

# PUBLIC HEALTH AND CLIMATE CHANGE ADAPTATION POLICIES IN THE EUROPEAN UNION

## Final report

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“Addressing the impacts of climate change on health”  
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## ABSTRACT

In 2017 the WHO Regional Office for Europe and the European Commission started a joint 18-month project to analyse developments in health policies to address adaptation to climate change in European Union countries and to compile a selection of good practice case studies. Results were extracted from a desk review of available documents and from interactions with country representatives from the health and environment sectors through a survey carried out from April to August 2017 and a workshop held in Bonn, Germany, in October 2017. Governance mechanisms for integrating climate action into health policy and planning seem well established in European Union countries. Several specific areas for technical improvement can be identified from the results, especially overall strengthening of capacities to ascertain the climate-sensitive disease burden in populations.

### Keywords

ADAPTATION  
CLIMATE CHANGE  
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The WHO Regional Office for Europe further acknowledges the valuable contributions of 15 case studies from eight European Union countries (Austria, Belgium, Croatia, Germany, Italy, Lithuania, Slovenia and Sweden).

## Abbreviations

BRT	boosted regression tree
CART	classification and regression tree
CI	confidence interval
CO <sub>2</sub>	carbon dioxide
CYPADAPT	Development of a national strategy for adaptation to climate change adverse impacts in Cyprus (project)
EEA	European Environment Agency
ECDC	European Centre for Disease Control and Prevention
EU	European Union
GPW13	Thirteenth general programme of work 2019–2023 (WHO)
ICD-10	International Classification of Diseases, tenth revision
IHR	International Health Regulations
IPCC	Intergovernmental Panel on Climate Change
IT	information technology
MEMO	Monitoring of Exotic Mosquitoes in Belgium (project)
PUUV	Puumala virus
RBHC	resource-based habitat concept
RCP	Representative Concentration Pathway
RR	relative risk
SDG	Sustainable Development Goal
SR18	special report on health, demography and climate change compiled by the Austrian Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
UV	ultraviolet

## Executive summary

The European Union (EU) Strategy on adaptation to climate change aims to support countries in developing effective approaches to adapting to climate change in different sectors. In 2017 the WHO Regional Office for Europe and the European Commission started a joint 18-month project to analyse developments in health policies to address adaptation to climate change in EU countries and to compile a selection of good practice case studies.

Results were extracted from a desk review of available documents and from interactions with country representatives from the health and environment sectors through a survey carried out from April to August 2017 and a workshop held in Bonn, Germany, in October 2017. Of the 28 EU countries 20 completed the survey questionnaire (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Slovakia, Slovenia, Spain and Sweden); a response rate of 71%.

The report also includes a review of past trends and future projections of selected weather- and climate-related hazards, including their health impacts. It is structured as five chapters.

- Chapter 1 sets the scene by summarizing the links between climate change and public health and provides a guide to the international policy frameworks relevant for climate change adaptation in the health sector. It concludes with an outline of the final project report and a short description of the specific project objectives and the approaches used to address them.
- Chapter 2 outlines the health effects of climate change, both observed and projected, focusing on EU countries. These are extracted from the literature review, questionnaire replies provided by participating EU countries and a desk review of the Seventh National Communications, which all EU countries listed in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC) were obliged to submit in December 2017.
- Chapter 3 reports on the implementation levels of policies across EU countries to protect health from climate change for a range of impacts (including heat, cold, flooding, vector- and waterborne diseases, food safety, nutrition and allergies) and of adaptation measures to make health systems more climate resilient, based on an analysis of the survey results.
- Chapter 4 summarizes case studies of climate change adaptation measures in the health sector: 15 case studies from eight countries (Austria, Belgium, Croatia, Germany, Italy, Lithuania, Slovenia and Sweden) were identified.
- Chapter 5 provides conclusions and recommendations.

The report also includes three annexes: Annex 1 shows the questionnaire sent to EU country representatives; Annex 2 sets out the data collected observed and projected health effects, vulnerability and adaptation policies submitted in EU countries' Seventh National Communications to the UNFCCC of December 2017; Annex 3 includes 15 case studies on climate change adaptation and health from EU countries.

The main findings of the project are as follows.

- Responding to climate change is a cross-government priority in many countries. It requires the health sector to work in a coordinated manner with other actors, often under a single climate change strategy and coordinating mechanism, as well as within its own sector to define adequate measures. Therefore, the health sector needs to lead adaptation



planning in the health and working with other sectors with the aim of achieving health benefits.

- Governance mechanisms for integrating climate action into health policy and planning seem well established in EU countries. All the responding countries are considering implementing adaptation actions to address climate change-related health impacts.
- There is a high level of awareness about climate change in the responding countries, although awareness of its health implications appears to be lower.
- Financial and human resources for health adaptation to climate change are integrated into ongoing activities and resource planning. While effective health adaptation also focuses on strengthening existing systems, there is a need to account for the additional burden of health impacts brought about by observed and predicted climate change.
- Vulnerability, impact and adaptation assessments seem to be an area of strong performance across all EU countries. Most vulnerability assessments are relatively recent, and in this regard provide a solid foundation for adaptation planning. There are, however, gaps in translating scientific evidence into action. Key areas like the economic consequences of inaction in climate health policy are still rarely included in assessment materials and communications.
- All EU countries consulted reported a wealth of activities on health system strengthening linked to climate change adaptation, with strong emphasis on infectious disease surveillance, implementation of the International Health Regulations, environmental health and early warning systems. Certain important areas, however, remain lacking, such as the development of integrated climate, environment and health surveillance systems and the creation of climate-resilient health infrastructures.
- National online platforms seem to be the preferred channels for sharing of good practices in climate and health policy-making in the responding countries. A review of such links and materials indicated that organizations designing knowledge-dissemination strategies in these topic areas might find it useful to consider these formats.
- Several specific areas for technical improvement can be identified from the results, especially overall strengthening of capacities to ascertain the climate-sensitive disease burden in populations; assessment of the adequacy of adaptation and its social, environmental and economic consequences; and development of general principles and guidance for climate change and health risk communication messages and materials.

Evidence on the health impacts of climate change is accumulating, increasing appreciation of the need to address both climate change and its impacts on health. Challenges for health are expected to increase, exacerbated by prevailing environmental health exposures and risks. In particular locations within the WHO European Region and specific settings (such as coastal, urban and rural areas) these challenges are and will be determined by climate exposures; changes in social, economic and environmental determinants (urbanization, social exclusion, air quality, water quality and quantity, food quality, housing safety, waste management and so on); and overall adaptive capacity.

While climate change affects everybody, some population groups and specific settings are more vulnerable than others. Thus, the health community should be fully engaged in national intersectoral mechanisms for adaptation to climate change. Incorporation of a climate-resilient approach contributes to ensuring the capacity of health systems to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stress, to bring sustained improvements in population health, despite an unstable climate.

# 1. Introduction

Evidence and knowledge about climate change and health are growing and are increasingly well communicated to both governments and the general public. Key reports of global and European relevance include the series of government-approved reports from the Intergovernmental Panel on Climate Change (IPCC) – specifically its Fifth Assessment Report, which reviewed the evidence on climate change and health and provided summaries for policy-makers (Stocker et al., 2013; IPCC, 2014a); a 2015 Lancet Commission report on climate change and global environmental change (Watts et al., 2015); and the 2016 United States Global Change Research Program assessment of the impacts of climate change on human health (Crimmins et al., 2016). In 2017 the WHO Regional Office for Europe presented an update on protecting health in Europe from climate change, drawing on the extensive body of new research and evidence (WHO Regional Office for Europe, 2017a). In the same year the European Environment Agency (EEA) published its fourth report on climate change, impacts and vulnerability in Europe (EEA, 2017a), along with an issue on climate change adaptation and disaster risk reduction, which assesses current practices and the level of knowledge, and highlights emerging innovative tools for national, regional and local authorities to tackle the impacts of weather- and climate-related hazards (EEA, 2017b).

The risks from current and future climate change can cause immense impacts on societies and ecosystems, as the IPCC’s Fifth Assessment Report concludes:

Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.

(IPCC, 2014a)

The magnitude and extent of health impacts and outcomes<sup>1</sup> from climate change are a function of the interactions between exposures to climate change-related alterations in weather patterns and the vulnerabilities of the exposed human and natural systems. Thus, the severity of impacts is determined by changes in climate and concurrent changes in non-climatic factors. Exposures include changes in the frequency and intensity of extreme weather events, and changes in mean temperature, precipitation and other weather variables that have consequences for health determinants (such as food and water safety and security) and for disease transmission pathways. Vulnerabilities are the consequence of a range of factors, which need to be investigated and understood within the context of the multiple determinants of health outcomes.

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<sup>1</sup> A negative health impact causes or contributes to ill health. For example, working in unhygienic or unsafe conditions or spending a lot of time in an area with poor air quality is likely to have an adverse effect on physical health status. Health outcomes refer to the effects a process has had on the people targeted by it. These might include, for example, changes in their self-perceived health status or changes in the distribution of health determinants, or factors which are known to affect their health, well-being and quality of life (<http://www.who.int/hia/about/glos/en/index1.html>).

## 1.1. Why climate change is a matter of public health

Climate change-related increases in temperature are disrupting global ecosystems and food production, causing more extreme weather events and wildfires, threatening coastal communities with accelerated sea level rise and creating favourable conditions for infectious diseases to spread (IPCC, 2014a). Exposure to health hazards related to climate change affects different communities to different degrees and in different ways. Health risks may emerge in places where they have not been known previously, or the severity and/or frequency of climate-sensitive health risks may be exacerbated. Observed and projected impacts on health put mitigation of and adaptation to climate change high on both the environmental and health agendas (Crimmins et al., 2016).

Some of the climatic changes in recent years have established new record levels, such as for global and European temperatures, winter Arctic sea ice extent and sea levels. Some of these changes (for instance, sea level rise) have accelerated recently. Furthermore, various extreme weather events that have recently occurred in Europe have become much more likely as a result of global climate change.

Overall, the health impacts of climate change across all 53 Member States in the WHO European Region<sup>2</sup> are wide ranging (see Chapter 2 for further details). Climate change will affect everybody, but vulnerability to weather and climate change depends on people's level of exposure, their personal characteristics (such as age, education, income and health status) and their access to health services. Elderly people, children, outdoor workers and homeless people are particularly susceptible population groups. Furthermore, the populations considered at greatest risk are those living in large cities or near a coast, and those considered water-stressed as they have limited access to water and/or live in arid areas.

In the European Union (EU) more than 75% of the population lives in urban areas; this is expected to grow to 82% by 2050 (UN-Habitat, 2011). Cities are priority areas for climate change impact assessment due to the agglomeration of people, assets and economic activity, which makes them particularly vulnerable. Climate change has a direct impact on cities, including increasing health problems due to heat or flooding damage to buildings and infrastructure. With a higher proportion of elderly people, cities are and will be more sensitive to heat-waves and other climatic hazards. In most European cities there is still limited awareness about the climate change health risks that target vulnerable groups and the need for assessments and adaptation policies. If vulnerable groups are not involved in adaptation solutions, implementation may deepen existing inequalities in the distribution of climate change consequences across urban societies and could exclude such groups from participating in the decision-making process (Breil et al., 2018).

Climate change may threaten the overall progress made in reducing the burden of diseases and injuries by increasing morbidity and mortality due to extreme weather events like heat-waves or flooding in the future. It should also become an integral planning dimension of existing and future health programmes, taking into account factors such as the accuracy of projections of where, when and how the health burden could change with climate change (Smith et al., 2014).

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<sup>2</sup> The WHO European Region comprises 53 Member States, including the 28 EU countries.

Adaptation is defined by the IPCC as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human interventions may facilitate adjustment to expected climate and its effects” (IPCC, 2014a). It is necessary to address both the current burden of disease and the additional burden posed by climate change. It is also well understood that coherent multisectoral action is necessary if the challenges posed by climate change are to be tackled effectively.

As a result of climate change, health systems need to prepare for and adapt to gradual changes in health outcomes caused by extreme events (such as heat-waves, storms, floods and associated infectious disease outbreaks). Health systems can improve the protection of population health from climate change through setting-specific local risk management and planning. In distinct geographical areas, risks such as high summer temperatures, heavy precipitation, sea level rise and flooding or the early onset of the pollen season often do not come as a surprise. It is crucial to assess actual and potential local, regional or national health impacts and vulnerabilities to inform and tailor health adaptation strategies.

Some of the elements of adaptation in the health sector need to be strengthened to anticipate potential health effects, such as emerging infectious disease spread, and to detect health threats early (for example, by monitoring heat-waves). The health sector should also engage in discussions with other sectors to initiate adaptation from the health-driver point of view in preventing hazardous conditions that could be further aggravated through climate change (such as unsafe water and food).

Responding to climate change is a cross-government priority in many countries. It requires the health sector to work both internally and in a coordinated manner with other actors, often under a single climate change strategy and coordinating mechanism, to define adequate measures. The health sector therefore needs to lead adaptation planning for health, working with other sectors to achieve health benefits.

The direct and indirect health impacts of emerging climate change risks need to be tackled urgently, as they are set to become one of the most prominent risks populations will face in the coming decades. Countries are at different stages of preparing, developing and implementing climate change adaptation strategies that put a lens on health. Policies for heat-health action plans, for example, are urgently needed in European countries facing an increasing risk of hot temperatures and heat-waves, to prevent the expected increase of climate change-related heat deaths.

The policy objective is now to continue to scale up the health contribution to the shared goal of addressing climate change. This requires the health community to play an active role in awareness-raising and advocacy, strengthening the evidence base and climate and health programming. This includes defining a systematic approach to placing climate resilience into mainstream core health programming, and to developing and using technical tools to strengthen evidence and to assess the health implications of mitigation policies (WHO, 2015).

### ***1.1.1. International policy frameworks for climate action and health***

Several international policy frameworks and platforms are in place; these stipulate a clear mandate to foster stronger engagement of the health sector with climate change adaptation and mitigation.

The **United Nations Framework Convention on Climate Change (UNFCCC)** sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It required all Annex I Parties (including all EU countries) to submit their Seventh National Communications<sup>3</sup> by January 2018; most countries have complied (UNFCCC, 2018).

Under the UNFCCC process, the **Paris Agreement on Climate Change** is the first universal, legally binding global deal to combat climate change and adapt to its effects (UNFCCC, 2015). Its global goal on adaptation focuses on “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the global temperature goal”. With regard to health, implementation of the Paris Agreement provides its parties with opportunities to:

- strengthen the climate resilience of their health systems – for example, through improved disease surveillance and preparedness for extreme weather events and ensuring climate-resilient health facilities, with undisturbed access of health facilities to essential services such as energy, water and sanitation;
- identify and promote measures that both mitigate climate change and improve health, for example, by reducing carbon emissions, air pollution and the environmental impact of the health sector itself (Box 1).

**Box 1. Estimate of health co-benefits if EU countries achieve the contributions submitted under the Paris Agreement**

Under the Paris Agreement, Member States in the WHO European Region committed through their intended nationally determined contributions to a substantial reduction in greenhouse gas emissions until 2030 compared to 1990 levels. Measures to reduce greenhouse gas emissions can improve population health immediately and directly through reduced air pollution. The cost savings from health co-benefits are potentially large. In EU countries, by 2030 emissions of fine particulate matter (PM<sub>2.5</sub>) would go down by 17%, sulfur dioxide (SO<sub>2</sub>) by 25% and nitrous oxides by 13% compared to 1990 levels. The tool “Linking carbon reduction to health benefits”, developed by the WHO Regional Office for Europe (in press), gives initial results that quantify the possible health benefits linked to these expected reductions in air pollutant emissions by 2030. The annual preventable premature mortality could amount to 74 000 deaths across the whole Region, of which 61% (45 100 deaths) would be averted across countries of the EU.

The **2030 Agenda for Sustainable Development** defines 17 Sustainable Development Goals (SDGs) and 169 targets focusing on people, planet, prosperity, peace and partnership (United Nations, 2015). Health is central to the three dimensions (social, environmental and

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<sup>3</sup> All Parties must report on the steps they are taking or envisage undertaking to implement the UNFCCC (Articles 4.1 and 12.1) by: “reporting to the Conference of the Parties on emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (greenhouse gas inventories); national or, where appropriate, regional programmes containing measures to mitigate, and to facilitate adequate adaptation to climate change (general description of steps taken or envisaged by the Party to implement the Convention).

economic) of sustainable development and to measuring its progress. Progress towards the SDGs will make an important contribution to protecting the health of the most vulnerable by reducing poverty and hunger, reducing child mortality, ensuring environmental sustainability and developing a global partnership for development. In November 2016 the European Commission published *Next steps for a sustainable European future: European action for sustainability* (European Commission, 2016). This outlines how the SDGs will be integrated into European policy frameworks, in conformity with the priorities of the Commission. The SDGs support the need for early warning and disaster risk reduction systems, adaptation to climate change, strengthened resilience, adequate facilities and infrastructure and appropriate policies (United Nations, 2015).

The **Sendai Framework for Disaster Risk Reduction 2015–2030** was adopted by representatives from 187 United Nations Member States in March 2015. As disaster risk reduction generally aims to prevent new and reducing existing disaster risk and to manage residual risk, it contributes to strengthening resilience and therefore to the achievement of sustainable development (IPCC, 2014b; UNISDR, 2015).

Four of the seven Sendai Framework global targets have direct links to health, focusing on reducing mortality, population well-being, early warning and promoting the safety of health facilities and hospitals. It also places strong emphasis on resilient health systems through the integration of disaster risk management into health care provision at all levels.

In 2017 the **Sixth Ministerial Conference on Environment and Health** took place in Ostrava, Czechia. It brought together health and environment ministers and high-level representatives of Member States in the WHO European Region, as well as many other stakeholders, including the European Commission, academia and civil society organizations. Member States committed to strengthen and promote actions to improve the environment and health at international, national and subnational levels through the Ostrava Declaration (WHO Regional Office for Europe, 2017b). According to the Declaration, by enhancing national implementation, countries will strive to make a difference for their citizens – to this end, developing national portfolios of actions on environment and health by the end of 2018, as standalone policy documents or parts of others, respecting differences in countries' circumstances, needs, priorities and capacities. These portfolios should draw on Annex 1 to the Declaration, which is a compendium of possible actions to facilitate its implementation, focusing on the seven priority areas, including climate change and health (WHO Regional Office for Europe, 2017c) (Box 2).

## **Box 2. The Ostrava Declaration and actions on climate change and health**

The overall objective for the priority area of climate change and health in the Ostrava Declaration is: “countries to strengthen adaptive capacity and resilience to climate change-related health risks, to support measures to mitigate climate change and to achieve health co-benefits in line with the Paris Agreement”. To achieve this objective, countries can include in their national portfolios some of the following proposed actions listed in Annex 1 to the Declaration, to advance implementation (WHO Regional Office for Europe, 2017c).

- Develop and implement a national strategy or action plan for public health adaptation to climate change as an independent policy or within wider national adaptation policies, as well as natural disaster risk reduction policies.
- Assess climate change risks to health in relevant national policies, strategies and plans.
- Include, on a voluntary basis, health considerations within Member States’ commitments to the UNFCCC.
- Consider climate change adaptation and mitigation in the development of specific environment and health policies, such as those on air quality, water and sanitation and others, bearing in mind that the cornerstones of adaptation are proper health protection infrastructure and housing standards.
- Strengthen natural risk reduction policies and early warning surveillance and preparedness systems for extreme weather events and climate-sensitive disease outbreaks.
- Develop information, tools and methodologies to support authorities and the public to increase their resilience against extreme weather and climate health risks.
- Include the health aspects of climate change in education curricula, nonformal education and workforce continuing professional education.
- Scale up public communication and awareness-raising campaigns on climate change and health.
- Conduct or update national health vulnerability, impact and adaptation assessments of climate change.
- Support research on the effectiveness, cost and economic implications of climate change and health interventions, with a particular focus on mutual co-benefits.

The **Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes** was adopted in 2005 (UNECE & WHO Regional Office for Europe, 2006). The Protocol is the first legally binding multilateral agreement to ensure safe drinking-water and sanitation in the WHO European Region. It has been ratified by 26 countries. Its goal is to protect human health and well-being through improved water resources management and by prevention, control and reduction of water-related diseases, as well as detection, contingency planning and response to outbreaks. Article 8 of the Protocol requires parties to establish, improve and maintain a comprehensive national and/or local surveillance and early warning system; to identify outbreaks or incidents of water-related diseases, including those resulting from extreme weather events; and to prepare contingency plans in response to such outbreaks and incidents. Guidance on water supply and sanitation in extreme weather events was developed under the Protocol and adopted at the second session of the Meeting of Parties in 2010. Guidance on water and climate adaptation was developed under the Water Convention jointly with the Convention’s Task Force on

Water and Climate, adopted by Parties of the Convention (UNECE, 2013). Article 6 of the Protocol provides a strong legal framework for setting national targets on strengthening climate resilience of water and sanitation services (thus protecting public health) and addressing the health impacts of water scarcity, among others.

The **Thirteenth general programme of work 2019–2023** (GPW13) sets out WHO’s strategic direction towards improving the health of the world over the coming five years (WHO, 2018). Its targets are woven around three strategic priorities, each setting a goal of 1 billion people and together known as the “triple billion” goal. These include: 1 billion more people benefiting from universal health coverage, 1 billion more people better protected from health emergencies and 1 billion more people enjoying better health and well-being. GPW13 highlights the importance of addressing climate change and health, specifically in small island developing states and other vulnerable settings, and of strengthening cross-sectoral collaboration towards Health in All Policies.

EU countries’ coastal and river-dwelling populations are at high risk of flooding, while urban populations are at risk of multiple exposures (air pollution also increases the health risks associated with high temperatures), including infectious disease vectors such as mosquitoes, ticks and rodents (WHO Regional Office for Europe, 2017a). In this regard, WHO will continue to work on the interface between climate change and health and the impact of air pollution. According to GPW13, WHO aims to triple health-related climate finance by 2023, both to ensure that health systems in all small island developing states are resilient to extreme weather and to climate-sensitive diseases by 2030; and to support countries in reducing CO<sub>2</sub> emissions globally, with a view to substantial health co-benefits. Envisaged activities to promote these aims include supporting national and global advocacy; providing evidence through country profiles and business cases for investment; ensuring technical and capacity-building support for implementation; facilitating access to climate finance by health ministries; supporting climate resilience, energy and water access in health care facilities; and linking to other WHO priorities, including strengthening capacities to manage risks of climate-related emergencies.

All Member States in the WHO European Region, including the 28 EU countries, approved **World Health Assembly Resolution WHA61.19** in 2008 (WHO, 2008), which urges countries to:

- include health measures in adaptation plans;
- build technical, strategic and leadership capacity in the health sector;
- strengthen capacity for preparedness for and response to natural disasters;
- promote active cross-sectoral engagement of the health sector; and
- express commitment to meeting the challenges of climate change, and guide planning and investments.

**Health 2020**, the European policy for health and well-being adopted by all Member States in the WHO European Region in 2012, gives policy-makers a vision, a strategic path, a set of priorities and a range of suggestions about what works to address health inequalities, improve health and ensure the health of future generations (WHO Regional Office for Europe, 2013a). Health 2020 features three priority areas which provide strong entry points to protecting health from climate change:

- tackling the Region’s major health challenges of noncommunicable and communicable diseases;



- strengthening people-centred health systems, public health capacity and emergency preparedness, surveillance and response; and
- creating resilient communities and supportive environments.

### ***1.1.2. The EU Strategy on adaptation to climate change***

The EU Strategy on adaptation to climate change (EU Adaptation Strategy) sets out a framework and mechanisms for raising the EU's preparedness for current and future climate impacts (European Commission, 2013a). It aims to support countries in developing effective approaches to adapting to climate change by prioritizing coherent, flexible and participatory approaches in the health and in other sectors. To make Europe more climate resilient, the Strategy aims to:

- increase the resilience of the EU countries, regions and cities;
- better inform decision-making with clear evidence;
- increase the resilience of key vulnerable sectors and their coordination and information-sharing by ensuring that adaptation considerations are addressed in all relevant EU policies.

The European Commission is conducting an evaluation of implementation of the Strategy, to be completed in autumn 2018.

Several working documents complement the EU Adaptation Strategy and focus on specific areas, such as infrastructure, marine coastal areas, environmental degradation and migration and health, or integrating adaptation into EU structural and investment funds. The Commission also published guidelines on developing adaptation strategies in support of the Strategy. The guidance includes detailed advice on methods for preparing an adaptation strategy, accompanied by practical examples (based on several countries' experience), checklists and detailed information on the range of support available at the European level (European Commission, 2013b).

The EU Adaptation Strategy also encourages the integration of climate change impacts and responsive measures into the health sector, including prevention and health determinants, such as nutrition. The accompanying working document on adaptation to climate change impacts on human, animal and plant health refers to studies and conclusive reports published by the WHO Regional Office for Europe, European Centre for Disease Control and Prevention (ECDC), IPCC and EEA to address countries' adaptation strategies and operational plans within the health sector (European Commission, 2013c).

According to the 2018 EEA report on national climate change impact, vulnerability and risk assessments, health featured among the sectors that attracted the greatest attention in national assessments across Europe. The EEA's European Climate Adaptation Platform website includes further information on EU countries' adaptation policies (EEA, 2018).

The EU health strategy "Together for Health" recognized climate change as a threat to health and highlighted the European Community's role to coordinate and respond rapidly to health threats globally and to enhance countries' capacities to do so (European Commission, 2008). The EU Health Programme (2014–2020) includes among its goals the need to protect EU citizens from serious cross-border health threats, including those caused by climate change (European Parliament, 2014).

In 2013, the EU adopted Decision 1082/2013/EU on serious cross-border threats to health (European Parliament, 2013). This decision strengthens preparedness in the EU and the coordination of responses to health threats. It helps countries prepare for and protect citizens against possible future pandemics and serious cross-border threats caused by communicable diseases, chemical, biological or environmental events, including climate change.

## **1.2. Scope of this report**

In 2017 the WHO Regional Office for Europe and European Commission started a joint 18-month project (January 2017 to June 2018) to address the impacts of climate change on health. Its objectives were:

- to assess progress in tackling health risks from climate change by analysing climate change adaptation developments related to public health in EU countries; and
- to compile a compendium of case studies with good practice examples of adaptation to climate change in the health sector, submitted by EU countries.

This report presents a summary of the project's findings, with a view to providing relevant information to the EU and national stakeholders on strengthening the links between health and climate change in relevant policy processes. It specifically explores how coherence in health risk management practices across sectors can be supported through public health policies, and to what extent transfer of knowledge and experience can drive mutually beneficial learning and capacity-building in this direction. It gives a snapshot of the degree of implementation of climate change adaptation measures contributing to improved health status and improved resilience of health systems across EU countries.

Findings were extracted from a desk review of the Seventh National Communications, which all EU countries listed in Annex I to the UNFCCC were obliged to submit in December 2017 (see Annex 2). The observed and projected health effects, health vulnerability and adaptation health policies contained in these were analysed. Additional data were provided from interactions with country representatives from the health and environment sectors through a questionnaire survey carried out from April to August 2017 and a workshop held in Bonn, Germany, in October 2017, which established a template for case studies, which countries were requested to submit. The report also includes a review of past trends and future projections of selected weather- and climate-related hazards, including their health impacts.

### **1.2.1. Questionnaire survey**

A semi-structured questionnaire was sent to the health departments of the governments of all EU countries through WHO national counterparts. It contained seven blocks of open and closed questions (see Annex 1). Data collection took place between April and August 2017.

Of the 28 EU countries 20 completed the questionnaire and returned it to the project partner (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Slovakia, Slovenia, Spain and Sweden). The survey thus reached a response rate of 71%.

For analysis, a questionnaires code structure was developed and entered into Atlas.ti data analysis software, with each code representing one theme. Themes were grouped into domains describing the level of integration of public health measures into national climate change adaptation strategies. For double checking, all answers were coded in numeric form

and stored in a dataset in Microsoft Excel. Data were summarized and entered for a qualitative analysis.

Generally, low response rates can be an expected drawback of questionnaire approaches, which was not the case with this survey. Certain limitations can be found in the study method, however, as the researchers were not able to establish objective criteria for measuring the level of preparedness of a country to deal with potential impacts of climate change on human health. Study participants may have had different understandings based on personal perception or knowledge, as not all those involved were experts from relevant sectors.

For missing responses (such as in the section on policy commitment), no quantitative analysis was conducted, as missing responses could not be directly correlated with a relative lack of progress towards policy commitment in different areas. Reasons for not answering individual items could have been manifold and may not be interpreted as negative responses. Overall, missing answers could not be explained and may inevitably influence the quality of the data obtained.

### ***1.2.2. Case study collection***

To compile a compendium of case studies on climate change adaptation and health from EU countries, a template was developed and agreed by country representatives during the thematic technical meeting in Bonn, Germany, on 22–23 October 2017. The template aimed to reflect the varying nature and objectives of good practices in climate change and health adaptation across countries.

All EU countries were invited to submit one or more case studies according the suggested structure. A total of 19 case studies from 10 countries were received, and 15 case studies from eight countries (Austria, Belgium, Croatia, Germany, Italy, Lithuania, Slovenia and Sweden) were selected. This report presents a summary of the case studies in Chapter 4; the full compendium of case studies received from countries is provided in Annex 3.

## **2. Health effects of climate change in Europe**

This chapter outlines the health effects of climate change, both observed and projected, by topic: heat, cold, floods, infectious diseases and aeroallergens. It summarizes the answers to the questionnaire survey on observed and projected health effects of climate change and on priorities for protecting health from climate change. Evidence is explained and further illustrated through examples from EU countries.

The increasing frequency and intensity of extreme weather events due to climate change pose growing risks to human health. In Europe in 1991–2015 heat-waves were the deadliest extreme climate event, particularly in southern and western Europe. Cold spells were the deadliest weather extremes in eastern Europe. The highest death rates from floods and wet mass movements, such as landslides, occurred in southern and eastern Europe, while the highest death rate from wildfires (forest fires) occurred in southern Europe. The deadliest storms were reported in northern and western Europe (EEA, 2017a).

Climate change is influencing mortality, injury and morbidity rates of both communicable (such as vector- and waterborne diseases) and noncommunicable (such as cardiovascular and respiratory diseases and mental health issues) diseases, and will continue to do so. The future health impacts of climate change are difficult to quantify because of the complex interplay between climatic and non-climatic drivers and the effects of climate change adaptation on health. By the end of the 21st century, two thirds of Europeans could be exposed to weather-related disasters every year, compared with only 5% during 1981–2010. Climate change is the dominant driver of the projected trends, accounting for more than 90% of the rise in the risk to humans (Forzieri et al., 2017).

### **2.1. Heat**

#### ***2.1.1. Health issue***

Heat extremes have serious impacts on public health in Europe. The effects of heat mostly occur on the same day and in the following three days. The observed increase in frequency and intensity of heat-waves – periods of hot weather lasting for several days, for example – has had significant effects on human health across Europe, particularly among elderly people and in cities due to the urban heat-island effect.

Age, pre-existing medical conditions and social deprivation are the key factors that make people experience more adverse health outcomes related to heat and extreme temperatures (Paavola, 2017). The effects of exposure can be directly related to heat (heat stress and dehydration or heat stroke) or indirectly related – such as a worsening of cardiovascular and respiratory diseases, kidney diseases or electrolyte disorders (Åström et al., 2013; Analitis et al., 2014).

#### ***2.1.2. Observed effects***

Across the WHO European Region the number of hot days has increased, with the strongest trends in the Iberian Peninsula and southern France (Field et al., 2012). Over recent decades high temperature extremes, including tropical nights and heat-waves, have become more frequent (EEA, 2017a) and Europe (in particular southern Europe) has experienced many summer heat-waves, droughts and forest fires characterized by lasting conditions of high temperatures and low precipitation.

Several extreme heat-waves have occurred since 2000 (in 2003, 2006, 2007, 2010, 2014, 2015 and 2017). The heat-wave during the summer of 2003 claimed more than 70 000 lives across mostly western EU countries (Robine et al., 2008) and the 2015 heat-wave caused more than 3000 additional deaths in France alone (CRED, 2016). In the summer of 2017 Portugal was severely affected by wildfires, which occurred during a concurrent heat-wave and severe drought, killing 65 people (Viegas, 2017). In the same year, in several southern European countries, including Greece, Italy and France, severe alert warning messages were issued, indicating that even healthy and active people could suffer from possible negative effects. In Italy hospital admissions went up by 15% during the heat-wave (Lancet Countdown & EPHA, 2017).

### **2.1.3. Projected effects**

Extreme heat-waves may affect many parts of the world regularly, including Europe, if global temperatures rise by 4 °C (Russo, Sillmann & Sterl, 2017). Under a high emissions scenario, extreme heat-waves are projected to occur as often as every two years in the second half of the 21st century, and by the end of the century 90% of the summers in southern, central and north-western Europe will be warmer than any summer in 1920–2014, with the most severe health risks for southern Europe and the Mediterranean coasts, where many densely populated urban centres are located (Lehner, Deser & Sanderson, 2018).

Projected increases in frequency and severity of heat-waves will lead to an increase in heat-attributable deaths unless adaptation measures are taken. Several studies – including the European Commission’s ClimateCost, PESETA and PESETA II projects – have been conducted to estimate future heat-related mortality in Europe using similar methods. All arrived at comparable results showing a significant increase compared with the present baseline, with the highest impacts in southern Europe. The projected mortality for EU countries in 2071–2099 is 35 000 and 96 000 deaths attributable to heat under the Representative Concentration Pathways (RCP) scenarios RCP4.5 and RCP8.5 (IPCC, 2018), respectively, in addition to the 11 500 deaths estimated without climate change. Mediterranean and eastern European countries will be the most affected by heat, but a non-negligible impact will be still registered in western and north-continental countries (Kendrovski et al., 2017). The results vary across climate models and emission scenarios, but heat-related mortality would be significantly lower within specific adaptation scenarios (Ciscar et al., 2011; Kovats et al., 2011; Watkiss & Hunt, 2012; Paci, 2014). Furthermore, hospital admissions are projected to be highest in southern Europe, where the proportion of heat-related admissions for respiratory conditions is expected to triple in 2021–2050 compared to the reference period 1981–2010 (Åström et al., 2013).

Projections of future heat effects on human health need to consider that the European population is projected to age (Lung et al., 2013; Watts et al., 2015). Heat-waves will also influence work productivity, and adaptations to buildings or work practices are likely to be needed to maintain labour productivity during hot weather (IPCC, 2014b). Highly urbanized areas are projected to be at increased risk of heat stress compared with surrounding areas.

## **2.2. Cold**

### **2.2.1. Health issue**

Cold weather and cold spells have significant health effects as a result of low outdoor and indoor temperatures, ice and snow (Smith et al., 2014). The lag time from the onset of cold

weather to its health consequences is very short – for example, mortality rates can increase within 24 hours – but cold effects were greatest 2–3 weeks after the event.

