Tackling the effects of climate change on health in the Mediterranean and surrounding regions

Including assessments from countries in the Middle East, North Africa and the Balkans

Summary of a workshop held in May 2021

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Cover image credit: "Why the Mediterranean is a climate change hotspot". Massachusetts Institute of Technology 17/6/2020 https://news.mit.edu/2020/why-mediterranean-climate-change-hotspot-0617

About the European Academies' Science Advisory Council (EASAC)

EASAC – the European Academies' Science Advisory Council – is formed by the national science academies of the EU Member States to enable them to collaborate with each other in giving advice to European policy-makers. It thus provides a means for the collective voice of European science to be heard. EASAC was founded in 2001 at the Royal Swedish Academy of Sciences.

Its mission reflects the view of academies that science is central to many aspects of modern life and that an appreciation of the scientific dimension is a pre-requisite to wise policy-making. This view already underpins the work of many academies at national level. With the growing importance of the European Union as an arena for policy, academies recognise that the scope of their advisory functions needs to extend beyond the national to cover also the European level. Here it is often the case that a trans-European grouping can be more effective than a body from a single country. The academies of Europe have therefore formed EASAC so that they can speak with a common voice with the goal of building science into policy at EU level.

Through EASAC, the academies work together to provide independent, expert, evidence-based advice about the scientific aspects of public policy to those who make or influence policy within the European institutions. Drawing on the memberships and networks of the academies, EASAC accesses the best of European science in carrying out its work. Its views are vigorously independent of commercial or political bias, and it is open and transparent in its processes. EASAC aims to deliver advice that is comprehensible, relevant and timely.

EASAC covers all scientific and technical disciplines, and its experts are drawn from all the countries of the European Union. It is funded by the member academies and by contracts with interested bodies. The expert members of EASAC's working groups give their time free of charge. EASAC has no commercial or business sponsors.

EASAC's activities include substantive studies of the scientific aspects of policy issues, reviews and advice about specific policy documents, workshops aimed at identifying current scientific thinking about major policy issues or at briefing policy-makers, and short, timely statements on topical subjects.

The EASAC Council has 29 individual members – highly experienced scientists nominated one each by the national science academies of EU Member States, by the Academia Europaea and by ALLEA. The national science academies of Norway, Switzerland and the United Kingdom are also represented. The Council is supported by a professional Secretariat based at the Leopoldina, the German National Academy of Sciences, in Halle (Saale) and by a Brussels Office at the Royal Academies for Science and the Arts of Belgium. The Council agrees the initiation of projects, appoints members of working groups, reviews drafts and approves reports for publication.

To find out more about EASAC, visit the website – www.easac.eu – or contact the EASAC Secretariat at secretariat@easac.eu.

About the InterAcademy Partnership (IAP)

Under the umbrella of the InterAcademy Partnership (IAP), more than 140 national, regional and global member academies work together to support the vital role of science in seeking evidence-based solutions to the world's most challenging problems. In particular, IAP harnesses the expertise of the world's scientific, medical and engineering leaders to advance sound policies, improve public health, promote excellence in science education and achieve other critical development goals.

IAP's four regional networks in Africa (the Network of African Science Academies, NASAC), the Americas (the InterAmerican Network of Academies of Sciences, IANAS), Asia (the Association of Academies and Societies of Sciences in Asia, AASSA) and Europe (the European Academies' Science Advisory Council, EASAC) are responsible for managing and implementing many IAP-funded projects and help make IAP's work relevant around the world. For more information about IAP see https://www.interacademies. org and follow IAP on Twitter https://twitter.com/IAPartnership, LinkedIn https://www. linkedin.com/company/interacademypartnership and YouTube https://tinyurl.com/ IAPyoutube.

About the Cyprus Institute

The Cyprus Institute (CyI) is an international science, technology and educational organization with an overarching mission to strengthen the research community and culture of Cyprus and help transform its economy to a knowledge-based one, and to serve as a research and innovation hub for the Eastern Mediterranean region addressing issues of regional relevance and global significance. Recognizing the unique geopolitical location of our country, CyI aspires to serve as a European Union (EU) gateway to research and technology in the Eastern Mediterranean and Middle East (EMME) region and, in this way, advance peace and prosperity and promote the cooperation among the peoples of the EMME region for the betterment of their future.

CyI operates under the institutional umbrella of the Cyprus Research and Educational Foundation (CREF) that is governed by an internationally acclaimed Board of Trustees (BoT) that involves world-renowned academics, current and former Presidents of the Republic of Cyprus, and regional and international political, civic and business leaders

The Institute operates under the aegis of the Cyprus Research and Educational Foundation (CREF), which is governed by a Board of Trustees, comprised of leading personalities of the international academic, political and business world. The creation of The Cyprus Institute (CyI), a novel, internationally recognized research institution, is the tangible manifestation of the Cyprus Research and Educational Foundation's vision to help transform Cyprus into a knowledge-based economy, and in doing so to advance the welfare of the island and the region. Today, the Institute is a world-class research and technology institution, carrying out pioneering research programs involving cutting-edge high throughput technologies, in order to address problems of regional as well as international significance. At the same time, it provides training for future researchers and scholars through its high quality doctoral programs. The CyI comprises four specialized multidisciplinary research centers, developed in partnership with leading international institutions in their respective thematic areas.

Contents

Foreword and conclusions

There is increasing evidence of adverse effects of climate change on health worldwide, both direct effects and indirect effects mediated by disruption in ecological and socio-economic systems. The increasing awareness of health issues brings new requests by decision-makers for robust evidence to inform policy for climate change adaptation and mitigation solutions.

The Mediterranean region is a "hotspot" and the effects of climate change are greater here than in some other regions. But there is also less information currently available to quantify the effects, understand attribution and implement solutions in this region by comparison with some others.

This report is an output of a workshop organised by the European Academies' Science Advisory Council (EASAC) in partnership with the InterAcademy Partnership (IAP) and the Cyprus Institute, to assess the science base and evaluate options for protecting and promoting human health in the face of climate change in the wider Mediterranean region (that is, countries bordering the Mediterranean Sea and their neighbours). The workshop was designed to inform three current scientific initiatives:

1. Provide additional country perspectives to the Cyprus Government-led Eastern Mediterranean/ Middle East Climate Change Initiative (EMME-CCI).

2. Extend work by EASAC to advise on how science can inform policy on climate change and health in the European Union (EU), with reference both to EU policies for its neighbourhood and to its domestic priorities.

3. Contribute to the IAP global project on climate change and health, in particular by providing additional country perspectives from North Africa and the Middle East.

A day of diverse inputs and discussions resulted in the following **key conclusions**:

Of course, the wider Mediterranean is not a homogenous region and there is considerable diversity in geography, socio-economic status, and health systems, as well as in scientific infrastructure, research capabilities, and the degree to which research outputs are used to guide policy and practice. Nonetheless, as workshop participants discussed, **there are also commonalities across the region**: in the challenges to health posed by climate change, in the need to develop resilient and equitable health systems, and to address fragmentation of research systems. Science is a global public good and **there are unprecedented opportunities to capitalise on scientific advances worldwide to develop the solutions, adapted to local contexts, for all regions**.

Workshop contributors emphasised the importance for the region in **developing collaborations between scientific disciplines and countries in research and data collection, sharing infrastructure, skills and methodologies**, in order to fill knowledge gaps, avoid wasteful duplication of research effort, and **build trust in responsible science** with other stakeholders.

However, it is important to emphasise **that the scientific community must work together** not only to generate new knowledge but also **to advise how to use the knowledge that is already available**, as a resource for innovation, to guide practice and inform public policy options.

In this context, in addition to integrating scientific activity between disciplines and countries in the region, there must also be **integration in the use of the scientific evidence for policy across sectors**. Health issues are relevant to the formulation of policy in many sectors beyond the formal responsibility of health sector policy-makers.

This **coordination of effort is essential** to understand trade-offs, avoid inadvertent consequences and capture synergies for diverse policy actions. Although the primary focus of the workshop resonated with the scope of the Health Task Force of the EMME-CCI, the parallel activities of other Task Forces in the initiative are of great value in facilitating **inter-sectoral action and policy convergence**.

Policy decisions depend on more than scientific evidence and must also take into account, for example, **societal attitudes towards risk and other social values**. There is significant variation in attitudes and values across the Mediterranean region: national academies of science are well placed to help policy-makers understand diversity so that the **regional emphasis in policy can be science-based and economically and socially feasible**.

We thank all those who contributed to planning and running the workshop which was, itself, an excellent example of the fruitful collaboration that can be accomplished in the region. We welcome feedback on any of the issues discussed in this report and suggestions for the next steps in strengthening the use of research to inform policy. Academies of science and their networks are eager to continue their contribution to the generation and use of the evidence base for action across the region.

Richard Catlow,
IAP President

Christina Moberg
EASAC President

Volker ter Meulen,
IAP Special Advisor

Costas Papanicolas,
Advisor to the President of the Republic of Cyprus and Special Envoy on Climate Change

Background

Climate change is already affecting human health, and projected changes in climate are expected to increase the burden on climate-sensitive health outcomes by multiple direct and indirect pathways. There is significant variation between regions: areas with weaker health infrastructure will be least able to cope, but the climate crisis will affect everybody. The evidence base is still relatively fragmented and, until recently, policy-makers had tended to ignore this public health emergency.

The Cyprus Academy of Sciences, Letters and Arts is working with the Cyprus Institute on a Cyprus Government-led initiative on climate change in the EMME region (Makri, 2018). This region has particularly high vulnerability to the impacts of climate change, and coordinated action is vital to manage impacts and advance mitigation actions. The EMME-CCI comprises a range of Task Forces reporting in 2021[I], one of which is addressing health issues.

Separate from the EMME-CCI, a global project on climate change and health[II] was launched in 2019 by the IAP, the global network of more than 140 academies of science, engineering and medicine, to support work by the regional academy networks in Africa, Asia and the Americas (NASAC, AASSA, and IANAS) together with previous activity in Europe (EASAC)[III]. The IAP project is addressing regional, inter-regional, and global issues for understanding the health risks from climate change and is identifying solutions for adaptation and mitigation. Mitigation is action to reduce emissions that cause climate change; adaptation is action to manage the risks of climate change impacts.

To maximise these two parallel initiatives, EASAC with IAP support co-organised a virtual workshop with the EMME-CCI Health Task Force with the aim of bringing together experts from additional countries across an expanded region. The collective aim was to share emerging issues and lessons for the region, assess the relative importance of impacts, clarify groups particularly affected, and focus on solutions, in order to help develop advice for policy-makers. The workshop was designed with wide scope, both geographically[IV] and in terms of the key topics. These included effects of extreme weather events, water shortage, food security, infectious diseases, air pollution, and health issues of displaced populations.

This report is a summary of the workshop proceedings that focuses on key issues for compiling and assessing the evidence base. To be relatively succinct, only selected literature is cited. Images were chosen from presentations to exemplify some of the strategic issues warranting further discussion within and beyond the region. In addition to collating material that may be useful for the EMME-CCI, this report will contribute to the final, global, report of the IAP project (augmenting AASSA and NASAC regional work in Asia and Africa) and from the EASAC perspective will help evaluate issues for EU policy, including the EU Neighbourhood Policy. A full recording of the workshop is available on https://www.youtube.com/playlist?list=PL7-ic31cMSbs9fkhnBynKLGd3SPcFV_ox.

I https://www.cyi.ac.cy/images/international_collaborations/cy_climate_change_init/Work_Programme_200929.pdf.
II https://www.interacademies.org/project/climate-change-and-health.
III https://easac.eu/fileadmin/PDF_s/reports_statements/Climate_Change_and_Health/EASAC_Report_No_38_Climate_Change_and_Health.pdf.
IV See Appendix for participant list and programme details.

Introduction to the challenges for climate change and health: scientific and societal aspects

Points emerging from the work of the EMME-CCI

Welcoming participants, Professor Costas Papanicolas (The Cyprus Institute) emphasised the importance of the workshop to inform concerted action across the region in support of Paris Agreement targets and amelioration of the effects of climate change. There is significant warming in the region (Ntoumos et al., 2020) and global climate models predict that the population of the EMME region (500 million) will be particularly adversely affected if current changes continue. A potential 5 °C increase in some parts of the region by the end of the century would be a calamity of unforeseeable impact. If the rise can be kept to 2 °C or less then the problems are more manageable.

The work of the EMME-CCI Task Forces, including the Health Task Force, is generating comprehensive scientific evaluation to help inform decision-makers in the region and beyond, for the period up to 2030. However, in some cases across the region, data are inadequate to guide policies and the lack of attention to funding climate research has created problems in filling knowledge gaps. There is need for collaborative research between countries and disciplines and for using the outputs from research and development for finding and quantifying solutions and thereby augmenting the policy tool kit. Potential policy priorities encompass joint funding schemes, regional networking in collecting data, and development of a Climate Services Hub (with specific responsibilities for health issues) alongside efforts to preserve and promote biodiversity.

Climate change: from impacts to action

In his keynote address, Professor Andy Haines (London School of Hygiene & Tropical Medicine, UK) provided a comprehensive assessment of literature relevant to the region. Recent research confirms that heating in the EMME region is escalating more than in other regions, which exacerbates the threats to health and may undermine the integrity of societies. Rising temperatures worldwide threaten ecosystems and, because relationships are not linear, may exceed tipping points with little warning (Figure 1).

Many of the risks are imperfectly understood and there are gaps in the evidence base. Nonetheless, current projected greenhouse gas (GHG) emission reductions fall short of the cuts needed to meet Paris Agreement targets and will lead to a temperature rise worldwide of perhaps 3 °C by 2100. If recent pledges are enacted, the rise may be limited to 2–2.4 °C. Thus, there is need to be more ambitious and active in decarbonisation efforts, albeit planned in a careful and considered way.

The implications for human health have been discussed in detail elsewhere (Haines and Ebi, 2019) and Figure 2 provides a global assessment to correlate pathways and health outcomes and to note other factors that may influence the magnitude and patterns of risksV.

