Geographical and temporal scope and current setting

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Chapter 2
Geographical and temporal scope and current setting

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.

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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

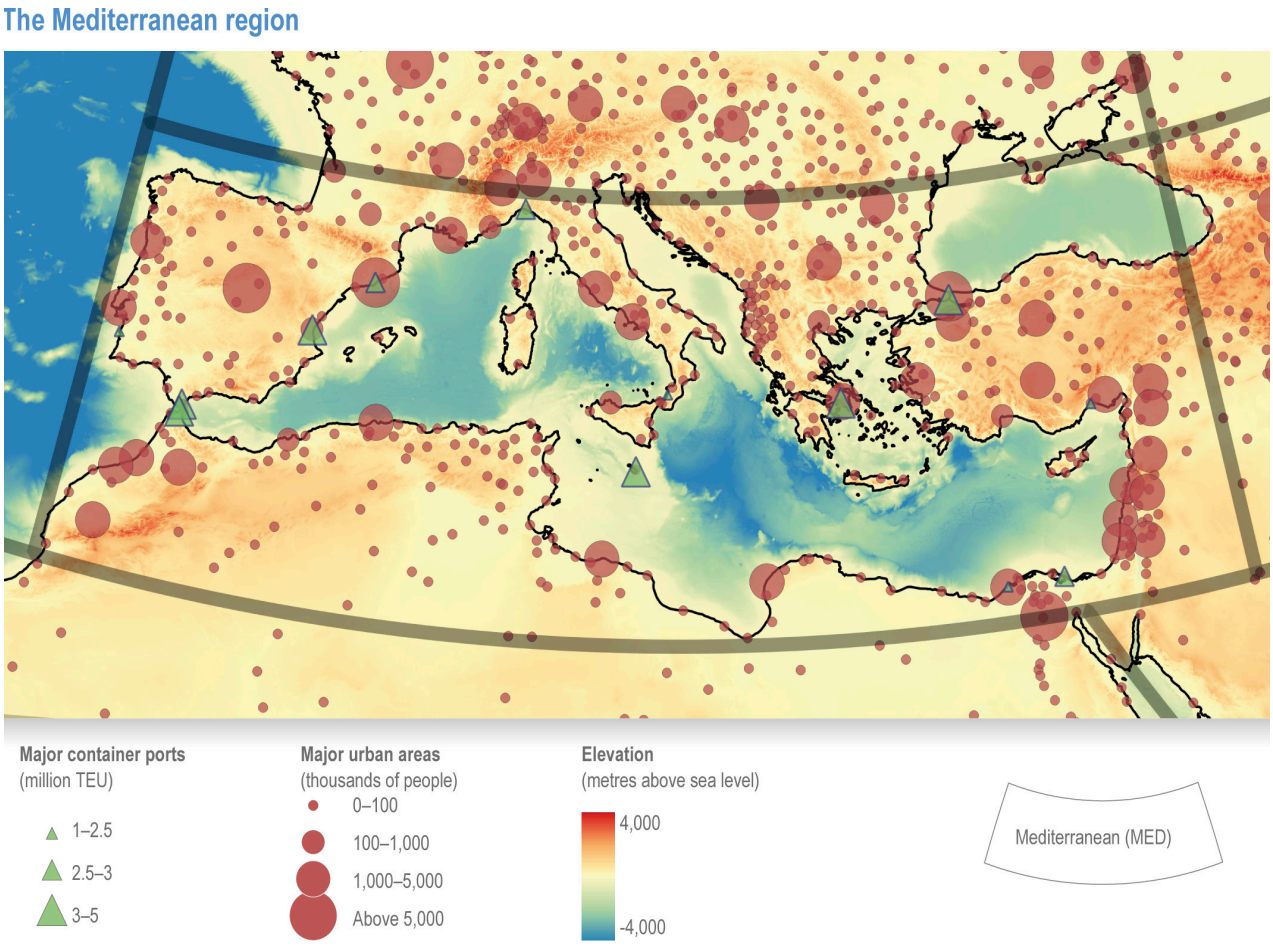

Figure 2.1 | Topography, bathymetry, major urban areas, container ports, and regional boundaries of the Mediterranean region. Map showing topography and bathymetry (colour bar in metres), main urban areas (population in thousands for 2020, from www.naturalearthdata.com), container ports (millions of 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.