Prolonged cold spells affect physiological and pathological health, especially among elderly people and those with respiratory and cardiovascular diseases (Ryti, Guo & Jaakola, 2015). Deaths associated with cold weather are caused by coronary heart disease, cerebrovascular incidents, respiratory diseases, hypothermia and trauma.

### ***2.2.2. Observed effects***

Many cold-related deaths occur on only moderately cold days; (moderate) cold is responsible for a higher proportion of deaths than (moderate) heat (Gasparrini et al., 2015). In contrast to heat-waves, fatalities associated with cold temperatures tend to concentrate in the east of Europe, where 28 people per million died as a result of extreme cold events in 1991–2015 (EEA, 2017a). Homeless people are 6–10 times more likely to die from hypothermia than the general population in moderate cold stress conditions (Vuillermoz et al., 2016; Romaszko et al., 2017).

Excess winter mortality in Portugal, Spain, Greece and Italy is higher than in Finland, Germany and the Netherlands, and deaths often occur several days or weeks after the coldest day of a cold period (Healy, 2003; Analitis et al., 2008). This is probably linked to the characteristics of housing and people’s acclimatization and adaptive capacity. Cold spells were also observed to have weaker impact on mortality than heat-waves in the Netherlands and Finland (Ekamper et al., 2009; Ruuhela et al., 2017).

### ***2.2.3. Projected effects***

The mean estimate of cold-related mortality will increase by approximately 3% in the 2020s, and then decrease by 2% in the 2050s and by 12% in the 2080s, from the baseline period 1993–2006 (Hajat et al., 2014). The PESETA II study does not consider a potential reduction in cold-related mortality in its climate impact estimates (Paci, 2014), mainly because of recent evidence of lower cold-related mortality (Åström et al., 2013; Kinney et al., 2015). Nevertheless, the risk from moderate cold is expected to continue to account for most of the temperature-related risk throughout this century (Vardoulakis et al., 2014; Arbuthnott et al., 2016).

## **2.3. Floods**

### ***2.3.1. Health issue***

The health impacts of floods vary between affected populations (related to their exposure, vulnerability and capacities to reduce risks and cope with the event). They also differ according to the type of flood event (whether the onset is slow or fast), the background health situation of the population and their access to health services.

Two thirds of deaths associated with flooding occur from drowning; the rest result from physical trauma, heart attacks, electrocution, carbon monoxide poisoning or fire associated with flooding. Often, only immediate traumatic deaths from flooding are recorded. Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (both acute and delayed). The longer-term health effects associated with a flood are less easily identified but include effects due to displacement, destruction of homes and delayed recovery, as well as health consequences (such as vector-borne diseases) arising from poor

performance of water supply and sanitation services (WHO Regional Office for Europe, 2017d).

### **2.3.2. Observed effects**

Since 1991 registered flood events have caused the deaths of more than 2000 people in the WHO European Region, affected 8.7 million others and generated at least €72 billion in losses (WHO Regional Office for Europe, 2017d). Major events include the catastrophic floods along the Elbe and Danube in August 2002 and March/April 2006; flooding in Romania and the Alpine countries in August 2005; severe summertime flooding in the United Kingdom in 2007; several events in Czechia, Italy and Poland in 2009 (EEA, 2010); and devastating floods in central and eastern Europe in June 2013 and in the Balkans in May 2014 (Guha-Sapir, Below & Hoyois, 2018).

### **2.3.3. Projected effects**

For a medium emissions scenario and in the absence of adaptation, river flooding is estimated to affect about 300 000 people per year in the EU by the 2050s and 390 000 people by the 2080s; the latter figure corresponds to more than double that of the baseline period (1961–1990). The British Isles, western Europe and northern Italy show a robust increase in future flood hazards; these regions also show the greatest increase in the population affected by river floods (Rojas et al., 2012; Rojas, Feyen & Watkiss, 2013; Ciscar et al., 2014).

If no additional adaptation measures were taken, the number of people affected by coastal flooding in the EU at the end of the 21st century would range from 775 000 to 5.5 million annually, depending on the emissions scenario. Two thirds of projected deaths would occur in western Europe. Coastal adaptation measures (dykes and beach nourishment), however, could significantly reduce risks to less than 10 deaths per year in 2080 (from 650 without adaptation), reducing residual impacts to around €5 million/year (Ciscar et al., 2011; Kovats et al., 2011).

Flooding is also associated with impacts on mental health. Coastal flooding in the EU could potentially cause 5 million additional cases of mild depression annually by the end of the 21st century under a high sea level rise scenario in the absence of adaptation (Bosello et al., 2011; Watkiss & Hunt, 2012).

## **2.4. Infectious diseases**

### **2.4.1. Health issue**

The activity, spread and survival of infectious agents, their vectors and intermediate hosts are affected by changes in temperature, humidity and rainfall (McMichael & Lindgren, 2011). Thus, changes in climate or weather conditions may affect infectious diseases, and extreme weather events may help create opportunities for more clustered disease outbreaks. Overall, climate conditions constrain the geographical and seasonal distributions of infectious diseases, and weather affects the timing and intensity of disease outbreaks (Kuhn et al., 2005; Wu et al., 2014).

Climate change is likely to cause changes in ecological systems that will affect the risk of infectious diseases in the WHO European Region through water, food, air, rodents and arthropod vectors (WHO Regional Office for Europe, 2017a). Waterborne pathogens often act in concert through two major exposure pathways: drinking-water and recreational water use. Heavy precipitation and flooding events can also disrupt water treatment and distribution

infrastructures, increasing the risk of ingress of faecal pathogens and waterborne outbreaks (Semenza et al., 2016; EEA, 2017a).

High air temperatures can adversely affect food quality during transport, storage and handling. Elevated marine water temperatures accelerate the growth rate of certain pathogens, such as *Vibrio* species that can cause foodborne outbreaks in seafood (EEA, 2017a).

#### **2.4.2. Observed effects**

A key determinant of the number of reported tick-borne diseases is the abundance of ticks, a factor sensitive to climatic variables – notably temperature and humidity. Tick-borne encephalitis and Lyme borreliosis (Lyme disease) are the two most important tick-borne diseases in Europe; both are transmitted primarily by *Ixodes ricinus*. Lyme disease is the most common vector-borne disease in the EU, with a reported incidence of approximately 65 000 cases per year. The number of reported cases of tick-borne encephalitis in the EU was 2560 during 2012 (ECDC, 2014; EEA, 2017a).

Mosquito habitats are influenced by temperature, humidity and precipitation levels. The Asian tiger mosquito (*Aedes albopictus*) is an important vector in Europe for transmitting viral diseases (ECDC, 2014). Mosquito-borne diseases have not been a substantial concern within Europe historically, but locally transmitted (autochthonous) outbreaks of chikungunya, dengue and even malaria have occurred in recent years. Chikungunya, for example, was reported in France and Italy in 2010, 2014 and 2015, as were local transmissions of dengue in Croatia and France in 2010. Heavy rainfall events may have increased the risk of the autochthonous transmission of chikungunya in France in 2014 by leading to a rapid rise in vector abundance (Delisle et al., 2015; EEA, 2017a). High temperature anomalies in summer 2010 were the most important determinant of the 2010 West Nile virus outbreak in Europe, in particular in south-eastern Europe (Paz et al., 2013).

Flooding has also been associated with waterborne outbreaks due to groundwater contamination during flooding events, for example in Finland and Austria (Schmid et al., 2005). Inadequate barriers to remove or inactivate *Cryptosporidium* in the public water supply resulted in a large outbreak in Sweden (Widerstrom et al., 2014). The number of *Vibrio* infections, which can be life-threatening, has increased substantially in Baltic Sea states since 1980. This has been linked to increases in sea surface temperature, which has improved environmental conditions for *Vibrio* species blooms in marine waters. These conditions can be found in the Baltic Sea, estuaries and enclosed water bodies with moderate salinity during the summer months. For these bacteria, open ocean environments do not offer appropriate growth conditions owing to the high salt content, lower temperature and limited nutrient content. Of most relevance to human health are the *Vibrio* species that can cause vibriosis infections, including *Vibrio parahaemolyticus*, *Vibrio vulnificus* (relevant for recreational exposure) and the non-toxigenic *Vibrio cholerae*. They may lead to septicaemia, severe necrotic ulcers and death in susceptible individuals exposed during bathing in contaminated marine environments. The unprecedented number of *Vibrio* infections in 2014 has been attributed to the unprecedented 2014 heat-wave in the Baltic region (EEA, 2017a).

Regarding foodborne diseases, it has been observed that cases of salmonellosis increase by 5–10% for each 1 °C increase in weekly temperature when ambient temperatures are above 5 °C (Kovats et al., 2004). The incidence of campylobacteriosis in humans is also positively associated with mean monthly temperature, with a lag time of up to one month (Jore et al., 2010). An analysis of foodborne illnesses in England and Wales, United Kingdom, showed



that the impact of the temperature of the current and preceding week has decreased over recent decades, indicating that the potential risk from elevated temperatures related to climate change can be counteracted through concerted public health action. Thus, regardless of climatic factors, health behaviour interventions and food safety regulations should be able to reduce possible negative consequences on public health (Semenza & Menne, 2009).

### **2.4.3. Projected effects**

Impacts of climate change on vector-borne disease transmission in Europe, focusing on tick-borne, mosquito-borne and sandfly-borne diseases, have been projected. It has been observed that ticks shift to elevated altitudes and latitudes as warmer temperatures occur, in particular during milder winters. This implies that with climate change due to warmer winters and longer vegetation this shift can be followed by their natural hosts. West Nile virus risk was projected to 2025 and 2050, keeping other variables constant (such as bird migratory routes, water index and state of vegetation); the results indicate a continuous extension of regions with an increased risk of West Nile virus infections, mainly at the fringes of the regions of transmission. Projections for 2025 show an elevated risk in north-east Greece, east Croatia and north-west Turkey; projections for 2050 show a further expansion of high-risk areas (Semenza & Suk, 2018).

Warm seasonal and annual temperatures and sufficient rainfall provide favourable climatic conditions for *Aedes albopictus* in Europe. In addition, globalization and international air travel contribute to pathogen and vector dispersion internationally. Nevertheless, monitoring forecasts of meteorological conditions can help detect epidemic precursors of vector-borne disease outbreaks and serve as early warning systems for risk reduction.

Climate change could result in up to 50% more temperature-related salmonellosis cases by the end of the 21st century under a high climate change emissions scenario than would be expected on the basis of population change alone (Watkiss & Hunt, 2012). As noted above, health promotion and food safety policies can mitigate adverse impacts on public health. The risk of campylobacteriosis and cryptosporidiosis could increase in those regions where precipitation or extreme flooding is projected to increase (EEA, 2017a).

Increased numbers of *Vibrio* infections can be expected, based on the effects of increased temperatures under climate change scenarios. The projected increase in risk is substantial, but the absolute increase is projected to be modest, owing to low current incidence rates (Vezzulli, Colwell & Pruzzo, 2013). Bacterial *Vibrio* blooms in coastal water can be monitored on the E3 Geoportal, developed by ECDC (2018).

Water scarcity is accelerating across the EU and can pose additional challenges for providing sustainable water and sanitation services. Occurrence of waterborne diseases is related to water quality and may be affected by changes in runoff, seasonality and frequency of extreme events such as heavy rains, floods and droughts (IPCC, 2014a). Areas under high water stress, for example, are estimated to increase from 19% in 2007 to 35% by the 2070s, by which time the number of additional people affected is expected to reach 16 million to 44 million (WHO Regional Office for Europe, 2017a).

## **2.5. Aeroallergens**

### **2.5.1. Health issue**

Allergic respiratory diseases and asthma are a result of environmental and immunological interactions. Prevalence of bronchial asthma and allergic rhinitis has increased over recent decades. The main diseases of concern are respiratory tract infections, rhinosinusitis, chronic obstructive pulmonary disease and asthma.

Estimates are that over 24% of adults living in Europe suffer from various allergies, while the proportion of children is 30–40% and rising (WHO & WMO, 2012). The most widespread types of allergy are related to allergenic pollen in the air, which affects urban more than rural populations (D'Amato, 2011). Seasonal outbreaks cause a rapid increase in symptoms and intake of antihistamines. For asthma alone, the economic costs in Europe are estimated at €18 billion per year, including the cost of lost productivity (WHO & WMO, 2012).

### **2.5.2. Observed effects**

The production and release of airborne allergens and pollen are associated with climate change, warmer conditions and increased CO<sub>2</sub>; they are therefore linked to increases in diseases such as asthma and allergic rhinitis (Makra, Matyasovszky & Deák, 2011). An increase in hospital admissions for respiratory disorders by 25% during 1999–2007 is associated with an increase in the concentration of *Ambrosia artemisiifolia* pollen by 10 grains per m<sup>3</sup> (Matyasovszky et al., 2011).

Significant associations have been identified between emergency calls concerning asthma exacerbation among children and springtime pollen concentrations (Tosca et al., 2014). In the last 30 years the spring events have advanced by six days, with the highest rate of phenological changes observed in western Europe and Baltic regions (D'Amato et al., 2015).

### **2.5.3. Projected effects**

Global warming is expected to affect the duration, start and intensity of the pollen season. Thus, the increased rate of asthma exacerbation due to respiratory infections is expected. The duration of the pollen season is also expected to extend, especially in summer and among late-flowering species.

Increased exposure to air pollutants that act synergistically, combined with exposure of allergens as a result of global warming, could intensify allergic responses and points to increased respiratory problems in the future. Weed species are also expected to proliferate (D'Amato et al., 2015).

## **2.6. Observed and projected health effects of climate change in selected EU countries – survey results**

The survey asked three questions on the health effects of climate change:

- What are the currently observed health effects of climate change in your country?
- What are the projected/expected future health effects of climate change in your country?
- What do you consider to be the main risks/priorities for protecting health from climate change in your country?

Understanding the impacts of climate change on human health is complex but necessary in order to advance climate change adaptation policies. Early detection of any outbreak and

improved public health surveillance and response are essential elements in adapting to climate change. It is vital to ensure that the infrastructure in place in countries is not only well maintained but also reviewed and improved in response to climate change. Countries have adopted a range of measures to avoid or reduce climate risks, and their experiences point to a need to shift the emphasis from disaster response to long-term risk management.

To assess progress in tackling health risks from climate change, questionnaires were sent to all EU countries; the response rate was 71% (20 of 28 countries). Part A of the questionnaire contained questions addressing countries' health policies on adaptation to climate change; part B contained open questions asking for technical information on climate change and health effects (see Annex 1). This section summarizes answers to part B on observed and projected health effects of climate change and priorities for protecting health.

The vast majority of countries' responses demonstrate that climate change has had a direct effect on human health and already shapes people's health protection behaviour. All responding countries reported concern about the impacts of climate change on their most vulnerable populations: elderly or very young people and those with low socioeconomic status, as well as people with cardiovascular and respiratory diseases. Three countries listed research into observed and projected health effects of climate change as a prerequisite and priority for protecting public health.

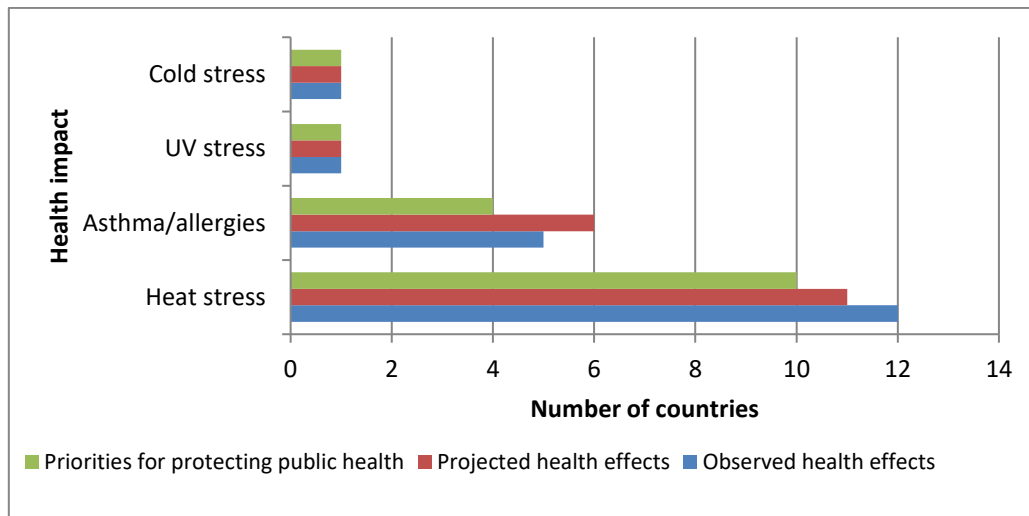
Of the 20 responding countries 12 reported a variety of health impacts due to climate change. These fell into four general categories of concern:

- climate change and associated risks of extreme weather events (heat and cold stress), asthma and allergies and ultraviolet (UV) stress and radiation damage;
- climate change and communicable diseases (vector-, water- and foodborne diseases);
- injuries due to flooding and other natural disasters caused by climate change; and
- climate change and food safety and water security.

Although the findings are discussed in reference to the current observed health effects of climate change, some countries provided data for the past 10 years.

Fig. 1 shows the distribution of the observed and projected climate change and associated health risks of extreme weather events reported by responding countries and their priorities.

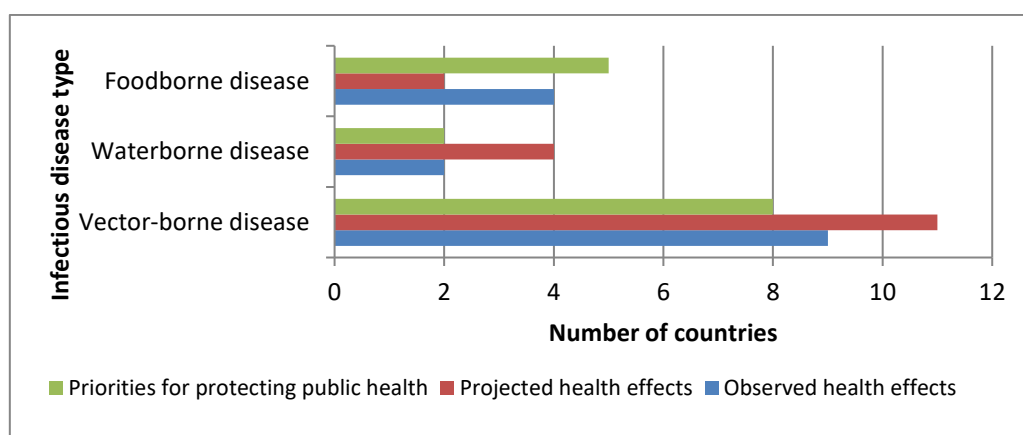
**Fig. 1. Observed and projected climate change and associated health risks of extreme weather events**



Of all climate change concerns mentioned, heat stress was the health impact ranked highest by all responding countries, followed by asthma and allergies. Further, 11 out of 12 countries listed heat stress as a projected health effect of climate change of the highest concern. The majority of countries listed existing policy options and strategies, which include a structured heat-alert system linked to specific measures targeting vulnerable population groups and communication, as priorities for protecting public health. For 50% of responding countries asthma and allergies are relevant projected health effects of climate change, while UV and cold stress concerns, both observed and projected, were reported by one country.

Participating countries also responded to the survey with concerns about the spread of infectious diseases, with vector-borne diseases the area of highest concern due to climate change (Fig. 2).

**Fig. 2. Observed and projected infectious disease concerns and priorities due to climate change**

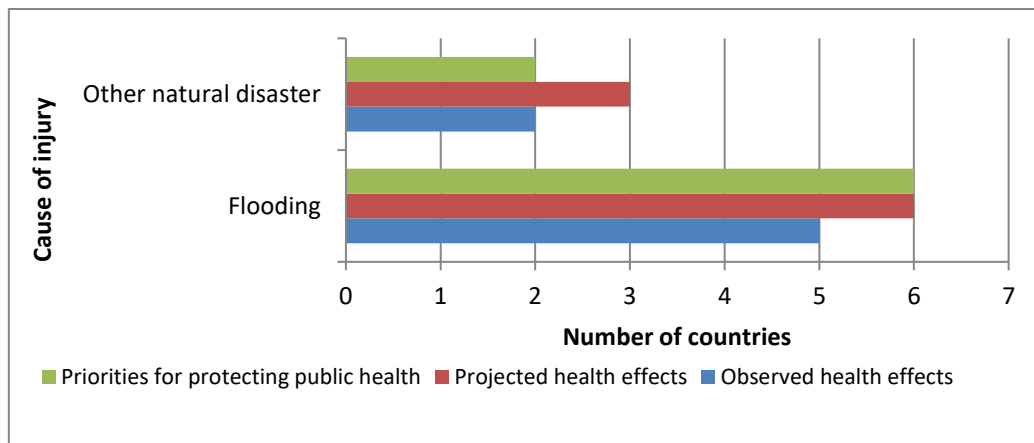


Infectious diseases (food-, water- and vector-borne) were a predicted health effect of climate change for 11 of the 12 responding countries, and 11 countries reported on a projected increase in prevalence of vector-borne diseases. Many cited the rise in temperature as creating longer breeding seasons and larger migration areas for common vectors of disease such as ticks and mosquitoes. Waterborne diseases were reported as a projected impact of climate change for four countries, and foodborne diseases for two. Vector-borne disease was

listed as a priority by eight countries to be dealt with to protect public health, which seemed to be the biggest concern, based on the number of positive responses. Foodborne and waterborne diseases were listed as priorities for five and two countries, respectively.

The third highest category of concern over climate change is the risk of injury due to flooding and other natural disasters (Fig. 3).

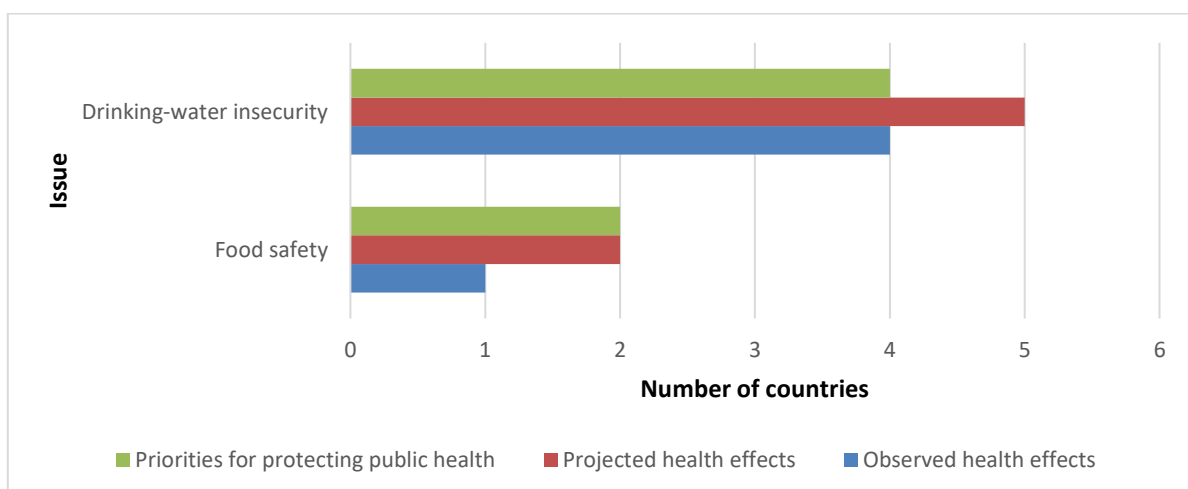
**Fig. 3. Observed and projected injury concerns and priorities due to climate change**



Health impacts of floods include injuries beside the risk of death (such as by drowning), mental health effects and the spread of infectious diseases. Climate change is expected to affect the occurrence of flooding and other weather-related natural disasters. Seven countries listed some form of injury risk as the main concern from these disasters. Injury as a result of flooding is a projected concern for six countries; injury from other natural disasters for three.

Climate change is not a “single-system threat” as it often compounds existing pressures on food and water security, as well as on other determinants of health (Fig. 4). It can affect both water and food quantity and quality.

**Fig. 4. Observed and projected food and water insecurity concerns and priorities due to climate change**



Five countries responded to the survey questions about food safety and water access. Of those, all were concerned about future clean water security, while two were concerned about food safety.

It is clear that robust frameworks to guide optimal adaptation to the effects of climate change on health are essential. The need to minimize and prevent adverse climate change-related health outcomes highlights the need for inclusion of health as a consideration in all policies, across all sectors.

## **2.7. Observed and projected health effects of climate change in 28 EU countries – desk review summary**

This section gives a summary outline of the overall findings of the desk review of observed and projected health effects, vulnerability and adaptation policies submitted in EU countries' Seventh National Communications to the UNFCCC of December 2017. As in section 2.6, some countries' Communications demonstrate that climate change has had a direct effect on human health and is a concern for their most vulnerable populations.

- Nine EU countries include a chapter on health in their Communications and four include a health subchapter in a chapter on impacts other than health.
- Less than half of EU countries (12 of 28) describe the observed national health effects of climate change in their Communications.
- Referring to the projected climate change effects by the end of the 21st century, 15 countries stress the main impacts of climate change that cause high vulnerability in the health sector and 11 use different scenarios to estimate how climate change may lead to increased health risks.
- More than half of the countries (15) define their populations considered vulnerable to the effects of climate change.

Table A2.1 in Annex 2.1 summarizes, by country, the full results of the review of the Seventh National Communications to the UNFCCC.

### 3. Climate change adaptation in EU countries' health systems

This chapter describes and summarizes the questionnaire answers from the 20 responding EU countries and provides a snapshot of the implementation status of adaptation measures to protect health from climate change by the middle of 2017.

Resilience is related to, but not synonymous with, adaptation, preparedness, response, resource management and coordination capacity. Understanding the resilience of a population's health and the health system at present provides some indication of future resilience to climate change, although direct indicators measuring this have not yet been developed and agreed. A summary of the questionnaire answers, by topic, considered in the analysis are presented in Table 1.

**Table 1. Summary analysis of survey responses, by topic**

Country	Governance and cross-sectoral collaboration	Vulnerability, impact and adaptation assessment	Health adaptation strategies and/or action plans	Health system adaptation
Austria	x	x	x	x
Belgium	x	x		
Bulgaria	x	x		
Croatia	x	x	x	x
Cyprus	x	x	x	x
Czechia	x	x	x	x
Estonia	x	x	x	x
Finland	x	x	x	
France	x	x	x	x
Germany	x	x	x	x
Latvia	x	x		
Lithuania	x	x	x	
Luxemburg	x	x		x
Malta	x	x	x	
Netherlands	x	x		
Poland	x	x		
Slovakia	x			
Slovenia	x		x	x
Spain	x	x	x	x
Sweden	x	x	x	x

All 20 countries that responded to the questionnaire in 2017 have a multisectoral body to deal with climate change and the health sector: 18 have national or federal multisectoral body; Belgium coordinates climate change adaptation through a specific intersectoral working group; and in Sweden the task is delegated within the 21 county administrative boards.

Climate change and health focal points designated within the health ministry, with a specific programme of action, are in place in 65% of responding countries. Cooperation is well established between the health ministry and main stakeholders at the national level, including specific roles and responsibilities in relation to protecting health from climate change in the majority of responding countries. Health representation is ensured in main climate change processes at the national level in 90% of responding countries.

Of the 20 responding countries, 17 have developed national climate change vulnerability, impact and adaptation assessments (Austria, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Spain and Sweden). Belgium has not done a national assessment but has piloted one at the federal and regional levels (Brussels, Flanders and Wallonia).

Most responding countries have developed strategic frameworks on climate change health adaptation and action plans. National policies (strategies or plans) on health and climate change have been developed in 13 countries (Austria, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Lithuania, Luxemburg, Malta, Spain and Sweden). Main policies and strategies reflect climate change and health considerations.

Most countries reported that they have strengthened their public health capacities and health systems to cope with impacts of climate change: strengthening early warning systems (85% of the responding countries) addressing vulnerable populations (80%) and strengthening infectious disease surveillance (75%).

Of the responding countries 17 have developed early warning systems for heat-waves, 16 for flooding, 14 for cold spells, 13 for fires and nine for droughts. Heat-waves, due to their high frequency in recent years, are the only extreme weather event for which health response plans are in place in 12 countries.

However, only 12 countries of the 20 responding have developed a communication plan for key messages on climate change and health for other sectors and the general population.

Overall, the heterogeneity of answers to the questionnaire in the section on health system adaptation is substantial. The risks from climate change and the sensitivities of health systems and populations vary among and even within countries. Action or inaction is considered to reflect each country's specific situation, including national priority-setting and decision-making, so the report generally avoids offering any judgement or comparative evaluation. Accordingly, detailed national information (presented as selected country examples throughout the chapter) is provided to illustrate action in response to the policies to protect health in an environment challenged by climate change.

Within the formal health sector, leadership and the will to address the health risks of climate change are essential to ensure implementation across the full range of programmes for climate-sensitive health risks. This includes ensuring collaboration between all relevant health divisions, such as environmental health, vector control, water, sanitation and hygiene, disaster management, health information systems, policy and finance.



At the same time, the health sector should use health arguments to advocate and be proactive in working towards an effective response to reducing health effects from climate-related risks that originate in other sectors. These sectors include agriculture and food, water, waste, energy, transport, labour and industry, land planning, housing and infrastructure and disaster management. For example, transport policies to reduce air pollution by fostering cycling and walking contribute to the alleviation of air pollution-related health effects and support positive health effects from physical activity (WHO Regional Office for Europe, 2014). With adequate coordination and monitoring, investments in these sectors can also contribute to maximizing health protection.

### **3.1. Governance and cross-sectoral collaboration**

The survey asked two questions on governance for climate change:

- Has your country identified a national focal point for climate change in the ministry of health?
- Has a multisectoral body been established to deal with climate change?

Responding to climate change is a cross-government priority in many countries. It requires the health sector to work in a coordinated manner with other actors, often under a single climate change strategy and coordinating mechanism, as well as within its own sector to define adequate measures. This normally requires adaptation planning in the health and other sectors, with the aim of achieving health benefits. This method of fostering dialogue between various sectors and government departments can facilitate broad coverage of issues in policy development as well as political commitment to implementation.

Analysis of the questionnaire responses shows that 65% of countries have established national focal points for climate change in their ministries of health. There are also additional national focal points for climate and health in other ministries, including those of environment, agriculture and social affairs, as well as centres for health education and diseases. All 20 responding countries have a national multisectoral body to deal with climate change, and it is well understood that coherent multisectoral action is necessary if the challenges posed by climate change are to be tackled effectively. Some countries that do not have a specific focal point for health and climate change or have not established a multisectoral body coordinate climate change adaptation through a specific intersectoral working group (such as in the example from Belgium below).

Countries provided the following examples through the survey.

In **Austria** the Federal Ministry of Agriculture, Forestry, Environment and Water Management holds overall responsibility for climate change and adaptation policy-making. An exchange of information and technical expertise exists between this Ministry and the Ministry of Health and Women's Affairs.

In **Belgium** climate change and health are discussed as one of the items on the agenda of the existing national environment and health action plan, organized by the National Cell Environment-Health – an institution that coordinates and informs all environment and/or health policy levels in the country. This is a working group of the Joint Interministerial Conference of Environment and Health, in which the different Belgian administrations of health and environment are represented, and which is the focal point for the European Environment and Health Process in Belgium.

In **Bulgaria** the Ministry of Environment and Waters has established the Coordination Council on Climate Change and National Expert Council on Climate Change, with health sector participation. The Chief State Health Inspector is the responsible focal point within the Ministry of Health for organizing and managing activities related to climate change, health adaptation promotion and integrated disease prevention, and to carry out preventive and anti-epidemic activities related to extreme weather events.

In **Croatia** the national climate change focal point at the Ministry of Health is responsible for communication, dissemination of information, representation at meetings, responding to various requests, collaboration with other stakeholder groups, monitoring, promoting and/or facilitating climate change policy implementation at the national level.

In **Cyprus** the Department of Environment coordinates climate change issues via a national multisectoral body. The role of the health sector is to support this body as one of the partners in implementation of health issues.

The Ministry of Environment is in charge of the whole climate change adaptation plan in **France**, but the country's Public Health Agency is in charge of climate change health adaptation actions. It also carries out scientific surveillance and research, vulnerability and health risk assessments, personnel training and risk communication.

In accordance with a decision of the Cabinet of Ministers of **Latvia**, two working groups were set up in 2008, based on a Cabinet-approved report on adaptation to climate change: an intergovernmental expert group, consisting of representatives from ministries, and an expert group, consisting of scientists, specialists from different agencies and representatives of companies and the insurance sector. Authorities from public health institutions are also represented in these working groups.

In **Lithuania** horizontal and vertical coordination of the implementation of mitigation and adaptation policy is ensured through the work of the National Climate Change Committee. Furthermore, the focal point for climate change and health is a director of the Centre for Health Education and Disease Prevention, which is the national health system's public health institution and works under the Ministry of Health.

The Office for Climate Change in **Spain** is responsible for developing policies generally related to climate change. Health policies related to climate change are formulated by the Ministry of Health.

**Sweden** recently established a national expert council that regulates the government's duty to work on climate change and issues legislative changes to reinforce climate adaptation efforts in the municipalities, in effect from 1 August 2018.

### **3.2. Policy on climate change and health**

Policy development on climate change is, together with governance and cross-sectoral collaboration, an important pillar for climate change adaptation in health systems. Many EU countries have policies in place in line with the international policy frameworks illustrated in section 1.1.1. Two main indicators were used to analyse the questionnaire responses to establish the existence of climate change policies in responding countries: whether a national health impact and vulnerability assessment of climate change has been carried out; and whether a national strategy on health and climate change has been developed.

### **3.2.1. National health impact and vulnerability assessments of climate change**

The survey asked one question on vulnerability, impact and adaptation assessments of climate change:

- Has your country carried out a national (or subregional) health impact, vulnerability assessment of climate change?

National assessments of climate change impacts, vulnerability and adaptation for health allow governments to understand more accurately the extent and magnitude of potential threats to health from climate change, the effectiveness of current adaptation and mitigation policies and future policy and programme requirements. In planning and implementing climate change adaptation, the critical first step is to carry out a vulnerability and adaptation assessment. This allows countries to assess which populations are most vulnerable to different kinds of health effects, to identify weaknesses in the systems that should protect them and to specify interventions to respond. Assessments can also improve evidence and understanding of the links between climate and health within the assessment area, serve as a baseline analysis against which changes in disease risk and protective measures can be monitored, provide an opportunity for capacity-building and strengthen the case for investment in health protection.

Vulnerability, impact and adaptation assessments are an area of strong performance for the EU: 18 of the 20 responding countries have developed them. Three quarters of vulnerability assessments conducted are relatively recent and covered the period since 2014, providing a solid foundation for planning the development of national adaptation strategies. The assessments also highlight the need for prevention of specific risks, such as heat-waves or emerging infectious diseases. The range of assessments used to generate policy-relevant evidence on the scale and nature of health risks and the most vulnerable populations, as described in the survey, take into account local circumstances.

