

PROTECTING HEALTH IN EUROPE FROM CLIMATE CHANGE: 2017 UPDATE



Abstract

Current evidence that the climate is changing is overwhelming. Impacts of climate change and variability are being observed: more intense heat-waves, fires and floods; and increased prevalence of food- water- and vector-borne diseases. Climate change will put pressure on environmental and health determinants, such as food safety, air pollution and water quantity and quality. A climate-resilient future depends fundamentally on reducing greenhouse gas emissions. Limiting warming to below 2 °C requires transformational technological, institutional, political and behavioural changes: the foundations for this are laid out in the Paris Agreement of December 2015. The health sector can lead by example, shifting to environmentally friendly practices and minimizing its carbon emissions. A climate-resilient future will increasingly depend on managing and reducing climate change risks to protect health. In the near term, this can be enhanced by including climate change in national health programming and creating climate-resilient health systems.

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Foreword

Health considerations are increasingly on the agendas of sectors and actors addressing climate change. Consideration of climate change warrants a correspondingly prominent place on the health agenda. Evidence about the health impacts of climate change is accumulating, and appreciation of the need to address climate change and the immediate health impacts of unsustainable energy consumption jointly is increasing. In 2008 the WHO Regional Office for Europe published Protecting health in Europe from climate change as part of the World Health Day campaign on climate change. This report updates that publication, drawing on the extensive body of new research and evidence while keeping a similarly easy-to-digest format. It not only presents good examples of health adaptation action but also includes the topic of the beneficial health outcomes – the co-benefits – of greenhouse gas emission reductions. The behavioural changes suggested for transport modes, diet and energy have important benefits for noncommunicable and respiratory diseases.

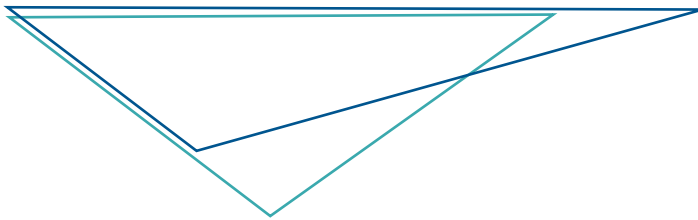
WHO continues to be very active in protecting health from climate change. All WHO Member States approved World Health Assembly resolution WHA61.19 in 2008 and its second workplan for 2014–2019, which urged Member States to develop health measures and integrate them into plans for adaptation to climate change; strengthen the capacity of health systems; promote effective engagement of the health sector and its collaboration with all related sectors; and provide clear direction for planning and investment. Member States are now at various stages of preparing, developing and implementing adaptation strategies and actions and of promoting the co-benefits of mitigation action.

Two major environment and development agreements and frameworks were achieved in 2015. The first was the 2030 Agenda for Sustainable Development, whose 17 Sustainable Development Goals will reflect the achievements in health. The second was the Paris Agreement on climate change reached at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, which includes clear references to the connections between climate change and health. The Paris Agreement refers to health impacts as a central justification for international climate action, national commitments to assess the health implications of climate policies and the identification of health as a priority for climate adaptation.

Research and sharing of information is crucial. In March 2010 at the Fifth Ministerial Conference on Environment and Health in Parma, Italy, all WHO European Region Member States and the European Commission declared a commitment to protect health and well-being, natural resources and ecosystems, and to promote health equity, health security and healthy environments in a changing climate. One detail of the commitments was to strengthen research and development and foster the sharing of information. This was reiterated in 2015 at the High-level Mid-term Review Meeting of the European Environment and Health Process, held in Haifa, Israel.

It remains necessary for the health community to build on these platforms as well as on new commitments to protect health from climate change in the context of the Sustainable Development Goals and Health 2020. Climate change and health was one of the priority areas in the Sixth Ministerial Conference on Environment and Health in Ostrava, Czech Republic, in June 2017. During the Conference participants took stock of the progress made on environment and health in the WHO European Region and committed the Region to further action, culminating in the signing of the Ostrava Declaration. The Declaration is the result of a long and complex consultation process, backed by long-standing intersectoral collaboration. It identifies a key focus on strengthening adaptive capacity and resilience to health risks related to climate change and supporting measures to mitigate climate change. At WHO we hope that this summary of current knowledge on the links between health and climate change will help policy-makers in the health and other sectors.

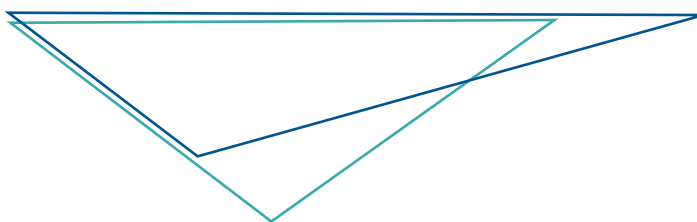
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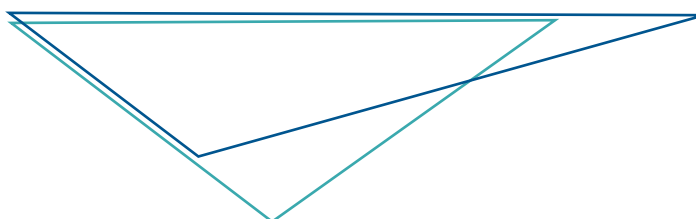
Introduction

Knowledge about climate change and health is growing and is increasingly well communicated. Among other examples, a series of government-approved reports from the Intergovernmental Panel on Climate Change (IPCC) reviewed the evidence and provided summaries for policy-makers; the IPCC's Fifth Assessment Report was published in 2013 and 2014 (IPCC, 2013; 2014a); in summer 2015 the Lancet Commission published a report on climate change and global environmental change (Watts et al., 2015); and in April 2016 the U.S. Global Change Research Program published an assessment of the impacts of climate change on human health (Crimmins et al., 2016). The scientific community has thus gone to great lengths to make the current knowledge available.

This document is an update of the publication *Protecting health in Europe from climate change*, prepared for World Health Day 2008 (Menne et al., 2008). Its target audience is health and environment professionals, civil servants in ministries of WHO Member States and decision-makers on policy development and implementation at the international and national levels. It aims to raise awareness and motivate readers to take and support action to protect health from climate change. Its structure is as follows.

- Chapter 1 outlines the health effects of climate change, focusing on the WHO European Region. It explains the pathways and evidence, as well as considerations of inequalities and social and economic vulnerability, setting out the current knowledge on impacts in different regions, settings and populations.
- Chapter 2 sets out how health benefits can be created through mitigation. It emphasizes the positive effects of mitigation on air quality and health in four areas (transport, energy supply, diet and housing).
- Chapter 3 proposes a championing role for the health sector: leading by example in mitigation and adaptation action. Health systems can implement the mitigation measures introduced in Chapter 2, and further adaptation measures will make the health and other sectors more climate resilient. Chapter 3 also reports on the level of implementation of the European Regional Framework for Action (WHO Regional Office for Europe, 2010b) to protect health from climate change for a range of impacts (heat, cold, flooding, vector-borne and waterborne diseases, food safety, nutrition and allergies).
- Chapter 4 provides a brief conclusion and outlook.

A glossary at the end helps with the terminology.

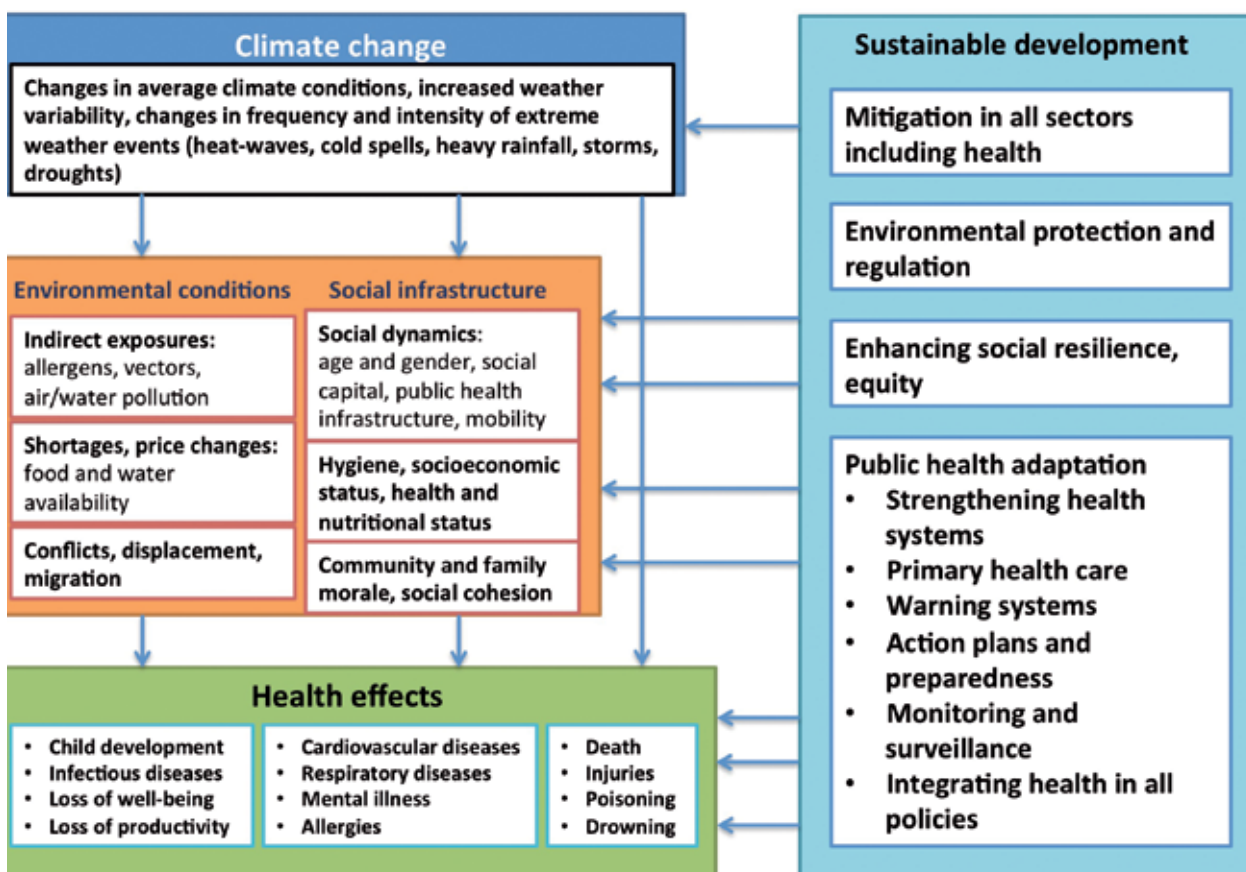


1. The health effects of climate change in the WHO European Region

Climate change affects the health of people in Europe through warming temperatures and changing weather patterns (EEA, 2017). More intense and frequent extreme events and changes in air, water and food (quality and quantity), ecosystems, agriculture, livelihoods and infrastructure affect human health and well-being (Kovats et al., 2014; Vardoulakis & Heaviside, 2012). Challenges for health will increase in the future and exacerbate existing environmental health exposures and risks.

The pathways by which climate change can affect health have been explained in a number of conceptual frameworks (Patz et al., 2000; McMichael, 2002; Confalonieri et al., 2007; Smith KR et al., 2014; Watts et al., 2015). Fig. 1 is a combination and adaptation of these frameworks in line with the topics of this report.

Fig. 1. Pathways of climate change, sustainable development and health



Source: adapted from Smith KR et al. (2014) and Watts et al. (2015).

Climate changes affect environmental conditions and social infrastructure. These determine the health effects, ranging from death to loss of well-being and productivity. Box 1 summarizes the reasons for concern of global warming of only 1–2 °C.

Box 1. Five key areas of concern with additional warming of 1–2 °C

Unique and threatened systems

Some ecosystems and cultures are already at risk from climate change, and the number of unique and threatened systems at risk of severe consequences is expected to increase.

Extreme weather events

Climate change-related risks from extreme events – such as heat-waves, heavy precipitation and coastal flooding – are already moderate and are projected to increase with further warming. Some of these risks, such as those related to extreme heat, increase progressively.

Distribution of impacts

Risks are generally greater everywhere for disadvantaged people, communities and regions. Regional differences in impacts related to climate change are being observed, particularly for crop production.

Global aggregate impacts

Risks of global aggregate impacts, reflecting impacts on both the Earth's biodiversity and the overall global economy, are expected to be moderate under additional warming. Under around 3 °C additional warming, extensive biodiversity loss, with associated loss of ecosystem goods and services and high associated risks, is expected.

Large-scale singular events

The Greenland and Antarctic ice sheets are the largest bodies of ice in the world and play an important role in the global climate system. Both have been losing large amounts of ice at an increasing rate since 1992. The cumulative ice loss from Greenland contributed to global sea-level rise by approximately 10 mm; the corresponding figure for Antarctica to approximately 5 mm since 1992.

Model projections suggest further declines in the future, but the uncertainties are large. The melting of the polar ice sheets is estimated to contribute up to 50 cm of global sea level rise during the 21st century. Very long-term projections (until the year 3000) suggest potential sea-level rise of several metres with continued melting of the ice sheets.

Sources: IPCC (2014b); EEA (2017).

1.1 Health-relevant climate change impacts in the Region

The WHO European Region encompasses a wide range of climates, from the Arctic to the arid regions of central Asia to the Mediterranean (EEA, 2017). As in other parts of the world, the climate is changing in countries in the Region as a result of human activities that have led to the emission of greenhouse gases (IPCC, 2013) (see Fig. 2 and section 1.3 for details). In summary, the trends are as follows.

- It is getting hotter. Across the WHO European Region the number of hot days has increased, with the strongest trends over the Iberian peninsula and southern France (Field et al., 2012). Since 1950, high-temperature extremes (tropical nights and heat-waves) have become more frequent. In eastern Europe, including the European part of the Russian Federation, summer 2010 was exceptionally hot, with an amplitude and spatial extent that exceeded the previous 2003 heat-wave (EEA, 2017).
- Rainfall patterns are changing. Heavy precipitation events are increasing in some regions, with strong regional and subregional variations in these trends (Field et al., 2012; EEA, 2017). Heavy rainfall and changed precipitation patterns (more rain; less snow) can lead to flooding. Flooding occurred in 50 of the 53 countries in the WHO European Region during the past

decade (Menne & Murray, 2013). 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 the Czech Republic, Italy and Poland in 2009 (EEA, 2010); and devastating floods in central and eastern Europe in June 2013 and in the Balkans in 2014 (Guha-Sapir, Below & Hoyois, 2015).

- Ice is melting. Over the period 1992–2011, the Greenland and Antarctic ice sheets have been losing mass. Northern hemisphere spring snow cover has decreased and permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperatures and changing snow cover (Vaughan et al., 2013; Zemp et al., 2015).
- Sea levels are rising. The global ocean will continue to warm during the 21st century, which will lead to a sea-level rise through glacier melting and thermal expansion of the ocean water. The global sea-level rise is projected to be between 0.26 and 0.98 metres by the year 2100, depending on the climate scenario. Shoreline erosion, amplified storm surges and saltwater intrusion are further risks in addition to the permanent inundation (Cazenave & Cozannet, 2014).