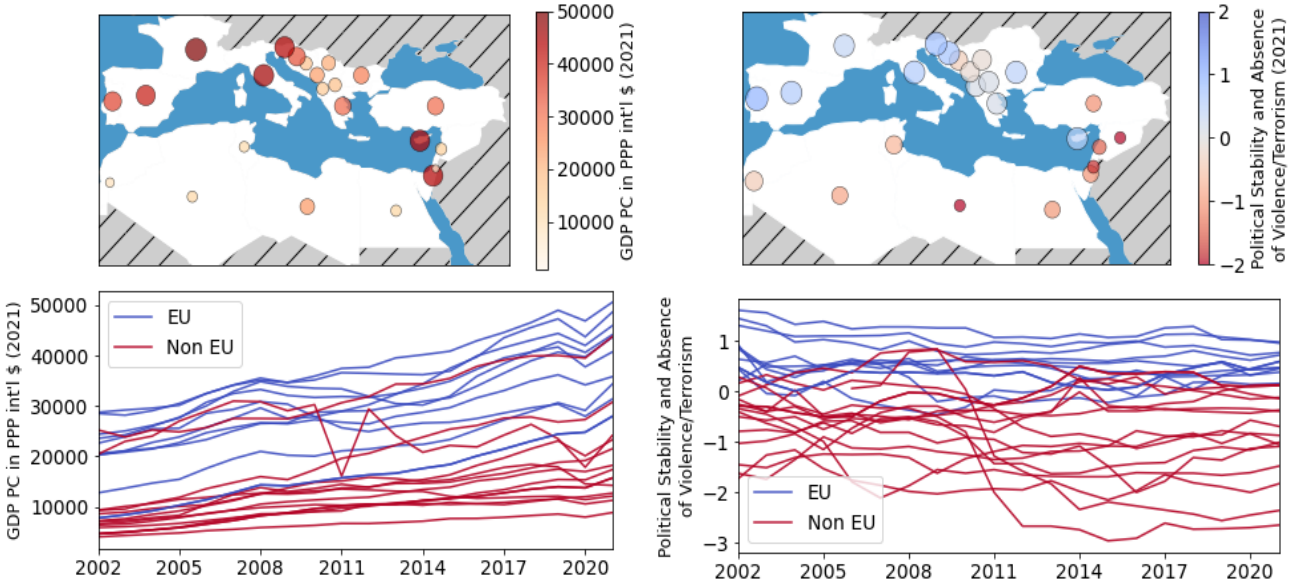

Figure 2.2 | Spatial patterns and temporal evolution of economic and political indicators in the Mediterranean since 2002. Spatial distribution within Mediterranean regions and temporal trends of gross domestic product per capita (GDP PC), expressed in constant international dollars adjusted for purchasing 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.