Of the 20 responding countries, 18 have conducted assessments of health impacts of climate change: most efforts were related to the UNFCCC requirement to include a section on vulnerability and adaptation in National Communications. No generally accepted approach is in place for assessing the health vulnerability and impacts of climate change among EU countries. Approaches vary among assessments in different countries: in some cases all climate-sensitive health outcomes are considered in the assessment; in others the focus lies on specific outcomes, such as infectious diseases or the health impacts of extreme weather events, depending on the relevance for the country. Some assessments start from the perspective of specific climatic changes (exposures) and determine their possible consequences, others from the perspective of current climate-sensitive health risks and how they could change with climate change. The geographical scale varies from national to subnational.

Although national assessments may vary in scope between countries, the number of countries that have assessed climate change impacts, vulnerability and adaptation for health is a key indicator to monitor the global availability of information required for adequate management of health services, infrastructure and capacity to address climate change.

Countries provided the following examples through the survey.

In **Austria** several health assessments have been conducted as part of the national adaptation strategy, including of heat risks, vector spread potential and allergenic pollens. The Austrian assessment report of 2014 contains a vulnerability assessment and one section discusses the impact of climate change on health.

**Belgium** has not done an assessment but has conducted studies at the regional (Brussels, Flanders and Wallonia) and federal levels. These preliminary studies covered several sectors, including health, and were the first step towards starting the development of regional and federal adaptation plans.

In **Bulgaria**, in a publication assessing the risks to sectors of the Bulgarian economy from climate change, a special part analyses and assesses the potential risks for public health and the country's vulnerability to climate change. The vulnerability assessment characterizes the health sector's vulnerability as moderate and adaptation capacity as insufficient. Considering the results of the analysis, the national adaptation strategy will include a dedicated section on human health and specific measures for the sector will be planned.

In **Germany** one chapter of the overall national vulnerability assessment is dedicated to human health. The report suggests medium vulnerability of human health in relation to climate change for the near future. In the area of health care, the report concludes that adaptive capacity is currently medium to high: capacity limits (load on emergency services, hospitals and doctors) have not been reached and there is a good basic service. With the adoption of the initial progress report on the German strategy for adaptation to climate change in 2015, the federal government decided to carry out vulnerability assessments every six years.

A study identifying climate change threats to human health in **Lithuania** was carried out in 2014. The main vulnerabilities and health effects identified were allergic diseases, tick-borne diseases, UV radiation, air pollution, extreme heat, sudden frost, floods and impacts from extreme weather events. The study also developed recommendations on adaptation to climate change. Existing vaccination practices are being assessed and the introduction of additional vaccines discussed.

In **Spain** evaluation of the effects of climate change on health took into account projections of the demographic structure in the country and the influence of other sectors under different climate change scenarios. This analysis provided the basis for the development of an observatory on health and climate change, which provides information and supports critical adaptation actions. These include mapping the most vulnerable areas for health under climate change, specific programmes for monitoring and control of vector-transmitted diseases, plans of action in public health early warning systems that enable the identification of risk situations before they occur and activities aimed at increasing awareness of and participation in all activities related to climate change and its implications for human health.

Links to most of these assessments are available via the European Climate Adaptation Platform (European Commission & EEA, 2018).

### ***3.2.2. Health adaptation strategies and plans***

The survey asked one question on national and subnational health adaptation strategies and/or action plans for climate change:

- Has your country (at the local, regional or national level) developed a climate change health adaptation strategy and associated implementation plan? If so, has it been approved by your government or relevant authorities?

Adaptation is necessary, both to address the burden of disease from climate change and to strengthen public health and health services. Creating climate-resilient communities means managing climate change impacts by applying well known and tested public health and health service interventions, such as education, vaccination, vector control, food hygiene and inspections, nutritional supplements, primary and mental health care, disease surveillance and disaster preparedness. Evidence suggests that there is high cost–benefit ratio for health adaptation, and that higher benefits are achieved with early adaptation action (WHO Regional Office for Europe, 2013b).

It is essential to ensure increased health sector engagement in relation to the potential risks from climate change. This includes awareness-raising and improving knowledge among public health practitioners on how to conduct, interpret and assess health impact studies and attributions to climate change.

Based on the findings of the desk review of the Seventh National Communications to the UNFCCC, the majority of EU countries (25 of 28) have developed their own strategic frameworks on climate change adaptation and/or action plans. Most national strategies focus on instruments to address climate change impacts and adaptation in the field of human health. Effective national responses to climate risks require the health sector to identify strategic goals in response to anticipate the threats. A crucial step in achieving these strategic goals is developing national health adaptation plans and outlining priority actions, resource requirements and a specific timeline and process for implementation.

Among the responding countries, three quarters have developed climate change health adaptation strategies and associated implementation plans, mainly with regard to information, early warning and emergencies.

Countries provided the following examples through the survey.

In 2012 the health targets for **Austria** were approved by the Federal Health Commission of Austria and the Austrian Council of Ministers. The overall objective was to improve the health of all people living in the country, irrespective of their level of education, income or situation in life. One specific health target deals with “securing sustainable natural resources such as air, water and soil and healthy environments for future generations”, and also discusses climate change adaptation.

Climate change challenges are taken into account in the latest version of public health procedures and policies in **Belgium**. This is also the case for the latest version of the national ozone and heat action plan (see Chapter 4 and case study 3 in Annex 3).

The Ministry of Health of **Croatia** approved a protocol on procedures and recommendations for protection from heat in 2012. A heat-health action plan is also currently under development. The EU supported development of a Croatian climate change adaptation strategy for the period to 2040, with an outlook to 2070 and an action plan for 2019–2023, as well as a strategy to reduce CO<sub>2</sub> emissions, with a time frame to 2030 and an outlook to 2050. Health aspects are included in both strategies; they are awaiting approval by the government.

The aim of **Finland's** national climate change adaptation plan to 2022 is to give the country the capacity to adapt to changes in climate and manage the risks associated with them. The health system needs to provide a high quality of services that allow a high level of disease surveillance – especially infectious diseases – and secure basic institutional health protection needs (such as safe water supply). The Ministry of Social Affairs and Health has provided municipalities with guidelines on how to integrate climate matters into health protection preparedness planning and how to secure thermal security (from heat-waves and cold spells), especially for those in long-term care.

**Latvia** is in the process of including health aspects related to climate change impacts, risks, policies, measures and indicators for monitoring in a national adaptation climate change strategy to 2030. Climate change risks are also mentioned in the national public health programme for 2014–2020.

In the **Netherlands**, apart from the national climate adaptation strategy adopted in 2016, no specific strategy for the health sector has been developed. However, a heat action plan is in force, as is a surveillance structure on emerging pathogens. Both programmes are considered to cover climate-related health impacts to an extent, for the time being.

Adaptation measures and activities in the field of climate change and public health are included within the national environmental health action plan of **Slovakia**. Several goals are defined, including incorporation of health issues in all adaptation and mitigation climate change policies and strategies in all sectors and at all levels. Other aims are strengthening health and social systems and providing services to improve responses to the impacts of climate change, taking into account the protection of water supplies, hygiene and safe food through preventive and adaptation measures.

The Public Health Agency of **Sweden** produced an action plan on climate change adaptation called “Public health in a changing climate” in 2017. The plan is limited to the mandate of the Agency and does not yet include tasks of other stakeholders.

Links to most of these strategies and implementation plans are available via the European Climate Adaptation Platform (European Commission & EEA, 2018).

### **3.3. Strengthening health system responses to climate change**

The survey asked one question on implementation of climate change-related health adaptation programmes:

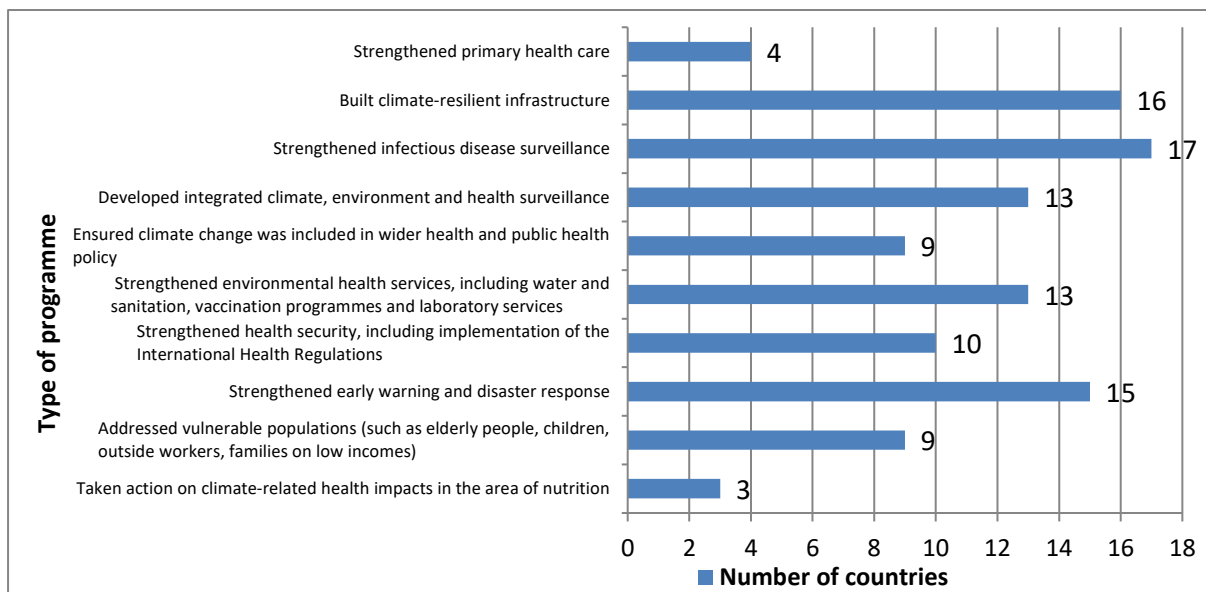
- Has your country implemented programmes or projects on health adaptation to climate change as follows:
  - strengthened primary health care;
  - built climate-resilient infrastructure;
  - strengthened infectious disease surveillance;
  - developed integrated climate, environment and health surveillance;
  - ensured climate change was included in wider health and public health policy;
  - strengthened environmental health services, including water and sanitation, vaccination programmes and laboratory services;
  - strengthened health security, including implementation of the International Health Regulations;
  - strengthened early warning and disaster response;

- addressed vulnerable populations (such as elderly people, children, outside workers, families on low incomes);
- taken action on climate-related health impacts in the area of nutrition;
- other – please specify?

Health system strengthening is a key component of climate change adaptation activity. This topic explores the level of implementation of measures to strengthen health systems. A climate-resilient health system is one that is capable of anticipating, responding to, coping with, recovering from and adapting to climate-related shocks and stress, to bring sustained improvements in population health despite an unstable climate (WHO, 2015). Resilience at all levels can reduce adverse health outcomes of climate change and should be a goal of adaptation planning. Adaptation to protect health must occur within the health sector by strengthening public health and clinical care systems and through collaboration with other sectors.

While effective health adaptation also focuses on strengthening existing health systems, there is a need to account for the additional burden of health impacts brought about by climate change. Among the 10 specific health adaptation programmes mentioned in the question, the most common in participating countries are: strengthening early warning system (85% of responding countries), addressing vulnerable populations (80%) and strengthening infectious disease surveillance (70%) (Fig. 5). Over half of the countries have also developed integrated surveillance, ensured climate change is included in wider public health policy and strengthened health security. These results indicate that most countries have effective efforts in surveillance and maintaining overall health security. Few go far enough, however, when it comes to building climate-resilient infrastructure, strengthening primary health care and environmental health services or ensuring nutrition security.

**Fig. 5. Programmes implemented on health adaptation to climate change**



Examples of integrated climate, environment and health surveillance include information on health early warning systems designed to anticipate and alert the public and health professionals that a rapid-onset emergency – such as an extreme weather event or disease outbreak – is expected. A heat-wave plan, with involvement of various stakeholders, is in place in **Luxembourg**. A similar project involving collaboration with meteorological services

for the emission of high temperature warnings is in place in **Spain**. Furthermore, integrated risk monitoring refers to the use of early detection tools and epidemiological surveillance, in conjunction with direct and remote sensing technologies for surveillance of environmental determinants of health (such as water and air quality, variability in ambient temperature and humidity or incidence of extreme weather events). In **Croatia** the establishment of an integrated information technology (IT) system is under way with several databases, accompanied by meteorological parameters (temperature, humidity, pressure) and air contaminants. Monitoring of meteorological and hydrological indicators and development and modernizing of monitoring like forecasting – and warning systems of weather phenomena (heat-waves, storms, floods) is in place in **Germany**.

The survey also asked three questions on capacity-building:

- Are health effects of climate change of high relevance in political processes?
- Do you have enough information at your disposal on climate change and its impact on health in your country?
- Has your country built capacity and developed a workforce on health-related aspects of climate change? If yes, how:
  - integrated training on climate change and health impacts and responses into mainstream under- and postgraduate training programmes;
  - ensured sufficient staffing and resources and built capacity of staff in priority areas related to climate change and health;
  - other – please specify?

Capacity-building for health adaptation requires countries to assess climate change health impacts and available responses, set policy and implement institutional changes, make informed investment decisions and access additional sources of finance. These can be categorized as three aspects of political priorities: political relevance, information accessibility and workforce capacity-building. In general, the highest number of responses from countries was for information availability: 12 of the 20 responding countries reported having enough information on climate change and its impact on health. Only nine of the 20 attach high political relevance to the health effects of climate change and only half have built up their workforce capacity on health-related aspects of climate change.

A health system relies on an effective health workforce to achieve the best health outcomes possible, given available resources and circumstances. Adaptation to climate change for financial and human resources for health needs to be integrated into ongoing activities and resource planning. Workforce capacity to adapt to climate change can be built up in two ways: by integrating climate change-related health issues into training programmes and by ensuring sufficient staffing and resources. About half of the 10 countries that reported building up workforce use one of the two ways; three countries use both.

The following sections focus on countries' approaches to mitigating climate change health risks.

### ***3.3.1. Strengthening early warning and disaster response***

The survey asked four questions on implementation of early warning and disaster-response programmes:

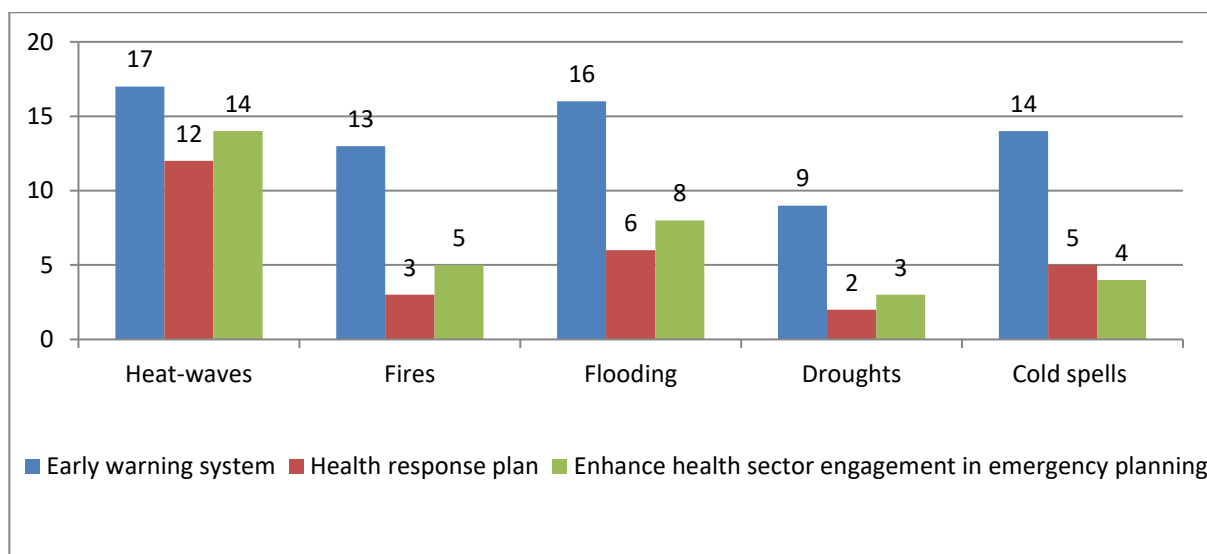


- Has your country developed early warning systems for extreme weather events and appropriate health sector response plans in the areas of heat-waves, fires, flooding, droughts, cold spells?
- Has your country strengthened health sector engagement in emergency planning for extreme weather events and have you developed cross-sectoral plans in those areas
- Has your country developed communication messages for extreme weather events to be released with an early warning for such an event?
- Has your country developed communication plans for key messages on climate change and health for other sectors and the general public?

According to the questionnaire responses, most countries (17 of 20) have introduced early warning systems as an approach to reducing the human health consequences of extreme weather events. Certain early warning systems include forecasts of health impacts associated with heat-waves and floods, for example. Their development depends on previous experience with such events, the magnitude and nature of the observed health effects, assessment of current and future vulnerability, capacity to adapt and willingness to act.

Engagement of the health sector in disaster preparedness for and response to extreme weather events was widely reported in the survey. Fig. 6 shows the responses on early warning systems and health response plans implemented. Far fewer countries have developed plans for public health preparedness for and response to extreme weather events, identified as enhanced health sector engagement in emergency planning. The lack of specific health response plans may not equate to an absence of health sector engagement in disaster preparedness for extreme weather events: when asked whether health sector engagement in emergency planning for extreme weather events is strengthened, most responding countries replied “Yes”. Nevertheless, the health sector being generally more engaged in emergency planning and response does not automatically mean that increased attention is paid to the protection of public health from climate change.

**Fig. 6. Presence of early warning systems, health response plans and health sector engagement**



Of the 20 responding countries 17 have developed early warning systems for heat-waves, 16 for flooding, 14 for cold spells, 13 for fires and nine for droughts. Owing to their high

frequency in recent years, heat-waves are the only extreme weather event category for which 12 countries have health response plans in place.

Overall, enhanced coherence between climate change adaptation and disaster risk reduction, at both the EU and national levels, could lead to more effective and efficient policies and practices in both areas, exploitation of synergies, more efficient use of human and financial resources and better preparedness for and response to disasters (EEA, 2017b).

Many initiatives at the community, national, regional and global levels support strengthening country capacities for health emergency and disaster risk management. All Member States should report annually to the World Health Assembly on the implementation of the International Health Regulations (IHR) (2005). To facilitate this process, WHO developed an IHR monitoring questionnaire, interpreting the core capacity requirements in Annex 1 of the IHR (2005) into 20 indicators for 13 capacities (WHO, 2017). These metrics serve as important proxies of health system adaptive capacity and resilience because they measure the extent to which health systems show a range of attributes necessary to detect, prepare for and respond to public health emergencies, some of which are climate-sensitive. IHR survey responses are self-reported; although national-level external verification has begun, it remains relatively limited. Further, these findings capture potential capacity, not action.

Countries provided the following examples through the survey.

A national **Belgian** generic preparedness plan, addressing public health emergencies of all types and all origins, is being drafted. It will include standard operating procedures that will strengthen the early warning and disaster-response system on its implementation.

In **Bulgaria** a national early warning and disclosure system for executive bodies and population provides warnings and informs the population about impending or emerging disasters. It also serves as a platform for exchange of information and coordination of activities of the executive authorities and the components of the joint rescue system (ministries and agencies, municipalities, commercial companies and sole traders, emergency medical care centres, other medical and health care establishments, non-profit legal entities including voluntary formations and armed forces) in the event of impending or occurring disasters.

A national heat prevention plan has been developed in **France**, based on collaboration between climate services and the Public Health Agency. It includes weather forecasting, near-real-time health surveillance and health promotion.

**Germany's** National Meteorological Service has strengthened its warning system by improving both the spatial resolution of severe weather warnings to municipal level and dissemination, especially by using online applications. Considerable improvements have been made to the development of the modular warning system run by the Ministry of the Interior for civil protection purposes. The system integrates warning systems running at different administrative levels (from federal to municipal) and a number of different warning devices. The National Meteorological Service, in addition to its own warning infrastructure, is also linked to the modular warning system (to deliver short-time warning messages to the public and connected media stations and authorities).

In **Latvia** disaster-related risks are defined within the civil protection mechanism – specifically storms, rainfall, intense snowfall, flooding and forest and peat bog fires. A state

emergency medicine plan has been developed for health sector preparedness and response, which includes descriptions of responses in the event of disasters related to climate.

An early warning and response system is in place for heat-waves in **Malta**. It is triggered by the Meteorological Office of Malta through the Health Care Standards Directorate, which issues guidelines to homes for older people. The general public is also alerted, and people are advised to take precautionary measures against the ill effects of heat-waves, such as staying in cool places and drinking plenty of water.

In **Slovakia** a pollen forecast informs the public about pollen concentrations in the air on a weekly basis.

In **Slovenia** cooperation between public health and civil protection is strengthened through implementation of a national plan for protection and rescue in the event of epidemic or pandemic infections.

In 2015 the **Swedish** Civil Contingencies Agency published a report on heat-wave impacts on society, providing a knowledge base for municipalities with fact sheets and recommendations for heat-waves.

Furthermore, the majority of countries (17 of 20) reported that they have developed health communication messages for extreme weather events as part of the early warning system. Only 12 countries, however, have developed a communication plan for key messages on climate change and health targeting other sectors (such as the education sector) and the general public. This discrepancy indicates that public communication of health adaptation strategies is not as well developed as early warning systems. In the long term, advanced development of specific health messages for extreme weather events is required.

**Lithuania** provided two examples of main messages on protecting health from climate change in its survey response: 1. Climate change is happening here and now; 2. We all can reduce the negative impacts of anthropogenic activities (main recommendations and sustainable decisions for mitigation and adaptation to climate change).

Links to most of these plans and policies are available via the European Climate Adaptation Platform (European Commission & EEA, 2018).

### ***3.3.2. Addressing vulnerable population groups***

The second highest ranked programme (reported by 16 of the 20 responding countries; see Fig. 5 above) was addressing the needs of vulnerable population groups.

Vulnerability to weather and climate change depends on people's level of exposure, personal characteristics, broader social and environmental contexts and access to resources. It is defined as a function of a population's or individual's exposure, sensitivity and adaptive capacity (IPCC, 2014b). For example, elderly people, children, outdoor workers, homeless people and refugees without shelter and low-income families are particularly vulnerable. The projected further increase in the length, frequency and intensity of extreme weather may lead to greater mortality, which is expected to be most pronounced among vulnerable population groups unless adaptation measures are taken to reduce these impacts.

Countries provided the following examples through the survey.

In **Belgium** health plans and policies always take into account vulnerable populations; these groups are usually identified by the Belgian Superior Health Council. Extreme climatic phenomena, such as tropical days, pose a risk of overheating, heat stroke, dehydration and health complications, especially for elderly people and small children. In these situations, people are informed about the risks via radio and television.

In **Croatia** heat-health recommendations have been established for the general population and specifically for vulnerable population groups – including, for example, elderly people, children, people working outdoors and athletes.

In **Czechia** radio and television channels are used to provide new information from the Czech Hydrometeorological Institute regarding river flow status in high-risk flood areas in the event of extreme rainfall. Daily television forecasts outline the potential health risk level due to temperature or other meteorological phenomena and include advice for affected vulnerable population groups on how to act in the given situation.

The national adaptation strategy in **Malta** makes explicit reference to air-conditioning and cooling facilities in homes for older people. These recommendations were taken up by the Health Care Standards Directorate, which obliges all homes for older people to monitor and control their ambient temperatures using temperature gauges. Actual temperature recordings are included in quality care audits performed by the Department of Active Ageing and Quality Care within the Ministry for Family and Social Solidarity.

**Sweden** has established a contingency plan at the highest political level to address high temperatures and a strategy to alert homes with special care/special housing units to such weather prognoses. In May 2017 a guideline for composing heat-wave response plans was published, consisting of information and training materials with recommendations for health care workers and groups at risk during heat-waves.

### ***3.3.3. Strengthening infectious disease surveillance***

Strengthening infectious disease surveillance was the third most common implemented measure, reported by 15 of the 20 responding countries (see Fig. 5 above).

To foster and promote EU-wide research into environmental infectious disease epidemiology, ECDC established the E3 Geoportal and Network (ECDC, 2018). Through these, ECDC aims to promote activity field by collecting and distributing environmental, demographic, climatic, and infectious disease data produced by a wide range of primarily European research projects, institutes and government agencies. It also makes available reports, maps and geospatial datasets to any interested E3 user. The E3 Network researched and created three early warning case studies: the environmental suitability of malaria transmission in Greece; recurrent West Nile virus outbreaks in south-eastern Europe; and autochthonous transmission of dengue. In the cases of dengue and chikungunya, WHO has outlined a framework for prevention of establishment and spread of invasive mosquitoes, with integrated vector and disease surveillance (WHO Regional Office for Europe, 2013c).

Downscaled climate impact models focused on the European continent could provide higher resolution on areas with projected changes in risk profiles. More detailed knowledge of the relationships between vector-borne disease transmission and climatic drivers could facilitate the development of early warning systems that integrate climatic and epidemiologic data (Lindgren et al., 2012; Semenza & Zeller, 2014).

Another priority for the field is to assemble data with as much detail as possible on the presence and absence of important disease vectors (and, ideally, disease reservoirs). One such initiative is VectorNet, a joint initiative of the European Food Safety Authority and ECDC (EFSA & ECDC, 2018), which collects data on ticks, mosquitoes, sandflies and biting midges in Europe. Just as VectorNet's information is relevant for both animal and human health, progress in the field more generally requires greater collaboration between ecologists, virologists, microbiologists, entomologists and stakeholders from the food, animal and human health sectors. In addition, a fully integrated perspective on climate change and vector-borne disease must also develop a more holistic understanding of risk by accounting for vulnerabilities.

Examples of strengthening infectious disease surveillance in relation to climate change include increasing the frequency and number of monitoring sites, expansion of the list of notifiable infectious diseases, enhancement of case definitions, updating response protocols, initiation of new monitoring for vectors and enhancement of coordination between related institutions on infectious disease and vectors. Health systems must prepare for and respond to potential cross-border health threats, including infectious disease outbreaks, ensure that adequate logistics and supplies (such as pharmaceuticals and vaccines) are available and develop links with veterinary services.

In EU countries capacities related to disease surveillance and early detection, multihazard public health emergency preparedness and response and the associated human resources to perform these public health functions are in place. Regarding strengthening health security, 13 of the 20 responding countries included information on implementation of the IHR (2005).

Nine countries included information about strengthened structures for laboratory diagnosis of vector-borne transmissible infections at the national and regional levels. In **Bulgaria**, for instance, the Ministry of Health annually purchases a vaccine against Crimean-Congo haemorrhagic fever, which is given to individuals at risk of infection (service personnel, agricultural workers, medical personnel in Crimean-Congo haemorrhagic fever endemic areas).

Countries provided the following examples through the survey.

In **Belgium** a new working group on exotic mosquitoes and other vectors was established, along with activity to strengthen vector surveillance. In 2016 the working group developed an exotic mosquito active monitoring plan (see Chapter 4 and case study 4 in Annex 3).

A national vector-borne disease control and prevention programme for 2014–2018 in **Bulgaria** was adopted by the government. The strategic goal of the programme was to reduce morbidity and mortality from vector-transmitted infections by controlling the spread of vectors through early detection and maintaining an integrated epidemiological, veterinary and entomological surveillance, with multilateral and intensive cooperation between medical and veterinary authorities at the national and regional levels.

In **Czechia** surveillance of water- and foodborne infections whose occurrence and spread are affected by high temperatures is undergoing strengthening. Surveillance of zoonoses that are significantly affected by climate changes that have an impact on both the animal host (as the vehicle of infection) and the infectious agent is also ongoing. Laboratory capacity has been strengthened in addition.

The **Estonian** national climate change adaptation strategy for 2030 and its action plan refer to planned activities that will monitor the expansion of vector-borne diseases due to the impact of climate change and will estimate the risk of parasites, primarily in surface water (especially in times of flood) and identifying hazards from cyanotoxin in water bodies.

Enhanced surveillance is in place in **Finland** for tick-borne encephalitis and legionella, relevant to the potential effects of climate change on disease incidence.

Most climate-sensitive pathogens are notifiable in **Germany**, and in-depth analyses of these data are performed regularly by the national Public Health Authority. National mosquito monitoring projects have been implemented by the Federal Ministry of Nutrition and Agriculture and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, which also investigated the impact of climate change on the route of entry and the establishment of invasive mosquitoes in Germany and the vector competence for human pathogens in native mosquito species. Tick monitoring projects have also been implemented. Germany has established a national commission for mosquitoes as vectors for disease agents, which has developed, for example, a national action plan to deal with *Aedes albopictus*.

In **Lithuania** in 2015 climate change and health indicators (morbidity of Lyme disease, tick-borne encephalitis and spread of *Ixodes ricinus*) were included in the list of environment and health indicators. A climate change-related disease (both allergic and infectious) prevention programme was adopted by order of the Minister of Health. This aims to improve management of climate change-related disease morbidity. It is oriented towards public health professionals, state agency personnel, policy-makers, health care providers, vulnerable population groups and the general public on human health risks associated with climate change.

The Infectious Disease Prevention and Control Unit in **Malta** carried out two risk assessments with foreign experts on local mosquitoes in 2009 and 2016. *Aedes albopictus* was found to have established itself on the island. A vector-borne disease plan is currently being drafted. The Unit has identified vectors of entomological and public health importance whose behaviour may be climate change-related, and joint surveillance on three mosquito species is being organized between the Unit and the veterinary department.

In 2015, the National Public Health Institute of **Slovenia**, in cooperation with other institutions, issued an intersectoral preparedness plan for West Nile virus. It includes a monitoring and surveillance plan, proposes public health measures, provides guidance for risk assessment and suggests a haemovigilance strategy, among others. The Institute cooperates with the veterinary authority to improve management of food- and waterborne diseases and zoonoses, and has issued guidance for managing foodborne outbreaks and other plans for zoonosis management.

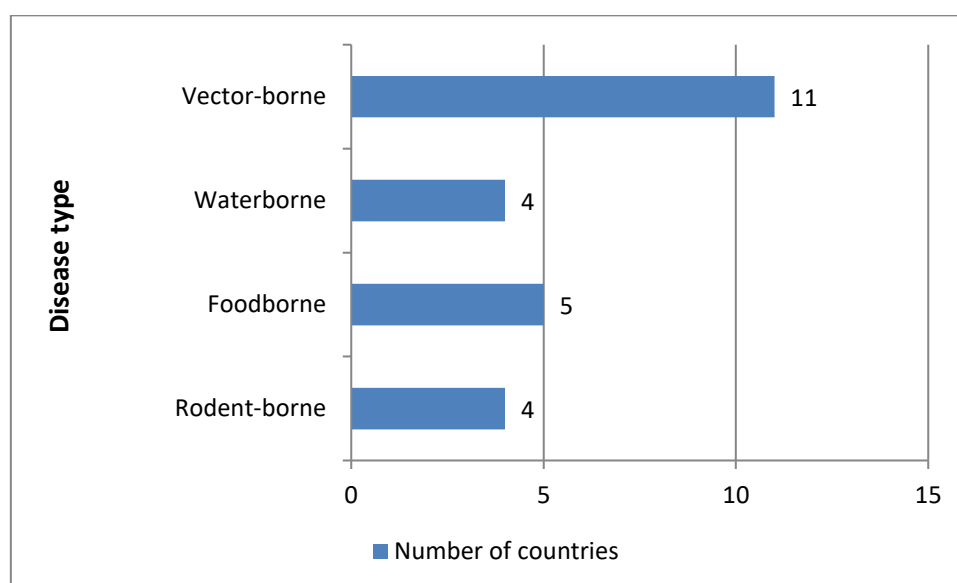
The Public Health Agency of **Sweden** monitors the most important infectious diseases in the country at individual and geographical levels. The Agency has analysed incidence with weather and climatic data several times. Investigations are carried out if signals of changes in disease epidemiology are detected. If needed, the investigations can include climate-related reasons for change.

The survey asked two questions on integration of climate information into disease surveillance and response:

- Has your country integrated climate information into infectious disease surveillance and response in the following areas:
  - vector-borne diseases;
  - waterborne diseases;
  - foodborne diseases;
  - rodent-borne diseases?
- If so, what has been done:
  - strengthened integrated surveillance of climate, environment, vectors and disease in multiple sectors;
  - strengthened the chain of zoonotic disease surveillance;
  - strengthened climate, water and disease monitoring;
  - carried out specific studies to examine the attribution to climate change of the risk of infectious disease insemination;
  - other – please specify?

The questionnaire data demonstrate that countries include more climate information on vector-borne diseases (reported in 11 of the 20 responding countries) than on rodent-, food- or waterborne diseases (no more than five countries), as presented in Fig. 7.

**Fig. 7. Integrating climate information into infectious disease surveillance and response**



With measures taken to integrate climate information into disease surveillance and response, most countries (seven of the 11 responding overall) have strengthened integrated multisectoral surveillance, the chain of zoonotic disease surveillance and specific research examining the attribution to climate change of the risk of infectious disease insemination, while only two countries have strengthened climate, water and disease monitoring. This corresponds with the results that more countries include climate information for vector-borne disease but fewer countries include information for waterborne diseases.

Countries provided the following examples through the survey.

In **Germany** available information on vector-borne and rodent-borne diseases is not sufficient to correlate climate effects and the infections. Several funded research projects are

under way, however, into climate change and ticks/tick-borne diseases, climate change and exotic mosquitoes and climate change and rodent-borne diseases (including investigation of correlation/causality of bank vole abundance and hantavirus infections).

In the **Netherlands** information on surveillance of infectious diseases is shared weekly with partners in signal meetings on infectious diseases as well as on zoonoses, where analysis of surveillance data is carried out. The level of surveillance on a specific pathogen is adapted if indicated, regardless of the driver.

Some countries have set up integrated surveillance of infectious diseases as a common public service that carry out many functions using similar structures, processes and personnel. In **Austria** a national mosquito surveillance system has been implemented with integrated cooperation between government agencies, human and veterinarian health institutions, the national reference laboratory and blood donor system. Surveillance of vector-borne infections is included, in addition to climatic and environmental aspects relevant to their spread and continuous monitoring of the circulation of etiologic agents. In **Czechia** cooperation between the National Institute of Public Health and the Czech Hydrometeorological Institute established a system of daily forecasts of tick activity, which has been tested and introduced into practice. A forecast including a quantified risk level of a tick bite is also provided in television news. The National Institute of Public Health has created information leaflets and educational brochures about how to protect against ticks and vaccination options. These are distributed to general physicians' offices. In **Sweden** the National Veterinary Institute creates forecasts through vector monitoring and modelling to achieve early detection and advance warning of outbreaks of vector-borne diseases.

Table 2 outlines the questionnaire data on projected diseases reported to have integrated short-term climate projection information into specific infectious disease surveillance and response due to climate change, by country.

