2017; Wiederkehr et al. 2018; Hoffmann et al. 2022). Rural dryland communities face various environmental hazards, frequently leading to extensive losses in agricultural yields and livestock (Huho et al. 2011; Middleton and Sternberg 2013). While dryland residents have adapted to their surroundings, the frequency and intensity of environmental hazards are on the rise due to climate change (Diffenbaugh et al. 2017), exacerbating the strain on local livelihoods (Thornton et al. 2011). In most dryland regions around the Mediterranean, the majority of climate models predict an increase in aridity, which will have a negative impact on agricultural and pastoral systems' productivity and reliability (Geddes 2015). In some cases, limits to adaptation may be reached, beyond which local adaptation may no longer be possible (Dow et al. 2013; Xu et al. 2020).

A case study in El Faouar in Tunisia demonstrates how affected communities must cope with unanticipated crop destruction that restricts their ability to pay their daily expenses by either selling livestock or migrating to seek out alternative income sources. The findings also demonstrate that local households attempt to increase their resistance to environmental constraints and climate change by expanding their agricultural capacity, provided they have additional funds from employment outside El Faouar, or remittances. Additionally, migration has evolved into a larger socio-economic transformation process where individuals move away to deal with or adapt to environmental changes (Sobczak-Szelc and Fekih 2020).

In addition to gradual changes in environmental conditions, sudden onset extreme weather events have caused displacement in the North African region. Overall, the region is less affected compared to other world regions with a share of only 0.35% of all displacements recorded in the period 2010–2019 (IDMC 2020). In Libya, for example, which does not have dedicated policies on internal displacement, approximately 7600 people were displaced between 2010 and 2019 due to disasters (IDMC 2020). In September 2023, Storm Daniel led to 42,000 displacements in the country (UNOCHA 2023). Infrastructure and agricultural lands that were crucial to the local economy were severely damaged by the floods.

5.2.2 The Middle East as part of the MENA region

The literature on environmental migration in the Middle East has largely focused on the links between environmental hazards, conflict, and migration. Conflict and violence continue to be the principal causes of displacement in the sub-region, despite progress in some countries toward peacebuilding and conflict resolution. Empirical studies have suggested a correlation between environmental change and hazards and the exacerbation of political instability in the MENA region, with climate change potentially contributing to intensifying pre-existing tensions (Sofuoğlu and Ay 2020).

Although historically accustomed to dealing with dryness, the Middle East has struggled with prolonged drought in the last decades, which is one of the costliest socio-economic disasters it has faced. However, obtaining clear statistics on the number of displaced individuals due to drought in the region remains challenging. As frequently discussed in the literature, a prolonged drought that destroyed sources of livelihood in the Syrian Arab Republic, prior to the conflict's outbreak in 2011, is considered one of the complex factors that contributed to the country's civil war *(Chapter 4, Section 4.2).* The severe drought that struck Syria between 2007 and 2010 was made two to three times more *likely* as a result of climate change (Kelley et al. 2015). This drought contributed to massive crop failures that undermined livelihoods and forced 1.5 million people to move from rural areas into cities, exacerbating existing social tensions (Gleick 2014).

However, the contribution of the drought to the conflict and resulting migratory movements is also questioned in the literature (see *Chapter 4* for discussion). An interdisciplinary study conducted in Türkiye reveals that Syrian farmers employed adaptive measures against the drought before the

war (Dinc and Eklund 2023). The authors also show that land abandonment during the drought was less extensive than often portrayed in the literature. Other evidence indicates that protests were more likely to occur in Syria's drought-prone regions, and that extreme weather events may have indirectly influenced civil unrest (Ash and Obradovich 2020).

Drought events and water scarcity represent a considerable challenge for the region. Cases of displacement in Iraq have shown that many families displaced due to water stress remained in their original governorates, with most of them moving towards urban areas (IDMC 2020; IOM 2022). Also, in Iran, environmental factors, including drought and resulting water stress, are among the main causes of rural migration, with many farmers heading to urban areas in pursuit of safety or a decent life (Khavarian-Garmsir et al. 2019; Ebadi et al. 2020). Since several countries in the area have recently experienced major droughts, there is enduring concern that the number of displaced people could rise as a result of environmental change.

Sudden onset disaster events also had adverse effects, in particular for those communities that are already affected by conflicts. Floods and wildfires caused hundreds of thousands of displacements in Lebanon and Syria recently. Between 2019 and 2022, there were multiple displacements due to repeated severe floods and storms, and the majority of people affected were internally displaced persons (IDPs) residing in camps (IDMC 2020). In some cases, the events have led to secondary displacements showing how the confluence of conflict and disaster creates a spiral of vulnerability and displacement (IDMC 2022).

In addition to severe floods, 25,000 people were forced to flee their homes due to wildfires in Syria in 2020, which caused damage to homes, water, electricity networks, and cropland, and increased food insecurity (IDMC 2021). Unfortunately, data on disaster displacement are collected incompletely, and small-scale disasters frequently go unreported because there is no systematic, national monitoring of displacement resulting from disasters in several countries in the Middle East (IDMC 2021). In Israel, 91,693 people were displaced by disasters between 2008 and 2021, and all the large-scale displacements in the country were due to wildfires (IDMC 2021).

In the future, environmental changes and hazards could lead to increased poverty and social instability, further destabilising the region and potentially contributing to increased migration (Geddes 2015). In the suddenly developing metropolitan areas of the Middle East, heat waves and flooding could result in significant losses and damages (Salimi and Al-Ghamdi 2020). Dervash and Wani (2022) draw attention to the fact that recently, migration from urban-to-urban areas has surpassed migration from rural to urban areas. The authors emphasise that the next stage may take place in the form of migration to Türkiye and Europe, due to the water shortage experienced in big cities, especially in summer.

Existing research on climate change and migration in the MENA region[69] has revealed important insights, but several gaps and unanswered questions remain. The availability and accuracy of data on environmental migration need to be improved in order to obtain precise statistics on the number of people displaced by environmental factors. It is crucial to understand the dynamics shaping the intricate relationship between environmental change and socio-economic and political factors, and particularly their long-term impact on migration decisions. Furthermore, studies focusing on the vulnerabilities and adaptive capacities of specific population groups, such as women, children, and marginalised communities, are necessary to address their unique challenges in the region.

5.2.3 Southeastern Europe

Climate change is expected to have a major impact on countries in southeastern Europe and the Balkans, including a significant increase in the number of extreme heat events in summer, and precipitation

[69] Although this Analysis focuses primarily on the Mediterranean region, it also draws on data from the Mediterranean Basin, the Eastern Mediterranean and Middle East (EMME), and the broader Middle East and North Africa (MENA) region (also referred to as Southern and Eastern Mediterranean Countries). In this Analysis, the MENA region refers specifically to countries bordering or closely connected to the Mediterranean Sea.

events in the winter months (Alfthan et al. 2015). The entire region will become drier as a result of rising temperatures and declining precipitation, with droughts predicted to increase in frequency, for example in Albania (Angelini et al. 2012). This trend has implications for agricultural production and food security in the region, especially in countries with an already strained food supply. For example, in 2022, more than 30% of the population in Albania and more than 20% in North Macedonia are moderately or severely food insecure (World Bank Data Catalog, World Bank Group[70]).

Increased insecurity can enhance migration intentions in the region. Although Southeastern European countries face a low to moderate risk regarding the effects of climate change in comparison to the rest of the world, they are already facing a number of sudden and slow onset disasters (Barron and van Manen 2022). Floods, drought, and extreme temperatures, for instance, caused 79% of crop and livestock production losses in the Western Balkans between 2005 and 2014 (FAO 2017). Countries like Montenegro have not seen a single year in the last two decades without an extreme event such as heat waves, floods, prolonged droughts, or forest fires (Burić et al. 2022).

Sudden onset disasters such as increasing and intensifying floods and wildfires are a key hazard in the Western Balkans, causing major livelihood losses and displacement (Alfthan et al. 2015). For example, severe late spring frosts have caused significant damage to fruit plants in Bosnia Herzegovina over the last five years (Trbic et al. 2021). Floods are the most prevalent disaster, with six flood events causing significant destruction in Montenegro in the last decade (Bisaro and Meyer 2022). The floods that occurred in May 2014 as a result of two months of rainfall in three days caused significant damage to settlements, and led to the relocation of approximately one million individuals in Serbia, Bosnia and Herzegovina, and Croatia (Hadžić 2022). The floods killed 51 people, displaced 31,000 individuals, and pushed an estimated 125,000 people into poverty (Alfthan et al. 2015). Those without a Schengen visa, who could not escape to neighbouring EU countries, were often trapped or internally displaced while seeking shelter (UNESCO 2023). In 2021, the Balkan region encountered catastrophic forest fires, like many other parts of the world. However, there is no conclusive evidence as to the impacts of these events on displacement and migration (Bisaro and Meyer 2022; IOM 2023).

Slow onset hazards, notably droughts, have had a considerable negative impact on the Balkans' welfare and economy in recent years. A Drought Management Centre for Southeastern Europe (DMCSEE)[71] was formed in 2009 to analyse regional vulnerability and risks, reduce the effects of drought, and establish an early warning system (Alfthan et al. 2015; Županić et al. 2021). This was especially important, since the Republic of North Macedonia is one of the driest countries in Europe (Županić et al. 2021). Albania is becoming more vulnerable to climate change due to its reliance on agriculture (Zhllima et al. 2022), and agricultural lands in Bosnia and Herzegovina are completely dependent on precipitation for water supply and groundwater replenishment (Trbic et al. 2021). The 2012 drought in the Western Balkans, particularly in Bosnia and Herzegovina, saw grain and vegetable production drop by up to 70% (Županić et al. 2021). Environmental change disproportionately affects those who are already vulnerable due to poverty, unemployment, and social exclusion, reducing their capacity to adapt and increasing the risks of displacement (IOM 2023). Recent studies from the region have raised doubts about the potential of migration as an adaptation strategy for households (Šimunić et al. 2020; Marić et al. 2023).

Türkiye experiences many sudden and slow onset climate events, such as floods, storms, forest fires and drought, and these mostly cause temporary displacement. During the last decade, hundreds of people have been displaced in Türkiye due to floods and wildfires, especially in the northern and southern parts of the country (IDMC 2020, 2021). The year 2021 was one of the country's worst in terms of sudden onset events. Four hundred and twelve widespread wildfires broke out in the southern and southwest provinces, displacing 81,000 people. At least 2500 homes were burned in the fires, putting almost 9000 people at risk of long-term displacement. In addition, a strong storm hit Türkiye in August of 2021, resulting

[70] Indicator 'Prevalence of moderate or severe food insecurity in the population (%)': https://data.worldbank.org/indicator/SN.ITK.MSFI.ZS

[71] https://www.dmcsee.org/

in heavy rains, flooding, and the deaths of 82 people. This disaster also led roughly 2500 people to flee their homes in several cities (IDMC 2021).

The overall effect of drought on migration in Türkiye is notable but not definitive; certain environmental factors, which might seem pivotal in driving migration, are overshadowed by non-climatic variables. Studies have reported declines in migration from rural areas during rainy seasons in regions where security is not an issue (Delju et al. 2019). Research indicates that it is often wealthier families that tend to permanently relocate to urban centres, whereas economically disadvantaged individuals often seek seasonal employment in agriculture (Afifi and Jäger 2010).

5.2.4 Southern Europe

In the empirical literature, Europe is mainly considered as a destination for migrants (Missirian and Schlenker 2017). Very limited evidence exists related to the impacts of environmental changes on migration within Europe. Given the expected impacts of climate change on relevant migration drivers, including agricultural productivity, it may be expected that parts of Southern Europe may also see increased migration in the future, if climatic impacts become more severe (EEA 2019; Hoffmann et al. 2023).

Climate change is expected to have a wide range of implications for mobility in Europe, including more frequent and powerful heat waves, retreating glaciers, and altered terrestrial ecosystems. In the Mediterranean and Southern Europe, rising temperatures and prolonged droughts are predicted to reduce water availability and crop productivity, and increase the possibility of wildfires. Despite receiving little attention in the literature, Southern Europe has witnessed thousands of people displaced in the previous decade because of a number of sudden onset disasters due to climate change.

The main causes of environmental displacements in the region are intensifying wildfires, floods, and storms. Between 2018 and 2021, an ongoing series of storms and floods displaced about 40,000 people in France, Greece, Italy, and Spain (IDMC 2020, 2021). Even though wildfires are a natural part of the Mediterranean ecosystem, changes in land use, overgrazing, deforestation, abandonment of agricultural lands, a decrease in rural population,

and record high temperatures and long-term droughts all contribute to an increase in their size and severity.

The region's intensifying wildfires also damage vegetation such as trees and grass, lowering the soil's ability to absorb water, increasing the risk of flooding (IDMC 2021), and bringing the compound risk of disasters and consequent displacements. In 2022, Spain experienced record high temperatures, rivers dried up in Italy, thousands of hectares of forest burned in Southern Europe, and about 100 million people across Europe were affected by water shortages (Kaeding et al. 2023).

Recent case studies in Southern Italy's Apennines highlight the need for targeted measures to prevent elevated risks of future disasters and capitalise on risk reduction and resilience capabilities associated with migration (L. Guadagno and E. Guadagno 2021; E. Guadagno 2022). These suggest that interventions should occur both at migrants' places of origin (e.g. planning, capacity building, risk awareness) and at their destinations (e.g. diaspora engagement), and should involve migrants, their households, and community members to ensure a fair distribution of risk-reduction benefits. More research and data, and a stronger focus on European countries, are needed to understand the implications of environmental change processes on migration within and across European countries.

5.3 Trajectories and destinations of mobile populations

5.3.1 Environmental changes and urbanisation processes

Urbanisation has changed the world in the 21st, with cities now housing more than half of the world's population. The urban population has grown dramatically, especially in the Global South's low- and middle-income countries (Gemenne et al. 2016). Small- and medium-sized cities in Africa, Asia, and Latin America are becoming more urbanised. By the middle of the century, approximatively two thirds (68%) of the world's population is expected to live in urban areas, with an estimated 2.5 billion additional individuals projected to live in cities worldwide by 2050 (UN DESA 2019).

While these trends are mainly driven by natural urban growth, rural-urban and urban-urban migration also contribute to these developments around the world (Gemenne et al. 2016). Rural-urban migration, particularly to major metropolitan areas, is an important engine of societal transformation (Geddes 2015). Historically, culturally, and linguistically interconnected countries in the Mediterranean Basin have experienced intense urbanisation since the 1950s (Tabak 2008; Marraccini et al. 2015). For example, between 1960 and 2015, the total population of the Middle East and North Africa quadrupled (Guida 2022), and 66% of the population was residing in urban areas by 2022 (World Bank 2023). While Egypt, Morocco, and Algeria are anticipated to continue to have an exceptionally high urbanisation rate at around 60% by 2030, Lebanon, Jordan, and Libya are expected to have an urbanisation rate of roughly 88%, 84% and 79%, respectively (UN DESA 2019).

Environmental change plays an important role in urbanisation processes, both as a driver and as a risk factor (de Haas 2011). As a driver, environmental factors can amplify rural-urban migration in pursuit of better opportunities, such as access to education, health care, and employment prospects (Lu 2010; Naude 2010; Scheffran et al. 2012; Henderson et al. 2014, 2017; Nguyen and Wodon 2014; Chen and Mueller 2019; Lyu et al. 2019; IPCC 2022; Helbling and Meierrieks 2023). In this context, secondary and tertiary cities, that is, smaller urban agglomerations, play an increasingly important role as migration destinations experiencing growing immigration in many countries (Andreasen et al. 2017; Marais and Cloete 2017).

Migration to urban destinations can contribute to economic growth and facilitate individuals' access to public goods. However, if not managed well, cities can struggle to cope with the influx of people, potentially leading to multidimensional social problems, including poverty and inequality. Displaced persons and migrants frequently settle in informal neighbourhoods, where they face health, economic, and security issues (Alexander and Tomalty 2002; Keivani 2009). Especially in North African countries, the percentage of the urban population living in informal settlements has increased in recent decades (UN-HABITAT 2022). This can lead to a downward spiral of 'slumification', with climate change contributing to increased risks alongside other socio-economic factors (Cities Alliance 2021; Abu Hatab et al. 2022). Poorly managed urbanisation and underdeveloped infrastructure can increase disaster risks due to a high population concentration, and exposure to threats. These risks can also influence relatives of urban dwellers outside the city (IOM 2020).

Rural-urban mobility, on the other hand, is also critical to risk reduction measures for households, offering access to markets, services, economic opportunities, and disaster and environmental protection systems. Cities provide prospects for development and prosperity, particularly in low- and middle-income countries (IDMC 2018). Although rural-urban migration is often blamed for rising urban poverty, in most countries rural migrants and displaced people do not make up the majority of the urban poor (Montgomery 2008), and are not the only residents of low-income informal settlements (Tacoli 2009). Evidence suggests that IDPs can boost local economies, and cities offer various advantages over camps hosting displaced people (Gemenne et al. 2016; IDMC 2020).

One of the key gaps in the data collected on disaster-related displacement is the lack of information on whether displaced people have achieved durable solutions by resettling elsewhere in the country. Addressing these gaps and gaining a more comprehensive understanding of not only where individuals are displaced from, but also where they seek shelter, would provide a clearer picture of the trajectories and destinations of environmental displacement in the Mediterranean and its

neighbouring countries. In this context, understanding the displacement risks that cities face is critical. Measures by local and provincial governments are essential for reducing risks by investing in coordinated climate change adaptation and urban development. To fully understand how cities respond to these challenges, power dynamics among different levels of governance and political stakeholders must be considered (Turhan and Armiero 2019).

5.3.2 Regional migration towards the Mediterranean

Countries in the Mediterranean are important migration destinations for both regular (i.e. legal, authorised, and documented) and irregular (i.e. illegal, unauthorised, and undocumented) migration. In total, approximately 25% of all immigrants worldwide live in the extended Mediterranean region (Testaverde and Pavilon 2022). In Europe, immigrants tend to be more concentrated in cities with larger labour markets and better infrastructure. For instance, in 2014, nearly three-fifths (61.3%) of immigrants of non-EU origin lived in cities, while almost a quarter (24.7%) lived in towns, and a seventh (13.9%) in rural areas (European Commission: Eurostat 2017).

Irregular migrants to Europe take three main routes: the Western Mediterranean route (from Morocco and Algeria to Spain), the Central Mediterranean route (from Libya and Tunisia to Italy), and the Eastern Mediterranean route (from Türkiye to Greece) (Fargues 2017). While the Eastern route is primarily used by Afghan, Iraqi, and Syrian refugees, the others are used by a more diverse migrant population (Werz and Hoffman 2017). Transit migration through Türkiye and the Western Balkans increased significantly in 2015 and early 2016 (McAuliffe and Triandafyllidou 2022).

The Mediterranean Sea represents an important transit route for migrants to Europe (see *Chapter 1, Section 1.1* and *Chapter 2, Section 2.2.1*). Over the last four decades, more than 2.5 million migrants have crossed the Mediterranean to Europe, driven by demographic disparities, economic inequalities, and political instability in their countries of origin (Marquina 2010). In 2016 and 2017, boat crossings from Libya to Italy and Türkiye to Greece via the Aegean Sea were the most popular routes into Europe. The Western Mediterranean route became more active than the Central Mediterranean route from 2018 to mid-2019, with more arrivals in Spain than Italy.

Historical linkages and post-colonial relationships have influenced migration pathways from North African countries to destinations such as France, Spain, and Italy (McAuliffe and Ruhs 2017). In 2020, Egypt, Morocco, South Sudan, Sudan, Somalia, and Algeria had the highest number of emigrants in Africa (McAuliffe and Triandafyllidou 2022). Sub-Saharan African migrants have also joined migration flows from North Africa, typically crossing the Mediterranean by boat (Marquina 2010). Due to conflicts and disasters, mixed migratory flows (see *Chapter 2, Section 2.5.2*) from Asia and Africa have become more prevalent in the Western Balkans over the last ten years.

Countries in the Middle East and North Africa represent important migration destinations and transit points, especially for regional migration flows from Western and Eastern African countries. Rural areas in Sub-Saharan Africa are particularly affected by environmental hazards and climate change due to their dependency on rain-fed agriculture and limited adaptive capacity (McAuliffe and Triandafyllidou 2022). A case study from Niger demonstrates that migrants from rural areas migrate to the Mediterranean region to cope with environmental hazards (Snorek 2016).

Morocco and Senegal launched the Initiative for Sustainability, Stability and Security in Africa (3S Initiative)[72] to address environmental drivers of migration in Africa. Its primary goal is to mitigate climate impacts by supporting affected areas and expanding arable land and forest protection. Furthermore, the project aims to create rural jobs through agriculture, agro-industry, and forestry investments, easing migration pressures. Fourteen African countries have planned activities to meet these targets, including Benin, Burkina Faso, Ghana, Morocco, Senegal, and others.

[72] https://www.unccd.int/resources/knowledge-sharing-system/initiative-sustainability-stability-and-security-3s-africa

Cross-border migration is frequently the result of a failure to protect and assist internally displaced persons (IDPs) in their home country, as many refugees have suffered internal displacement numerous times before leaving their home country (IDMC 2020). An emphasis on understanding the root causes of mobility and applying measures to improve adaptive capacity and resilience in the countries of origin is required. Development cooperation and emergency relief can be critical, as are the strengthening of communities' resilience to disasters and the provision of aid for safe passage and resettlement (Werz and Hoffman 2017).

5.4 Projecting environmental impacts on migration flows in the future

A growing portion of the existing scientific literature on the environment-migration nexus focuses on projecting future migration patterns within the context of environmental change. The main objective of such studies is to assess future human mobility considering anticipated changes in environmental conditions resulting from enhanced climate change.

5.4.1 Projection types and methods

In order to conduct projection exercises of the environment-mobility relationship, scholars must first evaluate how population movements and population compositions might evolve overall, regardless of environmental changes. The main tool used for this purpose is population scenarios. Two sets of scenarios are most prominently used, one developed following an approach adopted by the United Nations, and the other known as Shared Socioeconomic Pathways (SSP) (see *Chapter 3, Section 3.4.2*; O'Neill et al. 2014, 2017; K.C. and Lutz 2017). Neither restrict their focus to the Mediterranean region, yet both provide elements specific to it – with at least a country-level resolution and sometimes disaggregated further.

The UN approach includes probabilistic projections of population (Raftery et al. 2012), and emigration, return migration, and transit migration (Azose and Raftery 2019). The SSP framework, revolving around five narratives of future global socio-economic development (O'Neill et al. 2014, 2017), includes projections of population by age, sex, and level of education at the country level (K.C. and Lutz 2017), urbanisation (Jiang and O'Neill 2017), population change at highly local levels (Jones and O'Neill 2016), migration, population, and education for the EU countries (Lutz et al. 2019), and bilateral migration and remittance flows between pairs of countries, and the effects thereof on income and inequality (Benveniste et al. 2021).

Regarding migration specifically, projections often require estimating bilateral migration flows, that is, knowing both the origin and the destination – whereas most of the existing data is available for migrant stocks, that is, how many individuals from a given location are present at another location at a given time. Several methods have been developed to that end, recently providing refined results by sex (Abel 2018; Abel and Cohen 2019, 2022). Note that most existing migration projections assume levels of net migration tending towards zero in the long run (end of the century). However, this hypothesis is unlikely to hold in reality, and revising it could significantly impact population and migration projections (Abel 2018).

For projections of climate variability and the impacts of change on mobility patterns, existing projections are rarely confined to a specific geographic region. Nevertheless, most offer helpful information relevant for the Mediterranean Basin. To generate such projections of migration, scholars use a variety of models, ranging from including just some of the drivers of mobility, to general equilibrium approaches (Millock 2015). Some studies propose projections restricted solely to exposure to climate change impacts, not including the mobility response (Xu et al. 2020). Other analyses employ reduced-form approaches with causal inference to project migration, if unexamined drivers remain constant. By estimating migration responses to specific factors without accounting for all underlying mechanisms, these methods may overlook the complex interactions between various migration drivers (Missirian and Schlenker 2017).

More recent efforts complement empirical methods with machine learning (Molina et al. 2023), while others focus on individual decision-making using agent-based models (Bell et al. 2021; Choquette-Levy et al. 2021), although without a focus on the Mediterranean Basin yet. Finally, a prominent approach in the literature has used gravity-based models of internal migration (Rigaud et al. 2018; Clement et al. 2021), focusing on a series of world regions including Sub-Saharan Africa (2018), West Africa (2021), Middle East and North Africa (2021), and the Mediterranean region in the context of sea level rise (Reimann et al. 2023). Such gravity approaches have also been coupled with larger models capturing feedback between economic activity and the climate system (Benveniste et al. 2021, 2022). These models are foundational to models of dynamic economic assessment offering high spatial resolution (Desmet and Rossi-Hansberg 2015; Burzyński et al. 2021, 2022; Cruz et al. 2023).

5.4.2 Projecting future migration due to environmental stress in the Mediterranean

Overall, existing projections of future migration patterns related to climate change in the Mediterranean Basin offer a contrasting picture. Some studies suggest a substantial increase — up to a doubling — in migration flows under conditions of climate change, measured, for example, by internal migration towards urban centres in North Africa (Clement et al. 2021) or by asylum applications to the European Union (Missirian and Schlenker 2017).

Others counter that massive international flows of migrants are improbable, except in the unlikely event of both high levels of climate change and significant opening of borders (Burzyński et al. 2022). In particular, North Africa appears at high risk of a 'trapped population' effect, whereby increased climate change strongly limits the ability of lower income populations to migrate internationally due to decreased available resources (Benveniste et al. 2022).

Importantly, several studies highlight the key role of policies in determining both mobility outcomes and the conditions in which migration — or lack thereof — takes place. For instance, restrictive border policies are expected to significantly increase exposure and vulnerability to environmental change in North Africa, by trapping people in areas where they find themselves more vulnerable, than at locations that they would otherwise migrate to (Benveniste et al. 2021). As another example, projected significant internal migration from Mediterranean coastal areas to urban centres, for instance in the Nile Delta region, is significantly reduced when coastal adaptation policies such as hard protection, managed retreat, and accommodation strategies are implemented (Reimann et al. 2023).