Fig. 2. Climate change in the WHO European Region



Source: adapted from Kovats et al. (2014).

Both climate variability and change and climate-related disasters affect security in society. Human security depends on a range of interdependent determinants such as economic and livelihood security, cultural dimensions, migration and mobility dimensions, armed conflict, state integrity and geopolitical rivalry (Adger et al., 2014; Fig. 2). Direct causality and pathways between climate change and violent conflict have not been established so far. There are historical

examples of collapses of past empires, political upheaval and warfare in relation to large-scale climatic disruptions, but caution is recommended in drawing parallel conclusions for today's globalized world or even for the future (Butzer, 2012).

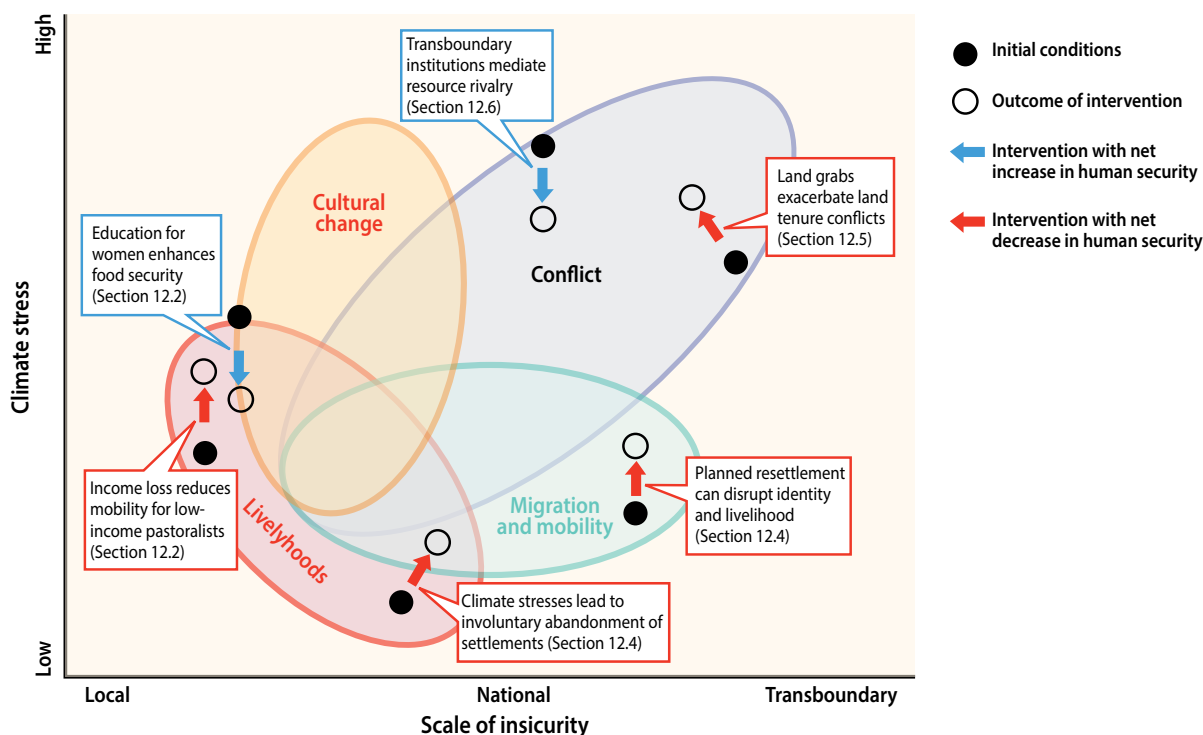
Nevertheless, critical factors that are known to contribute to violent conflict within states, such as low income and social inequality, are sensitive to climate. Violent conflict and its impacts and consequences (such as damage to and loss of infrastructure, institutions, natural resources, social capital and livelihood opportunities, as well as migration) in turn render populations generally more vulnerable, including to climate change (Adger et al., 2014; see Fig. 3).

The IPCC suggests that poverty reduction strategies should consider climate change risks to ensure progress towards health, education, training and access to safe water and sanitation, as well as good performance in other indicators of social and environmental status. The 2014 IPCC report concludes that

“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, 2014b).

Fig. 3. Climate change risks for human security and the interactions between livelihoods, conflict, culture and migration



Notes: interventions and policies are indicated by the difference between initial conditions (solid black circles) and the outcome of intervention (white circles). Some interventions (blue arrows) show a net increase in human security while others (red arrows) lead to a net reduction in human security.

Source: Adger et al. (2014).

1.2 Economic impacts and inequalities related to climate change and health

Climate change exacerbates health and economic inequality. Inequalities are generated through the interaction of climate-related impacts and existing deprivation (Olsson et al., 2014). Climate change may further reduce countries' abilities to achieve the Sustainable Development Goals, which target people, the planet, prosperity, peace and partnership (United Nations, 2015).

Climate change contributes to economic inequality, promotes poverty and slows down economic development in a variety of ways. It has adverse effects on economic growth, as shown by several estimates of gross domestic product (GDP) (Hutton & Menne, 2014; Martinez, Williams & Yu, 2015). It is estimated that global mean losses could be between 1% and 5% of GDP for 4 °C of warming, with substantial regional differences (Pachauri & Meyer, 2007).

Generally, health costs related to climate change can be divided into impact costs and adaptation costs. Impact costs affect the health sector directly through treatment costs and affect the economy and society more broadly in terms of reduced productivity and absence from work. Adaptation costs in the health sector occur through adaptation of health infrastructure, health care facilities and services, such as through the development of preparedness and response plans for extreme weather events and capacity-building measures for health personnel.

Nevertheless, it is estimated that adaptation measures in the health sector will result in savings overall, as seen in the compilation of available cost estimates for the health sector by Hutton and Menne (2014). Providing and weighing estimated damage and adaptation costs is increasingly a prerequisite to receiving financial support for climate change adaptation. The current evidence highlights the following issues.

- Climate-related hazards affect poorer populations – for example, through reduced crop yields, increased food prices and food insecurity. Food price increases and high food insecurity particularly affect poor wage-labour-dependent households that are net buyers of food (Olsson et al., 2014).
- Growing poverty, increased food prices and loss of property and livelihoods have the potential to exacerbate climate change-related health risks, particularly in poor and vulnerable population groups. New poverty pockets may develop with climate change in countries with multiple stresses, chronic poverty, weak institutional support, natural resource dependence, ethnic conflict, political instability, large-scale land conversions and inequitable trade relations (Olsson et al., 2014).
- Conflicts and loss of livelihoods, jobs, homes, property and other economic assets can lead to lack of resources to access health care or shelter (Adger et al., 2014; Olsson et al., 2014).
- Loss of property and livelihoods through extreme weather and disasters can also lead to psychological effects like sleeplessness, anxiety and depression (Cohen et al., 2016).
- Precarious living conditions resulting from loss of livelihoods, jobs, homes, property and other economic assets as effects of disasters and conflicts cause displacement and migration (Olsson et al., 2014).
- Migrant populations travelling to and within Europe appear to be disproportionately at risk of health problems. Austerity measures that lead to cuts in prevention and treatment programmes further exacerbate infectious disease risks among migrants (Kentikelenis et al., 2015).

1.3 Populations, settings and subregions at risk in the WHO European Region

Both climate impacts and physical and social risks in the WHO European Region vary by population group, setting and geographical area. Locations within European subregions and specific settings (coastal, urban and rural areas) determine climate exposures, changes in social, economic and environmental determinants and overall adaptive capacity. Climate change will affect everybody, but some population groups and specific settings are more vulnerable.

Collecting scientific evidence is the first important step in planning policies to protect health from climate change. Comparable scientific assessments should be undertaken, monitoring and documenting the observations and estimations of future impacts to facilitate appropriate adaptation action (WHO Regional Office for Europe, 2015a). At the time of writing, 32 countries in the WHO European Region had carried out vulnerability, impact and adaptation assessments in relation to climate change and 22 countries had developed national adaptation plans that included health aspects (see section 3.2 for details). The data from national studies and global assessments show that in the near future the following can be expected:

- economic, social and health consequences of **lost work capacity** and reduced labour productivity (see section 1.2);
- an increase in the frequency of **respiratory diseases** due to higher concentrations of ground-level ozone, concentrations of particulate matter in urban areas and changes in pollen distribution related to climate change (see sections 2.1 and 3.2.8);
- an increased risk of disease and death caused by more **intense heat and extreme heat-waves**, and a greater risk of injury and death from a larger number of fires (see section 3.2.1);
- modest reductions in cold-related mortality and morbidity in some areas (see section 3.2.2);
- increasing **flood-related health impacts** resulting from heavy rainfall, more snow coming down as rain and sea-level rises (see section 3.2.3);
- changes in **infectious disease patterns** such as vector-borne infectious diseases transmitted through ticks, mosquitoes, rodents and emerging tropical and subtropical species (see section 3.2.4) and foodborne diseases (including *Salmonella* and *Campylobacter* infections – see section 3.2.6);
- an increase in the burden of **waterborne diseases** in populations where water, sanitation and personal hygiene standards are already low (see section 3.2.5);
- geographical shifts in food production and potential **risks to food security and nutrition** in some areas (see section 3.2.7).

The following sections provide details for population groups, specific settings and subregions within the WHO European Region.

1.3.1 Population groups at risk across the WHO European Region

Vulnerability to weather and climate change depends on people's level of exposure, their personal characteristics, their broader social and environmental contexts and their access to resources. Elderly people, children, exposed workers and migrants, for example, are particularly susceptible population groups.

Elderly people are the focus of an increasing number of studies: their vulnerability derives from a complex mix of factors such as multiple chronic diseases, poverty, isolation, household characteristics, lack of access to transportation and other mobility issues (Aubrecht et al., 2013; Watts et al., 2015).

Children, in turn, are particularly vulnerable because of their physiological and cognitive immaturity and their greater potential for long-term exposure. In accordance with the life-course approach, climate-sensitive exposures (such as through extreme weather events, nutrition, water quality and infectious diseases) need to be considered not only during childhood but at all stages of development from preconception (through exposure of the mother) to the fetus, newborn, juvenile child and adolescent (Sheffield & Landrigan, 2011).

Workers are at particular risk at their place of occupation. Heat exhaustion and heat stroke, for example, are the main heat-related health effects that pose a risk to workers in exposed indoor and outdoor occupations. Heat-related health risks increase with the level of physical exertion. Agricultural and construction workers are therefore among the most exposed, but heat stress is also an issue for those working indoors in environments that are not temperature-controlled, a situation that occurs even in high-income countries (Centers for Disease Control and Prevention, 2008; Kjellstrom, Holmer & Lemke, 2009; Schulte & Chun, 2009; Bennett & McMichael, 2010; Dunne, Stouffer & John, 2013).

Some extreme weather events create specific dangers for emergency workers and volunteers, such as fire-fighters, police officers and health care workers. For instance, people fighting wildfires are exposed to extreme heat and toxic fumes, vapours and gases. Those engaged in flood relief run an increased risk of hypothermia, electrocution, drowning and other dangers. Climate-sensitive infectious diseases also pose occupational risks to health workers, which may in turn undermine health protection for the wider population (WHO Regional Office for Europe, 2009). Other mechanisms include elevated occupational exposures to toxic chemical solvents that evaporate faster at higher temperatures and the reduction of sea ice caused by rising temperatures, which increases the risk of drowning among those engaged in traditional hunting and fishing in the Arctic (Ford et al., 2008; Bennett & McMichael, 2010).

Migrants are particularly vulnerable to climate change-related impacts. Climate change is one factor that might trigger forced displacement and migration. Although the health risks associated with climate-related migration cannot be foreseen clearly, the evidence of health outcomes of analogous movements of people indicates that health risks predominate over health benefits. Forced displacement can lead to undernutrition; infectious diseases transmitted through poor sanitation, crowding and lack of health care; food- and waterborne diseases from poor drinking-water quality and sanitation as well as compromised food safety; sexually transmitted diseases; increased maternal mortality; gender violence and mental health disorders. The most common health conditions include diarrhoea, measles, meningitis, acute respiratory infections, tuberculosis, malaria, malnutrition and micronutrient deficiencies. Further, evidence shows that migrants are at higher risk of developing chronic diseases such as cancer, hypertension, coronary heart disease, cardiovascular disease and type 2 diabetes than those in places of origin (McMichael, Barnett & McMichael, 2012). In addition, poor chronic disease outcomes are linked to a lack of access to health care services, including preventive health care and early diagnosis (Rechel et al., 2011).

1.3.2 Settings at risk across the WHO European Region

Rural communities suffer from limited access to services, and coastal and river-dwelling populations are at higher risk from flooding, while urban populations are at risk of multiple exposures.

Coastal and low-lying areas are at risk from climate-related sea-level rise, storm surges, wind and waves, heavy precipitation and increasing seawater temperature and acidity. Flooding, storm surges, increased salinization of coastal land and coastal security, economic consequences of

reduced marine resources and impacts on the shipping industry have all been reported (Wong et al., 2014). Continuation of ocean acidification and warming will increasingly damage marine and coastal ecosystems; for many coastal communities these are the basis for livelihoods such as fishing and tourism. Small islands may be particularly susceptible economically and culturally as a result of marine and coastal ecosystem damage, especially in conjunction with potential falls in tourism levels (Perch-Nielsen, 2010).

Rural communities are at risk of specific health effects of climate change, such as water scarcity, reduced agricultural production, food security and disease transmission. Individuals living in rural and remote areas may be at increased risk of ill health because of limited access to health services and generally higher levels of social and economic disadvantage, depending on the country or region (Smith KR et al., 2014). Farmers and pastoralists with minimal capital in semi-arid regions are particularly vulnerable because of their economic dependence on agriculture and natural resources, low adaptive capacities and geographical locations (Dasgupta et al., 2014). Examples of livelihoods particularly vulnerable to the effects of climate change include rain-fed smallholder agriculture; seasonal employment in agriculture, fishing, pastoralism and tourism; and informal livelihoods and wage labour in poor urban settlements (Olsson et al., 2014).

Overall, 70% of the European population lives in urban areas. Urban climate change-related risks are creating challenges for people indoors and outdoors (Vardoulakis et al., 2015). Health effects have mainly been observed in relation to air quality, water shortages, allergens and heat-waves. The highly urbanized and older populations in other countries in the European Union (EU) are mainly affected by extreme events such as heat-waves and flooding (EEA, 2016). Increased frequency of hot days and warm spells will exacerbate urban heat-island effects, causing heat-related health problems (Revi et al., 2014; Heaviside, Vardoulakis & Cai, 2016). The incidence of asthma may also be affected by climate change-related increases in ground-level ozone exposures (Smith KR et al., 2014).

Synergistic effects of air pollution also increase the health risks associated with high temperatures. One positive result of climate change would be a reduction in cold-related mortality (Ballester et al., 2011; Vardoulakis & Heaviside, 2012) and some degree of adaptation to heat can be expected (Arbuthnott et al., 2016). The changing climate, however, alters ecosystems for infectious disease vectors such as mosquitoes, ticks and rodents, including in urban areas. Emerging or re-emerging infections include, among others, dengue and chikungunya, tick-borne diseases and leishmaniasis (Kovats et al., 2014).