**Table 2. Examples of integrated climate information in specific infectious disease surveillance and response**

Country	Vector-borne disease	Water-, food- and rodent-borne disease
<b>Croatia</b>	Dengue, chikungunya, West Nile virus and Zika virus	–
<b>France</b>	Dengue, chikungunya, West Nile virus and Zika virus	–
<b>Latvia</b>	Tick-borne diseases: focal territories, in the monitoring sites for abundance and pathogen prevalence	–
<b>Lithuania</b>	Lyme disease and tick-borne encephalitis	–
<b>Spain</b>	Diseases transmitted by mosquitoes (dengue, chikungunya and Zika virus) and ticks (Crimean-Congo haemorrhagic fever)	–



<b>Czechia</b>	Tick-borne encephalitis, Lyme disease, anaplasmosis	Shigellosis, leptospirosis, viral hepatitis A, tularaemia, hantavirus infections
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### ***3.3.4. Other measures and programmes to strengthen health systems***

Other measures that strengthen and render health systems more resilient aim to ensure that systems remain in a position to function properly even under increasing climatic pressure and during more frequent and more intense extreme weather events or emergencies. Climate-related events, such as severe storms and flooding, might compromise electricity and water supplies, interrupt supply chains, disable transportation links and disrupt communications and IT networks, reducing capacity to provide medical care. Functioning health infrastructure, however, is particularly essential during emergencies. Considering climate change aspects when designing and building health care infrastructure is important in order both to improve resilience and adaptation and to increase the contribution of the health sector to mitigation. Measures include improving the climate resilience of health infrastructure (such as hospitals) and related infrastructure such as retirement homes for elderly people, but also water, waste and transport infrastructure.

In the survey, nine of the 20 responding countries reported having built climate-resilient health infrastructure (see Fig. 5 above).

Countries provided the following examples of climate-resilient infrastructure through the survey.

The national risk assessment exercise in **Malta**, conducted in 2015, stipulated that all owners of critical infrastructure of national relevance should take into consideration climate change impacts, including related human health adaptation issues, in their risk assessments and resulting contingency/emergency/project plans and programmes.

In the **Netherlands**, under the Delta programme for river basins, water and wastewater, infrastructure is reviewed continuously for efficacy, taking into account scenario studies for floods and droughts, but mainly focusing on water quantity. Policy actions are formulated accordingly.

A main priority on hospital health care system modernization was listed within **Slovenia's** operational programme for health for 2007–2014. This addresses construction, reconstruction and modernization of the infrastructure of general hospitals with respect to environmental aspects, including reducing energy consumption and increasing the economic efficiency of buildings, and energy saving in the construction of new buildings or reconstruction of existing ones.

Countries also provided the following examples of climate-resilient environmental health services, including water and sanitation and laboratory services, through the survey.

In **Germany** a network of reference laboratories has been in place since 1997 and has gradually expanded to cover all pathogens sensitive to climatic changes. The National Food Agency leads a national project on climate change adaptation of drinking-water production, in cooperation with the Public Health Agency, among others.

In **Czechia** capacity-building activities for employees responsible for inspection of water and sanitary services have been put in place to increase knowledge about the risks resulting from

climate change. More frequent droughts are expected to affect drinking-water reserves in terms of both quantity and quality. Droughts can also lead to the creation of surface sources of bacterial and viral contamination.

The National Institute for Public Health and the Environment in the **Netherlands** developed models for precipitation events and their effects on microbiological surface water quality. A quantitative microbial risk assessment catch tool has not yet, however, been implemented for national surveillance efforts. In the national information programme on water and climate, knowledge is exchanged on how to build climate-resilient cities; pilot projects have been started to enhance the resilience of cities.

## 4. Summary of case study compendium

Sharing of experiences is an important element of mutual learning and capacity-building. Exchange of examples and lessons learned is therefore an important pillar of the overall analysis of developments in national health adaptation to climate change in EU countries. Within the framework of the joint WHO Regional Office for Europe/European Commission project, therefore, all EU countries were invited to submit case studies about their climate change adaptation measures in the health sector.

A compendium of all case studies submitted as national examples of involving the health sector in adaptation to climate change was compiled, with agreement that countries would like to share the good practices with others. In total, 19 case studies were collected from 10 countries, of which 15 from eight countries (Austria, Belgium, Croatia, Germany, Italy, Lithuania, Slovenia and Sweden) were selected for the compendium on the basis that they provided examples of adaptation measures and up-to-date information (with an inclusion criterion that they had not been published elsewhere before 2010). The four other published journal articles received as case studies from two countries were excluded from the portfolio with the countries' agreement.

The selected case studies cover a wider range of topics, from overarching policy and coordination issues and the links between climate change, demography and health to the implementation of specific preparedness and response plans and capacity-building. Table 3 lists the case study summaries categorized by five overarching topics, from a global perspective and overarching climate change aspects to specific examples for health adaptation plans, capacity-building and information:

- heat (health action plans and their implementation, heat and ozone);
- UV radiation (sun protection);
- infectious diseases (surveillance of disease vectors);
- capacity-building; and
- communication (an online climate change portal, “Planetary Health” vision recommendations and climate and health country profile development).

The full case studies are provided in Annex 3.

**Table 3. Summaries of case studies by topic**

Country	Title	Summary
<b>Heat</b>		
Austria	Operation of the national heat protection plan	An Austrian heat protection plan was prepared and put into action in 2017, led by the Ministry of Health and Women’s Affairs. Government institutions at the national and regional levels were involved in its elaboration and worked together, taking on various roles during different stages of the plan’s operation. Other actors involved include health professionals, hospitals and other emergency staff. The plan gives meteorological baseline information for heat warnings, provided by the National Meteorological Service. The Ministry of Health and Women’s Affairs sets out information about heat warnings on its website and

Country	Title	Summary
		provides and promotes precautionary measures for the citizens. The provinces communicate specific information to organizations (such as homes for elderly people, nursing homes, hospitals and kindergartens) as early as possible.
Belgium	Ozone and Heat Working Group	The Ozone and Heat Working Group is a permanent working group in Belgium that coordinates action across all government administrations (federal, regional and community) involved in the national ozone and heat action plan. Established in 2003, it is also a subworking group of the National Cell Environment-Health. The parties involved include both environment actors (considering the negative health impact of air pollutants such as ozone and nitrogen oxides) and health actors (working on preventing the negative effects of high temperatures and linked air pollutants). The members joined forces and budgets in setting up projects to model the health effects of high temperatures and air pollutants. The work of the Group has led to a more coordinated approach on high temperature and high ozone concentrations in Belgium: all regions and communities use the same approach and thresholds to announce the onset of the warning phase.
Croatia	A heat-health action plan	In 2012 the Croatian Ministry of Health launched a protocol on procedures and recommendations for heat protection and established a multisectoral Working Group on Heat. The protocol remains in place, and the government is in the process of approving a heat-health action plan prepared by the Working Group on Heat. The core elements and structure of the action plan are designed in line with WHO heat-health action plan guidance.
Germany	A masterplan for the implementation of heat-health action plans	The Federal Working Group on Adaptation to the Impacts of Climate Change in the Health Sector developed recommendations for heat-health action plans to protect human health, which serve as a masterplan to ensure better protection of public health in Germany during long periods of extremely high summertime temperatures. As a contribution to the national adaptation strategy on climate change for the health sector, the recommendations aim to implement adaptation measures and prevent health consequences associated with extreme heat at the regional and local levels. From 2018 the German Environment Agency and Federal Ministry for the Environment, Nature Conservation and Nuclear Safety will keep in touch with federal state governments and the local level to gain regular information about the implementation of any heat-health action plans in general, and about ongoing heat-health-related adaptation actions specifically.

Country	Title	Summary
Lithuania	A national public health and heat prevention action plan for 2016–2020	A national public health and heat prevention action plan for 2016–2020 was adopted in 2015 by order of the Minister of Health. Its main aims are to raise awareness of heat-related health risks and their prevention among the public, health professionals and teachers; to provide early warnings of heat-waves together with health advice; and to mobilize and coordinate all available resources in a timely manner. The first assessment of the plan will take place in 2020. Its implementation is in line with WHO’s European Regional Framework for Action, which aims to protect health from climate change, and the intention is to make it part of the country’s national portfolio for action, to which it committed at the Sixth Ministerial Conference on Environment and Health in Ostrava in 2017.
Slovenia	Protecting vulnerable population groups during heat-waves	Heat-waves affect the population’s health in Slovenia. Major heat-waves occurred in the summers of 2003 and 2015, leading to excess deaths. To target measures effectively, it is important to identify the most vulnerable population groups in the national context. Analysis of data on the heat-waves showed that the number of deaths among the most vulnerable groups – elderly people and those with diseases of the circulatory system – increased in 2015 compared to 2003. This demonstrates that additional public health interventions are needed. A series of workshops across the country to increase awareness of the impact of heat-waves on population health will be organized in the future.
Sweden	Guideline for heat-health action plans	In 2017 the Public Health Agency of Sweden published a guideline to support municipalities, county councils, regions and private health care providers in developing action plans for heat-waves. The guideline highlights important aspects to consider when designing action plans to prevent and manage the adverse health effects of heat-waves in the population, in connection with meteorological early warnings. In support of this work, the Public Health Agency developed information material to support health care providers in their efforts to develop action plans and reduce the health risks associated with heat-waves in the form of films, brochures, advice to various health care professions and a web-based training course.
<b>UV radiation</b>		
Slovenia	The sun safety programme	The aim of the sun safety programme is to raise awareness among children and their parents of the importance of proper protection against sun rays and UV radiation in particular. The interventions are intended to contribute to a change in the behaviour of

Country	Title	Summary
		<p>the entire population, and in the long run to reduce incidence of skin cancer in Slovenia. By 2017, 302 855 kindergarten children and 104 622 elementary school pupils had participated in the programme. All activities were evaluated to assess their impact on knowledge and behaviour changes in all institutions through questionnaires sent to teachers in kindergartens and schools and to parents of children in kindergartens. The programme is run by the National Institute of Public Health, Association of Slovenian Dermatovenerologists and Society for the Fight against Cancer of the Celje Region.</p>
<b>Infectious diseases</b>		
Belgium	Monitoring of exotic mosquitoes	<p>Following the discovery of exotic mosquitoes at various sites in the country, Belgian ministers of environment and public health established a national working group on exotic mosquitoes and other vectors, aiming to control vectors and the diseases they could transmit, taking into account the competences and responsibilities of the ministries and merging material and human resources. Furthermore, the group's representatives aim to identify all government actors involved in this area in the country and to clarify processes and procedures. The first major action and three-year project initiated by the working group in 2016 was the Monitoring of Exotic Mosquitoes in Belgium project. A national mechanism is expected to be created by the end of the project.</p>
Germany	Surveillance of <i>Aedes albopictus</i> as part of IHR (2005) implementation	<p>To detect possible routes of entry for new vector species, mosquitoes were regularly trapped between 2012 and 2016 at previously identified risk locations in Germany. Significant points of entry are motorways with tourist traffic from Italy and southern France and terminals for freight trains from Italy. In this regard, surveillance of <i>Aedes albopictus</i> contributes to the implementation of the IHR (2005) in Germany, as the mosquito is able to establish itself in Germany due to climate change. Regular monitoring of at-risk locations is necessary to detect introduction and establishment of <i>Aedes albopictus</i> at an early stage, as prompt control measures have to be implemented to prevent further spread.</p>
Germany	Regional forecast system for the occurrence of rodents	<p>Human-pathogenic hantaviruses in Germany are transmitted by small rodents such as bank voles (<i>Myodes glareolus</i>) that carry Puumala virus (PUUV). Weather-based prediction models for the occurrence of PUUV-transmitting bank voles and human PUUV incidences were developed. Close correlations of bank vole abundance with weather parameters of up to two previous years were found. This allows predictions about possible population outbreaks of the PUUV</p>

Country	Title	Summary
		rodent reservoir or PUUV epidemics in Germany 0.5–1.5 years in advance. With regard to changing climatic conditions, such a warning system offers an opportunity to alert health services and the general population in time to take preventive measures and thus to limit the effects of PUUV epidemics on human health.
<b>Capacity-building</b>		
Germany	The Climate Adaptation School	The Climate Adaptation School project was supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Its objective was to develop an interdisciplinary education and training programme for medical professionals, designed to develop and convey a summary of weather- or climate-related health hazards and risks and the possible responses to them, focusing on both preventive and diagnostic-therapeutic aspects. A series of lectures for doctors and nurses was delivered in various locations across Germany; overall, interest in the topic was strong. Following extensive consultation with the advisory board, the training modules of the Climate Adaptation School (especially those on UV, ozone, heat and pollen) were offered in the context of congresses in internal medicine, allergology, pneumology and dermatology, with very positive feedback. An associated climate change and health website was set up: a modern platform for knowledge sharing, which includes eLearning modules and a knowledge database.
<b>Communication</b>		
Sweden	Portal for Climate Change Adaptation	The Swedish Portal for Climate Change Adaptation is a multiannual collaboration between agencies within the Governmental Agency Network, which consists of 18 agencies at the national level and the county administrative boards. The Network also collaborates with the Swedish Association of Local Authorities and Regions. In order to analyse climate change-related consequences and vulnerabilities and to develop adaptation, cooperation is needed between the health and other sectors and functions of society, such as agriculture and livestock farming, veterinary medicine, the water and sewerage sector, the construction sector, urban planning, the transport sector and the energy sector. The Network aims to strengthen the capacity of participating government agencies and society by working towards improvement of frameworks and steering instruments.
<b>Coordination</b>		

Country	Title	Summary
Austria	Health, demography and climate change	A special report, compiled by the Austrian Panel on Climate Change, assesses the complex interrelations between health, demography and climate change. The report was developed to deliver a legitimate basis for decision-making in science, administration and politics. It highlights opportunities to combine climate and health policies and to increase preparedness and resilience with anticipatory rather than responsive action. The health co-benefits of mitigation and adaptation measures are particularly promising. The report supports policy design to improve population health status now and in the future.
Italy	Effects of climate change on human health within the “Planetary Health” vision	Effects of climate change on human health within the “Planetary Health” vision was an Italian project, implemented by the Ministry of Health and National Institute for Health in cooperation with WHO and the Ministry of Environment. It brought together over 40 Italian health and climate scientists from 12 relevant national institutions in the health, environment and climate sectors to provide substantial scientific recommendations to the 2017 G7 Health Ministerial Meeting. In the framework of the project the first climate and health country profile for Italy was compiled through extensive intersectoral research and analysis. This outlines current strategies to build resilience to climate change in the health sector through education, awareness-raising, integrated surveillance and effective early warning and response systems.

#### 4.1. Lessons learned and recommendations drawn from the case studies

Several examples of good practices were identified from the case studies, which incorporated outputs to address extreme weather and climate events because of the increase in the frequency, intensity and duration of some events, and of the significant (and preventable) associated health impacts. For example, Austria, Belgium, Croatia, Germany, Lithuania, Slovenia and Sweden designed and implemented heat-wave early warning and response systems that guide the issuance of warnings, taking into consideration the needs of the most vulnerable groups, and outline response plans to facilitate timely coordination of resources and strategies when heat-waves (or ozone and heat-waves in the case of Belgium) occur. Belgium and Germany included outcomes to augment surveillance and monitoring programmes to increase the capacity to assess risk, promote diagnosis and treatment and implement prevention programmes. To prioritize adaptation measures or inform specific activities undertaken in the countries, projections of how climate-sensitive health outcomes could increase were used; projected risks of future burdens are available at the country level.

Each good practice example in the case studies illustrates the lessons learned from the health adaptation measure described. Across all case studies, distinct commonalities can be identified across the lessons learned, which fall within a range of key topics. These reflect areas that need particular attention and strengthening when implementing health adaptation measures: cross-sectoral collaboration and coordination; development and implementation of



early warning, preparedness and response; sharing and communication of data and key messages.

The following section compiles recommendations for each topic, drawn from the lessons learned across all the case studies, for consideration when planning and implementing health adaptation measures. The list does not claim to be complete; nor does it reflect any prioritization.

#### ***4.1.1. Cross-sectoral collaboration for developing effective climate change adaptation measures***

Multisector collaboration was key to success in the countries' case studies to promote consideration of health issues in other sectors and coordinate synergies in environmental health preventive actions. Capacity was built by fostering dialogue, regular interactions and support across sectors and government departments, and by having a plan for engagement. The good practice examples dealing with heat and infectious diseases also emphasized the importance of strengthening integrated surveillance systems and improving early warning mechanisms. Fostering good working relationships across meteorological, environmental and health institutions leads to improved access to data, information and expertise in order to develop and implement early warning and response systems successfully.

Developing national or federal adaptation plans to deal with heat was viewed as helpful to increase understanding and overcome barriers with different stakeholders, although no formal evaluations of these plans have been conducted. Doing so led to more interventions using climate information to improve adaptation, particularly at the subnational and community levels, for approaches to heat, UV radiation and infectious diseases. Furthermore, positive synergies were created at the national or federal levels from involvement of different sectors, as effective adaptation requires mutual agreements and coordination for better joint operational working collaborations among all entities. It is helpful to intensify collaboration with experts in specific fields, as well as from neighbouring regions or countries, and to improve networking.

#### ***4.1.2. Governance for climate change health adaptation***

Ministries of health coordinate and structure policies and provisions for health prevention and protection in relation to climate-related effects and impacts, now and in the future. They should therefore optimize synergies with existing instruments and measures where possible. Managing the health risks of climate change is a relatively new activity for most countries, which means that new resources have been mobilized to address the large mandate. Two case studies on coordination highlighted the importance of adequate policies, particularly a climate change policy and a legislative framework that recognize the health implications of climate variability and change.

Starting points included at least some knowledge of climate variability and change, strong support within the ministry of health or department of health and good connections with other government ministries working on climate change for the case studies on heat, infectious diseases and capacity-building. In addition, stronger links and cooperation were needed among health practitioners, researchers and personnel working on health adaptation to climate change for coordination case studies. The need for national evaluations of capacities that require strengthening for climate change adaptation implementation, including additional and ongoing training in climate and health, was presented in the capacity-building case study, leading to a conclusion that capacity-building activities should be included in larger and

broader events for medical professionals, such as medical congresses, or through dedicated websites acting as modern platforms for knowledge sharing with eLearning modules and a knowledge database.

Specific case studies on heat and infectious diseases shared a vision of how to move from the current situation, typically with detected vulnerability to climate variability, to a future better able to prepare for and manage climate change health risks. Others on UV radiation and capacity-building ensured that target communities and the public fully participated in project implementation by raising awareness of the need to take action (regarding climate change, health impacts, risks, vulnerabilities and adaptation measures).

Specific recommendations derived from the case studies include the following.

- Increasing climate change health resilience is likely to be achieved through collaborative and longer-term multidisciplinary approaches, with supporting activities (and funding) for knowledge communication, capacity-building and institutionalized evaluation and monitoring.
- Effectively and efficiently managing the health risks of climate change is a long-term issue, so establishing effective processes is of considerable importance. The health risks of climate change are not new, and evidence-based interventions are available for all climate-sensitive health outcomes, although the extent of their implementation varies across countries; these interventions often need to be modified to take climate change into account.
- Health protection to manage the risks of climate change needs to be strengthened and integrated at all governance levels, and health plans and policies need to incorporate explicitly the risks of current and projected climate variability and change.
- Science and policy need to join forces in the decision-making process and work together towards mitigation of and adaptation to the impacts of climatic and environmental factors on health.
- Opportunities for capacity development related to climate change and health should be created, identified and reinforced for the full range of actors, including public health and health care professionals and decision- and policy-makers in the health sector and across ministries.

Several recommendations drawn from the lessons learned from countries' implementation of exemplary measures are reflected in the overall conclusions of the project set out in Chapter 5.

## **5. Conclusions and recommendations**

### **5.1. Conclusions**

While acknowledging the limitations of the questionnaire used as a tool to measure policy implementation, it is possible to derive some specific conclusions for the areas covered in the report.

#### ***5.1.1. Health effects of climate change in Europe***

- Impacts of climate change and variability have been observed in the majority of EU countries.
- Climate change is affecting health through many direct and indirect impacts, and will continue to do so. These include extreme weather events, changing infectious diseases, food safety and water insecurity.
- Some population groups are more exposed to specific risks areas or are more vulnerable due to age, health or social status.
- Extreme weather- and climate-related events (such as heat-waves, heavy precipitations and floods) can also disrupt health and social care service delivery, and can damage health care infrastructure.
- The observed increase in the frequency and intensity of heat-waves has had significant effects on human health across Europe, particularly in cities. The agglomeration of people, valuable assets and economic activities makes cities particularly vulnerable to climate change impacts; they should thus be priority areas for climate change health impact assessment and adaptation activities.
- Overall, the questionnaire survey results showed high climate change-related health concerns for both heat stress and communicable diseases. Heat stress was the highest ranked health concern among responding countries, as a current issue, a future effect of concern and a priority for protecting human health. Vector-borne diseases was the most reported category of concern among observed and predicted communicable diseases.
- Robust frameworks to guide optimal adaptation to the effects of climate change on health are essential. The need to minimize and prevent adverse climate change-related health outcomes highlights the need for inclusion of health as a consideration in all policies, across all sectors.
- The findings of the desk review of the 28 EU countries' Seventh National Communications to the UNFCCC, on observed and projected health effects and vulnerability, gave similar results to those from the survey: 12 countries' statements demonstrate that climate change has a direct effect on human health and is a concern for their most vulnerable populations, although only 13 (less than half) of the EU countries consider health in a dedicated chapter in their Communications.
- The main health impacts of climate change that cause high vulnerability are stressed by 15 countries, of which 11 use different scenarios to estimate how climate change may lead to an increased health risk. All define vulnerable population groups affected by climate change.
- There are, however, gaps in translating scientific evidence into action. Few of the Communications described observed and projected health effects due to climate change using recent national evidence.

#### ***5.1.2. Climate change adaptation in health systems of Europe***

- All 20 countries that responded the questionnaire have a national multisectoral body to deal with climate change, in which the health sector is represented. Further, 65% of

responding countries have designated climate change and health focal points within the health ministry with specific programmes of action. Cooperation is well established between the health ministry and main stakeholders at the national level in all responding countries, including specific roles and responsibilities in relation to protecting health from climate change.

- All responding countries are aware of the objectives of the EU Adaptation Strategy. It is understood that coherent multisectoral action is necessary if the challenges posed by climate change are to be tackled effectively. Health representation is ensured in main climate change processes at the national level in 90% of responding countries (for example, in National Communications to the UNFCCC).
- Most responding countries (18 of 20) have developed national climate change vulnerability, impact and adaptation assessments, making this an area of strong performance. The majority of efforts were related to the UNFCCC requirement that countries include such assessments as part of their National Communications, among other reports, strategies and policies.
- Most vulnerability assessments are relatively recent and covered a period after 2014. They provide a solid foundation for adaptation planning and can highlight the need for prevention of specific risks, such as heat-waves or emerging infectious diseases.
- Based on the findings of the desk review of National Communications, the majority of EU countries (25 of 28) have developed strategic frameworks on climate change adaptation and/or action plans. Most national strategies focus on instruments to address climate change impacts and adaptation in the field of human health.
- Most countries responding to the survey have developed strategic frameworks on climate change adaptation and action plans for health: 15 of 20 have planned or adopted measures involving health systems. In most of the strategies the focus is on climate change impacts and adaptation instruments in the areas of human health and risk management.
- Most countries reported that they had strengthened their public health capacities and their health systems to cope with impacts of climate change. Examples of strengthening infectious disease surveillance included increasing the frequency or number of sites of monitoring, expanding the list of notifiable infectious diseases, enhancing case definitions, updating protocols, initiating new monitoring for vectors and enhancing coordination between related institutions on infectious disease and vectors.
- Over half of the responding countries had also developed integrated surveillance, ensured climate change included in wider public health policy and strengthened health security through implementation of the IHR (2005) – this was mentioned by 13 of the 20 countries.
- Of the 20 responding countries 17 have developed early warning systems for heat-waves, 16 for flooding, 14 for cold spells, 13 for fires and nine for droughts. Heat-waves, due to their growing frequency in recent years, are the only extreme weather event to have health response plans in 12 countries.

### ***5.1.3. Case studies from EU countries***

- Two case studies highlighted the importance of adequate policies, particularly a climate change policy and a legislative framework that recognized the health implications of climate variability and change (categorized in the topic of coordination).
- Countries' case studies demonstrated strong support within the ministry of health or department of health and good connections with other government ministries working on climate change (heat, infectious diseases and capacity-building topics).

- In addition, stronger linkages and cooperation were needed among health practitioners, researchers and personnel working on health adaptation to climate change (coordination topic).
- The need for national evaluations of capacities that require strengthening for climate change adaptation implementation, including additional and ongoing training in climate and health was presented (capacity-building topic), concluding that it is necessary to include capacity-building activities in larger and broader events for medical professionals.
- Specific case studies shared a vision of how to move from the current situation, typically with detected vulnerability to climate variability, to a future better able to prepare for and manage climate change health risks (heat and infectious diseases topics). Others ensured that targeted communities and the public fully participated in project implementation (UV radiation and capacity-building topics) by raising awareness of the need to take action (regarding climate change, health impacts, risks, vulnerabilities and adaptation measures).

#### **5.1.4. Overall conclusions**

- The results suggest that countries are aware of the EU Adaptation Strategy and are considering implementation of recommended adaptation actions, but most efforts related to the UNFCCC requirements. Governance mechanisms for integrating climate action into health policy and planning seem well established.
- Effective national responses to climate risks require that the health sector identifies strategic goals in response to anticipate the threats. A crucial step in achieving these goals is outlining priority actions, resource requirements and a specific timeline and process for implementation. To promote integration of health aspects into national climate change adaptation plans, country capacities need to be built further to identify and address local health risks posed by climate change and to develop, implement and evaluate health-focused interventions through integrated approaches.
- Financial and human resources for health adaptation to climate change are integrated into ongoing activities and resource planning. While effective health adaptation also focuses on strengthening existing systems, there is a need to account for the additional burden of health impacts brought about by climate change.
- Vulnerability, impact and adaptation assessments seem to be an area of strong performance. Most vulnerability assessments are relatively recent, and in this regard provide a more solid foundation for adaptation planning. There are, however, gaps in translating scientific evidence into action. Health professionals need to have a more proactive role to promote use of health arguments and evidence in national climate change processes. Moreover, key areas like the economic consequences of inaction in climate policy are still rarely included in vulnerability, impact and adaptation assessment materials and communications.
- Countries reported a wealth of activities on health system strengthening, with strong overall performance on early warning systems, infectious disease surveillance and implementation of the IHR (2005). Certain important areas, however, remain lacking, such as developing integrated climate, environment and health surveillance or building climate-resilient health infrastructures.
- Responding countries showed a high level of awareness about climate change, although awareness of the health implications appears to be lower.
- Regional platforms and the Internet seem to be preferred channels for sharing of best practice in climate and health policy in responding countries. The review of the material indicated that these might be important considerations for organizations in the field when designing knowledge-dissemination strategies.

- Development of an objective tool for evaluation of climate change and health activities may be needed to complement the qualitative analysis of survey and questionnaire results. Further evaluation would benefit from a higher response rate and the inclusion of a larger number of EU countries, as well as wider representation of societal stakeholders from within countries.

## 5.2. Recommendations

National governments are continuing to evaluate potential public health adaptation options, following the adoption of the Paris Agreement, which gave great momentum to the health community for action on climate change. Tracking public health adaptation to climate change is crucial to improve understanding of how adaptation is occurring in practice and to ensure policy-oriented learning.

From the project results, several specific areas for technical, structural, managerial and operational improvements can be identified. Particular areas of focus are overall strengthening of capacities for ascertainment of climate-sensitive disease burden in populations; assessment of progress in adaptation and its social, environmental and economic consequences; and development of climate change and risk communication principles and materials.

*Recommendation 1: the health sector is responsible for protecting health from climate risks, but the ultimate responsibility is included in other sectoral policies too; thus, the health sector cannot accomplish this task alone, and needs to engage in intersectoral governance and development of sectoral policies by providing public health arguments and advice.*

The health community should be fully engaged in national intersectoral mechanisms for adaptation to climate change, including contributing to the development of the health components of national adaptation plans, nationally determined contributions to the UNFCCC and the SDGs.

*Recommendation 2: a comprehensive approach should be adopted to integrate climate risks into health systems.*

A climate-resilient health system is one that is capable of anticipating, responding to, coping with, recovering from and adapting to climate-related shocks and stress. The incorporation of a climate-resilient approach in a health system contributes to ensuring the system's capacity to improve the environmental and social determinants of health, ranging from improving air quality and access to clean water and sanitation to appropriate housing to enhancing disaster preparedness.

*Recommendation 3: the capacity of the health workforce should be developed to address climate health risks.*

Capacity-building is supported through the setting of norms and standards, development of technical guidance and training courses and integration of climate change and health topics into medical and public health training. Action should include integrating information on potential climate change threats to health into disease surveillance and early warning to improve and enhance health preparedness for and response to extreme weather events. Understanding and awareness of health risks from climate change are growing fast within the health community; these need to be reflected as core elements in training and career development for health professionals.

*Recommendation 4: risk assessment, surveillance and research in relation to emerging climate change-related health risks should be established and the results incorporated into wider climate change policy planning processes.*

Health professionals can use their considerable knowledge and expertise to assess future health risks and develop necessary responses in terms of enhanced disease surveillance and early warning systems for emerging risks. Targeted investment in research on risks and responses to protect health from climate change is required.

*Recommendation 5: management of environmental determinants of health, climate-informed health programming and emergency preparedness needs to be strengthened.*

Full protection of health from climate risks ultimately requires a comprehensive set of interventions along the causal chain from exposure to burden of disease. Adaptive actions to reduce health impacts can be considered in terms of the conventional public health categories of prevention. Thus, prevention can be achieved through management of the environmental risks exacerbated by climate change. It can also be enhanced by integrating climate into vertical health programmes that usually focus on one particular disease or group of diseases – for example, vector- or waterborne diseases. In view of progressing climate change actions, it is also necessary to strengthen further preparedness for and response to extreme weather events that are likely to become more frequent and intense.

*Recommendation 6: finance for health resilience to climate change should be scaled up.*

The health sector needs to ensure that the large investments already made in health systems take account of climate risks, to enhance both health system resilience to climate change and capacity-building in the public health domain. Adding criteria for climate resilience and health promotion to investment strategies can ensure that these investments bring the greatest possible benefit in terms of human health, climate adaptation and social return on investment over the long term.

*Recommendation 7: climate adaptation should be embedded in the EU budget, and countries, regions and cities should be further supported and encouraged to develop plans to build resilience and adapt to climate change, taking population health into account.*

The EU Adaptation Strategy has provided support and guidance on including adaptation in EU policies and funding programmes. An evaluation of the strategy, to be published in autumn 2018, found that there remains a need to deliver more when it comes to promoting and monitoring the implementation of adaptation strategies and action, in particular at the regional and local levels.

The evaluation also found that reinforcement of the links between public health and adaptation is needed, notably to improve cross-sectoral cooperation on risk assessment and surveillance and to increase the awareness and capacity of the health sector, including at the local level, to address current and emerging climate-related health risks. This could be facilitated through development and dissemination of best practices and new knowledge on climate-related health risks through relevant EU-funded programmes.

The European Commission plans to increase allocation from 20% of the current budget to 25% of the next Multiannual Financial Framework (2021–2027) on climate mitigation and adaptation objectives, with the Cohesion Fund, for example, aiming at 37% expenditure on

climate actions. The Commission also proposed that a wider range of EU-funded infrastructure investments should be climate resilient, and that support through regional funds should be conditional on disaster risk management plans consistent with national adaptation strategies.



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*Annex 1.*

## QUESTIONNAIRE

<b>Section A</b>	<b><i>Questions addressing the level of implementation of the EU Adaptation Strategy</i></b>
<b>1</b>	<b>Governance</b>
1.1	Has your country identified a national focal point for climate change within the ministry of health? (If so, please indicate the focal point's responsibilities; if not, please specify why not.)
1.2	Has a multisectoral body been established to deal with climate change? (If so, please indicate the body's responsibilities and the role of the health sector within it; if not, please specify why not.)
<b>2</b>	<b>Vulnerability, impact and adaptation assessment</b>
2.1	Has your country carried out a national or subregional health impact and vulnerability assessment of climate change? (If so, please list the key publications; if not, please specify why not.)
<b>3</b>	<b>National and subnational health adaptation strategies and/or action plans</b>
3.1	Has your country (at the local, regional or national level) developed a climate change health adaptation strategy and associated implementation plan? (If so, please provide references; if not, please specify why not.)
3.1.1	If so, has it been approved by your government or relevant authorities? (If so, please describe the key objectives and actions proposed; if not, please specify why not.)
<b>4</b>	<b>Health system adaptation</b>
4.1	Has your country implemented programmes or projects on health adaptation to climate change as follows? (If so, please provide details; if not, please specify why not.)
4.1.1	Strengthened primary health care
4.1.2	Built climate-resilient infrastructure
4.1.3	Strengthened infectious disease surveillance
4.1.4	Developed integrated climate, environment and health surveillance
4.1.5	Ensured climate change was included in wider health and public health policy
4.1.6	Strengthened environmental health services, including water and sanitation, vaccination programmes and laboratory services
4.1.7	Strengthened health security, including implementation of the International Health Regulations
4.1.8	Strengthened early warning and disaster response

4.1.9	Addressed vulnerable populations (such as elderly people, children, outside workers, families on low incomes)
4.1.10	Taken action on climate-related health impacts in the area of nutrition
4.1.11	Other – please specify
4.2	Has your country integrated climate information into infectious disease surveillance and response in the following areas? (If not, please specify why not.)
4.2/a	Vector-borne diseases
4.2/b	Waterborne diseases
4.2/c	Foodborne diseases
4.2/d	Rodent-borne diseases
4.2.1	If so, what has been done?
4.2.1/a	Strengthened integrated surveillance of climate, environment, vectors and disease in multiple sectors
4.2.1/b	Strengthened the chain of zoonotic disease surveillance
4.2.1/c	Strengthened climate, water and disease monitoring
4.2.1/d	Carried out specific studies to examine the attribution to climate change of the risk of infectious disease insemination
4.2.1/e	Other – please specify
4.3	Has your country developed early warning systems for extreme weather events and appropriate health sector response plans in the areas below? (If so, please provide details; if not, please specify why not.)
4.3/a	<i>Heat-waves</i>
	Early warning
	Health response plan
	Approved?
4.3/b	<i>Fires</i>
	Early warning
	Health response plan
	Approved?
4.3/c	<i>Flooding</i>
	Early warning
	Health response plan
	Approved?
4.3/d	<i>Droughts</i>
	Early warning

	Health response plan
	Approved?
4.3/e	<i>Cold spells</i>
	Early warning
	Health response plan
	Approved?
4.4	Has your country strengthened health sector engagement in emergency planning for extreme weather events and have you developed cross-sectoral plans in the areas below? (If so, please provide details; if not, please specify why not.)
4.4/a	Heat-waves
4.4/b	Cold spells
4.4/c	Flooding
4.4/d	Fires
4.4/e	Droughts/water scarcity
4.5	Has your country developed communication messages for extreme weather events to be released with an early warning for such an event? (If so, please provide details; if not, please specify why not.)
4.6	Has your country developed communication plans for key messages on climate change and health for other sectors and the general public? (If so, please provide details; if not, please specify why not.)
4.7	What are the main messages on protecting health from climate change you would like to communicate?
4.8	In the last 10 years has your country improved monitoring of climate-sensitive environmental determinants of health? If so, which factors? (If not, please specify why not.)
4.8.1	<i>Pollen</i>
	What data are used to improve future planning and responses?
4.8.2	<i>Water safety</i>
	What data are used to improve future planning and responses?
4.8.3	<i>Food, levels of malnutrition</i>
	What data are used to improve future planning and responses?
4.8.4	<i>Biodiversity loss and ecosystem change</i>
	What data are used to improve future planning and responses?
5	<b>Building capacity</b>
5.1	Are health effects of climate change of high relevance in political processes? (If so, please provide details; if not, please specify why not.)