References

Abel G. J. (2018). Estimates of Global Bilateral Migration Flows by Gender between 1960 and 2015. *International Migration Review*, *52*(3), 809–852. doi: 10.1111/imre.12327

Abel G. J., Brottrager M., Crespo Cuaresma J., and Muttarak R. (2019). Climate, conflict and forced migration. *Global Environmental Change: Human and Policy Dimensions*, *54*, 239–249. doi: 10.1016/j.gloenvcha.2018.12.003

Abel G. J., and Cohen J. E. (2019). Bilateral international migration flow estimates for 200 countries. *Scientific Data*, *6*(1), 82. doi: 10.1038/s41597-019-0089-3

Abel G. J., and Cohen J. E. (2022). Bilateral international migration flow estimates updated and refined by sex. *Scientific Data*, *9*(1), 173. doi: 10.1038/s41597-022-01271-z

Abu Hatab A., Amuakwa-Mensah F., and Lagerkvist C.-J. (2022). Who moves and who gains from internal migration in Egypt? Evidence from two waves of a labor market panel survey. *Habitat International*, *124*(102573). doi: 10.1016/j.habitatint.2022.102573

Adams H., and Kay S. (2019). Migration as a human affair: Integrating individual stress thresholds into quantitative models of climate migration. *Environmental Science & Policy*, *93*, 129–138. doi: 10.1016/j.envsci.2018.10.015

Adger W. N., Arnell N. W., Black R., Dercon S., Geddes A., and Thomas D. S. G. (2015). Focus on environmental risks and migration: causes and consequences. *Environmental Research Letters*, *10*(6), 060201. doi: 10.1088/1748-9326/10/6/060201

Adger W. N., Dessai S., Goulden M., Hulme M., Lorenzoni I., Nelson D. R., Naess L. O., Wolf J., and Wreford A. (2009). Are there social limits to adaptation to climate change? *Climatic Change*, *93*(3–4), 335–354. doi: 10.1007/s10584-008-9520-z

Afifi T., and Jäger J. (2010). Environment, forced migration and social vulnerability. In T. Afifi & J. Jäger (Eds.), *Environment, Forced Migration and Social Vulnerability*. Springer Berlin, Heidelberg. doi: 10.1007/978-3-642-12416-7

Alexander D., and Tomalty R. (2002). Smart Growth and Sustainable Development: Challenges, solutions and policy directions. *Local Environment*, *7*(4), 397–409. doi: 10.1080/1354983022000027578

Alfthan B., Krilasevic E., Venturini S., Bajrovic S., Jurek M., Schoolmeester T., Sandei P. C., Egerer H., and Kurvits T. (2015). *Outlook on climate change adaptation in the Western Balkan Mountains*. United Nations Environment Programme, GRID Arendal and Environmental Innovations Association. Vienna, Arendal and Sarajevo. https://www.grida.no/publications/162

Andreasen M. H., Agergaard J., Kiunsi R. B., and Namangaya A. H. (2017). Urban transformations, migration and residential mobility patterns in African secondary cities. *Geografisk Tidsskrift-Danish Journal of Geography*, *117*(2), 93–104. doi: 10.1080/00167223.2017.1326159

Angelini S., Re V., Guadagno E., Montini M., and Volpe F. (2012). *Climate Change and Adaptation in Southeastern Europe: A Background Report*. Environment and Security Initiative (ENVSEC), United Nations Environment Programme (UNEP). https://hdl.handle.net/11574/181029

Appiah-Nyamekye Sanny J., Logan C., and Gyimah-Boadi E. (2019). *In search of opportunity: Young and educated Africans most likely to consider moving abroad*. Afrobarometer Dispatch No. 288. https://www.afrobarometer.org/wp-content/uploads/migrated/files/publications/Dispatches/ab_r7_dispatchno288_looking_for_opportunity_africans_views_on_emigration1.pdf

Ash K., and Obradovich N. (2020). Climatic stress, internal migration, and Syrian civil war onset. *The Journal of Conflict Resolution*, *64*(1), 3–31. doi: 10.1177/0022002719864140

Azose J. J., and Raftery A. E. (2019). Estimation of emigration, return migration, and transit migration between all pairs of countries. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(1), 116–122. doi: 10.1073/pnas.1722334116

Bardsley D. K., and Hugo G. J. (2010). Migration and climate change: examining thresholds of change to guide effective adaptation decision-making. *Population and Environment*, *32*(2–3), 238–262. doi: 10.1007/s11111-010-0126-9

Barron E., and van Manen H. (2022). *The World Climate and Security Report 2022: Climate Security Snapshot - The Balkans* (E. Sikorsky & F. Femia, Eds.). Product of the Expert Group of the International Military Council on Climate and Security. Center for Climate and Security / Council on Strategic Risks. https://imccs.org/climate-security-snapshot-the-balkans/

Becerra-Valbuena L. G., and Millock K. (2021). Gendered migration responses to drought in Malawi. *Journal of Demographic Economics*, *87*(3), 437–477. doi: 10.1017/dem.2021.8

Bell A. R., Wrathall D. J., Mueller V., Chen J., Oppenheimer M., Hauer M., Adams H., Kulp S., Clark P. U., Fussell E., Magliocca N., Xiao T., Gilmore E. A., Abel K., Call M., and Slangen A. B. A. (2021). Migration towards Bangladesh coastlines projected to increase with sea-level rise through 2100. *Environmental Research Letters*, *16*(2), 024045. doi: 10.1088/1748-9326/abdc5b

Bellemare M. F. (2015). Rising food prices, food price volatility, and social unrest. *American Journal of Agricultural Economics*, *97*(1), 1–21. doi: 10.1093/ajae/aau038

Benveniste H., Cuaresma J. C., Gidden M., and Muttarak R. (2021). Tracing international migration in projections of income and inequality across the Shared Socioeconomic Pathways. *Climatic Change*, *166*(3), 39. doi: 10.1007/s10584-021-03133-w

Benveniste H., Oppenheimer M., and Fleurbaey M. (2022). Climate change increases resource-constrained international immobility. *Nature Climate Change*, *12*, 634–641. doi: 10.1038/s41558-022-01401-w

Berlemann M., and Steinhardt M. F. (2017). Climate change, natural disasters, and migration—a survey of the empirical evidence. *CESifo Economic Studies*, *63*(4), 353–385. doi: 10.1093/cesifo/ifx019

Bisaro A., and Meyer K. (2022). *Integrating Nature-based Solutions into policies for climate change adaptation and disaster risk reduction.* Gland, Switzerland: International Union for Conservation of Nature (IUCN). https://portals.iucn.org/library/efiles/documents/2022-030-En.pdf

Black R., Adger W. N., Arnell N. W., Dercon S., Geddes A., and Thomas D. (2011). The effect of environmental change on human migration. *Global Environmental Change*, *21*, S3–S11. doi: 10.1016/j.gloenvcha.2011.10.001

Black R., and Collyer M. (2014). "Trapped" Populations: Limits on mobility at times of crisis. In S. F. Martin, S. Weerasinghe, & A. Taylor (Eds.), *Humanitarian Crises and Migration: Causes, Consequences and Responses* (pp. 287–305). Routledge.

Boas I., Farbotko C., Adams H., Sterly H., Bush S., Van Der Geest K., Wiegel H., Ashraf H., Baldwin A., Bettini G., Blondin S., De Bruijn M., Durand-Delacre D., Fröhlich C., Gioli G., Guaita L., Hut E., Jarawura F. X., Lamers M., … Hulme M. (2019). Climate migration myths. *Nature Climate Change*, *9*(12), 901–903. doi: 10.1038/s41558-019-0633-3

Bohra-Mishra P., Oppenheimer M., and Hsiang S. M. (2014). Nonlinear permanent migration response to climatic variations but minimal response to disasters. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(27), 9780–9785. doi: /10.1073/pnas.1317166111

Borderon M., Sakdapolrak P., Muttarak R., Kebede E., Pagogna R., and Sporer E. (2019). Migration influenced by environmental change in Africa: A systematic review of empirical evidence. *Demographic Research*, *41*, 491–544. doi: 10.4054/demres.2019.41.18

Burić D., Banjak D., Doderović M., and Marčev A. (2022). Example of the importance of early warning of extreme weather events in Montenegro in the context of recent climate change. *Zbornik Radova - Geografski Fakultet Univerziteta u Beogradu*, *70*, 57–72. doi: 10.5937/zrgfub2270057B

Burzyński M., Deuster C., Docquier F., and de Melo J. (2022). Climate change, inequality, and human migration. *Journal of the European Economic Association*, *20*(3), 1145–1197. doi: 10.1093/jeea/jvab054

Burzyński M., Docquier F., and Scheewel H. (2021). The geography of climate migration. *Journal of Demographic Economics*, *87*(3), 345–381. doi: 10.1017/dem.2021.6

Cattaneo C., Beine M., Fröhlich C. J., Kniveton D., Martinez-Zarzoso I., Mastrorillo M., Millock K., Piguet E., and Schraven B. (2019). Human migration in the era of climate change. *Review of Environmental Economics and Policy*, *13*(2), 189–206. doi: 10.1093/reep/rez008

Cattaneo C., and Peri G. (2016). The migration response to increasing temperatures. *Journal of Development Economics*, *122*, 127–146. doi: 10.1016/j.jdeveco.2016.05.004

Chen J., and Mueller V. (2019). Climate-induced cross-border migration and change in demographic structure. *Population and Environment*, *41*(2), 98–125. doi: 10.1007/s11111-019-00328-3

Choquette-Levy N., Wildemeersch M., Oppenheimer M., and Levin S. A. (2021). Risk transfer policies and climate-induced immobility among smallholder farmers. *Nature Climate Change*, *11*(12), 1046–1054. doi: 10.1038/s41558-021-01205-4

Ciezadlo A. (2011, March 23). Let them eat bread: how food subsidies prevent (and provoke) revolutions in the Middle East. *Foreign Affairs*. https://www.foreignaffairs.com/articles/middle-east/2011-03-23/let-them-eat-bread

Cissé G., McLeman R., Adams H., Aldunce P., Bowen K., Campbell-Lendrum D., Clayton S., Ebi K. L., Hess J., Huang C., Liu Q., McGregor G., Semenza J., and Tirado M. C. (2022). Health, wellbeing and the changing structure of communities. In H.-O. Pörtner, D. C. Roberts, M. M. B. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1041–1170). Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009325844.009

Cities Alliance (2021). *The challenge of slums – an overview of past approaches to tackle it*. Cities Alliance, Brussels. https://www.citiesalliance.org/resources/publications/publications/challenge-slums%E2%80%94-overview-past-approaches-tackle-it

Clement V., Rigaud K. K., Sherbinin A., Jones B., Adamo S., Schewe J., Sadiq N., and Shabahat E. (2021). *Groundswell Part 2: Acting on Internal Climate Migration*. World Bank. doi: 10.1596/36248

Connolly-Boutin L., and Smit B. (2016). Climate change, food security, and livelihoods in sub-Saharan Africa. *Regional Environmental Change*, *16*(2), 385–399. doi: 10.1007/s10113-015-0761-x

Cottier F., and Salehyan I. (2021). Climate variability and irregular migration to the European Union. *Global Environmental Change: Human and Policy Dimensions*, *69*(102275). doi: 10.1016/j.gloenvcha.2021.102275

Cruz J.-L., and Rossi-Hansberg, E. (2023). The Economic Geography of Global Warming. *The Review of Economic Studies, 91*(2), 899–939. doi: 10.1093/restud/rdad042

Cundill G., Singh C., Adger W. N., Safra de Campos R., Vincent K., Tebboth M., and Maharjan A. (2021). Toward a climate mobilities research agenda: Intersectionality, immobility, and policy responses. *Global Environmental Change: Human and Policy Dimensions*, *69*, 102315. doi: 10.1016/j.gloenvcha.2021.102315

de Haas H. (2011). Mediterranean migration futures: Patterns, drivers and scenarios. *Global Environmental Change: Human and Policy Dimensions*, *21*, S59–S69. doi: 10.1016/j.gloenvcha.2011.09.003

de Sherbinin A., Grace K., McDermid S., van der Geest K., Puma M. J., and Bell A. (2022). Migration theory in climate mobility research. *Frontiers in Climate*, *4*, 882343. doi: 10.3389/fclim.2022.882343

Delju A. H., Piguet E., Rebetez M., and Ceylan A. (2019). *Drought-induced human displacement in Turkey*. Working Paper series MAPS, 2. https://www.unine.ch/maps/wp-content/uploads/sites/96/WP_2_2019_Delju_Piguet_Rebetez_Ceylan_EN.pdf

Dervash, M. A., & Wani, A. A. (Eds.). (2022). *Climate Change Alleviation for Sustainable Progression*. CRC Press. doi: 10.1201/9781003106982

Desmet K., and Rossi-Hansberg E. (2015). On the spatial economic impact of global warming. *Journal of Urban Economics*, *88*, 16–37. doi: 10.1016/j.jue.2015.04.004

Devkota R. P., Pandey V. P., Bhattarai U., Shrestha H., Adhikari S., and Dulal K. N. (2017). Climate change and adaptation strategies in Budhi Gandaki River Basin, Nepal: a perception-based analysis. *Climatic Change*, *140*(2), 195–208. doi: 10.1007/s10584-016-1836-5

Diffenbaugh N. S., Singh D., Mankin J. S., Horton D. E., Swain D. L., Touma D., Charland A., Liu Y., Haugen M., Tsiang M., and Rajaratnam B. (2017). Quantifying the influence of global warming on unprecedented extreme climate events. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(19), 4881–4886. doi: 10.1073/pnas.1618082114

Dillon A., Mueller V., and Salau S. (2011). Migratory responses to agricultural risk in northern Nigeria. *American Journal of Agricultural Economics*, *93*(4), 1048–1061. doi: 10.1093/ajae/aar033

Dinc P., and Eklund L. (2023). Syrian farmers in the midst of drought and conflict: the causes, patterns, and aftermath of land abandonment and migration. *Climate and Development*, *16*(5), 349–362. doi: 10.1080/17565529.2023.2223600

Dow K., Berkhout F., and Preston B. L. (2013). Limits to adaptation to climate change: a risk approach. *Current Opinion in Environmental Sustainability*, *5*(3–4), 384–391. doi: 10.1016/j.cosust.2013.07.005

Drabo A., and Mbaye L. M. (2015). Natural disasters, migration and education: an empirical analysis in developing countries. *Environment and Development Economics*, *20*(6), 767–796. doi: 10.1017/s1355770x14000606

Ebadi A. G., Toughani M., Najafi A., and Babaee M. (2020). A brief overview on current environmental issues in Iran. *Central Asian Journal of Environmental Science and Technology Innovation*, *1*(1), 1–11. doi: 10.22034/cajesti.2020.01.08

EEA (2019). *Climate change adaptation in the agriculture sector in Europe*. Luxembourg: Publications Office of the European Union. doi: 10.2800/537176

European Commission: Eurostat (2017). *Migrant Integration*. Luxembourg: Publications Office of the European Union. doi: 10.2785/295423

FAO (2017). *The future of food and agriculture: trends and challenges*. Rome, Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/handle/20.500.14283/i6583e

Fargues P. (2017). *Four decades of cross-Mediterranean undocumented migration to Europe: a review of the evidence*. International Organization for Migration. https://cadmus.eui.eu/handle/1814/51084

Foresight: Migration and Global Environmental Change. (2011). *Final Project Report*. The Government Office for Science, London. https://www.gov.uk/government/publications/migration-and-global-environmental-change-future-challenges-and-opportunities

Geddes A. (2015). Governing migration from a distance: interactions between climate, migration, and security in the South Mediterranean. *European Security*, *24*(3), 473–490. doi: 10.1080/09662839.2015.1028191

Gemenne F., Zickgraf C., Ionesco, and Dina. (2016). *The State of Environmental Migration 2016: A review of 2015*. Presses Universitaires de Liège. http://labos.ulg.ac.be/hugo/wp-content/uploads/sites/38/2016/09/The-State-of-Environmental-Migration-2016.pdf

Gleick P. H. (2014). Water, Drought, Climate Change, and Conflict in Syria. *Weather, Climate, and Society*, *6*(3), 331–340. doi: 10.1175/wcas-d-13-00059.1

Guadagno E. (2022). *Environment-related human mobility.* In L. Pellizzoni, E. Leonardi, & V. Asara (Eds.), *Handbook of Critical Environmental Politics* (pp. 362–373). Edward Elgar Publishing. doi: 10.4337/9781839100673.00035

Guadagno L., and Guadagno E. (2021). Migration, housing & disaster: Risk reduction and creation in Southern Italy's Apennines. *International Journal of Disaster Risk Reduction: IJDRR*, *61*, 102305. doi: 10.1016/j.ijdrr.2021.102305

Guida C. (2022). Climate adaptation in the Mediterranean: Where are we? *TeMA - Journal of Land Use, Mobility and Environment*, *15*(1), 141–148. doi: 10.6093/1970-9870/9037

Hadžić F. (2022). Impact of climate change in Southeast Europe; adaptation policies, environmental and human security, and normative resolutions. *Marine and Life Sciences*, *4*(1), 1–15. doi: 10.51756/marlife.1025195

Helbling M., and Meierrieks D. (2023). Global warming and urbanization. *Journal of Population Economics*, *36*(3), 1187–1223. doi: 10.1007/s00148-022-00924-y

Henderson J. V., Storeygard A., and Deichmann U. (2014). *50 Years of Urbanization in Africa: Examining the Role of Climate Change*. World Bank, Washington, DC. doi: 10.1596/1813-9450-6925

Henderson J. V., Storeygard A., and Deichmann U. (2017). Has climate change driven urbanization in Africa? *Journal of Development Economics*, *124*, 60–82. doi: 10.1016/j.jdeveco.2016.09.001

Hoffmann R., Abel G., Malpede M., Muttarak R., and Percoco M. (2023). *Climate Change, Aridity, and Internal Migration: Evidence from Census Microdata for 72 Countries*. IIASA Working Paper. Laxenburg, Austria: WP-23-008. https://pure.iiasa.ac.at/18922

Hoffmann R., Šedová B., and Vinke K. (2021). Improving the evidence base: A methodological review of the quantitative climate migration literature. *Global Environmental Change: Human and Policy Dimensions*, *71*, 102367. doi: 10.1016/j.gloenvcha.2021.102367

Hoffmann R., Wiederkehr C., Dimitrova A., and Hermans K. (2022). Agricultural livelihoods, adaptation, and environmental migration in sub-Saharan drylands: a meta-analytical review. *Environmental Research Letters*, *17*(8), 083003. doi: 10.1088/1748-9326/ac7d65

Holland A. (2012). *The Arab Spring and World Food Prices.* American Security Project. Climate Security. https://www.americansecurityproject.org/wp-content/uploads/2012/11/Ref-0096-The-Arab-Spring-and-World-Food-Prices.pdf

Horton R. M., de Sherbinin A., Wrathall D., and Oppenheimer M. (2021). Assessing human habitability and migration. *Science*, *372*(6548), 1279–1283. doi: 10.1126/science.abi8603

Hsiang S. M., Burke M., and Miguel E. (2013). Quantifying the Influence of Climate on Human Conflict. *Science*, *341*(6151). doi: 10.1126/science.1235367

Huho J. M., Ngaira J. K. W., and Ogindo H. O. (2011). Living with drought: the case of the Maasai pastoralists of northern Kenya. *Educational Research*, *2*(1), 779–789. https://www.researchgate.net/publication/228341183_Living_with_drought_the_case_of_the_Maasai_pastoralists_of_northern_Kenya

Hunter L. M., Luna J. K., and Norton R. M. (2015). Environmental Dimensions of Migration. *Annual Review of Sociology*, *41*, 377–397. doi: 10.1146/annurev-soc-073014-112223

IDMC (2018). *UnSettlement: Urban displacement in the 21st Century*. Internal Displacement Monitoring Center. https://www.internal-displacement.org/publications/unsettlement-urban-displacement-in-the-21st-century/

IDMC (2020). *Global Report on Internal Displacement 2020*. Internal Displacement Monitoring Center. https://www.internal-displacement.org/global-report/grid2020/

IDMC (2021). *Global Report on Internal Displacement 2021*. Internal Displacement Monitoring Center. https://www.internal-displacement.org/global-report/grid2021/

IDMC (2022). *2022 Global Report on Internal Displacement* (GRID 2022). Internal Displacement Monitoring Center. https://disasterdisplacement.org/resource/2022-global-report-on-internal-displacement-grid/

IOM (2007). *Discussion Note: Migration and the Environment (94th session- MC/INF/288)*. International Organization for Migration. https://www.iom.int/sites/g/files/tmzbdl486/files/jahia/webdav/shared/shared/mainsite/about_iom/en/council/94/MC_INF_288.pdf

IOM (2022). *Migration, Environment, and Climate Change in Iraq.* Geneva: International Organization for Migration. https://iraq.iom.int/resources/migration-environment-and-climate-change-iraq

IOM (2023). *Exploring The Links Between Migration, Environment and Climate Change in Bosnia and Herzegovina* International Organization for Migration. https://bih.iom.int/sites/g/files/tmzbdl1076/files/documents/2023-04/layout-iom-bih-analysis-of-migration-environment-and-climate-change-mecc-5.0-drina.pdf

IPCC (2018). *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield, Eds.). Cambridge University Press, Cambridge, UK and New York, NY, USA, 616 pp. doi: 10.1017/9781009157940

IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D. C. Roberts, E. S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, & A. Okem, Eds.). Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp. doi: 10.1017/9781009325844

Jacobson C., Crevello S., Chea C., and Jarihani B. (2019). When is migration a maladaptive response to climate change? *Regional Environmental Change*, *19*(1), 101–112. doi: 10.1007/s10113-018-1387-6

Jehn F. U., Kemp L., Ilin E., Funk C., Wang J. R., and Breuer L. (2022). Focus of the IPCC Assessment Reports Has Shifted to Lower Temperatures. *Earth's Future*, *10*(5), e2022EF002876. doi: 10.1029/2022ef002876

Jiang L., and O'Neill B. C. (2017). Global urbanization projections for the Shared Socioeconomic Pathways. *Global Environmental Change*, *42*, 193–199. doi: 10.1016/j.gloenvcha.2015.03.008

Jones B., and O'Neill B. C. (2016). Spatially explicit global population scenarios consistent with the Shared Socioeconomic Pathways. *Environmental Research Letters*, *11*(8), 084003. doi: 10.1088/1748-9326/11/8/084003

Kaeding, M., Pollak, J., & Schmidt, P. (Eds.). (2023). *Climate Change and the Future of Europe*. Springer Cham. doi: 10.1007/978-3-031-23328-9

K.C. S., and Lutz W. (2017). The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Global Environmental Change*, *42*, 181–192. doi: 10.1016/j.gloenvcha.2014.06.004

Keivani R. (2009). A review of the main challenges to urban sustainability. *International Journal of Urban Sustainable Development*, *1*(1–2), 5–16. doi: 10.1080/19463131003704213

Kelley C. P., Mohtadi S., Cane M. A., Seager R., and Kushnir Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3241–3246. doi: 10.1073/pnas.1421533112

Khavarian-Garmsir A. R., Pourahmad A., Hataminejad H., and Farhoodi R. (2019). Climate change and environmental degradation and the drivers of migration in the context of shrinking cities: A case study of Khuzestan province, Iran. *Sustainable Cities and Society*, *47*, 101480. doi: 10.1016/j.scs.2019.101480

Kim H., and Marcouiller D. W. (2018). Mitigating flood risk and enhancing community resilience to natural disasters: plan quality matters. *Environmental Hazards*, *17*(5), 397–417. doi: 10.1080/17477891.2017.1407743

Koubi V., Schaffer L., Spilker G., and Böhmelt T. (2022). Climate events and the role of adaptive capacity for (im-) mobility. *Population and Environment*, *43*(3), 367–392. doi: 10.1007/s11111-021-00395-5

Koubi V., Spilker G., Schaffer L., and Bernauer T. (2016a). Environmental Stressors and Migration: Evidence from Vietnam. *World Development*, *79*, 197–210. doi: 10.1016/j.worlddev.2015.11.016

Koubi V., Stoll S., and Spilker G. (2016b). Perceptions of environmental change and migration decisions. *Climatic Change*, *138*, 439–451. doi: 10.1007/s10584-016-1767-1

Kruczkiewicz A., Klopp J., Fisher J., Mason S., McClain S., Sheekh N. M., Moss R., Parks R. M., and Braneon C. (2021). Opinion: Compound risks and complex emergencies require new approaches to preparedness. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(19), e2106795118. doi: 10.1073/pnas.2106795118

Lu Y. (2010). Rural-urban migration and health: Evidence from longitudinal data in Indonesia. *Social Science & Medicine*, *70*(3), 412–419. doi: 10.1016/j.socscimed.2009.10.028

Lutz W., Cuaresma J. C., Kebede E., Prskawetz A., Sanderson W. C., and Striessnig E. (2019). Education rather than age structure brings demographic dividend. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(26), 12798–12803. doi: 10.1073/pnas.1820362116

Lyu H., Dong Z., Roobavannan M., Kandasamy J., and Pande S. (2019). Rural unemployment pushes migrants to urban areas in Jiangsu Province, China. *Palgrave Communications*, *5*(1), 1–12. doi: 10.1057/S41599-019-0302-1

Marais L., and Cloete J. (2017). The role of secondary cities in managing urbanisation in South Africa. *Development Southern Africa*, *34*(2), 182–195. doi: 10.1080/0376835X.2016.1259993

Marić A. Č., Čop T., Oplanić M., Ban S. G., and Njavro M. (2023). Adaptation to Climate Change in Adriatic Croatia—The View of Policymakers. *Sustainability*, *15*(9), 7085. doi: 10.3390/su15097085

Marquina A. (2010). From a Socioeconomic Approach to Migration to the Inclusion of Environmentally Induced Migration in the Mediterranean. In Marquina, A. (Ed), *Global Warming and Climate Change. Energy, Climate and the Environment Series* (pp. 187–207). Palgrave Macmillan UK. doi: 10.1057/9780230281257_12

Marraccini E., Debolini M., Moulery M., Abrantes P., Bouchier A., Chéry J.-P., Sanz Sanz E., Sabbatini T., and Napoleone C. (2015). Common features and different trajectories of land cover changes in six Western Mediterranean urban regions. *Applied Geography*, *62*, 347–356. doi: 10.1016/j.apgeog.2015.05.004

Massey D. S., Arango J., Hugo G., Kouaouci A., Pellegrino A., and Taylor J. E. (1993). Theories of International Migration: A Review and Appraisal. *Population and Development Review*, *19*(3), 431. doi: 10.2307/2938462

McAuliffe M., and Ruhs M. (2017). *World Migration Report 2018*. Geneva: International Organization for Migration (IOM). https://publications.iom.int/books/world-migration-report-2018?utm_source=chatgpt.com

McAuliffe, M., & Triandafyllidou, A. (Eds.). (2022). *World Migration Report 2022*. Geneva: International Organization for Migration (IOM). https://publications.iom.int/books/world-migration-report-2022

McLeman R. (2018). Thresholds in climate migration. *Population and Environment*, *39*(4), 319–338. doi: 10.1007/s11111-017-0290-2

McLeman, R., & Gemenne, F. (Eds.). (2018). *Routledge Handbook of Environmental Displacement and Migration*. Routledge. doi: 10.4324/9781315638843

McLeman R., Wrathall D., Gilmore E., Thornton P., Adams H., and Gemenne F. (2021). Conceptual framing to link climate risk assessments and climate-migration scholarship. *Climatic Change*, *165*(1–2), 24. doi: 10.1007/s10584-021-03056-6

Meze-Hausken E. (2008). On the (im-)possibilities of defining human climate thresholds. *Climatic Change*, *89*(3–4), 299–324. doi: 10.1007/S10584-007-9392-7

Middleton N. J., and Sternberg T. (2013). Climate hazards in drylands: A review. *Earth-Science Reviews*, *126*, 48–57. doi: 10.1016/j.earscirev.2013.07.008

Millock K. (2015). Migration and environment. *Annual Review of Resource Economics*, *7*(1), 35–60. doi: 10.1146/annurev-resource-100814-125031

Missirian A., and Schlenker W. (2017). Asylum applications respond to temperature fluctuations. *Science*, *358*(6370), 1610–1614. doi: 10.1126/science.aao0432

Miyan M. A. (2015). Droughts in Asian Least Developed Countries: Vulnerability and sustainability. *Weather and Climate Extremes*, *7*, 8–23. doi: 10.1016/j.wace.2014.06.003

Molina M. D., Chau N., Rodewald A. D., and Garip F. (2023). How to model the weather-migration link: a machine-learning approach to variable selection in the Mexico-U.S. context. *Journal of Ethnic and Migration Studies*, *49*(2), 465–491. doi: 10.1080/1369183X.2022.2100549

Montgomery M. R. (2008). The urban transformation of the developing world. *Science (New York, N.Y.)*, *319*(5864), 761–764. doi: 10.1126/science.1153012

Naude W. (2010). The determinants of migration from sub-Saharan African countries. *Journal of African Economies*, *19*(3), 330–356. doi: 10.1093/jae/ejq004

Nguyen M. C., and Wodon Q. (2014). Extreme Weather Events and Migration: The Case of Morocco. In Q. Wodon, A. Liverani, G. Joseph, & N. Bougnoux (Eds.), *Climate Change and Migration: Evidence from the Middle East and North Africa*. World Bank Study. Washington, DC: World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/748271468278938347

O'Neill B. C., Kriegler E., Ebi K. L., Kemp-Benedict E., Riahi K., Rothman D. S., van Ruijven B. J., van Vuuren D. P., Birkmann J., Kok K., Levy M., and Solecki W. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, *42*, 169–180. doi: 10.1016/j.gloenvcha.2015.01.004

O'Neill B. C., Kriegler E., Riahi K., Ebi K. L., Hallegatte S., Carter T. R., Mathur R., and van Vuuren D. P. (2014). A new scenario framework for climate change research: the concept of shared socioeconomic pathways. *Climatic Change*, *122*(3), 387–400. doi: 10.1007/s10584-013-0905-2

Piguet E., and Laczko F. (Eds) (2013). *People on the move in a changing climate*. Springer Dordrecht. doi: 10.1007/978-94-007-6985-4

Raftery A. E., Li N., Ševčíková H., Gerland P., and Heilig G. K. (2012). Bayesian probabilistic population projections for all countries. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(35), 13915–13921. doi: 10.1073/pnas.1211452109

Rahmstorf S., and Coumou D. (2011). Increase of extreme events in a warming world. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(44), 17905–17909. doi: 10.1073/pnas.1101766108