As shown in Figure 2, exposure pathways, direct and indirect, can be categorised in terms of extreme heat, severe weather events, air pollution, vector distribution and ecology, allergens, the impacts of water quality and of water and food supply, and environmental degradation. However, recent semi-automated, systematic mapping of the research worldwide on climate and health (Berrang-Ford et al. (2021) and Figure 3) demonstrates significant geographical gaps in the evidence, which apply to the EMME region and to Central Asia, Central and North Africa and South America, and weaker evidence to document low- and middle-income socio-economic groups. Moreover, much of the literature relates to short-term observations and there is less on longer-term trends or on how to adapt. Clarifying where gaps – geographical and

V See also EASAC (2019) for discussion of the effects in the EU.

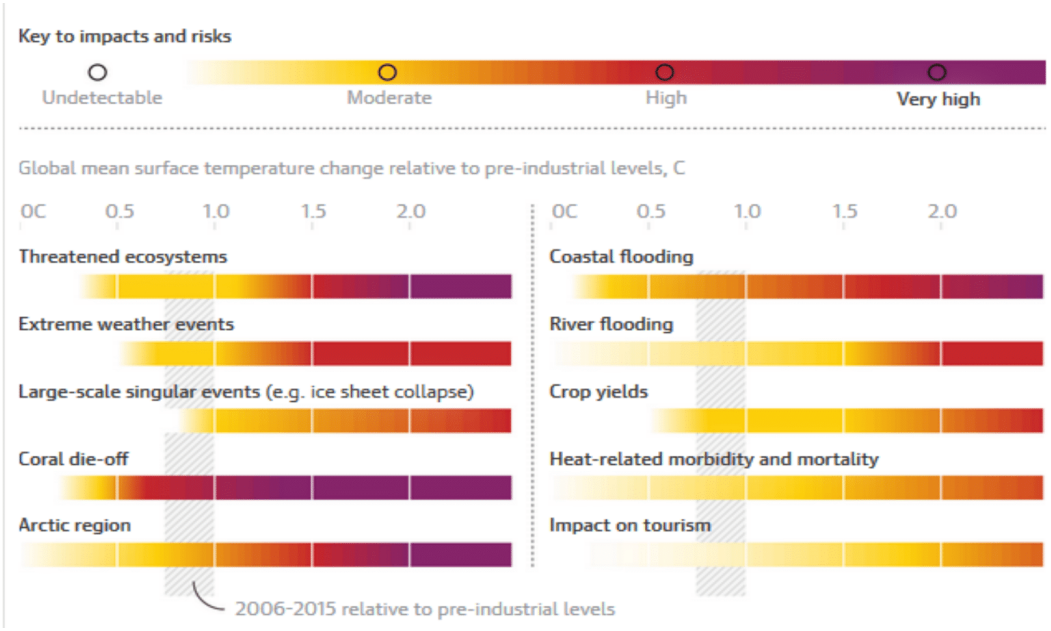


Figure 1: Global assessment and projections of risks from rising temperature. Source: Watts J. (2018). We have 12 years to limit climate change catastrophe, warns UN. The Guardian, 8 October 2018. Available at: https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report. Graphic reproduced courtesy of Guardian News & Media Ltd.

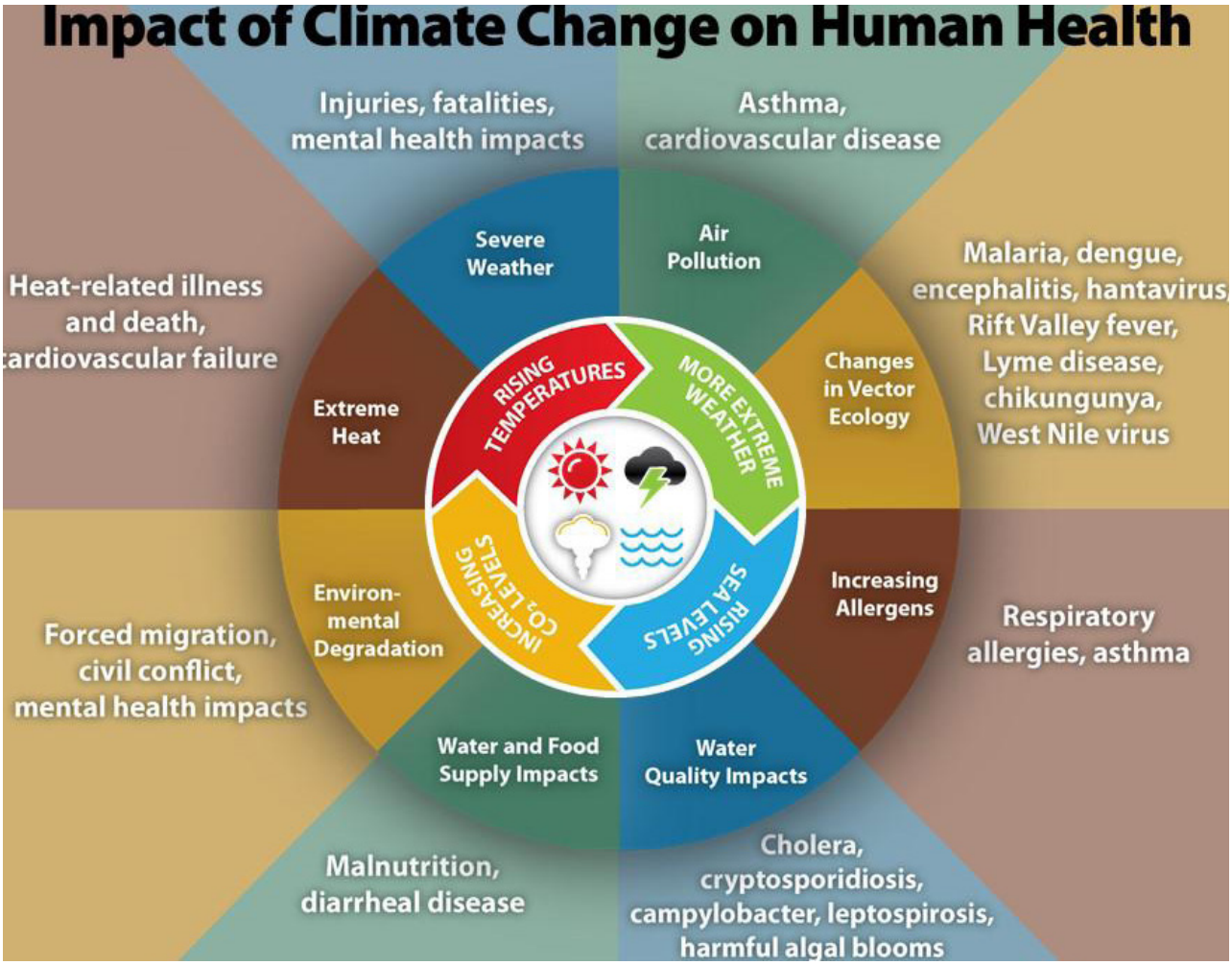


Figure 2: Impact of climate change on human health. Source: Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/climateandhealth/effects/default.htm.

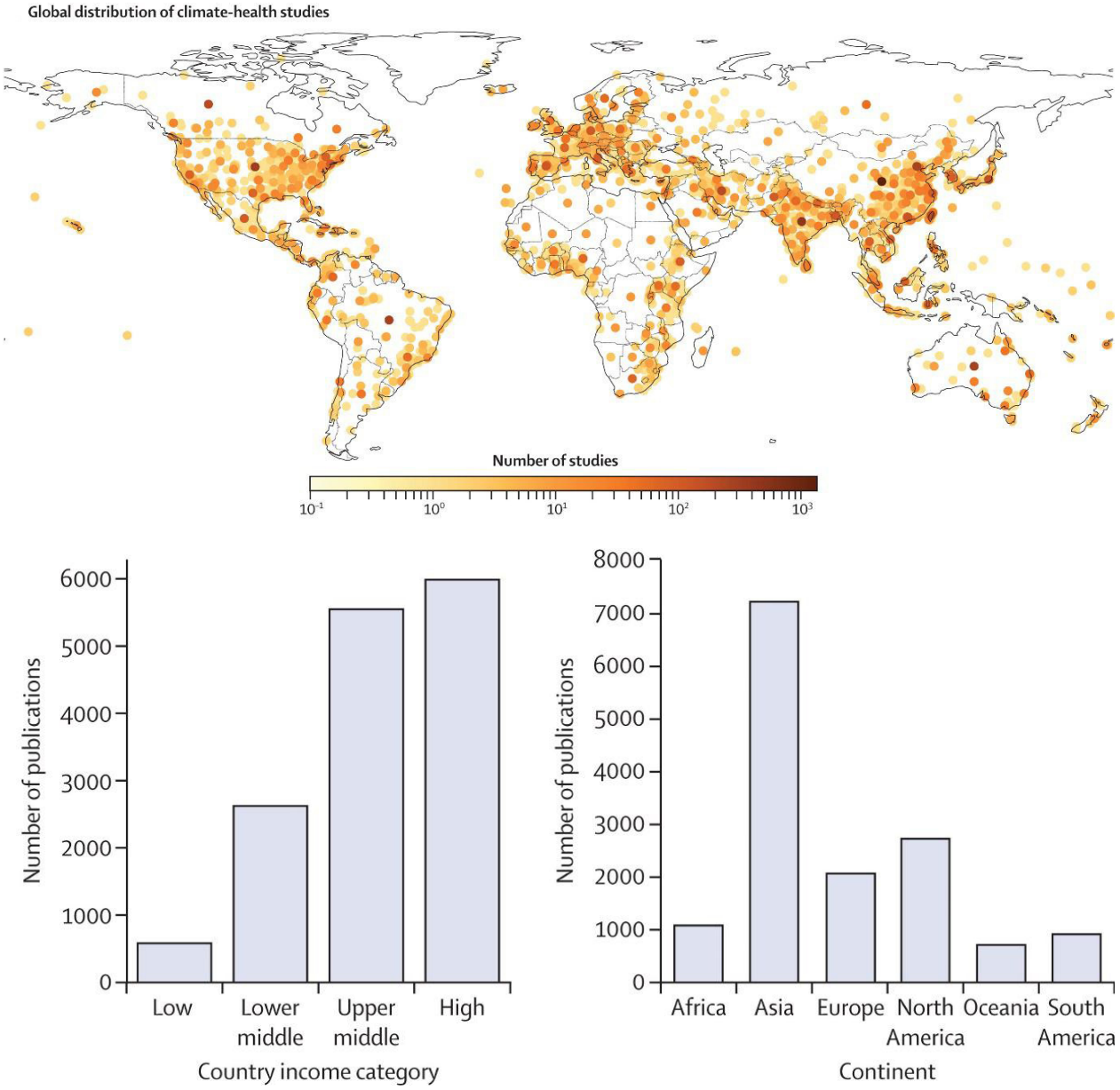


Figure 3: Systematic mapping of the research worldwide on climate and health (Berrang-Ford et al., 2021).

other – exist, helps to set priorities for future research in the region.

During the discussion, some of the gaps in knowledge were further specified. Research priorities are to collect and share data to monitor trends, for example, in heat-related deaths in the EMME region. Filling the evidence gaps requires investment in public health surveillance systems for direct observation rather than relying on modelling and indirect indicators. Also, there is need for research to determine the limits of adaptation and to quantify mitigation co-benefits to health.

Despite the weaknesses, significant advances in interpretation are being made and there is increasing confidence in attributing the health effects that are observed to climate change, for example in the re-analysis of data from the heat-related excess deaths in Paris and London Figure 3: Systematic mapping of the research worldwide on climate and health (Berrang-Ford et al., 2021). so, for example, are pregnant women with preterm births and other adverse outcomes increasing with temperature, according to meta-analysis of data from temperate regions (Chersich et al., 2020). It is possible that effects might be greater in other regions.

Continuing "business-as-usual" would lead to excessively high temperatures of extended duration in the Middle East and North Africa (Zittis et al., 2021); as most of the exposed population will live in urban areas there is potential for profound effects in Urban Heat-Islands.

Other effects of climate change on health worldwide 3include those mediated by the following.

- Wildfires (Xu *et al.*, 2020), where particles from wildfires are smaller than those from urban sources and may contain more oxidative compounds, in consequence being more pro-inflammatory in damaging lungs.

- Reduced productivity of food crops and declines in nutrient quality (for example for vegetables and legumes (see Scheelbeek *et al.*, 2018)). Increased temperatures in the growing season and drought-associated adverse effects outside the region may also be a significant reason for increases in EU asylum applications (Missirian and Schlenker, 2017).

- Increasing threats of infectious disease (water-, food-, and vector-borne) (Semenza *et al.*, 2016).

- Mental health pathways: studies have shown increases in common mental disorders for considerable periods after flood, wildfires, and droughts. Increasing temperature may also be associated with risk of suicide (Burke et al., 2018).

What can be done? Mitigation is action to reduce emissions that cause climate change. Adaptation is action to manage the risks of climate change impacts. Both are needed in efforts to build climate resilience that is the ability of society to integrate interventions, technologies, and actions to tackle climate change. Better early warning systems (for example, preparing for extreme weather events or infectious disease outbreaks) are an important part of adaptation but it must also be appreciated that there are limits – technical, geographical, demographic, and socio-economic – to what is possible in adaptation.

Mitigation requires multiple interventions across many economic sectors (Figure 4, characterising short-term actions, although it may no longer be possible to achieve the 1.5 °C target) and can bring local and rapid co-benefits to health to those populations undertaking the mitigation:

- Phasing out fossil fuel burning for energy: projections demonstrate that there are very large health co-benefits arising from reduction in ambient air pollution accompanying the reduction in GHGs (Lelieveld et al., 2019). Recently, research has also emphasised the potential benefits from reducing air pollution caused by nitrogen dioxide (NO_2) (a risk factor for asthma) (Chowdhury et al., 2021) associated with actions to reduce GHG emissions.