5.2	Do you have enough information at your disposal on climate change and its impact on health in your country? (If so, please provide details; if not, please specify why not.)
5.3	Has your country built capacity and developed a workforce on health-related aspects of climate change? If so, how? (If not, please specify why not.)
5.3.1	Integrated training on climate change and health impacts and responses into mainstream under- and postgraduate training programmes
5.3.2	Ensured sufficient staffing and resources and built capacity of staff in priority areas related to climate change and health
5.3.3	Other – please specify
<i>Section B</i>	<i>Technical information on climate change and health effects</i>
<b>6</b>	<b>Health effects of climate change</b>
6.1	What are the currently observed health effects of climate change in your country?
6.2	What are the projected/expected future health effects of climate change in your country?
6.3	What do you consider to be the main risks/priorities for protecting health from climate change in your country?

*Annex 2.*

**RESULTS OF AN ANALYSIS OF EU COUNTRIES' SEVENTH NATIONAL COMMUNICATIONS TO THE UNFCCC**

The EU considers adaptation to be an integral element of its internal policy and planning processes and is implementing actions to adapt to a changing climate. EU countries regularly submit information on their adaptation actions through National Communications to the UNFCCC, in line with their commitments under Article 4.1b of the Convention.<sup>1</sup> The Seventh National Communications, which all EU countries listed in Annex I to the UNFCCC were obliged to submit in December 2017, can be found on the UNFCCC website.<sup>2</sup> Table A2.1 presents a summary of the health findings submitted, listing whether a dedicated health chapter is included, the areas of health vulnerability, observed and projected health effects and adaptation health policies contained in their Communications.

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<sup>1</sup> UNFCCC (1992). United Nations Framework Convention on Climate Change. New York: United Nations ([https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg\\_no=XXVII-7&chapter=27&Temp=mtdsg3&clang=\\_en](https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XXVII-7&chapter=27&Temp=mtdsg3&clang=_en), accessed 7 November 2018).

<sup>2</sup> Source: UNFCCC (2018). Seventh National Communications – Annex I. In: United Nations Framework Convention on Climate Change [website]. Bonn: United Nations Framework Convention on Climate Change (<https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/national-communications-and-biennial-reports-annex-i-parties/seventh-national-communications-annex-I>, accessed 12 October 2018).

**Table A2.1. Data on vulnerability, observed and projected health effects and adaptation policies, by country**

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
<b>Austria</b>	08 February 2018	No	<p>Vulnerability to heat stress is high for children, elderly people and people with heart diseases; it is lower for the rest of the population.</p> <p>Vulnerability to increasing levels of ground-level ozone and increasing UV radiation is high for sensitive population groups but moderate for the general population.</p> <p>Changed climatic conditions may be favourable for the spread of pathogens, vectors and allergic plants, which poses a risk for the general population.</p>	<p>A detailed assessment of the aspects of climate change relevant to Austria has been compiled. A 2014 assessment report on climate change, developed in line with the IPCC assessment report model, deals with the physical science basis and consequences for society and nature, as well as mitigation and adaptation.</p>	<p>Model results for Austria, based on the SRES A1B emissions scenario, show a median temperature increase of almost 4 °C for the end of the century (compared to the reference period 1961–1990), a tripling of numbers of hot nights and heat-waves and a comparable reduction of days with frost, as well as seasonal changes of precipitation.</p> <p>Vulnerability concerning human health should be taken into account in policy-making for heat stress, air quality and spread of diseases.</p>	<p>A comprehensive national adaptation policy has been developed, based on expert knowledge and an extensive stakeholder process. It was adopted by the federal government and the federal states in 2012 and 2013 respectively; an update was adopted by the federal government in August 2017. The policy consists of two parts: a national adaptation strategy and an action plan.</p> <p>While the strategy focuses on the strategic components of adaptation (e.g. setting the scene for adaptation, policy developments at various levels, research activities, social aspects of adaptation), the action plan presents a catalogue of 136 adaptation options</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
						for 14 areas. Its recommendations are presented based on a qualitative vulnerability assessment for the health sector.
<b>Belgium</b>	20 December 2017	No	An in-depth description of impacts, vulnerabilities and adaptation measures in sectors including health is available in the Sixth National Communication. In the Seventh, updated information on implementation of actions to tackle climate change in the health sector is provided in Table 6.2.	In 2015 the Flanders Environment Agency published a report analysing observed and future climate changes in Flanders and Belgium. The indicators used in the report are regularly updated on the Agency's website.  The number of heat-waves in 2016 was significantly higher than at the beginning of the 20th century. The frequency of heat-waves has increased from one every three years on average to one per year.	No information	A national adaptation plan for 2017–2020 was adopted by the National Climate Commission in April 2017. It identifies specific adaptation measures that need to be taken at the national level to strengthen cooperation and develop synergies between different entities on adaptation. The plan addresses six sectors, including health.
<b>Bulgaria</b>	29 December 2017	No	No information	No information	No information	A national climate change adaptation strategy is due to be finalized and adopted during the second half of



Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
						<p>2018. The strategy provides analysis of the current situation in selected sectors, including health. It sets goals and priorities for improving adaptation capacity, by sector, and defines specific measures to achieve these.</p> <p>An action plan summarizes adaptation measures for all sectors identified in the strategy.</p>
<b>Croatia</b>	2 May 2018	Yes	Vulnerability in the health sector is most likely to be manifested in increased mortality due to heat stress; higher numbers of cases of vector-borne diseases and respiratory disease due to increased allergenic pollen in the air; and food safety and water insecurity issues.	A review of publications in Croatia showed a continuous increase in the number of vector-borne diseases due to the impact of climate change on their distribution; an increase in pollen concentrations of all species and medium daily temperature values has been confirmed; and a positive correlation between mortality and high temperatures in the	<p>Expected main impacts of climate change that cause high vulnerability in the health sector are:</p> <ul style="list-style-type: none"> <li>• changes in epidemiology of acute infectious diseases;</li> <li>• reduced quality of outdoor and indoor air due to extremely high and low temperatures and precipitation;</li> <li>• water insecurity;</li> </ul>	A draft climate change adaptation strategy for the period to 2040, with an outlook to 2070 and an action plan for 2019–2023, has been prepared. One of its goals is to reduce the vulnerability of social and natural systems (including health) to the adverse impacts of climate change in order to strengthen their resilience and ability to recover from these impacts.

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
				cities of Osijek, Rijeka, Split and Zagreb.	<ul style="list-style-type: none"> <li>impacts on epidemiology of diseases related to climatological factors.</li> </ul>	
<b>Cyprus</b>	22 February 2018	Yes	<p>An impact, vulnerability and adaptation assessment of the public health sector regarding climate changes observed in recent years showed that the sector has good adaptive capacity.</p> <p>The main vulnerability identified relates to deaths and health problems due to frequent heat-waves and high temperatures, especially during summer.</p> <p>In addition, human discomfort – in particular for elderly people – increases when humidity levels are high and when air is polluted with particles of dust from the Sahara Desert.</p>	<p>Research into the effects of climate change on public health in Cyprus is performed by institutions and government departments concerned with the study of climatological data and their possible health effects.</p> <p>Cyprus also participates in MedCLIVAR, an international network that aims to study climate change impacts and challenges posed to public health, as well as the occurrence of extreme events closely related to climate variability in the Mediterranean.</p>	<p>The climate change impacts on the public health sector were assessed on the basis of Providing Regional Climates for Impacts Studies projections for the future (2021–2050) within the Development of a national strategy for adaptation to climate change adverse impacts in Cyprus (CYPADAPT) project. Direct impacts include:</p> <ul style="list-style-type: none"> <li>deaths and health problems related to heat-waves and high temperatures;</li> <li>deaths/injuries from floods;</li> <li>deaths/injuries from landslides;</li> </ul>	<p>CYPADAPT has been further enhanced with new research work published since the end of the project. Its main aim is to strengthen and increase Cyprus’s adaptive capacity to climate change impacts through the development of a national adaptation strategy.</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
					<ul style="list-style-type: none"> <li>• deaths/injuries from fires.</li> </ul> <p>Indirect impacts include:</p> <ul style="list-style-type: none"> <li>• vector-borne and rodent-borne diseases;</li> <li>• water- and foodborne diseases;</li> <li>• climate-related effects on nutrition;</li> <li>• air pollution-related diseases.</li> </ul>	
<b>Czechia</b>	22 December 2017	Yes	<p>General vulnerability estimates, which include health and hygiene, are set out in in subchapter 6.2.6.</p> <p>Adaptation measures in the health care and hygiene sector primarily involve combating contagious and other diseases (such as cardiovascular disorders and allergies) and preventing harmful effects on human health caused by extreme weather events; these are</p>	No information	No information	<p>A strategy on adaptation to climate change was adopted by the government in October 2015 and implemented via a national action plan in place since January 2017. The strategy presents observed climate change and defines adaptation measures, including measures for the health sector.</p> <p>A concept for the prevention of drought in Czechia was approved by the government in July</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			mentioned in subchapter 6.3.6.			2017; its main objective is to create a strategic framework for adoption of effective legislative, organizational, technical and economic measures to minimize the impacts of drought and water scarcity on the lives and health of the population, environment and the overall quality of life in Czechia.
<b>Denmark</b>	1 January 2018	Yes	Heat-waves can lead to heat stroke and dehydration, which at their worst can be life-threatening. People in northern parts of the world are less used to coping with high temperatures than those who live further south.  Elderly people, patients in hospitals and individuals suffering from certain diseases are at high risk; infants and young children also require extra attention.	The latest statistics from the Danish Meteorological Institute show that the mean temperature is now above 8.6 °C (1991–2016), an increase of about 1.5 °C since the end of the 19th century.  The sea level around Denmark has risen over the past 115 years. The maximum observed rise is in southern Denmark, where the water level is rising by about 1.5 mm per year. In the	The impacts of possible climate change in Denmark have been evaluated several times, most recently in the 2012 report by the Task Force on Climate Change Adaptation.  No health effects are projected.	In March 2008 the government launched the first Danish strategy for adaptation to a changing climate. This was followed by an action plan for a climate-proof Denmark, launched in December 2012.  Implementation of the Danish Flood Risk Act (in line with the EU Floods Directive) meant that the 22 Danish municipalities had to prepare their first flood-risk management plans

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<p>Other risks include infections and similar when temperatures increase and in connection with flooding, and injuries caused by more powerful storms and extreme weather events.</p> <p>Further, changes in the Arctic cryosphere affect ecosystems, the economy, infrastructure, health, indigenous and non-indigenous livelihoods, culture and identity.</p>	<p>northernmost part of the country uplift of the land after the Ice Age is roughly in line with the rise in sea level.</p> <p>No information provided on health effects.</p>		and start analysing the adverse impact of flooding on the health of civil society, the environment, cultural heritage and economic activities.
<b>Estonia</b>	30 December 2017	Yes	The main vulnerability of the health sector arises from the capability and preparedness of health care systems to adapt to the changing climate and extreme weather phenomena (availability of medical care may be interrupted), sensitivity and social inequalities in the population, the proportion of more	<p>The impact of higher temperatures on hot days and the increased number of heat-waves has already been seen, as mortality was quite high during periods of hot weather (with the maximum daytime temperature exceeding 27 °C) during 1996–2013.</p> <p>The health of the Estonian population was</p>	As heat-waves become more frequent owing to climate change, depending on the climate change scenario used (RCP4.5 or RCP8.5), 506 and 679, or almost 655 and 1068 excessive deaths per year can be expected on average in the periods 2030–2050 or 2050–2100, respectively.	The topic of adaptation to the impacts of climate change is discussed most extensively in Estonia’s Emergency Act and Water Act. The Emergency Act sets out policies to deal with the following extreme climate events or conditions: floods in densely populated areas, extremely cold weather,

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<p>vulnerable people (elderly people, children, chronically ill people) and the existence and functioning of warning systems.</p> <p>The main factors from the aspect of rescue capability are floods in densely populated areas and extensive forest and landscape fires. The risk of both these emergency types was deemed high in the nationwide risk analyses of 2013. As 60% of forest fires occur in May and June, the higher frequency of drought periods in spring and summer also increases forest fire hazards. These emergencies do not present a very high risk to human lives and health in Estonian conditions.</p>	<p>especially significantly affected by the hot summer of 2010, when mortality in the summer months increased by almost 30% compared with previous summers.</p>	<p>In spite of the general warming of the climate, health risks arising from very low temperatures or formation of glare ice on roads should also not be underestimated in Estonia in the future. Further extreme weather conditions, which may endanger human health, include storms and heavy rain (resulting in floods), which may also make medical assistance less accessible or completely inaccessible.</p> <p>Changes in the spreading areas of vector-borne diseases will result in more frequent occurrences of diseases already prevalent, such as tick-borne encephalitis and Lyme disease.</p>	<p>extremely hot weather and extensive forest or landscape fires. The Health Board led the drawing up of risk analysis for emergencies concerning epidemic outbreaks.</p> <p>The area of adapting to the impacts of climate change is planned and managed comprehensively in Estonia in short (to 2030) and long (to 2050 and 2100) perspectives via a climate change adaptation development plan to 2030. This was based on the EU Adaptation Strategy guidelines for developing national strategies and the distribution of prioritized sectors, which brings together and harmonizes the adaptation approach.</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
<b>Finland</b>	13 December 2017	Yes	<p>Increasing summertime temperatures and, especially, increased frequency and duration of heat-waves threaten to increase heat-related mortality and morbidity in the future.</p> <p>The ageing population, increasing number of people living alone and low prevalence of air-conditioning further amplify the effect of heat. Heat also poses a challenge for occupational health.</p> <p>Studies on the health effects of heat-waves include identification of vulnerable population groups and evaluation of preparedness in health care facilities; evaluation of health risks posed by compromised drinking-water quality due to climatic and other factors; and ongoing work on vulnerability of</p>	Increased incidence of Lyme disease and tick-borne encephalitis has been observed in Finland.	<p>The number of days with heat stress will increase in both outdoor and indoor work environments; this will result in a need to revise instructions regarding work–rest cycles among high-risk groups.</p> <p>Milder winters are likely to lead to a lower risk of cold-related mortality from cardiovascular and pulmonary diseases. On the other hand, because of the large climate variability during wintertime, society and individuals will have to stay prepared for cold spells in future, too.</p> <p>Changing climate, together with ecological factors (such as density of key host species), contributes to the northward spread of ticks, and consequently may result in increased incidence of tick-borne</p>	<p>In the health sector a national water safety plan was introduced in 2016 to prevent waterborne epidemics.</p> <p>Measures to prevent tick-borne diseases include raising awareness of ways to protect from tick bites and providing free vaccines against tick-borne encephalitis in some high-risk areas.</p> <p>Finland was one of the first countries in the world to adopt a policy to guide climate change adaptation (in 2005). The second evaluation of implementation of the strategy in 2013 found that overall progress had been made compared to the first evaluation in 2009: climate change impacts are recognized in most sectors and adaptation measures identified in the strategy have been launched. The</p>

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			elderly people to climate change.		<p>diseases, which also depends on social and societal factors.</p> <p>Changes in hydrology, such as an increased number of heavy precipitation events and wintertime flooding, may increase the number of waterborne epidemics in future.</p>	<p>2013 evaluation included recommendations for revision of the strategy, such as further promotion of cooperation between authorities and other actors in different sectors and administrative levels, and of regional and local adaptation measures.</p> <p>The recommendations of the evaluation and the vulnerability analysis in 2013 were considered in preparation of a national climate change adaptation plan for 2022 (adopted by government resolution on 20 November 2014), which describes the current national adaptation policy framework. Indicators include, among others, risks to human health and adaptation measures executed in flood-risk areas.</p>



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France	29 December 2017	No	<p>An analysis of statistical data shows that 18.5% of towns in mainland France are highly exposed to climate risks; this figure rises to 50% if moderately exposed towns are included. The most exposed regions are Brittany (46%), the Provence-Alpes-Côte d'Azur region (44%) and Ile-de-France (40%).</p> <p>Comparing the indicators of population exposure to climate risks in 2005 and 2015 shows a very significant increase in the number of towns that are highly exposed to climate risks (+175%), while the number of towns moderately (+44%) or slightly (+68%) exposed increase to a lesser extent. The proportion of unexposed towns fell sharply (-65%), however. No specific</p>	<p>Temperatures in 2014 reached a record of +1.9 °C compared to the 1961–1990 reference period. This warming is comparable between French regions, but its rhythm is not regular. In particular, acceleration has been seen since the 1980s. From 1959 to 2009 there was a trend of an increase in the annual average by +0.3 °C per decade, with an even greater increase in the spring and summer.</p> <p>The change in precipitation levels varies depending on the region and season.</p> <p>No information provided on health effects.</p>	<p>In mainland France and the overseas territories, an average temperature increase of 2 °C would result in major changes in many regional climatic characteristics, particularly with regard to extreme events.</p> <p>Cold spells will be less severe and less frequent, yet without reducing the risks from spring frosts, exacerbated by the earlier growth of vegetation; and more intense rainfall will occur, even in areas where the annual amount of precipitation will decrease, increasing the risk of a rise in water levels and flooding.</p> <p>No information provided on health effects.</p>	<p>Adopted in 2006, the objectives of the national adaptation strategy are to underpin all the approaches recommended for adaptation to climate change, taking action for safety and public health.</p> <p>A national plan for adapting to climate change was adopted in July 2011. In accordance with France's climate plan, which is updated regularly (the latest version was published in July 2017), the government will publish a new national climate change adaptation plan, which will be implemented during the next five-year term.</p>

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			health vulnerabilities are noted.			
<b>Germany</b>	20 December 2017	No	<p>A vulnerability analysis was used as part of a screening process throughout Germany for the 15 fields of action of the German strategy for adaptation to climate change. The increase in heat stress is the clearest, strongest climate signal and has considerable effects on health and infrastructure, particularly in densely populated areas.</p> <p>A baseline study and a central information platform in the field of climate change and health was created during the countrywide survey of adaptation activities in 2014. This is the first ever compilation of federal-level and state-level adaptation activities relating to climate change and health. The</p>	<p>A 2015 monitoring report showed that the climate is changing in Germany, as revealed by both continuous temperature changes and the increased frequency of extreme weather events.</p> <p>In addition to the rising mean annual temperature, there has also been a rising trend of extreme heat events over the past 40 years.</p> <p>No information provided on health effects.</p>	<p>A further rise in temperature in Germany is expected (virtually certain, very high confidence). This increase is about 1.0–1.3 °C for the short-term planning horizon (2021–2050) (likely, medium confidence).</p> <p>Warming is more pronounced in southern Germany. An obvious change in total mean annual precipitation in the short-term planning horizon (2021–2050) is not expected for Germany (virtually certain, very high confidence).</p> <p>No information provided on health effects.</p>	<p>The federal cabinet agreed on a German strategy for adaptation to climate change in December 2008. Its overarching aim is to identify and reduce Germany’s vulnerability to climate change impacts and increase its climate change adaptation capacity, thus ensuring that existing operational objectives in the different policy areas remain as achievable as possible, even in conditions resulting from advancing climate change. The strategy is divided into 15 fields of action, including health.</p> <p>The adaptation action plan was adopted on 31 August 2011 and a second action plan was adopted by the government in December</p>

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			information platform enables all actors to network more effectively at the various levels and to learn from one another.			2015. One focus of the activities is on measures to monitor the spread of disease vectors in connection with relevant climate signals. This focuses on infectious vector-borne diseases and on sensitization to allergens (such as pollen and mould). Furthermore, the government is assessing activities to expand and reinforce health and environmental monitoring and to develop an integrated health and environmental monitoring system.
<b>Greece</b>	22 December 2017	Yes	The Bank of Greece's 2011 report <i>The environmental, economic and social impacts of climate change in Greece</i> includes information on health vulnerabilities.	The number of recorded natural disasters during 1900–2010 and the related number of deaths and economic impact are registered.	The results of future climate model simulations point to a sharp increase in the frequency of heat-waves and forest fires and, conversely, to a reduction in the frequency of cold spells by 2100.  The frequency of heavy rainfall and flooding	Law 4414/2016 includes formal endorsement of the first Greek national adaptation to climate change strategy and provides for the process of revision of the strategy along a 10-year planning cycle. The main priority areas described include health.

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					<p>events in most of the country (including Athens, where more than 50% of the total national population is concentrated) is expected to rise. This implies that the number of deaths due to climate change-related extreme weather events in the course of the 21st century will gradually increase, not only in Athens but also in other large cities.</p>	<p>The Hellenic Centre for Disease Control and Prevention focuses on communicable diseases that are directly linked to climate change. The impact of climate change on infectious diseases varies, as both the reproductive rate of the vectors and their activity is affected.</p> <p>Some important examples are analysed in the national adaptation strategy, including extreme weather conditions, air pollution, diseases transmitted via vectors and increased incidence of allergies due to climate change.</p>
<b>Hungary</b>	10 January 2018	Yes	No information	No information	Further increases in temperature, with an extent that reaches 1 °C in almost the entire country and in every season by 2021–2050, will exceed 4 °C in the summer months,	In 2008 Hungary developed its first national climate change strategy for 2008–2025. According to statutory requirements, this was reviewed in 2013 and a second strategy for 2014–

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					<p>compared to the reference period of 1961–1990.</p> <p>No health effects are projected.</p>	<p>2025 was created, but after the Paris Agreement this was updated again. The updated strategy for 2017–2030 was published and opened to public consultation in the spring of 2017. It was accepted by the government and submitted to parliament in May 2017. Climate adaptation tasks related to human health are included in the national environmental protection programme.</p>
<b>Ireland</b>	30 March 2018	No	<p>A national risk assessment of impacts of climate change has begun, the aim of which is to establish a national risk and impact assessment of the effect on Ireland of the current and future patterns of climate warming in the 21st century.</p>	<p>The report summarizes observed climate changes impacts for Ireland: temperature, precipitation, wind and storm, sea level rise.</p> <p>No information provided on health effects.</p>	<p>The report summarizes projected climate changes and impacts for Ireland: temperature, precipitation, wind and storm, sea level rise.</p> <p>No health effects are projected.</p>	<p>The Climate Action and Low Carbon Development Act of 2015 provides for the statutory preparation of a national adaptation framework in Ireland. Ireland’s first statutory framework was published in January 2018.</p>

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Italy	22 December 2017	No, but health subchapter included in Chapter 6.2 on assessment of risks	<p>A vulnerability assessment was carried out in relation to the development of the Italian national adaptation strategy in 2015 through a literature review by a scientific panel.</p> <p>Impacts on health – but also productivity, crop production, air quality and wildfires – are expected, in particular in relation to extreme heat events. Other changes mentioned that carry health risks include water restrictions and flooding in river basins and at coasts (including economic losses).</p> <p>Indirect health effects are mediated through climate effects on ecosystems, biodiversity, drinking- and bathing-water, soil and outdoor and indoor air. Vector-borne diseases are already</p>	<p>Observed effects include an increase in average temperature in the region of 2 °C degrees over the last 50 years, plus extreme temperature indicators, with the highest trends in spring and summer.</p> <p>A slight reduction in cumulative annual precipitation has been seen.</p>	<p>Climate projections include general warming with an increase in extreme heat events and an overall reduction in precipitation (especially in mean values), but an increase in extreme precipitation events.</p> <p>Expected health effects include:</p> <ul style="list-style-type: none"> <li>• increased heat-related mortality and morbidity from summer heat-waves;</li> <li>• a slight reduction in cold-related mortality;</li> <li>• increased risk of injuries, morbidity (e.g. enteric infections, post-traumatic stress disorder and vector-borne diseases) and deaths from floods, heavy precipitation and fires events;</li> </ul>	<p>A national adaptation strategy is being implemented through development of an adaptation plan, which includes the health sector. The plan will provide institutional guidance for national and local authorities on integration of adaptation measures into policy processes and spatial planning, and is due in the first half of 2018.</p>

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			being observed, including chikungunya, West Nile virus, leishmaniosis and dengue. Tick-borne disease incidence has increased, and the malaria potential is being studied.		<ul style="list-style-type: none"> <li>• increased respiratory diseases and allergic disorders;</li> <li>• respiratory diseases and adverse consequences related to ozone events and air pollution;</li> <li>• increased risk of West Nile virus infections and leishmaniosis, risk of malaria and dengue and of spread of other vector-borne diseases.</li> </ul>	

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Latvia	29 December 2017	No, but health included in subchapter 6.2.2 on climate change impacts on different sectors	<p>A recent risk and vulnerability assessment included health and welfare, as well as civil protection and emergency assistance (published in 2016 and 2017).</p> <p>Hazards include impacts of extreme events on urban environments, storms and heavy rainfalls: storm surges at the coast and in cities at river mouths; heavy rainfall-induced precipitation; and floods.</p> <p>Related health risks include an increase in heat stroke events, exacerbation of chronic (cardiovascular, diabetes and similar) and respiratory diseases, an increase in mortality, an increase in acute intestinal infections, vector-borne diseases becoming endemic, anticipated emergence of new species (including</p>	<p>Observed effects on physical and mental health are linked to increases in average temperatures, longer meteorological spring/summer/autumn, reductions in the duration of meteorological winter, increases in annual precipitation and the frequency of heavy rainfalls, increases in annual water temperature and the frequency and duration of heat-waves (creating urban heat islands).</p> <p>The impacts may vary across social groups and geographical locations. In rural areas health effects may also be related to a lack of assistance and services.</p>	<p>The most negative health effect expected from climate change is an increase in cardiovascular diseases.</p> <p>The highest health costs in relation to climate change are expected from respiratory diseases.</p> <p>Health effects through deterioration of the socioeconomic situation include an increase in social inequality and loss of productivity.</p>	<p>Latvia created a draft national climate change adaptation strategy until 2030 in 2017. Its goal is to reduce the climate change-related risks and vulnerabilities of people, the economy, infrastructure, buildings and nature, and to promote the opportunities offered by climate change.</p> <p>The first strategic objective is to protect human life and health from the negative impacts of climate change and focus on protection of the most vulnerable population groups.</p> <p>Actions include providing additional assistance to vulnerable groups of society (elderly people, children, people needing social care and so on) and reducing the load on the health care</p>



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			pests) and the risk of spread of pests and pathogens.			<p>system through implementation of various preventive measures.</p> <p>The task of the country's civil protection and early warning system is to protect people's health, life and safety by timely forecasting, warning and response to extreme climate events.</p> <p>Specific priority measures in the adaptation strategy are defined, including:</p> <ul style="list-style-type: none"> <li>• improving information, knowledge and awareness-raising needed for climate change adaptation policies;</li> <li>• integration of adaptation policies into the decision-making process and territorial and spatial planning;</li> </ul>

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						<ul style="list-style-type: none"> <li>a focus on preventive measures, including key science and innovation through a national research programme and health promotion in pre-schools and schools.</li> </ul>
<b>Lithuania</b>	29 December 2017	No	<p>A risk and vulnerability assessment in public health was carried out in 2014 and cost-efficient measures and indicators were proposed.</p> <p>The most vulnerable region in Lithuania is the coast: people are affected by sea level rise, storms and hurricanes, sea and Curonian Lagoon water</p>	A study of health effects from climate change in 2014 showed increased incidence of skin cancer and cataracts and spread of tick-borne diseases (including Lyme disease and tick-borne encephalitis).	<p>Overall, adverse and beneficial effects are expected, based on climate projections for four RCPs produced in 2013–2015 (including air temperature increase; sea level rise). Adverse health effects are expected through:</p> <ul style="list-style-type: none"> <li>extreme weather events (heat-waves</li> </ul>	<p>To minimize adverse effects, adaptation measures are needed. The main coordinating institution is the Ministry of Environment; its overall aim is to integrate climate goals into sectoral strategies and programmes.</p> <p>Specific short-term adaptation goals for 2020</p>

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			<p>warming and salinity changes.</p> <p>Adverse effects are set out in Table 6.2.</p>		<p>and extreme cold spells);</p> <ul style="list-style-type: none"> <li>• increased health risks from new invasive insect species (vector-borne diseases);</li> <li>• increased risk of tick-borne diseases;</li> <li>• increase in UV radiation;</li> <li>• stress caused by extreme weather events (floods, storms and droughts).</li> </ul>	<p>include public health issues.</p> <p>A national public health and heat prevention action plan for 2016–2020 has been developed.</p>
<b>Luxembourg</b>	11 February 2018	No	<p>A vulnerability assessment for human health is summarized in Chapter VI.1.2.</p> <p>Risks in relation to water are set out in Chapter VI.2.4.</p> <p>Table VI.3-1 lists sector-based information on vulnerability and adaptation to climate change.</p>	Observed health effects have arisen from earlier blooming seasons (allergies) and higher frequency of flood events.	<p>Projected impacts for Luxembourg are primarily related to vegetation and water.</p> <p>Projected climatic changes with health implications (based on a 2016 EEA report) are:</p> <ul style="list-style-type: none"> <li>• an increase in heat extremes;</li> <li>• a reduction in summer precipitation;</li> </ul>	<p>A national adaptation to climate change strategy was adopted in 2011. Priority areas of action include biodiversity, water, agriculture and forestry.</p> <p>A revised strategy is under development (within the next two years), which will consider 13 sectors and cross-cutting topics, including human health.</p>

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					<ul style="list-style-type: none"> <li>• increasing risks of river floods;</li> <li>• increasing risks of forest fires.</li> </ul> <p>Health effects include:</p> <ul style="list-style-type: none"> <li>• increased heat exposure (effects on vulnerable population groups especially and particular exposure in urban areas);</li> <li>• reductions in cold stress;</li> <li>• risks to human health and safety from flooding;</li> <li>• increased occurrences of allergies due to changes in vegetation periods;</li> <li>• drinking-water insecurity and shortages;</li> <li>• health risks related to reduced water quality and increased water scarcity;</li> </ul>	<p>Health-related measures include preparation of flood-risk maps, flood evacuation plans and early warning systems; and maintaining a “risk-aware culture”.</p> <p>Plans are under way for additional water intake points in emergency cases (by 2024) and the resizing of the drinking-water infrastructure.</p> <p>A crisis management group has been set up for containment of pollution in drinking-water.</p>

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					<ul style="list-style-type: none"> <li>risks related to bathing-water quality (from algae).</li> </ul>	
<b>Malta</b>	12 February 2018	No, but health subchapter included in chapter on vulnerability assessment and adaptation measures (6.3.4)	<p>Research on health and climate change has been conducted for some time.</p> <p>Sectors currently considered vulnerable include health and seven others.</p> <p>Vulnerability of islands in general can be caused by droughts, resilience of pests and sea level rise.</p> <p>Human health is vulnerable to high summer temperatures and dry weather; compromised food hygiene and increasing mortality rates are the result.</p>	<p>Health standards are currently high.</p> <p>A recent study (2010) on the perception of impacts of climate change on health showed that the main causes of deaths include circulatory diseases, neoplasms, ischaemic heart disease and cerebrovascular diseases.</p>	<p>Projected climate change impacts on health include: flooding of coastal areas, drought stress, extreme weather events, impacts on structures and infrastructure, impacts on vegetation and heavy storms.</p> <p>Aspects of human health affected include air quality, water and food quality and quantity, shelter and vector-borne diseases.</p> <p>Temperature increases will lead to more heat-related deaths (such as heat stroke), with groups at risk including elderly people, infants and young children.</p> <p>Seasonal changes in pollination may lead to</p>	<p>Areas of action include legislation, coordination between national entities, research and integration of climate change policies into socioeconomic and environmental policies.</p> <p>A national adaptation strategy was finalized in 2012, in which health is one of the key sectors identified as requiring attention when adaptation measures are being developed, along with:</p> <ul style="list-style-type: none"> <li>support by an appropriate framework for good governance, a robust set-up and funding for research and innovation;</li> <li>cross-cutting and cross-sectoral adaptation measures (e.g. stronger and</li> </ul>

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					<p>allergies and respiratory diseases.</p> <p>Vector-borne diseases from the tiger mosquito may increase.</p> <p>Storms may lead to risk of death and injury and indirect health effects may be caused by damage to health infrastructure.</p> <p>New occupational health concerns may arise.</p> <p>Air quality and respiratory diseases may increase.</p> <p>Irregular migration from third states may lead to food and water security issues.</p>	<p>better maintained infrastructure);</p> <ul style="list-style-type: none"> <li>the need for awareness-raising and for integrating climate change into cross-sectoral and sectoral policies; adaptation measures tailor-made for Malta's specific characteristics as an island state.</li> </ul> <p>Health adaptation actions include continuous and rigorous surveillance of infectious diseases and their vectors; a plan for outbreak control measures; food safety strengthening; establishment of early warning systems for extreme weather events; awareness-raising and public education campaigns; and research.</p>
<b>Netherlands</b>	29 December 2017	No, but health subchapter	Sectoral assessments were carried out in 2014–2015.	No information	Projected health effects include:	A national climate adaptation strategy, the result of the national

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		included in chapter on vulnerability assessment and adaptation measures (6.1.5)	Senior citizens and people who suffer from respiratory or cardiovascular conditions are particularly susceptible to extreme temperatures. During a heatwave, mortality rises by approximately 13%, largely due to aggravation of pre-existing conditions. The frequency with which extreme temperatures occur in urban areas is higher than in rural areas.		<ul style="list-style-type: none"> <li>• a reduction in winter mortality;</li> <li>• an increase in morbidity and mortality during summer due to heat stress;</li> <li>• an increase in mortality from flooding;</li> <li>• an increase in mental stress caused by increased pluvial flooding and flood threats;</li> <li>• an increase in diseases linked to deteriorated air quality, especially during heat-waves;</li> <li>• uncertainty in trends of infectious diseases;</li> <li>• a likely increase of vector-transmitted diseases such as Lyme disease;</li> <li>• an increase in allergies such as hay fever and house dust mite allergy, linked</li> </ul>	<p>climate agenda and the EU Adaptation Strategy was enforced in 2016. It aims to make the country more climate resilient. As climate change impacts on health can be severe, public health is among the priorities of climate change policies</p> <p>Targets include the most vulnerable population groups, considering demographic changes (population growth, ageing, migration and urbanization).</p> <p>A special Delta Programme addresses the risk of flooding.</p> <p>A monitoring and screening system for infectious diseases is in place.</p> <p>Opportunities of climate change include agricultural production, cost savings in winter and warmer weather, which</p>

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					<p>to changes in the growing and flowering season;</p> <ul style="list-style-type: none"> <li>• an increase in water-related diseases;</li> <li>• changes in the occurrence of food-related diseases;</li> <li>• an increase in exposure to UV and related disorders.</li> </ul> <p>The Netherlands could be affected by climate change and extremes that affect international stability.</p>	<p>might make the Netherlands more attractive for tourists.</p> <p>Urgent action is required to:</p> <ul style="list-style-type: none"> <li>• deal with more heat stress leading to increased morbidity, hospital admissions and mortality, as well as reduced productivity;</li> <li>• address a greater health burden and loss of productivity due to a possible increase in infectious diseases or allergic respiratory conditions such as hay fever;</li> <li>• raise awareness.</li> </ul>
<b>Poland</b>	29 December 2017	No, but health subchapter included (6.6.1.6)	Elderly people, small children and people with specific diseases are the groups particularly vulnerable to the impacts of high temperatures. With a maximum temperature increase of 1 °C, the risk of death	<p>The increased risk of death on days with a very high temperature is more than 10%.</p> <p>In Poland the number of cases of tick-borne encephalopathy is increasing: 4–27 cases</p>	<p>An increase of Lyme disease incidence from 20% to 50% is predicted.</p> <p>By the end of the century the number of deaths due to cardiovascular dysfunctions is expected</p>	<p>Issues related to adaptation to climate change were included in the responsible development strategy adopted by the Council of Ministers on 14 February 2017. The strategic adaptation plan for 2020</p>



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			among people above the age of 70 years increases from 0.9% to 1.5%.	were reported per year before 1993; currently 200–300 cases are reported per year. Areas threatened by Lyme disease include north-eastern Poland, the lagoon belt and south-western and southern Poland.  Across the whole country the increase in deaths from all causes and from cardiovascular disease in cold spells is 8%.	to increase by an average of around 20–30%.  As a result of progressive warming, incidence of and death from influenza are expected to reduce by 10–12%. At the end of the 21st century the number of deaths from hypothermia may decrease by 45–80%.	with a vision to 2030 outlines the priorities for adaptation measures to be taken by 2020 in the areas most sensitive to climate change, including health.
<b>Portugal</b>	29 December 2017	No	The first stage of Portugal's national adaptation to climate change strategy (2010–2015) involved specific stakeholders and experts for each of the sectors. This resulted, in many cases, in an exhaustive collection of key action areas and adaptation measures, published in sectoral reports. Health is represented but without country-specific data.	The impacts of increased exposure due to extreme events such as heat-waves, droughts, floods and forest fires demonstrate the significant population vulnerability. No information provided on health effects.	Extreme weather events such as heat-waves, floods and forest fires can cause death, other injuries and mental disorders. This, along with the appearance of new diseases or the resurgence of others (whether transmitted by food, water or vectors), affects the response capacity of the health services.	In 2010 Portugal adopted a national adaptation to climate change strategy. Policy coordination is assured under the terms of a national strategy for adaptation to climate change of 2015 (ENAAAC 2020). The health sector was also represented in the original strategy, in which a state-of-the-art report was produced on the effect of climate change in the sector.