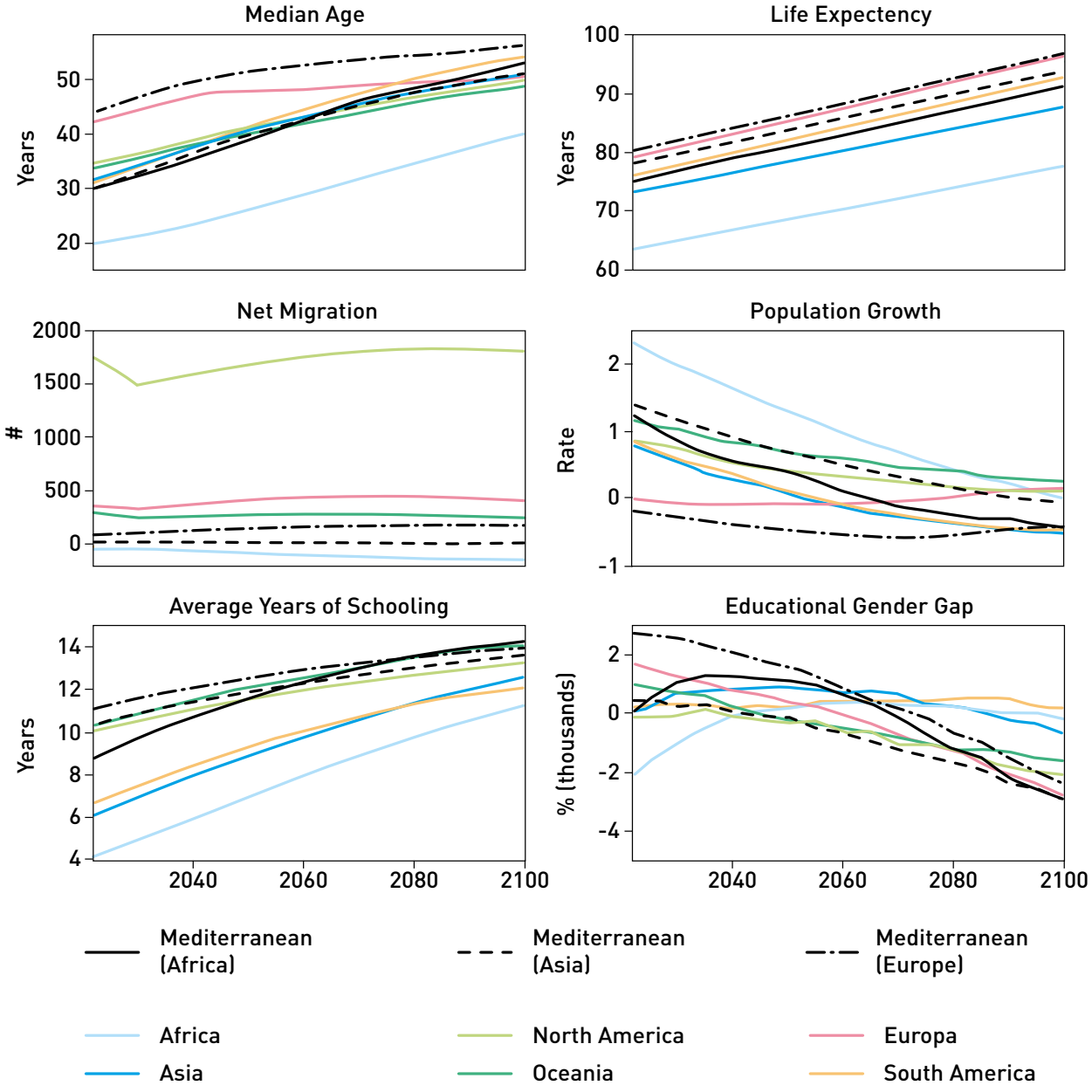

Figure 2.3 | Future demographic and socio-educational projections for the Mediterranean region from 2022 to 2100. Future projections for the Mediterranean include median age (top left), life expectancy (top right), net migration (in thousands, middle left), population growth (middle right), average years 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.