Reimann L., Jones B., Bieker N., Wolff C., Aerts J. C. J. H., and Vafeidis A. T. (2023). Exploring spatial feedbacks between adaptation policies and internal migration patterns due to sea-level rise. *Nature Communications*, *14*(1), 1–14. doi: 10.1038/s41467-023-38278-y

Rigaud K. K., de Sherbinin A., Jones B., Bergmann J., Clement V., Ober K., Schewe J., Adamo S., McCusker B., Heuser S., and Midgley A. (2018). *Groundswell: Preparing for Internal Climate Migration*. World Bank, Washington, DC. doi: 10.1596/29461

Safra de Campos R., Bell M., and Charles-Edwards E. (2017). Collecting and analysing data on climate–related local mobility: the MISTIC toolkit. *Population, Space and Place*, *23*(6), e2037. doi: 10.1002/psp.2037

Scheffran J., Marmer E., and Sow P. (2012). Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co–development in Northwest Africa. *Applied Geography*, *33*(1), 119–127. doi: 10.1016/j.apgeog.2011.10.002

Šedová B., Kalkuhl M., and Mendelsohn R. (2020). Distributional impacts of weather and climate in rural India. *Economics of Disasters and Climate Change*, *4*(1), 5–44. doi: 10.1007/s41885-019-00051-1

Šimunić I., Vukelić-Shutoska M., Spalević V., Škatarić G., Tanaskovik V., and Markoski M. (2020). Ameliorative measures aimed at prevention/mitigation consequences of climate change in agriculture in Croatia. *Poljoprivreda i Šumarstvo= Agriculture and Forestry*, *66*(2), 99–107. https://agricultforest.ac.me/data/20200630-10%20Simunic%20et%20al.pdf

Snorek J. (2016). Contested views of the causes of rural to urban migration amongst pastoralists in Niger. In T. Bloom & B. Gebrewold (Eds.), *Understanding Migrant Decisions: From Sub-Saharan Africa to the Mediterranean Region* (pp. 59–79). Ashgate. https://www.researchgate.net/publication/289980057_Contested_views_of_the_causes_of_rural_to_urban_migration_amongst_pastoralists_in_Niger

Sobczak-Szelc K., and Fekih N. (2020). Migration as one of several adaptation strategies for environmental limitations in Tunisia: evidence from El Faouar. *Comparative Migration Studies*, *8*(1), 1-20. doi: 10.1186/s40878-019-0163-1

Soffiantini G. (2020). Food insecurity and political instability during the Arab Spring. *Global Food Security*, *26*, 100400. doi: 10.1016/j.gfs.2020.100400

Sofuoğlu E., and Ay A. (2020). The relationship between climate change and political instability: the case of MENA countries (1985:01–2016:12). *Environmental Science and Pollution Research*, *27*(12), 14033–14043. doi: 10.1007/s11356-020-07937-8

Sow P., Marmer E., and Scheffran J. (2016). Between the heat and the hardships. Climate change and mixed migration flows in Morocco. *Migration and Development*, *5*(2), 293–213. doi: 10.1080/21632324.2015.1022968

Sternberg T. (2012). Chinese drought, bread and the Arab Spring. *Applied Geography*, *34*, 519–524. doi: 10.1016/j.apgeog.2012.02.004

Tabak F. (2008). *The Waning of the Mediterranean, 1550–1870*. Johns Hopkins University Press. doi: 10.1353/book.3493

Tacoli C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment and Urbanization*, *21*(2), 513–525. doi: 10.1177/0956247809342182

Testaverde M., and Pavilon J. (2022). *Building Resilient Migration Systems in the Mediterranean Region*. International Bank for Reconstruction and Development / The World Bank. doi: 10.1596/978-1-4648-1855-4

Thalheimer L. (2023). Compound impacts of extreme weather events and COVID-19 on climate mobilities. *Area*, *55*(1), 134–141. doi: 10.1073/pnas.1820362116

Thiede B., Gray C., and Mueller V. (2016). Climate variability and inter-provincial migration in South America, 1970–2011. *Global Environmental Change*, *41*, 228–240. doi: 10.1016/j.gloenvcha.2016.10.005

Thornton P. K., Jones P. G., Ericksen P. J., and Challinor A. J. (2011). Agriculture and food systems in sub-Saharan Africa in a 4°C+ world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *369*(1934), 117–136. doi: 10.1098/rsta.2010.0246

Trbic G., Popov T., Djurdjevic V., Milunovic I., Dejanovic T., Gnjato S., and Ivanisevic M. (2021). Climate Change in Bosnia and Herzegovina According to Climate Scenario RCP8.5 and Possible Impact on Fruit Production. *Atmosphere*, *13*(1), 1. doi: 10.3390/atmos13010001

Tschakert P., and Neef A. (2022). Tracking local and regional climate im/mobilities through a multidimensional lens. *Regional Environmental Change*, *22*(3), 95. doi: 10.1007/s10113-022-01948-6

Turhan E., and Armiero M. (2019). Of (not) being neighbors: cities, citizens and climate change in an age of migrations. *Mobilities*, *14*(3), 363–374. doi: 10.1080/17450101.2019.1600913

UN DESA (2019). *World Urbanization Prospects: The 2018 Revision*. New York: United Nations Department of Economic and Social Affairs. doi: 10.18356/b9e995fe-en

UNESCO (2023). *South-Eastern Europe regional synthesis: climate change, displacement and the right to education*. United Nations Educational, Scientific and Cultural Organization. doi: 10.54675/atxm1669

UN-HABITAT (2022). *World cities report 2022: envisaging the future of cities*. Nairobi, UN-Habitat. https://unhabitat.org/world-cities-report-2022-envisaging-the-future-of-cities

UNOCHA (2023). *Libya: Flood Response Humanitarian Update*. United Nations Office for the Coordination of Humanitarian Affairs. https://reliefweb.int/report/libya/libya-flood-response-humanitarian-update-31-october-2023-enar

Waha K., Krummenauer L., Adams S., Aich V., Baarsch F., Coumou D., Fader M., Hoff H., Jobbins G., Marcus R., Mengel M., Otto I. M., Perrette M., Rocha M., Robinson A., and Schleussner C.-F. (2017). Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. *Regional Environmental Change*, *17*(6), 1623–1638. doi: 10.1007/s10113-017-1144-2

Wallemacq P., and House R. (2018). *Economic Losses, Poverty & Disasters: 1998-2017*. Centre for Research on the Epidemiology of Disasters (CRED), The UN Office for Disaster Risk Reduction (UNDRR). https://www.undrr.org/quick/11678

Warner K., Hamza M., Oliver-Smith A., Renaud F., and Julca A. (2010). Climate change, environmental degradation and migration. *Natural Hazards*, *55*(3), 689–715. doi: 10.1007/s11069-009-9419-7

Werz M., and Hoffman M. (2017). Climate Change and Migration in the Mediterranean: Challenges for the Future. *IEMed Yearbook*. https://www.iemed.org/publication/climate-change-and-migration-in-the-mediterranean-challenges-for-the-future/?lang=fr

Wiederkehr C., Beckmann M., and Hermans K. (2018). Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. *Environmental Research Letters*, *13*(11), 113003. doi: 10.1088/1748-9326/aae6de

Wiegel H., Boas I., and Warner J. (2019). A mobilities perspective on migration in the context of environmental change. *WIREs Climate Change*, *10*(6), e610. doi: 10.1002/wcc.610

Wodon Q., Burger N., Grant A., Joseph G., Liverani A., and Tkacheva O. (2014). Climate Change, Extreme Weather Events, and Migration: Review of the Literature for Five Arab Countries. In E. Piguet & F. Laczko (Eds.), *People on the Move in a Changing Climate* (pp. 111–134). Global Migration Issues, vol 2. Springer, Dordrecht. doi: 10.1007/978-94-007-6985-4

Wolde S. G., D'Odorico P., and Rulli M. C. (2023). Environmental drivers of human migration in Sub-Saharan Africa. *Global Sustainability*, *6*, e9. doi: 10.1017/sus.2023.5

Xu C., Kohler T. A., Lenton T. M., Svenning J.-C., and Scheffer M. (2020). Future of the human climate niche. *Proceedings of the National Academy of Sciences*, *117*(21), 11350–11355. doi: 10.1073/pnas.1910114117

Zhllima E., Imami D., Nam J., Shoshi P., and Gjika I. (2022). Awareness of Climate Change Impact and Adaptation in Agriculture – The Case of Albania. *European Countryside*, *14*(4), 604–622. doi: 10.2478/euco-2022-0030

Zickgraf C. (2018). Immobility. In R. McLeman & F. Gemenne (Eds.), *Routledge Handbook of Environmental Displacement and Migration* (pp. 71–84). Routledge. doi: 10.4324/9781315638843

Zscheischler J., Westra S., van den Hurk B. J. J. M., Seneviratne S. I., Ward P. J., Pitman A., AghaKouchak A., Bresch D. N., Leonard M., Wahl T., and Zhang X. (2018). Future climate risk from compound events. *Nature Climate Change*, *8*(6), 469–477. doi: 10.1038/s41558-018-0156-3

Županić F. Ž., Radić D., and Podbregar I. (2021). Climate change and agriculture management: Western Balkan region analysis. *Energy, Sustainability and Society*, *11*(1), 51. doi: 10.1186/s13705-021-00327-z

Information about the authors

Coordinating Lead Authors

Roman HOFFMANN, International Institute for Applied Systems Analysis (IIASA), Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/OeAW, University of Vienna), *Austria*

Vally KOUBI, Department of Humanities, Social and Political Sciences, ETH Zurich, *Switzerland/Greece*

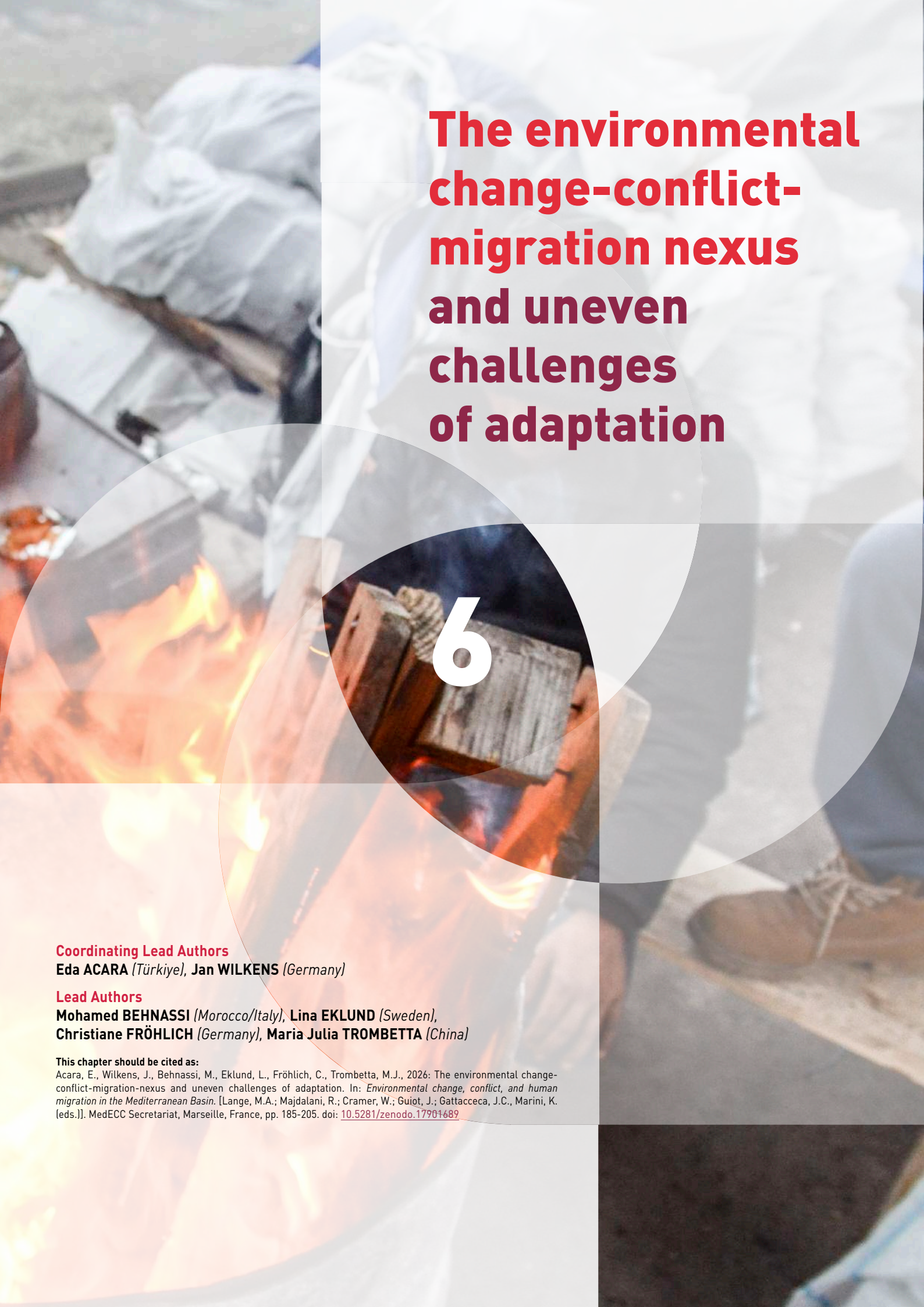
Lead Authors

Abdelslam BADRE, Mohammed V University in Rabat, *Morocco*

Helene BENVENISTE, Global Environmental Policy unit of the Department of Environmental Social Sciences, Stanford Doerr School of Sustainability, *USA*

Merve Suzan ILIK BILBEN, Faculty of Letters, Akdeniz University, *Türkiye*

Barbara ŠEDOVÁ, Potsdam Institute for Climate Impact Research (PIK), *Germany*



The environmental change-conflict-migration nexus and uneven challenges of adaptation

6

Coordinating Lead Authors
Eda ACARA *(Türkiye)*, **Jan WILKENS** *(Germany)*

Lead Authors
Mohamed BEHNASSI *(Morocco/Italy)*, **Lina EKLUND** *(Sweden)*, **Christiane FRÖHLICH** *(Germany)*, **Maria Julia TROMBETTA** *(China)*

This chapter should be cited as:
Acara, E., Wilkens, J., Behnassi, M., Eklund, L., Fröhlich, C., Trombetta, M.J., 2026: The environmental change-conflict-migration-nexus and uneven challenges of adaptation. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Secretariat, Marseille, France, pp. 185-205. doi: 10.5281/zenodo.17901689

Chapter 6

The environmental change-conflict-migration nexus and uneven challenges of adaptation

Executive summary 187

6.1 Complexity of interactions between environmental change, forced migration, and conflict 188
6.1.1 Limitations of available information, data, and sources on key dynamics for the nexus 188
6.1.2 Migration, adaptation, and the environmental change-conflict -migration nexus 190

6.2 Governance of environmental change, migration, and conflict in the Mediterranean 193

6.3 Legal frameworks and regimes to govern environmental migration 195

6.4 Migration and place-based vulnerabilities 196
6.4.1 Place-based vulnerabilities are central in the environment-migration-conflict nexus 196
6.4.2 Vulnerability varies across time and space 196

6.5 Migration, environment, and intersectional aspects 199

References 201

Information about the authors 205

Executive summary

Environmental change in the Mediterranean region exacerbates intersectional inequalities and poses challenges to existing governance structures, particularly with regard to human mobility and conflict. The complexities of these issues are compounded by a lack of empirical studies, methodological shortcomings, and limited access to data, hindering a comprehensive understanding of the phenomena. Addressing these challenges requires collective and collaborative efforts across local, national, regional, and international scales.

Migration is increasingly seen as a form of adaptation that operates across these various scales, while empirical evidence in the Mediterranean challenges the notion of migration as adaptation. To effectively tackle these issues, addressing the root causes of vulnerability, enhancing adaptation capacities, and promoting transformative adaptation strategies is crucial. However, environmental change in the Mediterranean has been securitised, prioritising certain threats such as conflict and migration over others, which may skew policy responses and resource allocations.

6.1 Complexity of interactions between environmental change, forced migration, and conflict

The environmental change-conflict-migration nexus is defined by context-specific interrelations of material and discursive conditions for involved and affected actors. Material conditions at this nexus encompass a range of issues, including environmental change, governance structures comprising legal regimes, and place-based vulnerabilities. Environmental change is happening at such a pace that it is eroding the resilience of human adaptability and intensifying significant social and environmental disruptions, posing a threat to human life and livelihoods. Water availability, droughts, sea level rise, pressure on ecosystems, and health are major areas of concern *(Chapter 3).* These changes can exacerbate existing political, social, economic, and ecological tensions, shaping inter- and intra-state conflicts and cooperation, and have therefore been described as 'threat multipliers' *(Chapter 4).* While the concept of 'threat multiplier' has been seen as useful in raising awareness about climate-security linkages, it risks becoming an empty signifier in policy debates by simplifying causal relationship between climate change and conflicts. Against this background, this chapter analyses the multifaceted landscape of conditions and further dynamics that are central in shaping the environmental change-conflict-migration nexus. These include current governance structures *(Section 6.2)* and legal regimes *(Section 6.3),* as well as place-based vulnerabilities, which are context specific *(Section 6.4)* and characterised by intersectional structural inequalities *(Section 6.5).* At the same time, material conditions are shaped by discursive constructions in which governance objects are framed in particular ways. This can be observed in narratives about environmental or climate migration *(Section 6.1.1),* and more prominently by turning climate into a security issue (securitisation[73]) *(Section 6.2).* Since the 1980s, there has been a trend to frame forced migrants[74] as a threat to human security, illustrated by the terms 'climate refugee' and 'environmental refugee' (Boas et al. 2019). The common understanding is that such environmentally-induced migration needs to be addressed by increasing resilience (Methmann and Oels 2015) and/or by stopping migration movements at their origins.

6.1.1 Limitations of available information, data, and sources on key dynamics for the nexus

The securitisation of climate change impacts often circumvents or disguises political power dynamics and insufficient governance structures, which are nevertheless important for the nexus. Here, country-specific information and data are often still missing. Only very limited information and data are available regarding the implications of renewable energy production and resource extractivism, a term used to describe a set of practices that enable resource exploitation that does not account for sustainability nor for equitable distribution of benefits. This issue is of growing importance for many Mediterranean countries, especially in the south of the Mediterranean. Although it constitutes another potential source of conflict beyond other inter-state disputes, little research exists on its linkages to displacement and migration dynamics. While it is often assumed that renewable energy facilities offer economic opportunities for countries in the region, recent developments indicate that they can also have a series of negative impacts on livelihoods, depending on the patterns of implementation (Hamouchene and Sandwell 2023). Renewable energies at scale are highly dependent on land use and also require significant resources, such as water, which could become a source of growing tension, particularly in countries of the southern Mediterranean, where agriculture is a key sector for national economies (Waha et al. 2017). Renewable energy power plants have the potential to significantly reduce CO_2

[73] The concept of 'securitisation' is used in this Analysis as defined in international relations and political science, particularly within the framework of the Copenhagen School (Buzan et al. 1998). Securitisation refers to the process through which an issue is constructed as an immediate and existential threat by a powerful actor—such as a government or political leader—through a speech act. This construction must be accepted by a relevant audience to legitimise the use of extraordinary measures beyond normal political procedures. As used in this Analysis, securitisation concerns the construction of issues as security threats, not the financial meaning of the term (i.e. the pooling and repackaging of assets into tradable securities).

[74] Throughout the report, the term 'involuntary' migration is preferred. In this chapter, the term forced migration is used as an essential concept that stems from the literature, as involuntary migration does not capture some of the points made in this chapter and in the academic literature used.

emissions, but they reshape land-use dynamics due to required space for construction and operation. Although research is still limited, existing studies underline that the impacts of constructing renewable energy facilities on landscape, land tenure, and land-use patterns can be significant, and have the potential to undermine the authority of local communities (Lamhamedi and de Vries 2022). Given the recent nature of these dynamics, little research exists that directly addresses the nexus, but it is important to note that research on renewable energy in countries around the Mediterranean highlights potential conflicts with the possibility of shaping displacement in the future.

This also shows that while both environmental and climate change are dynamics of increasing relevance for the Mediterranean region, the related impacts are uneven across southern shore countries and rural and urban areas, as well as on the sub-state level for different social groups. However, studies on the nexus of environmental change, conflict, and displacement are inconclusive as to the causal relationships between the nexus nodes, which makes it difficult to predict the long-term consequences of such complex and uncertain linkages, with medium- and long-term implications remaining mostly projections. This uncertainty is important to consider in the face of the prevailing understanding of climate-related migration as a national security issue. This has been of particular relevance since the 1990s, when natural scientists working on climate change started to project very high numbers of 'environmental refugees' or 'climate refugees' (see Myers 1997; Reuveny and Moore 2009). These underlying Eurocentric patterns of knowledge production have generated assumptions of causality at the nexus of environmental change, conflict, and (forced) migration that have been rebutted by recent scholarship (Brzoska and Fröhlich 2016; Selby et al. 2017; Scheffran 2020; *Chapters 4* and *5*). Additionally, most existing studies in the region focus on the relation between slow onset environmental changes and migration/displacement, such as sea level rise, droughts, and soil degradation. This research, mainly consisting of single-country case studies, underlines the complex relationship between environmental changes and migration, the diversity of migration patterns, including the temporality of migration, and the fact that migration is often seen as a last resort; since migration induced by environmental changes often leads to a worsening of individual conditions, as shown in the case of Egypt (Warner 2010). While environmental change is rarely identified as a prime reason for migration, it can shape already-existing patterns of migration induced by conflict. Limited evidence suggests, however, that in the context of this nexus, migration can also be seen as a form of adaptation by affected households. This applies especially in cases where food and water security are contested, and remittances can be a potential solution. Case studies further highlight context-specific circumstances and diverse ways of perceiving migration as adaptation (see Afifi 2010 for Egypt; Sobczak-Szelc and Fekih 2020 for Tunisia). However, while migration is increasingly being discussed as a form of adaptation in the context of environmental change (Gemenne and Blocher 2017; İçduygu and Gören 2023), including in the IPCC Sixth Assessment Report on impacts, adaptation, and vulnerability (IPCC 2022a), current evidence highlights that it might not be a suitable or sustainable adaptation strategy (Vinke et al. 2022). This tension between theoretical discussions and empirical evidence shows that framing adaptation in the context of human mobility tends to neglect the political, economic, and social dimensions of migration by merely understanding migrants as victims of environmental change, and as a challenge for national security (Ransan-Cooper et al. 2015). Instead of understanding migrants in the context of environmental change and conflict as political subjects whose norms, identities, and perceptions about mobility and adaptability could shape policy strategies, current dynamics are characterised by a lack of supportive governance structures. As assessed in *Chapters 3, 4,* and *5* of this report, the lack of governance structures and mismanagement are critical in understanding the relationship between environmental hazards, environmental change impacts, conflict, and migration.

This chapter therefore contextualises migration as adaptation within these intricate interactions in order to highlight current challenges and trajectories by drawing on different ideal types of adaptation, namely coping, incremental, and transformative adaptation, as well as maladaptation. Adaptation is often understood as a 'local' phenomenon or practice and, as part of the United Nations Framework Convention on Climate Change (UNFCCC), is subject to national adaptation plans. The chapter will discuss how migration as an adaptation strategy spans local, national, regional, and international scales. It

also underlines that adaptation is a highly socially demanding process, and not a mere functional option for migrants facing environmental change and conflict. The chapter examines adaptation gaps, alongside the policies that are currently in place or lacking in the Mediterranean region, and the vulnerabilities that result from these dynamics.

6.1.2 Migration, adaptation, and the environmental change-conflict-migration nexus

The IPCC Sixth Assessment Report on impacts, adaptation, and vulnerability identifies a high probability for new and existing multi-scale conflicts that might be transformed or exacerbated by increasing climate risks (IPCC 2023). Although evidence summarised in this report shows that there are uncertainties over how conflicts are shaped by climate risk, a densification of conflicts would put an additional burden on governance systems, already exhausted by conventional challenges. In addition, such shifts would not only threaten human and natural systems but also constitute emerging drivers of human insecurity and displacement both within and across national borders. Indeed, (violent) conflicts and human displacement are among the major social consequences of environmental change, environmental downgrading, and resource scarcity.

On the one hand, the report recognises that migration can be considered a form of adaptation that reduces risks and the consequences of climatic and non-climatic stressors when it is voluntary, safe, and orderly (Cissé et al. 2022). On the other hand, it underlines that the quantity and quality of existing data required to bridge the gap between data, science, and policy approaches in addressing human mobility challenges in disaster and environmental change contexts remain limited. While there is a common understanding that increasing extreme weather events, particularly floods and droughts, but also slow onset events, such as sea level rise, are likely to increase displacement, and that limited adaptive capacities contribute to involuntary migration, 'compared to other socio-economic factors the influence of climate on conflict is assessed as relatively weak'(IPCC 2022b, p.15).

The complex relationship between environmental change adaptation, migration, and conflict is therefore not only seen by the fact that neither climate change nor conflict is linked in a straightforward manner, but also by the observation that the meaning of climate change adaptation is contested depending on specific contexts. The goal of environmental change adaptation, as with mitigation, is to reduce risks, strengthen resilience, and address vulnerabilities in the short and long term (Huang-Lachmann and Guenther 2020). However, there are significant differences in the ways environmental change affects people in different places and contexts. There are also diverse ways of understanding what adaptation would mean for analytical and practical challenges with regard to a particular setting. International frameworks, such as the Paris Agreement (UN 2015), the Sustainable Development Goals (SDGs, UN General Assembly 2015), and the Santiago Network for Loss and Damage[75], established at UNFCC COP 25 (December 2019), underline that effective adaptation depends on effective mitigation, sufficient financial and other resources to increase adaptive capacities, and active coordination and planning (UNEP 2023). While these aspects can be understood as general conditions for climate change adaptation, they do not provide specific guidance to plan or implement adaptation efforts (IPCC 2022b, p.26). This also applies to displacement and forced migration in the Mediterranean region.

Given the specificity of spatial settings, such as coastal, urban, and rural systems, research on adaptation has analysed different adaptation pathways or ideal types in order to identify sustainable and unsustainable ways of adapting to environmental change (Gresse et al. 2023). In this context, ideal types of adaptation have been identified as coping, incremental adaptation, and transformative adaptation (Fedele et al. 2019). Coping is usually a result of limited resources and awareness of the demand for change and leads to practices that largely do not alter given systems (Kates et al. 2012; Fedele et al. 2019; Gresse et al. 2023). Incremental adaptation practices are implemented by addressing selected climate risks step-by-step. They might be effective in the short-term or with regard to a particular risk. However,

[75] https://unfccc.int/santiago-network

they may also risk reproducing unsustainable practices (Wakefield 2019). Transformative adaptation contrasts with mere risk management and encompasses fundamental changes to a given system by establishing new human-environment relationships (Adger and Jordan 2009; O'Brien 2012; Feola 2015; Fedele et al. 2019; Gresse et al. 2023). The diversity of ways in which these different adaptation pathways materialise are summarised in *Table 6.1.*

This differentiation of adaptation pathways highlights that a particular risk of adaptation practices is maladaptation. While adaptation is not only urgently needed, but also already happening, a growing number of studies highlight a lack of clarity in understanding successful or effective adaptation. Maladaptation occurs when adaptation practices or processes lead, often unintentionally, to a situation that enhances vulnerability to environmental change, instead of reducing it (Schipper 2022). This is particularly true in the context of displacement and forced migration in the Mediterranean region. In most cases, migration in the region is an attempt to cope with various risks, especially when climate change and environmental degradation exacerbate vulnerabilities due to existing socio-economic risks and conflicts. Several examples of these vulnerabilities are presented in *Chapter 5.* Various drivers of forced migration intersect with threats connected to environmental change (Mencütek 2018). While there is a substantial lack of data on the climate risk, conflict, and migration nexus for various countries in the region, recent research highlights

Table 6.1 | Examples of climate adaptation measures in coastal, urban, and rural systems. Source: adapted from Gresse et al. (2023, p.63).

