Eastern Mediterranean and Middle East
Climate Change Initiative of the Cyprus Government

Executive Summaries

of the Reports of the Climate Change Thematic Task Forces on

The Physical Basis of Climate Change

Energy Systems

The Built Environment

Health

Water Resources

Agriculture and Food Chain

Education and Outreach

Migration

Tourism

Enabling Technologies

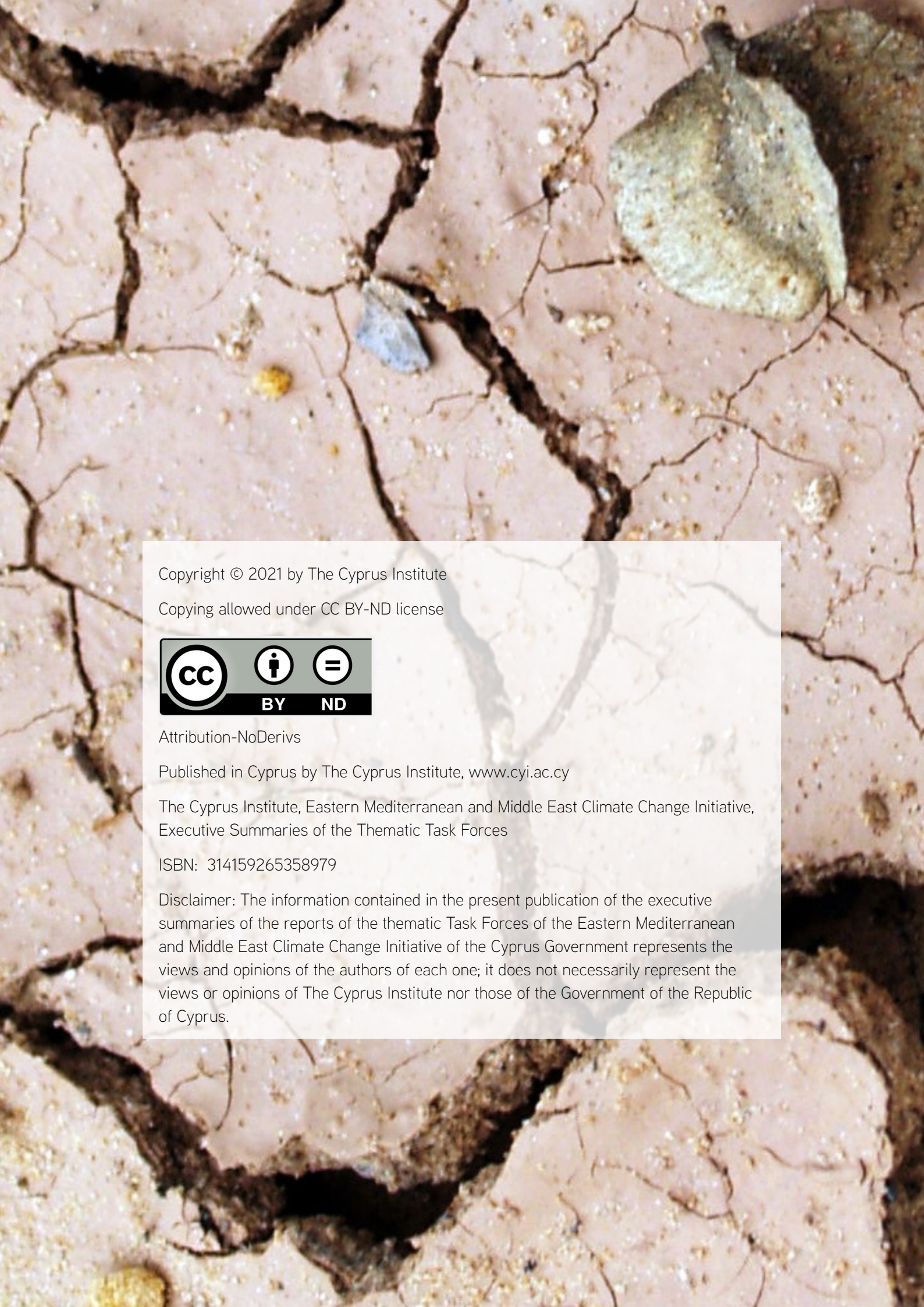
Green Economy and Innovation

Cultural Heritage

Regional Climate Change Initiative Republic of Cyprus

The Cyprus Institute
RESEARCH·TECHNOLOGY·INNOVATION

October 2021 | Nicosia, Cyprus



Published in Cyprus by The Cyprus Institute, www.cyi.ac.cy

The Cyprus Institute, Eastern Mediterranean and Middle East Climate Change Initiative, Executive Summaries of the Thematic Task Forces

ISBN: 314159265358979

Disclaimer: The information contained in the present publication of the executive summaries of the reports of the thematic Task Forces of the Eastern Mediterranean and Middle East Climate Change Initiative of the Cyprus Government represents the views and opinions of the authors of each one; it does not necessarily represent the views or opinions of The Cyprus Institute nor those of the Government of the Republic of Cyprus.

Contents

Coordinating Climate Change Actions in the Eastern Mediterranean & Middle East

Recent studies from prominent institutions such as the Intergovernmental Panel on Climate Change and the World Meteorological Organization have classified the Eastern Mediterranean and Middle East (EMME) region as a global "climate hot-spot" with particularly high vulnerability to climate change impacts. Research conducted by The Cyprus Institute (CyI) and its partners, has provided significant insights on the climate change impacts on agriculture, public health, ecosystem development, tourism, water resources and on humanitarian and security issues, including induced mass migration of environmental refugees. The findings have caused international concern, as the resulting geopolitical instability in the EMME region with a population of almost 500 million people will have global ramifications.

In May 2018 CyI organized an international Conference on *"Climate Change in the Mediterranean and the Middle East"* that took place in Cyprus under the aegis of the President of the Republic of Cyprus. The Conference examined in detail these findings and initiated a debate on how to address the forecasted crisis and its consequences. The Conference drew international attendance by eminent scientists and policy makers from thirty countries as well as leaders of global stature. One of the principal conclusions of the Conference was that regional concerted action is urgently needed.

All EMME countries have underlined their serious concerns about regional and national climate change impacts and expressed their willingness to comply with the Paris Agreement. Nevertheless, the EMME region suffers from lack of a) Detailed environmental observations and climate modeling predictions, both of which are necessary for formulating accurate mitigation and adaptation strategies to climate change, and b) Coordinated policy actions, sharing of good practices to implement such actions and joint activities for capacity building and knowledge transfer.

Following the Conference, the President of the Republic of Cyprus, H.E. **Nicos Anastasiades** decided that the Cyprus Government shall spearhead an international initiative to coordinate the efforts of EMME region to ameliorate climate change and its impacts. He communicated this to the Governments of the EMME Region and all the leaders of the EU Mediterranean Countries, as well as to all European Countries, the EU Parliament, and the UN.

Utilizing Cyprus' excellent relations with the countries of the region, the Presidential initiative has a dual goal, namely, to initiate or enhance:

EMME-focused Research of regional and international research institutions towards: a) a detailed understanding and accurate forecasting of regional climate change impacts b) the development of a science-based policy toolkit for the amelioration of the impacts of such phenomena including a dedicated Hub for the provision of climate services on sectors of the economy and the society (e.g. energy, agriculture, tourism, education, health, cities, cultural heritage, etc.), as well as a concerted outreach effort and c) identification of the appropriate per sector and application area (e.g. sub-regional, urban, etc.) adaptation and mitigation measures.

EMME-specific Policies in coordination with transnational and multinational stakeholders (EU and UN) and organizations (WMO, FAO, WHO) to address the overall impacts of climate change with the aim to: a) to support the implementation of the Paris Agreement and National Plans, b) to adopt specific action programs for distinct sectors related to the economy and society, and c) to investigate specific techno-economic scenarios to mitigate climate change effects in the EMME countries. An indispensable component is the identification of the necessary resources for the implementation of such a program.

To achieve the above objectives a detailed plan to produce a series of scientific, policy and techno- economic studies, which will feed ministerial meetings leading subsequently to a summit meeting of the EMME countries has been developed.

The program and work plan are characterized by inclusiveness. The expanding bi-lateral, tri-lateral and

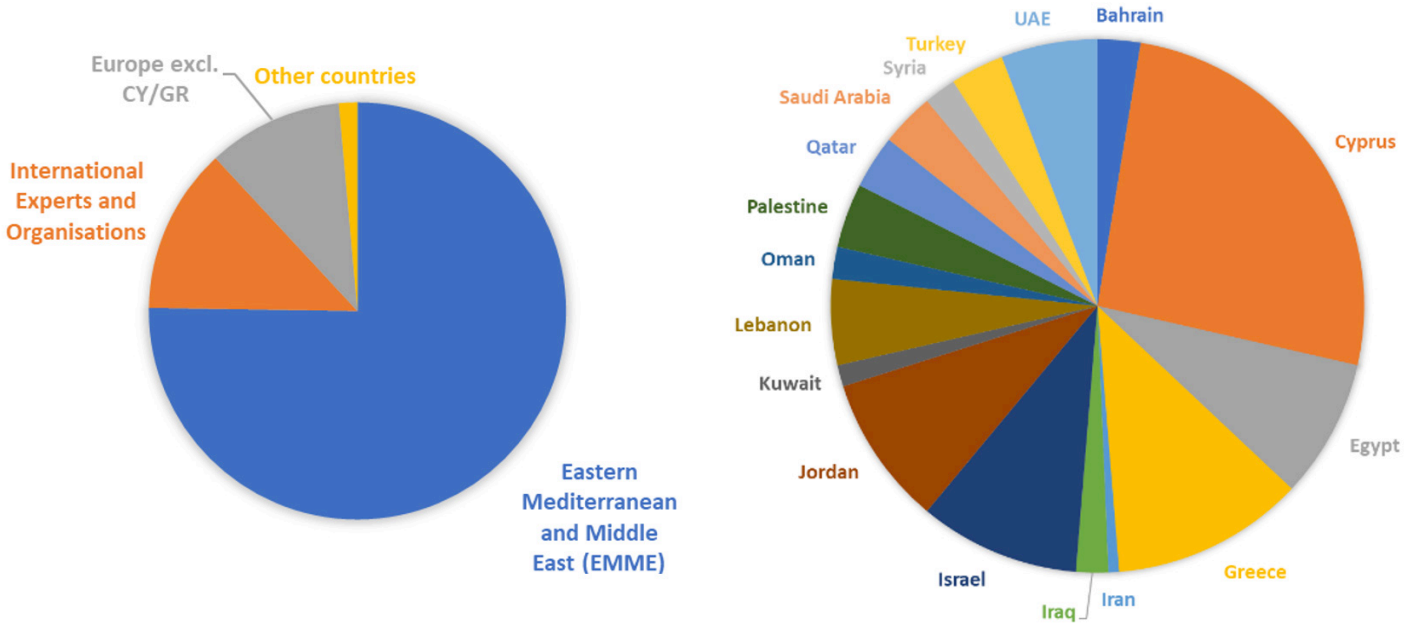
multi-lateral initiatives of the Cyprus Government along with the UN, EU, GCC and other international initiatives and organizations are being used and engaged maximally towards achieving success in this initiative. The complexity, diversity and varying development of the countries of the region present both a challenge and an opportunity, which will be taken into account.

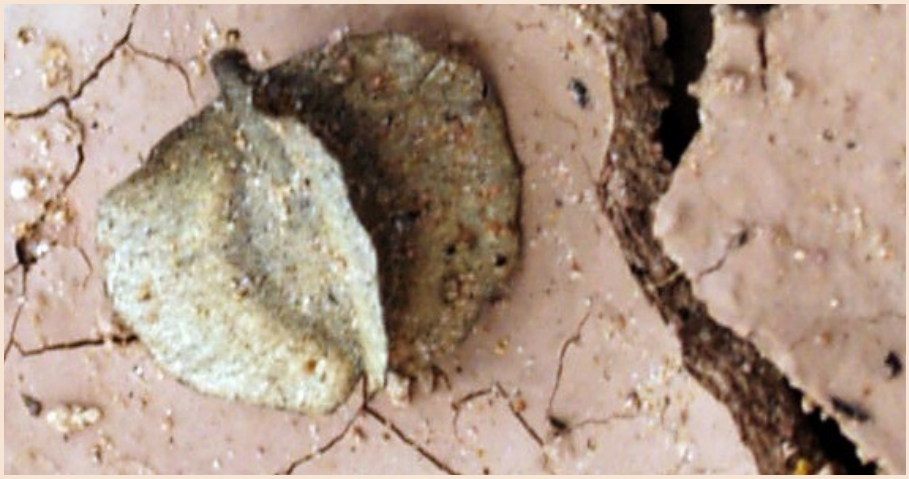
The scoping of the white papers which has been produced by the thematic Task Forces assembled to address topics of interest follow below. Their summaries are included in this pre-publication.

The Task Forces

A major part of the first phase of the Initiative, is carried out by thirteen Task Forces, engaging in excess of 220 Scientists. Three quarters of the scientists engaged in the Task Forces are from the EMME region. The Task Forces also engage scientists and policy makers from other countries, which are experts in the region, as well as representatives of International Organizations. Member distribution by region is illustrated in Figure 1, whereas member distribution by country of origin (EMME region only) is depicted in Figure 2.

Figure 1 & 2: Geographical representation in the composition of Task Forces





The work is coordinated by the Cyprus Institute under the leadership of Prof. C.N. Papanicolas, the Advisor and Special Envoy on Climate Change to the President of Cyprus. The thematic Task Forces have the following scientific foci:

1. The Physical Basis
2. Energy Systems
3. Built Environment
4. Health
5. Water resources
6. Agroforestry and Food Chain
7. Marine Environment/Resources
8. Education and Outreach
9. Migration
10. Tourism
11. Enabling Technologies
12. Development of Green Economy and Innovation
13. Cultural Heritage

1. The Physical Basis of Climate Change

Task Force Coordination

Jos Lelieveld, Jean Sciare

Cyprus Institute Liaison Scientist

George Zittis

Task Force Members

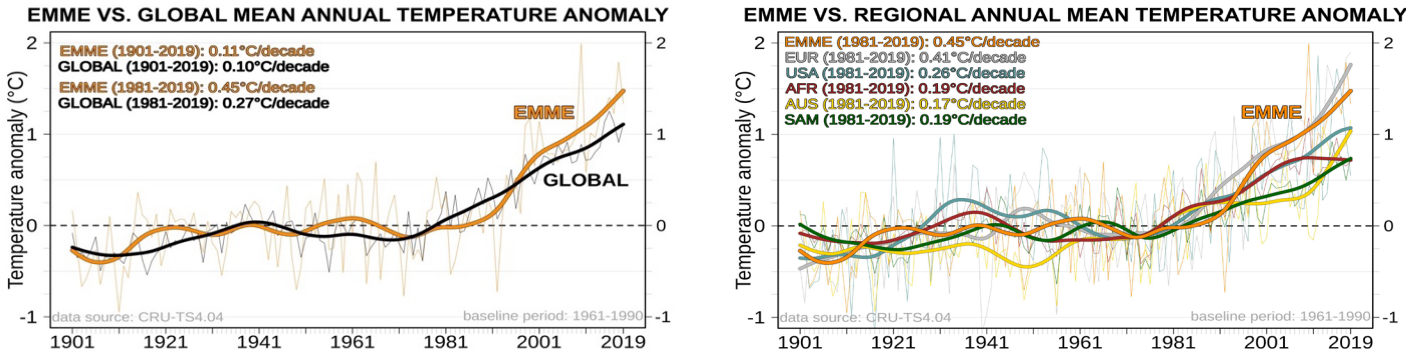
Mansour Almazroui
Pinhas Alpert
Philippe Ciais
Wolfgang Cramer
Yara Dahdal
Diana Francis
Panos Hadjinicolaou
Fares Howari
Amna Jrrar
Dimitris Kaskaoutis
Markku Kulmala
Xin Lin
Nikos Mihalopoulos
Yinon Rudich
Georgiy Stenchikov
Elena Xoplaki

The human influence on the Earth's climate, including its atmosphere, ocean and land components, is unequivocal (IPCC, 2021). Since the Industrial Revolution, the volume of greenhouse gases (GHGs) emitted into the atmosphere has grown at an accelerating pace, in addition to land-use changes (e.g. extensive deforestation and urbanisation), causing a significant increase in the global surface temperature, as well as changes in other meteorological factors such as rainfall. Regional responses to the climate forcings caused by GHG emissions are not linear or uniformly distributed. Because of geographically specific climate feedback mechanisms, some regions warm more rapidly than the global mean. One such climate change hotspot is the Eastern Mediterranean and Middle East (EMME) region.

According to the latest observations, the EMME region is currently warming almost two times faster than the global average and more rapidly than most other inhabited parts of the world (Figure1), especially during the summer season. In the past four decades (19812019), the observed temperature trend was about 0.45˚C per decade. Over the course of the 20th century, precipitation variability in the region was high, with pronounced fluctuations between drier and wetter periods. However, in recent decades, there are indications of a general decrease in precipitation and a transition to a drier climate regime. The combined impacts of warming and drying in this already environmentally stressed part of the world are of great concern.

The regional sea-level rise of the Mediterranean and Red seas and the Arabian Gulf follows the average global rate (23 centimetres per decade), posing challenges to coastal infrastructure, agriculture and ecosystems. Besides the observed changes in mean climatic conditions, the

Figure 1. Temperature anomalies since 1901: the EMME region vs. global (left panel) and regional (right panel) time series



Source: Based on gridded observations over land (annual values: thin curves; cubic smoothing splines: thick curves).

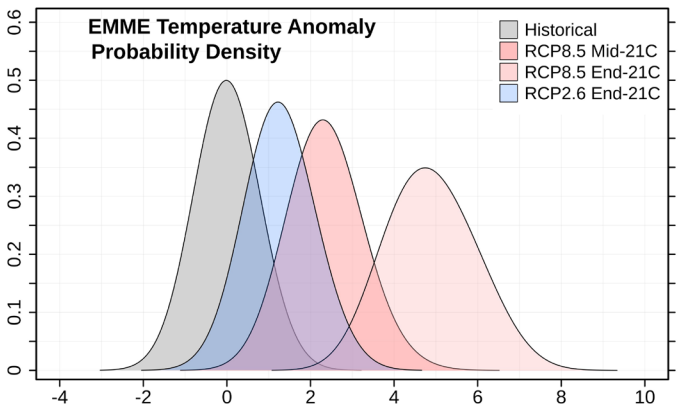
Note: Linear trends are presented for the Eastern Mediterranean and Middle East (EMME) region, Europe (EUR), the United States (USA), Africa (AFR), Australia (AUS), South America (SAM) and the globe (GLOBAL).

frequency and severity of extreme weather events in the EMME region have increased in the recent past. Regional high-impact events include intense heatwaves, prolonged droughts and, though more rarely, torrential rainfall events that can trigger flash floods that damage infrastructure and cause loss of life.

GHG emissions in the EMME region increased fivefold over the past several decades. Today, regional emissions are comparable to those of the European Union + United Kingdom or of India, and a strong upward trend suggests that the region will shortly become one of the world's dominant emitters. Carbon dioxide and methane together account for about 95% of the region's anthropogenic GHG emissions over the past five decades. More than 90% of these gases have been emitted by the fossil fuel energy sector.

Regional climate projections indicate that the overall warming trend will continue for the rest of the 21st century. A strong mitigation pathway (e.g. Representative Concentration Pathway [RCP] 2.6) might stabilise the regional warming levels slightly, to 1°C over the reference period (19862005), equivalent to 2°C more than the pre-industrial era (Figure 2). A business-as-usual pathway (e.g. RCP 8.5), implies warming levels close to 5°C by the end of the century (Figures 2 and 3). In such a scenario, the coolest years in the future will be comparable to the very warmest years of the reference period. Mountainous climate zones with snow will likely diminish by the end of the century, with consequences for river run-off and water supply.

Figure 2. Probability density curves of annual temperature anomalies (with respect to the 1986–2005 mean conditions), averaged across the region



These temperature projections refer to annual mean values. As a result of several climatic feedbacks (e.g. soil moisture interactions and atmospheric circulation changes), the warming will be strongest during summer. Large increases in both the intensity and duration of heatwaves are expected. This is a robust outcome of all emission scenarios and climate model projections. Depending on the scenario, heat extremes have the potential to become societally disruptive, as the EMME region will likely be subjected to unprecedented heat extremes. In parts of the Middle East, peak temperatures during heatwaves could exceed 60°C, particularly in urban environments.