1.3.3 Geographical focus: southern and south-eastern Europe

In southern and south-eastern Europe increasing temperatures and reduced precipitation are bringing new threats to human health. Changing water quantity and quality will have significant effects on the population and will require new and innovative ways of managing limited water sources. An increase in drought makes the Mediterranean Basin regions more vulnerable to longer fire seasons and more frequent severe fires (Fischlin et al., 2007). At the same time, occasional heavy precipitation events can lead to flooding, especially when dry landscapes with scarce vegetation or sealed surfaces lack the capacity to absorb large amounts of rainwater. 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 (Smith KR et al., 2014). Overall, 33 infectious diseases are considered climate-sensitive and relevant in the Mediterranean (Wolf et al., 2013). The threat of dengue in Europe, for example, has increased in recent years, with recently reported dengue cases in Croatia, France and Portugal (WHO Regional Office for Europe, 2014a).

1.3.4 Geographical focus: the Arctic

In **Arctic regions** communities are especially at risk because of their reliance on the physical environment for food, water and infrastructure (Larsen et al., 2014). Physical risks include a reduction in duration of the ice period on rivers and in the extent of sea ice, warming and thawing of permafrost and changes in the distribution and ranges of plant and animal species. These physical changes and changing weather patterns contribute to:

- unsafe hunting, gathering, fishing and travel conditions (leading to physical and mental injuries, death and disease);
- a reduction in numbers of Arctic sea mammals and birds (jeopardizing livelihoods and changing diets);
- compromised traditional food preservation (such as ice cellars and drying);
- damage to health services, water and sanitation infrastructure;
- release of contaminants;
- an expected northward shift of vectors carrying infectious diseases.

In addition to these challenges, however, climate change is also projected to have positive effects on the exposed populations in the Arctic region. For example, winter warming is expected to reduce winter mortality rates and cold-related injuries in northern parts of the Russian Federation, and a prolonged growing season would allow for more diversified farming (Shaposhnikov et al., 2011; Larsen et al., 2014).

1.3.5 Geographical focus: central Asia

In the central Asian region adequate water supply and drought are major challenges (Lioubimtseva & Henebry, 2009; Vörösmarty et al., 2010). Global warming is expected to accelerate glacial melting, which will influence the seasonal patterns of river runoff and contribute to water scarcity. Rapidly growing populations will both be affected by and contribute to water scarcity through increasing per capita domestic water use and more irrigation. An already high level of water stress in many parts of central Asia, combined with projected temperature increases and precipitation decreases in the western part of Kazakhstan, Turkmenistan and Uzbekistan, could exacerbate the problems of water shortages and water distribution (Lioubimtseva & Henebry, 2009). Water shortages are closely connected with food security and the problems of malnutrition, undernutrition and stunting (Smith P et al., 2014). Uzbekistan's agriculture, for example, depends heavily on irrigation and consumes more than 90% of the available water resources of the Amu Darya Basin (Schlüter, Hirsch & Pahl-Wostl, 2010).

Countries like Kazakhstan, however, could also benefit from climate change. The region would probably experience a longer growing season, warmer winters and a slight increase in precipitation, all of which would be beneficial for the country's cereal production. Conversely, other countries – such as Turkmenistan and Uzbekistan – would be negatively affected by climate change: frequent droughts could reduce cotton production, increase water demands for irrigation and exacerbate existing water shortages (Hijioka et al., 2014). In addition to effects on food productivity, changes in climate and extreme weather can exacerbate socioeconomic and political disparities and may add to central Asia's vulnerability to transnational security threats (Jasparro & Taylor, 2008; Lioubimtseva & Henebry, 2009).

1.4 Policy options and strategies

Policies that aim to reduce the effects of climate change on human health – for example, by strengthening health services – may also contribute to reducing poverty and inequalities. Strengthening and adaptation of health services can prevent populations being exposed to climate-related conditions. Universal access to health services is needed to protect poor strata of populations. Specific interventions may become necessary in case of extreme events or disasters (such as vaccination and treatment campaigns). Initiatives to support countries in preventing and protecting populations from adverse health effects of climate change should aim to strengthen existing national health systems rather than set up new structures. An illustrative selection of available frameworks and strategies is summarized below.

The 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (and 169 targets) builds on the Millennium Development Goals and puts people, planet, prosperity, peace and partnership into focus (United Nations, 2015). Health is central to the three dimensions of sustainable development (social, environmental and economic) and to measuring its progress. Progress towards the Sustainable Development Goals 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 the United Nations Framework Convention on Climate Change (UNFCCC) **Paris Agreement** of December 2015, 195 countries adopted the first ever universal legally binding global climate deal (UNFCCC, 2015). The Agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2 °C and to pursue efforts to limit the temperature increase even further to 1.5 °C. The threshold for entry was achieved on 5 October 2016 and the Agreement entered into force on 4 November 2016. The Paris Agreement requires all Parties to put forward their best efforts through nationally determined contributions and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and their implementation efforts. Further, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity-building framework will be put in place within the UNFCCC process, on agreement of the Conference of the Parties, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework. See Chapter 2 for details from the WHO European Region.

Health 2020, 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 includes three priority areas that specifically relate 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;
- creating resilient communities and supportive environments.

All Member States in the WHO European Region approved **World Health Assembly resolution WHA61.19** in 2008, which urged countries to:

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

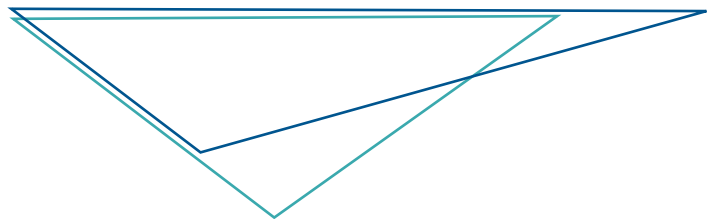
In a similar vein, WHO was requested by the Sixty-first World Health Assembly to develop and implement a first workplan to support Member States in the protection of human health from climate change. In 2014, at the request of Member States, the first WHO **Workplan on climate change and health** was revised (WHO, 2017). The main change is a call for establishment of a partnership “platform” to respond to the increasing number of activities and actors engaged in this field, to put greater emphasis on actions that can improve health while also mitigating the extent of climate change and on promoting the need and providing tools for more systematic provision of country-specific information and monitoring of progress.

In March 2010, at the Fifth Ministerial Conference on Environment and Health in Parma, Italy, all Member States in the WHO European Region and the European Commission agreed to the **Commitment to Act** (WHO Regional Office for Europe, 2010a). This welcomed the **European Regional Framework for Action** entitled *Protecting health in an environment challenged by climate change* (WHO Regional Office for Europe, 2010b). The policy options presented in this report relate to the objectives of the Framework for Action. Progress on environment and health in Europe was evaluated in the Mid-Term Review in Haifa, Israel, with a separate status report on implementing the Framework for Action (WHO Regional Office for Europe, 2015a).

The Sixth Ministerial Conference on Environment and Health, on 13–15 June 2017 in Ostrava, Czech Republic, brought together health and environment ministers and high-level representatives of Member States in the WHO European Region, partner organizations, academia and civil society. Member States committed to strengthen and promote actions to improve the environment and health at international, national and subnational levels through the Ostrava Declaration. Annex 1 of the Declaration (a compendium of possible actions to advance the implementation) highlights the importance of the themes addressed by the Declaration, presents the objectives to be attained with respect to these priorities and proposes actions to achieve them. The overall objective regarding climate change and health is to strengthen adaptive capacity and resilience to climate change-related health risks and support measures to mitigate climate change and achieve health co-benefits in line with the Paris Agreement. Proposed actions are the following.

- Develop and implement a national strategy or action plan for public health adaption 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, non-formal 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 (WHO Regional Office for Europe, 2017a).



2. Creating health benefits through mitigation

To stop the trend of climate change, mitigation measures need to be taken. These are defined as “anthropogenic interventions to reduce the sources or enhance the sinks of greenhouse gases” (Klein et al., 2007). Deep cuts in greenhouse gas emissions to limit warming to 2 °C relative to pre-industrial levels are possible but entail substantial technological, economic, institutional and behavioural changes (IPCC, 2014c). Even with the most stringent global mitigation policies, many climatic changes are projected to intensify over the next few decades, resulting in what has been called the “era of committed climate change” (Field et al., 2014). Scenarios after 2040 – which the IPCC defines as “era of climate options” – largely depend on the number and type of measures taken in the current decade (IPCC, 2014c).

When mitigation interventions yield net social benefits as well as reducing greenhouse gas emissions, these are referred to as “co-benefits” or “ancillary benefits”. Mitigation can result in large near-term and immediate co-benefits for human health and other societal goals (IPCC, 2014c). Reductions in emissions from fossil fuels reduce both air pollution and cardiovascular and respiratory diseases, while safer active transport reduces rates of obesity, diabetes, coronary heart disease, stroke and traffic injuries (Haines et al., 2009; Woodcock et al., 2009). Reducing emissions of so-called “short-lived climate pollutants” (SLCPs) like black carbon and methane would slow the rate of global warming while also saving nearly 2.5 million lives per year globally. The cost savings of the health co-benefits achieved by policies to cut greenhouse gas emissions are potentially large (Watts et al., 2015) and could also reduce noise and related health effects (Gidlöf-Gunnarsson & Öhrström, 2007).

Behavioural and individual lifestyle decisions affect resource and energy demand and thus carbon emissions. In the short term, influencing these decisions is an important cost-effective mitigation strategy and often associated with positive health benefits. Examples are switching to active transport, decarbonizing the energy supply system, choosing local and vegetarian food, low-carbon housing and practising and providing access to family planning (see sections 2.2–2.5).

There is little evidence on how to change behaviour that contributes to climate change. Four themes are described by Watts et al. (2015) as affecting behaviour change.

- Negative emotions such as fear and guilt rather than lack of knowledge can result in passive and defensive behaviour instead of change.
- Linking climate change actions to the core values of individuals brings out positive emotions that may lead to behaviour change.
- Governments and powerful institutions should lead by example.
- Changing unconscious and routine behaviour and habits is very challenging.

Behavioural change is catalysed by public opinion that supports stronger climate action. The public’s knowledge of climate change and health risks is determined by overall knowledge and belief systems (environmental, religious and political). Increasing public knowledge, communication and learning works best with trusted sources. Nevertheless, awareness, perceived importance of environmental issues and experience of climate-related hazards do not necessarily trigger behaviour change (Taylor, Dessai & Bruine de Bruin, 2014; Watts et al.,

2015). Societies rely on a range of infrastructure and assets of modern lifestyle that make it difficult to move away from fossil fuel use. A transition to low-carbon societies requires greater systemic change over time (O'Brien et al., 2012).

Supportive public opinion for action on climate change is important to achieve effective behavioural change (Clements, 2012). Communicating well to the public on climate change issues is challenging, however, because people tend to be more concerned and act upon issues that are closer in time, space and social group, and have high certainty (Taylor, Dessai & Bruine de Bruin, 2014). So-called “fear appeals” only work if messages on options and recommendations about how to address the problem are given at the same time. Positive framing of climate change as an ethical and intergenerational challenge, on the other hand, emphasizes the human capacity and encourages life shaping towards a sustainable future. Institutional barriers to change have to be removed to allow people to move forward (Watts et al., 2015).

Useful means of facilitating behavioural change in the population are non-monetary incentives, information and awareness-raising campaigns, as well as institutional and legal measures. A range of incentives has been used in the past to trigger behaviour change, such as economic, physical and psychological incentives (Watts et al., 2015). The Stern Review considered that a policy framework for carbon dioxide (CO₂) abatement should have three elements: the removal of barriers to behaviour change, technology policy and carbon pricing (Stern, 2006). It is assumed that the technological, investment and behavioural changes required to meet ambitious long-term goals are generally feasible (Watts et al., 2015).

Policy options and strategies for mitigation

The Paris Agreement of 2015 reflects a changing landscape in international climate policy. It renews the emphasis on reducing greenhouse gas emissions (mitigation) and on preparing for and managing current and projected consequences of a changing climate (adaptation). The Agreement formalized countries' commitment to achieve voluntary climate-related policy goals and targets. It entered into effect on 4 November 2016; all 53 Member States in the WHO European Region have signed it and thus far it has been ratified by 41 Member States.

The combined commitment of the 53 Member States is equivalent to reducing overall greenhouse gas emissions in the Region by 26% by 2030, estimated in comparison with baseline emissions in 1990. These commitments are reflected in the official submissions to the Secretariat of UNFCCC as intended nationally determined contributions (INDCs). INDCs reflect countries' ambition to reduce emissions, given their capabilities and circumstances. Some countries also address their intended activities to adapt to climate change impacts (WHO Regional Office for Europe, 2017b). The results of an analysis carried out by the WHO European Centre for Environment and Health showed that 52 of the 53 Member States in the Region had submitted INDCs to the UNFCCC in the context of the Paris Agreement (UNFCCC, 2015) outlining commitments to achieve climate-related policy goals and targets. A review of the INDCs highlights the differences among the WHO European Member States in their concerns about the health risks of climate change, and their plans for preparing for and managing those risks (Box 2).

Globally, about 67% of countries cite health in their INDCs. Systematic approaches to strengthen the climate resilience of health systems are now available, and experience of their application is emerging. New evidence has shown opportunities to improve health while cutting carbon emissions, using carbon credits from international mechanisms, in part.

Box 2. A review of INDCs in the WHO European Region

The process of creating INDCs combines national policy-setting with a global framework that drives collective action towards a low-carbon climate-resilient future. Countries determine their contributions depending on their national priorities, circumstances and capabilities. INDCs reflect each country's ambition for reducing emissions. Some countries in the Region also address how they adapt to climate change impacts in their own or other countries.

A review of INDCs in the Region highlighted the following details.

- No information on health or adaptation was contained in the INDCs from 37 Member States.
- INDCs from five Member States mention adaptation without referring to health systems.
- INDCs from 10 Member States mention health.

The health sector can help integrate health into carbon-cutting policies from inception through intersectoral action, advocacy and leading by example. Most measures and policies to reduce greenhouse gas emissions can benefit human health, if adequately designed and implemented. Carbon-cutting policies that are known to provide health benefits include those that reduce emissions of health-damaging pollutants through changes in energy production, energy efficiency, sustainable transportation and control of landfills, among others. These health benefits may result in economic savings of 0.4% to 1.2% of the Region's GDP (WHO Regional Office for Europe, 2017b). As Member States develop their next INDCs and/or national communications, more will highlight priority sectors for intensified adaptation actions. Ensuring health systems are among the priority sectors is both the responsibility of ministries of health and other organizations and an opportunity to align action on climate change with goals for improving health and well-being.

Implementation of the Paris Agreement provides Member States 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 access to essential services such as energy, water and sanitation;
- identify and promote measures that both reduce climate change and improve health – for example, by reducing air pollution and the environmental impact of the health sector itself.

Besides the Paris Agreement and the mechanisms of the UNFCCC process, specific policy options and strategies are in place in different sectors.