Type of adaptation	Coastal systems	Urban systems	Rural systems
Coping	Beach nourishment to restore sandy coastlines, maintenance dredging in artificially deepened estuarine channels (van Maren et al. 2015).	Air conditioning of buildings to adapt to extreme heat (e.g. Lundgren-Kownacki et al. 2018).	Mitigating the impacts of extreme events such as droughts or storms, e.g. with reduction of livestock size (Venot et al. 2010; Pili and Ncube 2022) or removal of damaged trees (DeWalle et al. 2003).
Incremental adaptation	Climate dykes with wide dyke base allowing for future dyke-height adjustment in case of a further sea level rise (MELUND 2022).	Modification of urban land cover to mitigate the urban heat island effect (Akbari et al. 2016), e.g. green roofs (Clar and Steurer 2021).	Expansion, intensification, and modification of production systems (Zullo et al. 2011; Kachulu 2018; Lara-Estrada et al. 2021; Bhalerao et al. 2022).
Transformative adaptation	Active storm-surge barrier control mitigating consequences of sea- level rise and tidal pumping of sediments (Masterplan Ems 2050 2022), Sand motor nourishing for eroding sandy coastlines (van den Hoek et al. 2012; Brière et al. 2018).	Water-sensitive city concept as an integrated approach for water management uniting water supply, sanitation, flood protection, and environmental protection strategies (Wong et al. 2020).	Shifts to healthier diets in combination with modified agricultural production and trade patterns (Zech and Schneider 2019; Chan et al. 2022); large-scale conservation and restoration of degraded peatland and floodplain ecosystems (Jantke et al. 2016; Heger et al. 2021; Temmink et al. 2022).

that the combination of limited resources available to affected people and existing governance dynamics turns migration into a form of coping and, potentially, maladaptation. In particular, the lack of coordination and cooperation among different stakeholders, policy and land use planning, as well as other governance practices, undermine transformative adaptation strategies that would effectively address vulnerability as a risk multiplier for conflict. The contested nature of root causes is one of the various challenges. While migration is increasingly being perceived as a strategy for adaptation to changing environmental and climate patterns, it may also increase conflict risks and lower the adaptive capacity of host countries due to an increase in resource scarcity, socio-political unrest, and by turning climate into a security issue (securitisation). In addition to material factors, discursive settings in which migration and human mobility are 'securitised', that is made into a security issue, when it should be a human rights issue, have an impact on migration aspirations and migration decision-making.

The uncertainty and complexity of interactions between environmental change, migration, and conflict affect the ability of decision-makers at all scales to shape appropriate and efficient response mechanisms. Nevertheless, the most relevant and effective response mechanisms have been proven to be community-based and location-specific (Rahman et al. 2023). This calls for processes that construct networks of local, national, regional — and potentially global — communities to build rural, coastal, and urban structures that develop sustainable adaptation strategies starting from the realities on the ground.

6.2 Governance of environmental change, migration, and conflict in the Mediterranean

The governance of environmental change and migration needs to be considered against a framework characterised by two broad and overlapping dynamics. On the one hand, migration — and to a lesser extent environmental change — is securitised. On the other hand, environmental change and climate change are presented as threat multipliers and addressed by promoting resilience, which is considered a way to deal with the multiple challenges they pose, including migration and conflict. The result is a limited, fragmented governance structure.

With regard to the process of turning climate into a security issue (securitisation), unmanaged migration tends to be considered problematic in a system of states. Despite the approval of the Global Compact for Safe, Orderly and Regular Migration (UN General Assembly 2018), the recognition of the right to migrate remains problematic and often limited to the right to seek refuge. Migration is presented as a threat to states and people and is therefore securitised. In Europe, the process is a long-term one (Huysmans 2000), which has been reinforced by several migration crises, and by alarming reports about possible future waves of climate and environmental refugees dating back to the 1990s (Myers 1997). The term securitisation refers to a framework originally developed by the Copenhagen School that considers how, and with what consequences, issues are transformed into security issues and governed accordingly (Buzan et al. 1998). The approach emphasises the discursive construction of threats and how labelling an issue as a security issue transforms the way it is governed, prioritised, and lifted over politics, but also contributes to an antagonistic defensive logic that creates enemies and divisions. This is the reason why the security framing, welcomed by some as a way to mobilise action, especially against environmental problems, is considered problematic by many. As part of a process of securitisation, migrants arriving in Europe are presented as threats to states, local identities, and the welfare system, or linked with other threats like terrorism or disease. The characterisation of the threats often remains unspecified, as part of what has been dubbed a 'governmentality of unease' surrounding migration. While the narrative tends to distinguish (and condemn) traffickers from migrants, often presented as vulnerable victims, the tension remains, and it is particularly evident in the case of climate change. The European Parliament has recognised the link between climate change and migration and proposed a study (Kraler et al. 2020), but the concept of climate refugee has not yet been accepted.

In general, the literature inspired by securitisation warns about the implications of labelling an issue as a security issue, and the implications of using labels like migrants rather than refugees. These approaches suggest that besides material aspects and problems, the ways issues are labelled matter for their governance.

With regard to the discourse on governing environmental change through resilience, the framing of climate change and environmental change more broadly as threat multipliers has a set of implications for governance. On the one hand, it allows scholars and practitioners to consider various ways in which environmental change is linked to security. Threats considered include both direct threats associated, for instance, with more frequent drought, heat waves, and flooding, as well as those determining social instability, migration, and conflict. The causal link between climate change and conflict is still debated and yet, the discursive link supports securitising moves that shape policy responses. On the other hand, the approach adopted to deal with this array of threats has been based on promoting sustainable development and resilience. Threats are often future ones, difficult to frame in terms of probability and risk assessment. It is therefore necessary to become resilient in order to cope with these multiple challenges. The concept of resilience, borrowed from ecology to describe the ability of a system to return to equilibrium and thus survive after a shock, has become a buzzword for dealing with a variety of problems including climate change and migration. The emphasis on resilience is both empowering and limiting. On the one hand, it involves the collaboration of a variety of actors in both developing and developed countries, empowering actors at different levels that go well beyond forms of humanitarian intervention. On the other hand, it transforms those who are not able to embrace sustainable development and become resilient into a threat, either because they can migrate or create instability (Methmann and Oels 2015). These

two dynamics make climate change and migration governance fragmented and not very proactive. On the EU side, Parliament's appeals to fight climate change and elaborate an international framework on climate migration, continue to generate nothing more than reactive and short-term responses (European Parliament 2022). This also makes it challenging to promote urgent measures while avoiding problematic, counterproductive narratives.

Effective governance would require international cooperation and coordination with other regional actors. However, 'the EU favours development interventions that effectively prevent migration, while African partners prefer measures that ease mobility for development' (Hahn and Fessler 2023, p.17; see also Zanker 2019). In February 2022, the African Union (AU) adopted the first continental climate change and resilient development strategy and action plan (2022–2032). While non-binding, this AU climate strategy aims to develop resource-efficient industry and make key sectors, from agriculture to transport, more climate-resilient, while providing a comprehensive approach. The AU acknowledges the technical and financial support of the EU, among other institutions, to develop its climate strategy. As part of the EU Green Deal and strategy on adaptation to climate change, the EU has committed to 'promote sub-national, national and regional approaches to adaptation, with a specific focus on adaptation in Africa, Small Island Developing States (SIDS), and Least Developed Countries (LDCs)' (European Commission 2021). In this larger political setting, migration remains securitised in the Mediterranean context.

6.3 Legal frameworks and regimes to govern environmental migration

The first IPCC reports referenced millions of potential climate migrants (IPCC 1990). However, most initiatives to improve the protection of people displaced by climate events or environmental degradation have so far failed, primarily due to a lack of political will, which can be explained, at least in part, by the constant securitisation of climate change and its consequences, especially climate-induced migration. The most prominent example of securitisation can be seen in the emergence and impact of the term 'climate refugee' linked to particular narratives including the following ingredients in various forms: a Global North, and often a West European perspective on the Mediterranean South, characterising migration as a security risk, as opposed to other possibilities, such as migration as adaptation, and an assumed correlation between a growing impact of environmental change and rising numbers of refugees despite the absence of empirical evidence in this regard (Klepp 2017; Nash 2019). While the term 'climate refugee' remains not only controversial in its use in political and activist settings, as well asand in regard to its analytical value, it also bears no legal value, as displacement due to climate change is not yet part of the Convention relating to the Status of Refugees ('1951 Refugee Convention' or the 'Geneva Convention') (UN 1951). The term is therefore used to discursively highlight the involuntariness of migration in the context of climate change, but without granting any rights or duties to the people thus described. In 2015, Ioane Teitiota from Kiribati, an island nation in the Pacific, formally requested asylum in New Zealand. However, this was rejected by New Zealand's Supreme Court on the grounds that, as a permanent climate migrant, he was not a refugee under the Geneva Convention. While international law still does not sufficiently recognise any environmental or climate-related reasons for displacement that would result in legal protection, in a ruling of January 2020, the UN Human Rights Committee[76] recognised that forcibly returning a person to a place where their life would be at risk due to the adverse effects of climate change may violate fundamental human rights, thereby underlining the principle of non-refoulement, and the Kampala Convention[77] also provides some protection for persons displaced by environmental or climate stressors in Africa (Rolli et al. 2023).

There are several proposals regarding how people affected by the consequences of climate change could be better protected, but their implementation is unlikely in the face of political resistance and legal hurdles (Pérez 2018). In 2015, the Nansen Initiative[78] adopted an agenda for protecting people who are displaced across national borders due to climate-related disasters. The initiative received strong support, as did its successor, the Platform on Disaster Displacement[79], but the Agenda for Protection is not legally binding (Nansen Initiative 2015).

A key dimension that is often overlooked in risk-focused approaches, but that needs more conceptual and empirical integration for a better understanding of the environmental change-conflict-migration nexus, is an in-depth analysis of vulnerabilities.

[76] https://www.ohchr.org/en/treaty-bodies/ccpr

[77] https://au.int/en/treaties/african-union-convention-protection-and-assistance-internally-displaced-persons-africa

[78] https://environmentalmigration.iom.int/nansen-initiative

[79] https://disasterdisplacement.org/

6.4 Migration and place-based vulnerabilities

6.4.1 Place-based vulnerabilities are central in the environment-migration-conflict nexus

Vulnerability as an analytical concept relating to climate and environmental change has several different definitions but generally refers to a combination of exposure to a hazard, sensitivity to the hazard, and the adaptive capacity of the affected community, household, or individuals (Smit and Pilifosova 2003; Füssel and Klein 2006; Adger and Jordan 2009). Migration can take place both as an adaptation to climate or environmental change (usually voluntary migration), or as a manifestation of vulnerability (often more forced migration or displacement) (Adger et al. 2018). In vulnerable communities lacking adaptive capacity, migration might not be an option at all, leading to immobility (Adams 2016; Zickgraf 2018). This shows that migration as an adaptation strategy is not accessible to all. Migration has the potential to reduce vulnerability and improve the resilience of migrants and communities (Call et al. 2017; Jha et al. 2018) but in other circumstances has been shown to increase vulnerability (Adger et al. 2018; Linke et al. 2018; Singh and Basu 2020). The literature on the debate about how migration becomes an adaptation strategy or remains a vulnerability issue in relation to existing or non-existing climate adaptation measures is categorised below in *Table 6.2*.

Table 6.2 emphasises the adaptation outcomes existing in different locations. These gaps contribute to migration being viewed as a form of maladaptation and vulnerability, as individuals and communities are forced to migrate due to insufficient adaptation measures in their place of origin. The lack of adequate support and resources for adaptation creates a situation where migration becomes a response to the challenges posed by climate change and other environmental factors. It is worth noting that Morocco stands out as an example. While migration may be a common response to environmental challenges in Morocco, *Table 6.2* highlights that social remittances play a significant role in sustaining those who are left behind. Social remittances refer to non-monetary contributions and support sent back to the home community by emigrants. These contributions can include knowledge, skills, ideas, and social networks, which can help in coping with the impacts of environmental change and in maintaining or building some level of resilience. However, it is important to note that while social remittances can serve as coping mechanisms, they may not provide a comprehensive solution to the underlying vulnerabilities and adaptation gaps. They often address immediate needs and may not offer long-term strategies for sustainable adaptation. It is therefore crucial to address the root causes of vulnerability, improve adaptation practices, and promote change and migration.

6.4.2 Vulnerability varies across time and space

Exposure to hazards can vary significantly across different parts of a country or region, and it is not constant over time. Factors such as geographical location, urbanisation, and environmental changes can influence the level of exposure to hazards in any given area. The sensitivity to a hazard, which is the degree to which a system is affected by or responsive to a particular hazard, may also change over time. This sensitivity is place-based and determined by the presence of local and national policies, as well as the adaptive capacities of traditional livelihoods, which can include agricultural practices, fishing, and other local economic activities.

Furthermore, adaptive capacities, which refer to the ability of a community or system to adjust to environmental changes, vary across space and time. Different communities and even individual households have varying socio-economic capacities to adapt to environmental change. Factors such as income levels, access to resources, education, and social networks can influence a community's or household's ability to respond effectively to environmental hazards. As McLeman and Hunter (2010) highlight, understanding these variations in adaptive capacity is crucial for developing targeted and effective strategies for building resilience in the face of climate change.

A clear example of how place-based vulnerabilities affect migration in response to environmental change is the case of Syria. A severe drought around 2007–2009, mostly affecting northeastern areas, was followed by the Syrian uprising and subsequent civil war in 2011. Much focus has been put on climate variability, manifested through a

Table 6.2 | Climate migration in the context of adaptation strategies in the Mediterranean region.

Climatic hazard	Type of adaptation	Mobility type	Adaptation Outcome	References
Droughts and water scarcity	Coping	Transnational mobility	Remittances support those left behind to climate variability. Financial and social remittances provide informal means to adapt without institutional response. Small farmers and women who do not have access to resources and land tenure necessary to cope with climate variability.	Diniega (2023) *(Morocco)*
Droughts and water scarcity	Coping	Transnational mobility	Migrants may become trapped in their new host country, due to their legal status and their rights, as refugees, including limited mobility in host country.	Dinc and Eklund (2024) *(Syria and Türkiye)*
Extreme climatic events (flooding, heat waves)	Coping	Displacement	Refugee settlements are often considered temporary solutions, lack of sustainable accommodation and inadequate and insufficient housing for refugees. These spaces are easily exposed to extreme climatic events in the Mediterranean.	Fransen et al. (2024) *(Lebanon and Greece)*
Drought	Maladaptation	Rural to urban mobility	No adaptation policy in place.	Kelley et al. (2015) *(Syria)*
Drought	Maladaptation	Rural to urban mobility	Mismanagement of water and land resources, over-reliance on agricultural sector, economic policy changes increasing vulnerability.	de Haas (2006) *(Morocco)* De Châtel (2014); Feitelson and Tubi (2017); Daoudy (2021); Eklund (2024) *(Syria)*
Drought	Maladaptation	Rural to urban mobility	Absence of transborder cooperation over shared water resources.	Eklund and Thompson (2017) (*Iraq, Syria, and Türkiye); Karnieli et al. (2019); Eklund et al. (2022) (Syria)*
Heat waves	Maladaptation	Rural to rural mobility (seasonal)	Absence of adaptive policy for agricultural workers and other seasonal workers. Poverty and class inequality in rural areas is exacerbated with increasing health concerns.	Turhan et al. (2015) *(Türkiye)* Zuccotti et al. (2018) *(Tunisia)* Dedeoglu (2022) *(Türkiye)*

severe drought, and its role in triggering widespread migration from farming areas and protests in urban areas (Kelley et al. 2015; Ash and Obradovich 2020). Other research, however, emphasises the role of the Syrian government in creating vulnerability (De Châtel 2014; Eklund and Thompson 2017; Selby et al. 2017; Selby 2019; Daoudy 2020, 2021). For example, long-term mismanagement of water resources and over-reliance on the agricultural sector increased vulnerability to climate stress in Syria (see De Châtel 2014; Feitelson and Tubi 2017; Daoudy 2021). Furthermore, the vulnerability to drought was place-based, as it differed across national borders between Iraq, Syria, and Türkiye, and Eklund et al. (2022) show that the drought response of the agricultural system varied across Syria. Moreover, the removal of subsidies during the drought period increased diesel prices by 350%, which decreased the ability to cope with the drought, and made crop production in certain areas economically unsustainable (Ababsa 2015; Selby et al. 2017; Dinc and Eklund 2024). Interviews with former Syrian farmers show that most pre-2011 migration and land abandonment actually took place during non-drought years, suggesting that the relationship between drought and migration in Syria was more complex than previously thought (Dinc and Eklund 2024; Eklund et al. 2024).

6.5 Migration, environment, and intersectional aspects

Intersectional structural inequalities that already permeate Mediterranean societies and economies also shape the complex realities of climate vulnerability, migration, and conflict. These inequalities are distributed unevenly across northern and southern Mediterranean countries. The latest IPCC Sixth Assessment Report (2022a) underlines that gender and social inequality are two significant SDG indicators that illustrate the wide gap in intersectional disparities between northern and southern Mediterranean countries. Climate variability reinforces and/or restructures these already unequal relations based on ethnicities, racialised groups, gender identities, age groups, abilities, and class, both within and between communities.

Not all these complex vulnerabilities in the climate-migration-conflict nexus result in coping, but incremental and/or transformative adaptation are also potential pathways. When analysing the influence of climate variability in conjunction with intersectional factors, the prevailing theme in the literature is the prevalence of maladaptation cases. This underscores the importance of intersectional issues and structural inequalities, spanning social and economic realms, in shaping adaptation pathways. It also highlights a policy gap in transformative adaptation within the Mediterranean context.

Intersectional issues and structural inequalities within the context of climate variability influence: (1) the likelihood of mobility and immobility as a consequence of climate change, and (2) the routes and conditions of mobility for different groups based on gender, occupation, and age.

There is scarce literature on intersectional aspects of climate variability in the Mediterranean and its mobility outcomes for specific groups (Sellers 2016). The existing scholarship points to gendered division of labour that permeates the migration experience in several ways. Social inequality exacerbated by climate change is directly linked to income, risk exposure, and weak adaptive capacity of people and groups (Chindarkar 2012; Braham 2018; Diab and Scissa 2023). Based on the existing social disparities and securitised and ambiguous migration contexts outlined in the earlier sections of *Chapter 6,* women, youth, and farmers have weaker adaptive capacities. However, this does not always result in immobility of these groups. In this sense, the way existing inequalities are addressed is crucial for the development of transformative adaptation practices in the Mediterranean region.

As shown by the literature that looks at rural to urban mobility, women living in rural areas are often observed to be left behind. Also known as the masculinisation of migration, men often migrate first, when livelihoods are impacted by uncertainty, for instance due to a decrease in yields and water availability, and/or to climate-induced disasters (Miletto et al. 2017; Braham 2018; Zuccotti et al. 2018). There are, however, also examples of women migrating in the face of climate change. In a case of climate-induced rural to rural migration in Morocco, women were the ones who migrated (Najjar et al. 2017). Housing opportunities at the destination, and land tenure alongside education, determine migration decision-making and routes for men and women (Najjar et al. 2017; Braham 2018).

There is a general trend of rural to urban migration, also exacerbated by climate-induced water scarcity issues. This pre-existing poverty exacerbates loss of agricultural livelihoods. Farmers without the means to install pumps to cope with water scarcity are the most likely to lose agricultural livelihoods and incomes (de Haas 2006). In many cases, especially for those who cannot afford to hire seasonal workers, the burden on women in the household and in production increases tremendously, exacerbating structural inequalities for women and girls, drawing them into cycles of exploitation and a burdened division of labour (Braham 2018). In this sense, climate variability and social justice are interconnected.

Mobile populations also make up a reserve army of labour for agribusinesses and agricultural sectors in the Mediterranean, working in dire conditions and subjected to climate-induced health and disaster risks (Turhan et al. 2015). These most vulnerable groups are the most invisible in climate adaptation policies (Turhan et al. 2015; Zuccotti et al. 2018). In Türkiye, Syrian refugee children and women increasingly work as agricultural workers in precarious conditions (Dedeoglu 2022).

Recent research further underlines the high vulnerability of refugee populations to extreme climatic events. The vulnerability of refugees in

the Mediterranean region to extreme weather is increasing. Displaced populations frequently end up in locations that are highly susceptible to climate-related incidents, which poses significant challenges for their ability to cope and adjust. A survey carried out by the United Nations High Commissioner for Refugees (UNHCR) revealed that 6% of refugees living in camps encountered natural disasters in 2014. Recent events further underscore the susceptibility of refugees to extreme weather conditions. The harsh winter storms in Lebanon and Jordan during 2019 and 2020 intensified the already precarious living conditions faced by Syrian refugees. These storms brought about low temperatures, heavy rainfall, snowfall, and strong winds, further worsening their situation. Additionally, the vulnerability of refugee camps in Europe became apparent when the Moria camp on Lesbos was devastated by a fire in 2020 (Fransen et al. 2024). Policymakers and governments see refugee settlements as temporary solutions, and they lack sustainable, sufficient, and protective accommodation (Fransen et al. 2024).

Lastly, it is worth noting that intersectional aspects have gained significant attention in the realm of climate finance for adaptation. In particular, the role of remittances has emerged as a crucial topic within this discourse. Scholars and researchers, such as Bendandi and Pauw (2016) and Randazzo et al. (2023), have examined the implications and potential contributions of remittances for and to climate adaptation. In this sense, not only migration, but also short-term mobility, serve as a source of knowledge and finance for those who are immobile in Morocco (Diniega 2023).

In conclusion, the intersectional structural inequalities that permeate Mediterranean societies are fundamental in shaping the complex realities of climate vulnerability, mobility, and conflict. These disparities, exacerbated between northern and southern Mediterranean countries, are reinforced and restructured by climate variability, influencing adaptive capacities and mobility outcomes across different social groups. The literature highlights the prevalence of maladaptive responses, underscoring the need for policies that address these intersectional issues to promote transformative adaptation. Addressing gendered divisions of labour and intersectional inequalities that impact diverse groups of women, youth, farmers, and refugees is crucial. A comprehensive understanding and integration of these factors into climate adaptation policies and practices will help bridge the existing policy gap and foster more equitable and effective adaptation strategies in the Mediterranean region.

References

Ababsa M. (2015). The End of a World. In R. Hinnebusch & T. Zintl (Eds.), *Syria from Reform to Revolt* (pp. 199–222). Syracuse University Press. doi: 10.2307/j.ctt1j2n833.13

Adams H. (2016). Why populations persist: mobility, place attachment and climate change. *Population and Environment*, *37*(4), 429–448. doi: 10.1007/s11111-015-0246-3

Adger W. N., de Campos R. S., and Mortreux C. (2018). Mobility, displacement and migration, and their interactions with vulnerability and adaptation to environmental risks. In W. N. Adger & A. Jordan (Eds.), *Routledge Handbook of Environmental Displacement and Migration* (pp. 3–31). Cambridge University Press. doi: 10.4324/9781315638843-3

Adger W. N., and Jordan A. (2009). Sustainability: Exploring the processes and outcomes of governance. In *Governing Sustainability* (pp. 3–31). Cambridge University Press. doi: 10.1017/cbO9780511807756.003

Afifi T. (2010). The environmental root causes triggering economic migration: The case of Egypt. In J. Jäger & T. Afifi (Eds.), *Environment, forced migration and social vulnerability* (pp. 197–209). Springer. doi: 10.1007/978-3-642-12416-7

Akbari H., Cartalis C., Kolokotsa D., Muscio A., Pisello A. L., Rossi F., Santamouris M., Synnefa A., Wong N. H., and Zinzi M. (2016). Local climate change and urban heat island mitigation techniques – the state of the art. *Journal of Civil Engineering and Management*, *22*(1), 1–16. doi: 10.3846/13923730.2015.1111934

Ash K., and Obradovich N. (2020). Climatic stress, internal migration, and Syrian civil war onset. *Journal of Conflict Resolution*, *64*(1), 3–31. doi: 10.1177/0022002719864140

Bendandi B., and Pauw P. (2016). Remittances for Adaptation: An 'Alternative Source' of International Climate Finance? In A. Milan, B. Schraven, K. Warner, & N. Cascone (Eds.), *Migration, Risk Management and Climate Change: Evidence and Policy Responses* (Vol. 6, pp. 195–211). Global Migration Issues. Springer, Cham. doi: 10.1007/978-3-319-42922-9_10

Bhalerao A. K., Rasche L., Scheffran J., and Schneider U. A. (2022). Sustainable agriculture in Northeastern India: how do tribal farmers perceive and respond to climate change? *International Journal of Sustainable Development & World Ecology*, *29*(4), 291–302. doi: 10.1080/13504509.2021.1986750

Boas I., Farbotko C., Adams H., Sterly H., Bush S., Van Der Geest K., Wiegel H., Ashraf H., Baldwin A., Bettini G., Blondin S., De Bruijn M., Durand-Delacre D., Fröhlich C., Gioli G., Guaita L., Hut E., Jarawura F. X., Lamers M., … Hulme M. (2019). Climate migration myths. *Nature Climate Change*, *9*(12), 901–903. doi: 10.1038/s41558-019-0633-3

Braham M. (2018). Chapter 9 - Gender and climate-induced migration in the Mediterranean: from resilience to peace and human security. In *CIHEAM MediTERRA: migration and inclusive rural development in the Mediterranean* (pp. 181–207). Presses de Sciences Po. https://shs.cairn.info/mediterra-2018--9782724623956-page-181

Brière C., Janssen S. K. H., Oost A. P., Taal M., and Tonnon P. K. (2018). Usability of the climate-resilient nature-based sand motor pilot, The Netherlands. *Journal of Coastal Conservation*, *22*(3), 491–502. doi: 10.1007/s11852-017-0527-3

Brzoska M., and Fröhlich C. (2016). Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies. *Migration and Development*, *5*(2), 190–210. doi: 10.1080/21632324.2015.1022973

Buzan B., Wæver O., and de Wilde J. (1998). *Security. A New Framework for Analysis*. Lynne Rienner Publishers.