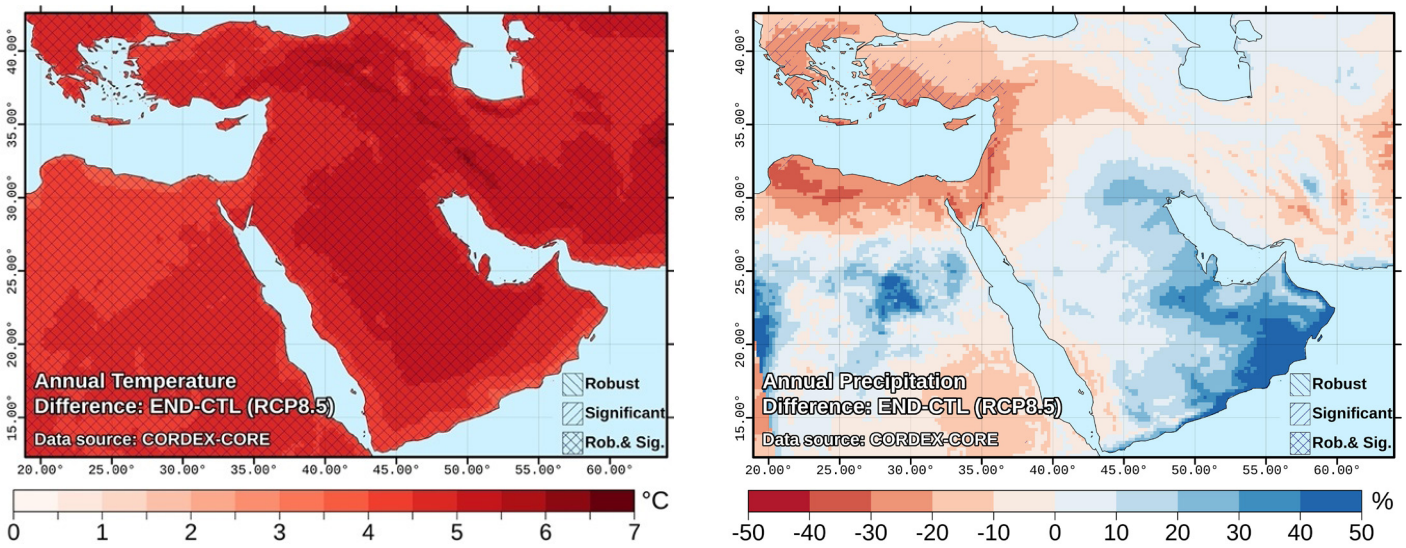
Business-as-usual pathways for the future imply a northward expansion of arid climate zones at the expense of more temperate Mediterranean zones. Precipitation will likely decrease by up to 2030% in many regions, particularly in the eastern Mediterranean (Figure 3, right panel). While moderate increases in precipitation are projected for parts of the Arabian Peninsula, these changes are associated with a low level of statistical significance, and their contribution to the replenishment of water resources will be minor. The combination of an overall decrease in precipitation and strong warming will likely contribute to severe meteorological and hydrological droughts. In combination with the rapid growth of population and water demand, significant water shortages may be expected. This will also be the case for regions where moderate precipitation increases occur.

The frequency, duration and severity of dust storms, which are a common natural hazard across the region, are expected to increase under a warmer and drier climate. Such changes might further degrade air quality in the region and affect ecosystems, agriculture and human health.

The regional mean sea level is projected to rise at a rate similar to that estimated for the global mean, with a possible outcome of more than 1 metre above the present level by the end of the 21st century (under high-end scenarios). This would imply severe challenges for coastal communities, critical infrastructure and agriculture, and lead to the salinisation of coastal aquifers in the EMME region.

Virtually all socio-economic sectors will be critically affected by the projected changes. Human health and well-being will be directly affected, especially among underprivileged people, the elderly, children and pregnant women. Sectors that will likely be critically affected

Figure 3. Projected end-of-century changes (END: 20812100) of mean annual temperature (left panel) and annual precipitation (right panel), with respect to the control reference period (CTL: 19862005) for the business-as-usual pathway RCP 8.5



include public health and security, agriculture, water and energy management, and likely more. Our multimodel and multiscenario approach confirms that the magnitude of climate change and its impacts during the second half of the 21st century and beyond strongly depend on the assumed increases of GHG emissions.

The region is currently contributing about 10% of global GHG emissions, and this share is expected to increase if emissions continue at the current rates. Thus, immediate and effective climate change mitigation measures are required. These include the decarbonisation of economic sectors such as energy production, industry and transportation. Furthermore, local communities in urban, rural and coastal areas of the EMME region will need to adapt to the increasingly challenging environmental conditions, especially related to heat extremes, prolonged droughts and sea-level rise. Adaptation solutions relevant to the region include the use of non-conventional water resources, the introduction of more heat- and water-stress-tolerant cultivars, the implementation of land restoration and afforestation projects, the development of early warning systems for extreme events, urban greening, the design of coastal erosion protection measures and more. Slowing down the regional manifestation of global warming through mitigation can help provide the time window needed for natural and human systems to adapt.

Many countries in the EMME region rely on climate data and analysis, modelling and assessments from countries outside the region. The region will need to strengthen its own research capacity, enhanced by regional collaboration and networking, to conduct independent climate mitigation and adaptation assessments and to verify policies. Since many of the regional outcomes of climate change are transboundary, improved co-ordination among the countries of the region is indispensable to cope with the expected adverse impacts. This will lead to synergies that are vital to achieving timely mitigation targets and concurrently ensuring energy, food and water security.

2. Energy Systems

Task Force Management Board

Prof. Theodoros Zachariadis, The Cyprus Institute

Dr. Kamal J. Araj, Independent Consultant & Former Vice Chairman of the Jordan Atomic Energy Commission (JAEC)

Dr. Rabia Ferroukhi, International Renewable Energy Agency

Cyprus Institute Liaison Scientist: Dr. Nestor Fylaktos

Members of the Task Force

Dr. Tareq Abu Hamed, Arava Institute, Israel

Dr. Mohammad A. Al-Ramadhan, Kuwait Foundation for the Advancement of Sciences, Kuwait

Dr. Omar Al-Ubaydli, Bahrain Centre for Strategic, International and Energy Studies, Bahrain

Prof. Derek Baker, Middle East Technical University, Turkey

Prof. Manuel J. Blanco, The Cyprus Institute, Cyprus

Prof. Steven Griffiths, Khalifa University of Science and Technology, United Arab Emirates

Prof. Sameh Nada, Egypt-Japan University of Science and Technology

Prof. Holger Rogner, International Institute for Applied Systems Analysis, Austria

Dr. Jan Steckel, Mercator Research Institute on Global Commons and Climate Change, Germany

Dr. Christos Tourkolias, Centre for Renewable Energy Sources, Greece

Dr. Sara Vakhshouri, SVB Energy International, Washington, DC

Dr. Eric Williams, King Abdullah Petroleum Studies and Research Centre, Saudi Arabia

Editorial Review and Assistance

Dr. Constantinos Taliotis (lead), Dr. Marios Karmellos, The Cyprus Institute

Dr. Arslan Khalid, Gerardo Escamilla, Diala Hawila, Costanza Strinati, International Renewable Energy Agency

József Kádár, Arava Institute, Israel

The Eastern Mediterranean and Middle East (EMME) region comprises countries at various stages of economic development. The region possesses a great many resources and faces diverse political and economic challenges. Located in a climate change hotspot, however, the countries of the region are projected to face major threats to their welfare in the coming decades. Today, the region hosts 5.5% of the global population, produces 4.7% of the world's economic output, but generates more than 8% of global carbon dioxide emissions. **Several EMME countries emit many times more carbon dioxide per capita than the world average while others are below the average.** Considering population trends, economic growth prospects and emission projections, almost all of the main emitters are far off the trajectory required to stabilise the global climate, in line with the objectives of the Paris Agreement. The energy system produces about three-quarters of these emissions in the region, and half the atmospheric pollution. So it must bear most of the burden of decarbonisation efforts to bring the region in line with the requirement for global climate stability. Apart from being fundamental for climate change mitigation, the green energy transition will also help nations adapt to worsening climate conditions and build climate-resilient societies.

The Task Force on Energy Systems has reviewed the socio-economic and technological trends in energy systems of the region and highlighted gaps in policy and knowledge that must be addressed rapidly. Its full report depicts the evolution of energy supply and demand in EMME countries, both in aggregate terms and by main energy carrier – oil, gas, renewables, and nuclear energy. The region sits on huge reserves of crude oil and natural gas, while it enjoys a substantial (and until now largely unexploited) renewable energy potential. Some countries are building capacity in nuclear power.

The report also reviews the landscape of energy and climate policies in the EMME region. It starts with an overview of existing national strategies and decarbonisation plans and delves into individual aspects of such policies: regulatory approaches for the uptake of clean energy and energy efficiency investments; market-based instruments to abolish fossil fuel subsidies and adopt carbon pricing

schemes; and institutional reforms, infrastructure investments and cross-cutting policies that can enable the clean energy transition. This review identifies **gaps in the design and implementation of appropriate decarbonisation policies**, both in energy supply (power generation and production of clean fuels) and energy use.

Based on these findings, the Energy Task Force has set up a **decarbonisation agenda** for the EMME region's energy systems, recognising that because **time is limited, substantial progress on decarbonisation is required**.

The path to low-carbon economies requires a **two-pronged** intervention that **reduces energy demand while satisfying the lower demand with energy a low or net-zero carbon footprint. Above all, it requires political willingness** to design a low-carbon economy achieved through clean energy transition plans with actionable policies over the medium and long terms. Regional co-operation and collaboration can greatly contribute a regional Green Deal by sharing technical expertise and best practices in policy implementation, but also with mutual capacity building.

The energy sector exists as part of the entire socioeconomic system. It cannot be considered in isolation from it. Fundamental for a transition, therefore, is the energy sector's interaction with the economy, along with social and environmental sectors. Indeed, an energy transition requires a systems approach that meet challenges across all aspects of the transition (economic, social, and environmental sectors) and the dynamics among them. This means that **policies to scale up deployment and integrate larger shares of zero-carbon energy need to be supported by cross-cutting, enabling policies on industry, skills and labour, society and finance** – formulated from a holistic perspective. With the components of these comprehensive policy frameworks in place, the transition will achieve global climate goals while producing millions of jobs, broader economic development and significant gains for health and welfare.

In this context, the report identifies **three pillars of the clean energy transition that need immediate and simultaneous attention** from the EMME region's governments:

- Planning the transition with robust data, analyses and research.
- Mitigating growth in energy demand and promoting the uptake of green technologies and practices by consumers and firms.
- Ensuring the supply of competitive, low-carbon energy.

Figure 1 outlines the major elements of each pillar and further elaborates them in the full report of the task force.

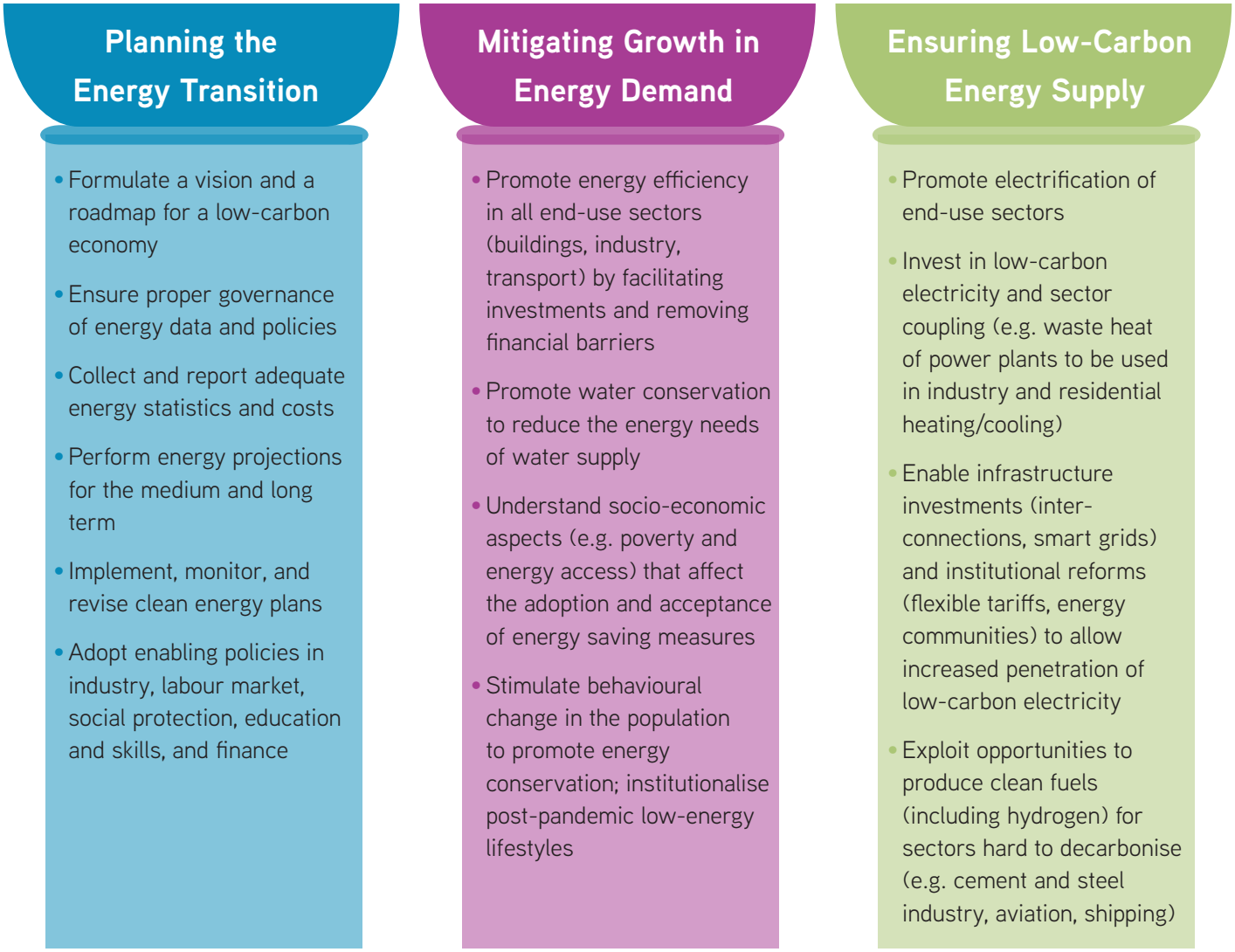
To achieve progress in this ambitious decarbonisation agenda, the need for **regional co-operation cannot be overstated**. Co-ordinated actions like sharing and co-developing energy infrastructures and networks, facilitating technical exchanges and capacity-building activities and conducting regional integrated assessments are essential elements towards decarbonisation.

In accordance with the gaps in knowledge and the policy proposals identified, the report outlines a wideranging **regional research and innovation agenda** that is urgently needed and should encompass the following topics:

- *Technologies* (clean fuels such as hydrocarbons and hydrogen, green desalination processes, zero-carbon power generation, energy storage, carbon capture and utilisation)
- *Enabling infrastructure* (inter-connections, energy communities)
- *Digitalisation* (smart grids, vehicle-to-grid systems, automation)
- *Circular economy* (impact of resource efficiency and waste prevention on the carbon footprint of industries and households)
- *Attitudes* (lifestyle changes and behavioural aspects to lower energy demand and adopt sustainability practices, especially after the pandemic)
- *Policies* (simulations of inter-connected/liberalised markets, decarbonisation pathways and their impact on economic growth and social equity)

Out of this research agenda, each country can choose the options that best fit its natural resources, accumulated expertise, and comparative advantages. It is important to emphasise that, regardless of national strategies, regional co-operation can accelerate research and innovation in the region. This can be enabled by targeted initiatives such as the creation of highly capable regional energy/climate/economic modelling networks, which will not only involve research institutions but also establish strong links with national decision makers to enable a policy-relevant decarbonisation agenda for the EMME region's energy system.

Figure 1. EMME energy systems: The policy priorities for decarbonisation



Finally, the report provides a detailed **policy toolkit for decarbonising energy systems**. It comprises more than 30 possible interventions across the entire spectrum of public policies: regulations, institutional reforms, removal of investment barriers, green fiscal measures, infrastructure investments and information initiatives. Some tools are more relevant for some countries, while other policy instruments may be more suitable for others. Yet common features apply: satisfying a large portion of energy needs with zero-carbon electricity and heat; utilising the region's natural resources to provide low- and zero-carbon fuels like synthetic hydrocarbons and hydrogen; improving energy efficiency in industry, buildings and transport and aligning the economic and research priorities of the countries with the strategic vision of a low-carbon future.

Geography and climate make it imperative for EMME countries to address their common energy future in a co-ordinated manner. Policy makers can combine the available international knowledge with regional resources to facilitate the transition of energy systems to climate neutrality, which will improve the well-being of all people in the region.

3. The Built Environment

Task Force Management Board

Prof. Salvatore Carlucci, The Cyprus Institute

Prof. Manfred A. Lange, The Cyprus Institute and Future Earth MENA Regional Centre

Cyprus Institute Liaison Scientist

Prof. George Artopoulos, The Cyprus Institute

Task Force Members

Prof. Hanan M. Albuflasa, University of Bahrain

Prof. Margarita-Niki Assimakopoulos, University of Athens

Prof. Shady Attia, University of Liège

Prof. Elie Azar, Khalifa University of Science and Technology

Prof. Erdem Cüce, Recep Tayyip Erdogan University

Dr. Ali Hajiah, Kuwait Institute of Scientific Research

Prof. Isaac A. Meir, Ben-Gurion University

Prof. Marina Neophytou, The University of Cyprus

Dr. Melina Nicolaides, Activate Non-profit Arts Organisation

Prof. Despina Serghides, The Cyprus Institute

Prof. Aaron Sprecher, Technion Israel Institute of Technology

Dr. Muhieddin Tawalbeh, National Energy Research Centre, Royal Scientific Society.

Editorial Review and Assistance

Ms Ioanna Kyprianou, The Cyprus Institute

Ms Stavroula Thravalou, The Cyprus Institute

The climate-related risks faced by the built environment of the Eastern Mediterranean and Middle East (EMME) region are summarised here.

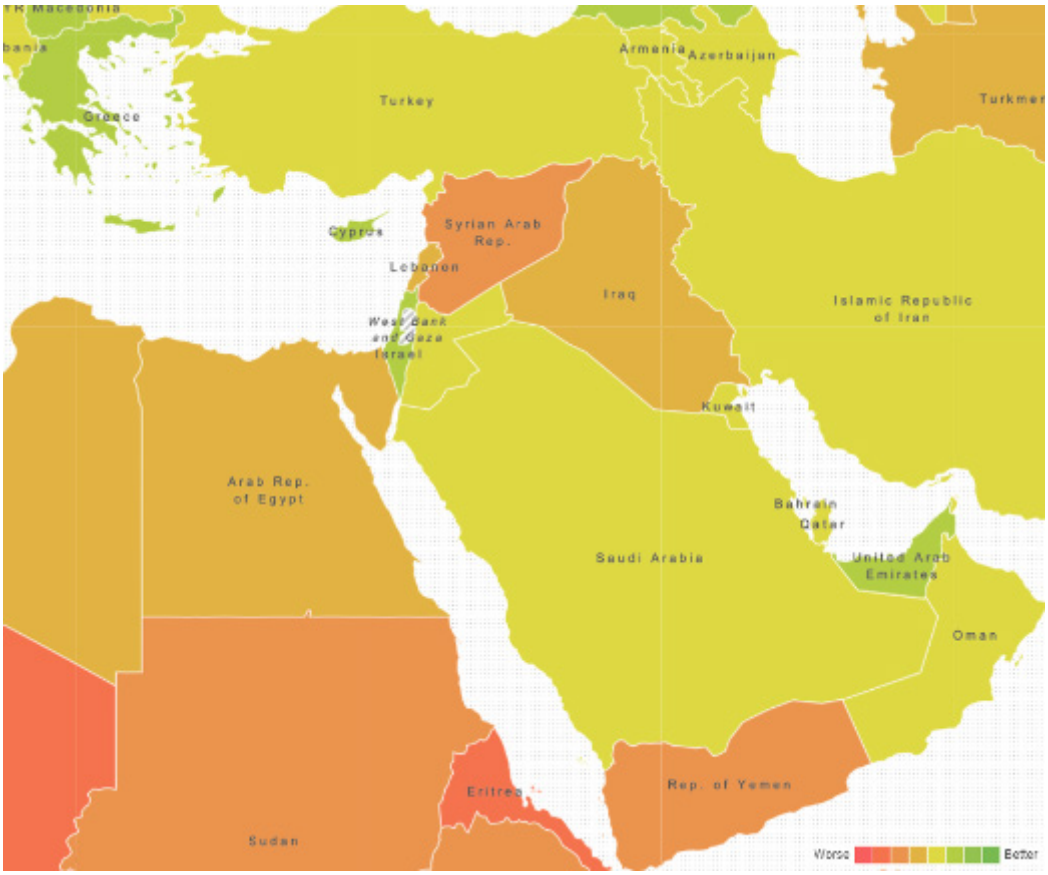
Yearly mean ambient temperatures are 1.4˚C higher in the region than in the late 19th century, averaged across the region (Cramer et al., 2018), and the intensity, length and number of heatwaves have increased by a factor of six to eight since the 1960s in the Eastern Mediterranean (Kuglitsch et al., 2010).