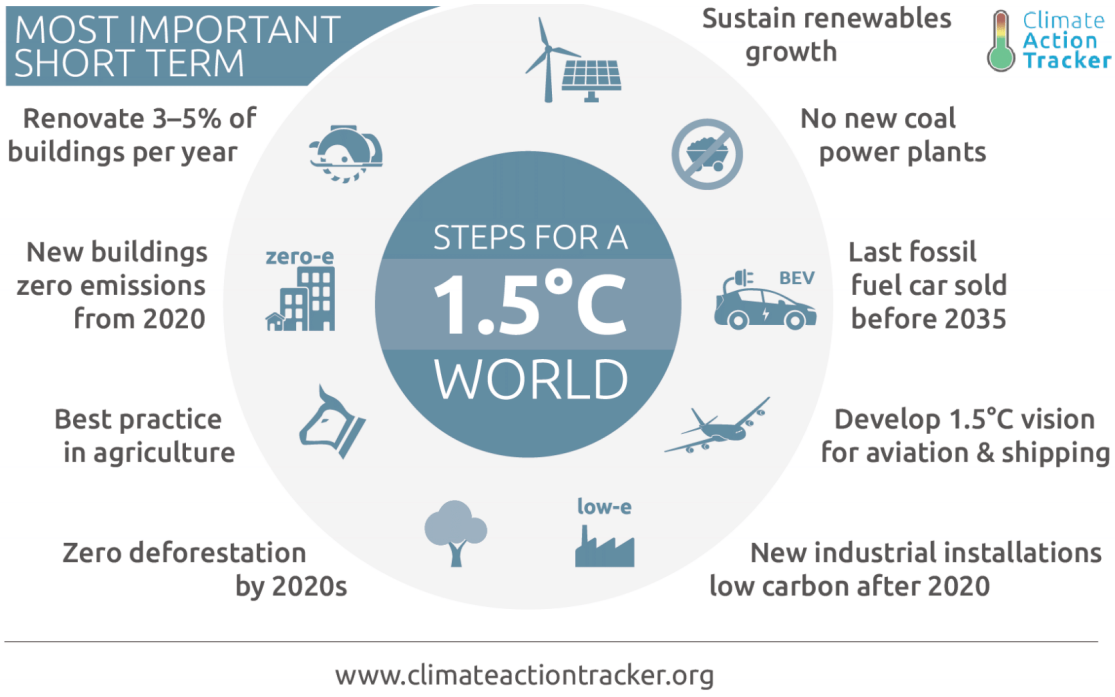


Figure 4: The 10 most important short-term steps to limit warming to 1.5 °C. November 2016. Climate Action Tracker (2016). Available at: https://climateactiontracker.org/press/the-ten-most-important-short-term-steps-to-limit-warming-to-15c/.

- Reducing food waste and promoting healthy diets, for example by adopting predominantly plant-based diets (Willett et al., 2019). Changes to food systems can bring significant environmental improvements in terms of GHG reduction and land and water use.

- Reforming transport systems to increase active travel, incurring both health and environmental benefits.

- Increasing green space in cities (see, for example, Mueller et al., 2020).

- Reducing carbon emissions from the health sector itself: see EASAC and FEAM (2021) for discussion of EU issues.

In conclusion, there are unprecedented challenges but also unprecedented opportunities to use science, technology, and innovation in supporting adaptation and mitigation solutions. During discussion, Professor Haines emphasised that, now public health is central on the political stage (partly in consequence of COVID-19), a public health rationale for action is more likely to evoke policy responses than a purely environmental focus.

Focusing on solutions to inform policy

Dr Robin Fears (EASAC) cited material from the 2019 EASAC report and the current IAP global project to examine some of the issues for using evidence to inform policy development. There are, of course, many other groups reviewing evidence and producing excellent inputs to advise policy-making (Box 1 lists some sources published since the EASAC report, with particular relevance to the workshop discussions).

How is the work of academy networks distinctive? Academies can add value by their commitment to inclusivity and diversity, spanning multiple disciplines (and including younger scientists) and by integrating local–regional–global activity on science and innovation. Using their convening power, they can show where there is consensus and, where controversial issues require clarification, develop evidence-based messages and share learning for capacity building (see Fears et al. (2020) for further discussion of the attributes of IAP inter-regional project design).

Examples from the EASAC 2019 report were selected to show how solutions are within reach by acting on present knowledge and to highlight the need to generate new knowledge:

- Developing climate-resilient agriculture in Europe where the severity of drought and heat-wave crop losses have tripled over the past 50 years (Bras et al., 2021). There are particular challenges in the EMME region as a climate hotspot that may also have consequences for EU assumptions about maintaining food imports from the region.

- Increasing preparedness and responsiveness to infectious disease threats. The recent expansion in distribution of West Nile virus westwards and northwards in the European region exemplifies the importance for the EU to work with neighbouring countries to strengthen public health surveillance systems.

In some respects, climate change and the COVID-19 pandemic can be regarded as converging crises. Both crises revealed lack of preparedness, both exert significant pressures on health systems with disproportionate consequences for vulnerable groups, and they have interacted in various ways. For example, climate-induced flooding has impaired local responses to COVID-19. And effects of the pandemic on food systems have compounded the vulnerabilities of low-income groups to the impacts of climate change on food and nutrition security—an issue considered recently by the UN Economic Commission for Europe Regional Forum (2021)[VI]. However, the pandemic has also created opportunities to plan for sustainable recovery, to ensure that objectives for the environment, health, and equity are given prominence alongside rebuilding economies. The scientific community has an important responsibility in guiding policy-makers about these opportunities and in monitoring implementation and impact of choices made.

EASAC has made multiple recommendations to EU audiences on strengthening and using the evidence base for: better linkage at science–policy interfaces; health risk communication and countering misinformation; addressing health issues in policy development in all sectors; and identifying the priorities for new research to fill knowledge gaps, including the responsibility to support research collaborations worldwide. The EU can also do more to understand the impacts of climate change occurring in the rest of the world on the EU, and the impacts of decisions made in the EU for domestic purposes on the rest of the world.

VI https://regionalforum.unece.org/.

There is a large policy agenda for the EU and its Member States (including those in the EMME region) (Figure 5, based on EASAC discussions with policy-makers before and after publication of the 2019 report).

Box 1: Some key resources from European Institutions and the World Health Organization (WHO) relevant to climate change and health in Europe
WHO (2019) Health in the Nationally Determined Contributions.
WHO and UNDP (2020) Addressing climate change and health in the Europe and Central Asia region. Joint value proposition.
WHO (2020a) COP26 key messages on climate change and health.
European Environment Agency (2020) Healthy environment, healthy lives: how the environment influences health and well-being in Europe.
European Commission (2021) Forging a climate-resilient Europe: The new EU strategy on adaptation to climate change.
WHO (2021) Quality criteria for national adaptation plans.
WHO Europe (2021) Heat and health in the WHO European region: updated evidence for effective prevention.
Van Daalen et al. (2021). The Lancet Countdown on health and climate change and the European Environment Agency (2021) Responding to the health risks of climate change in Europe, https://www.eea.europa.eu/highlights/how-to-keep-europeans-healthy.
European Commission Group of Chief Scientific Advisors (2020) Scientific Opinion – Adaptation to health effects of climate change in Europe.
WHO (2020b) Guidance for climate resilient and environmentally sustainable health care facilities.
WHO (2020c) Manifesto for a healthy recovery from COVID-19.
WHO and UNDP (2020) Addressing climate change and health in the Europe and Central Asia region. Joint Value Proposition.

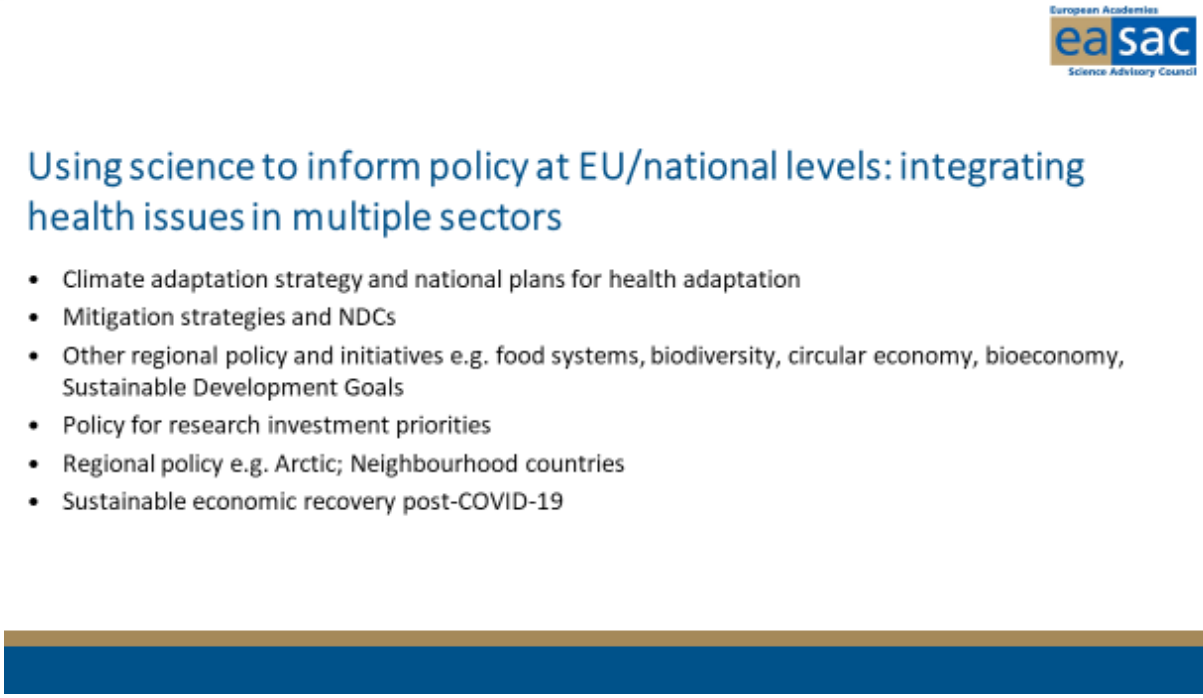


Figure 5: EASAC's assessment of policy instruments for integrating health issues in multiple sectors in EU and national policies.

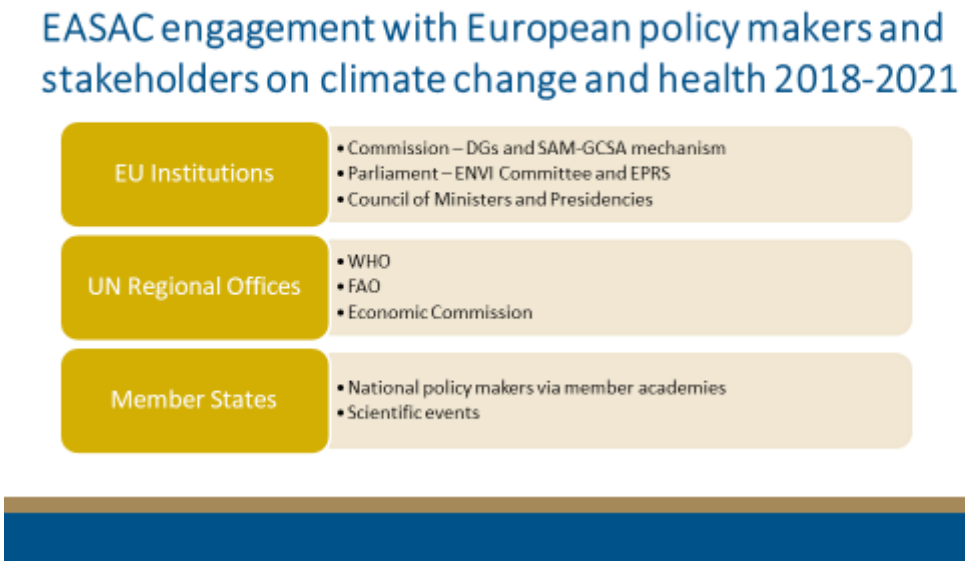


Figure 6: EASAC engagement with European policy-makers and stakeholders on climate change and health 2018–2021.

How can the scientific community help to inform policy options? During the period 2018–2021, EASAC has used its work on climate change and health to engage with multiple institutions and stakeholders (Figure 6) and this will continue.

IAP has also developed multiple contacts at global and inter-regional levels for engaging on climate change and health policy, in preparation for delivery of all the IAP project outputs in 2021–2022, exemplified in Figure 7.

The intergovernmental meetings (COP26 in the UK in 2021, and COP27 in Africa in 2022) will be of especial interest. During discussion, suggestions were made as to how academies can play additional roles in the EMME region, for example to catalyse the sharing of data, support contacts with national and regional policy-makers, and highlight strategic priorities for other intergovernmental action, such as through the current WHO regional consultations on climate and health.

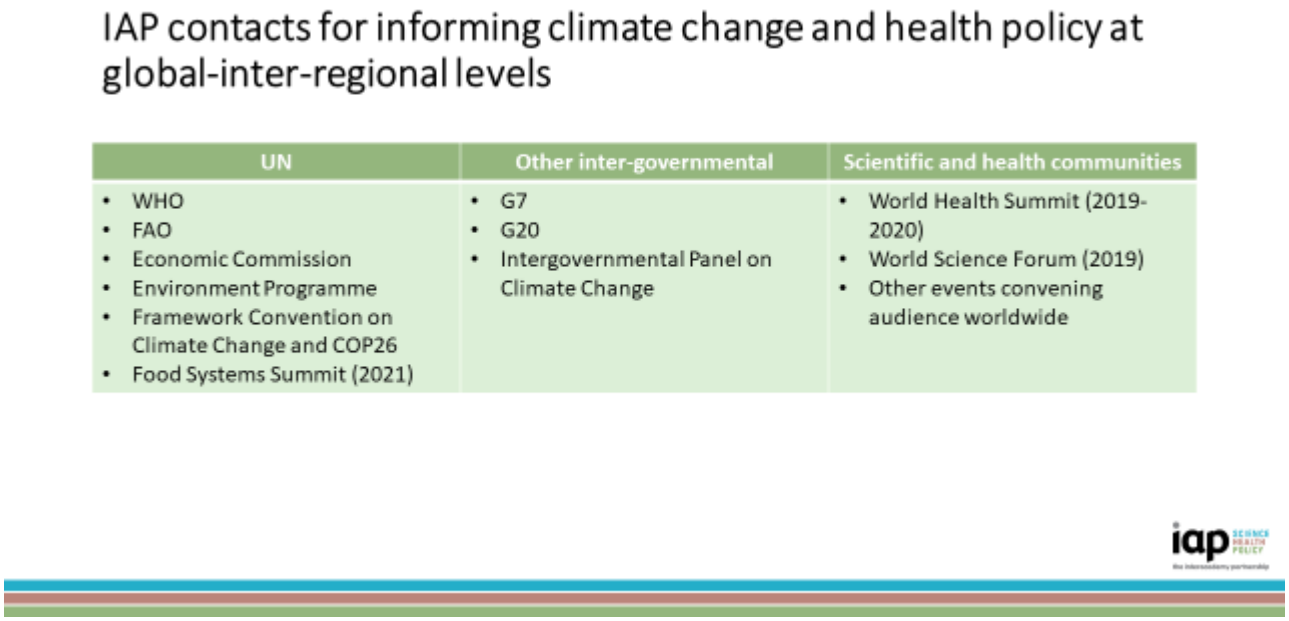


Figure 7: IAP contacts for informing climate change and health policy at global inter-regional levels.