Call M. A., Gray C., Yunus M., and Emch M. (2017). Disruption, not displacement: Environmental variability and temporary migration in Bangladesh. *Global Environmental Change*, *46*, 157–165. doi: 10.1016/j.gloenvcha.2017.08.008

Chan S., Hale T., Deneault A., Shrivastava M., Mbeva K., Chengo V., and Atela J. (2022). Assessing the effectiveness of orchestrated climate action from five years of summits. *Nature Climate Change*, *12*(7), 628–633. doi: 10.1038/s41558-022-01405-6

Chindarkar N. (2012). Gender and climate change-induced migration: proposing a framework for analysis. *Environmental Research Letters*, *7*(2), 025601. doi: 10.1088/1748-9326/7/2/025601

Cissé G., McLeman R., Adams H., Aldunce P., Bowen K., Campbell-Lendrum D., Clayton S., Ebi K. L., Hess J., Huang C., Liu Q., McGregor G., Semenza J., and Tirado M. C. (2022). Health, wellbeing and the changing structure of communities. In H.-O. Pörtner, D. C. Roberts, M. M. B. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1041–1170). Cambridge University Press, Cambridge, UK and New York, NY, USA70. doi: 10.1017/9781009325844.009

Clar C., and Steurer R. (2021). Climate change adaptation with green roofs: Instrument choice and facilitating factors in urban areas. *Journal of Urban Affairs*, *45*(4), 797–814. doi: 10.1080/07352166.2021.1877552

Daoudy M. (2020). *The Origins of the Syrian Conflict*. Cambridge University Press. doi: 10.1017/9781108567053

Daoudy M. (2021). Rethinking the Climate–Conflict Nexus: A Human–Environmental–Climate Security Approach. *Global Environmental Politics*, *21*(3), 4–25. doi: 10.1162/glep_a_00609

De Châtel F. (2014). The Role of Drought and Climate Change in the Syrian Uprising: Untangling the Triggers of the Revolution. *Middle Eastern Studies*, *50*(4), 521–535. doi: 10.1080/00263206.2013.850076

de Haas H. (2006). Migration, remittances and regional development in Southern Morocco. *Geoforum*, *37*(4), 565–580. doi: 10.1016/j.geoforum.2005.11.007

Dedeoglu S. (2022). Cultivating Precarisation: Intersecting Vulnerabilities of Syrian Refugees in the Turkish Agricultural Sector. *Work, Employment and Society*, *36*(2), 345–361. doi: 10.1177/09500170211041298

DeWalle D. R., Buda A. R., and Fisher A. (2003). Extreme weather and forest management in the mid-Atlantic region of the United States. *Northern Journal of Applied Forestry*, *20*(2), 61–70. doi: 10.1093/njaf/20.2.61

Diab J. L., and Scissa C. (2023). Gender, Migration and Environment in the MENA: Vulnerabilities, Frameworks and Ways Forward. *Journal of Migration Affairs*, *5*(1-2), 11–20. doi: 10.36931/jma.2023.5.1-2.11-20

Dinc P., and Eklund L. (2024). Syrian farmers in the midst of drought and conflict: the causes, patterns, and aftermath of land abandonment and migration. *Climate and Development*, *16*(5), 349–362. doi: 10.1080/17565529.2023.2223600

Diniega R. (2023). *Climate change, mobilities, and social remittances in Skoura M'Daz, Morocco*. Tangier American Legation Podcast. https://www.themaghribpodcast.com/2023/06/mobility-and-social-remittances-in.html

Eklund L., Mohr B., and Dinc P. (2024). Cropland abandonment in the context of drought, economic restructuring, and migration in northeast Syria. *Environmental Research Letters*, *19*(1), 014077. doi: 10.1088/1748-9326/ad1723

Eklund L., Theisen O. M., Baumann M., Forø Tollefsen A., Kuemmerle T., and Østergaard Nielsen J. (2022). Societal drought vulnerability and the Syrian climate-conflict nexus are better explained by agriculture than meteorology. *Communications Earth & Environment*, *3*(1), 85. doi: 10.1038/s43247-022-00405-w

Eklund L., and Thompson D. (2017). Differences in resource management affects drought vulnerability across the borders between Iraq, Syria, and Turkey. *Ecology and Society*, *22*(4), 9. doi: 10.5751/es-09179-220409

European Commission (2021). *Communication from the Commission to the European parliament, the Council, the European economic and social committee and the Committee of the regions: Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change*. (COM/2021/82 final). Brussels: European Comission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0082

European Parliament (2022). *Consequences of drought, fire, and other extreme weather phenomena: increasing EU's efforts to fight climate change (Resolution 2022/0330(INI))*. https://www.europarl.europa.eu/doceo/document/TA-9-2022-0330_EN.html

Fedele G., Donatti C. I., Harvey C. A., Hannah L., and Hole D. G. (2019). Transformative adaptation to climate change for sustainable social-ecological systems. *Environmental Science & Policy*, *101*, 116–125. doi: 10.1016/j.envsci.2019.07.001

Feitelson E., and Tubi A. (2017). A main driver or an intermediate variable? Climate change, water and security in the Middle East. *Global Environmental Change*, *44*, 39–48. doi: 10.1016/j.gloenvcha.2017.03.001

Feola G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, *44*(5), 376–390. doi: 10.1007/s13280-014-0582-z

Fransen S., Werntges A., Hunns A., Sirenko M., and Comes T. (2024). Refugee settlements are highly exposed to extreme weather conditions. *Proceedings of the National Academy of Sciences*, *121*(3), e220618912. doi: 10.1073/pnas.2206189120

Füssel H.-M., and Klein R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change*, *75*(3), 301–329. doi: 10.1007/s10584-006-0329-3

Gemenne F., and Blocher J. (2017). How can migration serve adaptation to climate change? Challenges to fleshing out a policy ideal. *The Geographical Journal*, *183*(4), 336–347. doi: 10.1111/geoj.12205

Gresse E., Schrum C., Hanf F. S., Jantke K., Pein J., Hawxwell T., Hoffmann P., Bolaños T. G., Langendijk G. S., Schneider U. A., Huang-Lachmann J.-T., Neuburger M., Umaña C. R., Seiffert R., Wickel M., Sillmann J., Scheffran J., and Held H. (2023). Toward a Sustainable Adaptation Plausibility Framework. In A. Engels, J. Marotzke, E. G. Gresse, A. López-Rivera, A. Pagnone, & J. Wilkens (Eds.), *Hamburg Climate Futures Outlook 2023. The plausibility of a 1.5°C limit to global warming—Social drivers and physical processes* (pp. 54–65). Cluster of Excellence Climate, Climatic Change, and Society (CLICCS). doi: 10.25592/uhhfdm.11230

Hahn H., and Fessler M. (2023). *The EU's approach to climate mobility: Which way forward?* European Investment Bank and European Policy Centre. https://epc-web-s3.s3.amazonaws.com/content/PDF/2023/Climate_Mobility_DP_v8.pdf

Hamouchene, H., & Sandwell, K. (Eds.). (2023). *Dismantling Green Colonialism Energy and Climate Justice in the Arab Region*. Pluto Press. doi: 10.2307/jj.7583922

Heger A., Becker J. N., Vásconez Navas L. K., and Eschenbach A. (2021). Factors controlling soil organic carbon stocks in hardwood floodplain forests of the lower middle Elbe River. *Geoderma*, *404*, 115389. doi: 10.1016/j.geoderma.2021.115389

Huang-Lachmann J.-T., and Guenther E. (2020). From Dichotomy to an Integrated Approach: Cities' Benefits of Integrating Climate Change Adaptation and Mitigation. *Sustainability*, *12*(18), 7591. doi: 10.3390/su12187591

Huysmans J. (2000). The European Union and the Securitization of Migration. *JCMS: Journal of Common Market Studies*, *38*(5), 751–777. doi: 10.1111/1468-5965.00263

İçduygu A., and Gören H. (2023). Exploring temporal and topical dynamics of research on climate/environment–migration nexus: A critical comparative perspective. *Migration Studies*, *11*(4), 572–597. doi: 10.1093/migration/mnad021

IPCC (1990). *Climate Change: the IPCC Impacts Assessment. Contribution of Working Group II to the First Assessment Report*. (W.J. McG. Tegart, G. W. Sheldon, & D. C. Griffiths, Eds.). Australian Government Publishing Service, Camberra, Australia 294 pp. https://archive.ipcc.ch/publications_and_data/publications_ipcc_first_assessment_1990_wg2.shtml

IPCC (2022a). *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. (H.-O. Pörtner, D. C. Roberts, E. S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, & A. Okem (Eds.)). Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp. doi: 10.1017/9781009325844

IPCC (2022b). Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: *Climate Change 2022: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-33. doi: 10.1017/9781009325844.001

IPCC (2023). Summary for Policymakers. In Core Writing Team, H. Lee, & J. Romero (Eds.), *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1–34). IPCC, Geneva, Switzerland. doi: 10.59327/IPCC/AR6-9789291691647.001

Jantke K., Müller J., Trapp N., and Blanz B. (2016). Is climate-smart conservation feasible in Europe? Spatial relations of protected areas, soil carbon, and land values. *Environmental Science & Policy*, *57*, 40–49. doi: 10.1016/j.envsci.2015.11.013

Jha C. K., Gupta V., Chattopadhyay U., and Amarayil Sreeraman B. (2018). Migration as adaptation strategy to cope with climate change. *International Journal of Climate Change Strategies and Management*, *10*(1), 121–141. doi: 10.1108/ijccsm-03-2017-0059

Kachulu M. (2018). Climate change effects on crop productivity and welfare sensitivity analysis for smallholder farmers in Malawi. *African Journal of Agricultural and Resource Economics*, *13*, 58–77. doi: 10.22004/ag.econ.273137

Karnieli A., Shtein A., Panov N., Weisbrod N., and Tal A. (2019). Was Drought Really the Trigger Behind the Syrian Civil War in 2011? *Water*, *11*(8), 1564. doi: 10.3390/w11081564

Kates R. W., Travis W. R., and Wilbanks T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, *109*(19), 7156–7161. doi: 10.1073/pnas.1115521109

Kelley C. P., Mohtadi S., Cane M. A., Seager R., and Kushnir Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences*, *112*(11), 3241–3246. doi: 10.1073/pnas.1421533112

Klepp S. (2017). Climate Change and Migration. In *Oxford Research Encyclopedia of Climate Science*. doi: 10.1093/acrefore/9780190228620.013.42

Kraler A., Katsiaficas C., and Wagner M. (2020). *Climate Change and Migration. Legal and policy challenges and responses to environmentally induced migration*. European Union. https://www.europarl.europa.eu/RegData/etudes/STUD/2020/655591/IPOL_STU(2020)655591_EN.pdf

Lamhamedi B. E. H., and de Vries W. T. (2022). An Exploration of the Land–(Renewable) Energy Nexus. *Land*, *11*(6), 767. doi: 10.3390/land11060767

Lara-Estrada L., Rasche L., and Schneider U. A. (2021). Land in Central America will become less suitable for coffee cultivation under climate change. *Regional Environmental Change*, *21*(3), 88. doi: 10.1007/s10113-021-01803-0

Linke A. M., Witmer F. D. W., O'Loughlin J., McCabe J. T., and Tir J. (2018). The consequences of relocating in response to drought: human mobility and conflict in contemporary Kenya. *Environmental Research Letters*, *13*(9), 094014. doi: 10.1088/1748-9326/aad8cc

Lundgren-Kownacki K., Hornyanszky E. D., Chu T. A., Olsson J. A., and Becker P. (2018). Challenges of using air conditioning in an increasingly hot climate. *International Journal of Biometeorology*, *62*(3), 401–412. doi: 10.1007/s00484-017-1493-z

Masterplan Ems 2050. (2022). *Vertrag Masterplan Ems 2050*. https://www.masterplan-ems.info/fileadmin/media/05_Informationen/05_01_Organisation/Vertragstext.pdf

McLeman R. A., and Hunter L. M. (2010). Migration in the context of vulnerability and adaptation to climate change: insights from analogues. *WIREs Climate Change*, *1*(3), 450–461. doi: 10.1002/wcc.51

MELUND (2022). *Generalplan Küstenschutz des Landes Schleswig-Holstein – Fortschreibung (2022)*. https://www.schleswig-holstein.de/DE/fachinhalte/K/kuestenschutz/generalplanKuestenschutz.html

Mencütek Z. Ş. (2018). *Refugee Governance, State and Politics in the Middle East*. Routledge. doi: 10.4324/9781351170369

Methmann C., and Oels A. (2015). From 'fearing' to 'empowering' climate refugees: Governing climate-induced migration in the name of resilience. *Security Dialogue*, *46*(1), 51–68. doi: 10.1177/0967010614552548

Miletto M., Caretta M. A., Burchi F. M., and Zanlucchi G. (2017). *Migration and its interdependencies with water scarcity, gender and youth employment*. WWAP. Paris, UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000258968

Myers N. (1997). Environmental Refugees. *Population and Environment*, *19*(2), 167–182. doi: 10.1023/A:1024623431924

Najjar D., Dhehibi B., Aw-Hassan A., and Bentaibi A. (2017). Climate Change, Gender, Decision-making Power, and Migration into the Saiss Region of Morocco. *Economic Research Forum Working Papers*, *1102*. doi: 10.13140/rg.2.2.30055.44960

Nansen Initiative (2015). *Agenda for the protection of cross-border displaced persons in the context of disasters and climate change*. https://migrationnetwork.un.org/policy-repository/agenda-protection-cross-border-displaced-persons-context-disasters-and-climate

Nash S. L. (2019). *Negotiating Migration in the Context of Climate Change*. Bristol University Press. doi: 10.2307/j.ctvpwhf1h

O'Brien K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography*, *36*(5), 667–676. doi: 10.1177/0309132511425767

Pérez B. F. (2018). Beyond The Shortcomings of International Law: A proposal for the legal protection of climate migrants. In Behrman; S. & A. Kent (Eds.), *Climate Refugees: Beyond the Legal Impasse?* (pp. 214–229). Routledge. https://www.routledge.com/Climate-Refugees-Beyond-the-Legal-Impasse/Behrman-Kent/p/book/9781138088825

Pili O., and Ncube B. (2022). Smallholder farmer coping and adaptation strategies for agricultural water use during drought periods in the Overberg and West Coast Districts, Western Cape, South Africa. *Water SA*, *48*(1), 97–109. doi: 10.17159/wsa/2022.v48.i1.3846

Rahman M. F., Falzon D., Robinson S., Kuhl L., Westoby R., Omukuti J., Schipper E. L. F., McNamara K. E., Resurrección B. P., Mfitumukiza D., and Nadiruzzaman Md. (2023). Locally led adaptation: Promise, pitfalls, and possibilities. *Ambio*, *52*(10), 1543–1557. doi: 10.1007/s13280-023-01884-7

Randazzo T., Pavanello F., and De Cian E. (2023). Adaptation to climate change: Air-conditioning and the role of remittances. *Journal of Environmental Economics and Management*, *120*, 102818. doi: 10.1016/j.jeem.2023.102818

Ransan-Cooper H., Farbotko C., McNamara K. E., Thornton F., and Chevalier E. (2015). Being(s) framed: The means and ends of framing environmental migrants. *Global Environmental Change*, *35*, 106–115. doi: 10.1016/j.gloenvcha.2015.07.013

Reuveny R., and Moore W. H. (2009). Does Environmental Degradation Influence Migration? Emigration to Developed Countries in the Late 1980s and 1990s. *Social Science Quarterly*, *90*(3), 461–479. doi: 10.1111/j.1540-6237.2009.00569.x

Rolli F., Reale M., Massolino G., and Lombardo A. (2023). Waters that Divide: Climate Refugees and Sea Barriers. *Development*, *66*(1–2), 89–94. doi: 10.1057/s41301-023-00368-1

Scheffran J. (2020). Climate extremes and conflict dynamics. In J. Sillmann, S. Sippel, & S. Russo (Eds.), *Climate Extremes and Their Implications for Impact and Risk Assessment* (pp. 293–315). Elsevier. doi: 10.1016/b978-0-12-814895-2.00016-1

Schipper E. L. F. (2022). Catching maladaptation before it happens. *Nature Climate Change*, *12*(7), 617–618. doi: 10.1038/s41558-022-01409-2

Selby J. (2019). Climate change and the Syrian civil war, Part II: The Jazira's agrarian crisis. *Geoforum*, *101*, 260–274. doi: 10.1016/j.geoforum.2018.06.010

Selby J., Dahi O. S., Fröhlich C., and Hulme M. (2017). Climate change and the Syrian civil war revisited. *Political Geography*, *60*, 232–244. doi: 10.1016/j.polgeo.2017.05.007

Sellers S. (2016). *Gender and Climate Change: A Closer Look at Existing Evidence*. Global Gender and Climate Alliance. https://wedo.org/wp-content/uploads/2016/11/GGCA-RP-FINAL.pdf

Singh C., and Basu R. (2020). Moving in and out of vulnerability: Interrogating migration as an adaptation strategy along a rural–urban continuum in India. *The Geographical Journal*, *186*(1), 87–102. doi: 10.1111/geoj.12328

Smit B., and Pilifosova O. (2003). From Adaptation to Adaptive Capacity and Vulnerability Reduction. In J. B. Smith, R. J. T. Klein, & S. Huq (Eds.), *Climate Change, Adaptive Capacity and Development* (Issue 9, pp. 9–28). Imperial College. doi: 10.1142/9781860945816_0002

Sobczak-Szelc K., and Fekih N. (2020). Migration as one of several adaptation strategies for environmental limitations in Tunisia: evidence from El Faouar. *Comparative Migration Studies*, *8*(8). doi: 10.1186/s40878-019-0163-1

Temmink R. J. M., Lamers L. P. M., Angelini C., Bouma T. J., Fritz C., van de Koppel J., Lexmond R., Rietkerk M., Silliman B. R., Joosten H., and van der Heide T. (2022). Recovering wetland biogeomorphic feedbacks to restore the world's biotic carbon hotspots. *Science*, *376*(6593), eabn1479. doi: 10.1126/science.abn1479

Turhan E., Zografos C., and Kallis G. (2015). Adaptation as biopolitics: Why state policies in Turkey do not reduce the vulnerability of seasonal agricultural workers to climate change. *Global Environmental Change*, *31*, 296–306. doi: 10.1016/j.gloenvcha.2015.02.003

UN (1951). *Convention relating to the status of refugees*. https://www.unhcr.org/3b66c2aa10

UN (2015). *The Paris Agreement*. United Nations Framework Convention on Climate Change (UNFCCC), 60 pp. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

UN General Assembly (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. Resolution Adopted by the General Assembly on 25 September 2015, A/RES/70/1. New York: UN, 21 Oct. 2015. https://docs.un.org/en/A/RES/70/1

UN General Assembly (2018). *Global Compact for Safe, Orderly and Regular Migration*. Adopted 10 December 2018, Marrakech, Morocco. https://refugeesmigrants.un.org/migration-compact

UNEP (2023). *Adaptation Gap Report 2023: Underfinanced. Underprepared. Inadequate investment and planning on climate adaptation leaves world exposed*. Nairobi: United Nations Environment Programme. doi: 10.59117/20.500.11822/43796

van den Hoek R. E., Brugnach M., and Hoekstra A. Y. (2012). Shifting to ecological engineering in flood management: Introducing new uncertainties in the development of a Building with Nature pilot project. *Environmental Science & Policy*, *22*, 85–99. doi: 10.1016/j.envsci.2012.05.003

van Maren D. S., Winterwerp J. C., and Vroom J. (2015). Fine sediment transport into the hyper-turbid lower Ems River: the role of channel deepening and sediment-induced drag reduction. *Ocean Dynamics*, *65*(4), 589–605. doi: 10.1007/s10236-015-0821-2

Venot J.-P., Reddy V. R., and Umapathy D. (2010). Coping with drought in irrigated South India: Farmers' adjustments in Nagarjuna Sagar. *Agricultural Water Management*, *97*(10), 1434–1442. doi: 10.1016/j.agwat.2010.04.009

Vinke K., Rottmann S., Gornott C., Zabre P., Nayna Schwerdtle P., and Sauerborn R. (2022). Is migration an effective adaptation to climate-related agricultural distress in sub-Saharan Africa? *Population and Environment*, *43*(3), 319–345. doi: 10.1007/s11111-021-00393-7

Waha K., Krummenauer L., Adams S., Aich V., Baarsch F., Coumou D., Fader M., Hoff H., Jobbins G., Marcus R., Mengel M., Otto I. M., Perrette M., Rocha M., Robinson A., and Schleussner C.-F. (2017). Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. *Regional Environmental Change*, *17*(6), 1623–1638. doi: 10.1007/s10113-017-1144-2

Wakefield S. (2019). Miami Beach forever? Urbanism in the back loop. *Geoforum*, *107*, 34–44. doi: 10.1016/j.geoforum.2019.10.016

Warner K. (2010). Global environmental change and migration: Governance challenges. *Global Environmental Change*, *20*(3), 402–413. doi: 10.1016/j.gloenvcha.2009.12.001

Wong T. H. F., Rogers B. C., and Brown R. R. (2020). Transforming Cities through Water-Sensitive Principles and Practices. *One Earth*, *3*(4), 436–447. doi: 10.1016/j.oneear.2020.09.012

Zanker F. (2019). Managing or restricting movement? Diverging approaches of African and European migration governance. *Comparative Migration Studies*, *7*(1), 17. doi: 10.1186/s40878-019-0115-9

Zech K. M., and Schneider U. A. (2019). Technical biofuel production and GHG mitigation potentials through healthy diets in the EU. *Agricultural Systems*, *168*, 27–35. doi: 10.1016/j.agsy.2018.10.004

Zickgraf C. (2018). Immobility. In *Routledge Handbook of Environmental Displacement and Migration* (pp. 71–84). Routledge. doi: 10.4324/9781315638843-5

Zuccotti C. V., Geddes A., Bachi A., Nori M., and Stojanov R. (2018). *Rural migration in Tunisia: Drivers and patterns of rural youth migration and its impact on food security and rural livelihoods in Tunisia*. Food and Agriculture Organization of the United Nations. https://n2t.net/ark:/13683/pbh9/HaG

Zullo J., Pinto H. S., Assad E. D., and de Ávila A. M. H. (2011). Potential for growing Arabica coffee in the extreme south of Brazil in a warmer world. *Climatic Change*, *109*(3), 535–548. doi: 10.1007/s10584-011-0058-0

Information about the authors

Coordinating Lead Authors

Eda ACARA, Istanbul Policy Center, Sabancı University, *Türkiye*

Jan WILKENS, German Institute for Global and Area Studies (GIGA) & Earth and Society Research Hub (ESRAH), University of Hamburg, *Germany*

Lead Authors

Mohamed BEHNASSI, Economic, Social and Environmental Council (CESE) / Center for Environment, Human Security, and Governance (CERES), *Morocco* / The Institute of Mediterranean Studies (CNR-ISMed), *Italy*

Lina EKLUND, Department of Earth and Environmental Science / Advanced Middle Eastern Studies (CMES), Lund University, *Sweden* / United Nations University Institute for Water, Environment and Health (UNU-INWEH), *Canada*

Christiane FRÖHLICH, German Institute for Global and Area Studies (GIGA), *Germany*

Maria Julia TROMBETTA, School of International Studies, University of Nottingham Ningbo China, *P.R. China*

Knowledge gaps and strategies to address them

7

Coordinating Lead Authors
Çağdaş DEDEOĞLU *(Canada)*, **Andrea DESSÌ** *(Italy)*

Lead Authors
Bernardo MONZANI *(Italy)*, **Luca RAINERI** *(Italy)*

Contributing Authors
Merve Suzan Ilık BILBEN *(Türkiye)*, **Francesca LENZI** *(Italy)*, **Çağla VURAL** *(Türkiye)*

This chapter should be cited as:
Dedeoğlu, C., Dessì, A., Monzani, B., Raineri, L., 2026: Knowledge gaps and strategies to address them. In: *Environmental change, conflict, and human migration in the Mediterranean Basin.* [Lange, M.A.; Majdalani, R.; Cramer, W.; Guiot, J.; Gattacceca, J.C., Marini, K. (eds.)]. MedECC Secretariat, Marseille, France, pp. 207-231. doi: 10.5281/zenodo.17901555

Chapter 7
Knowledge gaps and strategies to address them

Executive summary 209

7.1 Introduction 210

7.2 Mechanisms and pathways affecting the environment-migration-conflict nexus 212

7.3 Mediterranean challenges: diversity, instability, and the perils of securitisation 216

7.4 Methodological issue 220
7.4.1 Interdisciplinary and multidimensional research 220
7.4.2 Contextual complexities: multiple historical, regional, and cultural contexts and individual stories 220
7.4.3 From environmental conflict to environmental justice? 221
7.4.4 Data availability and reliability 222
7.4.5 Diverse methodologies and longitudinal and comparative studies 223

7.5 Conclusion: rethinking the environment-migration-conflict nexus 224

References 227

Information about the authors 231

Executive summary

The relationship between environmental change, conflict, and migration — referred to as the environment-migration-conflict nexus — is complex, nonlinear, and lacks direct causality. While the link between conflict and migration has a wide empirical basis in the Mediterranean (and beyond), there is less clarity regarding climate change's impact on the initiation of conflict. State capacity, socio-economic development, and foreign meddling or intervention are generally recognised as the primary drivers of conflict and migration in the Mediterranean Basin, while climate change is recognised as a 'threat multiplier'.

The relationship between environmental change and security is best understood in terms of the climate's disproportionate impact on human security (and its relationship with the environment, i.e. planetary security). This framing can assist in providing more holistic understandings of the nexus, while not losing track of pre-existing challenges derived from non-climatic variables (i.e. politics, governance, and social contracts) which also have a bearing on the incidence of conflict and migration.

Multidisciplinary approaches to the environment-conflict-migration nexus are therefore best placed to capture the complexity of the phenomena, addressing climatic and non-climatic variables relevant to conflict and migration, as well as the related capabilities of states and societies to implement mitigation and adaptation mechanisms.

The breadth and diversity of variables (political, economic, social, cultural, environmental, security-related, etc.) evolving under the influence of globalisation and digitalisation across the Mediterranean Basin, together with the broad timeframe needed to test the inter-relationships, create methodological complexity in addressing the environment-conflict-migration nexus in the Mediterranean Basin.

The legacy of Western colonialism, foreign interventionism, and geopolitical divides across Mediterranean Basin states impede region-wide policy approaches or genuine multilateralism on each dimension of the environment-conflict-migration nexus. Ultimately, any recognition of a linkage between environmental change and security should also acknowledge the destabilising legacy of foreign interventionism, as well as the impact of lifestyles in the Global North (increasingly also exported to some localities of the Mediterranean Basin) and thereby contain a dimension of burden-sharing and climate justice.

Securitised approaches to the climate emergency can raise awareness and resources but also risk distracting from pre-existing non-climate variables linked to governance and the social contract. Such approaches to climate change are in large part a by-product of a broader securitisation[80] trend in developmental literature, which followed the terrorist attacks of 11 September 2001. In a similar fashion, the current emphasis on the climate-migration nexus is at least partially driven by securitised policy priorities in Europe and the Global North to externalise migration flows across the Mediterranean. Such prioritisation risks skewing policy priorities and would benefit from a broader emphasis on global climate justice in order to better tackle the asymmetries across Mediterranean Basin states and neighbouring regions.

Future scenarios linked to accelerated climatic disruptions may well provide more direct correlations for the environment-conflict nexus in the Mediterranean, with repercussions likely to extend to migratory flows. This serves as the underlying rationale for much of the analysis contained in this report.

[80] The concept of 'securitisation' is used in this Analysis as defined in international relations and political science, particularly within the framework of the Copenhagen School (Buzan et al. 1998). Securitisation refers to the process through which an issue is constructed as an immediate and existential threat by a powerful actor—such as a government or political leader—through a speech act. This construction must be accepted by a relevant audience to legitimise the use of extraordinary measures beyond normal political procedures. As used in this Analysis, securitisation concerns the construction of issues as security threats, not the financial meaning of the term (i.e. the pooling and repackaging of assets into tradable securities). See *Chapter 6, Section 6.2.*

7

7.1 Introduction

The environment-conflict-migration nexus is complex and multidimensional. Scholarly literature has generally challenged the existence of a direct causal relationship between environmental change, migration, and/or conflict, the latter term covering both inter-state and intra-state conflict, including domains such as resource scarcity, socio-economic instability, repression, civil war, or revolution. While this complex relational understanding is widely accepted by academia, which generally points to governance and political variables as having a greater bearing on the outbreak of conflict or mass migration waves, a similar degree of nuance is absent in government policy, military strategy, and contingency planning. Within these circles, the securitised framing of climate change as a 'threat multiplier' with significant implications for national and international security is generally accepted. Such readings emphasise the indirect and cascading impact that climate change and environmental degradation can have on a wide range of socio-economic, political and governance fragilities, which in turn can lead to conflict and/or mass migration — while recognising that the mechanisms, methodologies, and policy implications related to such a nexus are still subject to debate.

The previous chapters have demonstrated the absence of a clear causal relationship by which environmental change directly and necessarily leads to conflict and migration. This chapter will critically engage with several 'pathways' outlined by the literature through which climate change, in conjunction with other pre-existing variables, is presumed to fuel mass migration and conflict, particularly over scarce resources such as water, food, or land. Such reflection underscores the need for a wider analytical prism that also accounts for non-climatic variables of a governance and political nature, which are recognised as having a greater correlation with conflict and migration, when seeking analytical clarity and policy responses to the environment-conflict-migration nexus in the Mediterranean Basin.

Moving to methodological issues in research and policy development, the breadth of variables and the long timeframe required to test the interlinkages between environment, conflict, and migration represent significant conceptual challenges. The broad diversity of Mediterranean Basin states, with their different political systems, capabilities, and developmental levels — as well as varying degrees of exposure to, and prioritisation of the threats of environmental change — further complicates data collection and the development of region-wide policy prescriptions. The presence of frozen and active conflicts and broader geopolitical tensions in multiple localities of the Mediterranean or in regions directly bordering Mediterranean Basin states (i.e. the Sahel; the Horn of Africa; the Persian Gulf), also represents a challenge. Such fault lines and fragilities, combined with a history of colonial exploitation and asymmetric North-South relations, weaken joint ownership and highlight the fragmentation of the region. This, in turn, complicates efforts to adequately address the transnational threats of environmental change and their possible correlation with conflict and migration in a region-wide framework. Ongoing geopolitical divisions between and among northern, southern, and eastern Mediterranean Basin states — also accentuated by the prevalence of North-South power asymmetries, revived great power competition, and more general grievances tied to the different degrees of responsibility for past polluting activities — create further complexity and fragmentation. Considering these methodological challenges, emphasis will be placed on multidisciplinarity and the need to widen the temporal scope of data collection to account for the broad diversity of Mediterranean Basin states and societies. Acknowledging how future scenarios may well demonstrate a greater degree of correlation due to suddenly worsening environmental conditions represents another important methodological consideration, pointing to the need for continued vigilance and data collection looking to the short and medium term.