Under certain climate scenarios, parts of the Mediterranean region are predicted to become uninhabitable by some species of the biosphere, including humans (Lelieveld et al., 2016). Since 1985, the Mediterranean Sea has been warming by about 0.4˚C (Nykjaer, 2009) and rising by about 3 centimetres per decade (Tsimplis et al., 2013). Ozone and aerosol air quality limits are often exceeded, with photochemical episodes mainly occurring in summer (EEA, 2018). These phenomena, as well as land-use changes, increasing pollution and compromised biodiversity, have aggravated several ongoing environmental problems in the area. The Intergovernmental Panel on Climate Change and the World Meteorological Organization have classified the EMME region as a global "climate hotspot," exceptionally vulnerable to climate change impacts (Giorgi, 2006; Stocker et al., 2013).

The vulnerability of urban structures to climate change is determined both by the magnitude of climate-induced impacts and by the adaptability capacity and exposure of a given site. As cities in the EMME region are exposed to various climate hazards, depending on their geographical position and morphology, their physical and socio-economic characteristics influence their adaptability capacity and, ultimately, their vulnerability (Figure ES.1). While climate change is a global phenomenon, and its mitigation through the reduction of greenhouse gas (GHG) emissions requires an international effort, its impacts are local and must be tackled in each geographical context considering site-specific features.

The EMME region is characterised by rapid population growth and urbanisation. Expanding cities and suburban areas are challenging the social cohesion and environmental regenerative capacity of some areas of the region. Several megacities in the region, such as Cairo and Istanbul, are home to more than 10 000 000 people, and, according to the Economic and Social Commission for Western Asia, more than 40% of the region's population can be classified as poor or vulnerable (Abu-Ismail, 2018). Furthermore, shifts in population density towards urban centres and changes in lifestyle have been accompanied by heedless land use, unplanned urban development, increased consumerism and energy consumption, along with higher GHG emissions. Traditionally, the EMME region has played a small part in global emissions; however, should current trends continue, this is likely to change. Sustainable development strategies are urgently needed in the region, across the built environment in general and in the construction industry in particular.

Figure ES.1 Vulnerability map of countries in the EMME region, November 2020



Source: Authors' compilation based on information from the ND-GAIN website.

The built environment is the human-made setting for human activity (Roof and Oleru, 2008). As a complex and tangled global system, with multiple scales ranging from buildings to neighbourhoods to cities (Pacific Institute for Climate Solutions, 2020), it encompasses the great variety of places and spaces created or modified by people. These include green spaces; infrastructure like transport, energy transmission, water supply and sewerage networks; and public, residential, commercial and industrial buildings. Buildings in particular are increasingly recognised as significant sources of both peak energy demand and GHG emissions. In the race to transform current practices, local authorities can be catalysts of change. Backed by deep knowledge of the characteristics and needs of their communities, they are in a good position to design and implement adaptive actions in line with major international agreements such as the Paris Agreement, the New Urban Agenda, the 2030 Sustainable Development Goals of the United Nations and the Sendai Framework for Disaster Risk Reduction. It is particularly urgent that adaptive measures be implemented in urban centres. While in 1950, cities hosted about 30% of the world's population, today they host nearly 55%, and this share is projected to reach 70% by 2050 (Department of Economic and Social Affairs, 2019). Urban adaptation is also necessary from an economic perspective. Urban areas are focal points of economic activity, generally characterised by high gross domestic product per capita (Lavalle et al., 2017) and industrial clusters. Indeed, urbanisation implies economic growth, with about 80% of global gross domestic product generated in cities (Grübler and Fisk, 2012), a share expected to grow. The importance of urban resilience to climate change is emphasised in key international agreements, frameworks and policies, including the United Nations 2030 Agenda for Sustainable Development (UN, 2015).

An analysis of the policy landscape related to climate change mitigation and adaptation actions already adopted in the countries of the EMME region identified major gaps in the degree to which climate change mitigation and adaptation actions are being implemented across countries in the region. Regulatory inertia hinders the smooth enactment of mitigation and adaptation measures and climate policies where available. This is possibly due to the lack of institutional co-ordination among different agencies or ministries, or non-obligatory regulations. Also,

decarbonisation is not always a political priority. Overcoming a technocratic approach and moving towards a people-centred approach with seamless integration of the built environment and natural resources require greater awareness among both citizens and policy makers about environmental issues, together with more state and private investments to support the deployment of mitigation strategies (meetMED, 2020). The Global Sustainability Assessment System is an example of an instrument aiming to improve the built environment in the region. It has already been adopted by some countries of the Gulf Cooperation Council, and could serve as a blueprint for a regionwide body of rules and regulations to achieve energy efficiency in the built environment across the EMME region (GORD, 2019).

While synergistic relationships between researchers and relevant stakeholders are furthering knowledge, public awareness and relevant policy across the EMME region, few tangible adaptive measures have been carried out. Robust resources, accessible and applicable at the local level, are needed to fully grasp current and projected climate threats. High-quality data are required for accurate vulnerability assessments.

Adaptation in the context of the EMME region, especially in urban settings, has arguably started taking place. However, an evaluation of current adaptation strategies across the region suggests that progress varies by country (UNEP, 2018). This report considers that variation while providing a comprehensive overview of urban and local governments' adaptation efforts. Cities of the EMME region need to address the following characteristics of the built environment:

- Urban sprawl – manage urban population pressures on agricultural and natural land and deal with the soil-sealing trend due to urban sprawl, especially in coastal areas.
- General co-ordination – promote information and communications technology readiness and open access to city data (monitoring of infrastructure operations).
- Port cities – manage environmental, cultural, spatial, economic and social peculiarities.
- Coastal cities – manage soil erosion, urbanisation and industrialisation of coastal areas.
- Lowland, continental cities – overcome insularity.

Moreover, providing open access to secure, high-quality, time-relevant and consistent demographic and environmental monitoring data is essential for planning and implementing the 2030 Agenda for Sustainable Development. Improvements in real-time monitoring of civil data and information systems, state-of-the-art capacity for analytics of urban big data, remote-sensing technologies, satellite observations and geo-referencing are necessary actions to manage pressing urbanisation challenges and provide grounds for the development of timely responses. An example of an information and communication technology application combining information from various governmental services, as well as external resources, is the National Statistical Data Program "Masdar". This programme aims to create a comprehensive database with information that can be accessed through an interactive data portal and also through smartphone applications (UN, 2018).

Lessons learned span several thematic axes: integration and co-ordination of mitigation and adaptation measures; regulatory inertia and carbon lock-in; new forms of co-ordinated management of city-regions; alignment between national and local levels on climate response and institutional co-ordination in the development of climate responses. Moreover, based on current knowledge, five main directions may drive advances in research on climate change mitigation and adaptation in the built environment: urban planning and design, built infrastructure, sustainable consumption and production, finance and informality.

Mitigation strategies to address the abovementioned challenges include the creation of low-energy, sustainable and resilient buildings and neighbourhoods while applying circular economy principles in the construction sector. In addition, urban design and land-use planning are focal in the mitigation of excessive heat and the urban heat island phenomenon, whereas sustainable mobility technologies will aid in the decarbonisation of local environments. As for climate change adaptation strategies, four approaches have been recognised: technology-, ecosystem-, community- and policy-based strategies.

The EMME region urgently needs holistic and co-ordinated actions, developing consolidated evidence-based strategies for cities that aspire to be resilient in the near and far future, cities able to absorb environmental shocks induced by climate change and offer safe and equitable lives for urban dwellers and commuters. Co-operation among countries and cities of the EMME region is vital,

Figure ES.2 Five policy topics to address in efforts towards urban sustainability

and harmonisation of climate actions is indispensable. Practical policy recommendations towards achieving sustainable and resilient cities and communities by 2050 focus on five topics (Figure ES.2) and are addressed to policy makers and relevant stakeholders of the region.

References

Abu-Ismail K (2018) Poverty and Vulnerability in Arab States. Beirut, Lebanon

Cramer W, Guiot J, Fader M, et al (2018) Climate change and interconnected risks to sustainable development in the Mediterranean. Nat. Clim. Chang.

Department of Economic and Social Affairs (2019) World Urbanization Prospects: The 2018 Revision

EEA (2018) Air quality in Europe — 2018 report No 12/2018

Giorgi F (2006) Climate change hot-spots. Geophys Res Lett. https://doi.org/10.1029/2006GL025734

GORD (2019) GSAS Technical Guide 2019 - Issue 2. Gulf Organisation for Research and Development (GORD)

Grübler A, Fisk D (2012) Energizing sustainable cities: Assessing urban energy

Kuglitsch FG, Toreti A, Xoplaki E, et al (2010) Heat wave changes in the eastern mediterranean since 1960. Geophys Res Lett. https://doi.org/10.1029/2009GL041841

Lavalle C, Pontarollo N, Batista E Silva F, et al (2017) European Territorial Trends - Facts and Prospects for Cities and Regions

Lelieveld J, Proestos Y, Hadjinicolaou P, et al (2016) Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century. Clim Change 137:245–260. https://doi.org/10.1007/s10584-016-1665-6

meetMED (2020) Energy Efficiency in Buildings. MEDENER and RCREEE

Nykjaer L (2009) Mediterranean Sea surface warming 1985-2006. Clim Res. https://doi.org/10.3354/cr00794

Pacific Institute for Climate Solutions (2020) Energy Efficiency in the Built Environment

Roof KM, Oleru N (2008) Public Health: Seattle and King County's Push for the Built Environment. J Environ Health 71:

Stocker TF, Qin D, Plattner GK, et al (2013) Climate change 2013 the physical science basis: Working Group I contribution to the fifth assessment report of the intergovernmental panel on climate change

Tsimplis MN, Calafat FM, Marcos M, et al (2013) The effect of the NAO on sea level and on mass changes in the Mediterranean Sea. J Geophys Res Ocean. https://doi.org/10.1002/jgrc.20078

UN (2015) Transforming our world: The 2030 Agenda for Sustainable Development

UN (2018) Towards Saudi Arabia's Sustainable Tomorrow

UNEP (2018) Putting the environment at the heart of people's lives

Eastern Mediterranean and Middle East Climate Change Initiative

4. The Effects of Climate Change on Human Health

Summary of the Report of the Health Task Force

Marco Neira, Climate and Atmosphere Research Centre, The Cyprus Institute, Nicosia, Cyprus

Kamil Erguler, Climate and Atmosphere Research Centre (CARE-C), The Cyprus Institute, Nicosia, Cyprus

Hesam Ahmady-Birgani, Faculty of Natural Resources, Urmia University, Iran

Nisreen DaifAllah AL-Hmoud, Bio-Safety and Bio-Security Centre, Royal Scientific Society, Jordan

Christiane Diehl, European Academies Science Advisory Council

Robin Fears, European Academies Science Advisory Council

Charalambos Gogos, School of Medicine, University of Patras, Patras, Greece

Maria Koliou, University of Cyprus Medical School, Nicosia, Cyprus 6,

Leontios Kostrikis, Laboratory of Biotechnology and Molecular Virology, University of Cyprus, Nicosia, Cyprus

Jos Lelieveld, Climate and Atmosphere Research Centre, The Cyprus Institute, Nicosia, Cyprus; and Max Planck Institute for Chemistry, Mainz, Germany

Azeem Majeed, Department of Primary Care and Public Health, Imperial College London, London, United Kingdom

Shlomit Paz, Department of Geography and Environmental Studies, University of Haifa, Haifa, Israel

Yinon Rudich, Faculty of Chemistry, The Weismann Institute of Science, Rehovot, Israel

Amal Saad-Hussein, National Research Centre, Giza, Egypt

Mohammed Shaheen, Centre for Development in Primary Health Care, Al-Quds University, Palestine

Volker ter Meulen, European Academies Science Advisory Council; Inter-Academy Partnership

Aurelio Tobias, Institute of Environmental Assessment and Water Research, Spanish Council for Scientific Research, Barcelona, Spain

George Christophides, Climate and Atmosphere Research Centre, The Cyprus Institute, Nicosia, Cyprus; Department of Life Sciences, Imperial College London, London, United Kingdom

Corresponding authors: Marco Neira, m.neira@cyi.ac.cy; George Christophides, g.christophides@cyi.ac.cy,

Climate change is predicted to affect many aspects of human life in complex and interconnected ways. The impacts of climate change on human health and well-being can be both direct (e.g., exposure to extreme and unusual temperatures, drought, and flooding) and indirect (e.g., changes in air quality, food and water availability/quality, and patterns of infectious disease transmission). These effects are further compounded by a variety of biological, ecological and socio-political factors.

An extensive body of research has identified several factors that can adversely affect the vulnerability of human health and wellbeing to climatic factors, including age, gender, geographic location, socio-economic status, occupation, health status and housing conditions, among other. Climate change is predicted to exacerbate these vulnerabilities, especially in the lower-income countries and resource-limited settings of the EMME region, which is also characterised by high rates of population growth, urbanisation, political tension and migration.

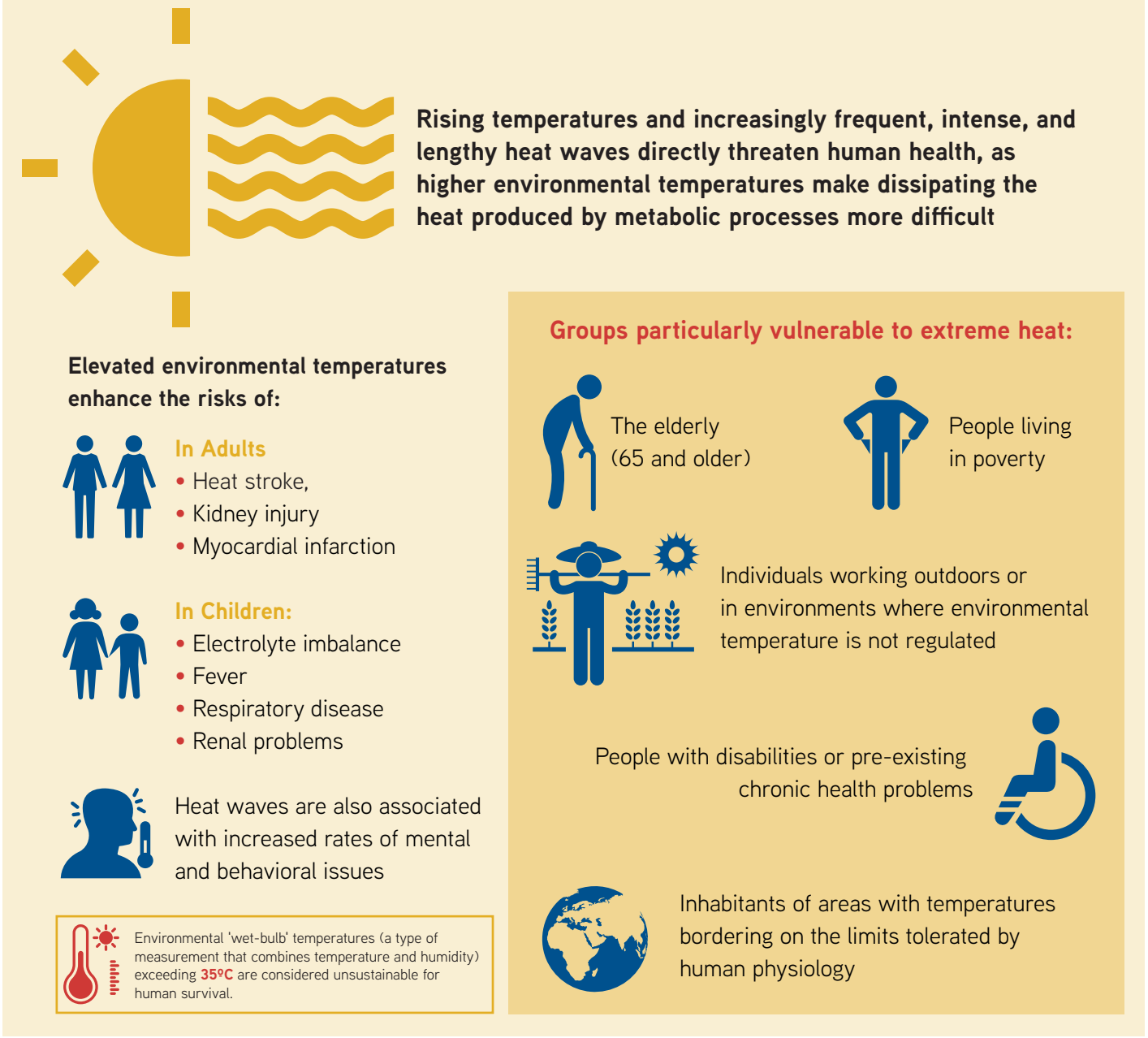
In this report we summarise the current knowledge regarding the effects of climate change on the health of the people of the EMME region. We provide recommendations regarding research priorities and relevant policies, which can help increase the region's resilience to human health challenges set to be imposed by climate change.

Extreme heat

Exposure to extreme heat is associated with heat stroke, kidney injuries and myocardial infarction in adults, especially the elderly, as well as electrolyte imbalance, respiratory conditions and renal problems in children (Figure 1). Extreme heat has also been linked to mental health problems, sleep disturbances and increased suicide rates. Factors such as air pollution, elevated humidity and urban heat islands can further compound the negative effects of heat stress on human health.

A large share of the population of the EMME region is already acclimated to high ambient temperatures. However, future heatwaves in the region are predicted to be increasingly severe and disproportionally affect vulnerable population groups including the elderly, people living in poverty, those with disabilities or chronic health conditions and individuals that regularly work outdoors (Figure 1). Thus, areas of the EMME region with large susceptible

Figure 1. The effects of increasing environmental temperatures on human health



populations, such as urban areas, will be particularly affected by future extreme heat events.

Water shortage

Human health is dependent on the availability of safe, reliable and accessible water supplies. The EMME region comprises some of the countries with the lowest water availability in the world, with nine out of 15 countries in the Middle East considered to experience absolute water scarcity.

The health consequences of freshwater scarcity (Figure 2) can be both direct and indirect and include diarrheal and parasitic diseases, chronic health issues, increases in the incidence of vector-borne diseases and nutritional deficiencies, among other. Reduced agricultural productivity due to water scarcity is expected to cause drops in export revenues in many of the EMME countries that range in the billions of dollars, potentially impacting health services and infrastructure.

Several countries in the region have successfully implemented strategies that allow them to increase the productivity of their water resources and obtain usable water through nonconventional means such as desalination and wastewater re-use. Unfortunately, the high costs associated with some of these processes currently limit their widespread use.

Air pollution, dust events, and wildfires

In Europe and the Eastern Mediterranean, around 1 million people die prematurely each year due to air pollution. Increased particulate matter concentrations in ambient air from energy generation, industrial pollutants, traffic, domestic energy use and wildfires are implicated with increases in the incidence of respiratory and cardiovascular diseases, as well as higher mortality rates. These health problems are aggravated by the growing abundance of desert dust, especially in the EMME region. Vulnerable groups include the very young and elderly, as well as people with chronic cardiopulmonary diseases.

The strong urbanisation trend in the EMME region is another direct effect of climate change and contributes significantly to the worsening of air pollution in urban areas. The byproducts of fossil fuel burning include greenhouse gases, particulate matter and various hazardous gases. Because heat facilitates the formation of some of these noxious reaction products, urban heat islands and heatwaves also contribute to the deterioration of air quality.

Vector-borne diseases

Infectious diseases transmitted by arthropod vectors, known as vector-borne diseases (VBDs), are particularly susceptible to climatic variability due to the complex structure of their natural cycles. The biology of mosquitoes, sandflies, ticks and other disease vectors is profoundly influenced by factors such as temperature, rainfall and humidity, creating a direct link between climate change and the epidemiology of VBDs.

Variation in climate and other environmental factors can also affect physiological parameters of vector-borne pathogens, altering their transmission patterns. Human interventions such as increased urbanisation and the disruption of natural ecosystems can further enhance the potential for VBD transmission.

Ecological and socio-economic factors currently found in the EMME region create the appropriate conditions for the local transmission of several VBDs, including dengue and Chikungunya fever, leishmaniasis, West Nile fever, and malaria, among others. Future climatic change is expected to influence the epidemiological landscape of these diseases by altering the vector geographic distribution, seasonality, abundance and capacity to transmit disease.

Population displacement

In the past 50 years, the displacement of human populations in the EMME region increased significantly due to complex environmental, economic and socio-political issues. Climate change can stimulate population displacement in several ways, including increases in the intensity and frequency of extreme weather events, loss of land to sea-level rise and deterioration of lifesustaining ecosystems and aggravation of armed conflicts.

Several EMME countries are listed among those with the largest shares of migrants in the world. As of 2019, Syria and Iraq were among the 10 countries with the highest number of internationally displaced persons, while Turkey, Iran and Lebanon were hosts to some of the largest refugee populations.