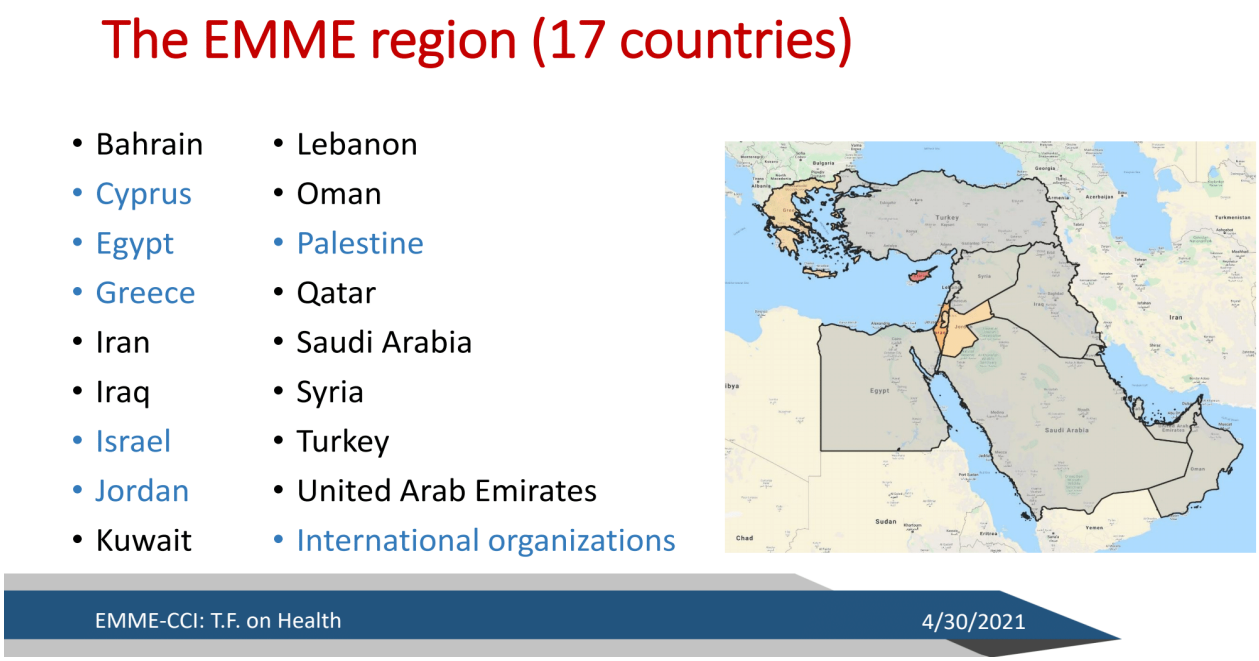


Figure 8: The Eastern Mediterranean/Middle East (EMME) region as defined by the Cyprus Government initiative on climate change in the EMME.

Task Force report on the effects of climate change on human health in the EMME

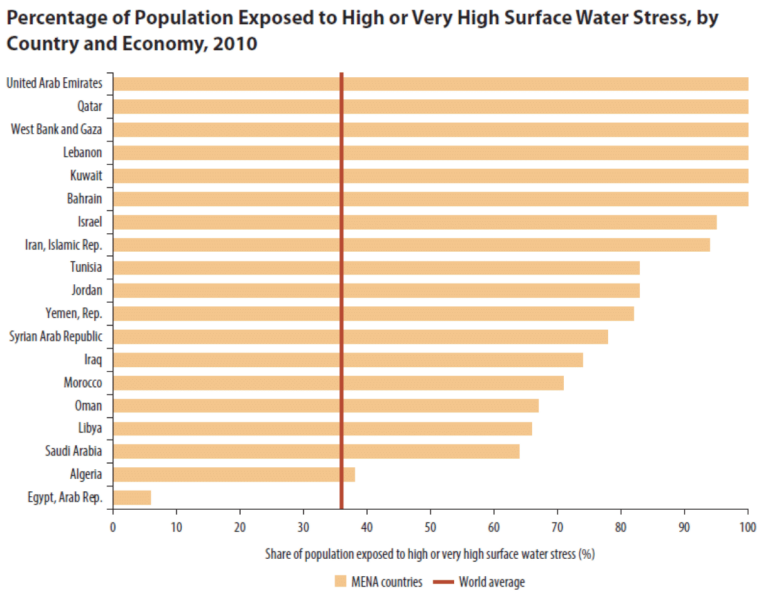
Dr Marco Neira (The Cyprus Institute) presented some emerging findings from the region (defined in Figure 8, members of the Health Task Force are highlighted; detailed information is published in the Task Force report).

Among major challenges discussed in the report are the following.

Extreme heat exposure: detailing effects on physical and mental health and identifying vulnerable groups. It has been observed that populations in warmer regions have adopted protective practices that generate resilience compared with those in colder regions more susceptible to heat waves. Nonetheless, reinforcing previous points made by Professors Papanicolas and Haines, a combination of high urbanisation rate and ageing populations indicates that under "business-as-usual" some cities in the region (for example, Abu Dhabi, Dubai, Doha, Dhahran, and Bandar Abbas) could experience such intense heat as to surpass the thermal limit for human survival.

Water shortage: the Middle East and Southeast Mediterranean are among the world's regions with least water availability (Figure 9). In the Middle East, 60% of the population live under high or very high water stress conditions; in the Southeast Mediterranean, more than 80 million people experience absolute water scarcity. Direct health consequences include diarrhoeal disease (especially in children younger than 9 years old); parasitic diseases such as dracunculiasis and schistosomiasis; toxicity from chemical contamination of water supplies with metals, pesticides, and other organic compounds; and increasing susceptibility to vector-borne diseases because water storage creates new breeding sites for vectors. Indirect health effects include those attributed to reduced agricultural productivity (nutritional and economic impacts) and those associated with physical transportation of water from distant sources, a task often assigned to women and children (injuries and consumption of time otherwise useable for education or financially productive activities).

Vector-borne diseases:__effects of climate change are mediated by multiple environmental and socio-economic factors, for example, temperature, precipitation, humidity, population density, housing quality, and access to running water. The increasing risk of local transmission of arboviral diseases includes West Nile, Dengue, Chikungunya, and Zika viruses. It is possible that higher temperatures increase genetic variability, leading to new viral strains. Malaria was historically endemic in the region and there is potential for re-emergence: cases of local transmission have been recorded in Cyprus, Greece, and Saudi Arabia. For leishmaniasis, modelling predicts changes in the distribution of Phlebotomus species vectors: spreading to new areas adjacent to the



Taken from: *World Bank. 2018. Beyond Scarcity: Water Security in the Middle East and North Africa. MENA Development Series. World Bank, Washington, DC.*

Figure 9: Percentage of population exposed to high or very high surface water stress in the EMME region, by country and economy, 2010.

Mediterranean but disappearing from previous habitats in parts of North Africa and the Middle East because of rising temperatures.

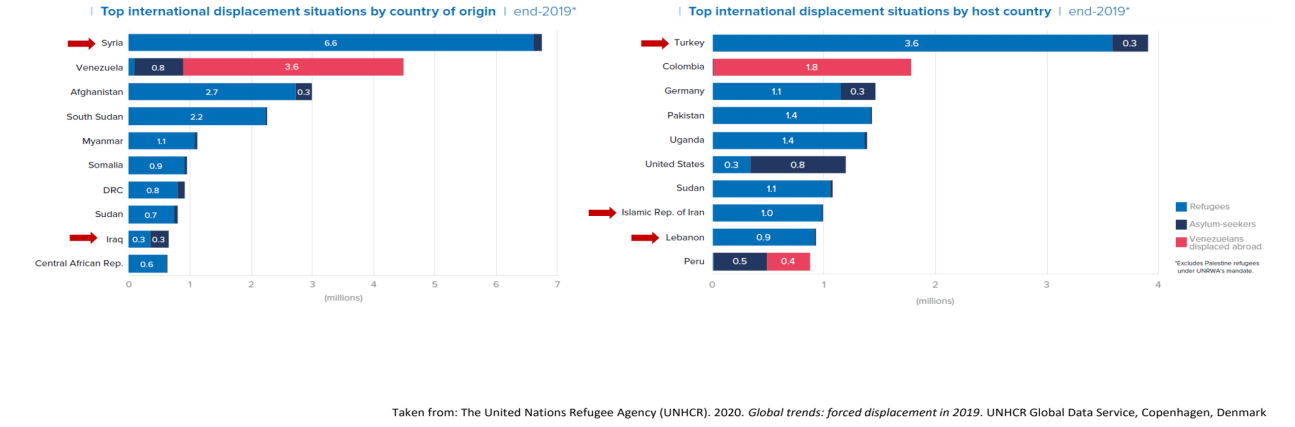
Dust storms and air pollution:_among the main determinants of air pollution are forest fires (with increasing occurrence recorded, for example, in Lebanon and Turkey), urbanisation (associated with increasing demand for fossil fuel energy by transportation, industry, air-conditioning, and desalination) and other fossil fuel burning, which dominates the region's energy supply. In Europe and the Eastern Mediterranean, about 1 million people die prematurely each year from air pollution[VII]: Egypt, Turkey, and Iran (in 2010) were among countries with highest attributed premature mortality. Adverse health effects include allergies, silicosis, infectious and chronic pulmonary disorders, acute lower respiratory illness, cerebrovascular and cardiovascular diseases, and lung cancer. The EMME region is susceptible to dust from the Sahara and Arabian Peninsula, associated with allergies, respiratory and circulatory disorders, and the carriage of pathogens and chemical contaminants over long distances. The frequency and intensity of dust storms are increasing.

Displaced populations:_climate change can contribute to population displacement in multiple ways, from extreme weather events, sea level rise, ecosystem deterioration, to risks of conflict. Countries in the EMME region are the place of origin of some of the world's largest displaced populations or are among the largest hosts of displaced populations (Figure 10).

The health of displaced populations is subject to the following.

- Direct effects: injuries, trauma, malnutrition, increased vulnerability to further climatic phenomena.
- Exposure to infectious diseases, compounded by lack of immunity to new infections and increasing risk of transmission in poor housing.
- Non-communicable diseases, where problems can be compounded by lack of access to medicines. The public health burden for host countries may also be high.
- Sexual and reproductive health risks, including sexual violence and exploitation, elevated risks of sexually transmitted diseases and pregnancy (with increased maternal and neonatal harm).
- High prevalence of mental health problems, estimated in 15–50% of displaced populations. Psychological support services are scarce, children are highly susceptible, and effects are long-lasting, even trans-generational.

VII Evidence from a study of Italian cities (Scortichini et al., 2018) demonstrates synergistic effects of air pollution and heat on mortality, and this conclusion is supported by a recent systematic review of the global literature (Anenberg et al., 2020).



Taken from: The United Nations Refugee Agency (UNHCR). 2020. *Global trends: forced displacement in 2019*. UNHCR Global Data Service, Copenhagen, Denmark

Figure 10: Top international displacement situations by country of origin and host country. Source: The United Nations Refugee Agency (UNHCR) (2020). Global trends: force displacements in 2019.

Dr Neira also discussed priorities for filling knowledge gaps and pursuing new research directions in the EMME region. These include the following.

- Effects of climate change on the epidemiology of vector-borne diseases at the regional level: better biological data are required to inform predictive models and to support monitoring and characterisation of the most relevant vectors. Development and implementation of new controls for vectors and efficient vaccines for vector-borne diseases.
- Standardised monitoring of environmentally driven morbidity and mortality: particularly for exposure to heat and air pollution. Understanding impacts of dust exposure on chronic health conditions.
- Development and implementation of health-focused predictive models and early warning systems, including prioritisation of vulnerable groups, such as the elderly.
- Development of tools to improve evaluation of the mental health of displaced populations.

In parallel, there are also policy gaps to fill. These include support for the following.

- Cross-border collaboration for monitoring of infectious diseases, especially vector-borne diseases.
- Training of health personnel in the detection and management of infectious disease potentially (re-)emerging in the region.
- Preparing regional contingency plans for the management of emerging infectious disease threats.
- Developing and implementing heat–health action plans throughout the region, with priorities for the elderly, those with underlying health conditions or with high occupational exposure.
- Providing health services to displaced populations, including services for mental health, maternal and reproductive health, access to medicines for chronic conditions, and the diagnosis and treatment of infectious diseases.

Country presentations on climate change, health, and policy

Following the regional overviews, experts in the extended region were invited to contribute country science-based perspectives on major challenges, options for solutions, and priorities for public policy. As noted earlier, these countries are mostly not members of the EMME-CCI but were chosen to exemplify issues for EMME neighbours to help set into context the EMME conclusions and implications for local and regional policy options.

Albania

Professor Alban Ylli (Tirana Medical University) supported previous speakers in their observations about the groups most vulnerable to the health effects of climate change, including the elderly, disabled and sick, women and children, lower income groups and, in Albania, Roma and Egyptian communities. Health problems most likely to be found include respiratory, cardiovascular, and other non-communicable diseases, infections, and mental health. Two case studies were presented.