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					An increase in respiratory disorders and deaths associated with poor air quality due to forest fires and episodes of high-level tropospheric ozone is also expected.	<p>A contingency plan for heat-waves has been in place since 2004, with warning systems and responses to emergencies.</p> <p>A surveillance system on vector-borne diseases was set up in 2007.</p> <p>Beside the common responses of disaster risk reduction, a working group on safety of people and assets has contributed to ENAAC 2020 with the publication of two manuals, one dedicated to best practices on flood-risk management and the other to best practices in risk prevention and management for resilient cities in Portugal 2016.</p>
<b>Romania</b>	27 December 2017	No, but health subchapter included (VI.B.10)	The effects of heat-waves are more severe in the crowded urban areas. Young and elderly people and people affected by	Some information provided on increased occurrence of extreme events and natural disasters (floods, storms, very hot weather,	The most pressing consequences are those related to the increase in average monthly temperature (by up to 3 °C in summer) and the	A national strategy for climate change in Romania, approved in July 2013, refers to the effects of climate change on different sectors,

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<p>certain diseases are vulnerable groups.</p> <p>Health is presented but without country-specific data.</p>	droughts) but not linked to health outcomes.	<p>reduction of the amount of precipitation in summer time by 8–9% in Romania.</p> <p>An urgent current issue is the impact of heat-waves in urban areas.</p> <p>Under climate change conditions, different areas of the country will be affected by frequent and persistent heat-waves.</p> <p>Some information provided on projections of increased occurrence of extreme events and natural disasters but not linked to health outcomes.</p>	<p>including health. A new version was approved by the government in October 2016. The updated strategy aims to develop and operationalize a comprehensive national climate change and low carbon green growth strategy for 2016–2030 and an associated action plan on climate change for 2016–2020.</p>
<b>Slovakia</b>	15 December 2017	Yes	<p>The infrastructure of the southern part of Slovakia is not prepared to meet the impact of heat-waves.</p> <p>As adaptation measures, it is important to concentrate on the education of doctors and medical staff about</p>	The number of tropical days is increasing every year. August 2015 was a critical month in the last decade, with 17 tropical days occurring in Bratislava.	The report consists of climate change phenomena and their impacts on public health predicted in Slovakia by the end of 2100.	The foundation document in the field of environmental health within the public health system in Slovakia is the national environmental health action plan. Its main aim is to realize specific activities to

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			climate change health impacts in order to recognize the early symptoms of diseases connected to heat. The level of doctors' knowledge about the risks of extremely high temperatures, warnings, social and rescue systems should guarantee that patients receive proper information and instructions on how to behave in case of higher risks.	No information provided on health effects.		<p>protect environmental health. Climate change impacts on public health are stressed in the plan. Every two years a national review of implementation of the action plan activities is prepared.</p> <p>The 2014 national adaptation to adverse effects of climate change strategy describes a comprehensive evaluation of climate change impacts on productive and service sectors, and lists suggested adaptation measures for each field of action, including cross-cutting issues and priority themes.</p>
<b>Slovenia</b>	13 March 2018	No	The Ministry of Health prepared an environmental health risk assessment and complemented it with consideration of climate impacts on the	No health effects have been observed.	No health effects are projected.	In December 2016 the Slovenian government adopted a strategic framework for climate change adaptation, which provides guidelines for planning and

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<p>occurrence of infectious diseases.</p> <p>During heat-waves, more people die due to cardiovascular diseases: elderly people are particularly vulnerable, and their number and proportion of population is growing in Slovenia.</p>			<p>implementation of climate change adaptation measures.</p> <p>For a decade the sun safety programme has informed the target population about the harmful effects of sunlight and measures that can effectively prevent these consequences.</p>
<b>Spain</b>	22 December 2017	No, but   health subchapter included in chapter on vulnerability assessment and adaptation measures (6.3.1.7)	The working groups created within the scope of the Spanish Office for Climate Change prepared a sector report structured into four major areas (extreme temperatures, water quality, air quality and vector-transmitted diseases). This analyses the foreseeable impacts of climate change in these areas and different adaptation options, possible gaps in knowledge and repercussions of the problem.	<p>A 2013 study of the impacts of climate change on health reported a severe forecast for temperature rises in Spain, significantly higher in summer than in winter, and a reduction in total annual accumulated precipitation, but with increased frequency of intense rain.</p> <p>The summer of 2012 experienced an average temperature of 24 °C, which was 1.7 °C higher than the normal average</p>	With regard to the impact on health, the projected health effects for Barcelona and Valencia estimate a 2% increase in mortality attributable to heat on the horizon for 2030, with a greater impact on Mediterranean cities. The rate is, however, presented as uncertain due to changes in welfare conditions and an aging population, since it concerns mostly disadvantaged and elderly population groups.	The Spanish Office for Climate Change was established to develop a national adaptation plan and monitor its implementation. The first plan, developed in 2006, has been amended in two further versions – the third in 2014. In its third version the plan addresses general orientations and appraisals to be carried out and legislative actions to be undertaken.

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			A national plan of preventive actions of the effects of excess of temperatures on health, originally approved in 2004, was recently updated. It establishes measures to reduce the effects associated with excessive temperatures and to coordinate institutions involved in general state administration, and proposes actions to be carried out by the autonomous communities and local administrations. An important aspect is the involvement of social services, since elderly people, especially the most unprotected, are the most vulnerable.	(reference period 1971–2000).	With regard to vector-borne diseases, the study generically reports on malaria, West Nile virus, chikungunya and Lyme disease.	
<b>Sweden</b>	22 December 2017	No	More frequent heat-waves will increase the number of deaths in summertime.  High-risk groups include people suffering from	Recent research has shown that warm periods lead to increased mortality and morbidity in Sweden.	As a result of climate change, temperatures in Sweden will increase by 2–7 °C by the end of the century, depending on the scenario used. The greatest increase is	To underpin the national strategy with specific actions, regional government offices have adopted 21 regional action plans covering the entire country, with

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			cardiovascular and respiratory diseases; young children and elderly people are also at risk, especially those who spend a lot of time indoors, where temperatures may be significantly higher, particularly if the building and ventilation are not adapted to a warmer climate.	Higher water temperatures also increase the risk of toxic algal blooms and the growth of gastrointestinal bacteria.	<p>expected in the north, and the increase will be greater in the winter than in the summer.</p> <p>Precipitation is expected to increase across the country, but in particular in the north and in summer.</p> <p>No health effects are projected.</p>	<p>nearly 800 proposed actions. The main actions concern protection against floods, protection of drinking-water, shorelines and infrastructure (roads, railways), adaptation of agriculture and forestry, resilience of health care for heat-waves. An overview of these plans is available as a summary.</p> <p>Swedish climate change adaptation work is primarily organized by sector. Several national authorities have developed or are developing action plans for the sectors that fall under their responsibility, including food production, human health, national environmental objectives and planning/construction.</p> <p>During 2016 the previous network of authorities</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
						behind the National Portal for Climate Change Adaptation became the National Network for Adaptation, with a wider remit and the aim of increasing the resilience of society to climate change: 18 national authorities with responsibility for adaptation participate in local and subregional networks. The secretariat is provided by the Swedish Meteorological and Hydrological Institute.
<b>United Kingdom of Great Britain and Northern Ireland</b>	30 December 2017	No	In Scotland an evidence report was published in July 2016. It highlighted the need for more action to address flood risks, the potential for water scarcity, heat-related impacts on health and well-being, risks to the natural environment and risks of food price volatility.	At present an estimated 1.8 million people live in areas at a 1:75 or greater annual risk of river, surface water or coastal flooding across the United Kingdom.  Policies do not exist at present to adapt homes or other buildings to higher temperatures.	Warming temperatures, combined with demographic change, may lead to an increased risk of overheating. The evidence report projects that the number of heat-related deaths in the United Kingdom could more than double by the 2050s from a current baseline of around 2000 per year. Fewer cold	In 2008 the United Kingdom adopted the Climate Change Act, defined roles of various institutions and planned studies to elaborate adaptation strategies. In this framework climate change risk assessments were carried out in 2012 and 2017.



Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<p>The United Kingdom's climate change risk assessment evidence report of 2017 highlighted the health impacts of climate change as follows:</p> <ul style="list-style-type: none"> <li>• flooding and coastal change risks to communities, businesses and infrastructure;</li> <li>• risks to health, well-being and productivity from high temperatures;</li> <li>• risk of shortages in the public water supply, and for agriculture, energy generation and industry;</li> <li>• risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity;</li> </ul>	<p>More research is needed to understand the influence of climate change on ground-level ozone and other outdoor air pollutants (especially particulates), and how climate and other factors (e.g. individual behaviour) affect indoor air quality.</p>	<p>events in future will benefit health system management. Several estimates of the reduction in cold-related mortality exist.</p> <p>Cold-related mortality is estimated to decline by 2% in 2050 from a baseline of around 41 000 deaths. The benefit of climate warming will not be sufficient to reduce the need for public health interventions for cold.</p> <p>Research is needed to improve evidence on the impact of endemic diseases in a changing environment.</p>	<p>On 1 July 2013 the first Scottish adaptation programme placed a duty on ministers to lay a programme for climate change adaptation before parliament as soon as reasonably practicable after they receive the climate change risk assessment for Scotland. Scotland's first climate change adaptation programme was launched in 2014.</p> <p>In light of this new legislation and the emerging evidence, such as the climate change risk assessment evidence report prepared by the Committee on Climate Change, the Welsh government is now developing a new climate change adaptation plan, to be delivered in 2018.</p> <p>The current Northern Ireland climate change</p>

Country	Date of original submission	Health chapter	Vulnerability	Current climate change effects	Projected climate change (health) effects	Adaptation in health systems
			<ul style="list-style-type: none"> <li>risks to domestic and international food production and trade.</li> </ul>			adaptation programme was produced in 2014.

## **CASE STUDIES COLLECTED WITHIN THE PROJECT**

### **Case study 1. Health, demography and climate change (Austria)**

#### ***Abstract***

While the effects of climate change are felt today, the future could reveal more severe risks to human health, amplified by changes in demography. A special report on health, demography and climate change compiled by the Austrian Panel on Climate Change strives for a comprehensive, inclusive and integrated assessment of the complex relationships between these three fields. It employs a transparent stakeholder process in line with IPCC and Austrian Panel on Climate Change standards, thereby aiming to deliver a legitimate basis for political decision-making with the goals of avoiding adverse health impacts by early action and highlighting where action in the interface between climate and health has great potential for health–climate co-benefits, while enabling well-being for all.

#### ***Background/problem***

Adverse climate-related health impacts throughout human history underscore the need for abating human-induced climate change at present and in future (McMichael, 2012). According to the 2014 IPCC assessment report, present and future adverse effects on human health are directly caused by changes in temperature and precipitation represented by, for example, heat-waves, floods, droughts and fire (Smith et al., 2014). Similarly, climate change-induced ecological disruptions (crop failures, shifting patterns of disease vectors) and social responses to climate change (such as displacement of populations following prolonged drought) can influence health indirectly.

The Lancet Commission recently inferred from analysis that future projections represent an unacceptably high and potentially catastrophic risk to human health (Watts et al., 2015). Further, it concluded that tackling climate change is a health opportunity and that many mitigation and adaptation responses are “no-regret” options.

Both climatic conditions as determinants of health and population distribution and composition are changing (Lutz, Butz & KC, 2014). This is important since different subgroups of population are vulnerable to the changing climate in different ways – for example, older populations are more vulnerable to heat-waves, while children are more vulnerable to malaria (Muttarak & Jiang, 2015). Thus, ageing of societies, ongoing urbanization and increased migration mean changes in the vulnerability pattern of the population.

#### ***Objectives***

A special report (SR18), compiled by the Austrian Panel on Climate Change, assesses the complex interrelations between health, demography and climate change (Austrian Panel on Climate Change, in press). As an assessment report it strives for:

- comprehensive coverage of research in the field for Austria, as well as other research at the European and global levels relevant to Austria;

- inclusive involvement of the overall research community to provide a well balanced and interdisciplinary assessment;
- an integrated approach to promote cross-connection of stakeholders;
- a transparent process, documenting stakeholder and scientific comments;
- highlighting not only of increased risks but also emerging opportunities and co-benefits; and
- compliance with the process of quality assurance of the Austrian Panel on Climate Change.

SR18 was developed to deliver a legitimate basis for decision-making for science, administration and politics. It highlights opportunities to combine climate and health policies and to increase preparedness and resilience with anticipatory rather than responsive action. The health co-benefits of mitigation and adaptation measures are particularly promising. Ultimately, the report supports design of clever policies to improve the health status of the population now and in the future.

### ***Local context***

SR18 is the first Austrian Panel on Climate Change special report, four years after the Panel's assessment report on climate change overall (Austrian Panel on Climate Change, 2014). The earlier report summarized research findings for Austria and rated several adverse health impacts as possible to very likely; it also set out the health sector's responsibility for mitigation activities and the impact of adaptation measures on health. SR18 deals with these issues and their interlinkages in greater depth and covers the increased number of scientific studies on this topic, both Austrian and international (Austrian Panel on Climate Change, in press).

### ***Approach***

The compilation process was in a close alignment with the IPCC review process and followed Austrian Panel on Climate Change quality standards. The drafting phase gathered input and comments through stakeholder involvement and a multilevel review process. Many issues are highly relevant to human health, but researchers and stakeholders have often not yet considered their topic in the intersection of human health, demography and climate change.

### ***Relevant changes***

The stakeholder process invited potential users to participate. A broad announcement attracted actors in all three thematic fields (climate, health and demography) and from various private and public arenas; they included policy-makers, administrators and representatives of businesses and nongovernmental organizations. Screening national and regional agendas and programmes elicited the view that climate is not a broad issue dealt with by actors in health or demography. Likewise, the issues of health and demography do not get a lot of attention from actors in climate research or policy. Integrated coverage and stronger cooperation could bring improvements in both the health and climate fields.

The final report and important byproducts such as a synthesis report and summary for policy-makers will be presented to the public through 2018 (Austrian Panel on Climate Change, in press). The report also delivers input to preparation for the next international climate conference in November 2018.

## ***Lessons learned***

SR18 aims to elicit resonance among decision-makers and governors. The issues assessed are presented in a credible way and targeted to specific groups. Key messages play a central role in identifying areas of action based on sound evidence with high agreement within the scientific community. These need entry points in different policy arenas to trigger change in the overlapping area between health, demography and climate change.

In this respect, the Austrian health targets (Ministry of Health and Women's Affairs, 2018) offer several opportunities to link health with climate change mitigation and adaptation measures. The most obvious link is with health target 4, which aims to secure sustainable natural resources such as air, water and soil and healthy environments for future generations. While climate change is not mentioned directly, the working group welcomes input to specify possible health risks caused by climate change in future and adaptation measures that seem appropriate to reduce risks of adverse health outcomes. As well as impacts, health co-benefits can be linked with at least two other health targets: target 7 aims to provide access to healthy diet for all and promotes a balanced diet that reduces risks for diseases. Since present diets are too heavy in meat from a health point of view, and since meat production is linked with significant carbon emissions, dietary changes towards reduced meat consumption promise co-benefits for health and climate. Target 8 aims to promote healthy, safe exercise and activity in everyday life through appropriate environments. Since motorized individual traffic in urban areas is linked with both a physically inactive lifestyle and high carbon emissions, a change of the built environment to promote more active modes of movement like walking and cycling can deliver both health gains and reduced carbon emissions.

Another entry point for joint efforts in climate and health policies are the SDGs (United Nations, 2015). Since Austria has committed to contribute its part towards achieving the SDGs, health and climate policy can jointly design measures in the areas of health co-benefits in diets and mobility that contribute to SDG3 “to ensure healthy lives and promote well-being for all at all ages” and SDG13 “to take urgent action to combat climate change and its impacts”. Proper framing of these measures should receive high acceptance in the policy arena.

A relatively new field of learning relates to how climate communication can benefit if linked with public health issues and vice versa. Climate issues tend to be discussed in moralistic tones and may thus lack acceptance by the wider public; public health issues, in turn, are mainly framed as individual health gains, but often fail to address structural factors that contribute to unhealthy behaviours. The weaknesses and strengths of the two issues could be combined for much stronger and more dialogue-oriented communication. Nevertheless, experiences of these issues need to be gathered and evaluated critically to learn how to improve communication in areas where change holds the promise of improvements for individuals and the wider community. An adaptive and reflexive dissemination and communication plan would help. This requires good relationships with potential target groups to identify which information catches the attention of wider groups of users and which messages have transformative potential in terms of preparing the ground for further change. Another element of successful dissemination is a permanent coordination team with responsibility for implementing central outcomes. Active stakeholders of the SR18 process could be invited to join existing national expert groups.

In summary, SR18 can contribute to making health a strong engine for climate policy and ensuring that climate change is seriously and routinely integrated into health research and

health policy. Opportunities that benefit both health and climate can be delivered by health co-benefits of mitigation and adaptation measures.

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## **Case study 2. Operation of the national heat protection plan (Austria)**

### ***Abstract***

Austria's heat protection plan is a national plan developed, funded and implemented by the Ministry of Labour, Social Affairs, Health and Consumer Protection and all relevant actors in the field of health and early warning at the national and regional levels. Its main objective is to reduce heat stress and prevent negative health effects in the population in especially heat-prone areas (such as urban areas affected by the heat-island effect).

In addition to climate change, broad demographic changes in Austrian society (including age distribution and size of the population) are expected to have implications for specific needs (for example, heat sensitivity increases with age). The plan serves to increase awareness of health-related problems caused by prolonged heat-waves. Practical tips and a guide for authorities and institutions should help to prevent heat-induced morbidity and mortality. Special attention is placed on the most vulnerable population groups (such as chronically ill or elderly people and children).

### ***Background/problem***

In 2003 a major heat-wave had severe health impacts on populations across Europe; more than 70 000 additional deaths occurred in Europe during hot periods in summer 2003, in comparison to the reference period of 1998–2002 (Robine et al., 2008).

With global climate change, it is very likely that heat-waves will occur more often and last longer (IPCC, 2014). The number of days with ozone concentrations exceeding human health thresholds is expected to increase. This applies particularly to Austria, Belgium, France, Germany, Luxembourg, Italy and the Netherlands (Meleux, Solmon and Giorgi, 2007).

High temperatures and heat-waves are responsible for a significant increase in morbidity and mortality, especially among at-risk groups such as elderly people and people with pre-existing diseases, or people living in urban versus rural locations. Performance impairment on hot days and during heat-waves is also possible. Heat-waves are defined by persistent daytime and night-time temperatures that exceed certain limits. The combination of extreme maximum daytime temperatures and warm nocturnal temperatures is particularly hazardous, and mortality can be up to three times higher during long, high-intensity heat-waves (Wolf et al., 2015).

### ***Local context***

The 2003 heat-wave in Europe raised awareness of the negative health impacts of heat stress in Austria, where heat-waves occur at regular intervals. Projected increased frequency of heat-waves will lead to an increase in heat stress, especially in urban areas where intensification of the heat-island effect is expected. New record high temperatures in low-lying areas of Austria have been measured in recent decades, as well as an increase in night-time minimum temperatures of over 20 °C, particularly during hot spells.

### ***Approach***

In response to the 2003 heat-wave, various Austrian provinces including Styria in 2011 (Feenstra, 2016) and Carinthia in 2013 (Land Kärnten Umweltmedizin, 2016) developed heat protection plans, based on WHO recommendations to develop strategies, plans and packages



of measures to protect citizens from heat stress (Matthies et al., 2008). These plans provide information for public health services.

Based on the experiences of the two provinces an Austrian heat protection plan, involving several relevant actors at the national and provincial levels, was prepared and put into action in 2017, led by the Ministry of Health and Women's Affairs (2017). The plan explains the connection between climate change and health and gives meteorological baseline information for heat warnings, provided by the National Meteorological Service (2018). The warnings and information are disseminated to citizens via a network of institutions and actors in the health sector.

In the case of heat warnings in the Styria and Carinthia provinces, a targeted email with detailed heat prognosis, heat-health advice and links for further information is sent to all relevant health actors. Details and examples are given in their heat protection plans (Land Kärnten Umweltmedizin, 2016; Feenstra, 2016). In Styria, for example, the provincial health authorities developed a data pool of all relevant organizations to be informed. This is shared with the National Meteorological Service and used as a distribution list for heat warnings. At the beginning of the hot season all relevant organizations in Styria receive general information about the heat protection plan. If a heat alert is activated, an email with regional forecasts, including health information sheets and additional relevant information, is disseminated as soon as possible to the listed recipients.

Since 2010 a preventive heat warning service in the province of Vienna, issued in cooperation with the National Meteorological Service, alerts all relevant actors in the health field and provides recommendations for protective measures (to the general public via the City of Vienna website and to provincial media if a heat level is exceeded for at least three days in a row; City of Vienna et al., 2018). This heat warning service was developed in response to the heat-wave of 2003 with differvariousent actors within the City of Vienna and the National Meteorological Service, as well as the Medical University and the Vienna Regional Health Insurance Fund.

### ***Relevant changes***

Collaboration between the national and regional levels and among actors in the health sector in developing the plan allows realistic risk assessments based on an early warning system, ensuring a faster response within the health system. The introduction of specific regional temperature cut-off values to trigger heat warnings is another important success. This part of the plan will be agreed on between the National Meteorological Service and individual provinces, however, which can benefit from more refined information.

The main elements and actions encompassed by the national plan include the following (Ministry of Health and Women's Affairs, 2017).

- **Roles and responsibilities** for each authority involved in the plan's operation are defined: within the health sector, roles and responsibilities involve national and regional levels. The Ministry of Health and Women's Affairs provides information about heat warnings on its website and provides and promotes precautionary measures for citizens. The provinces provide specific information to various organizations (such as homes for elderly people, nursing homes, hospitals and kindergartens) as early as possible.
- The National Meteorological Service issues **daily heat alerts** to the general public at different hazard levels related to extreme temperatures and heat-waves. Four possible

alert levels are in force: green, indicating normal temperatures for the time of the year; yellow, indicating that temperatures are higher than normal and may cause adverse health effects in the most sensitive population groups; orange, indicating that temperatures are high and likely to cause adverse health effects in sensitive population groups; and red, indicating extremely high temperatures likely to cause significant adverse health effects.

- For each alert level **specific protection measures** are established to reduce possible adverse health impacts. For example, during an orange and red alert the following measures are triggered: information is provided by the Ministry of Health and Women's Affairs and the regions to the public and relevant facilities to the general population, health facilities, social services and relevant media channels about the alert level, with recommendations of protective measures (such as drinking more water) that can be applied to reduce heat stress, particularly in vulnerable population groups; communication channels are enhanced at an early stage (allowing adequate lead time) between the health and other sectors; coordination is set up with emergency response services (including emergency services, mobile health care and medical associations) to promote precautionary measures in a timely way; coordinate takes place with pharmacies to inform customers about possible problems related to heat stress and pharmaceuticals.
- Recommendations for preventive measures are formulated specifically addressing the needs of **vulnerable population groups** (such as elderly people, individuals with chronic diseases, patients taking certain medication, people particularly exposed to the heat and children); information is disseminated by the Ministry of Health and Women's Affairs and the regions specifically to relevant facilities, such as homes for elderly people, nursing homes, hospitals and kindergartens.
- To enhance **preventive measures across health-relevant sectors**, a heat hotline is available for the general public at the Federal Office for Food Safety in the event of longer heat-waves.
- **Monitoring and surveillance** of mortality and morbidity associated with periods of heat stress take place through the health system.
- **Reports** to the Minister of Health and the general public are created on the activities developed, implemented and evaluated during the year.

### ***Lessons learned***

Following experience with heat-waves since 2003, the Austrian heat protection plan was established in 2017 and will be in operation every year. It establishes roles and functions for government institutions at national and regional levels. Although coordinated centrally by the Ministry of Health and Women's Affairs, it has a decentralized operational structure: government institutions at the national and regional levels were involved in its elaboration and work together, taking on different roles during various stages of its operation. Other actors involved include health professionals, hospitals and other emergency staff.

Communication regarding alert levels and corresponding risk reduction actions are issued to the media by the National Meteorological Service. Printed material on how to reduce risks is widely available in clinics and other locations targeting vulnerable population groups, such as the homes of elderly people. Information is also available online (on the website of the Ministry of Health and Women's Affairs as well as websites of the regional health authorities).

The heat early warning system has begun to be better known nationally, and previous experience gained in two regions (Styria and Carinthia) served as a good basis for its development in Austria. It will be challenging to assess how far the system will reduce

adverse health effects of heat, and no information is yet available apart from the number of clicks on the heat warnings page at the National Meteorological Service.

Actions set up by the heat protection plan are expected to continue for the long term. A revised version is planned after first experiences have been collected and evaluated over coming summer periods.

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### **Case study 3. Ozone and Heat Working Group (Belgium)**

#### ***Abstract***

The Ozone and Heat Working Group is a permanent working group that coordinates action across all government administrations (federal, regional and community) involved in the national ozone and heat action plan. Established in 2003, it is also a subworking group of the National Cell Environment-Health.

The members joined forces and budgets in setting up projects to model the health effects of high temperatures and air pollutants. The work of the Group has led to a more coordinated approach on high temperature and high ozone concentrations in Belgium: all regions and communities use the same approach and thresholds to announce the onset of the warning phase, to avoid confusing the Belgian population.

#### ***Background/problem***

In 2003, a major heat-wave had severe health impacts on populations across Europe; more than 70 000 additional deaths occurred across 12 countries during hot periods in summer 2003, in comparison to the reference period of 1998–2002 (Robine et al., 2008).

With global climate change, it is very likely that heat-waves will occur more often and last longer (IPCC, 2014). The number of days with ozone concentrations exceeding human health thresholds is expected to increase. This applies particularly to Austria, Belgium, France, Germany, Luxembourg, Italy and the Netherlands (Meleux, Solmon & Giorgi, 2007).

High temperatures and ozone concentrations are responsible for a significant increase in morbidity and mortality, especially among elderly people and people with existing respiratory diseases. The combination of extreme maximum daytime temperatures and warm nocturnal temperatures is particularly hazardous, and mortality can be up to three times higher during long, high-intensity heat-waves (Wolf et al., 2015).

Regional projections indicate a 10–14% increase in ozone-related morbidity and mortality by 2021–2050 in several countries including Belgium, France, Portugal and Spain (Orru et al., 2013). A positive association between high temperatures, ozone and coarse particulate matter concentrations with mortality has been observed, especially on heat-wave days (Katsouyanni & Analitis, 2009).

In response to the severe heat-wave in 2003, Belgium drew up an ozone and heat action plan (Tsachoua & Reynders, 2016). This comprises a series of measures to prevent and respond to the health impacts of heat-waves, high temperatures and high ozone concentrations.

#### ***Local context***

The main task of the national Ozone and Heat Working Group is to integrate and execute decisions taken by different Belgian administration levels. The parties involved include both environment actors (considering the negative health impact of air pollutants such as ozone and nitrogen oxides) and health actors (working to prevent the negative effects of high temperatures and linked air pollutants).

The Belgian federal government and the three federal levels – the Flanders, Walloon and Brussels Capital regions – all have their own action plans regarding ozone and heat. A coordinated approach is necessary to tackle the problems associated with ozone and heat

efficiently, however. Thus, the federal, regional and community governments worked together to develop and agree on a coordinated action plan in 2003, which is a composite of the different Belgian action plans. The Ozone and Heat Working Group initiated the plan and makes sure it is executed when triggered.

Other actors participating in the Working Group are the Interregional Environment Agency (a joint agency consisting of experts from the regional environment administrations) and researchers from the Scientific Institute of Public Health and Royal Meteorological Institute, which provides temperature forecasts (Royal Meteorological Institute, 2018).

### ***Approach***

The national ozone and heat action plan came to life in 2003 and was updated in 2016 (Tsachoua & Reynders, 2016); it was designed to address the risks of high temperatures and ozone concentrations. It sets out procedures structured according to three different warning levels: vigilance, warning and alarm. The vigilance phase runs continuously from 15 May till 30 September each year. A week before 15 May, regional and community authorities send reminders to strategic partners in the field (such as nurseries, hospitals, homes for elderly people, local authorities and the press) containing advice and best practices to protect the health and well-being of the population during the summer season.

The warning phase sets in when predicted temperatures will rise high enough above a defined temperature threshold to pose a possible health risk. The authorities notify health care professionals, health institutions, local authorities, the population and other partners about the health risks and precautionary measures to be taken.

Finally, the alarm phase is declared when extreme heat and extreme ozone concentrations are forecast and measures need to be strengthened. A crisis cell – the risk management group – is installed, which can decide on extraordinary measures (such as cancelling events). These measures are proposed by a group of experts whose objective is to support the risk management group by issuing rapid risk assessments of the situation and providing science-based recommendations. To date the alarm phase has never been triggered.

Data on temperatures are provided by the Royal Meteorological Institute and data on ozone concentrations by the Interregional Environment Agency, which has developed a protocol for the coordination of measures on ozone and heat among the three regions of Belgium, available on request.

### ***Relevant changes***

The work of the Ozone and Heat Working Group has led to a more coordinated approach in Belgium: all regions and communities use the same approach and temperature thresholds to announce the onset of the warning phase, to avoid confusing the Belgian population.

Environmental actors share their pollution data and predictions via the Interregional Environment Agency, while the Royal Meteorological Institute shares its meteorological data and predictions. The health sector uses its networks to communicate and warn actors and facilities such as hospitals, old people's homes and public centres for social welfare. The health professionals have also developed warning levels to communicate risks of heat or extreme to the public.

The Working Group members also joined forces and budgets in setting up projects, including those into short-term effects of atmospheric pollution and climate on mortality (all causes) in Belgium and the impact of acute exposure to outdoor atmospheric pollution on mortality (Bustos Sierra & Tersago, 2017). These projects used the Belgian Mortality Monitoring or Be-MoMo model of the Scientific Institute of Public Health (2018). Work on this model is further funded by the partners and the output will be shared via the Ozone and Heat Working Group in the future.

### ***Lessons learned***

High temperatures and high concentrations of outdoor air pollutants have adverse impacts on human health. Coordinated and structured timely early warning, preparedness and response are key to preventing heat and ozone health outcomes.

Ozone and Heat Working Group members share practices and experiences; for example, in 2017 the definition of the temperature thresholds for the warning levels was revised and turned into a single threshold warning level, using a study commissioned by the Flemish community. Working Group members have also asked the Royal Meteorological Institute to provide maps with temperatures to allow them to give more tailored and specific messages to certain areas, such as when it is cooler at the coast than inland.

The Working Group is planning to adapt its communication strategy to be more suitable for foreign visitors coming to Belgium during the summer, particularly for those who do not understand either the country's official languages (French, Dutch and German) or English. For this purpose, it is considering the use of simple and user-friendly pictograms.

One of the Working Group leaders is actively collaborating with health colleagues to explore the use and sharing of data collected from all Belgian emergency services. The Enregistrement des urgences project is a real-time, mandatory registration of emergency data in hospitals (Federal Public Service for Health, Food Chain Safety and Environment, 2018), which will allow authorities to trigger a public health emergency as soon as the population starts to experience substantial health effects due to high temperatures or high ozone concentrations, independent of reaching the established temperature and ozone thresholds.

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## **Case study 4. Monitoring of exotic mosquitoes (Belgium)**

### ***Abstract***

The Belgian ministers of environment and public health decided that national cooperation to control exotic mosquitoes and other vectors was necessary. They chose to establish a national working group to control vectors already present and those anticipated owing to climate change, as well as the diseases they could transmit in Belgium, taking into account the competences and responsibilities of the ministries and merging material and human resources.