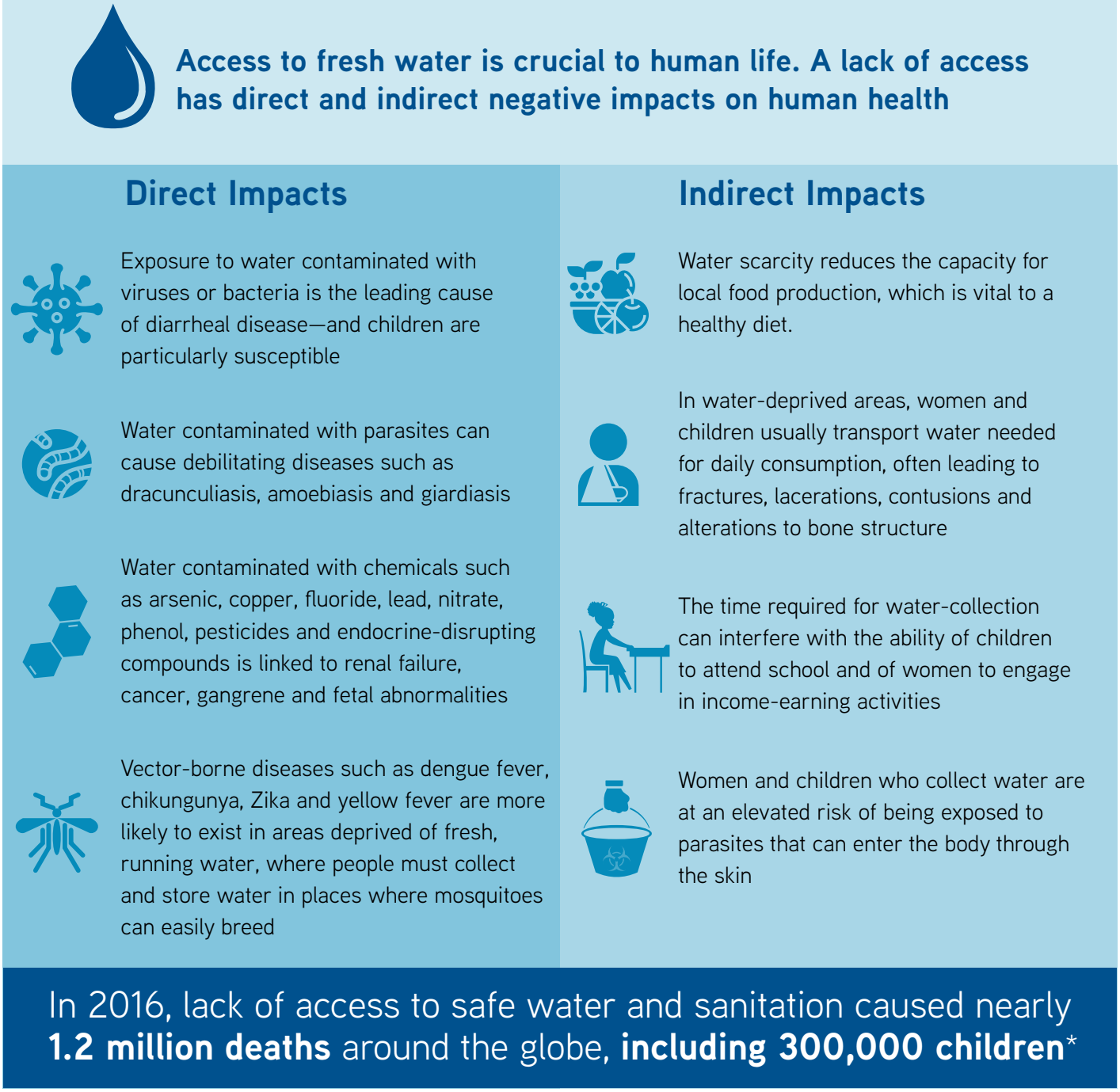
The distinct sanitary conditions of refugees, often housed in densely packed, makeshift dwellings and lack appropriate access to basic resources, such as running water and waste disposal, render this group extremely vulnerable to factors such as extreme temperatures, water scarcity, nutritional deficiencies, infectious diseases, maternal /neonatal morbidity and mortality and, importantly, mental health issues. The lack of resources and uncertain legal status associated with displacement can place the most vulnerable individuals (largely women and children) at an elevated risk of being the target of sexual violence and exploitation. Access to medical and psychiatric health care for refugees is limited, with some aspects (such as mental and reproductive health) being particularly difficult to address amid logistic and cultural challenges.

Research gaps

During the drafting of this report, we have identified several areas where additional research is required to either better understand or better address the health challenges posed by climate change. These include:

- **Empirical evidence on exposure-response functions involving climate change and specific health outcomes:** Our current understanding of the specific effects that climate exerts on several health conditions is relatively poor. Areas where further research is required include the impact of dust exposure on chronic health conditions, the development of tools to accurately evaluate the psychological effects associated with forced displacement, the effects of air pollution by wildfires on respiratory and neurologic health, and the effects of climate change on overall children's health, among others.
- **Assessment of the effects of climate change on ecological determinants of human health:** There is a dearth of empirical data about the influence of changing climate on ecological factors that can ultimately

Figure 2. Direct and indirect impacts of freshwater scarcity on human health



*Source: World Health Organization, World health statistics 2020: monitoring health for the SDGs, sustainable development goals. Geneva, Switzerland, 2020.

affect human health. This situation is particularly relevant in the field of vector-borne diseases due to the complex nature of their natural cycles. The generation of a larger body of empirical biological and/or ecological data could help improve the accuracy of predictive mathematical models, which are key components of climate-related health action plans.

- **Effects of long term exposure to climate change:** Currently available information related to the influence of climate change on human health is mostly based on the effects of severe weather events, which typically have a relatively short duration. Little information is available, however, on the effects of long-term exposure to smaller variations in climatic factors.

- **Evaluation of the interactions between adaptation and mitigation strategies:** The interactions between adaptation and mitigation strategies can be complex, and sometimes conflicting. These complexities are rooted in the inherent differences between these strategies (e.g., while adaptation often focuses on achieving short-term goals at the local level, mitigation focuses on long-term goals at the regional or global level). We propose that research in this area should characterise the cross-linking and trade-offs between mitigation and adaptation efforts.

Policy suggestions

Because most climate-related factors expected to impact human health (e.g., heat waves, air pollution, infectious disease transmission, etc.) are not contained by national boundaries, any effective adaptation and/or mitigation policies must be regional in nature and the result of collaborative efforts among EMME nations. Relevant policies suggested by our Task Force include:

- **Move decisively towards decarbonisation:** Achieving a significant reduction on the emission of greenhouse gasses is a key component of any plan aimed at protecting human health from climate change. Although phasing out fossil fuels is one of the most important steps to protect human health, our current rate of fossil fuel consumption is deeply rooted in complex and often outdated political and societal practices. Achieving meaningful, sustainable changes will require profound commitments on the side of consumers, institutions and policy makers alike. Therefore, only strong political determination at the national and regional levels can drive a concerted and efficient effort towards decarbonisation.
- **Integration of environmentally-driven morbidity and mortality data throughout the region:** The EMME region would greatly benefit from the development of an integrated system that facilitates the tracking of morbidity and mortality data attributable to climatic factors. The development of such system would not only make it possible to establish clearer correlations between regional variations in climatic parameters and the incidence of specific health issues but could also be instrumental in measuring the efficiency of mitigation or adaptation policies adopted in the region.
- **Advancing the development and widespread use of cheaper technologies for the production and management of drinking water by non-traditional means:** Water scarcity is a common threat for the future of most EMME countries. Therefore, efforts should be made to optimise the efficiency of water distribution systems, as well as to stimulate rational consumption by users. EMME countries should prioritise investments in research aimed at optimising and reducing the cost of alternative technologies for the generation of drinking water, and to mitigate any ecological costs associated with these technologies.
- **Comprehensive regional strategies for the improvement of the health status of displaced populations:** Policies related to the health of migrant populations need to consider aspects such as the inherent inequalities in healthcare access of the displaced vs. local populations, as well as the cultural, ethnical and religious complexities of refugee settlements. EMME countries hosting groups of displaced individuals should implement comprehensive health policies that include access to healthy food and water, mental health services, maternal and reproductive health and infant vaccination, among other.
- **Fostering regional networks to monitor and control the spread of infectious diseases and disease vectors:** Due to the inter-connected nature of our modern societies, infectious diseases can spread rapidly across national boundaries. Among infectious diseases, those transmitted by vectors can be particularly hard to track and control, as their spread is driven by the movement of vector and reservoir species, as well as human hosts. For this reason, efforts at the national level are often insufficient to adequately monitor and control the dissemination of infectious diseases, whereas regional efforts can be more efficient at producing large-scale epidemiological data, identifying dissemination routes and facilitating control strategies.

5. Water Resources

Task Force Coordination

Dr. Fadi Comair, Ministry of Energy and Water, Lebanon

Prof. Adriana Bruggeman, The Cyprus Institute, Cyprus

Cyprus Institute Liaison Scientist

Dr Elias Giannakis

Task Force Members

Dr. Amr AbdelMeguid, Centre for Environment and Development for the Arab Region and Europe (CEDARE), Egypt

Prof. Mohamed Abdulrazzak, Taibah University, Saudi Arabia

Ms. Laheab Al Maliki-Abbas, University of Al-Qasim Green, Iraq

Prof. Mohammad Al-Saidi, Qatar University, Qatar

Prof. Z. Selmin Burak, Istanbul University, Turkey

Dr. Carol Chouchamni Cherfane, United Nations Economic and Social Commission for Western Asia (ESCWA), Lebanon

Mr. Vangelis Constantianos, Global Water Partnership – Mediterranean (GWP-Med), Greece

Dr. Abdullah Droubi, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Damascus

Prof. Mutasem El Fadel, Khalifa University, United Arab Emirates

Prof. Emad Karablieh, University of Jordan, Jordan

Dr. Jauad El Kharraz, Senior Water-Energy-Climate Expert, Oman

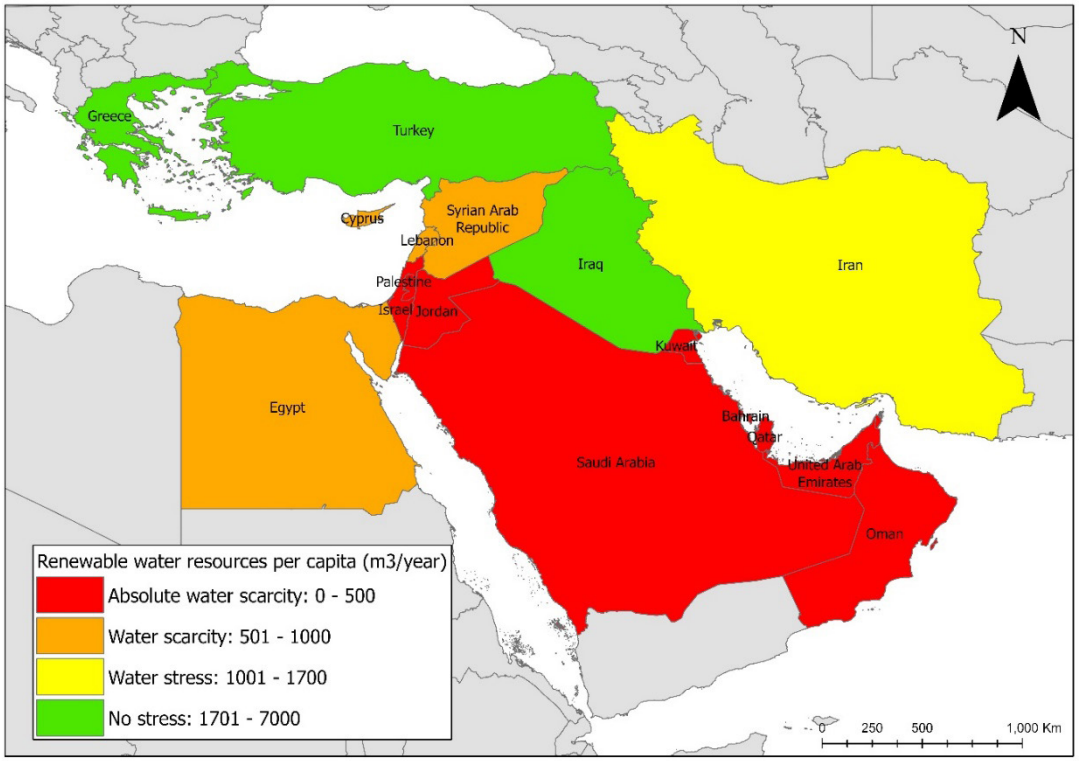
Prof. Maria Mimikou, National University of Athens, Greece

Dr. Ayman Rabi, Palestinian Hydrology Group, Palestine

Prof. Waleed K. Zubari, Arabian Gulf University, Bahrain

Most of the EMME region is marked by low rainfall, dry summers and high evapotranspiration. A country's renewable water resources are comprised of the fraction of the rain that flows into streams and surface water bodies or recharge groundwater aquifers, plus the net inflow of surface water and groundwater across the country's borders. The annual renewable water resources per capita of the 17 EMME countries are shown in Figure 1. The map shows the level of water scarcity experienced by the countries of the region, considering countries' annual per capita water needs for household use, agriculture

Figure 1. Annual renewable water resources per capita for the 17 countries of the EMME region



Source: FAO.

and industry. Nine of the seventeen EMME countries are below the absolute water scarcity threshold of 500 m3/year per capita, including all six countries of the Gulf region, Jordan and Palestine. Four others – Cyprus, Egypt, Lebanon and Syria – are below the scarcity threshold of 1,000 m3/year per capita. This places nearly 200 million people under conditions of water scarcity. Greece, Iraq, Iran and Turkey are currently the only countries above the water scarcity threshold.

These estimates of water resources represent long-term annual averages under a variable climate. These numbers mask the differential water availability over the area of the countries, as well as seasonal water shortages. In many places, the long, dry summer season affects the livelihoods of the rural population. Population growth also continues to shrink the countries' per capita water resources.

In nine of the seventeen EMME countries total annual water withdrawals exceed the total annual renewable water resources, indicating an unsustainable extraction of groundwater resources. Intrusion of seawater in overexploited aquifers has made many coastal aquifers unsuitable for use. Treated sewage water, agricultural drainage water and fossil groundwater resources are supporting the water needs of the countries. The Gulf countries are strongly reliant on desalination, which also accounts for more than 20% of water use in Israel and Cyprus. Desalination is an energy intensive process almost completely reliant on fossil energy, which contributes to greenhouse gas emissions and climate change.

Agriculture remains the top water user in the region, accounting for 85% of all water withdrawals. Universal and equitable access to safe and affordable drinking water for all (Sustainable Development Goal 6.1) is still far from being achieved. The water problems of the region are aggravated by poor water governance, insufficient hydrologic monitoring systems and a scarcity of publicly available data.

The fifth target of Sustainable Development Goal 6 (SDG6) emphasises the importance of integrated water resources management as a holistic framework for addressing demands and pressures on water resources across different sectors and at different scales. Integrated management ensures that resources are developed, managed and used in an equitable, sustainable and efficient manner, in consideration of local political, economic and social realities. SDG 6.5 aims to achieve integrated management of water resources at all levels, including through transboundary cooperation, by 2030. The EMME countries depend heavily on shared, transboundary surface water and groundwater resources, yet the cooperation needed for effective water management is insufficient or absent.

Climate change is making the region hotter and drier, imposing additional challenges for the region. Climate change projections show a 20-40% reduction in precipitation for the Mediterranean countries of the EMME region by the end of the century under the high-emissions RCP8.5 scenario. Climate change projections also show more severe droughts and possible increases in extreme rainfall events. A larger share of the rainfall is expected to fall as extreme events, increasing the stresses on water infrastructure. Hydrologic modelling studies demonstrate that reduced rainfall, higher temperatures and greater evaporative demand will increase water-supply risks and water-quality problems.

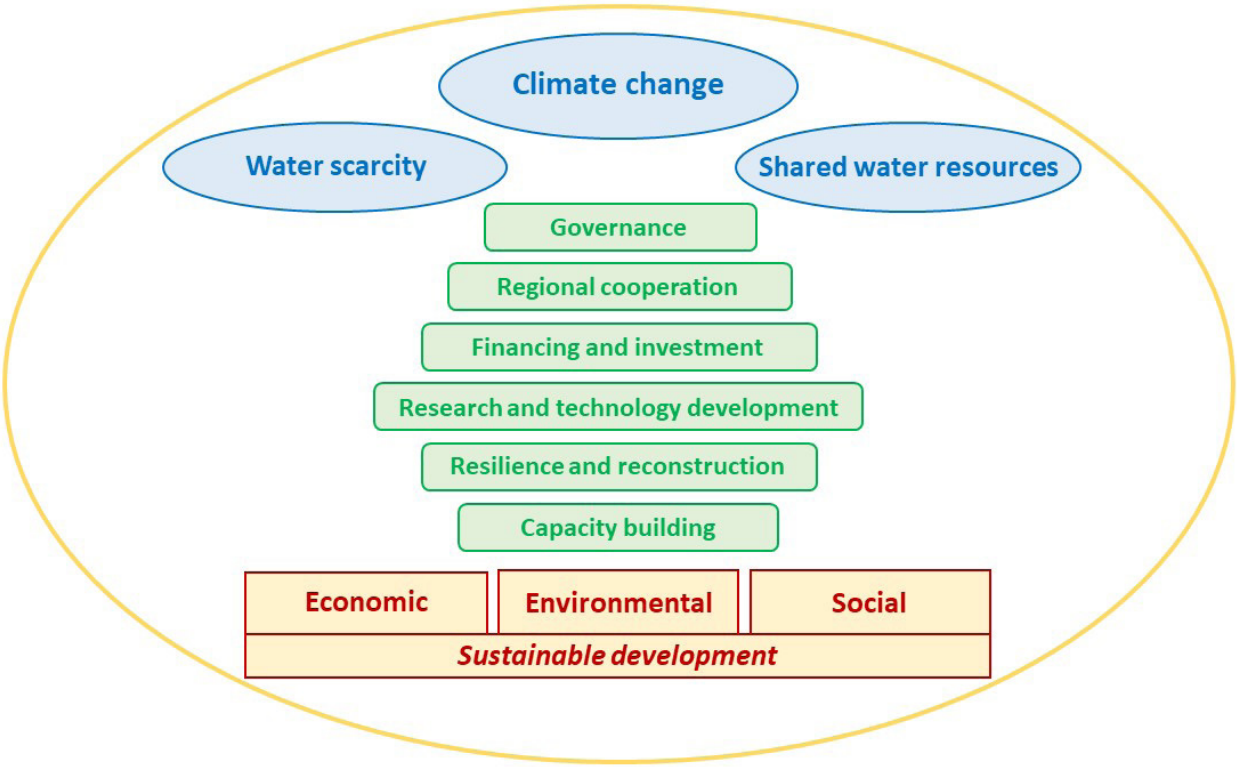
A conceptual framework is proposed for achieving climate resilience and water security in the region (Figure 2). The framework recognizes the human rights to water and sanitation. The framework recognises the systemic aspects of climate change, water scarcity and shared water resources. Actions in six areas should guide the region to water security and climate resilience: (i) good governance; (ii) regional cooperation; (iii) financing and investment; (iv) research and technology development; (v) climate resilience and reconstruction; and (vi) capacity building.

The adaptation measures listed in the national climate adaptation strategies and plans of the EMME countries demonstrate a good understanding of the threats to the water sector. However, the implementation and financing of the measures have so far been insufficient.

Research initiatives to address the climate-water knowledge gaps in the EMME region should focus on the following issues:

- Implementing the climate-water-energy-food nexus;
- Expanding, upgrading and automating hydrologic monitoring networks throughout the EMME region;
- Establishing an open access climate-water database and knowledge hub and improvement of data quality management;
- Instituting economic and environmental cost-benefit analyses of measures to achieve the climate resilience of the water sector across the region;

Figure 2. Conceptual frameworks for achieving climate resilience and water security in the EMME region



Source: Adapted from ESCWA.

- Building zero-brine and zero-carbon desalination systems;
- Requiring the sustainable use of treated sewage water and other marginal water resources, considering the effects and fate of chemicals and emerging contaminants on soils, water and food;
- Developing systems for forecasting, monitoring and alerting.