1. Heat waves and cardiovascular diseases: using data from two episodes in 2017 and the World Meteorological Organization definition of a heat wave (5 days consecutively recording daily highest temperature 5 °C above historical average). Analysing cardiovascular, stroke, heart failure, and total deaths, increases (9–16%) were found, particularly during the second heat wave. There was also some correlation between mortality and daily temperature throughout July and -August 2017. Projections indicate substantial public health impact: by 2030 there may be 400 excess deaths from heat wave in Albania, in a population of 3 million.

2. Gastroenteritis: an observed association of rate with daytime temperature during the hottest month of the year over the period 2006–2018, with children particularly vulnerable. Projections based on a 1.5 °C increase in summer temperature suggest an additional 250 gastroenteritis cases per 100,000 population.

National priorities for adaptation in the health sector are as follows.

- Raising both public awareness and capacity building among health professionals on possible effects of climate change on health.
- Adapting information systems to detect risk and evaluate health preparedness.
- Integrating health perspectives in all climate change policies.
- Increasing capacities, preparedness and coordination of the health system with other systems to deal with heat waves.
- Improving collaboration and integration of health system with national emergency structures responsible, for example, for floods and fires.
- Adapting and integrating surveillance and control systems for infectious diseases and vectors likely to be affected by climate change.

Algeria

Professor Zoubir Harrat (Pasteur Institute of Algeria) focused on vector-borne diseases (Figure 11, many of these also important for other countries in the region) affected by multiple environmental and other changes including climate change, urbanisation, land use, biodiversity loss, industrial and agricultural pollution, trade, travel, and immigration. Anopheles and Aedes mosquito species are sensitive to temperature and humidity through effects on their breeding and resting sites, and on mosquito development and pathogen incubation, resulting in increasing transmission rate.

Several case studies were presented.

Cutaneous leishmaniasis: examining the incidence over the period 1982–2017, it was found that cyclical outbreaks of cutaneous leishmaniasis were strongly related to annual rainfall (for further details, see Beniklef *et al.*, 2021). Professor Harrat highlighted that climate change would be a major risk factor for the spread of cutaneous leishmaniasis, acting via habitat and vector density, compounded by uncontrolled urbanisation and accumulation of organic waste, an important factor in the growth of sand fly populations.

List of vector-borne diseases and status (ALGERIA)

	Not present but considered as major threat	Rare but serious disease	Recurrent	Endemic
Mosquito-borne diseases	Dengue Rift valley fever Chikungunya	Malaria; Only imported cases. West Nile fever		
Sandfly diseases		Sandfly fever		Leishmaniasis
Tick-borne diseases	Crimean-Congo haemorrhagic fever Tick-borne encephalitis	Borreliosis		Mediterranean spotted fever
Other vector-borne diseases		Plague Bartonella Q fever		

Figure 11: List of vector-borne diseases and their status in Algeria.

Malaria: Algeria was certified by the WHO as malaria-free in 2019 and the Ministry of Health's national plan for 2019–2021 aims to sustain that status. However, *Anopheles gambiae*, the major malaria vector in Africa, was observed for the first time at the border with Mali in 2007. It creates a real threat, especially since the migratory flow of Sub-Saharan populations to Algeria is important and global warming may accelerate vector spread northwards, associated with increased evapotranspiration, such that the risk of malaria re-emergence in Algeria is high. Furthermore, a new malaria vector in Africa, *Anopheles stephensi*, is spreading from the Arabian Peninsula and Horn of Africa, with resistance to higher temperatures and common insecticides, and tolerance to pollution (Sinka *et al.*, 2020).

Arboviral viruses: dengue, chikungunya, and Zika. As cases are occurring in the Eastern Mediterranean region, there is a risk to Algeria while Aedes albopictus is still well established in the north of the country (Benallal *et al.*, 2016). Three imported cases were diagnosed in 2015–2016, imported from Malaysia, the Seychelles, and India. West Nile virus also circulates throughout Algeria, mainly in humid zones and within national parks during the bird migration season. Sporadic cases continue to be diagnosed in some cases. Culex perexiguus, a major vector of West Nile virus, was found naturally infected in Timimoun province, in southwest Algeria in 2018. This was the first evidence of the implication of this vector in the transmission of the disease in Algeria (Benbetka *et al.*, 2018).

Health adaptation to climate change to manage vector-borne diseases requires vector control, targeting of pathogens, and chemotherapy. Are there adaptation capacity limitations? Success in adaptation depends on capacities for effective surveillance, community ownership of new measures, and a viable public health infrastructure. Adaptive responses also require policy development to support early warning systems, case detection, monitoring and reporting, public information and education, and mapping.

Croatia

Professor Bojan Jelakovic (University Hospital Centre Zagreb) discussed the association of climate change with blood pressure. Croatia has a long history of meteorological observations, and detail was presented on the time series for mean annual air temperature from 1901 to 2008, demonstrating rising temperatures throughout the country in both winter and summer.

There is a large literature worldwide on the seasonality of cardiovascular risk factors such as blood pressure (consensus statement by the European Society of Hypertension (Stergiou *et al.*, 2020a)) and the Croatian data confirm findings of an inverse association between systolic blood pressure and temperature, supported by observations of the seasonal variation in hypertensive emergency hospitalisations (higher in winter). Seasonal variation in blood pressure is a neglected confounder in clinical hypertension research and practice (Stergiou *et al.*, 2020b) and illustrates the importance of taking into account new evidence to inform policy and practice.

During discussion it was agreed that the implications for understanding impacts of climate change are complex. Increasing temperature might be anticipated to produce further decreases in daytime blood pressure, leading to patients reducing their medication, but night-time blood pressure increases with a potential for adverse consequences.

Egypt

Professor Amal Saad-Hussein (National Research Centre) reviewed data from across Egypt, from work supported by the Egyptian Academy of Science, on temperature and precipitation trends from 1950 to 2017 and future projections. The numbers of hot days and nights are increasing, faster in Upper Egypt and along the Red Sea, and the frequency of extremely hot days is forecast to increase in most of the country (see Mostafa *et al.* (2019) for further detail). As in other countries, the effect of climate change on health will be mediated by diverse pathways including heat, extreme weather events, civil conflict, disease transmission, air pollution, and food systems.

Several case studies were presented.

Schistosomiasis: comparing data from Lower and Upper Egypt, again produced in collaboration with the Egyptian Academy of Science. The incidence is related to meteorological factors affecting the movement of snails and migration of farmers from the Nile Delta, because of salination and land erosion. Further details, and an investigation of the time series trend of Bilharzial bladder cancer in relation to climate change, are provided in Ahmed *et al.* (2014).

Fungal keratitis: time series data indicate that climate change is a potential risk factor for fungal infections. Temperature and humidity are likely to be good predictors of future risk (Saad-Hussein *et al.*, 2011).

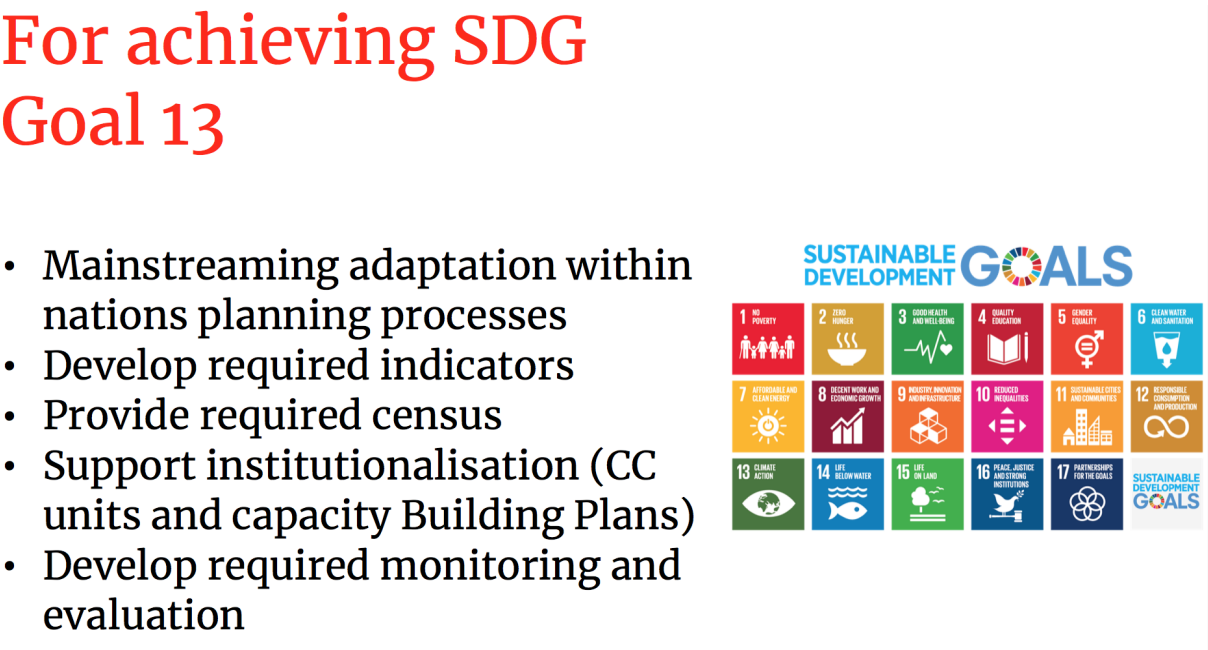


Figure 12: Successful health adaptation requires alignment with actions to tackle multiple SDGs.

Malaria: currently only a few cases are reported in limited residual foci but the potential is likely to increase because of hotter conditions, rainfall changes, and the movement of people.

Diarrhoea: relationships between morbidity data (bacterial infections) and meteorological parameters vary according to geographical location.

Successful health adaptation requires mainstreaming of measures within the national planning processes and their alignment with actions to tackle multiple Sustainable Development Goals (SDGs; Figure 12, recognising the importance also to take account of interactions between individual SDGs to capitalise on synergies, understand trade-offs, and avoid unintended consequences).

There are several relevant programmes under the Sustainable Development Strategy "Egypt Vision 2030" health axis (for example, applying comprehensive health coverage) and environment axis (for example, reducing air pollution). These are supported by broader national policy objectives covering, for example, reduction of socio-economic vulnerability, increase of adult literacy, provision of safe water and sanitation, and maintenance of public health infrastructure. Specific, established, programmes for health care include routine childhood immunisations, mass treatment for lymphatic falariasis, and directly observed therapies for tuberculosis. Programmes are being introduced for tackling hepatitis C and non-communicable diseases, for COVID-19 vaccination, and provision of health insurance for the unemployed.

Many climate-sensitive diseases are subject to monitoring under current health surveillance and early warning systems. These illustrate the importance of continuing to improve public health infrastructure for preparedness and responsiveness to climate change. The Climate Change Control Department of the Ministry of the Environment has responsibility for reporting, adaptation strategies, planning specific projects (for example, for coastal zones, water resources, agriculture, and urbanisation) and for tools such as the interactive vulnerability map. The national framework reporting to the United Nations Framework Convention on Climate Change (UNFCCC) covers both the direct and indirect pathways for impact on health, and key elements of the WHO work plan for advocacy, partnerships, scientific evidence, and health systems strengthening. Among gaps in knowledge to be filled are epidemiological studies on adaptation to decrease health impacts, accompanied by capacity building in different sectors of human resources to implement mitigation and adaptation strategies. In addition to the multiple actions identified for increasing quality of the health services in dealing with climate change, there is a priority to raise community awareness about the risks and the means of adaptation.

Israel

Professor Yinon Rudich (Weizmann Institute of Science) and Professor Shlomit Paz (University of Haifa) added further detail on the climate change trends observed throughout the region (Figure 13 and documented in the 2020 report on climate change in Israel).

Emergency hospital admissions from dehydration and heat stroke have risen markedly during 2019–2021, with the elderly and the young most vulnerable. Predicted temperature changes depend on the Representative Concentration Pathway scenario, up to 4–5 °C by 2100.

Air pollution PM_{10} (particulate matter with an aerodynamic diameter less than 10 µm) is high because of urban and desert dust, while $PM_{2.5}$ (less than 2.5 µm) has decreased, perhaps because of increasing use of natural gas. High levels of exposure to ozone (O_3; especially downwind from urban centres) and nitrogen oxides (NO_x; mostly from vehicles, trains, and ports) are also found. Cohort studies in Israel have shown causality between air pollution and asthma, cancer, cardiovascular disease, and birth defects.

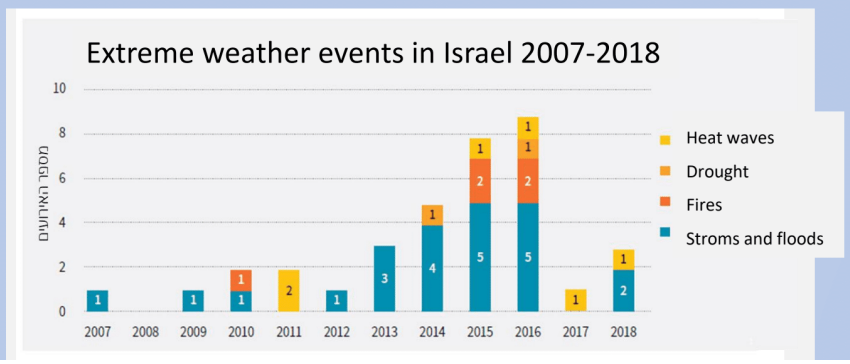
The following have been noted for infectious diseases in Israel.

- West Nile virus has increased recently.
- There is potential risk of dengue, chikungunya, and Zika viruses (again reflecting the proximity to southern Europe), but no cases yet.
- Cutaneous leishmaniasis shows an increasing trend, explained at least partly by the high ambient temperatures of early night-time on sand fly vectors, in terms of their activity patterns and northward expansion (Waitz *et al.*, 2018).

Warming trend with more frequent hot days and nights, longer and warmer summers.

Increase in the frequency, length and severity of heat waves.

Increased frequency of heavy rainstorms and floods, parallel with a redistribution in the amounts of precipitation.