The working group is used as a platform to discuss and share practices and experiences and, if required, to set up national projects. It aims to identify all government actors involved in this field in Belgium and to clarify processes and procedures. As a first step, working group members decided to tackle the monitoring of exotic mosquitoes, launching a three-year monitoring project to develop national expertise.

### ***Background/problem***

Climate change is a major global challenge that has had and will continue to have a profound impact on the way people live, in vital interaction with the environment. In Belgium a large amount of climate modelling work has already taken place and has provided valuable information. Some of the latest climatic projections forecast:

- a hotter climate, with an increase of temperature in all seasons (1.5–4.4 °C for winter and 2.4–7.2 °C for summer by 2100);
- increased seasonality of precipitation: rainfalls are expected to decrease in summer (by up to 25% by 2100) and increase in winter (by up to 22% by 2100), while results for annual precipitation are contrasting: either a reduction or an increase depending on the model used (National Climate Commission, 2016).

Climate change – through hotter and longer summers, warmer winters and potential increase of annual rainfall – increases the risk of introduction and establishment of exotic mosquitoes, which can be vectors for several diseases. This can lead to the manifestation of autochthonous cases of vector-borne diseases or so-called “tropical diseases” (such as chikungunya, dengue, Zika virus, malaria and Rift Valley fever). Considering the increase in international travel and trade, and the emergence or re-emergence of international disease threats and other public health risks, a standardized monitoring system was deemed necessary.

### ***Local context***

In Belgium several authorities are responsible for the control of vectors and the diseases they transmit, including those for environment, nature, public health, animal health and defence. Exotic mosquitoes are not yet an immediate public health threat, even though cases of autochthonous malaria, for example, have been diagnosed (mostly cases of airport malaria). Exotic mosquitoes (adults, larvae or eggs) were first detected in 2002 and have been discovered since then at different sites across the country, in the Walloon and Flanders regions, mainly near harbours or at locations of companies importing goods from endemic countries (such as used tyre companies and a bamboo company).

Control and eradication campaigns have been carried out and a surveillance network for early detection of exotic mosquitoes in Belgium has been initiated. There are also growing

concerns, among both the government and the general public, about ticks and the diseases they can transmit.

### ***Approach***

Following the discovery of exotic mosquitoes at various sites in Belgium, a coordinated approach between federal, regional and community government administrations to monitor them was deemed necessary by the Joint Interministerial Conference on Environment and Health, and a working group on exotic mosquitoes and other vectors was created under the existing framework of the National Cell Environment-Health. Nature and animal health experts were included to cover the scope of the working group, which was broadened to include all vectors able to transmit diseases, such as ticks. To date, hardly any specific legal frameworks are in place to regulate exotic mosquitoes in Belgium.

The first major action initiated by the working group was the Monitoring of Exotic Mosquitoes in Belgium (MEMO) project, developed in 2016. As experience in this field was lacking within the competent authorities, a call was launched via public procurement for a large-scale monitoring project, covering the entire Belgian territory over a period of three years. The proposal submitted by the Institute for Tropical Medicine and partners was selected and monitoring began in August 2017.

An important objective was to use the ECDC guidelines for the surveillance of invasive mosquitoes in Europe as a basis in the project's development (ECDC, 2012). This focuses on 23 sites where exotic mosquitoes can enter the country (including ports and airports, international roads, used tyre, garden, fruit and vegetable import companies and similar): traps are placed at these sites to attract mosquitoes. During the project points of entry can be changed, depending on needs and information collected (such as passive monitoring data collected via nature organizations). Monitoring is increased when exotic mosquitoes are found. Control and prevention, in turn, fall within the competence of the regional environment authorities in Belgium (Brussels, Flanders and Wallonia regions).

Two training courses for experts at the relevant authorities and a workshop at the end of the project are planned to guarantee knowledge transfer, as well as the usual scientific and other publications. A specific guidance committee, meeting twice a year, has been set up to verify the ongoing work. As the MEMO project is restricted to monitoring, the project coordinator needs to inform the relevant authorities as soon as possible of any discoveries for control.

Within the working group, partners can share their experiences and discuss challenges concerning vectors, such as the prevention and control of exotic mosquitoes; members are also interested in joining forces to monitor ticks. The National Cell Environment-Health also initiated a project concerning eLearning for health professionals in the field of environmental health. The plan is to include information on vectors and the diseases they can transmit, as well as more general information on the health impact of climate change, in the modules to be developed. Where possible, links with other projects and win-win situations are sought and used.

### ***Relevant changes***

In preparation for the MEMO project, the working group collected background information on exotic mosquitoes in Belgium and mapped the responsible actors. The project has its own guidance committee, led by an entomologist from the Flanders region, which is broader than the working group itself as it also includes animal health experts, defence experts and Dutch

mosquito surveillance experts who also hope to benefit and learn from this work. The three-year project will lead to recommendations for a national monitoring scheme and develop national expertise in this field. This should lead to the creation of a national mechanism at the end of the project.

The Flemish community organized a workshop to collect background information for its communication strategy regarding ticks, and a member of the Belgian Antibiotic Policy Coordination Committee presented Lyme disease recommendations to the working group (Belgian Antibiotic Policy Coordination Committee, 2016).

### ***Lessons learned***

Several research projects to monitor mosquitoes in Belgium have been undertaken in the past, but there was no continuity and each project had its own limited scope (by area or mosquito species; animal health versus public health) and duration. As the competent authorities did not have the necessary expertise to set up a monitoring programme required by ministers, establishment of the working group led to the start of the MEMO project via public procurement. Contact with more experienced Dutch colleagues was perceived as helpful during the process.

In setting up the working group and project, members learned that a lot of competent authorities are involved (health, environment, nature, animal health and defence) and that hardly any specific legal frameworks for surveillance and control of exotic mosquitoes are in place. Due to the lack of competence in the field it was difficult to find a leader for the working group, so a rotational one-year chairmanship was initiated, where the chair of the National Cell Environment-Health also becomes chair of the working group. Lack of time of health and environment actors involved in the National Cell is a challenge, however, as this is often added to their already overloaded list of tasks.

To this end, the working group is discussing the coordination and fine-tuning of individual communication actions and considering joining forces to initiate national projects concerning environmental control or to exchange experiences acquired in members' own projects.

Several health actors have already shared their communication strategies on ticks and how to prevent tick-borne diseases. This is an ongoing activity, aiming to avoid releasing contradictory messages to the Belgian public (Leroy, Dupont and Tersago, 2018). Again, a major challenge is the lack of time of members to invest in the working group. Use of social networks to reach young people and creation of a mobile application for risk mapping and notification are being discussed as part of the communication strategy to inform and notify exposed and concerned people.

Finally, the lack of approved biocides to control exotic mosquitoes was identified as a challenge. This will become even more critical in future if the European Commission no longer grants temporary derogations and if the manufacturers of these biocides do not apply for authorization due to the small market.

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## **Case study 5. A heat-health action plan (Croatia)**

### ***Abstract***

In 2012 the Croatian Ministry of Health launched a protocol on procedures and recommendations for heat protection and established a multisectoral Working Group on Heat. The protocol remains in force, and the government is in the process of approving a heat-health action plan prepared by the Working Group on Heat. The core elements and structure of the action plan are designed in line with WHO heat-health action plan guidance.

### ***Background/problem***

It has been proven scientifically that the climate is changing and that this will be related to major health challenges in the coming decades. In Europe adverse effects of climate change on human health are already being observed. With global warming, more and more extreme weather conditions (heat-waves, storms, droughts, floods, fires and similar) are expected, which can lead to various diseases, a lack of food and drinking-water, loss of homes and other impacts. Climate change is expected to increase the frequency and intensity of heat-waves, affecting the health of people across Europe (WHO Regional Office for Europe, 2013).

### ***Local context***

Croatia has experienced heat-waves in the past: Meteorological and Hydrological Service data for Zagreb show an increasing trend in midsummer temperatures from 1900 to 2015, which is particularly intense for the last 25 years. An increasing trend of mean summer maximum temperatures for the period is even steeper.

Climate scenarios for Croatia, according to RCP4.5 (IPCC, 2018), show that summer temperatures will increase, with a maximum air temperature above 35°C (Ministry of Environmental Protection and Energy, 2017). In the near future 3–5 more extremely hot days are expected during summer periods for most parts of northern Croatia, the northern coastline and central Dalmatia. In other parts of Croatia 1–3 more days with these maximum air temperatures are expected. An increase in the number of extremely hot days will be even greater in the middle of the 21st century.

In 2017 the highest air temperatures in Croatia were recorded at the beginning of August Knin: 42.3 °C (10 August 2017) and Kaštela, Split airport: 42.2 °C (2 August 2017). The highest recorded temperature since the beginning of continual meteorological recording and surveillance was recorded in Ploče: 42.8 °C (4 August 1981) and the second highest in Karlovac: 42.4 °C (5 July 1950).

With rising temperatures, the number of interventions of the emergency medical services increased in 2016. According to the Public Health Institute the majority of people who sought medical assistance were between the ages of 19 and 50 years – in the working population – and the most common diagnoses were vertigo, syncope, collapse and cardiovascular and respiratory diseases.

The objectives of the heat-health action plan (Ministry of Health, 2017) were to give health and social care services the capacity to act quickly and responsibly to reduce morbidity and mortality in the event of a heat-wave, especially in vulnerable population groups.

Anticipation and fast response to heat-waves is important because the highest number of deaths occurs in the first two days after the onset of dangerous temperatures and when the

period of dangerous temperatures is prolonged. It is therefore necessary to organize an early warning system, improve the preparedness and efficiency of health care institutions and educate the public about the possible adverse effects of heat-waves and how to avoid them (WHO, 2015).

### ***Approach***

In 2012 the Ministry of Health launched a protocol on procedures and recommendations for heat protection and organized a multisectoral Working Group on Heat, whose tasks were to prepare the health and social services and other bodies – as well as the public – for the hot season and to evaluate their work and results in autumn and recommend changes if needed.

This protocol remains in place while the government is in process of approving the heat-health action plan (Ministry of Health, 2017), prepared by the Working Group with experts from the Croatian Academy of Medical Sciences. The core elements and structure of the heat-health action plan are designed in line with WHO guidance (Matthies et al., 2008; WHO Regional Office for Europe, 2011). This includes advice on the plan's scope and core elements, responsibilities at national and local level for alerting the public once a heat-wave has been forecast, advice on what to do during a heat-wave and recommendations for health professionals.

### ***Relevant changes***

The Meteoalarm system became operational in 2007 as part of EUMETNET (2018). Croatia was a member from its inception and began to contribute data in 2009 when the system was established in Croatia, functioning from 0 May to 30 September. When the Meteorological and Hydrological Service announces a heat-wave in one or more regions of the country, defined by forecasts of maximum and minimum temperatures and their duration, it informs the Ministry of Health, as the overall responsible institution, and the Institute of Public Health, which is the coordinating body for implementation of the heat-health action plan. The Ministry of Health issues warnings and activates levels of response from the Institute of Public Health, which includes providing information and recommendations to the health and social sector at the national and local levels and to the public. The primary focus is vulnerable population groups already identified and listed by the Ministry of Health. The multisectoral Working Group on Heat is responsible for monitoring and surveillance and for evaluation of the results.

### ***Lessons learned***

Implementation of the protocol on procedures and recommendations for heat protection started in 2012. To date, the heat-health action plan has been prepared but not yet approved by the government (Ministry of Health, 2017). Lessons learned based on the implementation of the protocol are that:

- not all health care institutions provide reports on morbidity and mortality during the hot season;
- only weekly and no daily real-time reports on heat-related mortality and morbidity are available;
- limited human capacity is available for the plan's implementation.

Strengthening health protection requires:

- investment in IT;

- better networking by stakeholders;
- awareness among authorities of the limited availability of human capacity;
- preparing health and social care professionals – and the public – for the hot season;
- a free phone line and mobile phone application (desirable).

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## **Case study 6. A masterplan for the implementation of heat-health action plans (Germany)**

### ***Abstract***

The Working Group on Adaptation to the Impacts of Climate Change in the Health Sector, led by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, developed recommendations for heat-health action plans to protect human health, which serve as a masterplan to ensure better protection of public health in Germany during long periods of extremely high summertime temperatures. As a contribution to the national adaptation strategy on climate change for the health sector, the recommendations aim to implement adaptation measures and prevent health consequences associated with extreme heat at the regional and local levels. The goal is to reduce morbidity connected with heat-waves by issuing heat and health warnings, to encourage planning in the relevant sectors, to integrate health into all policies and to raise awareness among the public and health sector workers, as well as to mobilize resources for managing the effects of heat.

### ***Background/problem***

Global climate change has led to more frequent and longer heat events in many regions throughout the world, including Germany (IPCC, 2014). Heat can have adverse effects on human health and heat-waves can pose a problem for the health sector, as identified during the extreme summer heat-wave in 2003 that contributed to over 70 000 premature deaths in western Europe and about 7000 in Germany (Koppe & Jendritzky, 2008; Robine et al., 2008). Aside from climate change mitigation measures, undertaking joint efforts to prevent the impacts of heat on the population can help to counteract these issues.

### ***Local context***

The Federal Environment Agency conducted studies on information about, and adaptation to the health impacts of climate change as a task for environment-related health protection between 2012 and 2015 (UBA, 2015a; 2015b). These revealed that too seldom were clear action requirements and concrete adaptation measures spelt out or implemented in preparation for heat events.

The German health care system has an important role in establishing adaptation, health prevention and response measures to address the health risks related to climate change, such as:

- strengthening existing public health capacities for early detection and adequate response;
- anticipating the consequences of emerging diseases possibly related to climate change;
- raising awareness among the population about the possible links between climate change and health.

### ***Approach***

The aim of the heat-health action plan is to reduce heat-wave-related morbidity and mortality through heat-health warnings, especially for the most vulnerable population groups: elderly, chronically ill or overweight people, infants and children aged up to five years, outdoor workers and those with low socioeconomic status or more vulnerable to the effects of heat-waves because of social factors (profession, education, social isolation and so on) (BMU, 2017).



A Federal Ministry for the Environment, Nature Conservation and Nuclear Safety-led Working Group on Adaptation to the Impacts of Climate Change in the Health Sector was established to give advice to decision-makers at the national, regional and local levels. It was set up in 2012 under the auspices of the National Conference of Environment Ministers, and representatives included German federal and state ministries for health and the environment and various higher federal and state authorities. The main aim of the Working Group was to take stock of, communicate and discuss the possible risks to health in Germany arising from climate change.

In March 2016 a team of authors, led by the Federal Environment Agency, began work on developing recommendations for action. The Working Group compiled general recommendations for drawing up heat action plans to protect human health in 2017 (BMU, 2017): this masterplan was adopted and published in 2017. It should be viewed as a uniform basis for drawing up and establishing coordinated and practical heat action plans tailored to each region; it is directed first and foremost at the federal states. Implementation will largely be carried out in the individual states at the municipal level. Drawing up heat action plans can contribute to an overarching climate change adaptation strategy in the health sector.

### ***Relevant changes***

The masterplan is based on WHO guidance on heat-health action plans (Matthies et al., 2008), including the following eight core elements.

- Lead body and interdisciplinary cooperation: a central coordinating body (the Working Group) is needed with interagency responsibility for introducing a heat action plan in cooperation with other authorities and institutions with different areas of competence.
- Use of heat-alert system: the National Meteorological Service issues heat warnings when high levels of heat are forecast for at least two consecutive days; public authorities and organizations actively introduce measures; and measures are communicated in specific ways according to different levels of heat warning.
- Information and communication: anticipatory planning and acute cases of imminent heat events must be considered separately when communicating heat-related health information, with information kits for different target groups (WHO Regional Office for Europe, 2011).
- Reducing heat indoors: short-term measures include recommendations for behaviour and simple technical possibilities; medium-term measures address building-related cooling options, like installing shutters, wall insulation and creating roof gardens.
- Particular care for vulnerable population groups: these include elderly, isolated, chronically ill or severely overweight people; those in need of care, with febrile illness, with dementia, with thermoregulation problems or taking certain medications; and infants/small children. Distinctions should be made when seeking suitable approaches for communicating health risks related to heat.
- Preparedness for the health and social care system: providing employees in the health and social care system with education and training can help communicate important points regarding proper action during heat-waves. Plans of measures to prepare for heat events will be developed for:
  - retirement and nursing homes
  - facilities for people with physical and mental impairments
  - hospitals, emergency and rescue services
  - schools and kindergartens

- certain workplaces.
- Long-term urban planning and building sector: long-term or costly adaptation measures (building and urban planning measures) in the area of heat protection always need to be weighed up against other interests and should be tailored to each region.
- Monitoring and evaluation of measures: monitoring data is needed in real time for effective evaluation and actions. Data should be collected and further analysed later for exposure–effect correlations. Heat action plans should also be evaluated with a view to making further improvements.

### ***Lessons learned***

In summer 2017 pilot implementation of heat-health action plans in Germany was announced and promoted countrywide at various meetings and conferences. Lessons learned during the process can be summarized as follows.

- Information on the impacts of climate change needs to be translated from the scientific research domain into language and timescales relevant for policy-makers.
- It is very important to acknowledge the need for national data and to recognize the limited human capacity for its implementation.
- All relevant stakeholders need to be involved, but their needs for information may vary.

More broadly, strengthening health security would require:

- maximizing synergies with existing instruments, including heat-health action plans;
- preparing the health and social care sector workforce to respond to health-related consequences of climate change and strengthening health services to address climate-related events in a timely manner;
- promoting consideration of health issues and related responses within other sectors, such as the urban planning, building and transport sectors;
- building capacity in the health and social care sector workforce.

From 2018 the German Environment Agency and Federal Ministry for the Environment, Nature Conservation and Nuclear Safety will keep in touch with federal state governments and the local level to gain regular information about the implementation of any heat-health action plans in general, and about ongoing heat-health-related adaptation actions specifically.

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## **Case study 7. Surveillance of *Aedes albopictus* as part of the IHR (2005) implementation (Germany)**

### ***Abstract***

New invasive mosquito species, as vectors for human pathogens, may contribute to the spread of infectious diseases not currently present in Germany. To detect possible routes of entry for new vector species, mosquitoes were regularly trapped between 2012 and 2016 at previously identified risk locations. These sites were characterized by high volumes of freight and extensive shipment of international goods, including sea, air and inland ports, as well as freight yards and a terminal for freight trains. In addition, numerous rest areas along federal highways, which are characterized by high traffic volumes of freight or passengers from countries in which invasive mosquitoes have already been identified, were investigated. Both the terminal for freight trains from Italy and motorways with tourist traffic from Italy and southern France were found to represent significant points of entry for *Aedes albopictus*.

### ***Background/problem***

Climate changes directly and indirectly influence the development and distribution of pathogen-transmitting arthropods whose developmental cycle mainly takes place in natural biotopes. Increased temperatures could, for example, favour the development of native or exotic mosquito species (short generation sequences) and extreme events such as flooding or prolonged rainfall could create suitable breeding grounds for larval development. New exotic mosquito species could act as vectors of pathogens for infectious diseases not currently endemic in Germany, such as dengue, chikungunya or West Nile virus (Becker et al., 2013; UBA, 2015).

In the context of climate impact research, the distribution patterns of vectorially significant arthropods should be assessed regularly to identify future threats in a timely fashion. Due to globalization and international trade, exotic species are now moved to new areas within short time periods. If suitable conditions are available on site, there is high risk that the new species will become established and spread. Thus, climatic changes pose new potential threats to human and animal health from disease vectors.

In the recent past, various mosquito species have been introduced and become established in Europe, outside their original area of distribution. For example, the Asian tiger mosquito *Aedes albopictus* has been able to become established in temperate zones worldwide within the last 40 years. It is considered the most invasive mosquito species in the world and is a vector of a variety of viruses that are pathogenic for humans (such as chikungunya or dengue) (UBA, 2015). It was the primary vector in several chikungunya outbreaks in Italy and France (2017) and in autochthonous dengue infections in France (2015) and Croatia (2010). This mosquito species is considered extremely adaptable to various climatic conditions.

Surveillance of *Aedes albopictus* contributes to the implementation of the IHR (2005), by not limiting the application of the IHR to specific diseases (WHO, 2016).

### ***Local context***

In the course of its worldwide spread, *Aedes albopictus* has been detected in Germany (Kampen, Schuhbauer & Walther, 2017). Its entry pathways were identified in the framework of this project (Becker et al., 2017). Mosquito population densities were sufficient for local disease outbreaks. Whether disease outbreaks will occur depends on additional factors (such

as climatic conditions, likelihood of introduction of specific virus strains); these are currently being investigated.

### **Approach**

Mosquito catches were performed from May to October at selected sites over a period of four years. The sites were characterized by high volumes and extensive handling of international cargo, such as sea or inland harbours, airports, freight yards and a terminal for freight trains: all were previously identified as risk locations for the introduction of exotic mosquitoes. In addition, numerous motorway service stations, featuring high volumes of freight and passenger traffic from countries in which invasive mosquitoes are already established, were included.

To catch the mosquitoes, each site was equipped with at least one sentinel and several ovitraps. Traps were checked every two weeks. Climatic data were recorded at all locations.

Trapped mosquitoes or eggs were determined by morphological criteria. If invasive species were suspected, eggs were flooded to destroy them and species were determined on the basis of hatched larvae or adult animals. In addition, all invasive mosquitoes as well as damaged specimens that were difficult to assess morphologically, were examined by molecular taxonomic determination methods.

### **Relevant changes**

In the event of detection of *Aedes albopictus*, surveillance measures were extended and control measures introduced (use of *Bacillus thuringiensis israelensis* and physical measures such as the removal of breeding grounds).

### **Lessons learned**

- *Aedes albopictus* is regularly introduced into Germany.
- Significant points of entry are:
  - motorways with tourist traffic from Italy and southern France;
  - terminals for freight trains from Italy.
- Introduction is independent of local climatic conditions.
- *Aedes albopictus* is able to become established in Germany.
- Regular monitoring of at-risk locations is necessary to detect introduction and establishment of *Aedes albopictus* at an early stage.
- Early control measures should be implemented to prevent further spread of *Aedes albopictus* in Germany.

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## **Case study 8. Regional forecast system for the occurrence of rodents (Germany)**

### **Abstract**

Human-pathogenic hantaviruses in Germany are transmitted by small rodents such as bank voles (*Myodes glareolus*) that carry Puumala virus (PUUV). The probability of pathogen transmission to humans is particularly increased in years with a high population density of voles. Variation in their population dynamics is mainly influenced by climate and climate-dependent food availability.

Weather-based prediction models for the occurrence of PUUV-transmitting bank voles and human PUUV incidences were developed. Close correlations of bank vole abundance with weather parameters of up to two previous years were found. This allows predictions about possible population outbreaks of the PUUV rodent reservoir or PUUV epidemics in Germany 0.5–1.5 years in advance.

With regard to changing climatic conditions, such a warning system offers an opportunity to alert health services and the general population in time to take preventive measures and thus to limit the effects of PUUV epidemics on human health.

### **Background/problem**

Rodents are widely distributed and are important vectors for the transmission of infectious diseases to humans, livestock and companion animals. One pathogen causing infectious disease in humans is the hantavirus. According to current knowledge, only a few hantavirus species cause significant human diseases: PUUV is the most important hantavirus of public health concern as it can be transmitted to humans, causing a mild to moderate form of haemorrhagic fever with renal syndrome (Reil, Rosenfeld et al., 2017), by forest-living bank voles (*Myodes glareolus*), which are widely distributed in Europe. High levels of seed production (mast) in beech forests causes an explosion in rodent and stoat populations that is a serious threat to endangered native wildlife. When beech mast occurred, bank voles multiplied and human PUUV infections increased a year later (Reil et al., 2015). An important factor of the transmission pattern within the rodent host population and for human infection risk is the prevalence of the pathogen within the reservoir population (Reil, Rosenfeld et al., 2017). These parameters can be affected by climate change and are highly relevant for public health (Imholt et al., 2015).

Fluctuations in the population size of bank voles are influenced by the food supply provided by oak and beech seeds during mast years, among other factors (Reil et al., 2015). Since acorns and beech nuts are an important source of food for bank voles, mast years often result in an above-average increase in the number of individuals. The occurrence of mast years is obviously influenced by weather parameters, and their frequency is likely to be affected by climate change (Imholt et al., 2015). This could result in negative effects on the human risk of infection by rodent-transmitted diseases, which should be managed with appropriate action.

Thus, weather parameters are highly relevant for developing a prediction model for human PUUV infections in Germany. The so-called “resource-based habitat concept” (RBHC) provides another analytical method for systematically identifying relevant ecological resources (environmental parameters) for the PUUV–bank vole–human system. It focuses on the pathogen itself with a bottom-up approach and investigates potential factors influencing

pathogen transmission between the rodent reservoir and humans, taking into account their functional habitat. The RBHC is a promising way to improve understanding of the associations between the environment and vector-borne diseases.

Especially in endemic areas, increased occurrence of the PUUV rodent reservoir could pose an increased risk of infection for humans. It is therefore necessary to determine the PUUV prevalence within the host populations quickly, to be able to identify the actual infection risk for the general public (Reil et al., 2015).

The aims of the RBHC project were to:

- develop a weather-based prediction model for the population dynamics of bank voles on small spatial scale, including validation of the model on further existing data, collecting data of other institutions (such as forest authorities) and/or if possible on reported numbers of human PUUV infections;
- validate a commercial serological PUUV rapid field test for bank voles for application in Germany (Reil, Imholt et al., 2017).

### **Local context**

In Germany, four hantavirus species have been identified in rodents (Puumala, Tula, Dobrava-Belgrad and Seoul viruses). Recent studies of hantavirus outbreaks revealed a broad geographical distribution and high genetic diversity of PUUV in Germany. The Dobrava-Belgrade virus is transmitted by the striped field mouse (*Apodemus agrarius*) and the Tula virus, with low human pathogenicity, by the common vole (*Microtus arvalis*) and field vole (*Microtus agrestis*).

### **Approach**

Boosted regression tree (BRT) and classification and regression tree (CART) analyses were used to analyse weather parameters for correlation with bank vole abundance, and climate-dependent food availability (beech mast) was included. Further alternative analyses were performed replacing the dependent variable “bank vole abundance” with “human PUUV incidence” at an administrative district level. Again, BRT and CART analyses were used to investigate the influence of weather parameters on human PUUV incidence fluctuations. The proportion of deciduous forest per administrative district was included as a further parameter.

In cooperation with the Université Catholique de Louvain, the RBHC was developed to identify relevant environmental resources (environmental parameters) systematically for PUUV transmission cycles. For this purpose, data were collected on bank vole occurrence or absence, on PUUV infections in the rodent host and on human PUUV infections. A scheme was developed to determine possible associations in the RBHC between functional ecological factors (climate and landscape parameters) and the three levels virus, rodent host and human. In accordance with the RBHC scheme, relevant climate and landscape parameters were selected and compiled in a table, including their potential impact on resources associated with the PUUV per level (virus, rodent host, human). Subsequently, Wilcoxon statistical tests were conducted to compare environmental and landscape parameters between the occurrence and absence of the PUUV reservoir, and between PUUV occurrence and bank vole occurrence, regardless of PUUV infection. Human PUUV cases were analysed using BRTs and resulting predictions of the probability of occurrence were compared with the actual occurrence of human PUUV infections.



To validate the PUUV rapid field test for rodents in Germany, bank voles were caught in 2013–2015 several times a year using Ugglan multiple-live traps. Collected blood samples were first tested with the rapid field test for PUUV antibodies and subsequently by standard laboratory enzyme-linked immunosorbent assay (Reil, Imholt et al., 2017). Results of both methods were statistically compared afterwards.

### ***Relevant changes***

Increasing frequency of tree seed mast in recent decades may trigger population outbreaks of relevant rodent host species more often (Reil et al., 2015). Data on human hantavirus infections have been collected since 2001 when the disease was made notifiable and are now available for analyses.

A predictive model system can be transferred to further German regions. Outcomes of this and other studies are likely to:

- raise awareness among practitioners and authorities, which may lead to an increase in reporting human cases;
- be used to optimize and fine-tune predictive models for human PUUV infections and other rodent-borne disease in follow-up studies;
- be used to develop and present a platform for forecast results.

### ***Lessons learned***

A weather-based prediction model for the population dynamics of hantavirus-transmitting bank voles was developed and validated for northern Germany at an administrative district level. Weather parameters from up to two previous years affected bank vole abundance. All weather parameters relevant for bank vole abundance originated temporally from before the preceding beech fructification. Therefore, it is assumed that these parameters matter for bank vole abundance indirectly, via food availability (Reil et al., 2015).

Furthermore, it could be shown that certain weather parameters from up to two previous years indirectly influenced human PUUV incidence by affecting the abundance of the rodent reservoir via impact on food availability for bank voles (Imholt et al., 2015; Reil et al., 2015).

The RBHC – focusing on the ecology of the pathogen PUUV – allowed researchers to determine ecologically relevant climate and landscape parameters and their effects on the respective resource virus or rodent host. These parameters partially complement each other. The hypothetical impacts of the significant climate and landscape parameters were all confirmed, as was their suspected direction of impact (positive or negative) on the PUUV and/or rodent host. Furthermore, relevant environmental parameters with predictive power for the PUUV infection risk for humans could be detected.

A PUUV rapid field test for bank voles was successfully validated for use in Germany in comparison to standard laboratory methods (Reil, Imholt et al., 2017). The rapid field test showed an efficacy of 93–95% and thus appears to be suitable for a rapid and accurate determination of the PUUV prevalence in bank vole populations during field studies. This enables quick identification of the risk for human PUUV infections and allows appropriate preventive measures to protect human health to be taken.

The findings obtained here can provide the basis for a warning system for human PUUV infections. The weather-based prediction models for bank vole abundance and human PUUV

incidence allow forecasts of possible population outbreaks of the PUUV rodent reservoir or human PUUV epidemics in Germany 0.5–1.5 years in advance on a small spatial scale (administrative district level).

In combination with the findings of the RBHC analyses, the weather-based prediction models developed here could be further adapted in the future to optimize predictive power. The PUUV rapid field test is useful especially when increases of rodent host populations or human PUUV infections are predicted. Regarding changing climatic conditions in the future, such a warning system would offer an opportunity to alert health services and the general population in time to take preventive measures and thus limit possible PUUV epidemics (Imholt et al., 2015).

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## **Case study 9. The Climate Adaptation School (Germany)**

### ***Abstract***

The Climate Adaptation School project was supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Its objective was to develop an interdisciplinary education and training offer for medical professionals, designed to develop and convey a summary of weather- or climate-related health hazards and risks and the possible responses to them, focusing on both preventive and diagnostic-therapeutic aspects. A series of lectures for doctors and nurses was delivered in various locations across Germany; overall, interest in the topic was strong.

In accordance with the project's advisory board, topics were organized for internal medicine and for dermatology/paediatrics, and lectures were offered in the context of different medical congresses. A project extension request was submitted with the intention of deepening the breadth of topics covered and extending the audience.

### ***Approach***

The Climate Adaptation School was designed to transfer knowledge about medical preparedness for and response to weather- or climate-related health risks and impacts rather than meteorological facts. The focus was on population groups that are particularly vulnerable for medical reasons, including certain age groups (such as infants and elderly people), people with existing chronic diseases (such as chronic respiratory and cardiovascular diseases or allergies) and people with limited social protection.

Four main learning objectives were formulated for the training packages: through the lectures and discussions the participants should be able to:

- identify climate change-related health disorders;
- provide appropriate medical assistance for climate- and weather-related health issues;
- respond to climate-related changes in the environment with targeted medical measures, including both preventive and therapeutic measures, in health facilities;
- inform and guide other people.

Speakers were recruited to a large extent within the Charité-University Hospital in Berlin. The content of the programme was agreed with representatives of the Innovation Network of Climate Change Adaptation Brandenburg Berlin. The teams at the Allergy-Centre-Charité and European Foundation for Allergy Research Institute have experience in planning and realizing training events and in project management, including financial management. An advisory board was appointed to guide the scientific focus and practical delivery of the training units.

A series of events, with the purpose of developing and communicating a summary of weather- or climate-related health hazards and risks and the possible responses to them, was offered to medical professionals throughout Germany, including at the Department of Dermatology of the Charité-University Hospital Berlin, covering the following topics:

- temperature extremes: heat and care;
- UV radiation: detection, effect, medical importance;
- diagnosis and treatment of allergic diseases.

An anonymous evaluation of the topics and speakers was very positive and all participants declared their interest in participating in further events. The discussion focused mainly on practical issues, such as drinking enough water in hot conditions.

At the beginning of the project a simple website was set up, containing news about the Climate Adaptation School, the programme and schedule of events; extended abstracts of lectures with PowerPoint slides were also offered online.

### ***Relevant changes***

Despite the positive response to the lectures, it was perceived as difficult to cover all available topics of the Climate Adaptation School for a variety of audiences with specific professional interests. Thus, the advisory board suggested dividing all lectures into two topic areas and integrating the units into other corresponding training areas and events. The lectures were divided into those important for physicians in the field of internal medicine (including modules on infectious disease vectors and infections, chronic respiratory diseases, heart diseases, allergic diseases and temperature extremes: heat as well as cold) and those important for dermatologists and paediatricians (including UV damage, skin diseases under changing weather conditions, climate changes from a paediatric point of view and balanced nutrition for recovery and stabilization of health). All modules were offered as part of training activities in the areas of allergology, internal medicine and dermatology.

All changes were implemented and lectures on the health impacts of climate change and their management were held for physicians in Berlin, Stromberg, Leipzig and Adendorf, and for nurses in Berlin. Overall, approximately 150 physicians participated in the training sessions and demonstrated greatest interest in the topics of climate change and respiratory diseases, pollen and allergies, UV and ozone, and the related practical consequences. The lectures focused on the risks and documented impacts of climate change and the associated medical responses (such as preparation for heat-wave days in doctors' surgeries and hospitals; adaptation of prescriptions, dosage and formulation of antihistamines at the beginning of the specific allergen immunotherapy).

An assessment showed that continuing education for physicians and nurses on the health impacts of climate change as standalone training modules was not in demand. Following extensive consultation with the advisory board, the Climate Adaptation School modules (especially those on UV, ozone, heat and pollen) were offered in the context of congresses in internal medicine, allergology, pneumology and dermatology, with very positive feedback.

To meet the great interest and need of physicians and nurses for capacity-building in the area of health impacts of climate change and their management, it was recommended that the training materials available should be broadened in scope and supplemented. A request for a project extension based on the country's climate change adaptation programme was therefore submitted to the Federal Ministry for Environmental Protection. The aim of the application was to extend the training materials and modules to multiply them in educational settings such as schools, while keeping the topics of climate change and health for physicians, nurses and health care professionals. This would create capacity-building opportunities for more important target groups.