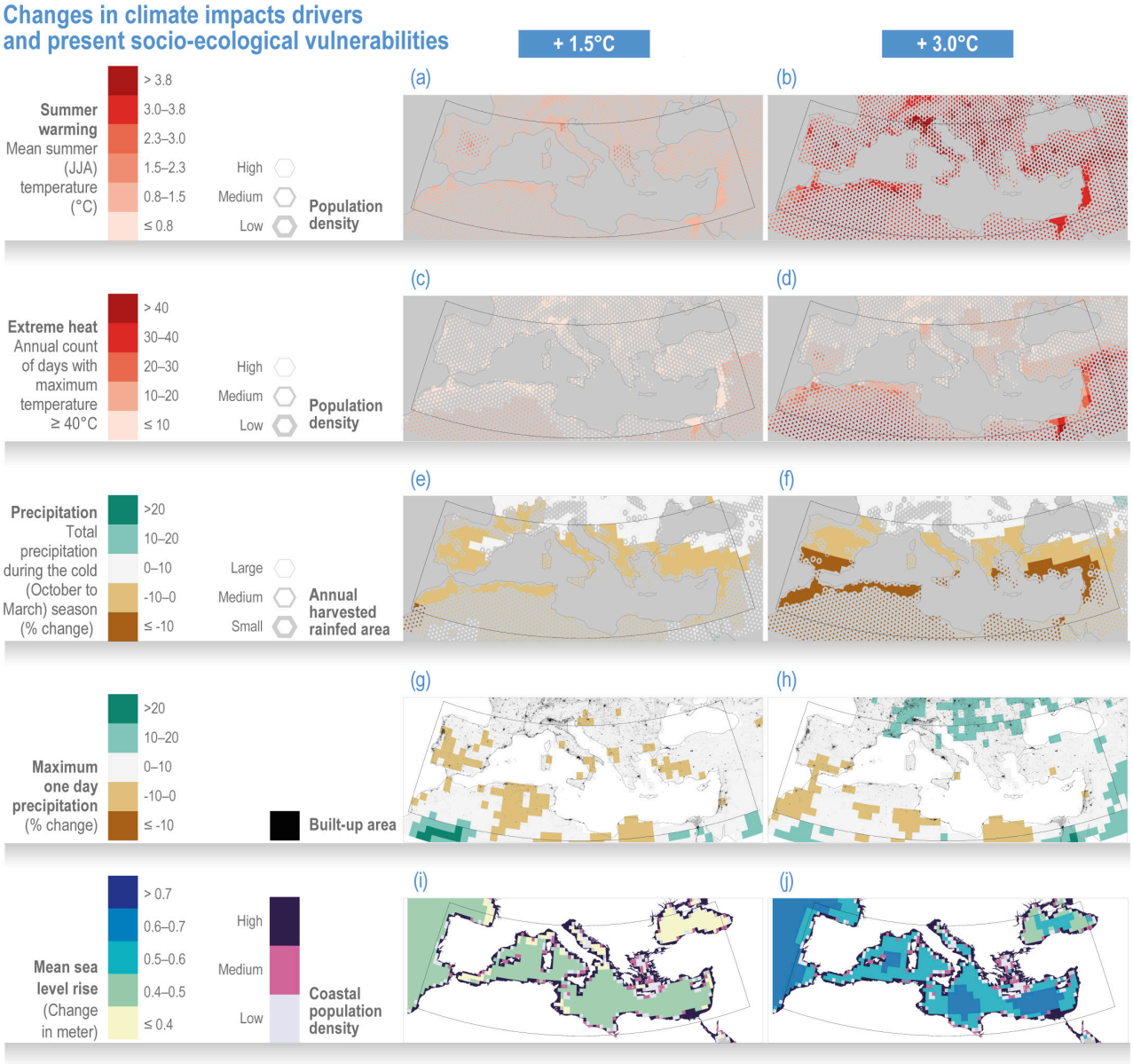

Figure 2.4 | Projected changes in temperature and precipitation across the Mediterranean region by the end of the 21st century. Spatial distribution of projected changes in extreme temperature and total precipitation by the end of the 21st century with respect to the 1995–2014 period for +1.5°C (left 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