2.1 Health benefits from improving air quality

The quality of the air we breathe affects our health. It contains emissions from motor vehicles, industry, heating and commercial sources, as well as tobacco smoke and household fuels. Outdoor and indoor air pollution harms human health, particularly among those already vulnerable because of their age or existing health problems. Data from the WHO Environment and Health Information System (EHIS), covering 357 European cities in 33 countries, show that in 2009 almost 83% of the population in these cities was exposed to particulate matter (PM) with a diameter smaller than 10 μ m (PM₁₀) levels exceeding WHO guidelines (WHO Regional Office for Europe, 2017c). In the WHO European Region exposure to PM decreases the life expectancy of every person by an average of almost one year, mostly due to increased risk of cardiovascular and respiratory diseases and lung cancer. Furthermore, a recent study using data from 25 cities in the EU estimated that life expectancy could be increased by up to approximately 22 months if

the long-term PM with a diameter smaller than 2.5 µm (PM_{2.5}) concentration was reduced to the WHO guideline annual level in the most polluted cities (Pascal et al., 2013).

Generally, climate factors and climate change affect air pollution via changes in temperature, precipitation and wind patterns, and frequency of heat-waves, droughts, desertification and wildfires (EEA, 2017; Myhre et al., 2013). Many measures to reduce emissions of greenhouse gases and mitigate climate change have benefits for air quality and thus also for health, especially among SLCPs. These persist in the atmosphere for periods ranging from only few days to about a decade but produce strong warming effects and thus are a substantial driving force of climate change. SLCPs include black carbon, methane and ozone; they cause a significant proportion of air pollution-related deaths and diseases that kill some 7 million people per year, globally. Accordingly, reducing emissions of SLCPs can provide direct health benefits from reduced air pollution and related ill health. (WHO, 2015a).

Tropospheric ozone is formed through photochemical reactions with other pollutants in the atmosphere in the presence of sunlight and elevated temperatures (US EPA, 2013). Owing to its highly reactive chemical properties, ozone is harmful to vegetation, materials and human health, and even small increases in atmospheric concentrations of ground-level ozone may affect health (Bell, Peng & Dominici, 2006; Jerrett et al., 2009; Ebi & McGregor, 2008). Exposure to ozone decreases lung function, leading to respiratory hospital admission and emergency department visits, including for asthma. Short-term exposure also has effects on the cardiovascular system (US EPA, 2013). Exposure to ozone is associated with about 21 000 premature deaths per year in 25 Member States in the Region (WHO Regional Office for Europe, 2017d).

Future concentrations of several ambient air pollutants hazardous to health will depend on trends in both emissions of primary and precursor pollutants and meteorological factors that affect the dispersal of pollutants and secondary chemical atmospheric processes. Future climate change may, for example, increase ozone pollution in the Region owing to higher temperatures and weaker atmospheric circulation (Denman et al., 2007). Thus, if temperatures rise, many air pollution models project increased ozone production, especially within and surrounding urban areas (Ebi & McGregor, 2008; Tsai et al., 2008; Chang, Zhou & Fuentes, 2010; Polvani et al., 2011). Ozone concentrations in the United Kingdom, for example, are estimated to increase with a changing climate: modelling of exposure to surface ozone shows that the health burden in the form of attributable deaths and hospital admissions related to ozone is highly sensitive to emissions (Heal et al., 2013). A future reduction in ozone precursors in Europe could also outweigh a projected increase in summertime ozone concentration (EEA, 2017).

The long-range transport of air pollutants – including aerosols, ozone, resuspended dust, mould spores and pollen (see also section 3.2.8 on aeroallergens) and pesticides – is also affected by climate change. Climate change impacts on air quality, particularly in urban areas, are still highly uncertain, however, and may include increases and reductions of certain pollutants (IPCC, 2013). There is little evidence so far that climate change per se will affect long-term PM levels in a consistent way (Myhre et al., 2013).

According to preliminary results from the INDCs tool “Linking carbon reduction to health benefits, version 1.0” in development by the WHO Regional Office for Europe, by 2030 the proposed climate interventions within INDC in the context of Paris Agreement could reduce emissions of PM_{2.5} by 17%, sulfur dioxide by 25% and nitrous oxides by 13% from 1990 levels (WHO Regional Office for Europe, 2017b). A sizeable reduction in annual air emissions would occur across the 28 countries of the EU and the Russian Federation. Together, this block of countries would account for at least 75% of the reduced emissions budget of health-damaging pollutants by

2030. The annual preventable premature mortality from reduced air pollutant emissions in 2030 could be 74 000 deaths in the whole Region, of which 61% (45 100 deaths) would be averted across countries of the EU. The health benefit in the Russian Federation would equal 17% of the avoidable deaths (12 700).

In addition to avoided mortality, improved air quality results in fewer cases of illnesses, including:

- 49 000 fewer hospital admissions
- 1.9 million fewer incidences of asthma attacks
- 350 000 avoided cases of bronchitis in children
- 50 000 fewer cases of chronic bronchitis in adults
- an estimated 17 million fewer lost work days.

The economic cost of reduced health, illnesses and mortality in 2030 is US\$ 277 billion. Put another way, these results would represent between 0.4% and 1.2% of the annual GDP of the 53 Member States in the WHO European Region. The benefit of avoided mortality and morbidity to the EU is 64% of the total savings. Avoided morbidity alone contributes about US\$ 19 billion (WHO Regional Office for Europe, 2017b).

Policy options and strategies for reducing respiratory diseases

Policies to reduce emissions of air pollutants can often offer co-benefits for health in addition to direct benefits of improved air quality – for example, increased physical activity through active transport. Policies aimed at improving air quality are likely to be more beneficial to deprived and vulnerable populations, and as such should be recognized as important public health initiatives. Climate change and energy efficiency policies in turn can also reduce emissions of air pollutants with potential benefits for health and ecosystems (WHO Regional Office for Europe & OECD, 2015). On the other hand, policies to reduce greenhouse gases may adversely affect health. The increased use of diesel fuels and biodiesel to replace petrol can result in increased emissions of and exposure to fine PM, thereby potentially increasing health problems (Krzyzanowski, Kuna-Dibbert & Schneider, 2005).

Several international conventions and agreements provide mechanisms for action. The Convention on Long-range Transboundary Air Pollution, for example, requires full implementation for pollution reduction (UNECE, 1979). In May 2015 the World Health Assembly, the decision-making body of WHO, adopted resolution WHA68.8 on health and the environment: addressing the health impact of air pollution, which urged Member States and WHO to redouble their efforts to protect populations from the health risks posed by air pollution. The resolution recognized for the first time the role of WHO air quality guidelines in providing guidance and recommendations for clean air that protect human health (WHO Regional Office for Europe, 2017e).

The European Commission adopted a clean air package in 2013. It includes the new Clean Air Programme for Europe, with measures to ensure that existing targets are met in the short term and new air quality objectives for the period up to 2030. Support measures to cut air pollution and a revised National Emission Ceilings Directive aim at avoiding 58 000 premature deaths by 2030 compared to business as usual (EC, 2013).

At the national level, reducing the health impact of air pollution related to climate change requires reviewing and strengthening of national policies and programmes on air quality management in accordance with the WHO air quality guidelines. Monitoring PM to assess population exposure is crucial to improve air quality (WHO Regional Office for Europe, 2017e).

2.2 Example 1. Transport: reducing air pollution and promoting physical activity

Transport is an important determinant of health and health equity. The transport sector is the also the second largest source of greenhouse gas emissions in Europe. Its relative share of emissions is increasing, particularly from road transport and aviation. In addition to producing greenhouse gas, motorized transport negatively affects health through outdoor air pollution, lack of physical activity, road traffic injuries and noise (Hosking, Mudu & Dora, 2011).

Road transport is a significant source of outdoor air pollution (Hosking, Mudu & Dora, 2011; Bhalla et al., 2014). For the year 2012, 482 000 premature deaths were attributed to ambient air pollution in Europe (WHO Regional Office for Europe, 2014b). For 2010, the costs of ambient air pollution in Organisation for Economic Co-operation and Development (OECD) countries were estimated at US\$1.6 trillion (WHO Regional Office for Europe & OECD, 2015).

Road traffic injuries are the leading cause of death in the 5–29-year age group. The Bhalla et al. (2014) report on transport for health states that “injuries and pollution from vehicles contribute to six of the top 10 causes of death globally” and that “road injuries have substantial impact on maternal and child health”. Of people dying in road traffic in the European Region, 43% are vulnerable road users (27% pedestrians, 12% users of motorized two- or three-wheelers and 4% cyclists) and 50% are car occupants (Bhalla et al., 2014).

A lack of adequate physical activity is estimated to be associated with about 900 000 deaths per year in the European Region, where about 20–30% of adults are estimated to be obese (WHO, 2009).

Long-term noise exposure is associated with a number of effects on health and well-being. These include not only community responses such as annoyance and sleep disturbance but also physiological effects – for example, on the cardiovascular system. Road transport is the most important source of noise pollution in urban areas (Hosking, Mudu & Dora, 2011).

Policy options and strategies for transport

Increasing the share of alternative, non-motorized modes of transport could alleviate the negative impacts of transport and substantially contribute to better health. Changes in the transport sector have the potential both to reduce greenhouse gas emissions and to protect human health (Hosking, Mudu & Dora, 2011). In the WHO European Region, the transport, health and environment sectors work together under the Transport, Health and Environment Pan-European Programme (THE PEP), building understanding of their interconnectedness while promoting green and healthy mobility to attain a healthier state for all. THE PEP provides an international platform to work across sectors to influence transport policies upstream for better health and environmental results (WHO Regional Office for Europe & UNECE, 2014).

Sustainable transport practices are of critical importance for the protection and promotion of human health. Integrating health and transport concerns can bring mutual benefits: reducing congestion and emissions, moving towards a low-carbon economy and increasing physical activity (Hosking, Mudu & Dora, 2011). For example, a survey in the Netherlands analysed prevalence of walking and cycling in comparison to car use for different trip purposes (including shopping, commuting, chauffeuring and sports). For trips of less than 7.5 km, 44% were made by car, regardless of the purpose. Bicycle use was highest for commuting (47%), falling to 35% for both chauffeuring and shopping. It is estimated that replacing driving with cycling and walking would increase road safety (Scheepers & Heinen, 2013). Walking and cycling integrate

physical activity into daily life and are particularly practicable for groups excluded from other forms of physical activity for economic, social or cultural reasons (Mueller et al., 2015).

Modal shifts towards low-carbon alternatives and active transport can create population health benefits. To encourage such shifts, integrated urban planning and redevelopment of infrastructure to design pedestrian- and cycle-friendly cities, as well as investment in high-speed rail to reduce dependence on short-haul aviation, are needed. Behavioural changes to increase uptake of these low-carbon modes of transport are also required (Sims et al., 2014).

Sustainable transport reduces air pollution exposure and thus the risk of cardiovascular disease, chronic lung diseases and some cancers. In addition, increased physical activity through active transport and reductions in traffic injuries brings health gains. For example, in London, promotion of walking and cycling was estimated to reduce emissions by two fifths (Woodcock et al., 2009). If a combination of walking, cycling and low-emission vehicles were implemented, this would lead to a reduction in emissions by three fifths. Heart disease and stroke could fall by 10–20%, with reductions also in breast cancer (12–13%), dementia (8%) and depression (5%) (Watts, 2009). Combining increased active travel with low-emission vehicles would bring even greater benefits by further reducing air pollution (see Table 1).

Table 1. Health-relevant impacts of greenhouse gas emission reduction measures in the transport sector

Measure	Pathway to potential health co-benefits	Pathway to potential adverse impacts
Reduction of fuel carbon and energy intensity	Reduced urban air pollution – in particular, from use of electricity, hydrogen fuel, compressed natural gas and biofuels For electrified vehicles, significantly less exposure to urban noise, potentially leading to less noise-related stress, mental illness and cardiovascular disease	Increased urban air pollution from use of diesel fuel Reduced road safety (silent electric cars at low speed) No improvement in physical activity or risk of traffic injury No improvement in access for groups without cars
Improved transport infrastructure and modal shift	For non-motorized modes Potential reduction of obesity and risk of diseases related to physical inactivity, including diabetes, cancer and cardiovascular disease From reduced urban noise (modal shift and travel reduction) Reduced stress and sleep-related illness Potential improvements in mental health and well-being	For increased active transport Potentially higher exposure to urban air pollution and traffic for pedestrians and cyclists – if not accompanied by lower levels of car use and investments in safe non-motorized networks
	Other co-benefits Equitable access to services, jobs, education and leisure opportunities – particularly in developing countries Increased road safety (via modal shift and/or infrastructure for pedestrians and cyclists) Less risk of injury	
Journey reduction and avoidance	Reduced levels of air pollution Increased physical activity: through non-motorized transport modes	

Sources: compiled and adapted from Hosking, Mudu & Dora (2011); Woodcock et al. (2009).

2.3 Example 2. Decarbonizing the energy supply system

The energy supply sector, which includes electricity power plants, oil refining and solid fuel manufacture, is the most important source of greenhouse gas emissions in Europe. Energy sector emissions – including energy extraction, electricity generation, transmission and delivery to end users (industry, transport, buildings and agriculture) – currently represent about 35% of total greenhouse gas emissions (IPCC, 2014b).

Energy consumption and choices in Europe have effects on health and the environment, now and in the future. While access to energy has a range of health benefits, most sources of energy such as fossil fuels, nuclear and renewable also carry health risks (Smith et al., 2013). The biggest health impacts are linked to the harvesting and burning of solid fossil fuels, coal and biomass, mainly in the form of occupational health risks, health risks related to indoor air pollution in households and general ambient air pollution. All fossil fuels contribute to global climate change because their combustion releases climate-altering pollutants – principally CO₂, methane, black carbon and ozone precursors. Each energy source and related pollutants have varying direct and indirect impacts on human health and climate change. The revised Global Burden of Disease Study and a comparative risk assessment give updated estimates of the health impacts of household air pollution, outdoor air pollution and other energy-related risk factors globally and by region (Lim et al., 2012).

The health effects of ambient air pollution have been intensively studied in recent years and are relatively well characterized. PM₁₀ and PM_{2.5} are epidemiologically associated with both acute and chronic mortality in urban areas, as well as with increases in hospitalizations and respiratory symptoms and reductions in lung function. In 2010, PM resulted in 3.1 million premature deaths or approximately 3% of the total healthy life-years lost globally due to adult heart disease, stroke, lung cancer and acute lower respiratory infections in children up to the age of 4 years (Lim et al., 2012).

As with coal, combustion of petroleum products yields a range of air pollutants, including CO₂, carbon monoxide, oxides of nitrogen and sulfur, hydrocarbons, PM and metals; secondary ozone formation is also important. The major use of petroleum as transportation fuel and related health impacts have been well studied. Household cooking with solid fuels was estimated to cause approximately 3.5 million premature deaths in 2010 through pneumonia in children younger than 5 years old, and chronic obstructive pulmonary disease, cardiovascular disease, cataracts and lung cancer in adults (Smith et al., 2013).