Ultimately, the chapter will propose constructive rethinking of prevalent conceptual frameworks applied to the environment-migration-conflict nexus. A reframing of the nexus to underscore its direct and detrimental impact on human security (and planetary security) as opposed to the prevalent emphasis placed on hard security (i.e. intra- or inter-state armed conflict, terrorism, smuggling, etc.) will be proposed. Overcoming fragmented policy approaches, breaking down policy silos, and enhancing integrated 'whole society' approaches that mirror the objectives of the UN's Agenda 2030 is part and parcel of a less securitised approach to the environment-conflict-migration nexus in

the Mediterranean Basin. Such an approach can leverage improvements across multiple social, political, and institutional domains to enhance preparedness to face climatic events, and possible correlations with conflict and migratory waves. Reflections of this kind are important to improve the way in which environmental change is framed as a 'threat multiplier', while at the same time reminding decision-makers that such readings should also account for the destabilising impact that lifestyles and consumption models in the Global North have had (and are still having) on the initiation of climate change.

Finally, the analysis will underscore how current securitisation trends in international approaches to climate change, and the environment-migration-conflict nexus, are part of a broader process of turning climate into a security issue (securitisation) in developmental studies underway since the terrorist attacks of 11 September 2001. While this framing may carry some benefits in terms of awareness and budgetary commitments, a more inclusive focus that encompasses other frameworks prioritising good governance, human rights, and legitimate social contracts would enhance the resilience of Mediterranean states and societies to better face the environmental emergency and its complex, multidimensional relationship with conflict and migration flows.

A focus on human security can also help in identifying alternative pathways to enhance joint ownership, as well as capabilities to implement needed adaptation and mitigation strategies. Such a focus should build on local traditions and experiences inherited from ancestral practices that are today still part of ecological and sustainable development approaches in certain localities of the Mediterranean (e.g. Algeria, Morocco, Tunisia, and Libya, as well as further afield in Iran).

7.2 Mechanisms and pathways affecting the environment-migration-conflict nexus

Since the 1972 UN Conference on Human Environment in Stockholm[81], policy, media, and scholarly discussions have raised warnings about the possible connections between climate change and security dynamics, including most notably conflict and migration. Such warnings have increasingly gained international recognition in the wake of the terrorist acts of 11 September 2001, due in part to the initiative of the US military establishment and the British government under Tony Blair's New Labour (Brown et al. 2007; Crawford 2022). In 2009, both a UN General Assembly resolution (63/281) and a UN Secretary General report (A/64/350) highlighted the 'possible security implications' of climate change (UN General Assembly 2009; UN Secretary-General 2009). The last decade has witnessed a proliferation of UN Security Council open debates and country-specific resolutions on climate and security (Cusato 2022). While very few of these resolutions target countries in the (extended) Mediterranean, the recognition that the Mediterranean Basin is a climate change hotspot raises concerns about the possible security implications on regional security *(Chapter 1, Section 1.1.3; Chapter 3, Section 3.2.1).*

Many studies have investigated whether, how, and to what extent changing climate factors are causally linked to (in)security dynamics, including instability and conflict, as well as migration flows. Remarkably, the large majority of these studies find that evidence of such a causal link — whether deterministic, probabilistic, or other — is tenuous at best, often contradictory, and largely inconclusive (Homer-Dixon 1994 1999; Gleditsch 1998; Nordås and Gleditsch 2007; Salehyan 2008; Buhaug 2010; Benjaminsen et al. 2012; Theisen et al. 2013; Selby 2014; Buhaug et al. 2015; Mach et al. 2019). In fact, today there is a substantial scientific consensus that the claim that climate change is a direct cause of conflicts is unsubstantiated (see *Chapter 4*). This does not imply a sceptical view on the reality of climate change. While there is overwhelming evidence for the evolution of geophysical trends and its expected disruptions, their impact on human societies is far more difficult to predict (Hulme 2011).

Building on these findings, the presentation of the connection between climate change and conflict in terms of a causal relationship has largely been dropped. Instead, reports and declarations from the international community (including CNA Military Advisory Board 2007; UN Secretary-General 2009; IPCC 2014; G7 2015; US DoD 2019; NATO 2021) have increasingly framed climate change as a 'threat multiplier', having an impact (whose magnitude remains to be determined) on pre-existing social, political, and security fragilities. Subsequent analyses have therefore focused less on extrapolating alleged causal linkages between climate variables and security outcomes, and more on the search for 'pathways' capable of articulating heterogeneous dimensions — climate, environment, governance, and security — in a more flexible and holistic manner. Recent reports by prominent international organisations (e.g. Rüttinger et al. 2015; Mobjörk et al. 2020; UN DPPA 2020) have put forward several such pathways. From this perspective, climate change is seen as having the potential to affect security by exacerbating, for instance, livelihood deterioration and resource competition; mobility, migration and, transhumance; food price volatility and/or food shortages; transboundary water management challenges; and social grievances.

While these pathways highlight different drivers of insecurity, most of them appear to allude to a common argument, that environmental security scholars have dubbed the 'scarcity' mechanism *(Chapter 3, Section 3.3.4).* According to this view, worsening climatic conditions (often compounded by other environmental stressors, such as demographic growth and/or unsustainable livelihoods) contribute to the progressive depletion of valuable natural resources on which livelihoods depend *(Chapter 5, Section 5.3.1).* Increasing resource scarcity exacerbates competition, which could escalate and lead to violent conflict. Variants of the same argument include the 'greed' mechanism, whereby the declining supply of natural resources is not seen as a survival threat, but as an economic opportunity, because the inelastic demand of basic consumption goods pushes prices upward. Conflict may then result from the hoarding of resources driven by greedy (violent) entrepreneurs; as well

[81] https://www.un.org/en/conferences/environment/stockholm1972

as the 'migration' mechanism, whereby climate change-induced scarcity of resources — whether the result of incremental depletion or of sudden disruptions caused by 'natural' disasters — prompts enhanced human mobility. This, in turn, may intensify frictions and heighten tensions between indigenous/host communities and displaced/migrant groups (see *Chapter 4*). On the ground, the empirical manifestations of these mechanisms may vary. In temporal terms, the impact of 'scarcity' and 'migration' mechanisms may be seen in the long term, while the 'greed' mechanism is more closely linked to short-term price variations of basic commodities. On the spatial scale, conflicts would tend to cluster where resources are less abundant according to the 'scarcity' mechanism, and more abundant according to the 'migration' mechanism.

While all these mechanisms may appear reasonable, numerous studies have highlighted their manifold shortcomings, which contribute to questioning the explanatory value of the overall scarcity argument and its variants.

Firstly, at a conceptual level, scarcity tends to be so vaguely defined that it loses most of its meaning (Fairhead 2001). Scholars have stressed that 'scarcity' cannot possibly refer to an objectively small quantum of resources, because it is an inherently relational concept. Therefore, scarcity is less the outcome of the supply-demand (in)balance than of the rise of new ideologies, policies, or political and economic structures, which result in the resources in question being deemed more valuable and conflict-worthy than hitherto (Selby and Hoffmann 2014). The recognition that environmental scarcity is in fact endogenous to social relations and social meanings suggests a need to shift from attributing conflict outcomes to exogenous, 'natural' factors, towards considering the role of policies and decision-making processes that actively contribute to shaping scarcity in pursuit of specific objectives (Verhoeven 2011; Mehta et al. 2019).

Second, the scarcity mechanism demonstrates a very poor predictive capacity. The concern that scarcity of water and soil depletion would trigger conflicts, especially in drylands such as North Africa and the Middle East, has been present for three decades (Gleick 1993; Homer-Dixon 1994) — or even since Malthus, as has been argued. This contention continues to be reiterated in influential policy (UNEP 2007) and scholarly (Welzer 2012) works warning about imminent 'climate wars'. Such dire predictions, though, have generally not been borne out by empirical evidence. Accurate empirical research suggests that water scarcity does not appear to be a significant conflict driver (Gleditsch et al. 2007), and that peaceful settlements largely prevail over violent escalations whenever conflicts over competitive uses of scarce natural resources do occur, whether for water (Stucki 2005), or fertile lands sought by farmers and herders (Moritz 2010). As stated in previous chapters, there is no evidence of active or past conflicts being driven by water scarcity in the Middle East and North Africa (MENA)[82] region and the wider Mediterranean Basin. While political tensions have increased over the management of transboundary water resources (e.g. among Egypt, Sudan, and Ethiopia over the Nile River; Türkiye with Iraq and Syria; Iran and Iraq; and between Israel, Jordan, and Palestine), none of these tensions have (yet) escalated into outright conflict. Much of the same applies to other resources — most notably hydrocarbons. Oil did play a role in heightening tensions between Saudi Arabia and Iran (prior to the 1979 Iranian Revolution) and was among the causes of the Iraqi invasion of Kuwait in the First Gulf War, but cannot be described as the determining variable for conflict in the region.

Having failed to accurately predict the outbreak of conflict, the scarcity mechanism and/or its variants have been increasingly used to provide ex post explanations of violent conflicts that did occur. Remarkably, some of the most important conflicts linked to changes of environmental dynamics have taken place in the Mediterranean region and neighbouring countries, including the civil war in Syria since 2011, the conflict in Darfur in 2003, and the ongoing conflict in the Sahel. In these cases, however, comprehensive multidisciplinary studies

[82] Although this Analysis focuses primarily on the Mediterranean region, it also draws on data from the Mediterranean Basin, the Eastern Mediterranean and Middle East (EMME), and the broader Middle East and North Africa (MENA) region (also referred to as Southern and Eastern Mediterranean Countries). In this Analysis, the MENA region refers specifically to countries bordering or closely connected to the Mediterranean Sea.

have disputed that climate change, and the scarcity mechanism provide convincing explanations for the onset and evolution of such conflicts (see *Chapter 4, Section 4.1*). In the case of Darfur, while UN reports have lent some credit to scarcity-based explanations of the conflict (UNEP 2007), subsequent studies have demonstrated that the war did in fact break out while Darfur experienced above average rainfall, and the aggregate food output (and export) in Sudan was increasing (Verhoeven 2011; Selby and Hoffmann 2014). This narrative thus contributes to misrepresenting the fundamental political and economic drivers of the crisis in Darfur, and to concealing how 'environmental scarcity' was in fact socially engineered. Lastly, the semi-arid region of the Sahel, at the southern edge of the extended Mediterranean space, is often viewed as the quintessential case of a scarcity-induced conflict exacerbated by climate change. Nevertheless, empirical studies have found no convincing correlation between climate and conflict events in the Sahel (Hissler 2010; Benjaminsen et al. 2012). Other studies question the responsibility of climate change in the phenomena of desertification (Behnke and Mortimore 2016) and food crisis (ICG 2020; Cold-Ravnkilde and Ba 2022) that are claimed to be behind many conflicts in the Sahel.

A further strand of academic research has recently focused on the possibility that, in times of climate and environmental emergency, natural resources could be weaponised as a warfare strategy. Several well-known events have been reported, especially in the Middle East and Africa, associated with the violent conflicts in Syria and Iraq, and the disputes that occurred in the Nile River area between Egypt, Sudan, and Ethiopia. The statistical probability of the weaponisation of natural resources materialising as an integral practice in conflict dynamics is significantly increased in contexts where the natural resource is directly affected by environmental change. Much attention has been paid, in particular, to the case of water and its strategic military role that seems to go back to the era of the ancient Mesopotamians. It has been highlighted that water, as a renewable natural resource, presents a complex scenario. It is subject not only to risks from mismanagement and overuse by communities but also to physical impacts from climate change, which together put pressure on its availability and usability (Gleditsch et al. 2007; Daoudy 2020; Kohler 2020; MedECC 2020; IPCC 2022). Water scarcity may create conditions where state and non-state actors can instrumentalise and exploit such natural resources as an offensive but also defensive capability. The tactic is deployed not only through military weaponisation, but very often political weaponisation plays a relevant role for state and non-state groups to establish political leverage and reinforce their legitimacy with local vulnerable populations. Moreover, there have been cases of water apartheid under water scarcity conditions, considered a direct abuse of human rights. The case of Nigeria, Somalia, Sudan, Syria, alongside the Lake Chad Basin region, are well-established examples in the literature, further underscored by Niger's recent decision to join the UN Water Convention[83], a crucial transboundary water-sharing agreement. Nevertheless, the literature highlights how resource access could affect conflict dynamics but also shows that it can offer means for cooperation, especially on water scarcity mechanisms (Koubi et al. 2014; Vesco et al. 2020; Feuer 2023). Cooperation over natural resources does not indicate that there is an absolute absence of conflict, but it at least demonstrates that there is a willingness and openness to address water or natural resources scarcity and abundance challenges through positive dynamics, in the future as well (King 2023; see also *Chapter 4*).

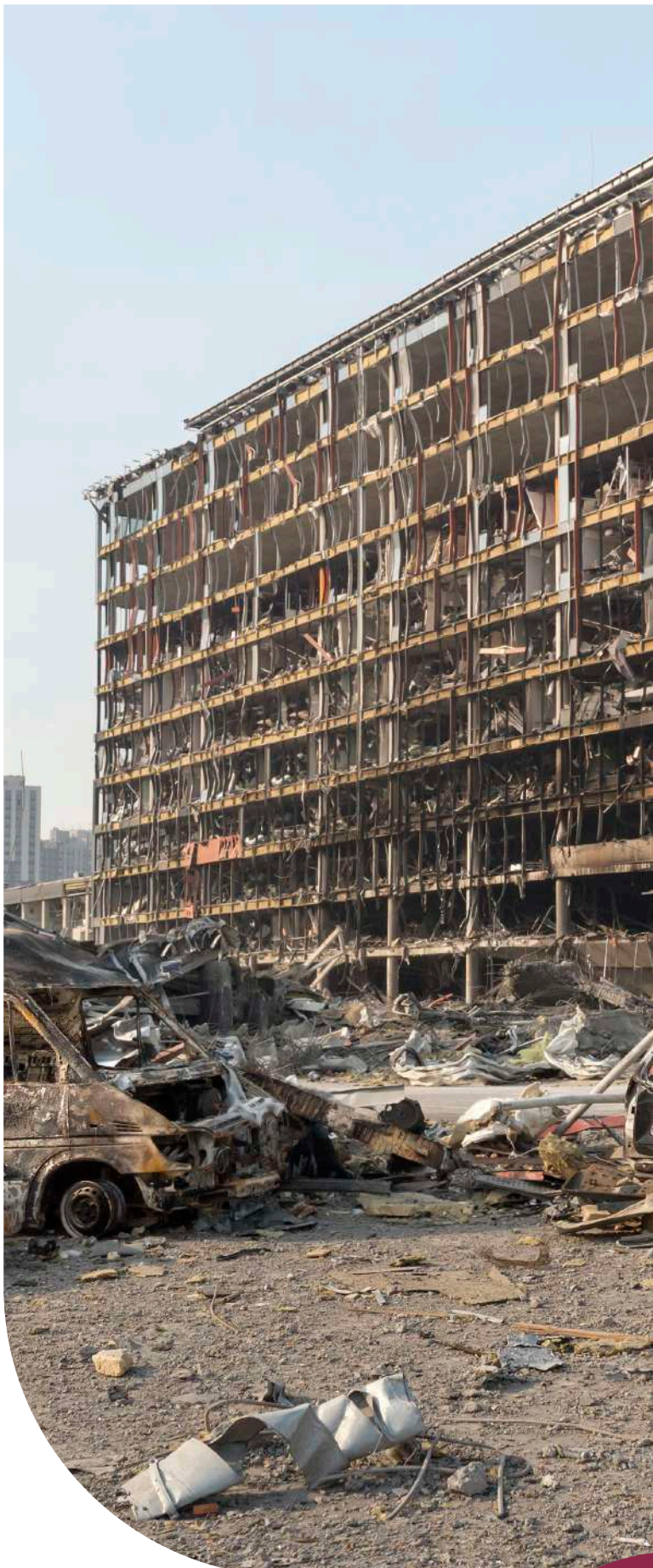
Building on the 'migration' mechanism, environmental stress is often presented as a possible driver of migration, with climate change-induced resource scarcity or localised (relational) abundance providing respective push and pull factors for increased human mobility. This view appeared to prevail in early policy reports (Hinnawi 1985; Jacobson 1988), sometimes with alarmist tones, and surfaced in the First Assessment Report of the IPCC Working Group II on Impacts, Adaptation and Vulnerability (IPCC 1990). Noting the debate's lack of scientific rigour (Piguet et al. 2011), however, subsequent IPCC Reports have adopted an increasingly sceptical stance regarding bold claims connecting climate change and migration (see also (Klepp 2017). Research has progressively recognised the complexity and interactions of the

[83] https://unece.org/environment-policy/water/about-the-convention/introduction

various drivers of migration with environmental factors, which makes it difficult to identify climate change as a direct determinant of mobility choices (Cattaneo et al. 2019; Kuhnt 2019). In most cases, environmental change is more likely to have an indirect, non-linear effect on migration dynamics, which could both increase the incentives to leave, while simultaneously limiting the capacity to do so (Black et al. 2011), thereby 'trapping' impoverished people in impoverished environments (Foresight: Migration and Global Environmental Change 2011). Taking stock of a decade of research, a recent report therefore concludes that 'most people moving due to climate change and other environmental factors tend to move within their country and, if they cross borders, tend to stay within regions. Warnings of mass transcontinental migration are unsubstantiated' (Mixed Migration Centre 2022) (see also *Chapter 5, Section 5.3.1*). Environmental change also appears to have a limited impact on the attractiveness of the migrant smuggling business. The analysis of migrant smuggling dynamics from Sub-Saharan to North Africa suggests that 'most smugglers were attracted to the smuggling industry, not out of desperation to escape desertification and resource scarcity, but because of the potential to earn substantially more than what they were earning as day-labourers at the mines, or as gardeners, mechanics, or motorcyclists' (Mccullough et al. 2019).

All of these observations undermine the credibility of the scarcity argument, and its variants, and invite scholars to adopt a cautious attitude, and refrain from sensationalistic claims when assessing the possible connections between environmental change, conflict, and migration. Culminating several decades of research, two of the most influential studies in this domain have come to similar conclusions: a prominent article in *Nature* has demonstrated that 'state capacity and socio-economic development generally represent the main causes of conflicts, while climate variability potentially only plays a secondary role' (Mach et al. 2019) (see *Chapter 3, Section 3.3.3*). The latest 6th Assessment Report of the IPCC Working Group II on Impacts, Adaptation and Vulnerability concurrently stresses that 'compared to other socio-economic factors, the influence of climate on conflict is assessed as relatively weak *(high confidence)*' (IPCC 2022).

These considerations should invite scholars to



shift the analytical focus away from rigid climatic determinism and instead pay much greater attention to the key factors that appear to be crucial in processing environmental stressors and making them veer towards either conflict escalation or peaceful settlement — governance, institutions, and adaptation mechanisms.

7.3 Mediterranean challenges: diversity, instability, and the perils of securitisation

Widely recognised as a climate change hotspot, the Mediterranean Basin represents an important, albeit highly complex and variegated, case study to test hypotheses concerning the environment-migration-conflict nexus. Currently host to a number of active or frozen conflicts, the Mediterranean Basin, which is also a major origin and transit region for migration, contains many of the fundamental variables associated with the nexus. At the same time, there is little evidence to support the thesis that climate change has played a direct role in the initiation and recurrence of conflict or migration across Mediterranean Basin states. This holds true retroactively for a wide range and diversity of cases across a large timespan. While much has been written on the role of water scarcity for the advent of the Syrian uprising (see *Chapter 4*), or the role that global food price spikes linked to the fires in Russia and Siberia played in the advent of the so-called Arab Spring in late 2010, such dynamics can at best be considered contributing variables for the onset of such crises. The role of hydrocarbons in the First Gulf War, of water in the Israeli-Palestinian conflict or the Iran-Iraq war of the 1980s, and of desertification or other climate disruptions in the multiple conflicts in the Sahel are also hardly deterministic. At the same time, future trajectories are difficult to predict. It may be possible that under certain trajectories a climate-driven conflict could occur in the Mediterranean Basin, with repercussions in terms of major population displacements.

While few debate the correlation between conflict and migration, with the MENA providing ample evidence for this relationship — for example the Israeli-Palestinian conflict and Palestinian refugee crisis; Iraqi refugee waves following the 2003 US-led intervention; the 2011 Syria war and ensuing refugee crisis; outward migration from Libya to neighbouring states following the 2011 NATO intervention, to name but a few examples — there is little evidence to support the contention that climate change and/or environmental degradation have played deterministic roles in any past or ongoing conflicts in the region. Instead, they have resulted from a confluence of international and domestic variables, ranging from the recurrence of foreign interventionism since World War I, the legacy of European colonialism, the failures of post-independence Arab developmental models, and the prevalence of authoritarianism and zero-sum geopolitical rivalries (exacerbated by global geopolitical priorities) across Mediterranean Basin states.

A number of challenges specifically linked to the Mediterranean are worth examining when approaching the environment-migration-conflict nexus. These relate in the first instance to the region's broad socio-economic, political, and cultural diversity present. All states across the Mediterranean Basin are exposed to the threats of environmental change (declining precipitation, rising temperatures, soil degradation, and ecosystem disruptions), but their respective capabilities for, and prioritisation of, responses to such phenomena vary significantly across the eastern, northern, and southern shores. While this diversity should not be an impediment to developing environmental impact reduction frameworks, the Mediterranean Basin's political and geostrategic divisions present more of a challenge. Three of the longest-lasting modern conflicts are located in the Mediterranean Basin — the Morocco-Algeria dispute, the Israeli-Palestinian conflict, and the Cyprus dispute — underscoring the geopolitical complexities of the region. These long-lasting conflict divisions have been compounded by many more recent civil and proxy wars that have caused widespread destruction and major migratory waves across much of the region and yet have often also been intertwined with broader international variables. A practical result is that regional cooperation frameworks in the Mediterranean Basin are weak or non-inclusive, thus adding to the fragmentation of the region and the complexity of promoting multilateral frameworks to address common challenges.

The prevalence of conflicts and fragilities across Mediterranean Basin states also translates into varying priorities according to location and proximity. Across and within Mediterranean Basin states, socio-economic, political, and security indicators vary to significant extents (e.g. 'North vs. South',

'East vs. South', rural vs. urban, etc.). Capabilities, needs, and sensitivities also change as a result. The threat of environmental change for many struggling societies in the southern and eastern Mediterranean may appear as one among other, often more pressing or deadly, crises and challenges. This makes it particularly challenging to convince states and societies facing profound security crises to dedicate adequate resources and political capital to the task of confronting environmental change. While recent polls in the Arab world have identified climate change — and especially water scarcity — as a key concern of many Arab populations (Abufalgha 2022), the degree to which governing institutions have internalised this priority varies considerably across the region. Iraq, for example, has been recognised by the UN as among the top five countries most at risk of climate collapse, but little has been concretely done to address this threat amidst the multiple security, governance, and economic crises affecting the Iraqi government (UN Iraq 2022; Younis 2022; Alwash 2023).

Turning to the question of migration, it is frequently assumed that human beings are forced to migrate as a practical response to the consequences of environmental degradation and climate hazards (Baldwin et al. 2019). Yet, as with conflict, a systematic theoretical understanding of the role of climate and environmental change on human migration processes has not yet been outlined in the literature *(Chapter 5, Section 5.1.1).* While some cases have confirmed this relationship, especially in the Pacific Island area due to significant sea level rise (see *Ioane Teitiota vs. New Zealand,* UN HCR (2020)), the Mediterranean presents a more complex case. In the southern Mediterranean, there have been cases of migration due to rising temperatures resulting in impacts on land drying, water scarcity, and food security *(Chapter 5, Section 5.2.3).* At the same time, in some Mediterranean Basin states there are examples where environmental migration is currently preferably replaced by a local adaptive response to climate change. As the impacts of climate shocks on migration are non-linear, societies are becoming more resilient to environmental and climate change through adaptation and cooperation strategies. This behaviour is defined as voluntary resistance to climate mobility, where the desire to remain in areas affected by the effects of environmental change is stronger than the necessity to leave *(Chapter 5, Section 5.3.3).* Moreover, migration flows are often regional or national and rarely reach an international level. Furthermore, most cases registered underline an intensification of urban migration flows, where cities are becoming new climate adaptation hubs (Dalby 2020). This circumstance is due to the fact that long-distance migration routes are expensive, and do not match the economic availability of vulnerable groups already affected by economic, socio-political issues, and possible conflict tensions. This assumption is confirmed by the well-established inverted U-shape association between the availability of wealth resources and migration, whereby migration is found to increase as the overall wealth and prosperity of a country increases, before stabilising after a certain level of prosperity is reached *(Chapter 5, Section 5.1.4).*

Overall, a narrow focus on climate-related disruptions risks overlooking the broader context of pre-existing governance and economic variables, which have a greater bearing on the outbreak of conflict or migration and are also of a higher priority for many states and societies in the southern and eastern Mediterranean.

Fraying governance models, authoritarianism, and declining socio-economic indicators, variables that have already contributed to conflict and insecurity across Mediterranean Basin states over recent decades, cannot be overlooked when examining the possible security implications of environmental change across the area. Ultimately, the very legitimacy and effectiveness of mitigation and adaptation mechanisms aimed at confronting the climate emergency will also rely on a degree of buy-in and consultation with the general public. This implies that transparent governance and social contracts are recognised as indispensable components for effective contingency planning to tackle the climate emergency, as well as possible security-related issues (Dessì et al. 2021; Dessì and Fusco 2022). In this context, the best way to improve the groundwork for confronting climatic and non-climatic disruptions alike is to invest in both state and society via the social contract, functioning and transparent institutions, good governance, and the rule of law (Dessì 2017, 2021). This more nuanced approach also includes an appreciation of how securitised approaches to the nexus in the Mediterranean Basin may in fact be partially driven by other political or security priorities largely concentrated in the Global North. These range from Europe's emphasis on migration management

via an externalisation of border controls to eastern and southern Mediterranean states, to more general efforts that prioritise stability, countering violent extremism, trade interests, and energy security over political reform, human rights, transparency, or good governance.

An appreciation of these legacies and the potential for ingrained biases are indispensable for contextualising the trajectories of state fragility in parts of the Mediterranean Basin, as well as the impact that state policies and consumption models in the Global North have had on these trajectories. Rebuilding trust and interdependencies via structured and equal dialogue — between the northern, southern, and eastern shores of the Mediterranean, but also within single states and specific shores — is no simple feat. It will likely require a higher degree of burden-sharing by the Global North compared to southern and eastern Mediterranean states, as indeed is being called for by Egypt and the United Arab Emirates (UAE), hosts of the UNFCCC COP 27 and COP 28 conferences in 2022 and 2023, respectively. Such dialogue can be strengthened by co-dependencies and the promise of enhanced and mutually beneficial integrations across and within Mediterranean Basin states but will necessarily also need to respond to the actual priorities of states and societies in this space. The parallel promotion of legal migration pathways as well as increased technical and developmental assistance and support for civil society, human rights, and the rule of law would help respond to some of the societal grievances emanating from southern and eastern Basin states. Concepts such as 'just transition', burden-sharing, and environmental peace (see *Chapter 4,* and particularly *Section 4.6*) could go some way towards addressing these challenges and seeking more balanced interactions across Mediterranean Basin states. Such approaches can provide new impetus and groundwork for relaunching more genuine forms of Euro-Mediterranean cooperation based on mutually beneficial frameworks of integration and co-dependency, thereby reviving some of the original objectives of the Barcelona Process launched in 1995. If successful, such efforts would significantly improve the region's coping capacities in the face of the climate emergency. Improvements in these political, security, and governance domains would increase room for more sectoral climate-related interventions. This includes efforts that generally require a degree of government legitimacy and societal buy-in to achieve results, but more broadly also require a transnational dimension of inter-state cooperation and interdependence to be sustainable in the long term. In this regard, rebuilding trust across the Mediterranean and renewing genuine political and diplomatic efforts to resolve key outstanding conflicts in the region would also go some way towards increasing the regional capabilities of states and societies to entertain joint efforts to better enhance regional resilience to the climate emergency.