1st report - 2020

Figure 13: Main impacts of climate change in Israel. Y-axis shows number of events/year. Report (cover shown on right) by the Israel Ministry of Environment: 'Climate change and energy efficiency. Climate report 2021'

- Leptospirosis is increasing, possibly in association with seasonally low water levels containing high levels of organic matter, from multi-year drought conditions.

What are the main challenges for Israel? Despite high acclimation rates there are many vulnerable groups including the poor, elderly, those working outside or with pre-existing conditions, and immigrants. Other pathways for impacts include those mediated by water shortage (addressed by desalination and re-use of sewage water), increased forest fires during the hot season, air quality, and extreme precipitation events.

General recommendations for a Disaster Risk Reduction Strategy cover climate change as part of the national strategic threat and include preparedness for extreme events; climate-adapted urban planning; strengthening ecosystem sustainability; improving meteorological forecasting; afforestation; strengthening social resilience; updating air quality standards, monitoring and implementation; introducing electric cars, developing renewable energy sources; and introducing traffic restrictions in some urban areas.

Specific recommendations to reduce health impacts include heat–health warning systems and action plans; systematic collection of epidemiological data and combination with climate, environmental, ecological, and demographic data; attention to vulnerable populations; modelling and projections to guide national and regional policy-making; strengthening public awareness; and vector surveillance and control programmes.

It was concluded that collaboration between countries should be a priority for health agencies to address cross-border challenges of disease transmission, even between countries lacking diplomatic relations. The Middle East Consortium on Infectious Disease Surveillance (MECIDS) network between Israel, Jordan, and Palestine (www.mecidsnetwork.org, founded in 2003 with intentions to expand network membership to all countries in the region) is an example of good practice that could be shared more widely.

Italy

Professor Pietro Cappuccinelli (University of Sassari and Accademia Nazionale dei Lincei) contributed further assessment of the multiple direct and indirect pathways whereby climate affects health, and agreed with the analysis

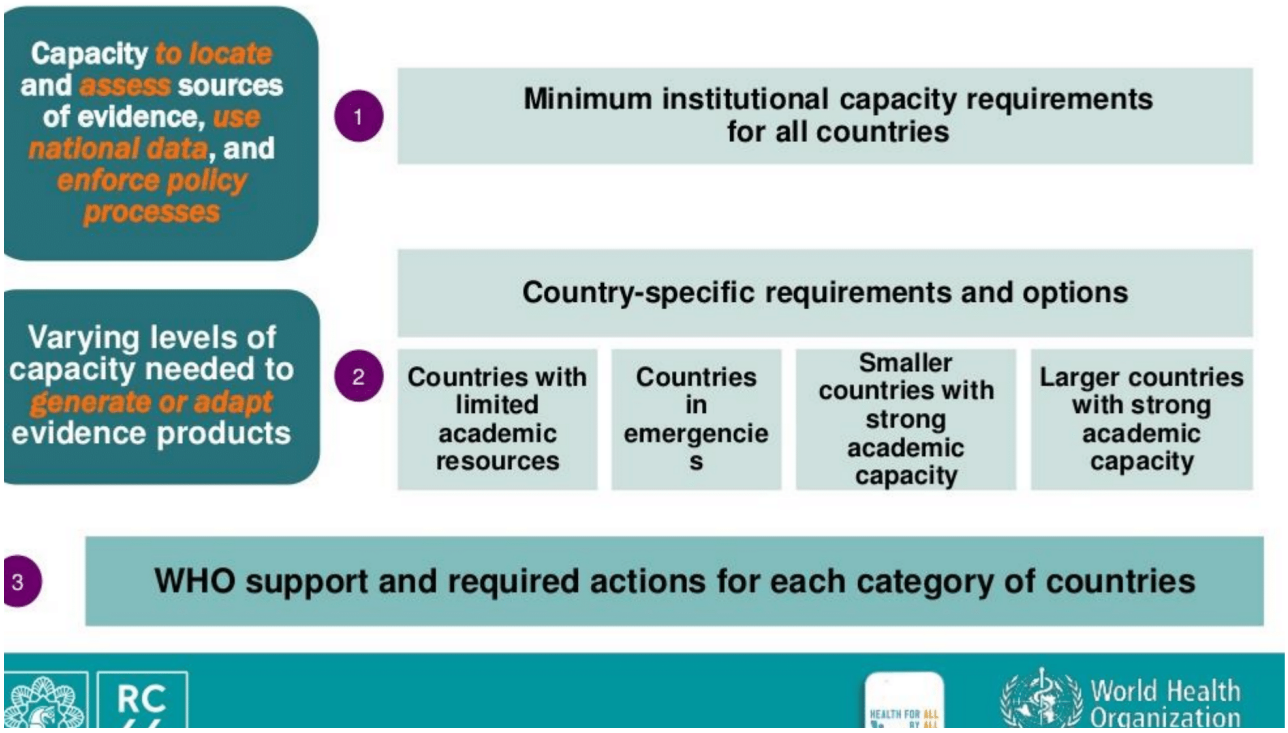


Figure 14: WHO-EMRO framework for improving national institutional capacity for use of evidence in health policy-making in the eastern Mediterranean region (2020–2024).

of the main impacts described by previous speakers: heat-related, extreme weather events, air pollution, water-, food- and vector-borne diseases, food and water shortages, and population displacement effects. He proposed that urgent implementation of a One Health approach to the control of communicable diseases would be very useful.

Because of its geographical features, post-industrial pollution, and seismic and hydrogeological vulnerabilities, Italy can be regarded as a natural laboratory to study the impact of climate change and health, and to demonstrate how policies to prevent and mitigate climate change can be operationalised. There are three levels of decision-making in Italy: national (Ministry of Health); regional government; and local level (cities and local health units). Coordination of the system is challenged at times of stress (for example, during the COVID-19 pandemic) and is sensitive to external interference, such as by the media. The *Accademia Nazionale dei Lincei* has an important role as a scientific advisory body to the President of the Republic and the Government.

Opportunities for developing national institutional capacity in the Eastern Mediterranean region for evidence-based policy-making on climate and health are exemplified by the Evidence-Informed Policy Network (EVIPNet) of the WHO Regional Office for the Eastern Mediterranean (EMRO; www.emro.who.int/rpc/evipnet), which promotes systematic use of health research evidence in policy-making and partnerships between policy-makers, researchers, and civil society, with a focus on low- to middle-income countries (Figure 14).

Jordan

Professor Nisreen Al-Hmoud (Royal Scientific Society) noted that, despite recent reforms in education and health, Jordan faces ongoing challenges associated with regional instability, high unemployment, and pressure on natural resources. It also ranks among those countries with the lowest water availability, which is likely to be exacerbated by changing temperature and precipitation. Jordan shares the impacts of climate change on health described by other countries in the region and low-income groups are particularly affected (for example in their ability to purchase water).

Adaptation measures to address water shortages include increasing efficiency in use by water-saving techniques for residential supplies, crop irrigation methods, water safety plans, wastewater re-use, and raising public and industry awareness of the issues. Increasing risk of infectious disease under climate change may be aggravated by the unintended consequences of water projects with impacts on intermediate hosts or vectors responsible for the transmission

of malaria, schistosomiasis, and leishmaniasis. Drawing on analysis of the COVID-19 pandemic, it can also be anticipated that new threats will arise because of ecosystem changes, which need to be addressed at both national and global levels.

What else is foreseeable? Heat-related mortality and morbidity are expected to increase, associated with heat exhaustion, heat stroke, and the exacerbation of chronic conditions. Outdoor workers are vulnerable in being exposed to impacts of ultraviolet radiation and heat stress. Indoor workers and farmers may also be exposed to higher levels of air pollutants resulting from increased temperature. Nutrition intakes are expected to reduce, which is a particular concern in Jordan where (in 2012) the prevalence of stunting in children under 5 years old was 7.8% and the prevalences of underweight and wasting were 3.0 and 3.4% respectively.

National policy responses have included support for the UNFCCC, with the 4th National Communication on Climate Change to be submitted in 2022, development of a Green Economy Plan (2016), and a National Climate Change Adaptation Plan (2021). Specific health adaptation programmes, based on the national assessments, aim to support improved understanding of the potential risk on the health sector due to climate change, and enhancing adaptive capacity of the sector (for example, early warning systems).

Lebanon

Professor Najat A. Saliba (American University of Beirut), focusing on air pollution, made the case for linking action to grassroots movements in the difficult circumstances suffered by Lebanon and other countries emerging from conflict. Among major problems experienced by Lebanon is the limited electricity supply (lack of infrastructure leading to use of local diesel generators and associated pollution), the high flux of migrants, drought, proximity to deserts, and declining vegetation.

The Nationally Determined Contribution (NDC) was updated in 2020 to include coverage of the efforts to protect public health through climate-resilient systems. Integration between national and regional levels is exemplified by action on air pollution, where the government has introduced legislation in conjunction with responding to pressure from the EU and neighbouring countries.

Professor Saliba emphasised the opportunity for partnership to tackle problems, involving local public authorities and informing citizens' participation in local contexts: developing a social contract between public authorities and the community and promoting social readiness to adapt. Focusing on air pollution, there are knowledge gaps relating to the impact on health of women (particularly reproductive health), children, and the elderly. Different stakeholder groups (for example, religious organisations, community activists) have varying influences on the community but the value of involving these groups in local action must also depend on their willingness to change in response to the climate crisis. Knowledge production (Hajir et al., 2021) as part of collaboration in the community can be a valuable transdisciplinary resource to inform joined-up policy and to raise patient awareness of the risks of environmental pollution, when health professionals themselves may not be confident about doing this.

North Macedonia

Professor Natasa Markovska (Macedonian Academy of Sciences and Arts) reviewed the Third National Communication on Climate Change: Health and Climate Change Vulnerability Assessment and Adaptation Measures (Figure 15), which provides further detailed analysis of national experience of climate effects, impacts, probabilities, and consequences for the health system.

The highest probabilities were assigned to effects of increased summer temperatures (increasing mortality) and duration (increasing demand on health services), winter temperatures and cold waves, and extreme weather events (overwhelming public services).

The revised NDC2 (April 2021) is more ambitious than NDC1 in terms of the GHG emission reduction 2030 target (50% greater reduction) and in its greater coverage of sectors: energy, agriculture, land use, and waste. Mitigation targets are being integrated with other policy measures and with other countries, with collaboration on research and innovation. There is also detailed analysis of economic and environmental evaluation of sectoral targets, for example in terms of new jobs created, and of synergies/trade-offs assessed for all SDGs. NDC2 also introduces gender indicators for the measures, assesses the role of the private sector in mitigation actions, the benefits of the circular economy, and is accompanied by a consultation with younger people about the opportunities

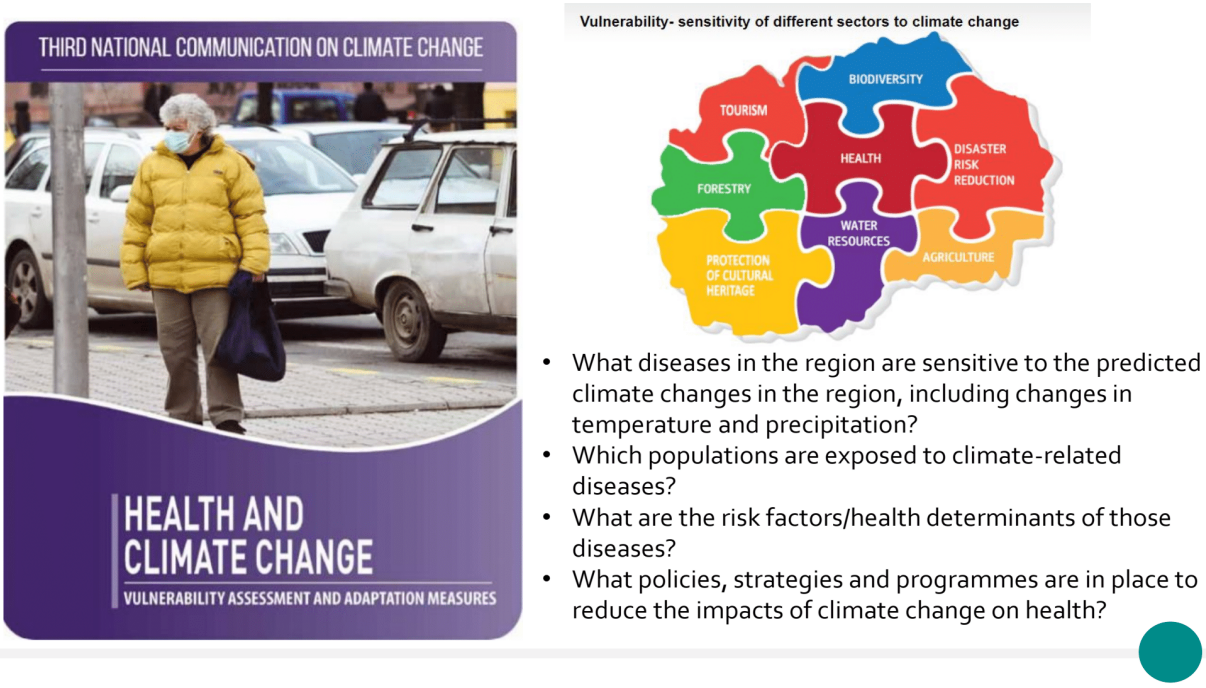


Figure 15: Third National Communication on Climate Change in North Macedonia: Health and Climate Change Vulnerability Assessment and Adaptation Measures.

and challenges. Current assessment is using the CaRBonH (Carbon Reduction Benefits on Health, WHO Europe 2018) calculator tool to quantify the physical and economic consequences for human health. The CaRBonH model uses inputs at country or regional levels for emissions reductions projected to 2030 in the context of country statistics on demographics, health indicators, and health economics, to calculate population exposure changes, physical health benefits, and economic gains (monetised health benefits).

Romania

Professor Valentin-Veron Toma (Institute of Anthropology "Francisc I. Rainer", Romanian Academy) noted that 2015 was the hottest year on record in Romania, with an increasing number of thermal anomalies observed during the period 2012–2018. Large summer temperature increases (3 °C) are projected up to 2030 and an increasing frequency and intensity of extreme weather events. In the worst-case scenario, summer temperatures higher than 50 °C may be expected. The vulnerability of the Romanian population is increased by its ageing demographic structure; cardiovascular disease is the leading cause of death (see Micheu *et al.* (2021) for the implications of climate change on cardiovascular disease).