The potential for health co-benefits from strategies affecting fuel combustion for energy has the highest number of studies. Their effect can be summarized as follows (Smith et al., 2009).

- Increased use of non-combustion sources – such as wind, solar, tidal, wave and geothermal energy – would reduce emissions of warming climate-altering pollutants and health-damaging air pollutants, providing benefits for climate and health (Jacobson et al., 2013).
- Improvements in energy efficiency can reduce emissions of CO₂ and health-damaging pollutants, provided these gains are not outpaced by increases in energy use (Whitmee et al., 2015).
- An increase in combustion efficiency (reducing emissions of incomplete combustion products) will in itself have both climate and health benefits because a number of the products of incomplete combustion are climate-altering and nearly all are damaging to health (Smith & Balakrishnan, 2009).
- Very large health benefits may come from improving household biomass fuel combustion, which in addition could reduce net warming by reducing emissions of aerosols (including black carbon), methane and other climate-altering pollutants produced by incomplete combustion (Myhre et al., 2013).

Policy options and strategies for energy supply

Decarbonizing the energy supply has immediate and future positive effects on health and the environment through reducing emissions of climate-altering pollutants such as CO₂, methane and black carbon, as well as through improving local health (Smith et al., 2013; Watts et al., 2015). Health co-benefits may occur from improving household combustion in poorer populations and reducing energy use associated with transport (Smith et al., 2013).

Decarbonization means significantly reducing the carbon intensity of energy supply, with the aim of achieving greenhouse gas stabilization levels of around 450–530 parts per million CO₂ equivalent by 2100. Low-carbon electricity sources comprise renewable energy (solar, biofuels and wind), nuclear and carbon capture and storage. Their share would need to grow from the current figure of approximately 30% to more than 80% by 2050, and to almost 100% by 2100 (IPCC, 2014c).

Current technological solutions will not be sufficient to achieve the necessary reduction in greenhouse gas emissions from energy supply. Changes in consumer demand and energy use, particularly in high carbon-emitting countries, are also needed. Individual behaviour affects end-user energy efficiency, such as using less energy with high-efficiency heating and cooling systems and more efficient driving practices, for example (Watts et al., 2015).

Globally, economic and population growth continue to be the most important drivers of increases in CO₂ emissions from fossil fuel combustion. Between 2000 and 2010 CO₂ emissions from population and economic growth outpaced emission reductions from improvements in energy intensity. Without additional efforts to reduce greenhouse gas emissions beyond those in place today, emissions growth is expected to persist, driven by growth in global population and economic activities (IPCC, 2014b). Hence, providing improved access to family planning services to a larger proportion of the world's women, especially in high-fertility populations, would reduce population growth as well as child and maternal mortality, and consequently reduce energy demand and climate impact (Smith et al., 2013). It is imperative to transfer technologies within and outside the WHO European Region from more- to less-developed countries to ensure that urgent developmental needs can be met without further contributing to adverse health and environmental effects.

The health sector, health concerns and health benefits can drive the agenda. Health impact assessments of energy choices; mandatory energy labelling of appliances, cars, homes and products; and links with air quality guidelines can help to make the health benefits of decarbonized energy supply more evident and support decision-making.

2.4 Example 3. Dietary choices: reducing emissions and improving health

Meeting the increase of food demand in a sustainable manner and promoting good nutrition is one of the main challenges of the modern age. Food demand is increasingly driven by population, economic growth and urbanization; this trend is expected to continue, reaching a 70% increase in total food demand by 2050 (FAO, 2009). Changes in dietary patterns towards more meat and animal products present a set of complex challenges for climate change mitigation, agriculture and nutrition (FAO, 2009; Tirado et al., 2013). These global trends in meat consumption can have an impact on health (Smith KR et al., 2014) and can also have profound long-term effects on the production, availability and pricing of certain basic food commodities and access to nutritionally diverse food sources (Friel et al., 2009). Promoting more sustainable and healthy diets can contribute to both a reduction in greenhouse gas emissions and improved public health and

nutritional outcomes (Green et al., 2015; Friel et al., 2009; Tirado et al., 2013). Research has shown the following.

- If the population follows a food consumption growth pattern dependent on income across time, then in 2050 the greenhouse gas emission from agriculture and livestock will have increased by 32% compared to 2009 levels (Tilman & Clark, 2014).
- Alternative diets such as Mediterranean (focused on seasonal fruits, vegetables, pulses and fish), pescetarian and vegetarian diets could reduce emissions from food production below those of the projected 2050 income-dependent diet, with per capita reductions. This may contribute to the reduction (relative to conventional omnivorous diets) of incidence rates of type 2 diabetes and cancer, and relative mortality rates from coronary heart disease (Tilman & Clark, 2014).
- According to WHO, diets rich in fruits and vegetables (400 g per day) can save 2.7 million lives by reducing the risks of obesity, heart disease and cancer associated with consumption of red meat and some processed foods (WHO, 2005).
- Although some prepared diets may have lower greenhouse gas emissions, these may also have a high level of sugar and fat content. Solutions should maintain a balance between diet, environment and health. A diet with lower greenhouse gas emissions that reduces risks of noncommunicable diseases is ideal (Tilman & Clark, 2014).

Policy options and strategies for healthy and sustainable diets

Climate-friendly and environmentally sustainable diets tend to be healthier for the individual and allow a more equitable distribution/pricing of food globally. The IPCC's Fifth Assessment Report highlighted the opportunities to achieve co-benefits from actions that both reduce emissions and improve health by shifting consumption away from animal products – especially from ruminant sources – in high-meat-consumption societies and towards less emission-intensive and healthy diets (Smith KR et al. 2014). Furthermore, the framework for action of the Food and Agriculture Organization of the United Nations (FAO) and WHO from the Second International Conference on Nutrition recommends actions for sustainable food systems and promotion of healthy diets (FAO & WHO, 2014). Demand-side interventions aim to encourage a reduction in demand for forestry products, to improve the efficiency of supply chains and to bring about changes in human diets.

The identification of healthy dietary patterns that are sustainable is a first step towards driving consumer behaviour change and demand and supply-chain changes in the WHO European Region. This needs to be supported by consideration of cultural heritage and the inclusion of sustainability criteria in dietary guidelines. The Mediterranean diet traditionally consumed in more than 12 countries in the WHO European Region (including Albania, Croatia, Cyprus, France, Israel, Italy, Greece, Malta, Montenegro, Portugal, Spain and Turkey) has been proposed as a model of sustainable and healthy diet (FAO & CIHEAM, 2012).

Nordic countries, such as Sweden, integrated sustainability criteria in their dietary guidelines: the Nordic Nutrition Recommendations highlighted the environmental impact of dietary recommendations (Clonan & Holdsworth, 2012; Nordic Council of Ministers, 2014). Sustainability has been a widely discussed aspect of nutrition policy for the past decade in countries such as Germany, Sweden and other Nordic countries and the Netherlands, among others. In general, the sustainable dietary guidance from these countries focuses on reducing meat consumption, choosing seafood from non-threatened stocks, eating more plants and plant-based products, reducing energy intake and reducing waste. For example, the Health Council of the Netherlands's *Guidelines for a healthy diet: the ecological perspective* focus on both health and ecological benefits (Health Council of the Netherlands, 2011).

The promotion of sustainable diets, rich in fruits, vegetables and pulses, has been proposed as a strategy to direct consumers' choices towards more sustainable and healthy dietary patterns (Tirado et al., 2013). Policies for promoting sustainable and healthy diets include (among others) economic interventions such as taxation of specific types of food; retailer purchasing guidelines, for example, to restrict consumer choices; public education campaigns such as advertising and programmes in schools; and labelling of products (Foresight, 2011). For instance, public sector incentives for distributors to provide properly labelled food products (including nutritional, carbon and water footprint information and similar) that help consumers achieve their nutritional requirements while meeting environmental goals represent a potential tool to promote sustainable healthy eating patterns in Europe.

Overall, sustainable and healthy diets can be realized by developing a food system that embraces fundamental values such as establishing a culture of healthy living and traditions, embracing equitable solutions, supporting universal food security and encouraging active citizenship to steward natural resources and transparency (Dietary Guidelines Advisory Committee, 2015). These values need to be implemented through coherent policies across the health, nutrition, food, education, agriculture, water, energy, transport and environmental sectors, as well as through robust and transparent private and public sector partnerships. Reducing greenhouse gas emissions in agriculture, water, energy, transport will also decrease the environmental carbon footprint and generate health co-benefits (see Box 3).

Box 3. Promotion of healthy diets to reduce greenhouse gas in the United Kingdom

A general transition to more nutritious diets in the United Kingdom (with fewer processed foods and more fruit and vegetables) could contribute to reduced greenhouse gas emissions and likely reductions in noncommunicable diseases (Green et al., 2015; Milner et al., 2015).

By adopting dietary patterns optimized to conform to WHO dietary guidelines, the greenhouse gas emissions associated with diets would be substantially reduced by 17% in the United Kingdom; this would increase life expectancy at birth by about 8 months, mainly from benefits to coronary heart disease (Green et al., 2015; Milner et al., 2015). Further greenhouse gas emission reductions of around 40% could be achieved by making realistic modifications to diets so that they contain fewer animal products and processed snacks and more fruit, vegetables and cereals (Green et al., 2015).

2.5 Example 4. Healthy and low-carbon housing

Through building construction and the burning of fossil fuels for heating and cooling, residential, public and commercial buildings contribute to greenhouse gas emissions and climate change. Buildings also affect health – for example, through provision of adequate indoor temperatures and good indoor air quality. The design of settlements and urban structures influences transport choices, access to green spaces, social interaction and equity. Thermal stress and uncomfortable indoor temperatures increase the risk of various health outcomes and contribute to excess mortality in both winter and summer. The evidence, in summary, is as follows.

- In the EU buildings are responsible for 40% of energy consumption and 36% of CO₂ emissions. Most of the energy is used for heating and cooling. To reduce energy consumption by building stock significantly, the EU has set a target for all new buildings to be nearly zero-energy by 2020 (EC, 2016).
- An estimated 61 000 premature deaths are attributable to ambient air pollution from residential heating with wood and coal in Europe each year (WHO Regional Office for Europe, 2015b).
- Morbidity and mortality from low temperatures, especially during cold spells, are most common in households that cannot afford to pay for fuel and heating, often in poorly insulated

homes, offices, hospitals and schools (Braubach, Jacobs & Ormandy, 2011). Similar factors affect heat-related impacts: the 2003 heat-wave in Paris had much stronger effects on elderly residents in dwellings with low-quality insulation and increased heat exposure through large window surfaces or locations directly under a roof (Vandentorren et al., 2004).

Policy options and strategies for healthy housing

Reducing the energy consumption of housing stock is considered a promising strategy for climate change mitigation. In the EU, for example, many countries have established national programmes to provide economic incentives for improving heating systems and thermal insulation of building surfaces to adhere to the corresponding EU directive on energy efficiency (EU, 2012). These improvements should reduce energy consumption on heating and cooling and enable households to achieve adequate thermal comfort. It is important to note, however, that sufficient air exchange rates and prevention/limitation of indoor pollution sources should be ensured in highly energy-efficient buildings to protect indoor air quality and prevent undesired health impacts (Röbbel, 2011; Davies & Oreszczyn, 2012). Opportunities to merge healthy housing objectives with reduced energy consumption requirements include the following (see also Table 2):

- fuel switching away from coal and other solid fuels towards especially clean and renewable energy sources;
- more efficient heating and cooling technologies;
- low-emitting indoor equipment and amenities;
- filters to reduce health effects from indoor air pollution;
- regulatory measures (such as eco-design or labels);
- financial incentives to support fuel switching and technology change-out;
- education campaigns.

Table 2. Health-relevant impacts of greenhouse gas emission reduction measures in the building sector

Measure	Potential health co-benefits	Potential adverse impacts
Changes in residential behaviour to reduce energy consumption	Less outdoor air pollution Improved indoor environmental conditions	Inadequate indoor temperatures or insufficient ventilation when energy saving becomes the exclusive objective
Switching to clean fuels and technologies	Less outdoor air pollution Improved indoor environmental conditions Less risk of injury Improved kitchen hygiene	Investment costs for equipment and devices leading to equity concerns
Thermal retrofits of existing buildings and energy regulations for new buildings to reduce energy consumption	Less outdoor air pollution Improved thermal comfort Reduced energy bills and release of household budget	Buildings that are too air-tight; insufficient ventilation potentially leading to accumulation of indoor pollutants Risk of overheating in summer Investment costs for energy efficiency features leading to equity concerns
Increased energy efficiency of building technology, systems and applications	Less outdoor air pollution Improved thermal comfort Reduced energy bills and release of household budget	Investment costs for building technology leading to equity concerns

Sources: Röbbel (2011); Smith P et al. (2014).



3. Leading by example: mitigation and adaptation in the health sector

Health systems are defined as “all the activities whose primary purpose is to promote, restore and/or maintain health; the people, institutions and resources, arranged together in accordance with established policies, to improve the health of the population they serve, while responding to people’s legitimate expectations and protecting them against the cost of ill health through a variety of activities whose primary intent is to improve health” (WHO, 2011b). They are fundamental to achieving and maintaining societal health and welfare, as well as key components for development and economic growth. Health systems can prevent and control communicable and noncommunicable diseases, and can also improve the social, economic or environmental conditions in which people live (WHO, 2007; WHO Regional Office for Europe, 2008).

The volume of health system activities, along with a high consumption of resources and energy and unconventional waste streams, gives rise to concerns about environmental sustainability in general, and specifically about greenhouse gas emissions (Chung & Meltzer, 2009; Hazeldine et al., 2010; LCB HEALTHCARE, 2011; EcoQUIP, 2017). Both adaptation to climate change and action to reduce greenhouse gas emissions require the active engagement and support of different sectors of government, the economy and civil society (WHO, 2015b). The health and health care community is perceived as influential and trustworthy. It can help avert the effects of climate change and can lead by example towards creating a healthier, more sustainable, low-carbon future.

The following sections show how the health sector can lead by example in mitigation (section 3.1) and sets out the state of art in health adaptation to climate change (section 3.2, with several subsections on adaptation to protect health from extreme weather events such as heat, cold and floods, as well as food security, food safety, infectious diseases and allergens).

3.1 Mitigation: low-carbon and environmentally sustainable health systems

Health systems represent a large segment of national economies in Europe. In the 28 countries in the EU, for instance, health expenditure in 2012 represented an average of 8.7% of GDP (OECD, 2014) and 8–10% of GDP in the WHO European Region (WHO Regional Office for Europe, 2016). Hospitals and health systems, particularly in more industrialized settings, account for around 10% of GDP and have a significant carbon footprint; thus, the health sector can contribute its share to emission reduction (Watts et al., 2015).

While the full extent of health care’s climate impacts is not known, emerging data confirms its significance and the need for mitigation strategies. The National Health Service (NHS) in England, United Kingdom, for example, calculated its carbon footprint at more than 18 million tonnes of CO₂ each year, representing 25% of total public sector emissions (NHS Sustainable Development Unit, 2009). Of the NHS’s carbon footprint, 72% is related to procurement and the remainder split between travel and energy use in buildings (NHS Sustainable Development Unit, 2014).