As part of the change in concept and in order to achieve or facilitate wider dissemination of the units of the Climate Adaptation School, the website was newly designed in a professional way, with an added subtitle of "Education on the health effects of climate change", and

relaunched. Its content was substantially expanded to include an eLearning tool, certified by the Berlin Chamber of Physicians, and a knowledge database. The climate change and health website is now a modern platform for knowledge sharing.

The continuing education and training opportunities for medical professionals have been significantly expanded on the website. The most important innovations are:

- eLearning modules on climate change and health, providing practical and scientifically sound online training for physicians and nurses, which is certified as a further education module by the Berlin Chamber of Physicians;
- a knowledge database, in which the vast expertise of the project's scientists is made available to nurses and doctors – including lecture notes, presentations, short summaries and other information materials – in an easily accessible way and free of charge.

The instructions and recommendations for independent, practical decisions in difficult situations (such as heat-waves, flooding, heavy air pollution and so on) need to be developed and made available to health professionals.

### ***Lessons learned***

To include training on the topic of climate change and the risks in broader and larger events, such as congresses for specialized topic areas, is a better strategy for strengthening the area among medical professionals than standalone symposia or other events focusing solely on climate change and health.

Despite the termination of the project, the events planned for 2014 were implemented, to make the most of the experience gained in integrating relevant climate change and health topics into continuing medical education events.

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## **Case study 10. Effects of climate change on human health within the “Planetary Health” vision project (Italy)**

### ***Abstract***

Effects of climate change on human health within the “Planetary Health” vision was an Italian project, implemented by the Ministry of Health and National Institute for Health in cooperation with WHO and the Ministry of Environment. It brought together over 40 Italian health and climate scientists from 12 relevant national institutions in the health, environment and climate sectors to provide substantial scientific recommendations to the 2017 G7 Health Ministerial Meeting. By leading an innovative, science-based approach to the development of the G7 Health communiqué, Italy played a fundamental role in calling attention to the many complex health and environmental issues facing the planet.

Within the framework of the project the first climate and health country profile for Italy was compiled through extensive intersectoral research and analysis. This outlines current strategies to build resilience to climate change in the health sector through education, awareness-raising, integrated surveillance and effective early warning and response systems.

### ***Background/problem***

Climate change directly and indirectly affects the social and environmental determinants of health all over the world – particularly clean air, safe drinking-water, sufficient food and secure shelter.

### ***Local context***

Owing to its geographical features – set in the middle of the Mediterranean basin with longitudinal extension, very heterogeneous environments and climatic zones, post-industrial pollution phenomena and intrinsic hydrogeological and seismic vulnerability, Italy is a living laboratory of climatic and environmental changes (WHO & UNFCCC, 2018). Country model projections clearly present climate hazards that may affect human health.

In 2017 six of Italy’s 20 regions called on the government to declare a state of emergency due to water stress (WHO & UNFCCC, 2018). A recent study of 12 countries and regions concluded that Italy was one of those at highest risk of heat-related mortality around the world (Guo et al., 2014). Research is also taking place into recent outbreaks of mosquito-borne diseases such as West Nile virus and chikungunya in parts of Italy and how the risk is growing of emergence of these types of vector-borne diseases (Rezza et al., 2007; Zehender et al., 2017).

Climate change is intensifying these health threats to the Italian population and the situation is expected to worsen in coming years if urgent action is not taken. Evidence also indicates that agricultural production, food safety, ecosystem biodiversity and ability to manage the pressures of migration will also deteriorate if effective interventions are not put in place. Further, air pollution – a key driver of climate change – continues to be above WHO recommended levels in most major Italian cities, resulting in increased risk of ischaemic heart disease, stroke, chronic obstructive pulmonary disease, other respiratory diseases and lung cancer – often in the most vulnerable populations. Data from the Ministry of Health estimate that an annual average of 30 000 deaths in Italy are attributable to outdoor air pollution. Although significant progress has been made in recent decades in reducing harmful pollutants, continued efforts are necessary.

The number of hot days is projected to increase from about 10 days in 1990 to about 250 days on average in 2100 under a high emission scenario, or to about 75 days if global emissions decrease rapidly (WHO & UNFCCC, 2018).

### ***Approach***

The Effects of climate change on human health within the “Planetary Health” vision project established a multidisciplinary team composed of representatives from 12 relevant institutions in the health, environment and climate communities to deal in an integrated framework with the main thematic climate change-related health impact areas. Tasks focused on studies of the health impacts of environmental degradation and climate change; they were bolstered by components providing advice on national strategies and coordination on climate change actions, and by supporting knowledge on model projections of climate hazards. Components aimed at training (creating a network of sentinel physicians) and communication offered fundamental contributions to improve awareness and to disseminate science-based information about hazards related to climate and environmental health.

The project’s objectives were:

- to strengthen the Italian health perspective in multidisciplinary and intersectoral decisions, aiming to understand and cope with the effects of climate change on the health of humans and of the planet, according to the “Planetary Health” vision (Horton, 2013; Clark, 2015; Horton & Lo, 2015);
- to set up, conduct and follow advice to the 2017 G7 Health Ministerial Meeting in producing the G7 Health communiqué to call attention to complex health and environmental issues affecting human and planetary health;
- to support WHO and the UNFCCC in producing the first joint climate and health country profile for Italy (WHO & UNFCCC, 2018), outlining strategies to build resilience to climate change in the health sector through education, awareness-raising, integrated surveillance and effective early warning and response systems.

### ***Relevant changes***

The initiatives activated by the project are concrete examples of actions working to the WHO renewed workplan on climate change and health (WHO, 2015a) by:

- creating multistakeholder partnerships with health advocates to cope with environmental factors contributing to health risks, such as those associated with changing patterns of infectious diseases, extreme weather events, changes of marine environments and sea level, air, natural water resources, drinking-water, hygiene and sanitation, biodiversity, soil pollution, food safety and security and increased migration;
- raising awareness through sharing professional knowledge and providing and disseminating information on the impacts of climate and environmental factors on health, and on the co-benefits to health of actions aimed at climate change mitigation and building resilience to climate change and environmental degradation;
- using science and evidence-based knowledge as an approach to identify climate and environmental factors potentially aggravating existing health risks and creating new threats in present and medium-term (2030) scenarios – a commitment to strengthen surveillance systems to identify and analyse emerging risks was outlined, along with promotion of use of evidence-based meteorological and climatic early warning systems as a basis to forecast health impacts and risks;

- supporting implementation of a public health response to climate change: intersectoral coordination has been established as the best approach to mitigate climate change and preserve the planet, particularly through CO<sub>2</sub> reduction and sustainable use of available resources to build a more resilient future.

A key outcome of the project was provision of scientific support to the 2017 G7 Health Ministerial Meeting on November 5–6 in Milan, Italy, which focused on identification and promotion of fundamental adaptation actions to address the effects of climate change and environmental deterioration on planetary health.

An important benchmark consisted of gaining commitment of the Ministry of Health of Italy and the National Institute for Health to collaborate with WHO and the UNFCCC on development of a joint climate and health country profile for Italy (WHO & UNFCCC, 2018). The country profile project is a global initiative started in 2015 that works directly with governments and health authorities to develop country-specific evidence on climate and health risks and to track national adaptation and mitigation efforts in the health sector (WHO & UNFCCC, 2015; WHO, 2015b).

The WHO UNFCCC climate and health profile for Italy summarized research and analysis from leading experts around the globe, including over 40 Italian health and climate scientists from 12 national institutions, on the threat of climate change to health outcomes and ecosystems in Italy (WHO & UNFCCC, 2018). It outlines the strategies in place to protect the health of Italian citizens and how health stakeholders must continue to build resilience to climate change in the health sector through education, awareness-raising, integrated surveillance and effective early warning and response systems. The findings of the country profile were presented in a national workshop that concluded the project.

### ***Lessons learned***

The Effects of climate change on human health within the “Planetary Health” vision project was carried out by the Ministry of Health and National Institute for Health in collaboration with WHO and the Ministry of Environment from March 2017 to March 2018.

Lessons learned during the project can be summarized as follows.

- According to the “Planetary Health” vision, the connection of sustainability and health and their effect on climate mitigation should be acknowledged.
- Science and policies need to join forces in the decision-making process and work together towards mitigation of and adaptation to the impacts of climatic and environmental factors on health (Campostrini and Guerra, 2018).
- The health sector should coordinate synergies between different key parties to pursue environmental health preventive actions, aiming at vector control, access to safe water supply and sanitation services and waste management; it should also promote sustainable urban planning.
- Research, education, training and development of key tools in building, validating and disseminating knowledge of interconnected environmental and health issues are pivotal actions to prevent health effects due to climate and environmental changes, and to achieve the objectives of the 2030 Agenda for Sustainable Development and its SDGs (United Nations, 2015).



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## **Case study 11. A national public health and heat prevention action plan for 2016–2020 (Lithuania)**

### ***Abstract***

In Lithuania scientific evidence suggests a significant impact of thermal extremes on health and well-being. A national public health and heat prevention action plan for 2016–2020 was adopted in 2015 by order of the Minister of Health. Its main aims are to raise awareness of heat-related health risks and their prevention among the public, health professionals and teachers; to provide early warnings of heat-waves together with health advice; and to mobilize and coordinate all available resources in a timely manner.

Implementation of the plan is in line with the five objectives defined in WHO's European Regional Framework for Action, which aims to protect health from climate change, and the intention is to make it part of the country's national portfolio for action, to which it committed at the Sixth Ministerial Conference on Environment and Health in Ostrava in 2017.

### ***Background/problem***

Scientific consensus indicates that anthropogenic climate change is likely to cause a range of direct and indirect effects on human health in developed and developing countries (Smith et al., 2014). According to the EM-DAT international database, heat-waves, cold events and storms were the deadliest extreme weather events in 1991–2015 in northern Europe (Guha-Sapir, Below & Hoyois, 2018).

The national health system plays an important role in establishing health adaptation, prevention and response measures to address the health risks related to climate change, and particularly to thermal extremes. Activities accommodate the importance and extent of impacts through thermal extremes on health and well-being and recognize the need for systematic awareness-raising and capacity-building among public health experts.

### ***Local context***

In contrast to the solid evidence base for the association between health and heat in some western European countries, research is scarce in Baltic countries. Various studies suggest a significant impact of thermal extremes on health and well-being in Lithuania (Styra et al., 2009; Liukaityte, 2011; Vaičiulis & Radišauskas, 2014), but to date no research has comprehensively analysed the impacts of heat and cold on mortality in urban settings.

### ***Approach***

A group of environment and health experts from various institutions shared information on existing climate change and health research in order to develop a heat-health action plan. The aim was to provide suggestions and recommendations on how to cope with heat-related impacts on health, representing the needs and expectations of national, regional and local public health authorities.

Implementation of the plan is in line with the five objectives defined in WHO's European Regional Framework for Action, which aims to protect health from climate change (WHO Regional Office for Europe, 2010), and the intention is to make it part of the country's national portfolio for action, to which it committed at the Sixth Ministerial Conference on Environment and Health in Ostrava in 2017 (WHO Regional Office for Europe, 2017).

In 2016, a year after adoption of the national public health and heat prevention action plan for 2016–2020 (Ministry of Health, 2015), and following the interinstitutional action plan on the implementation of the goals and objectives for 2013–2020 of the strategy for the national climate change management policy (Ministry of Environment, 2012), the Heat Impacts Prevention Intersectoral Working Group was established. Its main aim is to prepare for a possible heat-wave and prevent adverse health effects. The Working Group meets before, during and after the warm season (defined as 1 May to 30 September) to follow up and assess progress on prevention. Its operational functions and body of work are regulated.

### ***Relevant changes***

Adoption of the heat-health action plan gave a strong stimulus and commitment to ensure effective prevention of and response to health impacts of heat. The main activities are:

- a mechanism to ensure the timely extreme events warnings and provision of emergency care for vulnerable population groups;
- recommendations for the business sector on how to protect employee health from negative heat effects;
- a pilot testing tool (questionnaires) to evaluate society's perceptions and knowledge of health risks related to climate change, and heat-waves in particular.

The Ministry of Health is the main coordination body with overall responsibility for implementing the heat-health action plan in Lithuania (Ministry of Health, 2015). Successful implementation requires coordinated action between many diverse stakeholders, including the Ministry of Environment, government health and environment institutions, public health experts and community groups.

### ***Lessons learned***

The first formal assessment of the heat-health action plan will take place in 2020. Nevertheless, key lessons were learned after detailed consultations with the members of the Heat Impacts Prevention Intersectoral Working Group in 2016–2017. Three main actions were identified as important for successful implementation of the plan (Table A3.1).

**Table A3.1. Lessons learned, including enabling factors and challenges, key actors and leaders in the process, evidence used and solutions**

Challenge	Key actors and leaders in the process	Evidence used to propose measures	Solutions	Lessons learned
Reaching the general public, particularly at-risk communities	Public health authorities, media, public health specialists in schools	IPCC reports and WHO publications	User-friendly guidelines and a brochure for prevention of health impacts of heat were prepared and disseminated at various events; heat warnings were posted via various communication channels (websites, radio, television, mobile application). Various training courses were organized to improve public health authorities' responses to weather extremes and heat-waves in particular, and to strengthen collaboration among institutions and with the public.	It is essential to raise awareness among the public by providing reliable data on health effects of heat and user-friendly practical recommendations for prevention and response.
Heat-health data collection	Members of Heat Impacts Prevention Intersectoral Working Group, WHO experts and academic research groups	Studies implemented in Lithuania and WHO guidelines, tools	The process of managing heat-health data collection should be streamlined, making it easier to evaluate the heat-health action plan.	It is important to develop relationships with meteorological, environment and health institutions to get access to climate and health information.
Lack of reliable analysis of costs and benefits	Members of Heat Impacts Prevention Intersectoral Working Group, and academic research groups	WHO publications	It is necessary to prioritize economic assessment activities in the national and institutional action plans.	To influence interinstitutional policy decision-makers, it is essential to provide climate change and health costs and mitigation benefits analysis.



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## **Case study 12. Protecting vulnerable population groups during heat-waves (Slovenia)**

### ***Abstract***

Numbers of deaths increase during periods of elevated extreme heat. Researchers from the National Institute of Public Health Slovenia, Medical Faculty of the University of Ljubljana and Slovenian Environment Agency undertook a study to identify vulnerable population subgroups by pre-existing diagnosis, sex, area and age group, to inform public health prevention efforts. Relative risks (RRs) and confidence intervals (CIs) for deaths of the observed diagnoses and excess deaths associated with large-scale Slovenian heat-waves in 2003 and 2015 were estimated, comparing deaths during the heat-waves with reference days. RRs and CIs were also calculated to compare heat-wave deaths between the two years.

In the analysis, only three RRs for deaths during heat-waves were statistically significant in 2015 and only one in 2003. When comparing the number of deaths by population subgroups between these two years, deaths increased statistically significantly in the subgroups “circulatory diseases” and “old age” in 2015 compared to 2003. Public health efforts should thus target these two vulnerable population subgroups.

### ***Background/problem***

Current climate change is predicted to lead to more frequent and more intense extreme weather events, including heat-waves (Meehl & Tebaldi, 2004). At the same time, increased longevity is changing society’s demographics (United Nations, 2013), which is very likely to have a direct impact on population health. Many studies have shown that elderly people are among the most vulnerable in heat-waves (Åström, Forsberg & Rocklöv, 2011).

### ***Local context***

Although Slovenia is a small country in the middle of Europe, it is important to know how heat-waves affect the population’s health. Major heat-waves occurred in Slovenia in the summers of 2003 and 2015, leading to excess deaths.

Understanding which causes of mortality are affected by heat is important for preventing heat-related deaths, particularly in vulnerable subgroups. The goal of the study was to identify vulnerable subgroups by pre-existing diagnosis, sex and age group in order to target public health prevention efforts effectively.

### ***Approach***

The short-term associations between the number of deaths, excess deaths and the large-scale Slovenian heat-waves in 2003 and 2015 were investigated. RRs and 95% CIs for deaths were estimated, stratified according to observed diagnoses (all-cause mortality and diseases of the circulatory, respiratory, endocrine, nervous, digestive and genitourinary systems, as well as neoplasms), sex, age and area. Excess deaths associated with the heat-waves were calculated, comparing deaths during the heat-waves with reference days, and investigating differences in the number of heat-wave deaths between the two years. RRs and 95% CI ratios for all observed population subgroups were also calculated, using similar methodology to that used in earlier studies (Hoshiko et al., 2010).



## **Relevant changes**

During the heat-wave in 2015, 137 excess deaths occurred in the category of total (whole population) all-cause mortality, corresponding to a 7% increase over expected deaths; however, this was not statistically significant (RR = 1.07, 95% CI: 0.99–1.16). Only RRs of heat-wave death for three population subgroups were statistically significant: all-cause mortality in the age group 75+ years (International Classification of Diseases, tenth revision (ICD-10) codes A00–T98) (RR = 1.10, CI: 1.00–1.22); diseases of the circulatory system across all age groups (ICD-10 codes, I00–I99) (RR = 1.14, CI: 1.01–1.30) and diseases of circulatory system in the age group 75+ years (ICD 10 codes I00–I99) (RR = 1.17, CI: 1.01–1.34) (Perčić et al., 2018).

During the heat-wave in 2003, 88 excess deaths occurred in the category of total (whole population) all-cause mortality across all age groups, corresponding to a 6% increase over expected deaths; again, however, this was not statistically significant (RR = 1.06, 95% CI: 0.97–1.15). Only one RR was statistically significant in 2003: circulatory system diseases in females aged 5–74 years (ICD-10 codes I00–I99) (Perčić et al., 2018).

Interesting results were obtained when comparing deaths in all subgroups between the heat-waves in 2003 and 2015: statistically significant higher numbers of deaths occurred in 2015 for circulatory diseases in five population subgroups in all age groups and sexes (RR = 1.25, 95% CI: 1.01–1.55); in males (RR = 1.85, 95% CI: 1.41–2.23); in both sexes in the age group 75+ years (RR = 1.34, 95% CI: 1.07–1.69); in males aged 75+ years (RR = 1.52, 95% CI: 1.03–2.25); and in females aged 75+ years (RR = 1.43, 95% CI: 1.08–1.89) (Perčić et al., 2018).

Elderly people are most susceptible to the health effects of extreme heat (Åström, Forsberg & Rocklöv, 2011) due to physiological changes that occur with ageing, chronic illness, certain medications and sedentary lifestyles that contribute to impaired body temperature regulation and dehydration (Kenney & Munce, 2003). Heat-waves could reveal or aggravate several adverse drug reactions in elderly people using diuretics, serotonergic antidepressants, angiotensin-converting inhibitors, proton pump inhibitors, non-dopaminergic antiparkinsonian medication or anti-epileptics and beta-blockers (Sommet et al., 2012).

People over 70 years of age suffering from cardiovascular disease, pulmonary diseases, long standing diabetes type 1 and 2 and obesity are at increased risk of heat-related stress during heat-waves, as physiological impairments occur in the different thermoregulation mechanisms described. If these mechanisms are known, elderly individuals can be empowered to prevent health effects on days of high heat (with appropriate behaviour, especially fluid intake, and careful medication use).

Social risk factors such as sedentary lifestyles, living alone, social exclusion and reduced mobility can also contribute to an increased risk of adverse health effects of heat. These factors can be influenced with different protective approaches: identifying lonely elderly individuals, providing them with air conditioners or fans, moving them to cool environments during prolonged heat events and controlling their medical situation, as well as warning members of vulnerable populations to increase physiological adaptation factors.

Heat-waves are included on the list of dangerous weather events and the national weather service issues warnings about them. Internet publications are prepared for dissemination of information and advice to the entire population and to vulnerable population groups in

particular (elderly people and patients with circulatory diseases). In addition, countrywide and local television channels, radio stations and newspapers are used to publish useful information about how to cope with elevated temperatures. Primary care centres are aware of the problem and warn chronically ill patients – such as those on antihypertensive drugs, for example – of possible complications.

### ***Lessons learned***

The results of the analysis show that deaths in the most vulnerable population groups – old people and those with diseases of the circulatory system – increased in 2015 compared to 2003. The burden of deaths during heat-waves in these population groups is expected to rise further over the coming years, not only because people are living longer and the burden of chronic noncommunicable diseases is increasing but also because heat-waves are becoming more pronounced in Slovenia. This demonstrates that additional public health interventions are needed to protect vulnerable groups in the event of heat-waves.

For dissemination of information and advice to vulnerable population groups, the use of mass-media campaigns is sufficient in Slovenia due to its small population size and other relevant public health efforts. A series of workshops across the country to increase awareness of the impact of heat-waves on population health will be organized in the future. A study to compare mortality during heat-waves over two decades, in order to identify and assess possible physiological and behaviour adaptation of citizens, is also in preparation.

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## **Case study 13. The sun safety programme (Slovenia)**

### ***Abstract***

Children are more susceptible to environmental threats, including UV radiation, than adults, as they are in a dynamic state of growth, and children's skin is thinner and more sensitive. Even a short time outdoors in the midday sun can result in serious burns; thus, encouraging children to take simple precautions will prevent both short-term and long-term damage, while still allowing them to enjoy the time they spend outdoors (WHO & WMO, 2012). The goal of Slovenia's sun safety programme is to diminish unhealthy excess sun exposure for children and to reduce incidence of skin cancers in adults in the long term.

### ***Background/problem***

Prolonged human exposure to solar UV radiation may result in acute and chronic health effects on the skin, eyes and immune system. A major cause of the rise in skin cancer rates in recent decades is considered to be people's behaviour in the sun. Changes in sunbathing habits and increases in popular outdoor activities often result in excessive exposure to UV radiation. As WHO research has shown, "many people consider intensive sunbathing to be normal; unfortunately, even children, adolescents and their parents" (WHO, 2002), but "acute, irregular and excessive exposure to the sun, mainly during childhood is a major risk factor for melanoma, a malignant cancer of pigment cells in the skin" (WHO Regional Office for Europe & ENHIS, 2009).

Studies of stratospheric ozone recovery forecast that UV radiation levels at the Earth's surface will generally return to pre-1980 levels by the middle of the century and may diminish further by 2100. Higher temperatures in countries with temperate climates, on the other hand, may lead to people spending more time outdoors, resulting in additional UV-induced adverse effects (Smith et al., 2014).

### ***Local context***

UV exposure during childhood contributes significantly to total lifetime exposure. Kindergartens and schools are thus important settings through which to promote education about UV radiation and sun protection.

Slovenia experienced an increasing trend in the average air temperature and duration of solar irradiation in the spring and summer during 1961–2011 (Vertačnik & Bertalaníč, 2017). The country's sun safety programme was developed as a response to alarming epidemiological data on the increasing number of skin cancers received by the National Cancer Registry, and as a response to the fact that the incidence of skin cancer is connected to exposure to UV radiation as well as frequency of sunburn.

### ***Approach***

The sun safety programme, run by the National Institute of Public Health, Association of Slovenian Dermatovenerologists and Society for the Fight against Cancer of the Celje Region, was first piloted in one kindergarten (230 children) in the spring of 2007. In 2008 the programme targeted children in kindergartens throughout the country (National Institute of Public Health, 2014), where they learned about the harmful effects of the sun rays through games – indoor and outdoor activities – setting the basis for natural self-protection. The programme consists of materials and introductory training for representatives of participating kindergartens, as well as the course programme for kindergarten children. It was introduced

in elementary schools in 2010, implemented according to the same principles used in kindergartens. In 2017 it took place in 202 kindergartens (479 different kindergarten units), involving more than 40% of preschoolchildren, and in 122 elementary schools, involving more than 10% of elementary schoolchildren.

The sun protection measures promoted through the programme included:

- taking into account the time of day – organizing outdoor activities to take place before or after a period when the sun has the highest power;
- shade creation (1): searching for existing shade (retreating to a house or beneath a tree);
- shade creation (2): creating shade to withdraw into (for example, opening an umbrella);
- shade creation (3): creating personal shade (wearing suitable headgear, clothing and sunglasses);
- acquainting participants with the correct use of sunscreens, which provide additional protection;
- promoting proper fluid replacement (encouraging drinking-water intake).

By 2017, 302 855 kindergarten children and 104 622 elementary school pupils had participated in the programme. All activities were evaluated to assess their impact on knowledge and behaviour changes in all institutions through questionnaires sent to teachers in kindergartens and schools and to parents of children in kindergartens.

### ***Relevant changes***

The programme's aim is to raise awareness among children and their parents of the importance of proper protection against sun rays and UV radiation in particular. The interventions are intended to contribute to a change in the behaviour of the entire population, and in the long run to reduce incidence of skin cancer in Slovenia. Considering the 20–40-year time-lag between exposure to the sun and onset of cancer, the impact of the project (decreasing incidence of melanoma among adults) is expected to be seen in several decades.

Evaluation of the sun safety programme in 2017 showed the following results.

- The programme has been successfully implemented in kindergartens and elementary schools.
- Teachers noticed, once they implemented the programme, that the principles of UV protection were taken into account by a larger proportion of pupils than in previous years.
- The vast majority of kindergartens comply fully with protection rules throughout the summer.
- Both parents and educators in kindergartens and elementary schools stated that raising awareness of children about natural protection is very important, and this is especially emphasized as the greatest advantage of the sun safety programme.
- Most parents believed that their child gained a lot by joining the programme.
- Most parents declared that implementation of sun protection measures is important for all members of their family.

### ***Lessons learned***

In addition to good knowledge of the problem and availability of at least the basic resources, for implementation of such a comprehensive programme the following are needed:

- defined goals (for the long and short term);

- good intersectoral cooperation (including among representatives of various institutions such as the National Institute of Public Health, dermatologists and participating kindergartens and elementary schools);
- strong project organization;
- knowledge of the principles of education of educators;
- good motivation of educators (teachers and school and kindergarten educators);
- a lot of enthusiasm from the main protagonists in the programme.

In addition to the programme organizers (National Institute of Public Health, Association of Slovenian Dermatovenerologists and Society for the Fight against Cancer of the Celje Region), teachers in elementary schools and kindergartens play a key role, offering exciting new approaches and methods of presenting the issues to the children's age groups in an interesting way.

Recommendations and suggestions are available through prepared working materials for teachers and educators from participating kindergartens and elementary schools, accessible on the website or sent by email, including examples of activities on the topic of sun protection in elementary schools and kindergartens.

Every year optional training is conducted that, in addition to professional contents and guidance for implementation of the programme, also offers an opportunity to transfer knowledge and experiences between individual elementary schools and kindergartens.

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## **Case study 14. Guideline for heat-health action plans (Sweden)**

### ***Abstract***

Preventive health strategies can lower morbidity and mortality caused by heat-waves. The Public Health Agency of Sweden published a guideline to support municipalities, county councils, regions and private health care providers in developing action plans for heat-waves. The guideline highlights important aspects to consider when designing heat-health action plans, and was published together with information to facilitate implementation.

### ***Background/ problem***

Global warming has already demonstrated effects on environment and human health (Smith et al., 2014). Periods of high temperatures are likely to become more common in Sweden in the future: according the Swedish Meteorological and Hydrological Institute they may occur as often as every third to fifth year by the end of the century. Research has shown that warm periods lead to increased morbidity and mortality and that a widespread heat-wave can cause serious consequences for society, not least in view of the population's health.

Extreme heat causes various risks for individuals, depending on their state of health, their capacity and ability to manage the situation and their level of exposure. Those with pre-existing illnesses – such as cardiovascular or respiratory disease – patients taking certain medication, elderly people and children will be particularly affected. It is important that preventive measures to protect the health and well-being of these most vulnerable population groups are defined in advance and pursued in the event of high temperatures (Åström, Forsberg & Rocklöv, 2011; Åström et al., 2015).

### ***Local context***

Studies carried out in Sweden indicate an increase in mortality rates at high temperatures over time (Åström et al., 2013; Åström et al., 2015). The Swedish Meteorological and Hydrological Institute has issued meteorological warnings about high temperatures since 2014, but Sweden did not previously have national recommendations concerning heat-waves and their adverse health effects. A few regional heat-health action plans have been created, but the need for coordinated recommendations and guidance was highlighted as important by several stakeholders.

Health care in Sweden is provided by municipalities, county councils, regions and private health care providers. Heat-health action plans should therefore be established by these organizations and aimed particularly at vulnerable groups, including:

- elderly people (aged 65 years and over)
- people with chronic illnesses
- people with disabilities
- small children and pregnant women
- people on certain medication.

### ***Approach***

In 2017 the Public Health Agency of Sweden published a guideline to support municipalities, county councils, regions and private health care providers in developing heat-health action plans (Public Health Agency, 2017a). The guideline highlights important aspects to consider when developing heat-health action plans to prevent and manage the adverse health effects of heat-waves in the population, in connection with meteorological early warnings.



In support of this work, the Public Health Agency developed information material to support health care providers in their efforts to develop action plans and reduce the health risks associated with heat-waves in the form of films, brochures, advice to various health care professions and a web-based training course (Public Health Agency, 2017b).

### ***Relevant changes***

In 2017 the guideline for the development of heat-health action plans and the information material were evaluated by an external body to assess the effectiveness of the guideline. The evaluation was carried out in three steps: a web-based survey covering all county councils, regions and municipalities and telephone interviews with private health care providers; eight qualitative case studies of municipalities and county councils; and an analysis of the material's strengths, weaknesses, opportunities and threats.

The evaluation shows that the Public Health Agency's material is of high quality, educational and easily accessible, but strategies for more effective dissemination are needed. Due to a limited time frame since launch, the impact of the guideline is hard to evaluate. Less than 60% of respondents to the survey indicated that their organization has an agreed action plan covering heat-waves.

### ***Lessons learned***

The evaluation gives some conclusions on general development measures needed to enhance the health sector's preparedness for and response to heat-waves.

- More stakeholders in Sweden need to note the severity of heat-waves and the associated increased risk of morbidity and mortality.
- More stakeholders should implement or develop heat-health action plans to enhance preparedness for and response to heat-waves.
- More stakeholders should conduct preventive work – for example, by inventorying facilities to ensure that the interior temperatures can be kept low at all times; ensuring that all medical staff and health care workers have relevant knowledge and access to information and checklists, regardless of staffing; and identifying other critical factors relevant to managing a heat-wave in the health care sector.
- A systematic qualitative assessment should be conducted, for example through emergency drills to identify weaknesses and maintain readiness of the heat-health action plans in place.
- Collaboration between stakeholders, including the County Administrative Board, municipalities, regions/county councils and private health care providers, in the alarm chain and relief work should be strengthened.

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## **Case study 15. Portal for Climate Change Adaptation (Sweden)**

### ***Abstract***

The Swedish Portal for Climate Change Adaptation is intended to support society and citizens preparing for climate change impacts. It offers comprehensive information and support within a number of areas and, including details about the effects of climate change, risk management, how adaptation plans can be developed and examples of how climate change adaptation can be integrated into daily work. It also provides information to support both short- and long-term adaptation.

The Portal is the result of cooperation between agencies within the Governmental Agency Network. Each agency is responsible for its own area of expertise; the combination results in a broad spectrum of information.

### ***Background***

The Swedish Portal for Climate Change Adaptation is a multiannual cooperation between agencies within the Governmental Agency Network, which consists of 18 agencies at the national level and the county administrative boards (Swedish National Knowledge Centre for Climate Change Adaptation, 2018). The Network also collaborates with the Swedish Association of Local Authorities and Regions. Participants have joined to facilitate national planning and implementation of climate change adaptation measures. The main purpose of the Network is to increase society's resilience against climate change. It aims to strengthen the capacity of participating government agencies and society by working towards improvements of frameworks and steering instruments. Each agency is responsible for its own area of expertise; the combination results in a broad spectrum of knowledge.

The following government agencies are involved in the Network and the Swedish Portal for Climate Change Adaptation:

- Geological Survey of Sweden
- National Food Agency
- National Veterinary Institute
- Public Health Agency of Sweden
- Sami Parliament of Sweden
- Swedish Agency for Marine and Water Management
- Swedish Board of Agriculture
- Swedish Civil Contingencies Agency
- Swedish County Administrative Boards
- Swedish Energy Agency
- Swedish Environmental Protection Agency
- Swedish Forest Agency
- Swedish Geotechnical Institute
- Swedish Mapping, Cadastral and Land Registration Authority
- Swedish Meteorological and Hydrological Institute
- Swedish National Board of Housing, Building and Planning
- Swedish National Heritage Board
- Swedish Transport Administration
- Swedish Transport Agency

## ***Local context***

The roles and responsibilities of climate change adaptation in Sweden are divided across different levels – from local and regional to national. Collaboration between the different sectoral responsibilities is essential to achieve the adaptation targets.

At the local level the role of the municipalities includes several important activities in which adaptation can and should be integrated. They are responsible for functioning water and sewerage systems, energy and waste facilities, hospitals and health care facilities, schools and welfare. Furthermore, they are responsible for environmental protection and nature conservation, as well as the examination and surveillance of the Environmental Code. Municipal emergency management and civil protection are important features for the development of risk and vulnerability analyses of adaptation strategies. Their responsibility includes both sectoral operational planning and physical planning.

At the regional level the 21 county administrative boards are government agencies commissioned with broad social and environmental responsibility. The regional mission includes an important role in providing support to municipalities for their environmental efforts. The county administrative boards have been responsible for coordinating climate change adaptation within their counties since 2009.

At the national level many central agencies play an important role through their respective sectoral responsibility. About 30 agencies work on prevention, increased competence and knowledge, as well as improved preparedness for disruptions in vital public services. No national agency currently has overall responsibility for climate change adaptation, however.

## ***Approach***

The Swedish Meteorological and Hydrological Institute has managed a national knowledge centre for climate change adaptation since 2014. Its purpose is to collect updated knowledge about vulnerability and climate change adaptation, for which the Swedish Portal for Climate Change Adaptation operates as a tool for disseminating information.

One important aspect of the Portal is to provide good examples and thereby make it easier to practise adaptation at the local and regional levels. The target group for the Portal is currently municipalities and county administrative boards.

## ***Relevant changes***

Participants in the Governmental Agency Network maintain ongoing dialogue to develop cooperation and work models for climate change adaptation of the Network and bring in new participants. The Network also works towards continuous development of the Swedish Portal for Climate Change Adaptation, including collaborations with the Nordic and the EU portals.

## ***Lessons learned***

Collaboration between authorities with different sectoral responsibilities in Sweden is essential to achieve the targets for climate change adaptation – not least in terms of health and climate change. In order to analyse climate change-related consequences and vulnerabilities and to develop adaptation, cooperation is needed between the health and other sectors and functions of society, such as agriculture and livestock farming, veterinary medicine, the water and sewerage sector, the construction sector, urban planning, the transport sector and the energy sector.

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## The WHO Regional Office for Europe

The World Health Organization (WHO) is a specialized agency of the United Nations created in 1948 with the primary responsibility for international health matters and public health. The WHO Regional Office for Europe is one of six regional offices throughout the world, each with its own programme geared to the particular health conditions of the countries it serves.

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