Policy initiatives should focus on:

- Improving water governance, including the establishment of national open access databases, development of a water accounting system, regulation of groundwater abstraction, sound water allocation and cuts, with special attention to integrated water resources management (SDG 6.5) and the application of the climate-water-energy-food nexus;
- Encouraging regional cooperation, including the shared management of transboundary water resources, the establishment of riparian rights with neighbouring countries and the creation of transboundary organizations;
- Securing sustainable financing and investment, including integration of public and private finance in the water sector, water pricing and subsidies;
- Reducing water demand, increasing irrigation efficiency, promoting hydroponics, water savings technologies, water metering and network maintenance and reduction of losses
- Improving water supply, including desalination with net zero-carbon, improving wastewater treatment, reuse of grey and treated wastewater, enhancing recharge of aquifers and rainwater harvesting;
- Developing resilience and reconstruction, including river basin management plans and drought plans, improving management of reservoirs, improving forecasting, monitoring and alert systems;
- Building capacity and educational initiatives for the water sector to support water governance capacity, such as the establishment of a UNESCO-IHP Metropolitan ECO-MED Academy;
- Raising awareness and improving school curricula on climate change and water security.

6. Agriculture and Food Chain

Task Management Board

Prof. Andreas Karamanos, Dr. Michalis Omirou,
Dr. Reem Nejdawi

Cyprus Institute Liaison Scientist

Dr. Michalis Omirou

Task Force Members

Prof. Tayel-El Hassan
Dr. Pauline Y. Aad
Prof. Konstantinos Kormas
Prof. Ioannis Ipsilantis
Prof. Athanasios Tsikliras
Dr. Dionysia Fasoula
Dr. Georgia Hadjipavlou
Prof. Mark Tester
Prof. Constantinos Kosmas
Prof. Mohtar Rabi
Dr. Costas Stamoulis

The report provides a comprehensive assessment of the impact of climate change on crop and animal production, food security, land degradation, fisheries and aquaculture in the Eastern Mediterranean and Middle East (EMME) region. Furthermore, it describes adaptation and mitigation measures, identifies relevant knowledge gaps and suggests the appropriate policies.

Every component of the food supply sector has been affected by climate change, and climate scenarios show the sector sustaining further pressure. Besides, the ongoing global and regional deforestation due to devastating forest fires especially over the past decade has turned major global forest ecosystems (e.g., in the Amazon, Siberia, Indonesia, Australia) into emitters rather than absorbers of greenhouse gases. In the EMME region, additional forest losses due to local fires are expected to worsen existing drought and high temperatures – adverse impacts with unprecedented consequences for the food chain. Moreover, the EMME region countries face extensive urban expansion and population growth along with varying successes in economic growth and employment. Primary food production is a major economic activity for some countries in the EMME region (6.03% of the region's mean GDP), ranging from 0.19% in Qatar to 22.5% in Syria (FAO, 2018). At the same time, the sector is a rural cornerstone for social cohesion, a catalyst for retaining local communities and an essential source of employment. In 2020, 28.3% of jobholders in Yemen listed an agricultural occupation – the highest in the region – while Israel's agricultural workers stood below one percent (0.89%), while the mean agricultural employment in the region is 9.38% (World Bank, 2020).

The EMME region faces extreme shortages in water, the most critical component of primary production. In addition, the region suffers from conflicts, refugees, and crises of displacement and migration, which further worsen the challenges related to food production and distribution.

Climate change is already aggravating food insecurity the EMME region, and future models and scenarios predict more unfavourable climatic conditions for food production for the middle and the end of the century. Irrespective of the cropping system, what's inevitable are larger water deficits, higher average temperatures, and the more intense and frequent extreme climate events (droughts, heat waves, floods etc.); crops, livestock and aquaculture will be affected by all these things. The rise in temperature and the increased variability in annual rainfall are likely to make the region even more arid, exacerbating the already-low productivity of agricultural ecosystems and the loss of biodiversity, above- and belowground. On the one hand, loss of biodiversity in managed and unmanaged ecosystems will irreparably harm the regional ecosystem. On the other hand, the higher CO2-concentration levels may partly offset the any adverse effects of high temperatures and aridity on some crop species. In addition, new plant pests, weeds, and pathogens are also expected to encroach on the region, causing severe and unpredictable crop losses.

Heat stress will have the gravest impact on livestock production, presenting a significant financial burden to livestock producers through decreases across the board: milk components and milk production, meat production, reproductive efficiency and animal health. Thus, the projected rise in air temperature could directly affect livestock as a productive livelihood. In addition, climate change will

indirectly affect livestock production in the form of less feed and fewer water resources. Climate change is predicted to affect the quantity and stability of forage production and quality, water demand for cultivation of forage crops, as well as rangeland vegetation patterns on a large scale. Animals exposed to heat stress eat less and drink more. Their endocrine status changes, which in turn amps up the maintenance requirements, reducing performance. Environmental stressing agents will lower body weight, reduce the average daily gain, and worsen livestock body condition.

Declines in milk yield are pronounced, while milk quality is affected by lower fat content, lower-chain fatty acids, solid nonfat and lactose contents, while higher palmitic and stearic acid contents are observed. Generally, highly productive animals are most affected. Thermal stress hampers reproductive processes, reducing conception rates among dairy by 20–27% in the summer, while heat stressed cows often have poor expression of oestrus due to reduced oestradiol secretion. Heat stress can alter ovarian function and embryonic development by degrading the competence of oocyte to be fertilised, thus hampering reproductive efficiency. Heat stress is also linked to impaired embryo development and increased embryonic mortality in cattle. During pregnancy, heat stress slows the growth of the foetus and can increase foetal loss. In males, heat stress adversely affects spermatogenesis, perhaps by inhibiting the proliferation of spermatocytes. Variations in temperature and rainfall are the most notable climatic variables affecting outbreaks of livestock disease. Warmer and wetter weather (particularly warmer winters) will increase the risk and the occurrence of animal diseases, because certain species that serve as disease vectors, such as biting flies and ticks, are more likely to survive year-round. The movement of disease vectors into new areas – e.g., malaria and livestock's tick-borne diseases (babesiosis, theileriosis, anaplasmosis), Rift Valley fever and bluetongue disease in Europe – has been documented.

Climate change is necessitating changes in livestock production practices. Science and technology in animal production systems have failed, first, to address climatic adaptation and, second, to disseminate new findings on rangeland ecology that encompass a holistic understanding of pastoral management. For example, the integration of grain production with pasture plants and livestock could produce a more diverse and resilient ecosystem in the face of higher temperatures, elevated carbon dioxide levels, erratic precipitation, and other dramatic effects resulting from global climate change.

Climate change is expected to hasten soil desertification (the most serious degradation of land) in the arid and semi-arid areas of the EMME region. Direct anthropogenic drivers for land degradation stem from managed agricultural ecosystems (croplands, agroforestry, pasture land), urbanisation, infrastructure and development, a changing fire regime (where the patter is changing in frequency, intensity, size, pattern, season, and severity), soil salinisation, the encroachment of invasive species and extraction of non-timber natural resources. Worsening water scarcity combined with higher temperatures are accelerating the mineralisation of organic matter in the soil, making the soils more vulnerable to desertification. In addition, the predicted increase in rainfall intensity would intensify land degradation through erosion, irrespective of soil structure and stability. Soil erosion harms soil productivity by changes the physical and chemical properties of soil, including aggregate stability and grains size. Soil erosion accrues mostly through intense rainfall and wind speed. But desertification is also affected by land inclination and land-use management. Inappropriate tillage practices in hilly arid and semi-arid areas engender a rapid degradation of soil resources.

Natural and anthropogenic environmental changes can affect marine environments and their biota, particularly with regard to biodiversity. Declines were recently reported in studies on the eastern Mediterranean Sea, where fisheries and aquaculture both depend on a functioning marine food webs. Higher water temperature, rising sea levels (which induce changes in ocean circulation), and decreased salinity all threaten aquaculture, especially as they also seem to strengthen pathogen development and survival rates, disease transmission, and host susceptibility to infection. Marine disease agents reduce somatic size and create mass mortalities of reared populations (causing catastrophic economic losses). Disease agents include viruses, bacteria, protists and metazoan parasites. Worse, disease agents in aquaculture could transfer from farms to the wild via escapes or by water outflow (effluent) to the environment, thus affecting wild fisheries.

The task forces face knowledge gaps

The task forces lack knowledge about each other and available functions and tools, specifically:

- Meteorological models and emission scenarios to assess climate change impacts over the whole EMME region (e.g., link with scientific basis task force).
- Common exercises for predicting extreme events (like heat waves, floods, droughts, etc.) in the region (link with scientific basis task force)
- Detailed surveys of climate change impacts on water resources (link with eater resources task force).

Regarding EMME food systems, the task forces lack:

- Detailed regional surveys that show climate change impacts on soil resources and vulnerability.
- Common crop-simulation models to ease comparable assessments of climate change impacts on production.
- Farmer awareness about adverse effects of climate change on yield and quality of crops, animals and aquaculture.
- Knowledge about new, invasive pests, diseases, and weeds (dispersion and epidemiology) in agricultural ecosystems. Need to monitor and establish early warning systems against outbreaks.
- Knowledge on crop/pathogen interactions under climate change.
- Knowledge about urban and peri-urban agricultural ecosystems and their contributions to food production
- Knowledge on climate change impacts on food prices, non-agricultural income and food safety.
- Knowledge on technologies and best-performing practices for water management practices.

Regarding animal production, there are task force gaps in knowledge about:

- Animal adaptation to stressing agents introduced by climate change.
- New practices in rangeland ecology (matching stocking rates with pasture production, adjusting herd and water point management to altered seasonal and spatial patterns of forage production, managing diet quality, more effective use of silage, pasture seeding and rotation and the use of more suitable livestock breeds or species etc.).

Regarding land degradation, the task forces lack knowledge about:

- How desertification is tied to socio-economic development.
- Available solutions and best practices to combat desertification.
- The contribution of microbial communities on CO2 fixation in soils.
- Soil biodiversity and function across the region.

Finally, regarding aquaculture, the task forces lack knowledge about:

- Diseases baselines and time-series monitoring.
- Baseline setting and monitoring of wild populations and farmed species via standardised methodologies.
- Determining the climate parameters for disease outbreaks among the farmed species.

Policy measures for climate adaptation and mitigation

To secure food production in the EMME region in the face of climate change will require national governments to adopt strong policies and measures. Yet fundamental reforms and synergies should be regionally coordinated. At a regional level, key policy guidance should flow out of institutional interactions, technical upgrades, and science-based solutions. It will be essential to mobilise regional resources to ensure knowledge transfer and investments in agriculture ecosystems so the food production sector can adapt to climate change. The table below summarises the policy measures for adaptation to climate change in the EMME region.

Table 1. Policy measures for adaptation to climate change in the EMME region

Policy	Implementation measures	Examples of actions	Mitigation	Adaptation	Beneficiaries	Implementation term
Create strong, direct links between science and administration	• Build capacity with novel structure easing communication bn scientists and politicians				National Transnational	Short
Produce new knowledge through research	• Prioritise climate change and adaptation research in national research policies • Establish cooperative funding for regional research	• Master crop and weed physiology linked to climate change. • Organise surveys on climate change impacts on agriculture and fisheries. • Utilise local germplasm for new resilient cultivars		+	National Transnational	Short and medium
Emphasise education/ outreach	• Raise public awareness on the initiative and its benefits to national economies and societies • Disseminate joint research outcomes to all stakeholders		+	+	National	Medium and long
Develop policy tools for adaptation/ mitigation measures	• Create reliable indicators for assessing adaptation/ mitigation frameworks and measures	• Best practices of sustainable measures for agriculture and natural ecosystems • Adopt and scale up conservation practices in rainfed agriculture • Best practices of integrated livestock–crop production systems	+	+	National	Short
Prepare strong package of incentives for farmers	• Adopt sustainability measures for soil, water, biodiversity, energy • Promote low-input agriculture		+	+	National	Short
Predict and face environmental degradation and crop losses by pests and diseases	• Build networks of observatories to monitor water resources, soil degradation, and track invasive pests and pathogens			+	National Transnational	Short and medium
Build appropriate infrastructures for facing extreme events	• More investments from national and international foundations	• protection from floods. -• water reservoirs • reforestation and restoration • modernised irrigation		+	National	Medium and long
Protect rural income	• Establish new (or extend existing) insurance for agricultural production from extreme events	• develop reliable crop-loss assessment capacity		+	National	Medium

7. Education and Outreach

Coordinators

Aravella Zachariou
Emad Adly

Cyprus Institute Liaison Scientist

Thanasis Hadzilacos

Task Force Members

Ghaida Abbdulkareem Abu-Rumman
Sabah Saleh Aljenaid
Ali Awadh Al Amoudi
Wijdan Ali Al-Oqab
Safa Ahmad Baydoun
Bernard Combes
Abdoul Wahab Coulibaly
Mona El Zoghbi
Arnault Graves
Imad Hassoun Homsi
Alexander Leicht
Vasileios Makrakis
Michael Scoullos
Mohammed Saleem Ali Shtayeh

The content of the report was reviewed and finalised by Prof. Michael Scoullos and Dr. Aravella Zachariou

How does education relate to climate change mitigation and adaptation?

Education is one of the greatest tools available to combat climate change. The percentage of people who are aware of climate change and understand its global impact shows the importance of education. This awareness was achieved through education. People who see and understand the threat of climate change are accordingly prepared to undertake the measures needed to mitigate and adapt to climate change.

Addressing climate change requires scientific advancement, social inclusion, and a strong understanding of the challenges posed by, and potential solutions for addressing, climate change, all of which can be achieved only through a transformative approach achieved through education itself. Climate change education (or CCE) should from the beginning be understood as integral to Education for Sustainable Development (ESD), which focuses on learnings, teachings and experiences about complex phenomena, beyond emissions of greenhouse gases, and in so doing develop effective responses (including both mitigation and adaptation) to climate change. CCE requires citizens to take a deeper look at ESD efforts and policies. It involves understanding what additional actions on climate change make the best use, within ESD concepts and structures, of existing initiatives, while developing necessary new approaches to better address this huge challenge. In order to mobilise positive change in the EMME region, CCE is a prerequisite if key policy makers and leaders are to inform, convince and involve people at the right political levels while mobilising stakeholder support for appropriate action throughout the EMME region.

Why CCE is critical to the EMME region

The aim of this report is to support countries in the EMME region to more effectively address the climate change crisis by integrating CCE into their overall policies and activities. The report is based on an analysis of diverse resources, including formal country and regional reports, research papers, policies, and surveys on CCE provided by the respective ministries and national and regional agencies, organisations and institutions. The report also examined resources and initiatives arising from general approaches to ESD, Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs), and other relevant documents regarding CCE and sustainable development. The report devotes different sections, below, to CCE throughout the range of educational systems and professional development, extending through research on CCE and regional cooperation.

Despite the limitations of the report, the authors are pleased to note that it represents the first large-scale climate change educational initiative in the region. It identifies CCE trends, commonalities and gaps in EMME region, and seeks to cover, to the extent possible, key areas integrating climate change knowledge and practice into education. The breadth of the effort to explore and acknowledge climate change in education has long been addressed through ESD approaches. The report nevertheless emphasises the value of this work because it provides a baseline against which future progress can be assessed.

What are the main gaps and challenges?

The report reveals diverse CCE challenges, which differ across educational settings and levels.

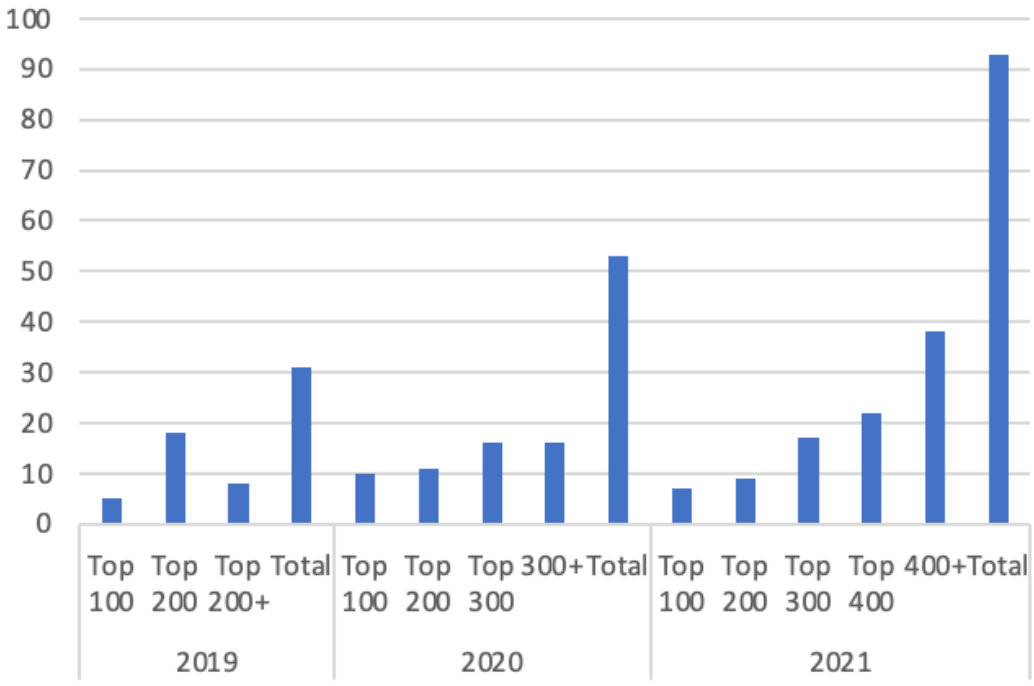
School-age CCE. There is evident progress on instruction that integrates CCE with ESD and the SDGs among school-aged children across the region. There is, in addition, greater emphasis on interactive and student-centered learning techniques. Despite this progress, however, CCE lacks emphasis on social and cultural aspects of climate change. Additionally, gaps were noted on CCE approaches to critical thinking and problem solving, in comparison with the prevalent knowledge-based approaches that teach "what climate change is." There is also a need for educators to address climate change in a more direct and explicit way, as compared with generic sustainability topics, and to focus on teacher preparation and training and new and innovative teaching methods addressing climate change and its impacts.

CCE in higher education. University education has seen significant new attention to climate change through new CCE approaches and initiatives. Since the rankings were first established in 2019, the number of universities offering CCE has approximately tripled, and many universities in the region maintain high levels of global competitiveness in terms of SDG 13 (see figure below).

Despite the CCE progress in these institutions of higher education, the report identified various gaps throughout the EMME region in university programs (both undergraduate and post-graduate) on pre-service and in-service teacher education directly addressing ESD and CCE. In addition, most programs that the report identified on climate change are post-graduate offerings. While the undergraduate curricula integrate some CCE elements into topics and lectures, there were no stand-alone undergraduate-level programs on climate change. As with the findings, above, for school-age curricula, there are obvious gaps in CC and SD courses that are not directly related to natural science or engineering (e.g., medicine, business, arts, sociology, etc.).

CCE in professional development. Teacher education on climate change needs further elaboration. The main challenges for CCE in professional development settings arise from inadequate support structures that governments have mandated to provide such development. While various initiatives have been undertaken to train teachers, mostly in-service, on ESD and CCE, the region has few dedicated professional education programs to offer its teachers. CCE training is therefore difficult to integrate into professional development. Another gap stems from trainee-educators themselves. Many say they do not see how CCE training advances their careers and livelihood, so they pay scant

Figure 1. Universities offering education in climate change, 2019-21



attention. Others have much higher expectations of the trainings than what their systems can offer.

CCE in vocational education and training. Integrating CCE and ESD as topics within the TVET institutional curriculum would be one way to teach climate change. A more advanced approach would be directly linking climate careers and green jobs with CCE in TVET, so economic advancement is tied to climate change work opportunities. There is significant work to be done in matching demand for climate change jobs with supply in a rapidly developing market. High-quality knowledge and expertise are needed to meet both the current country conditions and to prepare for the future.

CCE in informal and non-formal education. This difficult challenge involves, first, selecting the best modes for reaching the general public and, second, choosing specific issue and how to characterise a given topic. Because climate change is highly complex, the issues do not lend themselves readily to traditional methods of awareness raising. Another difficulty is balancing the need to convey urgency without resorting to alarming exaggerations. The right balance mixes "positive thinking" without the fatalism or superficial criticism of others that mars some awareness- raising campaigns. It imparts the need for critical thinking in a spirit of solidarity and social mobilisation.

CCE teaching materials. In the EMME region, governments, regional organisations and NGOs have developed various tools (manuals, guides, handbooks, and other material) to help teachers address ESD and CCE in formal, nonformal and informal educational settings. Despite specific, balanced, conclusive and comprehensive CCE content, a truly interdisciplinary approach seems lacking. This gap is growing because many educators in the region are not fluent in English (or French), the languages in which most of the internationally available materials are produced. Furthermore, educators and/or students have limited access to electronic media. The pre- and in-service teacher training should cover digitalisation, familiarisation with French and English and, where possible (see permits, copyrights, etc.), transactions in Mediterranean languages, particularly Arabic.

CCE research. ESD and CCE are governed by two, independent theoretical and scientific approaches. The first is purely educational, based on pedagogies, methodologies for inspiring, influencing behavioral changes and forming attitudes about striving for a better environment and a safer world. The second is based on the sciences, mostly natural sciences, complemented by analyses in which socioecological and cultural dimensions are important. Education about climate change is a global challenge. To enhance CCE research, the region needs to strengthen cross-sectoral and interdepartmental collaborations among scientists promoting problem solving and critical thinking.