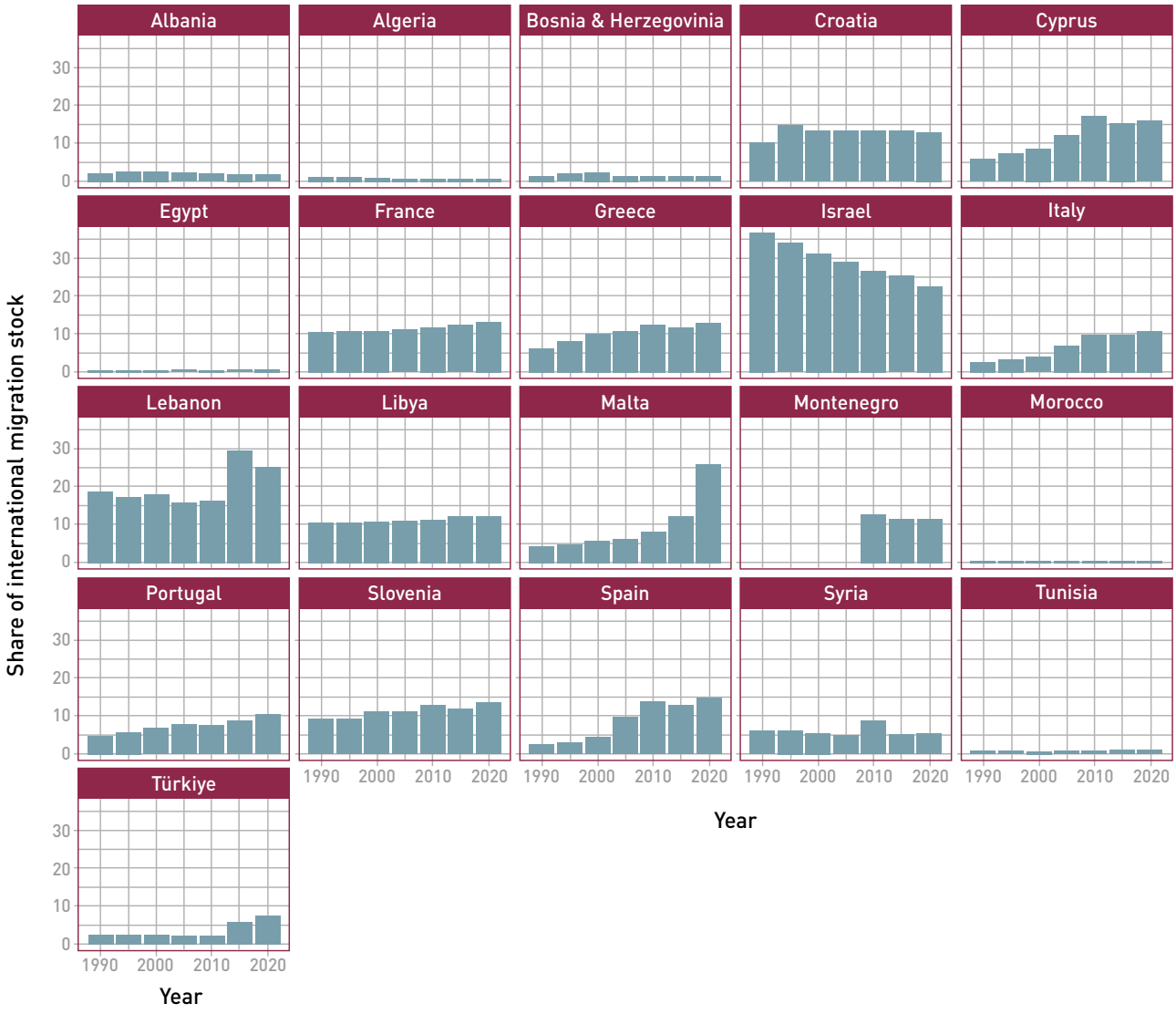

Figure 2.5 | Share of international migration stock in Mediterranean countries as a percentage of the total population per country. Source: UN DESA, Population Division (2020).

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.