There is no disputing that climate change will exacerbate fragilities for states and societies across all shores of the Mediterranean Basin. What is required is a deeper appreciation of the broad diversity affecting the Mediterranean space, as well as the complex ways environmental change is affecting a whole range of pre-existing fragilities in the socio-economic, political, and governance domains that are the most direct drivers for conflict or migration in the region. In this sense, developing context-specific and tailored engagements capable of addressing both climate and non-climatic dimensions simultaneously in a specific country or sub-regional grouping of countries is required. Such efforts should be driven by a focus on human security, the social contract, and governance indicators within single states. Simultaneously, the promotion of enhanced forms of interdependence and integration for the management of increasingly scarce resources in a region that still suffers from the lowest levels of integration in the world (Malpass 2021; OECD 2021) should be pursued across the Mediterranean. In this context, it may be preferable to prioritise sectoral cooperation frameworks among specific sub-groupings of states, instead of broad one-size-fits all prescriptions applied to the whole Basin. Finding ways to improve the coping capacities and resilience of groups of states — through enhanced forms of infrastructure connectivity, burden-sharing, and integration — as a means to encourage regional de-escalation and détente, should be considered an effective policy approach to tackle the environmental risks associated with the nexus in the Mediterranean Basin.

The importance of strengthening cooperative governance arrangements has also been emphasised in the literature. As Scheffran (2021) notes: 'Cooperative platforms, interagency frameworks, and multi-institutional processes are beneficial for bridging diverse interests across the region

and establishing rapid response mechanisms. Climate diplomacy practices are implemented by a broad range of actors, including national and local governments involved in policymaking, international organisations, such as the UN and the EU, NGOs, and donor funding projects. Regional partnerships and initiatives can connect global and local actions, jointly address climate-fragility risks, and improve resilience, engaging with existing networks, fora, and conferences'. Multilateral dialogues providing frameworks for climate diplomacy already coexist at different levels (EEAS, NATO, OSCE) but with little interaction amongst them. More improvement and the exploitation of synergies is therefore necessary, as is the breaking down of policy silos across and within these organisations. Such multilateral efforts could also include key powers external to the Mediterranean (China, Iran, Saudi Arabia, the Russian Federation, and the United States of America) to identify cooperative pathways in North-South or South-South frameworks (Ehteshami and Horesh 2019).

A final important caveat concerns temporality. While existing literature and current climate conditions have not yet demonstrated significant and direct correlations between environmental change, conflict, and migration, future scenarios may change this outlook. In light of the worsening trajectory of climate change model projections, and the prevalence of political fragilities across many parts of the Mediterranean Basin, more direct correlations could emerge in the future. Several studies have delineated scenarios in which global temperature increases of 2.7°C, 3.6°C, and 4°C could lead to future conflict or migration waves (see *Chapter 4,* and particularly *Section 4.3*), given their significant impact on states and societies in the region. Such prospective climatic scenarios represent the prevailing motivation to promote new research by academia, policymakers, and the scientific community on the environment-conflict-migration nexus. While these scenarios are important to pursue and consider, maintaining a strong focus on governance and political variables remains essential, as they are highly crucial for strengthening the capacity of states and societies to mitigate climate-related threats, while at the same time containing their non-climatic, conflict, or migration-related implications.

7.4 Methodological issues

The environmental change-migration-conflict nexus has been studied in different fields using different methodologies. Researchers follow a methodology based on several parameters, such as the research objectives, the type and availability of data required, the accessibility of resources and participants, ethical considerations, and the desired level of depth and breadth of analysis. However, some issues are to be noted regarding these parameters. In their study, Hoffmann et al. (2021) identify five methodological challenges: correct measurement of climate migration, conceptualisation and representation of climatic events and hazards, integration and aggregation of data, causality identification and modelling, and understanding the effects of diverse mechanisms and contexts. It is important to note that out of the 127 studies Hoffmann et al. take into consideration, only twelve studies focus on Mediterranean countries. While eight of these are in Africa, the others use units of analysis such as the 'developing world', non-OECD countries, and MENA countries.

An approach more focused on Mediterranean countries reveals various methodological challenges, which are discussed below, along with relevant suggestions for addressing them.

7.4.1 Interdisciplinary and multidimensional research

Addressing the complex challenges of environmental change, conflict, and migration requires taking a multidimensional approach that considers social, economic, and political factors. This includes seeking sustainable development practices that reduce vulnerability to environmental climate change by addressing its root causes, while paying attention to protecting human rights, ensuring the safety of migrants and refugees, and strengthening international cooperation and governance. Not only climate mobility, but in some cases, climate immobility, may also be linked to conflict. In this context, there is a pressing need for further research into the political, historical, economic, sociological, and psychological dimensions of persistent fragilities in the Basin. It is imperative to pay meticulous attention to the enduring impacts of colonialism, foreign interventionism, and the economies of war.

This raises the theme of interdisciplinary research. Just as Disaster Risk Reduction (DRR) studies have gained importance in disasters caused by the sudden onset effects of environmental change, a similar necessity applies to slow onset effects. Since the effects of these events unfold gradually, efforts focus on investigating the causes, consequences, and processes over a long period. Only then can the steps needed for adaptation and resilience be identified. However, there are cases where the environmental stressors on communities can be managed without resulting in conflict and migration. Local cooperation mechanisms that enable the exchange of knowledge and experience between these good practice examples and vulnerable regions can be a functional method that serves as Conflict Risk Reduction (CRR) (Collins 2019). This approach operates on the principle of interoperability, which entails the ability to share information and capacities between various actors. By doing so, the focus can be shifted from the environment-migration-conflict nexus to the environment-mobility-stability nexus.

7.4.2 Contextual complexities: multiple historical, regional, and cultural contexts and individual stories

The Mediterranean region is characterised by diverse cultures, histories, and political systems. This can make it difficult to draw generalisable conclusions about the relationship between environmental change, migration, and conflict, as different contexts may require different approaches and methods of analysis. Another important issue is the superficial view that can lead to environmental pressure, migration, and conflict being seen and approached as entirely new phenomena in the relevant region. In other words, researchers who focus on the migration and conflict risk nexus in the context of environmental change may analyse existing cases by dissecting them as outsiders, separating them from their socio-political basis, and potentially ignoring their own positionality. An effort to understand how anthropogenic climate change affects and transforms the existing dynamics of migration, conflict, environmental degradation, and disaster culture in the relevant geography is important for producing scientific knowledge associated with this nexus.

Another factor that increases the complexities in the region is the EU's security-oriented approach

to migration through 'governing from a distance' (Geddes 2015, p.475). This approach is reflected in the EU's efforts to promote adaptation and build resilience in the region. However, the recent data showing that environmental change-related mobility is mostly internal or directed towards neighbouring countries may adversely affect the distribution of international climate change adaptation financing in these regions. In this respect, it is important that the primary motivation for supporting climate change adaptation and resilience efforts in the Mediterranean Basin is not limited to migration towards Europe across the Mediterranean Sea, but also aims at achieving global climate justice.

Moreover, efforts also need to focus on adopting effective policies and methods to minimise the effects of climate change and environmental degradation, particularly through the restoration of lands and ecosystems (Fargues et al. 2020). In this regard, studies highlight the importance of focusing primarily on populations at risk of being trapped by the climate crisis (Black et al. 2011; Geddes et al. 2012), rather than only considering them as potential involuntary migrants once conflicts arise. Otherwise, security-driven approaches to migration might gain more popularity, leaving many to move via irregular channels as the only alternative for survival if large-scale initiatives on migration, development, and the environment fail to achieve their goals (Fargues et al. 2020) and fail to prioritise climate justice. This difficulty calls for embracing plural ontologies of security (Dedeoğlu 2019). In addressing the complex security context, ontological plurality can be sustained by incorporating post-humanist, post-colonial, queer, and indigenous philosophies that pay attention to more-than-human entanglements and argue for critical engagements with the different forms and politics of matter.

For a more complete picture of these mechanisms and pathways, researchers also need to pay attention to a diversity of dynamics. While the environment-migration-conflict nexus is mainly discussed in the context of race, ethnicity, religious groups, and local communities, the context of social class and gender is less explored (for example see Hunter et al. 2015; Miletto et al. 2017). More in-depth and intersectional research is needed in this area — a top-down approach focusing on states, governing elites, the private sector, etc. is still dominant, overlooking local communities or specific sub-groups like gender-based, ethnic, or other minorities. The recommendation in this case would be to also have more bottom-up or horizontal research on techniques and local capabilities/strategies.

Another problem is the lack of attention to small-scale mobility and the greater focus on large-scale or mass migrations, because the cumulative effect of small-scale environmental migrations — which occur more frequently than in the past due to environmental change — may be one of the basic grounds that prepare the emergence of conflicts. Greater attention to small-scale climate mobility could therefore serve as CRR.

7.4.3 From environmental conflict to environmental justice?

The question, 'How can the relationship between environmental change, migration, and conflicts be measured?' is central to understanding climate-related mobility. It is equally important to ask: what is actually being measured? How can migratory experiences be better understood? What does conflict refer to? For instance, conflict has recently gained prominence in the context of the impact of slow onset effects on climate mobility. Rising incidents of violence, particularly in sudden onset displacement, are significant concerns in both rural origin areas and urban destinations. However, the effect of environmental mobility on the increase in violence in camps and remain insufficiently examined.

Anthropological and ethnographic research may help address these questions by offering a more nuanced understanding of migratory experiences, integrating insights from both migration and mobility studies. Ethnography, with its focus on the lived experiences of individuals and communities, provides a powerful tool for capturing the complex realities of migration in a globalised world (Heil et al. 2017). An interdisciplinary framework, as proposed by Brettell and Hollifield (2022), that encompasses a wide range of research questions, levels of analysis, and methodologies is also needed for the nexus of environmental change and mobility. This framework stresses the need for dialogue across disciplines to share theoretical perspectives and analytical concepts, challenging core assumptions and aiming to foster a more unified field of migration studies. It can be used to address the complexities of migration, including its causes, processes, and

effects on individuals, families, communities, and societies, while also considering the legal, political, and economic dimensions of migration policies and practices, before framing it as a source of conflict. Furthermore, the bibliography database curated as part of the CliMig project[84] may support the development of such interdisciplinary perspectives.

In addition, the Transhumance Tracking Tool (used by Displacement Tracking Matrix missions in west and central Africa) provides for a more in-depth examination of the environmental and social effects of migration and, through an alert mechanism, can assist in identifying possible and actual conflicts (Nicoletti et al. 2023). However, 'transhumance movements' and 'climate mobility as a form of adaptation' are two separate phenomena with different dynamics, and trying to make sense of the latter by deriving from the former may cause misleading inferences. The transhumance movement is a custom that spans a much longer period of time and even continues as a part of the relevant culture. Both the cultural values of the community and the social system in which they are integrated have been shaped accordingly. However, climate mobility as a result of gradual effects or sudden onset effects, to which members of the settled agricultural society are exposed, needs to be evaluated in a different context. Although it is very useful to examine these migration movements in order to prevent and mediate potential conflicts, it should be noted that while reading the data obtained here, transhumance mobility exhibits a very different structure-agent relationship.

Another question to consider is whether to take environmental conflicts into account, and how methodologies should be updated. Should environmental conflicts be viewed from the perspective of scarcity? What alternatives emerge? Climate change is primarily caused by human activities such as burning fossil fuels, deforestation, and industrial processes, therefore representing an anthropogenic phenomenon. These same activities often lead to other environmental conflicts, such as mineral extraction, pollution, loss of biodiversity, and resource depletion. Addressing environmental change therefore requires a fundamental shift in how we understand and approach conflict. It entails fundamental conceptual reconsideration and involves rethinking the economic assumptions behind these conceptualisations, based on the recent updates to the planetary boundaries approach (Richardson et al. 2023). This means moving beyond business-as-usual practices that exploit natural resources and human labour, often to the detriment of public interests, particularly in the context of interactions between the Global North and the Global South. It also requires recognising the interconnectedness of environmental issues and understanding that addressing climate change is not only important for reducing its impacts but also for promoting environmental justice and preventing further conflict. In this respect, it is crucial to incorporate environmental justice research on the rights of non-humans and commons into the study of the environmental change-conflict-migration nexus.

7.4.4 Data availability and reliability

Another area of concern is data availability and reliability. The use of household surveys, combined with key informant interviews and secondary data, can offer insights into the factors influencing mobility decisions and the vulnerability of populations, including migrants. While data collection tools in humanitarian contexts have focused on mobility associated with environmental and climate changes and disasters, they have not adequately considered environmental determinants and their interactions with other factors that may shape mobility decisions, and adaptation outcomes (Nicoletti et al. 2023). New tools, such as the Displacement Tracking Matrix and the Transhumance Tracking Tool, can be used to respond to these challenges and provide more timely data on movements and outcomes. However, as noted by Nicoletti et al. (2023), these tools may hinder a rapid response to urgent needs. The authors recommend a balanced approach and suggest that more effort should be made to finance and deploy joint longitudinal approaches, focus on 'blind spots' and internal mobility, and include populations that do not move to shed light on issues of immobility. These recommended actions will help stakeholders better understand why people move, facilitate return migration, and reduce future out-migration.

[84] https://environmentalmigration.iom.int/climig

One of the main reasons for insufficient data on whether environmental migrations cause conflicts is the data gaps on disaster-related internal displacement in national databases of Mediterranean countries. There is not enough data on the contribution or role of governments and local authorities' success or failure in adequately tackling environmental change, implementing necessary measures, or misallocating resources that may influence the occurrence or escalation of conflicts between communities. For example, the International Organization for Migration (IOM 2016) has noted that despite Morocco's concerns about environmentally induced mobility, no comprehensive study or analysis of environmental migration has been conducted in the country. Additionally, while the Moroccan government recognises that droughts can impact vulnerability and migration, no research has been conducted on internal migration induced by environmental factors (see *Section 5.2.1* for details).

The principle of interoperability can also be very helpful in overcoming some biases and blind spots that may arise in the data collection process. Unlike slow onset events such as drought, in sudden onset events like tornadoes, there tends to be a lower involvement of national and local actors in the data collection process. In such scenarios, international institutions and organisations may collect data in the region, and sometimes that is even the preferred option. This would have the advantage of preventing the emergence of trust issues with national data. On the other hand, in the case of slow onset events, a more sceptical approach toward national and local data may be necessary, due to the intertwining of economic and related political factors with environmental factors and diminishing resources. Of course, this does not mean that the path to unbiased data lies solely through independent international organisations. Data biases cannot solely be addressed through the perspective of an international observer due to the complexities of localities and the multi-layered and multidimensional relationships surrounding them. Because of all these dimensions, collaboration and coordination between local organisations, international organisations, and researchers with diverse disciplinary backgrounds, as mentioned in *Section 7.4.3,* are crucial for understanding and analysing local climate dynamics and conflict relationships.

7.4.5 Diverse methodologies and longitudinal and comparative studies

Climate mobility is a phenomenon formed by the intricate relationship of many different factors. When conflict is associated, the mixed-methods research becomes even more important. It is crucial to determine which factors play a role in the formation of mobility and to what extent, to understand how these factors interact with each other and what processes they create, and finally to analyse both quantitative and qualitative data to gain a deeper understanding. This approach is undoubtedly an effort that requires substantial resources.

Singh et al. (2019) have already documented the rich spectrum of methodologies used in climate change vulnerability and adaptation (CCVA) research with respect to environmental migration, which can be implemented by scholars looking at the nexus with a specific focus on the Mediterranean Basin. Environmental migration is explored through various methods such as spatial and multi-scalar analyses, historical analogues, a hotspots approach using vulnerability indices, and qualitative field case studies using ethnographic methods (Piguet 2010). The scholarship on environmental migration conceptualises livelihoods as dynamic and multi-scalar, where agency and structure interact and exert feedback on one another. This has led to a methodological expansion where issues of identity, history, culture, and values are being examined more rigorously through qualitative methods focusing on temporality and migration decision-making. However, there are several gaps in the literature too. More research is needed on how drivers of vulnerability interact to shape household response behaviour, and how barriers to adaptation interact and shape responses. While there is some research on factors shaping adaptation, there is a lack of understanding of individual decision-making. Growing calls are being made for understanding the role of intra-household dynamics in mediating risk management choices and their outcomes. CCVA research has also been criticised for its silence on temporality and over-reliance on static methodologies, which do not capture complex structural conditions. Additionally, changing aspirations are rarely examined in adaptation research and practice, and there is a need to understand how shifting aspirations mediate adaptation behaviour.

7.5 Conclusion: rethinking the environment-migration-conflict nexus

This report assesses the available academic literature to shed light on the environment-migration-conflict nexus in relation to the Mediterranean Basin. This work has yielded considerable insight into a growing body of literature, which is allowing certain aspects of the nexus to come into greater focus. For example, the report provides an overview of the strong evidence that supports the existence of causal links between conflict and migration, while less clarity and linkages are demonstrated regarding environmental change and conflict. This proven relationship between conflict and migration is related to the flow of IDPs and refugees that accompany conflict events. The literature has shown that this relationship is of a distinctive cyclical nature: rising violent conflict swells the number of people on the move; the resolution of conflict then reduces this number, as the vast majority of those who fled tend to return to their residences. Within the nexus, then, the causal link that remains largely unproven is the one between environmental change and conflict.

This is an important dimension of the nexus, which has been explored by an increasing number of investigators since the early 2000s on the assumption that the physical effects of environmental change would increase the risk of violent conflict among individuals, communities and nations. Yet, the evidence remains inconclusive, and no direct causal link between climate change and conflict has been proven in the literature.

Currently, the main conceptual framework for understanding the nexus has been that environmental change is seen as a 'threat multiplier'. This multiplying factor, while not directly linked to conflict, is understood to increase cleavages and tensions between individuals, groups, and nations, particularly those that are already struggling to find ways to collaborate in the management of natural resources and in defining collective security, and thus to contribute to the risk of violent conflict. As noted above, the validity of the 'threat multiplier' framework has, to date, been neither confirmed nor refuted. The framework has focused almost entirely on the effects of climate change on security and, more specifically, national security (i.e. hard security). It has also tended to focus on the role of national institutions in countries already affected by conflict or fragilities, suggesting that where these institutions are weak or fragile, the risk of further conflict would naturally be higher. While a number of 'pathways' have been analysed above, whereby environmental change is presumed to lead to conflict or migration via the 'scarcity' mechanism (and its variations), these, too, remain inconclusive with regards to the Mediterranean Basin. Overall, while the 'threat multiplier' framework is beneficial to widen the scope of the focus away from climate-related variables alone, the broad adoption of this framework has also removed incentives for multidisciplinary approaches to the study of the environment-conflict-migration nexus. Indeed, 'threat multiplier' frameworks have focused mainly on security and security studies as the key determinant for the behaviour of individuals, communities, and nations in response to climate change. An overbearing focus on security has, however, left other potentially determining factors underexplored, including some particularly salient ones in relation to the study of conflict and peace, for example justice and economics. Moreover, the 'threat multiplier' framework has also largely ignored the role of institutions in developed (or Global North) nations, and that of intergovernmental organisations. These institutions and organisations should also be considered important variables for explaining the occurrence (or non-occurrence) of violent conflict, as well as the emergence of environmental change in the first place, in light of the destabilising impact of lifestyles in the Global North. The primary impetus behind endorsing initiatives geared towards environmental change adaptation and resilience in the Mediterranean and the MENA region extends beyond simply understanding migration towards Europe via the Mediterranean Sea. Instead, a broader perspective centred on global climate justice may offer a more comprehensive approach. This shows that the focus, often limited to preventing migration, should also encompass the broader objective of addressing the inequities and injustices arising from environmental change on a global scale.

In this regard, a better understanding of the complex causal links between the environment-conflict-migration nexus will require a reframing of the nexus in a more holistic fashion, underscoring the climate emergency's direct and detrimental impact on human security (and planetary security) as opposed to the prevalent, albeit rather recent, hard security emphasis common in policy circles. The concept of human security might represent a better and more

holistic analytical concept for understanding how the phenomena of environmental change, migration, and conflict interact. Human security is 'an approach to assist Member states in identifying and addressing widespread and cross-cutting challenges to the survival, livelihood, and dignity of their people' through 'people-centred, comprehensive, context-specific, and prevention-oriented responses that strengthen the protection and empowerment of all people' (UN General Assembly 2012). In this regard, human security-centred policies mirror the recent emphasis by the UN and other INGOs on a 'whole society' approach, linked as well to the implementation of the UN's Agenda 2030 and associated Sustainable Development Goals (SDGs). Human security draws attention to socio-economic hardships and inequalities, which, in general terms, climate and environmental change are known to exacerbate (Taconet et al. 2020; Dessì and Fusco 2022; Figueres 2022). Human security also integrates the discourse around human rights and governance and can therefore account for factors related to a country's treatment of its own citizens — whether virtuous or not. The reviewed literature suggests these considerations are a strong determinant for understanding where and how environmental change might exacerbate conflict and migration. Ultimately, a human security-centred approach will require equal emphasis on climatic and non-climatic challenges facing states and societies in the Mediterranean Basin, seeking policy prescriptions capable of having a positive impact on both domains. Seeking to tackle one domain — climate disruptions and their potential impact on conflict and migration — without a simultaneous emphasis on good governance, human rights, the rule of law, and transparent and legitimate institutions will prove unsatisfactory. It is also likely to be counterproductive, as challenges with governance are likely to carry over and negatively impact the effectiveness and buy-in of mitigation and adaptation mechanisms promoted to tackle the climate emergency.

Beyond human security, it would be valuable to allocate more resources to exploring instances of environmental cooperation, which, as the report duly notes, exist across the Mediterranean Basin. The cases cited in the report *(Chapter 4)* suggest that stressors like migration and climate change may indeed serve as an opportunity for collaboration and conflict resolution — as much as they might represent a risk multiplier for violent conflict. Several possible explanations, including the political system of a country or the inclusiveness of its decision-making processes, all of which would receive scant attention under an approach strictly focused on hard security, can influence conflict or cooperation trajectories between states and societies on these issues. Furthermore, investigating cases of cooperation might create a helpful counterweight to the oft-cited cases supporting the view that environmental change exacerbates conflict. A greater variety of cases in the literature could provide valuable insights.

As already mentioned, there are few studies specific to the Mediterranean Basin, certainly when compared with similar literature for Sub-Saharan Africa. Increased variety in the geographical distribution of case studies would provide clear benefits to the understanding and testing of the nexus in this geographic region. The same goes for increased variety in methodologies and conceptual frameworks to be used for investigating identified case studies.

Returning to the prevalence of securitised approaches applied to the present environmental emergency, it is similarly important to appreciate the reasons behind these frameworks and the prioritisation of national and hard security. The current securitisation trend in international approaches to the climate-migration-conflict nexus is indeed part and parcel of the broader process of framing climate change as a security issue (securitisation) in developmental studies underway since the terrorist attacks of 11 September 2001.

While this shift may have generated useful outcomes in terms of urgency and allocation of budgetary resources, an over-reliance on a single conceptual framework should not detract from others that also account for deeper sociological, economic, political, and even anthropological or historical research lenses.

These may hold value in identifying alternative pathways for enhancing joint ownership and local capabilities to implement needed adaptation and mitigation strategies that build on local traditions and experiences. To help achieve this, future inquiries need to be more multidisciplinary, integrating economic theories and analysis frameworks that focus on understanding (and predicting) the management of common goods and the distribution of resources. Political economy analyses (PEA) have, in particular, become a commonly-used approach for successfully

understanding resource allocation and growing inequalities, offering valuable insights into why and how nations — on both sides of the Mediterranean — engage in the economic (and political) effort that can exacerbate conflict and climate change. On the more extreme spectrum of multidisciplinarity is the concept of 'environmental peacebuilding', which seeks to include 'natural resource management in conflict prevention. mitigation, resolution, and recovery to build resilience in communities affected by conflict' (Environmental Peacebuilding Association®, also known as EnPAx®[85]). Environmental peacebuilding has emerged over the past five years to improve understanding of the linkages between environmental change and conflict. It integrates the concepts of natural resources management and peacebuilding, while also shifting the unit of analysis to the local level — where individuals and communities need to make localised decisions to remain resilient in the face of both phenomena.

Ultimately, this report provides ample insights into the primary methodological and policy challenges linked to understanding the determinants and implications of the environment-conflict-migration nexus in the Mediterranean Basin. Widely recognised as a climate change hotspot, the Mediterranean Basin is well placed to serve as a test case for present and future determinants across the nexus. That said, the broad diversity of the region, combined with the deep legacies of geopolitical conflict and divisions within and across its northern, southern, and eastern shores, represent the primary challenges for the adoption of multilateral frameworks based on genuine cooperation, interdependence, and burden-sharing (or interdependency) across Mediterranean states and societies.

The different levels of prioritisation of the environmental emergency, and the prevalence of authoritarianism across the southern and eastern Mediterranean, where societies are often confronted with a mixture of pressing, even existential hardships, also represents a challenge. Meanwhile, the emphasis on migration management, energy security, and anti-terrorism among European states and extra-regional actors all point to a mismatch in expectations and policy priorities across the Basin. This creates significant impediments to the promotion of region-wide prescriptions to test and tackle the environment-conflict-migration nexus in the Mediterranean Basin.

Building on the above, this chapter has emphasised the need to broaden the scope of data collection and analysis, embrace more multidisciplinary approaches, and question the prevalent security framework applied to the nexus in the literature. In emphasising 'whole society' approaches centred on human security, the analysis has underscored the need to simultaneously consider climatic and non-climatic variables when considering the nexus in the Mediterranean. While the report has repeatedly emphasised the lack of a direct causal relationship between environmental change and conflict/migration in the Mediterranean, this lack of correlation does not imply a decreased probability of such phenomena taking place in the future. In light of the considerably worsening outlook in the global fight against climate change and environmental degradation, and the consequent modelling for future climatic events in the Mediterranean, it may well be that more direct correlations emerge in the future.

Given the severe fragility of many states and societies across the Mediterranean Basin today, a deep sense of urgency is called for when devising policies and predictive modelling for this region over the coming decades. Against this backdrop, the key methodological and policy takeaway from our analysis is not to overlook governance, the rule of law, and human rights — in a nutshell the essence of politics and the social contract — when seeking to devise strategies to tackle the environment-conflict-migration nexus. Strengthening good governance, transparency, and accountability, while acknowledging the role of historical dependencies and power asymmetries, represents the best investment to enhance the coping capacities and resilience of states and societies in the Mediterranean. Ultimately, it will be these institutional capacities and mechanisms that will determine a given state's and society's ability to mitigate and adapt to the changing environment, whether this is determined by rising sea levels, resource scarcity, and temperature increases, or other phenomena linked to governance breakdown, armed conflict, or migratory flows.

[85] https://www.enpax.org/about

References

Abufalgha M. (2022). *Views on the Environment and Climate Change in the Middle East and North Africa*. Arab Barometer, Wave VII, Climate Change Report. https://www.arabbarometer.org/wp-content/uploads/ABVII_Climate_Change_Report-EN.pdf

Alwash A. (2023). *From Threat to Opportunity: Harnessing Climate Change to Build a Prosperous Future for Iraq and the Region*. Istituto Affari Internazionali (IAI). https://www.iai.it/en/publications/c03/threat-opportunity-harnessing-climate-change-build-prosperous-future-iraq-and

Baldwin A., Fröhlich C., and Rothe D. (2019). From climate migration to anthropocene mobilities: shifting the debate. *Mobilities*, *14*(3), 289–297. doi: 10.1080/17450101.2019.1620510

Behnke, R., & Mortimore, M. (Eds.). (2016). *The End of Desertification?* Springer Berlin Heidelberg. doi: 10.1007/978-3-642-16014-1

Benjaminsen T. A., Alinon K., Buhaug H., and Buseth J. T. (2012). Does climate change drive land-use conflicts in the Sahel? *Journal of Peace Research*, *49*(1), 97–111. doi: 10.1177/0022343311427343

Black R., Adger W. N., Arnell N. W., Dercon S., Geddes A., and Thomas D. (2011). The effect of environmental change on human migration. *Global Environmental Change*, *21*, S3–S11. doi: 10.1016/j.gloenvcha.2011.10.001

Brettell C. B., and Hollifield J. F. (2022). Introduction. Migration Theory: Talking across Disciplines. In C. B. Brettell & J. F. Hollifield (Eds.), *Migration Theory* (pp. 1–43). Routledge. doi: 10.4324/9781003121015-1

Brown O., Hammill A., and McLeman R. (2007). Climate change as the 'new' security threat: implications for Africa. *International Affairs*, *83*(6), 1141–1154. doi: 10.1111/J.1468-2346.2007.00678.x

Buhaug H. (2010). Climate not to blame for African civil wars. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(38), 16477–16482. doi: 10.1073/pnas.1005739107

Buhaug H., Benjaminsen T. A., Sjaastad E., and Magnus Theisen O. (2015). Climate variability, food production shocks, and violent conflict in Sub-Saharan Africa. *Environmental Research Letters*, *10*(12), 125015. doi: 10.1088/1748-9326/10/12/125015

Buzan B., Wæver O., and de Wilde J. (1998). *Security. A New Framework for Analysis*. Lynne Rienner Publishers.