In the field of **CCE and regional cooperation**, despite the political difficulties besetting the region, there is genuine will and significant engagement with the impact of climate change. People want to find appropriate modes and channels of cooperation and synergies in addressing the critical common challenge of climate change. There are three levels of potential cooperation: (a) among governmental ministries of the EMME countries; (b) among networks of governmental Environmental Education Centers (EECs) able to undertake informal education through campaigns raising public awareness; and (c) facilitated interactions among NGOs, CSOs, and academic institutions active in the region.

Suggested strategic orientations for CCE and outreach in the EMME region

The analyses have value not for their details, where the policy recommendations appear in each section in the report. The value is to be found in the overall understanding, on the one hand, of the prevailing conditions and needs at regional level, and, on the other, of how the policy landscape is formulated for climate change education.

The first strategic orientation concerns the autonomy of the CCE work/task force in relation to the CCI overall. Two options are proposed.

- **Option 1:** The CCE initiative would follow in the path of the Regional Climate Initiative and the general provisions contained therein.
- **Option 2:** The EMME countries agree that the CCE initiative may move somewhat independently; or it might move faster or even in an operationally differentiated, more flexible way than other components of the CCI that are more political, technical, or costly.

The second strategic orientation concerns the process for elaborating a roadmap that can be understood and easily followed by all, without creating costly structures and bureaucracy, meanwhile safeguarding transparency, fair play and accountability so as to avoid the cost pitfalls and power games that sometimes befall similar initiatives.

For the second strategic orientation, there could be several alternative ways to move forward:

- **Identify gaps** to be prioritised, followed by an elaboration of recommendations to overcome the gaps at national and then regional levels, where collaboration could be encouraged and eventually supported through joint efforts.
- **Agree on a vision** that will include the ambition of the EMME region to turn what is considered a turbulent and vulnerable world region into a global pioneer in the use of CCE to inspire youth, academics, and other stakeholders (and society as a whole) towards a more secure future.
- **Agree on a facilitating structure** able to coordinate action for the promotion of CCE. The structure would mobilise other countries and stakeholders and eventually find financing for programmes, projects and joint activities.
- A CCE/ESD committee/task force, comprising representation from each of the EMME countries, could eventually grant regional bodies observer status and bestow advisory roles on a few more competent organisations (e.g., the MCESD). The committee could appoint a provisional presidium, supported during an initial period by a small provisional secretariat.
- A strategic document could be proposed – a declaration or charter or memorandum of understanding. It should be a brief vision paper stating the scope, ambitions and a general action plan for CCE in the EMME region, to be agreed among the countries as a document providing broad guidance for the CCE development at country and regional levels.

8. Migration

Task Force Coordination and Lead Author

Dr. Nicolas Jarraud, the Cyprus Institute

Members of the Migration Task Force (in alphabetical order):

Dr. Bertrand Baldet, SeeD

Mr. Mahmoud Driaat, Ecopeace

Asst. Prof. Dr. Mazin Nazar Fadhel, Mosul University

Ms. Roula Majdalani, UN-ESCWA

Dr. Rita Der Sarkissian, École des Ingénieurs de la Ville de Paris

Prof. Ourania Tzoraki, University of the Aegean

Other Contributors

Dr. Marco Neira, Cyprus Institute/EMME-CCI Health Task Force

Dr. Nestor Fylaktos, Cyprus Institute/EMME-CCI Energy Task Force

Prof. Thanasis Hadzilacos, Cyprus Institute

Disclaimer

The opinions expressed in this publication are those of the authors. They do not purport to reflect the opinions or views of the wider EMME-CCI nor the official policy of countries participating in this initiative, nor any of the other partners who were consulted. Migration is a sensitive issue, and the authors have attempted to the best of their ability to reflect the current literature on the climate and migration nexus in the EMME region. This report is a collective effort, and the result of deliberations and compromise between the various authors and external stakeholders who also informed its compilation.

Acknowledgements

We would like to thank all members of the Migration Task Force of the Eastern Mediterranean and Middle East Climate Change Initiative, with whom the authors deliberated on various important sections of the report. In particular, the authors would also like to thank colleagues from the International Organization for Migration (Alice Baillat) and the United Nations High Commissioner for Refugees (Florence Geoffroy), who over the past few months have provided us with constructive dialogue, pointed us to invaluable references in the literature and generally shared their vast expertise and insights into this complex and delicate subject.

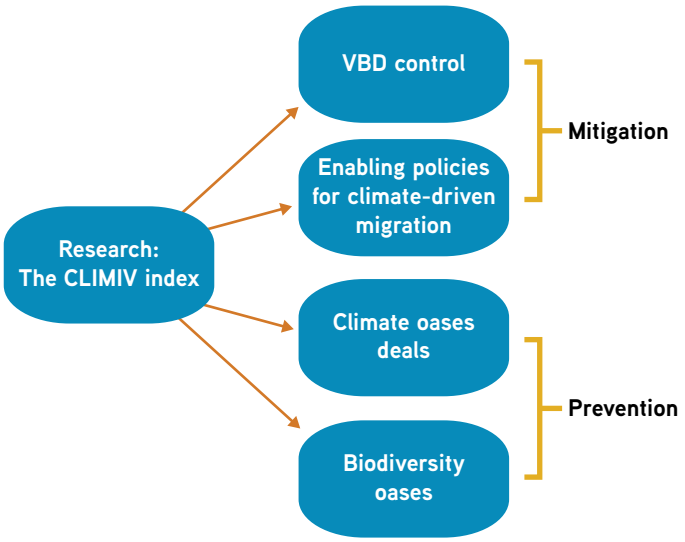
The Eastern Mediterranean and Middle East (EMME) region is at the confluence of several global challenges: this region of almost 400 million inhabitants is not only suffering disproportionately from the effects of climate change, but it is also prone to a range of challenges, from environmental degradation to economic challenges to civic strife and conflicts, with migration a major consequence. Climate change is clearly a threat multiplier, and although the full extent of its impact on migration at the present time is hotly debated, most analysts agree that it will play a larger role in decades to come as a driver of migration, either directly or indirectly.

The Migration Task Force of the EMME Climate Change Initiative (EMME-CCI) reviewed linkages between climate and migration in the region, identified knowledge and policy gaps and proposed concrete policy recommendations and frameworks aimed at addressing the challenges posed by the climate-migration nexus.

Unfortunately, the EMME region is characterised by a dearth of policies aimed at addressing the combined challenges of climate change and migration, and of efforts towards transboundary co-operation to address these issues. There are also some major gaps in knowledge, especially regarding the precise nature of the interaction between climate change and migration in the region. Although it is obviously crucial to address the root causes of migration through climate adaptation and other measures, these would not be enough and would come too late to prevent further forced migrations unless accompanied by strong measures to protect internally or internationally displaced people and ensure safe, orderly and regular migration in the context of climate change, environmental degradation and disasters. In addition, we must move away from rhetoric that characterises migration as a negative phenomenon. Migration has multiple benefits to those emigrating (moving out of harm's way, easing pressure on vulnerable areas, etc.) and to host societies (bringing skills, labour, remittances, intangible cultural heritage, etc.). As such, migration is one of several possible climate adaptation measures.

The policy recommendations identified by the task force focus on a full range of solutions, from collecting data to informing the policy-making process, to climate adaptation,

Figure 1. The research and policy framework of the Migration Task Force



Note: CLIMIV = Climate-Migration Vulnerability; VBD = vector-borne disease.

disaster risk reduction and development measures that build community resilience and are conflict, gender and migration sensitive. It is important that climate adaptation measures improve the well-being of refugee and migrant communities and help them better integrate in, and contribute to, their host countries as well as safely return to their places of origin if that is possible.

Based on this analysis, the task force produced five key recommendations, which fit into the wider policy framework laid out in Figure 1.

Within this context, the five recommendations of the task force can be summarised as follows:

- Produce an EMME Climate-Migration Vulnerability Index, an evidence-based policy tool that would be used by policy makers in most countries in the EMME region to identify climate-driven migration hotspots. This measure must precede all the other recommendations below, since without it, there will be an insufficient evidence base for rolling out effective programmes to address the climate-migration nexus. Indeed, if any of these suggested policy measures, frameworks and initiatives are to be successful, we must first address the massive gaps in knowledge of the climate-migration nexus in the EMME region.
- Facilitate community engagement to control vector-borne diseases among displaced populations. In camps that house refugees and internally displaced persons throughout the EMME region, community-based groups would work to:
  - Monitor populations for disease vectors.
  - Raise awareness of hygiene and other health measures, including vaccination campaigns.
  - Provide early warnings to authorities of disease outbreaks.
  - Implement simple measures to reduce insect breeding grounds in refugee camps.
  - Ultimately, the objective is to see a 25% reduction in the incidence of vector-borne diseases in refugee camps within a decade.
- **Establish so-called climate oases.** The aim is to create a significant number of green jobs through the implementation of concrete climate adaptation measures. This would reduce the incentives for migration and foster community resilience to climate change.
- **Set enabling policy frameworks that include climate-driven migration.** The premise of this recommendation is that, in many cases, migration will be a valid climate adaptation measure, most climate migration will be internal, climate change drivers are difficult to prove and not all migration is forced. As such, the idea is to promote the consistent integration of existing international treaties and policy frameworks into national legislation throughout the EMME region. This would support efforts to recognise climate-migration linkages, and protect and integrate migrants, whether they are internally displaced or refugees, and engage with them as actors in the climate adaptation struggle.
- **Create biodiversity oases.** Based on the premise that healthy ecosystems act as buffers against the worst impacts of climate change and build community resilience, this initiative would provide pathways to conflict transformation and climate adaptation for the EMME region. A series of participatory pilot projects centred on the protection of biodiversity would ultimately lead to the creation of incentives to reduce the pressure behind the climate- or conflict-driven exodus.

9. Tourism and Climate Change in the EMME Region

Task Force Coordinator

Harry Coccossis

Members of the Task Force

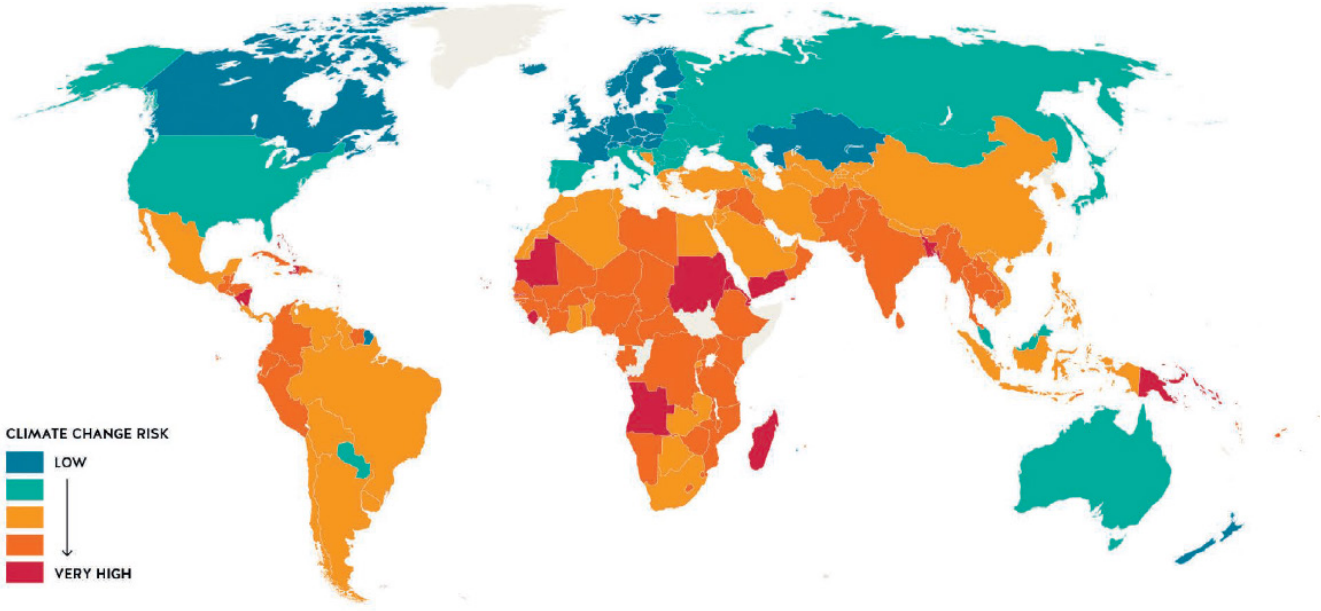
Nikolaos Boukas
Anthi Charalambous
Anna Farmaki
Dimitrios Stylidis
assisted by Tonia Koutsopoulou

Tourism is affected by climate change worldwide. But the Eastern Mediterranean and Middle East (EMME) region is considered a hotspot because of increases in mean temperatures and the temporal variability of its meteorological features. Temperature trends (mean temperature and summer peaks) in the region will continue to intensify through the 21st century, leading to extreme weather events such as heatwaves and severe prolonged droughts. The frequency, duration and magnitude of these events is expected to grow, with severe impacts on society, environment and economic activity in the region. These will affect tourism in many ways. In addition to the region's growing population and urbanisation, competition over natural resources is expected to intensify, exacerbating environmental problems and social inequalities, conditions which may also affect tourism.

The far-reaching direct and indirect impacts of climate change are already threatening the sustainability of tourism activity worldwide. However, the sensitivity of specific destinations to climate change, as well as their ability of adapt to the risks and opportunities that may rise, vary significantly by region. The implications of climate change for living conditions, the environment and the economy of the EMME countries are expected to intensify. Based on the European Travel Commission's 2018 global analysis of climate change risk for tourism, the countries of the EMME region face a medium to high level of risk for the future of their tourism economy (Figure 1). The vulnerability and economic viability of the sector depends highly on the adaptive capacity of each country in relation to its economic, social and political conditions (MedECC,2020).

More specifically, the increase in mean temperature and heat waves is expected to affect summertime comfort for tourists and therefore reduce tourism flows in the core summer months from June to August. Sea level rise will probably affect tourism infrastructure and activities in coastal areas. Even more crucial to the tourism sector – and to living conditions in the region – is the predicted drop in access to freshwater resources. The Middle East, in particular, has been identified as the first world region to run out of fresh water, with major implications for

Figure 1: Global climate risk for tourism (ETC, 2018)



Source: ETC (2018).

tourism, touching both tourists and related infrastructure. The limited availability of water resources will aggravate conflicts over the use of water for economic activities in the region, especially during the summer months when tourism activity is at its highest peak (MedECC, 2020; CIMME, n.d.).

Alongside the direct effects of climate change on tourism, the indirect implications for tourism's primary resources in the region are likely to be very serious. The degradation of natural resources, including freshwater availability, may make some destinations less attractive. Climate change can raise nutrient enrichment, which in turn poses a major threat to coastal and marine ecosystems because of potential eutrophication. The effects of eutrophication on marine ecosystem services include the deterioration of beach waters and the alteration or even loss of the natural habitats that are considered primary resources for the type of tourism activities currently developed in the area. Coastal erosion owing to sea level rise will further the degradation of the coastal landscapes, causing severe alterations to beaches and threatening cultural heritage sites located on the coast (MedECC,2020).

Given the importance of tourism in the economy of the EMME region, adaptation policies and mitigation measures are needed to increase the resilience of the sector against climate change. Engaging all sub-sectors of the tourism industry in awareness-raising campaigns, strengthening the participation of local communities in decision making, enhancing the support of municipal and governmental authorities, weighing the merits of various potential actions, and improving managerial skills at the local, municipal and regional levels will all be required to save the region's vital tourism industry from the deleterious effects of climate change.

Moreover, the diversification of the tourism product in EMME region through the development of niche forms of tourism (rural, cultural, agricultural, urban, nature-based, sport, wellness, etc.) will be needed, not only to mitigate the effects of mass tourism development on the climate, but also to ensure the future of the tourism industry itself. Smaller-scale development in the hinterland could promote a more sustainable use of natural and cultural resources and formulate strong linkages with other important industries (e.g. the agri-food sector).

Reorientation of the tourism product in EMME should entail the "decongestion" of tourism hotspots by spreading tourism activity to less-accessible and less-developed areas (e.g., mountainous, natural, rural, cultural, etc.) through the enhancement of their infrastructure and superstructure. Decongestion of tourism hotspots – usually coastal destinations – is fundamental to climate change adaptation and can be achieved by improving accessibility and understanding the tourist needs of these areas.

Another important policy aspect is the transition towards greener tourist establishments and greener destinations through the introduction of green innovation measures in tourism services. Until now, many tourist facilities across the EMME region have operated in non-sustainable ways, exploiting local natural resources. Such practices threaten the sustainability of destinations by eroding their attractiveness and increasing their vulnerability to climate change.

In addition, there is a need to revise branding and marketing strategies that focus only on sun and sea, while ignoring alternative tourist attractions. Branding and marketing strategies should reflect a broader stakeholder perspective that includes the vision of the local community and highlights the full tourism potential of the destination. The development of sustainable brands that reflect the ethos of the destination and encourage the active participation of the local community in shaping and preserving each destination's identity is a powerful tool in building the resilience and sustainability of tourist destinations in the EMME region.

Finally, any adaptation framework for the EMME region needs to be reinforced by a set of mitigation measures for decarbonisation of the tourism sector. The tourism industry inevitably will have to reduce its environmental impacts, particularly in relation to the sector's water consumption and carbon footprint. This can be achieved by improving awareness and understanding of energy use in various tourism subsectors (such as accommodations); exploiting energy efficiency and renewable energy; reducing energy consumption; monitoring emissions; and raising consumer awareness to support change and overcome barriers.

The development and successful implementation of adaptation policies in the tourism sector will require a change of mentality among many different stakeholders, including

tourists, local communities, tourist companies and governments at all levels. Achieving cooperation among them and aligning their interests will require strong communication efforts and top-to-bottom techniques. Prerequisites for the necessary changes include effective and inclusive governance, constant communication among levels of government, and collaboration of various stakeholders' groups with the local community to shape a common vision for the future.

Governmental support and efficient organisation to align actions, accompanied by a mechanism for the evaluation of outcomes, will also be required. Furthermore, consulting local stakeholders about local needs and helping them to identify and prioritise those needs could significantly contribute to the transition of the region's destinations to a greener future. Communication strategies to raise awareness among stakeholders' groups and the sharing of best practices among regional destinations would also contribute to this end.

In conclusion, policy recommendations to improve adaptation to climate change will necessarily vary in their territorial coverage and face different challenges. However, despite differences in context, objectives and implementation methods, policy recommendations should fall within in a complementary and collaborative framework if they are to effectively address the multiple impacts of climate change on the sustainability of the region's tourism sector. Local and national policies to promote tourism and adaptation should be compatible with policies at other levels (global, European and regional) and in other areas (such as employment, transportation, heritage management and local well-being). They should also be aligned with policy frameworks related to innovation, biodiversity protection, and climate observation and research, as well as with the Sustainable Development Goals through better use of natural and cultural resources, exploitation of multiplier effects for the local economy, and the development of better working and living conditions for tourism employees and local communities.

References

European Travel Commission (ETC), 2018. *Tourism and Climate Change Mitigation, Embracing the Paris Agreement: Pathways to Decarbonisation*. Brussels.

MedECC, 2020. C*limate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future*. First Mediterranean Assessment Report. Marseille: Plan Bleu.

The Cyprus Institute (CIMME), n.d. *Climate change and impacts in the Eastern Mediterranean and the Middle East*. Research Media Ltd.

10. Enabling Technologies

Task Force Coordination

Prof. Constantinos Cartalis, National and Kapodistrian University of Athens

Cyprus Institute Liaison Scientist

Dr. George Tsouloupas

Task Force Members

Assistant Professor Fodil Fadli, Qatar University

Professor Diofantos Hadjimitsis, Cyprus University of Technology

Associate Professor Kareem Tonbol, Arab Academy for Science, Technology & Maritime Transport

Dr. Konstantinos Philippopoulos, National and Kapodistrian University of Athens

Dr. Jean Sciare, Cyprus Institute

The main findings of the task force concerning the use of enabling technologies to assess, mitigate and adapt to climate change in the EMME region are described below.

Several countries in the region are already making advanced use of enabling technologies, especially Earth observation and artificial intelligence. Substantial gaps exist, however, in regional knowledge and awareness about enabling technologies, resulting in the limited use of Earth observation data in public policy or AI in climate applications, as well as in drafting sectoral mitigation and adaptation plans. Poorer nations may find it hard to access enabling technologies. Disparities can be traced to varying levels of economic development and degrees of integration of information technology.

These essential technologies can be leveraged to benefit the entire region through the exchange of technologies and innovation; to demonstrate the potential of Earth observation, AI and other technologies can meet public sector needs; and to establish open-access climate data repositories.

Understanding the practical applications of enabling technologies is a top priority best addressed through capacity building and knowledge transfer, which can be facilitated through regional and international cooperation. A policy environment that promotes open data and a culture of data integration and use is needed. Enabling technologies must be assessed continually to track beneficial developments related to climate change.