The cost savings and health co-benefits achieved by policies to cut greenhouse gas emissions are potentially large. This is particularly important in a context where efficiency is of paramount importance in tackling growing health care costs and constrained resources. Strengthening public health, environmental and occupational health services may relatively reduce the need for curative and rehabilitative health services, and in turn the associated environmental impacts, including greenhouse gas emissions (see Box 4).

Box 4. Environmentally sustainable health systems in Europe

A general transition to more nutritious diets in the United environmental impact of health systems in Europe, the potential benefits of fostering environmental sustainability in health systems and the barriers to and incentives for such action.

The evidence is clear that health systems have a considerable impact on the environment, contributing to greenhouse gas emissions and climate change, releasing ecologically toxic substances into the environment, producing large volumes of waste material and contributing to the depletion of natural resources such as drinking-water. Nevertheless, health systems also have positive environmental effects, particularly as a result of environmental health protection and some health promotion activities.

Overall, the evidence reviewed in this report illustrates the compelling rationale for fostering environmental sustainability in health systems.

Source: WHO Regional Office for Europe (2016).



Policy options and strategies for low carbon and environmentally sustainable health systems

Energy consumption and greenhouse gas emissions within health systems come from a number of sources, including buildings and health care facility infrastructure; health system-related transport; and procurement of services, food, medical devices, medicines and health commodities. The health sector and its facilities can adopt basic measures to reduce their overall environmental impact – for example, by reducing toxic waste, using safer chemicals and purchasing eco-friendly products. The sector can demonstrate leadership and responsibility in dealing with climate change by acting to reduce its own carbon footprint: interventions can both reduce greenhouse gas emissions and save costs (Energy4Health, 2014; RES-Hospitals, 2014). Framed within a wider approach to overall environmental sustainability, and integrated into the core health systems functions (governance, service delivery, resource generation and financing), various actions (see examples below) can improve environmental sustainability and reduce greenhouse gas emissions in health systems (WHO Regional Office for Europe, 2015c).

The overall objective of implementation of the Ostrava Declaration is to build the environmental sustainability of health systems and reduce their environmental impact through, inter alia, efficiency in the use of energy and resources, sound management of medical products and chemicals throughout their life cycle, and reduced pollution through safely managed waste and wastewater, without prejudice to the primary mission of health systems to promote, restore or maintain health (WHO Regional Office for Europe, 2017a).

A collection of strategies to reduce greenhouse gas emissions in the health sector is presented below. These include capacity-building for staff; models of care; use of public and non-motorized transport; local sourcing of food and other goods and services; and management of resources, with specific measures for health care buildings.

The health workforce can be engaged as agents of low-carbon, environmentally sustainable and resilient health systems through clear policies, capacity-building, adequate motivation and ensuring that staff development and performance management processes support this shift. Further, the greenhouse gas implications of innovative **models of care** should be evaluated in relation to:

- changes in emphasis on levels of care;
- coordination of care;
- access to care and universal health coverage;
- innovative technologies, including telemedicine, use of electronic or mobile phone means to deliver health-related information, resources and services (eHealth and mHealth);
- changes in clinical guidelines or standard operating procedures.

Opportunities to promote local environmental and social assets include promoting and enabling the use of public and non-motorized transport (such as cycling and walking) for patients, visitors and staff by:

- setting up agreements with local transport operators;
- organizing reduced fees for public transport;
- providing parking facilities for bikes;
- ensuring that travel infrastructure and logistics are resilient to extreme weather events;
- placing health care facilities at locations easily accessible by public transport and active mobility.

Another opportunity is the local sourcing of food and – where feasible and appropriate – other goods and services, although a greenhouse gas emissions evaluation should precede any such decision if based on carbon considerations. Opportunities to engage in sustainable, low-carbon procurement include:

- using health systems' purchasing power to maximize positive environmental outcomes, including greenhouse gas emission reductions;
- reducing demand by looking for opportunities to buy and use less;
- increasing efficiency in use through buying products, equipment or services that consume less and have a lower environmental impact through their "in-use" life and disposal;
- substituting and innovating – assessing the environmental impact of products and services used or delivered by the health system.

Careful use and management of resources should be ensured. In buildings, actions include:

- aiming to minimize carbon emissions from the extraction of raw materials used for construction and later during the construction itself;
- improving elements of building design such as site location, lighting, ventilation, open green spaces and architectural flow;
- improving insulation, use of natural ventilation, energy-efficient lighting or installation of combined heat and power systems throughout the useful life of the building;

- decreasing electricity wastage by reducing unnecessary usage, increasing efficiency and understanding where energy supply resilience can be improved.

Further resource management measures, beyond those in health care buildings, include the following.

- Water management can be improved by developing water safety plans for health care facilities, reducing water usage and ensuring responsible disposal of wastewater.
- Waste should be minimized and managed in line with the “3R” concept (reduce, reuse and recycle) for conventional waste and through adequate procedures and guidelines for health care waste management and safe disposal. Actions include developing municipal and regional waste management infrastructures to enable safe and responsible disposal of separate waste streams.
- Pollution should be reduced both upstream and downstream from health systems – for example, by reducing mercury pollution through sound management of mercury-containing and other toxic chemical-containing waste or by replacing toxic chemicals where feasible in medical products, facilities and practices.

3.2 How health systems in Europe can adapt

Climate change may threaten the progress that has been made in reducing the burden of climate-related disease and injury. The degree to which programs and measures will need modification to address additional pressures from climate change will depend on the current burden of ill health, the effectiveness of current interventions, projections of where, when, and how the health burden could change with climate change, the feasibility of implementing additional programs, other stressors that could increase or decrease resilience, and the social, economic, and political context for intervention.

(Smith KR et al., 2014: 733)

Adaptation is necessary to address both the current burden of disease and the additional burden posed by climate change. 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 intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014a). It is well understood that coherent multisectoral action is necessary if the challenges posed by climate change are to be tackled effectively. The IPCC distinguishes between three types of adaptation: incremental, transitional and transformational adaptation (O’Brien et al., 2012). The three different types are characterized and exemplified as follows.

Incremental adaptation involves actions where the central aim is to maintain the essence and integrity of a system or process at a given scale. This includes actions to improve public health and health care services for climate-related health outcomes (Smith KR et al., 2014), such as:

- strengthening primary health care and building capacity in the workforce;
- enhancing disease surveillance;
- strengthening monitoring, surveillance and early warning;
- assessing capacity, impacts and developments;
- ensuring essential medical supplies during disasters;
- improving heat-wave preparedness planning and response;

- coordinating intersectoral response to changes in the incidence and geographical range of diseases.

Transitional adaptation requires additional effort with shifts in attitudes and perceptions, leading to new initiatives (Smith KR et al., 2014). Examples of transitional health system adaptation include:

- vulnerability mapping (including use of advanced technologies such as remote sensing and spatial modelling);
- further development of early warning systems for health (such as climate services and early weather warnings);
- strengthening energy security through renewable and clean-energy technologies to reduce hospitals' vulnerability to disruption in case of intermittent energy supply or natural disasters.

Transformational adaptation requires fundamental change in a system, ultimately achieving adaptation at a greater scale or magnitude. This most often happens in response to significantly disruptive events, but transformational adaptation has yet to be realized in the health sector (Smith KR et al., 2014).

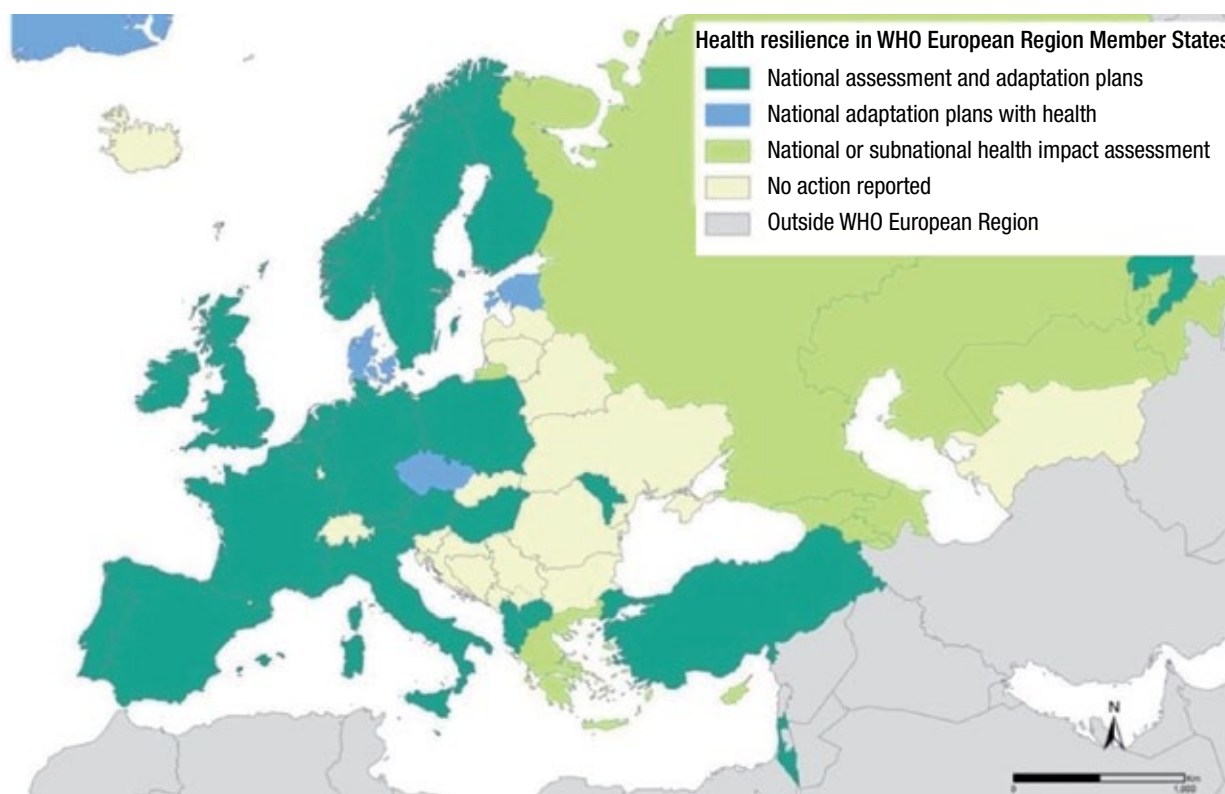
As a result of climate change, health systems need to prepare for gradual changes in health outcomes caused by sudden extreme events (such as heat-waves and infectious disease outbreaks) and for an extra burden of disease and potential new conditions. Health systems can improve the protection of population health from climate change through place-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. To assess local, regional or national impacts and vulnerabilities it is crucial to inform and tailor health adaptation strategies. Key elements of adaptation in the health sector include:

- anticipating potential health effects (such as emerging infectious diseases);
- detecting them early (for example, by monitoring heat-waves);
- 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 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.

Governments at various levels are starting to develop adaptation plans and policies and to integrate climate change considerations into broader development plans. Of the 53 Member States in the WHO European Region, 24 appear to have published a national adaptation strategy or action plan (see Fig. 4). In a survey answered by 22 countries, 19 responses included actions improving public health in response to climate change. In addition, eight countries had developed health-specific national or subnational adaptation plans (WHO Regional Office for Europe, 2015a).

Fig. 4. Countries that have carried out a vulnerability, impact and adaptation assessment and/or developed national adaptation plans



Source: WHO Regional Office for Europe (2015a).

The capacity of health systems in the WHO European Region to respond to climate change varies greatly. This variation reflects historical processes, as well as current economic and human-resource constraints. In some countries concerns persist about the ability of publicly funded institutions to provide even basic services to most of the population. Their health systems require substantial strengthening to address the added burden posed by climate-related threats. Such strengthening can lead to broad health benefits today and in the years to come. Assessing potential effects and response capacities can both provide evidence for development strategies for resource and service delivery and identify needs for investment (such as vaccines, medicines, laboratory diagnostics), training (undergraduate and postgraduate) and service delivery, including ways to reach the most vulnerable populations. Systematic, interdisciplinary applied research can help health systems to gather intelligence and to monitor and evaluate the efficacy of their approaches (WHO, 2015b). Box 5 lists examples of measurable outputs to enhance climate resilience.

The national healthy cities networks are examples of how building alliances and sharing good practice can improve targeted activities for areas at risk such as urban areas or cities, coastal and low-lying areas and for vulnerable groups such as rural populations. Assessing risks and vulnerability is the first step towards increasing adaptive capacity and resilience in vulnerable settings and communities. Solidarity among and within countries is needed more than ever within a changing climate (Lafond, 2015).

As the following sections describe, adaptation helps to protect health from climate change and increase resilience through:

- reducing health effects from heat and heat-waves

- reducing health effects from cold weather and cold spells
- reducing health effects from floods
- anticipating changes in vector-borne diseases
- reducing the risk of waterborne diseases
- ensuring food safety
- protecting nutrition and food security
- dealing with reactions to aeroallergens.

Box 5. Examples of measurable outputs to enhance climate resilience

Policies and regulatory outputs

- National strategy on health and climate change and/or health component of the national adaptation plan developed
- Regulations on key environmental determinants of health (air quality, water quality, food quality, housing safety, waste management) revised and enforced to reflect broader ranges of expected climate conditions
- Building regulations and waste management infrastructure that are both environmentally sustainable and resistant to locally likely extreme events promoted
- Medium- and long-term plans for disease control programmes revised to consider capacities that may be stressed or exceeded by climate change
- Contingency plans for health care provision in extreme weather events or delivery of interventions to control outbreaks of infectious disease in new areas developed and tested

Cross-sectoral collaboration

- Agreements such as a memorandum of understanding or memorandum of agreement between the ministry of health and main stakeholders at the national level (such as meteorological services, ministries of food and agriculture, environment, energy, transport and planning) signed, including specific roles and responsibilities in relation to protecting health from climate change
- Health representation ensured in main climate change processes at the national, regional and global levels, such as UNFCCC meetings and sessions of the Conference of the Parties, national adaptation plans and national communications to the UNFCCC
- Climate change and health considerations in relation to both adaptation (for example, in climate-resilient water safety plans) and mitigation (for example, via health co-benefits in transport policies) reflected in main policies and strategies from health-determining sectors
- Health impact assessments conducted for new mitigation and adaptation policies and programmes in all climate-sensitive sectors in accordance with article 4.1.f of the UNFCCC

Institutional

- Focal point on climate change and health designated within the ministry of health with a specific programme of action and budget allocated
- Climate change and health focal points or units working in collaboration with relevant climate-sensitive health programmes (for example, on vector-borne diseases, nutrition, infectious diseases and disaster risk reduction) to build programme resilience
- Intersectoral cooperation with other units to tackle climate change impacts
- Investment plans defined to address identified capacity gaps.

Sources: WHO (2014); United Nations (1992).