Monitoring and surveillance of health status in relation to environmental pollutants, as well as risk characterisation and especially communication to the population of environmental risks, are the responsibility of the Ministry of Health, through the National Institute of Public Health/Centrul National de Monitorizare a Riscurilor din Mediul Comunitar (CNMRMC) in collaboration and coordination with the authorities or structures responsible for health and environment at the subnational level. A national electronic environmental register (ReSanMed) was established in 2019, supported by territorial health directorates, with an accessible web portal and objectives to identify vulnerable groups, monitor health status, establish health measures, assess climate change effects, and inform the population of the risks of climate change. Thus, the register can be a resource both for evidence-based medicine and for better public policy.

What about the contribution by the health sector itself to GHG emissions? The environmental footprint of buildings in Romania is discussed in the analysis made in October 2020 by the European Commission on *Planul Național Integrat în domeniul Energiei și Schimbărilor Climatice* 2021–2030 (PNIESC). Although Romania has started a building renovation plan, it has not yet developed a long-term plan and the issue of a systematic rehabilitation of health system buildings has not been discussed at governmental level. Most of the buildings were erected either before 1945 or between 1950 and 1989. They have a high energy consumption and are incompatible with the

new European directives on the energy security of non-residential buildings. An assessment of the level of pollution induced by the health building system itself is missing. There is a lack of a plan for the renovation and modernisation of hospitals and clinics, but also rules for the construction of buildings with high energy efficiency and low impact on the environment. The Health Strategy 2014–2020 envisages only "the modernization and endowment of health facilities to ensure compliance with standards and legislation in the field of environmental protection on the proper management of medical waste".

Other major national policies reflect EU policies (together with strategy development in collaboration with the WHO office in Romania), for example sharing in EU GHG emission reduction targets. There is an air quality law (2011) but no national climate law.

In 2020 the Romanian Academy organised a series of conferences on "Global warming and its impact", including a conference on climate change impact on the health of human populations (Toma 2020). Subsequently, the Romanian Academy published a point of view on climate change (Hera *et al.*, 2020). An important role in creating national awareness about the importance of the climate change and health agenda was played by an event organised by the Department of Climate and Sustainability and the Department of Public Health under the auspices of the Romanian Presidency, on the occasion of World Health Day (7 April 2021). This event was attended both by representatives of government institutions and by leaders in the field of health and scientific research.

Serbia

Professor Ana Vukovia Vimic (University of Agriculture, Serbia) and Professor Fedor Mesinger (Serbian Academy of Arts and Sciences) agreed that recent years have been the hottest on record. Comparing the period 2008–2017 with 1961–1990, mean temperature has increased by 1.2 °C, mean summer temperature by 1.8 °C, and mean maximum summer temperature by 2.2 °C, while mean summer precipitation has decreased. Vulnerable groups, comprising about 35% of the population, include the elderly (19% of the population is older than 65 years), impoverished rural groups (low income and low health care access, and more likely to work outside), those with chronic illness, children, and premature babies.

As in other countries in the extended region, records in Serbia document health effects associated with a range of climate change indicators, including heat waves, extreme precipitation/floods, wildfires, and drought. However, more detail is needed to quantify and prioritise adaptation measures, increase resilience in vulnerable groups, and strengthen infrastructure capacities. Prioritisation of the adaptation targets is contributing to the current NDC revision for the following.

Public health sector. Plans for urban areas; introduction of disease monitoring, for example for West Nile virus and chikungunya; and interdisciplinary research.

Other sectors, where relevant to public health. In particular, water quality protection; flood risk management planning and implementation; improved water management during shortages; risk assessment and reduction of loss and damage from natural hazards; monitoring, forecasting and early warning hydro-meteorological systems; and integrating climate change projections into national and other risk assessments.

Spain

Professor Francisco Garcia Novo (University of Seville) covered climate change impacts on society and the landscape; the latter in Spain is varied and subject to fragmentation because of competition for different land uses. Although climate change effects vary between regions in Spain, there are shared concerns about reduced rainfall with implications for water supplies for agriculture, industry, and urban areas. Rising temperatures and their duration may also negatively affect agriculture and tourism. Warmer winters may be associated with invasive tropical plants and diseases (such as the red palm weevil, *Rhynchophorus ferrugineus)* and vectors such as *Aedes albopictus*. Although warmer winters may alleviate respiratory diseases, Spain shares the risks that hot summers increase heat shock and dehydration in vulnerable groups (such as the elderly and babies) and vector-borne diseases such as West Nile virus and malaria.

Professor García Novo suggested that there is a growing development in the community of a "natural conscience" accelerated by thinking about COVID-19 and characterised by interests in nature conservation, but that the positive environmental consequences may be offset by other trends, for example in pet ownership,

tourism, and urban expansion. In terms of attitudes to climate change, the population is not fully aware of what is happening but there is some readiness to adopt lifestyle changes and to pay for reducing GHGs to limit the danger for the next generation. Nonetheless, it is also necessary to continue building willingness to share resources and knowledge among countries, alongside planning for global resources, to ensure equity.

Academies have important roles to play in documenting and exchanging climate information, particularly with those institutions in countries suffering from political interference in their selection or reporting of research; making the case for open publication of results as the standard; building academy networks; and pressing governments for action.

Sudan

Professor Suad Sulaiman (Health and Environment Adviser, Sudan National Academy of Science) identified multiple local environmental conditions increasing vulnerability to climate change: rural livelihoods dependent on rain-fed agriculture or pastoralist systems, sometimes in conflict and greatly affected both by drought and by high rainfall over the past two to three decades; economic growth dependency on oil but revenues reduced following separation of South Sudan; and frequent environment-related disease outbreaks, including malaria, dengue, yellow fever, and meningitis. Populations have been displaced to urban centres by desertification, crop failures, and extended conflict, augmented by migration from neighbouring countries. High population growth adds to pressure on natural resources.

What is in prospect? Temperature rises of up to 3 °C are predicted by 2050, with continuing desertification. The likelihood of water resource crises is increasing, especially in the north with further negative implications for agriculture and for disputes with neighbouring countries over water rights. Malaria and arboviral diseases are increasing in response to multiple environmental challenges and the lack of efficient surveillance and management systems. Little is known about the epidemiology, distribution, and dynamics

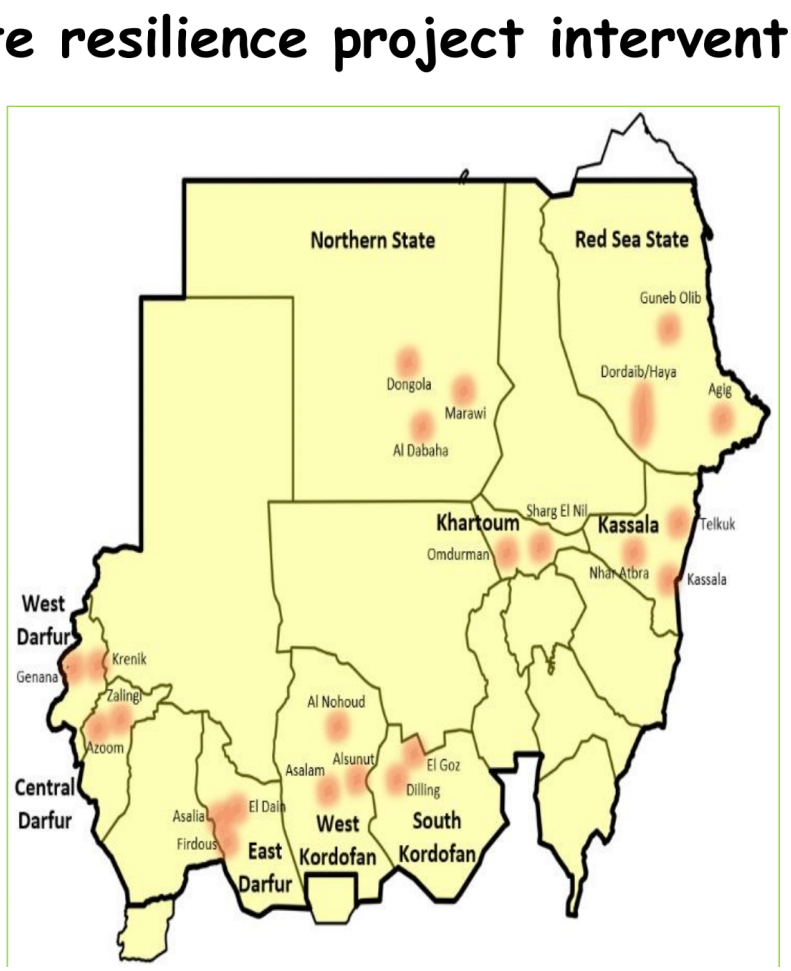


Figure 16: Current foci for intervention in the Sudan of Green Climate Fund projects designed to promote agriculture, health, and food and water security.

of arboviruses despite their rapid increase and expanding distribution. Moreover, their misdiagnosis as malaria or other febrile illness can lead to their underestimation alongside an overestimation of the prevalence of malaria (Ahmed *et al.*, 2020). *Anopheles stephensi* as an urban malaria vector has been confirmed in East Sudan, outside its previous geographical range of Southeast Asia and the Arabian Peninsula, possibly brought in by migrants. An interdisciplinary research project mapping social and environmental factors in the spread of *A. stephensi* malaria in Sudan and Ethiopia is in progress in collaboration with international partners.

Institutional frameworks for tackling climate change include the Higher Council for Environment and Natural Resources as the focal point for the UNFCCC. The Higher Council is being supported by the United Nations Environment Programme (UNEP) in implementing a major climate change project supporting preparation of the National Adaptation Plan. The Green Climate Fund (2020) is an innovative climate resilience project designed to promote agriculture, health, and food and water security in 138 villages (Figure 16) in specific regions of Sudan.

The project should take a One Health approach and include disease vector surveillance in the community, which consists mostly of farmers and herdsmen who live closely with their animals, such that zoonotic disease transmission is anticipated. Eastern states (Figure 16) are not included in the Green Climate Fund; however, because they are at high risk from malaria and arboviruses, and because they may serve as a risk for disease expansion westwards, they also require One Health-based assessment for better surveillance.

Tunisia

Professor Habib Ben Boubaker (University of Manouba) and Professor Mongi Bourgou (University of Tunis) reinforced points made by previous speakers in characterising the relationship between climate and human health as strong, complex, and changing. Developed countries are responsible for most of the climate change attributable to human activity (Figure 17) but the consequences are felt by all countries, including those with the lowest incomes in the EMME region.

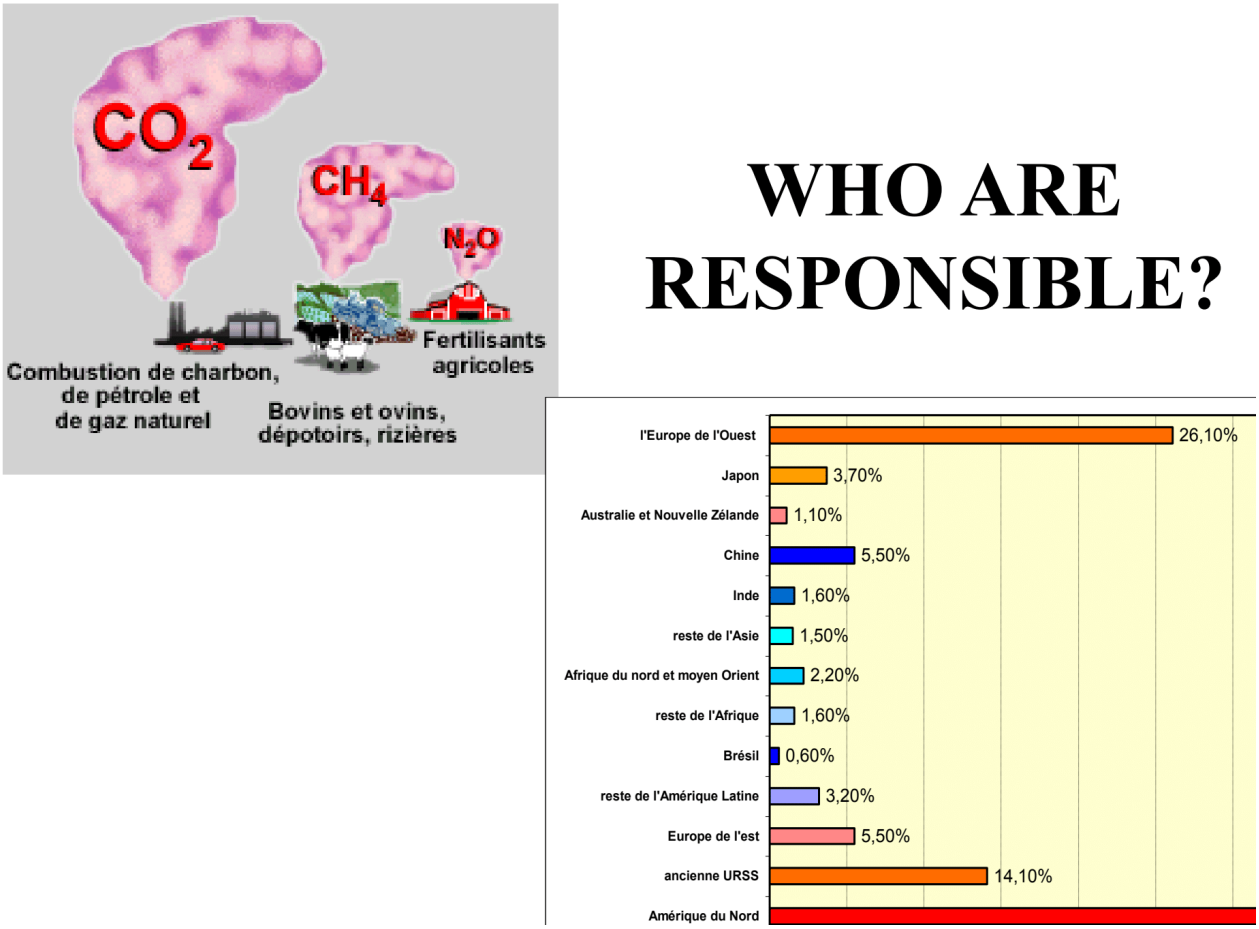


Figure 17: Developed countries are responsible for most of the climate change attributable to human activity, with consequences for all countries, including those with lowest incomes in the EMME region.