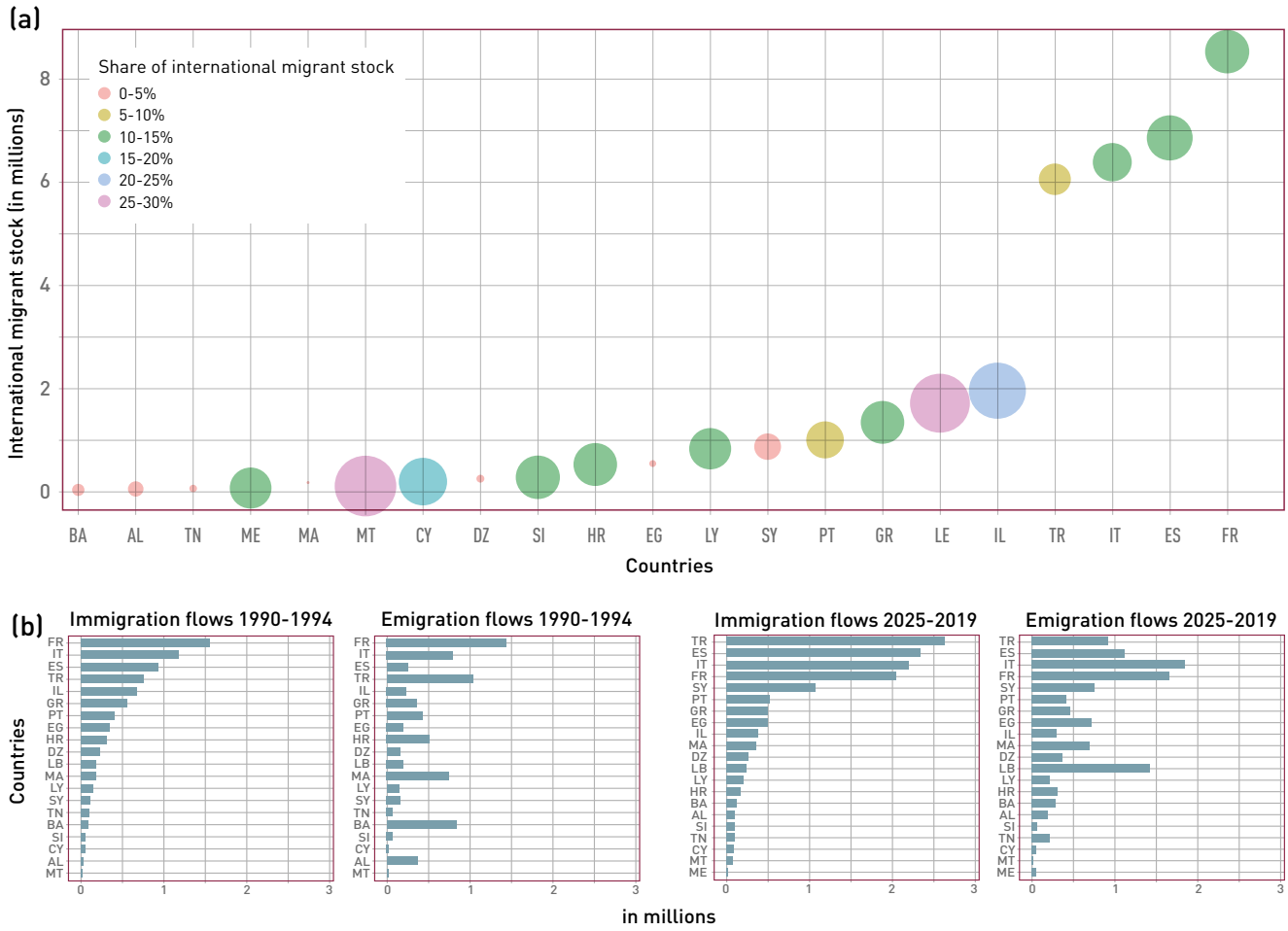

Figure 2.6 | International migration patterns by country. (a) International migrant stock and percentage of migrant stock in population in 2020 per country (UN DESA, Population Division 2020). (b) International migration flows. Source: Abel and Yildiz (2022).

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

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