3.2.1 Reducing health effects from heat and heat-waves

Hot weather and heat-wave-related deaths are an emerging problem in summer months in the WHO European Region (IPCC, 2014b). Heat-waves have caused much higher fatality rates in Europe in recent decades than any other extreme weather event. Heat-related problems are largest in cities; among many interrelated factors, the urban heat-island effect plays an important role. While ill health from heat can affect all groups and ages, some population subgroups are more at risk. These include elderly people, infants and children, people working in occupations connected to potential heat exposure (indoor or outdoor), people taking medications that increase heat vulnerability, people with disabilities, those living alone or who are socially isolated and chronically ill people (Bouchama et al., 2007; Kovats & Hajat, 2008).

An individual's risk of heat stress is increased by a wide range of factors, including chronic medical conditions, social isolation, overcrowding, being confined to bed and certain medical treatments. Future climate change is very likely to increase the frequency, intensity and duration of heat-waves (EEA, 2017). The effects of exposure can be directly heat-related (such as heat stroke, heat fatigue and dehydration) or caused by heat stress, which can contribute to a worsening of respiratory and cardiovascular diseases, electrolyte disorders and kidney problems (Aström et al., 2013).

The occurrence of heat-waves is uncommon relative to the total number of hot days; thus, the effect of heat-waves is a fraction of the total heat impact (Smith KR et al., 2014). Deaths attributable to extreme heat are roughly as frequent as those attributable to moderate heat (Gasparrini et al., 2015). Furthermore, long warm and dry periods in combination with other factors can lead to forest fires, which can also have severe health impacts (Analitis, Georgiadis & Katsouyanni, 2012).

In eastern Europe, including the European part of the Russian Federation, summer 2010 was exceptionally hot, with an amplitude and spatial extent that exceeded the previous heat-wave of summer 2003. The main observed health effect was an increase in daily mortality. In the 2003 heat-wave more than 70 000 excess deaths were recorded in 12 European countries (Robine et al., 2008). The 2010 heat-wave led to more than 15 000 deaths in the Russian Federation alone (Matsueda, 2011). Investigators who extended the analysis to the whole summer season for the years 1990–2001 reported estimates of 2.0% for heat-attributable mortality (Baccini et al., 2011). Synergistic effects between high temperature and air pollution (PM₁₀ and ozone) lead to an increase in hospital admissions for cardiovascular and respiratory diseases (Kovats & Hajat, 2008). For example, respiratory and cardiovascular deaths are higher during heat-waves when ozone and PM pollution are high (WHO Regional Office for Europe, 2009).

WHO has estimated the annual climate change-attributable mortality in 2030 and 2050 in the base case scenario of economic development in a quantitative risk assessment (Hales et al., 2014). More specifically, heat-related excess mortality is projected for the WHO European Region for 2030 and 2050 on the basis of a published temperature–mortality model (Honda et al., 2014). The annual heat-related mortality in 2030 in Europe for the population aged over 65 years, assuming no adaptation, is projected to be:

- about 13 500 additional annual heat-related deaths in 2030 (central, western and eastern European countries);
- about 1750 additional heat-related deaths in central Asia¹ in 2030;

¹ All central Asian countries as defined in the Hales et al. (2014) report (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan and Uzbekistan) are Member States in the WHO European Region with the exception of Mongolia.

- about 27 000 additional annual heat-related deaths in 2050 (central, western and eastern European countries);
- about 4886 additional heat-related deaths in central Asia for 2050 (Hales et al., 2014).

If 50% adaptation is assumed, heat-related excess mortality is reduced to about 4058 excess deaths (central, western and eastern European countries) and about 360 additional deaths in central Asia for 2030, while 8962 excess deaths are expected for central, western and eastern European countries and about 1070 in central Asia for 2050 (Hales et al., 2014).

In the United Kingdom a significantly raised risk of heat-related and cold-related mortality is projected for the 2020s, 2050s and 2080s, with the elderly most at risk. Without adaptation, and partly driven by projected population growth and ageing, heat-related deaths could rise by more than 250% by the 2050s (Hajat et al., 2014).

Several studies – including ClimateCost, PESETA and PESETA II – have been conducted to estimate future heat-related mortality in Europe using similar methods; they arrived at largely comparable results (Ciscar et al., 2011; Kovats et al., 2011; Watkiss & Hunt, 2012; Paci, 2014). Results of the recent IMPACT2C study show that 0.7% of all deaths were attributable to the mean apparent temperature above the threshold for some European countries. In view of climate change, people in Mediterranean and eastern European countries will be most affected by heat (Kendrovski, Baccini & Menne, 2016).

Policy options and strategies for protection from heat

Heat-related illnesses and deaths are largely preventable. One of the most effective health system preparations for a heat-related emergency is the development and implementation of heat–health action plans. Further improvement, development and implementation of heat-wave preparedness, planning and response in European countries is expected to lead to a reduction in heat-related mortality. In 2008, the WHO Regional Office for Europe identified eight core elements of heat–health action plans (Matthies et al., 2008):

- agreement on a lead body
- accurate and timely alert systems
- a heat-related health information plan
- a reduction in indoor heat exposure
- particular care for vulnerable population groups
- preparedness of the health and social care system
- long-term urban planning
- real-time surveillance and evaluation.

Bittner et al. (2014) analysed existing heat–health action plans across the WHO European Region with regard to these core elements and their geographical focus, structure and measures. The analysis included 51 countries, 18 of which had developed heat–health action plans. These plans varied in degree of comprehensiveness; gaps with regard to the eight core elements were mainly identified in the areas of (intersectoral) long-term measures, surveillance and evaluation (see Table 3 – red cells). When developing new or improving existing plans, emphasis should therefore be placed on developing strong intersectoral coordination and effective mechanisms for early warning and health system response, as well as surveillance and evaluation measures.

Table 3. Heat–health action plans in 18 countries in the WHO European Region

Country	Year	Lead body	Alert system	Information plan	Indoor heat reduction	Vulnerable groups	Health care prepared-ness	Urban planning	Real-time surveillance	Evaluation	Sum score
Austria ^a	2011							b			13.75
Belgium	2005							b			11
Croatia	2012										16
France	2012							b			16.25
Germany ^a	2004–2008							b			10
Hungary	2007										12
Italy	2008										15
Luxembourg	2006							b			12
Monaco	2012							b			10
Netherlands	2007							b			15
Portugal	2010							b			17.5
Republic of Moldova	2010										12
Romania	2008										8 ^c
Serbia	2012							b			4 ^c
Spain	2012							b			12
Switzerland ^a	2007							b			11
The former Yugoslav Republic of Macedonia	2010–2011										18.75
United Kingdom	2012										20

Notes: ^a regional-level plan; ^b in other documents; ^c plan to be considered non-functional. This analysis allows data to be interpreted both by country, using the distance to the ideal situation (the maximum score) of the composite index, and across countries, looking at the distribution of green (present), yellow (in preparation) and red (none) for each of the core elements, thereby identifying gap areas in need of further improvement.

Source: Bittner et al. (2014).

Exchange of experiences and lessons learnt can accelerate and improve this process substantially. National risk and vulnerability assessments of various countries in view of climate change may indicate an urgent need for development and implementation of heat–health action plans. A recent example of the development of a national heat–health action plan is described in Box 6. Policy options and strategies include a structured heat-alert system linked to specific measures targeting vulnerable population groups, workers’ health and communication. At the local level, actions to reduce the health impacts of air pollution during heat-waves should include raising awareness among vulnerable populations and alerting them to required adaptive behaviour.

In the long term the most important measures policy-makers can take include improving energy and transport policies, urban planning and architecture. Such improvements should begin as quickly as possible, as there is a lengthy lead time from policy development to implementation.

Box 6. Heat–health action plan of the former Yugoslav Republic of Macedonia

A national heat–health action plan for 2010–2016 was developed within the former Yugoslav Republic of Macedonia's strategy for adaptation for the health sector to prevent health consequences associated with extreme heat due to climate change. Its goal is to reduce morbidity connected with heat-waves by issuing heat and health warnings, encouraging planning in the relevant sectors, popularizing health in all policies, raising public and health sector workers' awareness and mobilizing resources for managing heat effects. One of the main solutions proposed is setting up a structured alert system for timely announcement of heat-waves, especially during the period 1 May to 30 September. This includes creation of a responsible body, a 24- or 48-hour early warning system for heat-waves, specific thresholds for action and priorities for vulnerable populations, workers' health and communication.



Source: WHO Regional Office for Europe (2011).

3.2.2 Reducing health effects from cold and cold spells

Severe cold weather spells are a common occurrence across many countries in the WHO European Region, especially in eastern European countries, where 28 people per million died as a result of extreme cold events in 1991–2015 (EEA, 2017). Cold weather can have significant health effects as a result of low outdoor and indoor temperatures, ice and snow (Smith KR et al., 2014). Healy et al. (2003) calculated average excess winter death rates for the years 1988–1997 for 14 countries. Rates ranged from 10% in Finland to 28% in Portugal. The increase in mortality is greater in milder Mediterranean countries than in colder northern and central European countries (Analitis et al., 2008; Healy, 2003). Adverse health effects of cold weather are also costly to health care systems: in 2009 the United Kingdom's Department of Health estimated that annual costs to the NHS of treating winter-related diseases amounted to around £859 million (Donaldson, 2010).

A global observational study found that more temperature-attributable deaths were due to cold than heat. Overall, an increase of mortality during heat-waves is expected to reach about 8.9–12.1%; the expected increase is 12.8% during cold spells. Moderate, non-optimum temperatures – for both cold and heat – caused most of the total health burden, however (Gasparrini et al., 2015). The proportion of mortality attributable to cold, and to moderate cold in particular, is high compared to the proportion caused by heat (Dear & Wang, 2015).

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 health impacts can persist for some time. Many cold-related deaths actually occur on moderately cold days (Gasparrini et al., 2015). Deaths associated with cold weather are caused by coronary heart disease, cerebrovascular incidents, respiratory diseases, hypothermia and trauma. Health problems associated with cold temperatures include:

- injuries such as fractures, sprains and strains from falls and accidents, as well as hypothermia and frostbite from cold injuries;
- cardiovascular problems such as coronary heart disease, myocardial infarction, cerebrovascular incidents and disorders of peripheral circulation;

- respiratory problems such as colds, influenza, pneumonia and exacerbation of asthma and chronic obstructive pulmonary disease;
- mental health issues including depression and developmental problems such as reduced infant weight gain and delayed child development.

Elderly people, children, people with disabilities or chronic diseases, malnourished people and people in outdoor occupations are most vulnerable to cold weather. Certain behaviours can put individuals at increased risk of suffering from cold exposure, such as excessive use of alcohol. The economic and social status of individuals and families also plays an important role: deprivation, low income, poor-quality housing, fuel poverty and social isolation are associated with greater cold-related ill health and death (WHO Regional Office for Europe, 2017f).

Policy options and strategies for protection from cold stress

The adverse health effects of cold weather are largely preventable. Although climate change is expected to result in a certain degree of warming, cold weather will still occur. Policy-makers have various options to reduce the health impacts caused by cold weather.

The short lag time from the onset of cold weather to its health effects and the sequence of mortality means that planning and preparedness are essential if they are to be minimized. The WHO Regional Office for Europe recommends development and implementation of “cold–health action plans” to reduce cold-related mortality and the health impacts of acute cold episodes (see Box 7).

Box 7. Cold weather plan for England

The United Kingdom developed its first cold weather plan for England in 2011 to reduce the health impact of cold weather by raising public awareness of the harm of extreme cold and to provide guidance on preparation and response. It recommends a series of steps for the NHS and related public agencies, professionals working with vulnerable populations and the public.

The plan is republished every year, building on experiences and lessons learnt to improve and develop it.

Source: Public Health England (2015).



Findings by Gasparrini et al. (2015) suggest that health policies and climate change adaptation and mitigation measures should take into account the whole spectrum of effects of temperature. As cold-related deaths are attributable to moderate non-optimum conditions, the focus of studies should not just be on extreme temperatures. As this observation is more applicable for cold than for heat, it has been suggested that the two extremes – heat and cold – should be treated separately, preparing strategies according to local conditions. Efforts to reduce health risks from hot and cold temperatures could be improved through further in-depth studies on the interaction

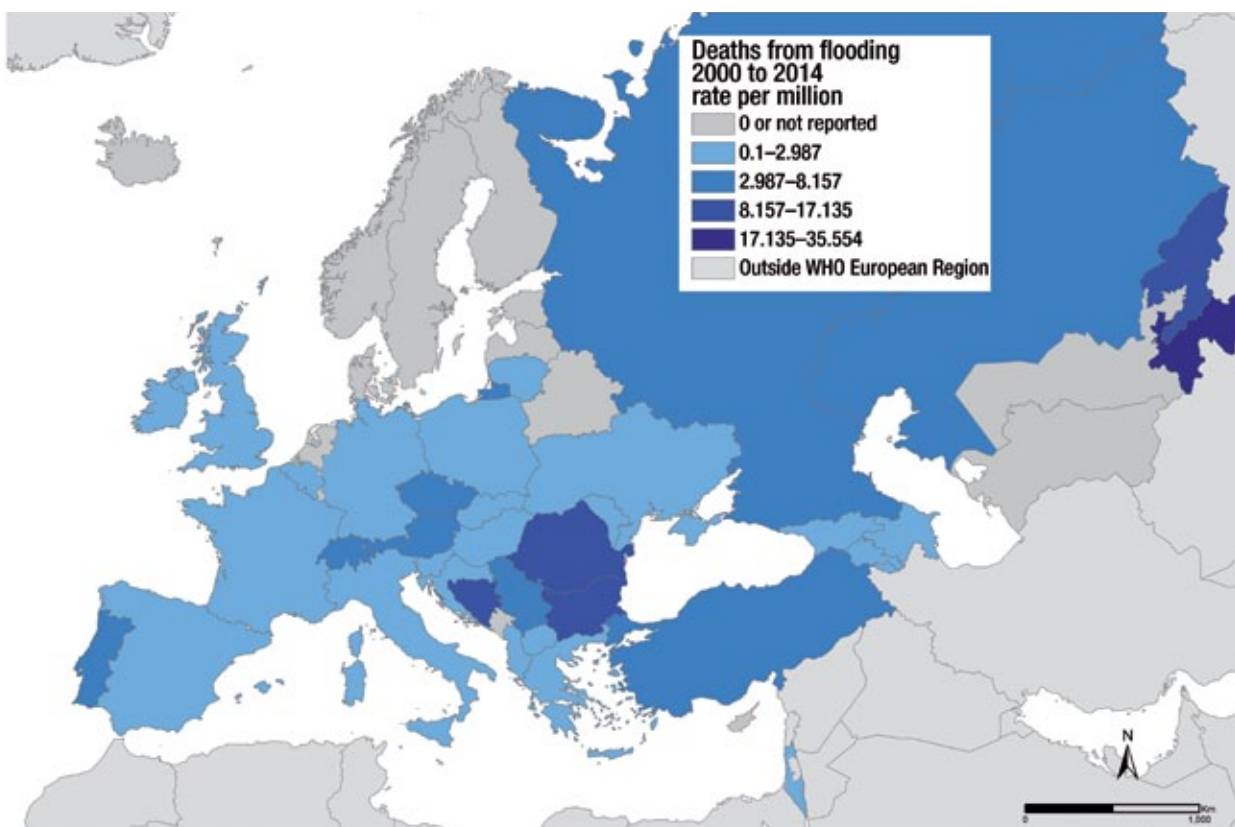
between attributable mortality and factors determining susceptibility or resilience (Dear & Wang, 2015). Measures that achieve a reduction in both health impacts of cold weather and greenhouse gas emissions include improving the energy efficiency of housing through improving insulation to make homes warmer and reduce energy consumption (see section 2.5).