Affordable and wide-scale deployment of enabling technologies will spur advances and support widespread adoption. Government use is critical in ensuring that enabling technologies address climate change and its impacts, while scalable deployment is critical to resilience strategies at all levels.

Enabling technologies have decision-support systems that help to (1) assess the spatial impacts of climate change, now and in the future; (2) tailor products to address the links between climate change and energy, agriculture and the urban environment sectors; and (3) adopt policies to mitigate and adapt to climate change.

Enabling technologies in the EMME region have a high potential to support the assessment and mitigation of climate change (and adaptations to its impacts) through Earth observation, geographic information systems, artificial intelligence (AI), machine learning, visualisation, digitalisation, and data-sharing systems.

The broad applications of these technologies include monitoring extreme weather events, measuring thermal environments in urban areas, deploying climate and geospatial data both to depict climate risks and assess vulnerability to those risks, predicting climate change's temporal and spatial effects, and assessing the links between climate change and energy production and consumption.

Enabling technologies can support the development of a system of climate services. These services would support smart decisions and better management of the risks and opportunities of climate variability and change in climate-sensitive productive sectors – including agriculture, energy, tourism and food security – as well as in society as a whole. A system of climate services depends on the following tasks:

- Collection of knowledge about the climate system, past, present and likely future
- Identification of the necessary data – climate-related, environmental, geospatial and socioeconomic
- Identification of the climate risks facing the region

- Alignment of those risks with the sector circumstances, especially those most sensitive to climate variability and change
- Development and provision of tools and products to support decisions about adaptation to and mitigation of climate change
- Identification of the enabling technologies needed to carry out these tasks.

Based on its analysis of the characteristics of the EMME region and the needs of end users and stakeholders in the region, it is proposed that the climate services system take the form of a **Climate Services Hub** having the capacity to:

Organise data in a robust repository

- Deploy multi-scale climate modelling, including statistical and dynamic downscaling
- Develop a system of indicators for the early recognition of trends
- Support visualisation of the temporal and spatial effects of climate change
- Provide climate services in key sectors of the EMME region
- Facilitate the development of adaptation and mitigation policies and plans using specially designed tools and indicators
- Promote the Hub's potential to support the needs of the public and private sectors in the EMME region
- Build a strong educational pillar
- Transfer knowledge and build capacity to achieve the desired outcomes.

The architecture of the Climate Services Hub is shown in the following figure.

Figure 1. Architecture of the proposed Climate Services Hub

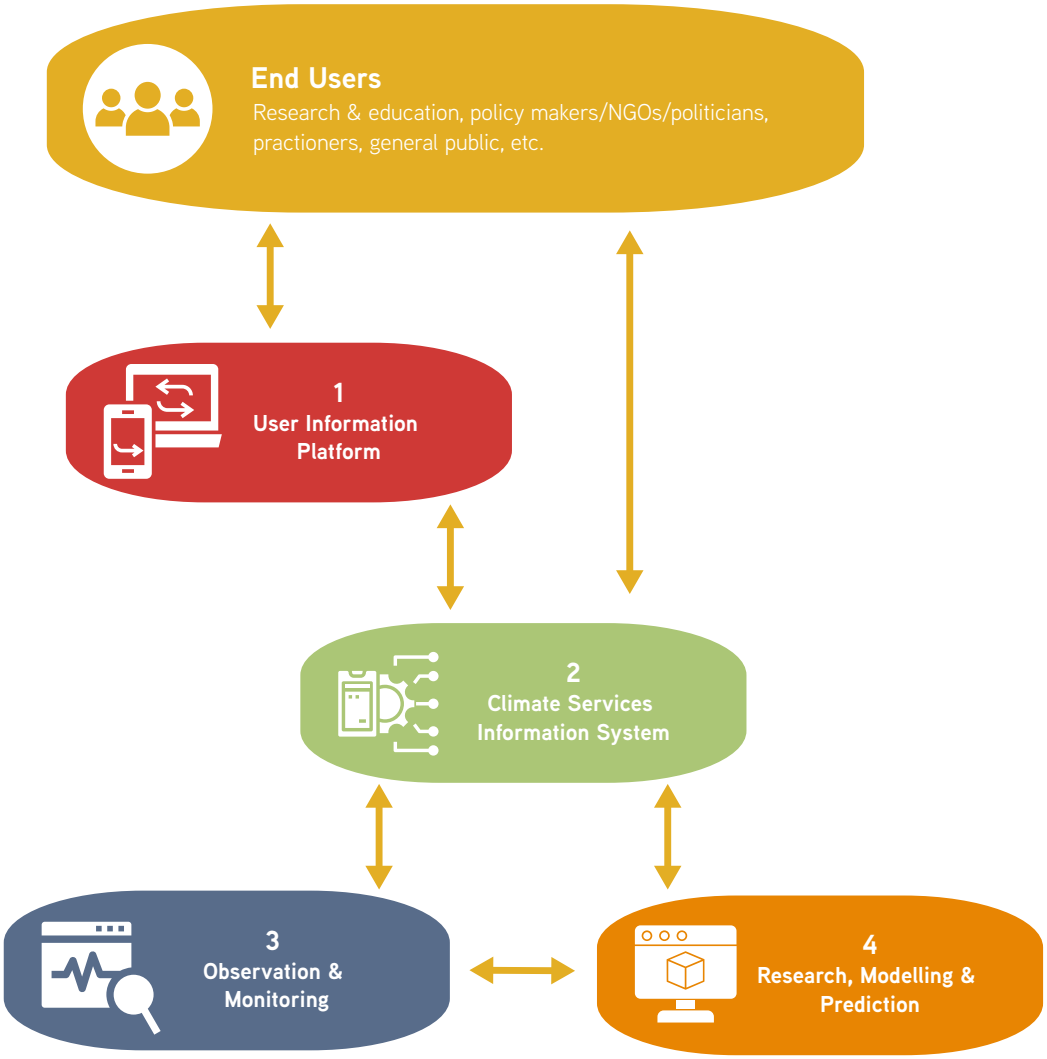
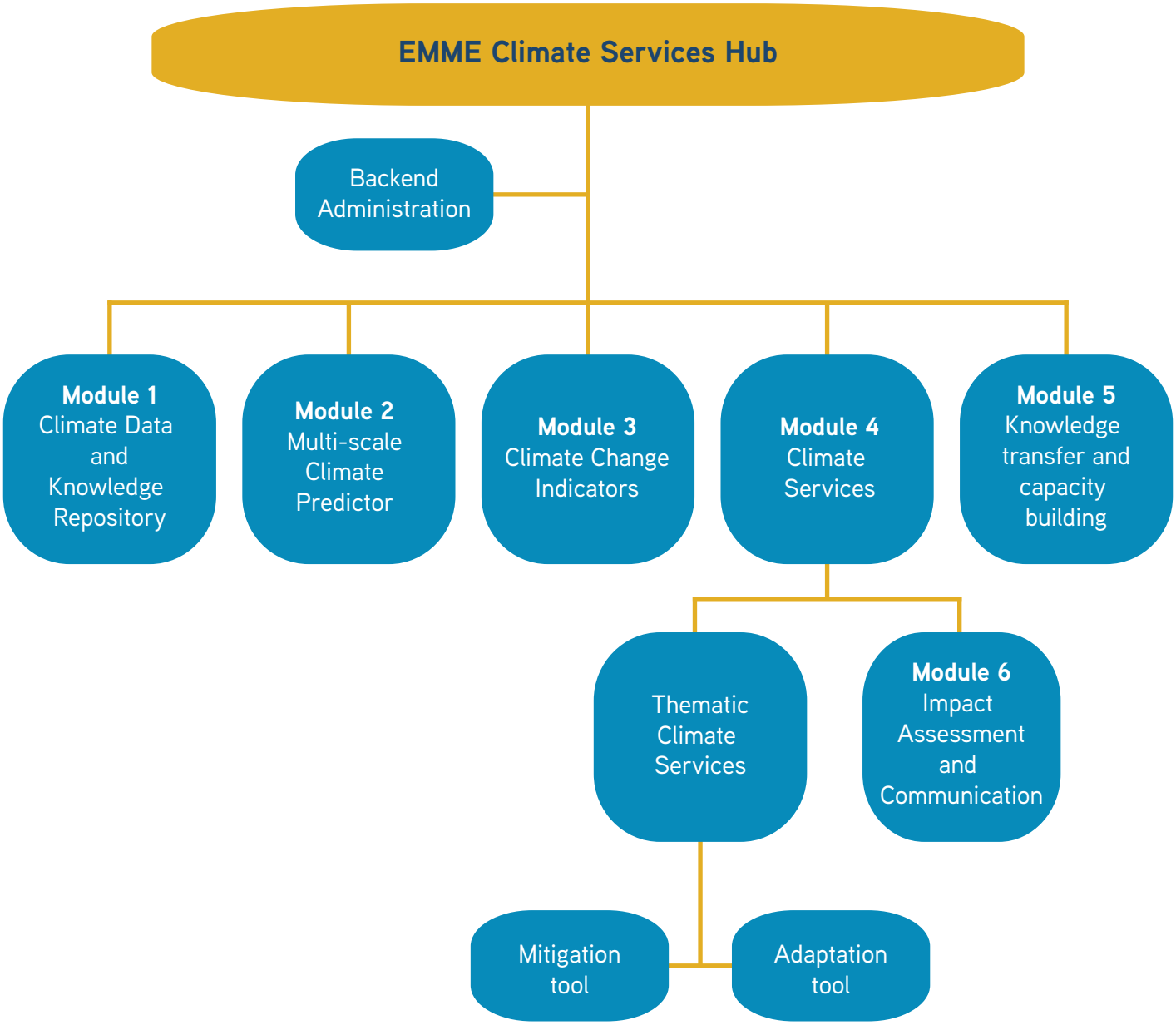


Figure 2. Modules of the proposed Climate Services Hub



The **user interface platform** allows users, scientists, climate researchers, climate information providers, stakeholders and end users to interact at all levels.

The **climate services information system** is a mechanism for collecting information about the climate and then organising, storing and processing the information to generate products and services.

A **system for observation and monitoring** ensures that climate observations (including Earth observation) and other data (including metadata) are collected, managed and disseminated to meet the needs of end users.

Research, modelling and prediction functions promote research on climate modelling, embracing statistical and dynamic downscaling and including decadal to seasonal predictions.

At a second level of analysis, the modules of the proposed **Climate Services Hub** are presented below.

In conclusion, enabling technologies offer innovative solutions to meet the climate-related needs of the EMME region. Leveraging enabling technologies to provide climate services represents a significant opportunity to accelerate efforts to combat climate change and its impacts. The proposed **Climate Services Hub** would go far to meet the needs of the public and private sectors of the countries of the region to assess, mitigate and adapt to climate change.

11. Green Economy and Innovation

Task Force Coordination

Fabio Maria Montagnino, The Cyprus Institute

Cyprus Institute Liaison Scientist

Vassilios Tsakalos

Task Force Members

Hussein Abaza, Advisor, Minister of Environment, Egypt

Fahmi Abu Al-Rub, Director, Applied Scientific Research Fund (ASRF), Jordan

Thomas Andersson, President, IKED, Oman

Adi Barel, Director, European Institute of Innovation and Technology- EIT Hub, Israel

Nicola Bettio, Professor, HCT, UAE

Ramy Boujawdeh, Deputy General Manager, Berytech Incubator, Lebanon

Federico Maria Butera, Professor Emeritus, Politecnico di Milano, Intl. Exp.

Alexandros Charalambidis, Professor, CUT / EIT Climate KIC hub, Cyprus

Anthi Charalambous, OEB, Cyprus

Shada El-Sharif, Senior Advisor, SustainMENA, Jordan

Scott Fargher, Associate Professor, Mohammed Bin Rashid School of Government, UAE

Piero Formica, Professor, Innovation Value Institute at Maynooth University, Intl. Exp.

Cleofe Guardigli, Sociologist, International IPA II Expert, Turkey

Yousef Haik, Professor, Hamad Bin Khalifa University, Qatar

Khaled Shana'a, Professor, Palestinian Ahlyia University (PAU), Palestine

Suhil Kiwan, Dean of Engineering Faculty, Jordan University of Science and Technology (JUST), Jordan

Konstantinos Klevoulou, Assist. VP Strategy, The Cyprus Institute, Cyprus

Maria Markidou Georgiadou, Managing Director, Cyprus Seeds, Cyprus

Deepti Mahajan Mittal, Senior Policy Specialist, UAE Ministry of Environment, UAE

Vincenzo Nicolò, Professor, INTENTAC, Intl. Exp.

Amr Radwan, Director of Research, Egyptian Centre for Innovation and Technology Development (ECITD), Egypt

Nicos Rossides, Advisor to the Board, The Cyprus Institute, Cyprus

Penelope Shihab, CEO, Monojo, Jordan

Andri Theodorou, KEBE, Cyprus

Anastasios Vasiliadis, Director, IED, Greece

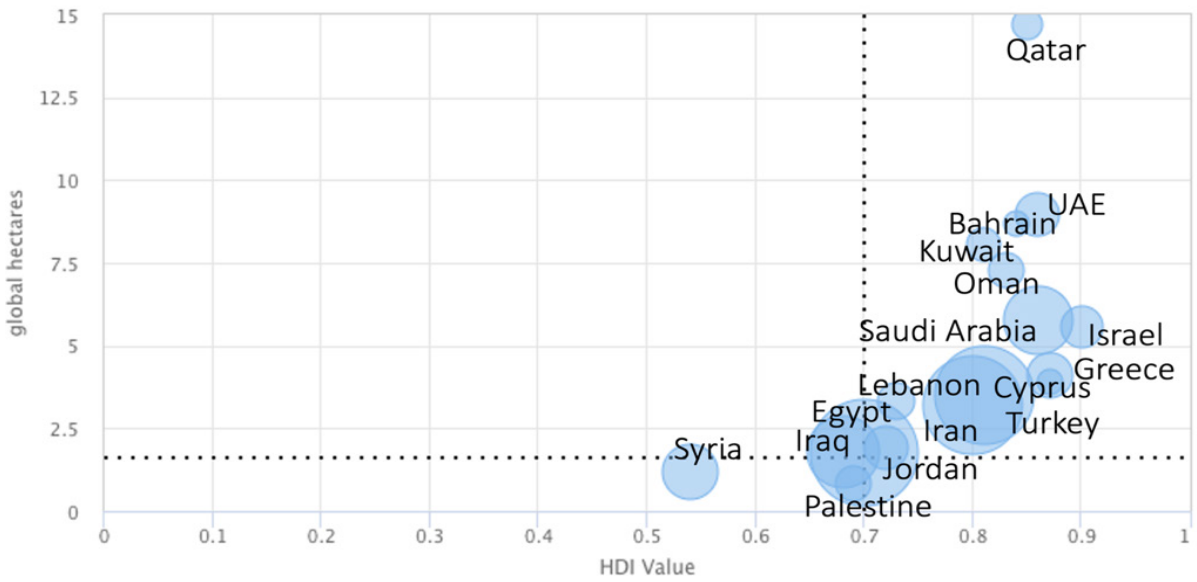
Mohamed Ahmed Wageih, Project Management Officer, PRIMA Foundation, Egypt

Shiri Zemah Shamir, Researcher, School of Sustainability of IDC Herzliya, Israel

Only a deep, rapid transformation of our economic model can offset the emissions affecting the climate stability, stop the loss of natural environments and biodiversity, and regenerate the global commons that have been over-exploited. To systemically address the grave challenge of economic efficiency should give way to economically effective and purpose-driven, multilevel policies able to re-orient the economy towards an ecologically sustainable balance. To achieve that, a portfolio of transformative actions, should meanwhile address (i) economic and policy context and regulations, (ii) physical and digital infrastructures, (iii) social & cultural dimensions, (iv) science, education and skills.

For most of the EMME communities, which still require social improvements, green growth would be a practical pathway to fuse sustainable economic and environmental development into a single policy framework. Meanwhile, the wealthiest countries will be asked to implement new strategies that target prosperity instead of growth. In terms of Human Development Index (HDI), EMME countries are positioned in an "arch" spanning from low to high HDI, where the socio-economic performance is detrimental in terms of environmental impact equivalent hectares. GDP per capita structures the countries in three groups, apart from the exceptionally high value of Qatar: low income (Turkey, Lebanon, Jordan, Egypt, Iraq, Iran, Syria, Palestine), mid income (Greece, Cyprus, Oman, Saudi Arabia, Bahrain), high income (Israel, UAE, Kuwait).

Human Development Index in the EMME countries.
GEI TF elaboration of Global Footprint Network open data



The economy of the region is, on a country basis, highly diversified, and this adds greater complexity to efforts to establish a common regional trajectory towards green economy. In terms of GDP per capita, the correlation between innovation and economic development shows an interesting complementarity, providing hints for a country's trajectories. Israel has an excellent ranking, followed by Cyprus, and the UAE clearly leading the climb into the best quadrant with its determined effort to diversify its economy, an approach the other rich countries in the region are emulating. It's clear that innovative capacity and related investments could leverage the green transition, if framed in a consistent regional framework.

All the EMME countries show percentages of an urbanised population that exceed the world average, except for Egypt and Syria, and some cases of almost total urbanisation. Therefore, the region's transition to an urban metabolism (the green and circular model) emerges both as a priority and offers a playground for developing place-based green business models and innovation. It is also evident that the transformation of the food chain in the EMME region is particularly challenging, due to harsh or even prohibitive climatic conditions; relevant innovations are needed to optimise the overall system.

The economic transition should be supported by an appropriate financial system, which could leverage some pioneering experiences already established in the EMME region. A deeper scientific understanding of the interaction of economic processes with the regional stocks of natural capital should also pave the way to the implementation of Nature-Based Economy strategies. Emerging technologies will play a crucial, although not self-sufficient, role in driving the transition towards the green economy paradigm. Support for technology transfer, start-up and scale-up processes, and access to finance must all be part of the green economy framework. Specific EU measures and national policies are already available, and these should be tied into a regional ecosystem to offer a single EMME space for eco-innovation. Promoting green jobs through national employment policies and programs will also need a comprehensive policy approach that, on the one hand, stimulates investment in green sectors and, on the other, enhances the skills levels and employability of workers.

Despite the urgency and potential for development, it appears that green economy and innovation in the EMME region still lack a comprehensive design and coherence. Cross-border innovation policy frameworks and actions are missing, except for collaborations promoted by international donors. The information collected shows that moderate coverage, at the national level, of eco-innovation policies, while relevant efforts are needed to improve national initiatives and create a regional model. Greece and Cyprus are now committed to implement the EU's Green Deal framework, while Israel adopted a specific policy in 2014, which was recently revamped when the COVID-19 pandemic struck. In 2020 Jordan established the Jordan

Environmental Fund, supported by USAID, and a Green Growth Strategy. The UAE adopted its Green Growth Strategy in 2012, and in 2015 approved the implementation mechanism for its Green Agenda 2030. Saudi Arabia recently followed its Strategic Vision 2030 with the launch of the Green Saudi Initiative and the Green Middle East Initiative, which are set to implement several ambitious programs in the country and the region. Other GCC countries have established strategies that envisage transitional paths towards a diversified and more green economy, which are already backing explorative initiatives. A contradictory situation is determined when green trends meet strong incentivising schemes for fossil fuels and energy-intensive activities, which remain in place, together with EMME's mainstream economic sector of oil and gas exploitation. Turkey and Egypt have explicitly adopted UN SDGs as the reference framework for their respective country strategies, while their growth model is still tied to heavy infrastructural investments and the expansion of resource-depleting markets. Iran appears to be delayed due to international economic sanctions affecting its overall economy, while Syria and Iraq are facing enormous problems arising from the disruptions of war. Lebanon and Palestine have set ambitious and dynamic environments, which are affected by adverse geopolitical factors and multiple acute crises.

The EMME region, due to this geopolitical specificity and fragility, should adopt a portfolio of actions and economic cases that translate generic global analysis into local, but deep and interconnected economics of change. The implementation of a regional policy for accelerating clean innovation should merge local and linear pipelines into a systemic and cross-border vision that considers the complex interactions that underpin the region's techno-social pathways. From this perspective, the Task Force suggests the implementation of EMME region green transitional missions in the four critical sectors of (i) urban transition, (ii) industrial symbiosis, (iii) water-energy-food nexus, (iv) economy of natural systems. Governance of these missions should enable an open and inclusive process of innovation, experimentation, evaluation and learning. Policies, legal arrangements and governance models that hinder the implementation of specific transitional paths should be holistically reconsidered. Substantial effort should be invested in co-creation, collaboration and communication, in order to achieve the largest consensus. Exploitable results and knowledge gained from previous schemes and projects – like good practices, open software and hardware, available capacities and skills, and existing infrastructure at piloting sites – should be leveraged at the regional level.