Cattaneo C., Beine M., Fröhlich C. J., Kniveton D., Martinez-Zarzoso I., Mastrorillo M., Millock K., Piguet E., and Schraven B. (2019). Human Migration in the Era of Climate Change. *Review of Environmental Economics and Policy*, *13*(2), 189–206. doi: 10.1093/reep/rez008

CNA Military Advisory Board (2007). *National security and the threat of climate change*. Alexandria: CNA Corporation. https://www.cna.org/analyses/2007/national-security-and-the-threat-of-climate-change

Cold-Ravnkilde S. M., and Ba B. (2022). *Actors and drivers of conflict in the Sahel: Unpacking "new climate wars."* Copenhagen: Danish Institute for International Studies (DIIS). https://research.diis.dk/en/publications/actors-and-drivers-of-conflict-in-the-sahel-unpacking-new-climate

Collins A. E. (2019). Advancing Disaster and Conflict Risk Reduction. In H. Brauch, Ú. Oswald Spring, & S. Serrano Oswald (Eds.), *Climate Change, Disasters, Sustainability Transition and Peace in the Anthropocene*. The Anthropocene: Politik—Economics—Society—Science, vol 25. Springer, Cham. doi: 10.1007/978-3-319-97562-7_2

Crawford N. C. (2022). *The Pentagon, climate change, and war: charting the rise and fall of U.S. military emissions*. MIT Press. doi: 10.7551/mitpress/14617.001.0001

Cusato E. (2022). Of violence and (in)visibility: the securitisation of climate change in international law. *London Review of International Law*, *10*(2), 203–242. doi: 10.1093/lril/lraC015

Dalby S. (2020). *Anthropocene Geopolitics*. University of Ottawa Press. doi: 10.2307/j.ctvx5w8dk

Daoudy M. (2020). Water weaponization in the Syrian conflict: strategies of domination and cooperation. *International Affairs*, *96*(5), 1347–1366. doi: 10.1093/ia/iiaa131

Dedeoğlu Ç. (2019). The Ontology of Security and its Implications for Maritime Security. *Güvenlik Stratejileri Dergisi*, *15*(32), 631–654. doi: 10.17752/guvenlikstrtj.668182

Dessì A. (2017). Crisis and Breakdown: How Can the EU Foster Resilience in the Middle East and North Africa? In *IAI Working Papers* (Issue 37). Roma: IAI, 31 p. https://www.iai.it/en/publications/c21/crisis-and-breakdown-how-can-eu-foster-resilience-middle-east-and-north-africa

Dessì A. (2021). Popular Mobilisation and Authoritarian Reconstitution in the Middle East and North Africa: Ten Years of Arab Uprisings. *IAI Papers.* Roma: IAI, 16 p. https://www.iai.it/en/publications/c03/popular-mobilisation-and-authoritarian-reconstitution-middle-east-and-north-africa

Dessì, A., Fattibene, D., & Fusco, F. (Eds.). (2021). Climate Change and Sustainability: Mediterranean Perspectives. *IAI Research Studies.* Rome, Nuova Cultura, 135 p. https://www.iai.it/en/publications/c02/climate-change-and-sustainability-mediterranean-perspectives

Dessì, A., & Fusco, F. (Eds.). (2022). Climate Change and Security in the Mediterranean: Exploring the Nexus. *IAI Research Studies.* Rome, Nuova Cultura, 146 p. https://www.iai.it/en/publications/c02/climate-change-and-security-mediterranean-exploring-nexus

Ehteshami A., and Horesh N. (2019). *How China's Rise Is Changing the Middle East*. Routledge. doi: 10.4324/9780429288425

Fairhead J. (2001). International Dimensions of Conflict Over Natural and Environmental Resources. In M. Watts & N. L. Peluso (Eds.), *Violent environments* (pp. 213–236). Ithaca (N.Y.): Cornell University Press. https://lib.ugent.be/catalog/rug01:000710062

Fargues, P., Rango, M., Borgnäs, E., & Schöfberger, I. (Eds.). (2020). *Migration in West and North Africa and across the Mediterranean: trends, risks, development and governance*. International Organization for Migration, Geneva. https://publications.iom.int/books/migration-west-and-north-africa-and-across-mediterranean

Feuer A. (2023). Environmental Warfare Tactics in Irregular Conflicts. *Perspectives on Politics*, *21*(2), 533–549. doi: 10.1017/s153759272200189x

Figueres C. (2022). Solving Climate Change Requires A New Social Contract. *TIME*. https://time.com/6140430/climate-change-trust/

Foresight: Migration and Global Environmental Change. (2011). *Final Project Report*. The Government Office for Science, London.

G7 (2015). *G7 Leaders' Declaration, Schloss Elmau, 7-8 June 2015*. German Federal Government. https://g7.utoronto.ca/summit/2015elmau/2015-G7-declaration-en.html

Geddes A. (2015). Governing migration from a distance: interactions between climate, migration, and security in the South Mediterranean. *European Security*, *24*(3), 473–490. doi: 10.1080/09662839.2015.1028191

Geddes A., Neil Adger W., Arnell N. W., Black R., and Thomas D. S. G. (2012). Migration, Environmental Change, and the 'Challenges of Governance.' *Environment and Planning C: Government and Policy*, *30*(6), 951–967. doi: 10.1068/C3006ED

Gleditsch N. (1998). Armed Conflict and The Environment: A Critique of the Literature. *Journal of Peace Research*, *35*(3), 381–400. doi: 10.1177/0022343398035003007

Gleditsch N., Hegre H., and Wollebaek Toset H. (2007). Conflicts in shared river basins. In V. I. Grover (Ed.), *Water: a source of conflict or cooperation?* Enfield: Science Publishers.

Gleick P. H. (1993). Water and Conflict: Fresh Water Resources and International Security. *International Security*, *18*(1), 79–112. doi: 10.2307/2539033

Heil T., Priori A., Riccio B., and Shwarz I. (2017). Mobilities – Migratory Experiences Ethnographically Connected: An Introduction. *New Diversities*, *19*(3), 1–11. doi: 10.58002/f0pq-e283

Hinnawi E. E. (1985). *Environmental refugees*. Nairobi: UNEP. https://digitallibrary.un.org/record/121267

Hissler S. (2010). *Econometric Study on the Impact of Rainfall Variability on Security in the Sahel Region*. Paris, OECD.

Hoffmann R., Šedová B., and Vinke K. (2021). Improving the evidence base: A methodological review of the quantitative climate migration literature. *Global Environmental Change*, *71*, 102367. doi: 10.1016/j.gloenvcha.2021.102367

Homer-Dixon T. F. (1994). Environmental Scarcities and Violent Conflict: Evidence from Cases. *International Security*, *19*(1), 5–40. doi: 10.2307/2539147

Homer-Dixon T. F. (1999). *Environment, scarcity, and violence*. Princeton University Press.

Hulme M. (2011). Reducing the future to climate: A story of climate determinism and reductionism. *Osiris*, *26*(1), 245–266. doi: 10.1086/661274

Hunter L. M., Luna J. K., and Norton R. M. (2015). Environmental Dimensions of Migration. *Annual Review of Sociology*, *41*, 377–397. doi: 10.1146/annurev-soc-073014-112223

ICG (2020). *The Central Sahel: Scene of New Climate Wars? Scene of New Climate Wars?* ICG Africa Briefing No 154. Dakar, Niamey, Brussel: International Crisis Group.

IOM (2016). *Environmental Migration in Morocco: Stocktaking, Challenges and Opportunities*. IOM Policy Brief, Vol. 2, No. 3. Geneva: International Organization for Migration (IOM). https://environmentalmigration.iom.int/resources/policy-brief-series-issue-3-vol-2-environmental-migration-morocco-stocktaking-challenges-and-opportunities

IPCC (1990). *Climate Change: the IPCC Impacts Assessment. Contribution of Working Group II to the First Assessment Report.* (W.J. McG. Tegart, G. W. Sheldon, & D. C. Griffiths, Eds.). Australian Government Publishing Service, Camberra, Australia, 294 pp. https://archive.ipcc.ch/publications_and_data/publications_ipcc_first_assessment_1990_wg2.shtml

IPCC (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Core Writing Team, R. K. Pachauri, & L. A. Meyer, Eds.). IPCC, Geneva, Switzerland, 151 pp. https://www.ipcc.ch/report/ar5/syr/

IPCC (2022). Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001

Jacobson J. L. (1988). Environmental refugees: a yardstick of habitability. *Bulletin of Science, Technology & Society*, *8*(3), 257–258. doi: 10.1177/027046768800800304

Klepp S. (2017). Climate Change and Migration. In *Oxford Research Encyclopedia of Climate Science*. Oxford Research Encyclopedias, Climate Science. Oxford University Press. doi: 10.1093/acrefore/9780190228620.013.42

Kohler C. (2020). *An Ancient Practice with a New Face. The Use of Water as a Weapon in Times of Climate Change*. PRIF Spotlight, 9, Frankfurt/M. https://www.prif.org/publikationen/publikationssuche/publikation/an-ancient-practice-with-a-new-face

Koubi V., Spilker G., Böhmelt T., and Bernauer T. (2014). Do natural resources matter for interstate and intrastate armed conflict? *Journal of Peace Research*, *51*(2), 227–243. doi: 10.1177/0022343313493455

Kuhnt J. (2019). *Literature review: drivers of migration. Why do people leave their homes? Is there an easy answer? A structured overview of migratory determinants*. Discussion Paper. Bonn: German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE). doi: 10.23661/dp9.2019

Mach K. J., Kraan C. M., Adger W. N., Buhaug H., Burke M., Fearon J. D., Field C. B., Hendrix C. S., Maystadt J.-F., O'Loughlin J., Roessler P., Scheffran J., Schultz K. A., and von Uexkull N. (2019). Climate as a risk factor for armed conflict. *Nature*, *571*(7764), 193–197. doi: 10.1038/s41586-019-1300-6

Malpass D. R. (2021, October 21). Regional Integration in the MENA region: A call for action. *Al Jazeera*. https://www.aljazeera.com/opinions/2021/10/28/regional-integration-in-the-mena-region-a-call-for-action

Mccullough A., Mayhew L., Opitz-Stapleton S., Abouka A., and Botto D. M. (2019). *When rising temperatures don't lead to rising tempers climate and insecurity in Niger*. Overseas Development Institute. https://media.odi.org/documents/12946.pdf

MedECC (2020). Summary for Policymakers. In W. Cramer, J. Guiot, & K. Marini (Eds.), *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report* (pp.11-40). Union for the Mediterranean, Plan Bleu, UNEP/ MAP, Marseille, France. doi: 10.5281/zenodo.5513887

Mehta L., Huff A., and Allouche J. (2019). The new politics and geographies of scarcity. *Geoforum*, *101*, 222–230. doi: 10.1016/j.geoforum.2018.10.027

Miletto M., Caretta M. A., Burchi F. M., and Zanlucchi G. (2017). *Migration and its interdependencies with water scarcity, gender and youth employment*. WAP. Paris, UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000258968

Mixed Migration Centre. (2022). *Climate change, environmental stressors, and mixed migration*. https://mixedmigration.org/resource/climate-change-environmental-stressors-mixed-migration/

Mobjörk M., Krampe F., and Tarif K. (2020). *Pathways of Climate Insecurity: Guidance for Policymakers*. Stockholm: SIPRI. https://www.sipri.org/publications/2020/sipri-policy-briefs/pathways-climate-insecurity-guidance-policymakers

Moritz M. (2010). Understanding Herder-Farmer Conflicts in West Africa: Outline of a Processual Approach. *Human Organization*, *69*(2), 138–148. doi: 10.17730/humo.69.2.aq85k02453w83363

NATO (2021). *NATO Climate Change and Security Action Plan*. North Atlantic Treaty Organization. https://www.nato.int/en/about-us/official-texts-and-resources/official-texts/2021/06/14/nato-climate-change-and-security-action-plan

Nicoletti A., Melde S., Guadagno L., and Bilsborrow R. E. (2023). Human mobility in the context of environmental and climate change: Recent data collection tools from the International Organization for Migration to address key methodological and conceptual issues. *International Migration*, *61*(5), 47–59. doi: 10.1111/imig.13043

Nordås R., and Gleditsch N. P. (2007). Climate change and conflict. *Political Geography*, *26*(6), 627–638. doi: 10.1016/j.polgeo.2007.06.003

OECD (2021). *Regional Integration in the Union for the Mediterranean: Progress Report*. OECD Publishing, Paris. doi: 10.1787/325884b3-en

Piguet E. (2010). Linking climate change, environmental degradation, and migration: a methodological overview. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(4), 517–524. doi: 10.1002/wcc.54

Piguet E., Pécoud A., and de Guchteneire P. (2011). Migration and Climate Change: An Overview. *Refugee Survey Quarterly*, *30*(3), 1–23. doi: 10.1093/rsq/hdr006

Richardson K., Steffen W., Lucht W., Bendtsen J., Cornell S. E., Donges J. F., Drüke M., Fetzer I., Bala G., von Bloh W., Feulner G., Fiedler S., Gerten D., Gleeson T., Hofmann M., Huiskamp W., Kummu M., Mohan C., Nogués-Bravo D., ... Rockström J. (2023). Earth beyond six of nine planetary boundaries. *Science Advances*, *9*(37), eadh2458. doi: 10.1126/sciadv.adh2458

Rüttinger L., Smith D., Stang G., Tänzler D., and Vivekananda J. (2015). *A New Climate for Peace: Taking Action on Climate and Fragility Risks*. adelphi, International Alert, Woodrow Wilson International Center for Scholars,European Union Institute for Security Studies. https://www.wilsoncenter.org/publication/new-climate-for-peace-taking-action-climate-and-fragility-risks

Salehyan I. (2008). From Climate Change to Conflict? No Consensus Yet. *Journal of Peace Research*, *45*(3), 315–326. doi: 10.1177/0022343308088812

Scheffran J. (2021). Environmental Security and Climate Diplomacy in the Mediterranean. In B. Ovest & G. Marconi (Eds.), *Peacebuilding and Climate Change. Report of the Bologna Peacebuilding Forum, 18-19 May 2021 (Issue 25, pp. 28–44)*. Agency for Peacebuilding. https://www.iai.it/sites/default/files/bpf_2021_report.pdf

Selby J. (2014). Positivist Climate Conflict Research: A Critique. *Geopolitics*, *19*(4), 829–856. doi: 10.1080/14650045.2014.964865

Selby J., and Hoffmann C. (2014). Beyond scarcity: Rethinking water, climate change and conflict in the Sudans. *Global Environmental Change*, *29*, 360–370. doi: 10.1016/j.gloenvcha.2014.01.008

Singh C., Tebboth M., Spear D., Ansah P., and Mensah A. (2019). Exploring methodological approaches to assess climate change vulnerability and adaptation: reflections from using life history approaches. *Regional Environmental Change*, *19*(8), 2667–2682. doi: 10.1007/S10113-019-01562-z

Stucki P. (2005). *Water wars or water peace? Rethinking the nexus between water scarcity and armed conflict*. PSIS Occasional Paper I Number 3/2005. Geneva: Programme for Strategic and International Security Studies.

Taconet N., Méjean A., and Guivarch C. (2020). Influence of climate change impacts and mitigation costs on inequality between countries. *Climatic Change*, *160*(1), 15–34. doi: 10.1007/s10584-019-02637-w

Theisen O. M., Gleditsch N. P., and Buhaug H. (2013). Is climate change a driver of armed conflict? *Climatic Change*, *117*(3), 613–625. doi: 10.1007/S10584-012-0649-4

UN DPPA (2020). *Climate Security Mechanism Toolbox - Conceptual Approach*. New York: United Nations, 7p. https://digitallibrary.un.org/record/4030868?v=pdf

UN General Assembly (2009). *Climate change and its possible security implications* Resolution 63/281, UN Doc A/RES/63/281. New York: United Nations. https://docs.un.org/A/RES/63/281

UN General Assembly (2012). *Follow-up to paragraph 143 on human security of the 2005 World Summit Outcome: resolution / adopted by the General Assembly*. A/RES/66/290. New York: United Nations. https://digitallibrary.un.org/record/737105?v=pdf

UN HCR (2020). *Ioane Teitiota v. New Zealand*. CCPR/C/127/D/2728/2016. United Nations High Commissioner for Refugees. https://www.refworld.org/jurisprudence/caselaw/hrc/2020/en/123128

UN Iraq (2022). *Factsheet: The Impact of Climate Change on the Environment in IDP and Returnee Locations*. Integrated Location Assessment VII. International Organization for Migration (IOM). https://iraq.un.org/en/202663-factsheet-impact-climate-change-environment-idp-and-returnee-locations-integrated-location

UN Secretary-General (2009). *Climate change and its possible security implications (Report No. A/64/350)*. United Nations, New York. https://docs.un.org/A/64/350

UNEP (2007). *Sudan: Post-Conflict Environmental Assessment*. Nairobi, Kenya: United Nations Environment Programme. https://www.cmi.no/file/1850-Sudan-post-conflict-environmental-assessment.pdf

US DoD (2019). *Report on effects of a changing climate to the Department of Defense*. Office of the Under Secretary of Defense for Acquisition and Sustainment. https://media.defense.gov/2019/jan/29/2002084200/-1/-1/1/climate-change-report-2019.pdf

Verhoeven H. (2011). Climate Change, Conflict and Development in Sudan: Global Neo-Malthusian Narratives and Local Power Struggles. *Development and Change*, *42*(3), 679–707. doi: 10.1111/J.1467-7660.2011.01707.x

Vesco P., Dasgupta S., De Cian E., and Carraro C. (2020). Natural resources and conflict: A meta-analysis of the empirical literature. *Ecological Economics*, *172*, 106633. doi: 10.1016/j.ecolecon.2020.106633

Welzer H. (2012). *Climate wars: why people will be killed in the twenty-first century*. Polity Press. https://www.politybooks.com/bookdetail?book_slug=climate-wars-what-people-will-be-killed-for-in-the-21st-century--9780745651453

Younis N. (2022). *Early warning: how Iraq can adapt to climate change.* European Council on Foreign Relations. https://ecfr.eu/publication/early-warning-how-iraq-can-adapt-to-climate-change/

Information about the authors

Coordinating Lead Authors

Çağdaş DEDEOĞLU, Liberal Arts, Yorkville University, *Canada*
Andrea DESSÌ, American University of Rome (AUR) / Istituto Affari Internazionali (IAI), *Italy*

Lead Authors

Bernardo MONZANI, Agency for Peacebuilding, *Italy*
Luca RAINERI, Sant'Anna School of Advanced Studies / DIRPOLIS Institute, *Italy*

Contributing Authors

Merve Suzan ILIK BILBEN, Faculty of Letters, Akdeniz University, *Türkiye*
Francesca LENZI, Istituto Affari Internazionali (IAI), *Italy*
Çağla VURAL, Akdeniz University, *Türkiye*

Annex I: List of Contributors

Note: Coordinating Lead Authors, Lead Authors, Contributing Authors are each listed alphabetically by surname for each chapter.

Chapter 1
Introduction and framing

Coordinating Lead Authors
Manfred A. LANGE, Energy, Environment and Water Research Center (EEWRC), The Cyprus Institute, *Cyprus*
Roula MAJDALANI, International Center for Agricultural Research in the Dry Areas, Consultative Group on International Agricultural Research (ICARDA-One CGIAR), *Lebanon*

Lead Author
Julien LE TELLIER, United Nations Economic and Social Commission for Western Asia (UN-ESCWA), *Lebanon*

Chapter 2
Geographical and temporal scope and current setting

Coordinating Lead Authors
Audrey BROUILLET, ESPACE-DEV, Institut de Recherche pour le Développement (IRD), *France* / Potsdam Institute for Climate Impact Research (PIK), *Germany*

Lead Authors
Lucas KLUGE, Potsdam Institute for Climate Impact Research (PIK), *Germany*
George ZITTIS, Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute, *Cyprus*

Contributing Authors
Tuba BIRCAN, Vrije Universiteit Brussel (VUB), *Belgium*
Efthymia NIKITA, Science and Technology in Archaeology and Culture Research Center (STARC), The Cyprus Institute, *Cyprus*
Dilek YILDIZ, International Institute for Applied Systems Analysis (IIASA), *Austria*

Chapter 3
Threats to human life and livelihoods from environmental change

Coordinating Lead Authors
Lena REIMANN, Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, *The Netherlands* / Department of Built Environment, Aalto University, *Finland*
Ourania TZORAKI, Marine Sciences Department, School of the Environment, University of the Aegean, *Greece*

Lead Authors
Dias HARALAMBOPOULOS, Department of the Environment, School of the Environment, University of the Aegean, *Greece*
Manfred A. LANGE, Energy, Environment and Water Research Center (EEWRC), The Cyprus Institute, *Cyprus*
Maya NEGEV, School of Public Health, University of Haifa, *Israel*
Alejandra RODRIGUEZ ENRIQUEZ, Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, *The Netherlands* / Coastal Risks and Engineering Lab, University of Central Florida, *USA* / School of Geosciences, University of South Florida, *USA*
Cecilia ZAGARIA, Institute for Environmental Studies, Vrije Universiteit Amsterdam / Farming Systems Ecology Group, Wageningen University & Research, *The Netherlands*

Contributing Authors
Tuba BUCAK, Aarhus University, *Denmark*
Shlomit PAZ, School of Environmental Sciences, University of Haifa, *Israel*
Ignacio PITA-VACA, MARine Biodiversity, Exploitation & Conservation (UMR MARBEC), Université de Montpellier, *France*

Chapter 4
Key challenges for security: conflict and cooperation in the Mediterranean

Coordinating Lead Authors
Vally KOUBI, Department of Humanities, Social and Political Sciences, ETH Zurich, *Switzerland/Greece*
Jürgen SCHEFFRAN, Institute of Geography & Research Group Climate Change and Security (CLISEC), University of Hamburg, *Germany*

Lead Author
Paola VESCO, Peace Research Institute Oslo (PRIO), *Norway*

Chapter 5
Understanding the environment and migration nexus in the Mediterranean

Coordinating Lead Authors
Roman HOFFMANN, International Institute for Applied Systems Analysis (IIASA), Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/OeAW, University of Vienna), *Austria*
Vally KOUBI, Department of Humanities, Social and Political Sciences, ETH Zurich, *Switzerland/Greece*

Lead Authors
Abdelslam BADRE, Mohammed V University in Rabat, *Morocco*
Helene BENVENISTE, Global Environmental Policy unit of the Department of Environmental Social Sciences, Stanford Doerr School of Sustainability, *USA*
Merve Suzan ILIK BİLBEN, Faculty of Letters, Akdeniz University, *Türkiye*
Barbara ŠEDOVÁ, Potsdam Institute for Climate Impact Research (PIK), *Germany*

Chapter 6
The environmental change-conflict-migration-nexus and uneven challenges of adaptation

Coordinating Lead Authors
Eda ACARA, Istanbul Policy Center, Sabancı University, *Türkiye*
Jan WILKENS, German Institute for Global and Area Studies (GIGA) & Earth and Society Research Hub (ESRAH), University of Hamburg, Hamburg, *Germany*

Lead Authors
Mohamed BEHNASSI, Economic, Social and Environmental Council (CESE) / Center for Environment, Human Security, and Governance (CERES), *Morocco* / The Institute of Mediterranean Studies (CNR-ISMed), *Italy*
Lina EKLUND, Department of Earth and Environmental Science, Lund University, Sweden & Centre for Advanced Middle Eastern Studies (CMES), Lund University, *Sweden* / United Nations University Institute for Water, Environment and Health (UNU-INWEH), *Canada*
Christiane FRÖHLICH, German Institute for Global and Area Studies (GIGA), *Germany*
Maria Julia TROMBETTA, School of International Studies, University of Nottingham Ningbo China, *P.R. China*

Chapter 7
Knowledge gaps and strategies to address them

Coordinating Lead Authors
Çağdaş DEDEOĞLU, Liberal Arts, Yorkville University, *Canada*
Andrea DESSÌ, American University of Rome (AUR) and Istituto Affari Internazionali (IAI), *Italy*

Lead Authors
Bernardo MONZANI, Agency for Peacebuilding, *Italy*
Luca RAINERI, Sant'Anna School of Advanced Studies / DIRPOLIS Institute, *Italy*

Contributing Authors
Merve Suzan ILIK BILBEN, Faculty of Letters, Akdeniz University, *Türkiye*
Francesca LENZI, Istituto Affari Internazionali (IAI), *Italy*
Çağla VURAL, Akdeniz University, *Türkiye*

Annex II: List of Expert Reviewers

ABD-ELMABOD Sameh Kotb
Agriculture & Biological Research Institute
National Research Centre (NRC)
Egypt
&
Xinjiang Institute of Ecology and Geography
Chinese Academy of Sciences (XIEG-CAS)
China

ADDER, Mustapha
Independent Consultant
France

ALLENDE ÁLVAREZ, Fernando
Universidad Autónoma de Madrid (UAM)
Spain

BEN HACHMI, Mohammed Karim
University Hassan II-Casablanca
Morocco

CASARTELL, Maria Veronica
Euro-Mediterranean Center on Climate Change
(CMCC)
Italy

CASTILLA, Karlos
University of Barcelona / Pompeu Fabra University
Spain

de CHEVEIGNÉ, Suzanne
CNRS, Centre Norber Elias
France

DÖRING, Stefan
Uppsala University
Sweden
&
Peace Research Institute Oslo (PRIO)
Norway

EEKHOUT, Joris
CEBAS-CSIC
Spain

EREN, Ayşen
Independent Researcher
Türkiye

FERREIRA FERNANDES, Carla Sofia
Universidade Aberta / University of Coimbra
Portugal

GASSIEN, Julie
Norwegian Refugee Council
Switzerland

GHSOUB, Myriam
National Center for Marine Sciences, CNRS-L
Lebanon

GILMORE, Elisabeth A.
Carleton University
Canada

GREEN, Andy J.
Estación Biológica de Doñana (EBD), CSIC
Spain

GUADAGNO, Eleonora
University of Naples L'Orientale /
eCampus University
Italy

HADJINICOLAOU, Panos
The Cyprus Institute
Cyprus

HESS, Lynn Sara
UN Economic and Social Commission for Western
Asia (UN ESCWA)
Lebanon

KADIRBEYOGLU, Zeynep
University of Toronto
Canada

KASSIMERIS, Christos
European University Cyprus / CERIDES
Cyprus

KULELI, Tuncay
Mugla SK University
Türkiye

MAOUI, Ammar
University 8 may 1945 Guelma
Algeria

MARROUCH, Walid
Lebanese American University (LAU)
Lebanon

MORABET El, Rachida
University Hassan II-Casablanca
Morocco

PENCA, Jerneja
Science and Research Centre Koper (ZRS Koper)
Slovenia

PEREZ FELIPE, Beatriz
Centre for environmental law studies (CEDAT-URV)
CICrA Justicia Ambiental, CECC
Spain

PETRILLO, Enza Roberta
UNICEF Europe & Central Asia
Italy

POUFFARY Jacques Stéphane
ENERGIES 2050
France

QUENOT, Sébastien
University of Corsica – UMR CNRS LISA
France

ROLLI, Flavia
National Institute and Oceanography and Applied Geophysics – OGS
Italy

SAAD-HUSSEIN, Amal
Environment & Climate Change Research Institute, National Research Centre (NRC)
Egypt

SADJADI, Ebrahim
University Carlos III of Madrid
Spain

SHEHI, Reina
Epoka University
Albania

ZAKARIA, Patty
University of Niagara Falls
Canada

ZLATKOVIĆ, Slobodan
Agency for ecological consulting 'Akvatorija'
Serbia

ISBN: 978-2-493662-16-3

www.medecc.org
contact@medecc.org

doi: 10.5281/zenodo.14800746

MedECC
Mediterranean Experts on Climate and environmental Change