Tunisia is vulnerable, because of the intensity of the climate change foreseen, the sensitivity of its natural and anthropogenic systems, and limited capacities for adaptation. Particular vulnerabilities are geographical (the coastline), natural resources (water), and economic sectors (agriculture and tourism). Records for the past century show temperature (increasing) and rainfall (decreasing) anomalies with increases of 0.5–3 °C expected by 2050. Hot days will be more intense and persistent, winters shorter and less cold. However, there is a significant methodological issue: how to identify hot and cold days in a hot climate? Most thresholds are designed according to data from colder countries: using modified methods it was found that very hot days can occur outside the summer season both in the north and south of the country, alongside lengthening of the warm season and shortening of the cold season. The link between heat and mortality is not linear. Moreover, individuals can adapt their behaviour, for example by using fans during heat waves although this can lead to social inequity because of cost or lack of electricity supply. Furthermore, high temperatures lead to electricity shortages and thence to water scarcity and social disruption.

In addition to heat waves, cold waves, and droughts, extreme events such as floods and tornadoes (never seen before 2004) bring additional health risks but there is little information on consequences other than fatalities. Vector-borne diseases, assumed eradicated, such as malaria and leishmaniasis, have reappeared: these include zoonotic cutaneous leishmaniasis in central Tunisia where climate change is associated with changes in land use, habitat; and vectors. New vector-borne diseases such as West Nile virus and dengue are emerging.

National solutions encompass mitigation to reduce GHGs and adaptation to impacts linked to health, economic sectors (agriculture, tourism, urbanisation), natural resources (water, soil and biodiversity), and ecosystems (wetlands, forests). There is strategic cooperation with the WHO and other UN bodies on health adaptation, particularly relating to re-emerging infectious disease, water quality and availability, and food security. Accomplishing the objectives requires urgent capacity building for prevention and early warning systems; adaptation, which requires, in turn, strengthening of skills, knowledge, and research systems; and cooperation between neighbouring countries and with the WHO.

General discussion and focus on policy challenges

(Chaired by Professor George Christophides, The Cyprus Institute)

The countries brought together in this workshop cover a very large region. There is great variation in landscape, environmental resources, population characteristics, and the challenges experienced. But there are also many similarities: in the pathways by which climate change acts on health, the main categories of health impacts, the probability of much greater impacts under "business-as-usual" scenarios, and in the collective need for evidence-based solutions.

Discussants agree that, to inform policy options, it is necessary for the scientific community to engage early and in a sustained way with policy-makers, using messages understandable by non-specialists. How can policy-makers be encouraged to ask for, and act upon, the evidence? Experience shows that politicians are more likely to be influenced by evidence on the economic impacts of climate change effects on health[VIII] and by information on quantifiable solutions. Furthermore, many politicians are receptive to public opinion. There is an important role for the scientists in engaging with the public – perhaps particularly the younger generation – to provide robust information, counter misinformation, and to help implement solutions in the community.

The workshop has provided much scientific evidence that can be used to help inform specific priorities for policy-making on climate change and health. Contributors have emphasised the strategic importance of tackling underlying problems relating to socio-economic inequity, marginalisation of vulnerable groups, literacy, water quality and accessibility, as well as the broad societal problems associated with climate change and other environmental change, such as the loss of biodiversity. In terms of targeted policy action on the health effects of climate change, to drive adaptation and mitigation solutions, particularly where mitigation is associated with health co-benefits, outputs from the workshop can also be used to help clarify responsibilities in the policy matrix (Table 1).

In addition to the examples in Table 1, there are other opportunities for countries in the region to participate in collective action:

- Global Race to Zero and Race to Resilience Campaigns[IX].
- Adaptation Action Coalition[X], with the objective of building momentum and supporting action to adapt and build resilience to the impacts of climate change. Egypt was a founding partner of the coalition and one principal work stream is "Building climate resilient work streams" (launched during the UK's COP26 Presidency, Spain as a founding partner).
- Capitalising on momentum for health equity created by the work of the Commission on Social Determinants of Health in the Eastern Mediterranean (Marmot et al., 2021).

There is a particular relevance in the final item in Table 1, for the EU and its European External Action Service and Neighbourhood Policy priorities for structural transformation, which includes climate action. For example, the EU Neighbours South Clima-Med project (2018–2022) supports the formulation of mitigation and adaptation actions in Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine, and Tunisia. Moreover, many of the issues for the neighbourhood also have consequences for EU domestic priorities in tackling the health effects of climate change and it is important for EU policy-makers to be aware of the assessments from this workshop.

VIII A recent report on the USA (De Alwis and Limaye, 2021) estimates annual health costs of climate change and air pollution as far in excess of US$800 billion.

IX https://unfccc.int/sites/default/files/resource/MP_achievements_progress_April2021.pdf.

X https://www.gov.uk/government/publications/adaptation-action-coalition-an-overview.

Table 1: What information has the workshop collected to help navigate the policy matrix?	
Integrating policy action at local–regional–global levels	**Insights from the workshop**
What is already happening to address climate change effects in policy at the national level?	Examples of how health promotion is covered in NDCs, especially recent revisions, e.g. Egypt, Jordan, North Macedonia, Serbia; how climate change and health are covered in national development plans, e.g. Jordan; or national disaster/emergency plans, e.g. Albania, Israel.
What issues should also be covered at regional level, and how?	Examples of transboundary health issues (such as air pollution, infectious disease) and of cross-boundary initiatives, e.g. EVIP Network WHO-EMRO; country inclusion in EU GHG targets (Romania); adoption of EU air pollution standards (Lebanon)[XI]. Major opportunities to work with regional offices of UN (particularly WHO, Food and Agriculture Organization (FAO), United Nations Economic Commission for Europe (UNECE), UNEP), e.g. Romania, Tunisia.
How should imbalances within the region be reduced?	Countries making only small contribution to GHGs may be among the most vulnerable to impacts. Opportunities for sharing good practice for resilient systems and filling knowledge gaps by collaboration in research and data collection, which also build skills, infrastructure and innovation, e.g. the MECIDS network between Israel, Jordan, and Palestine. Collective action on development of shared services (Climate Services Hub). An additional example from Africa Genetic Biocontrol Consortium (www.genbioconsortium.africa, with NASAC as a partner) aims to expand Africa's self-determination through research and development to tackle malaria and other vector-borne diseases.
How can public engagement help to support science–policy interfaces?	Objectives for improving public engagement, e.g. Egypt, Romania. Community involvement in research and implementing solutions provides motivation and momentum for broader action for "triple wins": health, climate, and equity, e.g. Lebanon, Spain.
Health and climate issues are important for all policies. How can integrated policy be developed across economic sectors?	Examples of how adaptation in other sectors and their development of sustainable objectives (such as for agriculture, urban planning, industry, tourism) influences health issues, e.g. North Macedonia, Serbia, Tunisia. Health professionals can lead discussions on risks and solutions across multiple sectors, particularly if leading by example (decarbonisation of the health sector itself, e.g. Romania, and see EASAC and FEAM (2021)). Opportunities for taking a One Health approach across human and animal health, e.g. Italy, Sudan, and alignment with SDGs, e.g. Egypt. Significant opportunity for EMME-CCI to emphasise shared priorities and integrated actions across Task Forces.
Issues for the region are likely to be relevant outside the region. How can these be brought to the attention of other policy-makers?	Workshop outputs will be integrated into the ongoing work of IAP (Figure 7) with intergovernmental (UNFCCC, Intergovernmental Panel on Climate Change (IPCC)) and other international bodies (G7, G20).

XI EU air quality standards are currently being revised, with a public consultation in the third quarter of 2021 and the adoption of new standards by the third quarter of 2022.

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Appendix: workshop programme and participants

Workshop programme

Climate Change and Health Workshop

6 May 2021, 10:00–18:00 Eastern European Summer Time, by Cisco Webex

Session 1	**Welcome and background information**
10:00–10:20	Welcome and organisational information
	Professor Costas Papanicolas, The Cyprus Institute, Cyprus
	Professor George Christophides, The Cyprus Institute, Cyprus
	Professor Volker ter Meulen, The InterAcademy Partnership (IAP)
10:20–10:50	**Keynote address: Climate change and health–from impacts to action**
	Professor Sir Andy Haines, London School of Hygiene & Tropical Medicine
10:50–11:20	Regional and global perspectives on climate change and health: focusing on solutions to inform policy
	Dr Robin Fears, European Academies' Science Advisory Council (EASAC)
11:20–11:30	Coffee break
11:30–12:00	Climate Change and Health in the EMME Region
	Dr Marco Neira, The Cyprus Institute, Cyprus
12:00–12:20	Discussion and introduction to afternoon sessions
12:20–12:45	Lunch break
Session 2	**Invited presentations on climate change, health, and policy**
	Chair: Dr Nina Hobbhahn
12:45–13:00	Assoc. Professor Alban Ylli, Tirana Medical University, Albania
13:00–13:15	Dr Zoubir Harrat, Pasteur Institute of Algeria, Algeria
	Impact of Climate change on Vector-Born-Diseases in Algeria
13:15–13:30	Professor Bojan Jelaković, University Hospital Centre Zagreb, Croatia
	Professor Mirko Orlić, University of Zagreb, Croatia

13:30–13:45	Professor Amal Saad-Hussein, National Research Centre, Egypt
	Climate change impacts on health in Egypt
13:45–14:00	Assoc. Professor Shlomit Paz, University of Haifa, Israel
	Professor Yinon Rudich, Weizmann Institute of Science, Israel
14:00–14:15	Professor Emeritus Pietro Cappuccinelli, University of Sassari, Italy
14:15–14:30	Coffee break
	Chair: Dr Kamil Erguler
14:30–14:45	**Dr Nisreen DaifAllah Al-Hmoud, Royal Scientific Society, Jordan**
14:45–15:00	Professor Najat A. Saliba, American University of Beirut, Lebanon
15:00–15:15	Dr Natasa Markovska, Macedonian Academy of Sciences and Arts, N. Macedonia
15:15–15:30	Professor Valentin-Veron Toma, Romanian Academy, Romania
15:30–15:45	Dr Ana Vuković, University of Belgrade, Serbia
	Professor Fedor Mesinger, Serbian Academy of Sciences and Arts, Serbia
	Climate change and health in Serbia, as known at present
15:45–16:00	Professor Francisco García Novo, University of Seville, Spain
16:00–16:15	Coffee break
	Chair: Dr Nina Hobbhahn
16:15–16:30	Professor Suad Sulaiman, Freelance Health & Environment Adviser, Sudan
16:30–16:45	Professor Habib Ben Boubaker, University of Manouba, Tunisia
	Professor Mongi Bourgou, University of Tunis, Tunisia
	Climate change and health challenges in the Mediterranean countries: case of Tunisia
Session 3	**General discussions**
16:45–18:00	Chair: Professor George Christophides and Dr Robin Fears

Workshop participants

Name	Affiliation
Dr Nisreen DaifAllah Al-Hmoud	Royal Scientific Society, Jordan
Professor Habib Ben Boubaker	University of Manouba, Tunisia
Professor Mongi Bourgou	University of Tunis, Tunisia
Dr Claudia Canales	InterAcademy Partnership
Professor Emeritus Pietro Cappuccinelli	University of Sassari, Italy
Professor George Christophides	The Cyprus Institute, Cyprus
Dr Kamil Erguler	The Cyprus Institute, Cyprus
Dr Robin Fears	European Academies' Science Advisory Council, UK
Professor Francisco García Novo	University of Seville, Spain
Professor Sir Andy Haines	London School of Hygiene & Tropical Medicine, UK
Professor Zoubir Harrat	Pasteur Institute of Algeria, Algeria
Dr Nina Hobbhahn	European Academies' Advisory Council, Germany
Professor Bojan Jelaković	University Hospital Centre Zagreb, Croatia
Professor Jos Lelieveld	Max Planck Institute for Chemistry, Germany
Professor Azeem Majeed	Imperial College London, UK
Professor Julian Mamo	University of Malta, Malta
Dr Natasa Markovska	Macedonian Academy of Sciences and Arts, North Macedonia
Associate Professor Maria Koliou Mazeri	University of Cyprus, Cyprus
Professor Jeremy McNeil	Western University, Canada
Professor Fedor Mesinger	Serbian Academy of Sciences and Arts, Serbia
Johanna Mogwitz	InterAcademy Partnership, Germany
Dr Marco Neira	The Cyprus Institute, Cyprus
Professor Mirko Orlić	University of Zagreb, Croatia
Professor Costas Papanicolas	The Cyprus Institute, Cyprus
Associate Professor Shlomit Paz	University of Haifa, Israel
Professor Yinon Rudich	Weizmann Institute of Science, Israel
Professor Amal Saad-Hussein	National Research Centre, Egypt
Professor Najat A. Saliba	American University of Beirut, Lebanon
Professor Suad Sulaiman	Freelance Health and Environment Advisor, Sudan
Professor Volker ter Meulen	InterAcademy Partnership, Germany
Professor Valentin-Veron Toma	Romanian Academy, Romania
Dr Ana Vuković Vimic	University of Belgrade, Serbia
Associate Professor Alban Ylli	Tirana Medical University, Albania

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Abbreviations

AASSA	Association of Academies and Societies of Sciences in Asia
EASAC	European Academies' Science Advisory Council
EMME	Eastern Mediterranean/Middle East
EVIPNet	Evidence-Informed Policy Network
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
IANAS	Inter-American Network of Academies of Sciences
IAP	InterAcademy Partnership
MECIDS	Middle East Consortium on Infectious Disease Surveillance
NASAC	Network of African Science Academies
NDC	Nationally determined contribution
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WHO-EMRO	World Health Organization Regional Office for the Eastern Mediterranean


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