Figure 1. Levels of maturity of national green economy policy frameworks

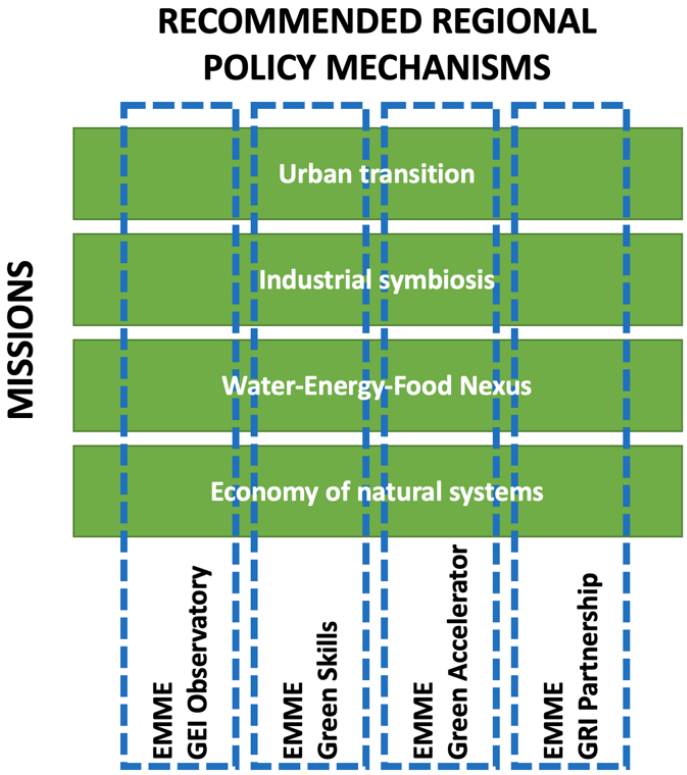
Legend: Pale green (e.g. Syria) = early debate. Light green (e.g. Oman) = partially established within country strategy/vision. Dark green (e.g. Egypt) = consolidated into a specific strategy. Darkest green (e.g. Greece) = structured into a commitment framework.

Apart from the geopolitical fragmentation and economic diversity, the development of a regional green-economy strategy in the EMME area is presently affected by the lack of policy and economic data collection. A regional analysis is missing, as well as regional policy design and evaluation frameworks. To overcome this gap, the Task Force recommends the establishment of a stable facility **(EMME GEI Observatory)**, which would facilitate the monitoring of information and data on Green Economy and Innovation in the region, along with the identification of relevant policies, policy measures and innovative schemes (including technologies, know-how and jobs).

The **EMME Green Skills** mechanism, inspired by the EU Erasmus+ program, would establish an international training and mobility program for trainees circulating among the EMME countries to gain skills and be re-skilled according to the demand arising from the growth of green economy sectors and the development of joint transformation agendas in the domains of Education and Vocational Training.

It is also recommended to implement an integrated regional model for green innovation, as a distributed system of green innovation hubs for creation and diffusion of knowledge, entrepreneurial experimentation, infrastructure support, and resource mobilisation. The **EMME Green Accelerator** platform would orient, integrate and empower already existing facilitation tools (incubators, accelerators, innovation hubs, science and technology parks) and local open-innovation ecosystems to promote the scaleup of transitional businesses in a regional perspective.Most task forces have identified major gaps in climate knowledge and scientific data for the region, highlighting the need for further research to ensure that policy recommendations are founded on solid information. As evidenced by bibliometric analysis, limited cooperation on regional research produces inefficiencies and duplication. Specifically, the GEI Task Force points to the untapped innovation potential from sharing data, best practices, emerging technologies and methodologies that can be reached through enhanced coordination both among EMME countries and between EMME countries and international agencies and organisations. It is suggested the establishment of an inter-governmental EMME regional research and innovation partnership (EMME Green Research & Innovation Partnership or **EMME GRI Partnership**) to promote and finance the implementation of transnational joint research and innovation activities, including the collection and sharing of scientific data as well as the identification and sharing of good practices and innovative solutions in climate change adaptation and environmental footprint mitigation. The partnership will serve as a mechanism to support, from the "push" side, the implementation of the suggested four green economy transitional missions, again: (i) urban transition, (ii) industrial symbiosis, (iii) water-energy-food nexus, and (iv) economy of natural systems.

Schematic representation of the proposed policy framework to support green economy and innovation in the EMME region



12. Cultural Heritage

Task Force Members

Prof. Nizar Abu-Jaber, German Jordanian University

Prof. Seif Assaad, Lebanese University

Prof. Nikolas Bakirtzis, The Cyprus Institute (Task Force Coordinator)

Prof. Costas Cartalis, University of Athens

Dr. Veronique Chankowski, French Archaeological School in Athens

Prof. Stella Demesticha, University of Cyprus

Prof. Mona Haggag, University of Alexandria

Prof. Sturt Manning, Cornell University

Dr. Houmam Saad, Syria Directorate General of Antiquities & Museums

Dr. Marina Solomidou-Ieronymidou, Cyprus Department of Antiquities

Dr. Jelena Trkulja, Qatar Museums Authority

Prof. Paolo Vitti / Mrs. Sneška Quaedvlic-Mihailović, Europa Nostra

Dr. Dante Abate, The Cyprus Institute (Cyprus Institute Liaison Scientist)

Climate change has emerged as one of the gravest threats, both at present and in the near future, to World Heritage and its protection and preservation. The Eastern Mediterranean and Middle East (EMME) region faces particularly grave threats from climate change. These hazards are already affecting sites, monuments and landscapes, posing critical challenges to the region's cultural and natural heritage, as well as its tangible and intangible legacies. On the one hand, climate change and its impacts are now inevitable. On the other hand, despite their enormous socioeconomic importance and value, cultural heritage sites remain a low priority for EMME region states. Consequently, significant gaps in knowledge and data are obscuring the specific impacts of climate change on cultural heritage (tangible and intangible) in the region. Beyond the framework of bodies like UNESCO, the International Council on Monuments and Sites (ICOMOS), the European Union and other international organisations and institutions have identified the threat and offered proposals for mitigation, adaptation and sustainability measures. EMME policies meanwhile remain limited and fragmented, lacking regional focus. Moreover, there is no coordinated monitoring to provide baseline data across the region and, thus, a platform for actions, policies and research.

The EMME region is an epicentre of World Cultural Heritage. As the proverbial cradle of several world civilisations—the Old World—with a rich archaeology tracing the formation of prehistoric and ancient cultures, civilisations and empires through time. These include Southwest Asian Neolithic sites and their first sedentary villages, in addition to the Babylonian, Egyptian, Assyrian, Hittite, Levantine, Cycladic, Minoan, Cypriot, Phoenician, Persian, Greek and Roman, Parthian, Sasanian, Byzantine and Umayyad, Abbasid and Seljuq civilisations, among others. All flourished in the region that also gave birth the three great monotheistic religions of Judaism, Christianity, and Islam. As a result, the region is home to a rich and diverse body of cultural heritage properties and traditions, hence making the challenge to protect them, through mitigation and adaptation to climate change measures, even greater.

The region's cultural heritage is, in addition, a significant economic resource: central to regional tourism. The region comprises country-states of varying sizes and populations, in different economic stages of development, and with differing political, social and cultural conditions and characteristics. Yet they all face a common challenge in climate change, which threatens their well-being and growth over the next decades. The region's rich cultural heritage is already affected and is expected to suffer further. Rising temperatures and sea level, increased coastal erosion, rainfall and extreme weather (droughts, fires, floods etc.), soil erosion, desertification and dwindling water resources, environmental/atmospheric pollution, as well as destructive development, looting, neglect, migration and war threaten both tangible and intangible heritage and the cultural landscapes that since antiquity have been the backbone of local communities and societies across the region.

Regional coordination is seen as essential to tackle these challenges. The Task Force on Cultural Heritage therefore aims to identify the threats, highlight knowledge, and fill research gaps so the landscape can be mapped. This effort will establish the groundwork for a policy toolkit and framework for regional collaboration. In doing so, it will

foster the exchange of know-how, expertise and good practices while it builds capacity among regional stakeholder-states. The report's vision is to capture where we stand at present, touch upon existing policies and strategies, and, then articulate a policy framework for adapting to and mitigating the shortfalls in attaining a resilient cultural heritage. Science and technology provide robust solutions for documenting, monitoring, predicting and assessing the impacts of climate change. In addition, this report points to the regional relevance of existing international policies and strategies and identifies the knowledge and research gaps across the stakeholder-countries. Finally, the role of cultural heritage as a change agent in any approach to sustainable development, a vital regional need.

Gaps in research and knowledge

A comprehensive knowledge outline is needed to enable stakeholder countries to identify gaps in research. The necessary step of providing such an outline will permit the region to arrange priorities and address the challenges that pose existential threats to cultural and natural heritage.

The correlation of climate parameters, climate change risks and the related impacts on the physical, social and cultural aspects of heritage represents the most significant gap in research. Aligned with and drawing from international initiatives and proposals (i.e., ICOMOS, ICCROM, UNESCO, Europa Nostra, Hellenic Initiative for the Protection of Cultural & Natural Heritage from climate change impact), the region requires a detailed listing of these correlations, adjusted for the EMME region, to begin assessing where we are, coordinating knowledge on these issues and, finally, prioritising our needs and related responses. As such, this correlation of climate parameters, risks and impacts is organised in the following cultural heritage categories: cultural landscapes, associated and traditional communities, intangible heritage, moveable heritage, archaeological resources, and buildings and structures.

These broad categories are correlated to a range of climate changes such as: increased temperature; changed freeze/thaw cycles; permafrost thaw; increased water vapor in the air; increased wind; climate-influenced wildfires; changes in seasonality and phenology; spread of invasive species and pests; changes in range, distribution and population of species; less precipitation / more drought; desertification; increased precipitation and more intense rainfall events; coastal, estuarine & freshwater flooding events; chronic coastal, estuarine & freshwater flooding & inundation; intensified storms; increased coastal erosion; rising water table; saltwater intrusion; sea acidification; pollution; climate driven development; and risks from climate mitigation actions.

The urgent need for mitigation measures in the EMME region will draw on the correlation between climate change parameters, risks and expected impacts on cultural heritage. Science and technology advances and tools can greatly aid efforts to document, monitor, predict, assess and as well to craft policies and strategies to meet the challenge. Furthermore, the humanities and the social sciences can be critical catalysts in framing the broader challenge in the EMME region as we try to learn from the past and redefine the meaning, value and role of cultural heritage in a changing world. A vital priority is the systematic mapping of at-risk heritage and the relevant strategic prioritisation of immediate, short and long-term measures and actions. Moreover, the region's low priority of cultural heritage in risk-management plans and the lack of integrated approaches for the protection of cultural heritage aggravates the regional predicament.

Another key gap in research for the region is the comprehensive integration of cultural heritage and its preservation in green economy developments. While tourism is vital for economic growth for stakeholder countries, the role that cultural heritage plays in sustainability planning (including responses to the impacts of climate change) remains limited; in several cases it's non-existent. Without focused data or studies, there can be no comprehensive understanding of the region's broader needs and challenges. Nonetheless, being able to promote the local up to the regional level is of critical importance.

Policy recommendations

While the regional nature of climate change is evident, cultural heritage sites and landscapes are profoundly local, each with a specific context, microclimate, hydrology, relief and so forth. And while there may be characteristics common to some sites and monuments (for example, in coastal or mountainous areas), the differences may outnumber the similarities. Taking this into consideration, it is still of vital importance to coordinate across the region, to exchange experiences, insights and good practices as we develop flexible yet nuanced responses to climate change impacts on cultural heritage. The policy areas listed below relate to the gaps described above and are recommended as a suitable way forward.

- **Mapping, risk assessment, monitoring and mitigation at both local and regional levels:** Identification

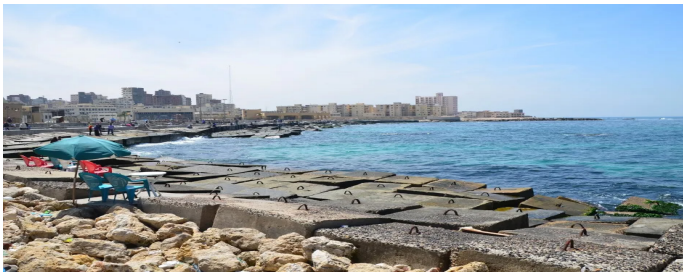
and prioritisation of the threats of climate change on cultural heritage. The region's stakeholders can move towards a more collective response to the challenge by drawing on a systematic mapping and risk assessment of heritage threatened by the impacts of climate change, targeted policies, mitigation and adaptation strategies as well as best practices.

- **Linking cultural heritage to the green economy:** Cultural heritage can be a change agent for adaptation and mitigation plans within broader green growth developments. Sustainable cultural heritage strategies can promote the valorisation of heritage assets (tourism, community engagement, local industries) and thus promote their direct association with key social and economic sustainability goals. While learning from international initiatives (i.e., the European Cultural Heritage Green Paper (2021) developed by Europa Nostra and ICOMOS to promote cultural heritage in the context of the European Green Deal framework), the EMME region can retain its valuable focus on sustainable solutions adjusted to regional needs and socioeconomic realities.
- **Raising awareness:** Communication, outreach and education can promote new policies, strategies and best practices, raising awareness and helping the region to prepare for and ameliorate climate change impacts so a more resilient cultural heritage can survive in the region. Again, an acute regional focus holds great potential for success and results.

Selected examples

A few case studies from the region show the range of threats directly and indirectly linked with the impacts of Climate Change, as well as, useful comparisons of plans, strategies, good practices.

Alexandria, Egypt



Rising sea levels and the related corrosion of coastal areas in the Mediterranean can be seen most notably in the ancient and historic city of Alexandria. This threat to Alexandria's heritage is further exacerbated by combined factors ranging from humidity, subsoil water, historically eroding geomorphology, the impact of climate change on the Nile Delta and uncontrolled urban development.

Besides efforts to strengthen the city's coastline and famous Corniche with the use of breakwaters and wave barriers, there is limited capacity to undertake large-scale planning, mitigation and adaptation measures. Interventions and initiatives focusing on specific sites and monuments can provide good-practice guidelines and raise awareness for the broader city. Examples include the effort of the American Research Center in Cairo project to restore and protect the Kom El-Shokafa cemetery, the Archaeological Society of Alexandria's project to safeguard and develop the Shatby necropolis with support from the A.G. Leventis Foundation, and the project to protect the Abu Mina site from groundwater erosion.

Petra, Jordan

Flash floods in the World Heritage site of Petra in Jordan have been a problem ever since the Nabateans built the city over 2000 years ago.

The Nabateans intervened in the surrounding landscape (building terraces, gabions, check dams, etc.) aimed at slowing floods and reduce the amount of water flowing into the core of their city. In recent years, flash floods have been exacerbated by climate change, posing greater risks for the site, residents and tourists. Efforts to reduce the flood risk need to be compatible with the site's integrity. Research conducted by the German Jordanian University was adopted by the Petra Development Tourism Regional Authority (PDTRA), show that the rehabilitation and reuse of ancient flood control systems can sustainably protect the unique site to while learning from the original Nabatean engineers.

Olympia, Greece and Troodos region, Cyprus

Wildfires have been devastating the forested areas of countries like Greece, Cyprus and Turkey.

Natural heritage is directly affected as these forests are integral components of broader cultural landscapes; their loss has shattering impacts to the well-being local communities. Furthermore, World Heritage monuments and sites, like Olympia in Greece and the Painted Churches of the Troodos region in Cyprus, located within forests, are threatened with complete destruction. Although the increasingly dry and hot summers of the region cannot be averted, holistic documentation, sophisticated monitoring, fire-prevention, and fire-suppression systems can help. Moreover, the Hellenic Ministry of Culture and Sports and the Cyprus Department of Antiquities have been integrating climate change measures in the management plans for these sites thus connecting their protection and well-being with sustainable growth. The engagement of local communities in this scheme is an absolute priority.

13. EMME Climate Change (EMME CC) Policy Framework

The EMME Climate Change Policy Framework is an outcome of the Eastern Mediterranean – Middle East (EMME) Climate Change Initiative which is coordinated by the Government of Cyprus politically and the Cyprus Institute scientifically. It organizes climate change policy measures in six interrelated "thrusts": Research, Observations, Biodiversity, Innovation/Green Development, Climate Services and Education/Outreach.

The EMME-CC Policy Framework is a system of policies and measures, which are scientifically sound, technologically mature, replicable, affordable, and suitable for the socioeconomic and geographical setting of the EMME region. These policy measures resulted from the work of the thirteen thematic Task Forces of the EMME Climate Change Initiative, which examined most of the aspects of climate change affecting the EMME region.

The EMME-CC Policy Framework thus offers a comprehensive scheme where the aforementioned policy measures/Framework thrusts are organized in a way that makes them easily understood and accessible to the governments of the region, to international agencies and other competent policy makers.

The implementation and monitoring of the EMME Climate Change Policy Framework will require regional mechanisms for support, coordination, and dissemination. Such mechanisms, which will be defined by the parties involved, may be multilateral agreements and treaties, periodic ministerial meetings, multinational high level working groups and task forces; an international organization could be established to pursue the provisions of the EMME-CC Policy Framework, as modified and adopted by the Governments engaged in the initiative, and ensure the effective implementation and needed continuity.

Climate change policies and measures are related in various ways to the six thrusts of the Framework. Briefly, the thrusts concern:

- **Research programs** are to provide better understanding of specific issues of climate change. Gaps in knowledge, being data or processes, need to be filled through high quality research programs. Emphasis is expected to be placed in coordinating national programs and launching transnational programs of regional nature. Improved understanding of EMME Climate issues is a prerequisite for the planning and selection of specific policies/measures and for the optimization of their effectiveness; it also provides the necessary knowledge in order to devise new or readjust existing policies, with emphasis given to the precautionary principle.
- **Observation networks** are necessary for monitoring the evolving climate situation and its impacts in the environment and various sectors of the economy, in addition to tracking emissions of greenhouse gases. Standardization, compatibility, sharing of data and optimal geographical coverage are requirements to be met. The development of Key Performance Indicators (KPIs), which need to be closely monitored as they evolve over time, is a most desirable outcome of the Observation Networks. The effectiveness of most policy actions (especially with respect to adaptation and mitigation) needs to be observed in one or more of the networks, in view of assessing their performance and promote their potential readjustment.
- **Biodiversity** is going to be severely affected by climate change in the EMME region with considerable impacts to natural capital. Biodiversity actions, including the possible formation of a network of protected regions, both at land and the sea are needed in the EMME region, emulating aspects of the very successful "Natura 2000" program of the European Union. Such a network comprised of areas under natural juristrictions could be managed in a federated way, where coordinated actions are planned and implemented in close coordination of the national authorities involved.
- **Innovation & Green Development** support the decarbonization of the economies of the EMME region, necessary as it is for the mitigation of climate change. They offer a unique opportunity to transform the economies of the region to knowledge economies, driven by innovation in green development. Cooperation among the countries will increase their international competitiveness. Climate action policies in various sectors

Policy Framework: a system of sound, mature, affordable climate change mitigation and adaptation measures and policies

Observation Networks
To monitor climate crisis and its impacts

Research
To better understand for policy planning

Climate Services
To support decisions and manage risks and opportunities

Biodiversity
Set up network of protected areas

Innovation & Green Development
Decarbonize and innovate
Better jobs for people and the environment

Education & Outreach
Educate, train, inform youth, companies, and policy makers

need to be designed to encourage innovation and catalyze the transformation of the regional economy while increasing employment in quantity and quality.

- **Climate Services** refers to a system of interconnected modules (data, modelling, visualization, indicators, tools, etc.), organized in an elaborate structure (Hub) and allowing the transformation of climate information to easily accessible climate services for all stakeholders, affected by or concerned with Climate Change in the EMME region. The Climate Services Hub will support climate-smart decisions that will enable better management of the risks and opportunities in climate-sensitive sectors, such as agriculture, energy, tourism, food security, cultural heritage, as well as in disaster risk management and resources management.
- **Education and Outreach** is formulated in short, medium, and long-term strategies and material to help educate various sectors of society, help train public administrators and private investors and provide climate advocacy groups and influencers with the suitable, scientifically sound arguments and data. Education and Outreach help forge transnational alliances, especially youth-based and driven, as well as a network of Climate Ambassadors in each country.

The six Framework thrusts are interconnected in multiple ways. The Framework thrusts as organizational schemes in cooperation, support implementation, give input and output to one another.

The EMME - CCPF is expected to be available as a policy planning tool during the ministerial and heads of states meetings already in 2022. Technical and economic feasibility studies for every single thrust will be prepared, in view of turning the thrusts to operational pillars of EMME-CCPF. In each thrust demonstration actions/projects will be presented, which will be ready for early implementation. EMME – CC Policy Framework will evolve, be enriched and refined continuously, following its initial endorsement by the relevant stakeholders.

Regional Climate
Change Initiative
Republic of
Cyprus