3.2.3 Reducing health effects from floods

Floods affected millions of people in Europe in the last decade. People became ill or died from drowning, heart attacks, injuries, infections, exposure to chemical hazards and mental health consequences. Disruption of services – including health services, safe water and sanitation provision and transportation – plays a major role in vulnerability to health effects from flooding. The latest evidence shows the following.

- Flooding occurred in 50 of the 53 countries in the WHO European Region during the last decade (Menne & Murray, 2013). Floods killed more than 2000 people and affected 8.7 million in the period 2000–2014. The highest numbers of deaths were in south-eastern and eastern Europe, central Asia and central Europe (see Fig. 5).
- Certain groups are more vulnerable to the health effects of floods; these include children, pregnant women, people with disabilities, elderly people, tourists, members of ethnic minority groups and homeless people (Menne & Murray, 2013).
- Heavy precipitation events are likely to become more frequent in many regions in Europe, and sea-level rise is projected to accelerate compared to 20th-century levels in all emissions scenarios. If no additional adaptation measures are taken, the number of people affected by coastal flooding in the EU at the end of the 21st century will range between 775 000 and 5.5 million people annually, depending on the emissions scenario (Ciscar et al., 2011; Kovats et al., 2011).

Fig. 5. Deaths from flooding in the WHO European Region, 2000–2014



Source: adapted from Guha-Sapir, Below & Hoyois (2015).

Policy options and strategies to protect from flooding

Countries have adopted a range of measures to avoid or reduce flood risks. These include structural (such as physically engineered interventions) and non-structural measures (for example, policy and organization interventions). Experiences in the Region point to a need to shift the emphasis from disaster response to long-term risk management (see Box 8). The approach should include health impact assessments of structural measures to combat flooding, building regulations in flood-prone areas and insurance policies. Flood health risk management, through developing flood health action plans, should therefore be multisectoral. This refers to the systematic analysis and management of health risks posed by floods, through a combination of hazard and vulnerability reduction measures to prevent risks, as well as response and recovery measures, corresponding to the four phases of emergency management: prevention, preparedness, response and recovery. Hospitals, ambulance stations, retirement homes, schools and kindergartens in flood-prone areas are at particular risk, and evacuating patients and other vulnerable groups may represent a special challenge.

Box 8. Balkan floods

In May 2014 Cyclone Tamara caused wide-scale damage and destruction throughout Bosnia and Herzegovina, Croatia and Serbia. The rainfall and subsequent flooding and landslides displaced more than 60 000 people from their homes; killed 55 people; destroyed infrastructure and agricultural farms; killed livestock; and disrupted electricity, water and other basic services. It also damaged more than 50 health facilities. It affected 1 million people in Bosnia and Herzegovina and left 180 000 people in need of assistance in Serbia and 30 000 in Croatia. In light of the scale, urgency, complexity and context of this natural disaster, WHO categorized the event as a Grade 2 emergency according to the Emergency Response Framework (WHO, 2013).

The lack of access to safe drinking-water posed a serious risk of outbreaks of communicable diseases. Of particular concern was the forecast rise in temperature that was likely to lead to increased mosquito breeding in a region that experienced a West Nile fever outbreak in summer 2013 in Bosnia and Herzegovina. Further, dislodged land mines left from the Balkan wars in the 1990s posed a serious risk of injury, while industrial and chemical pollution of the flood water and a large number of animal carcasses presented additional health threats. Mental health and psychosocial support services also needed to be provided to people affected by the disaster.

An emergency support team was established at the WHO Regional Office for Europe's Emergency Operations Centre to support all three countries through the WHO country offices. Following WHO's Emergency Response Framework procedures, and to fulfil WHO's core functions in emergencies, staff from the country offices and Regional Office were repurposed and deployed to support the response operations. Efforts focused on:

- setting up a health sector coordination mechanism with all partners and the ministries of health in Bosnia and Herzegovina and Serbia;
- surveillance and prevention of water- and vector-borne diseases;
- strengthening disease surveillance and early warning systems for communicable diseases;
- recovery of damaged health facilities;
- prevention of health threats related to industrial and chemical pollution;
- strengthening capacities for related public health response.

Sources: WHO Regional Office for Europe (2014c).

3.2.4 Anticipating changes in vector-borne diseases

Climate variability has had a significant impact on the occurrence of disease outbreaks in Europe over the past 50 years. Researchers studied 2058 outbreaks of 114 infectious diseases in 36 countries from 1950 to 2009 and found that climatic variations and seasonal changes in air pressure across the continent influenced the outbreak occurrences of 11 diseases (Morand et al., 2013). It is not possible to assess whether past climate change has already affected water- and food-borne diseases in Europe, but the sensitivity of pathogens to climate factors suggests that it could be having effects on these diseases. The number of vibriosis infections, which can be life-threatening, has increased substantially in Baltic Sea states since 1980. This increase has been linked to observed increases in sea-surface temperature, which has improved environmental conditions for *Vibrio* species blooms in marine waters. The unprecedented number of vibriosis infections in 2014 has been attributed to the unprecedented 2014 heat-wave in the Baltic region. 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. This includes changes in the seasonal activity of local vectors and the establishment of tropical and subtropical species (EEA, 2017).

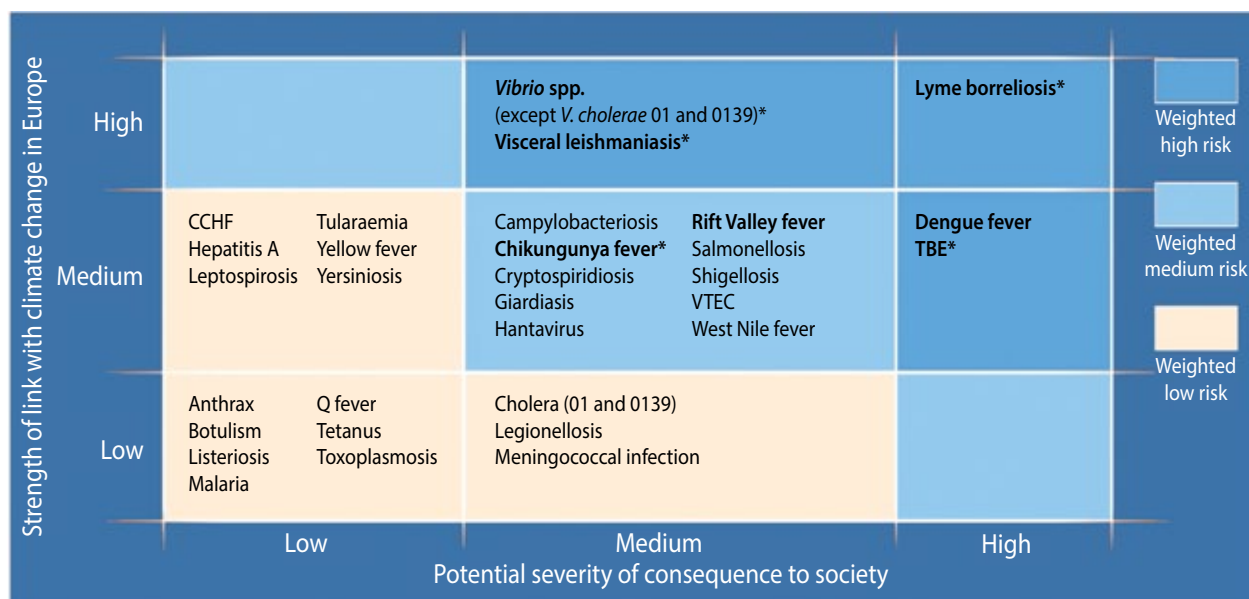
The broad patterns of species and biome shifts towards the poles and higher altitudes in response to a warming climate are well established (IPCC, 2014b). The spread, survival and activity of infectious agents and their vectors and intermediate hosts are also affected by changes in temperature, rainfall and humidity (McMichael & Lindgren, 2011). Many plant and animal species have shifted their geographical ranges, altered their abundance and shifted their seasonal activities (such as bird migration or pollen production) in response to observed climate change over recent decades (Thuiller, 2007). Substantial warming in higher-latitude regions will also open up new terrain for some infectious diseases that are presently limited by low-temperature boundaries, as shown by the northward extensions of tick populations in Canada and Scandinavia – the vectors for Lyme disease and tick-borne encephalitis (Lindgren & Gustafson, 2001; WHO Regional Office for Europe, 2004; Ogden et al., 2006).

Relevant vectors are ticks (carriers of tick-borne encephalitis, Lyme borreliosis (Lyme disease), Crimean-Congo haemorrhagic fever and rickettsia), mosquitoes (Zika, chikungunya, dengue and West Nile viruses) and sandflies (leishmaniasis) (EEA, 2017). Fig. 6 lists selected weighted infectious diseases risks in view of climate change for the EU.

Policy options and strategies to protect from vector-borne diseases

The European Centre for Disease Prevention and Control (ECDC) assesses the effects of climate change on infectious diseases and has established a pan-EU network dedicated to vector surveillance (ECDC, 2012). Early detection of any outbreak and improved public health surveillance and response are essential elements in adapting to climate change. The International Health Regulations (IHR) provide a global platform for early detection of climate-related events and strengthening of public health surveillance and response capacities (WHO, 2008). They are a set of rules and procedures agreed by 193 countries to make the world more secure from threats to global health. Countries are required to report all events that could result in public health emergencies of international concern, including those caused by chemical agents, radioactive materials and contaminated food. The IHR are particularly important with regard to climate change, as they allow early identification of potential crises. They not only improve national management of infectious disease outbreaks and public health emergencies but also provide international warning.

Fig. 6. Weighted risk analysis of climate change impacts on infectious disease risks



Notes: CCHF: Crimean-Congo haemorrhagic fever; spp.: multiple species; VTEC: verocytotoxin-producing *Escherichia coli*; TBE: tick-borne encephalitis. Candidates for suggested changes to disease-specific surveillance are in bold. Asterisks indicate diseases currently notifiable in some EU countries but not legally reportable to the ECDC.

Source: Lindgren et al. (2012).

In response to IHR implementation, health systems must prepare for and respond to potential new disease outbreaks, ensure that adequate logistics and supplies (such as pharmaceuticals and vaccines) are available and develop links with veterinary services. In addition to strengthening response capacity, many preventive measures can be taken. For example, 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, 2013b). Furthermore, to promote awareness of work on protecting health from vector-borne diseases in a changing climate, the WHO Regional Office for Europe has published factsheets on dengue and chikungunya (WHO Regional Office for Europe 2014a; see also Box 9).

Box 9. World Health Day 2014: vector-borne diseases

World Health Day 2014 was used as a key opportunity to engage governments and people, with special emphasis on people on the move, in protecting health from vector-borne diseases both globally and in the WHO European Region.

As part of the campaign, bilingual factsheets (in English and Russian) were developed on seven climate-sensitive vector-borne diseases: chikungunya, dengue, leishmaniasis, Lyme borreliosis, malaria, tick-borne encephalitis and West Nile virus. Tips for prevention and onsite events at London Heathrow and Washington Dulles Airports particularly targeting travellers were aimed to raise awareness.

Source: WHO Regional Office for Europe (2014d).



Enhanced intersectoral collaboration is needed to improve practices for vector surveillance and control, as well as capacities for disease surveillance and diagnosis. Advice on how residents can protect themselves from diseases is also necessary in areas with potential of disease transmission. Locally integrated vector-control measures need to be revised and strengthened, including environmental management (for example, improving the design and operation of projects to develop water resources) and personal protection/preventive strategies.

3.2.5 Reducing the risk of water-related diseases

Easy access to adequate sanitation and sufficient amounts of safe water for drinking and hygiene at home, schools and health care facilities are essential to human health and well-being and should be a prerequisite for a decent life in the 21st century. Of the 912 million people living in the WHO European Region in 2015 more than 62 million lacked access to an adequate sanitation facility and 14 million did not use a basic drinking-water source. While access has increased in recent decades, notable disparities remain between rural and urban areas, especially in the Caucasus and central Asia, where less than 40% of rural dwellers use piped water on the premises (UNICEF & WHO, 2015).

Diseases related to inadequate water, sanitation and hygiene include not only diarrhoea but also other disease outcomes such as hepatitis A, legionellosis and soil-transmitted helminth infections. In the WHO European Region 14 diarrhoea deaths a day can be attributed to inadequate water, sanitation and hygiene. Infants and children under 5 years of age are particularly vulnerable to diarrhoea as a leading cause of malnutrition and death.

Microbial contamination of water used for drinking, hygiene and recreation is of prime concern throughout the Region. Chemical pollution is often localized but may also have a significant impact on health. Priority chemicals in drinking-water that can cause non-infectious disease include arsenic, fluoride, lead and nitrates (UNICEF & WHO, 2015).

On top of this, climate change is expected to challenge the situation further, as it can affect both water quantity and quality. Climate change is likely to increase heavy precipitation events, reduce the amount of available fresh water in parts of the Region and affect source water quality. The impact will greatly depend on local water management practices.

The consequences of climate change on water quantity are the following.

- Water stress is expected to increase across central and southern Europe and central Asia. The estimated proportion of the area of the EU under high water stress is forecast to increase from 19% in 2007 to 35% by the 2070s, by which time the number of additional people affected is expected to be 16–44 million (Alcamo et al., 2007).
- Globally, each 1 °C of temperature increase caused by global warming is projected to result in a 20% reduction in renewable water resources and to affect an additional 7% of the population (Jiménez Cisneros et al., 2014).
- Central Asia is likely to have reduced availability of freshwater. Similar situations may occur in central and eastern Europe, where freshwater flows may decrease by 80% (Alcamo et al., 2007).
- Projected water scarcity and agricultural droughts may increase the demand on irrigation, including wastewater reuse. Competition for access to water will increase (IPCC, 2014b).

Increasing temperatures and changing water composition create new ecological niches that allow pathogens to invade new areas. Depending on the local conditions, limited or temporarily

limited availability of water resources for drinking-water production and potential problems for drinking-water quality management include the following.

- Insufficient sanitation in water-stress conditions may lead to higher concentrations of faecal matter in surface water sources, containing viral, protozoal and/or bacterial pathogens (Pandey et al., 2014).
- Low water flows and reduced water levels in surface water bodies will tend to increase the concentration of pathogens, chemical pollutants and nutrients (Sirbu et al., 2012).
- Within large reservoirs, higher water temperatures can reduce dissolved oxygen levels and increase benthic nutrient (such as phosphorus) release. This promotes (harmful) phytoplankton proliferation – including toxic cyanobacteria – and release of sediment-bound metals, such as iron and manganese, into the water body (Hou et al., 2013).
- Algae proliferation may increase in source waters, such as cyanobacteria and associated cyanotoxins (including microcystin), resulting in poisoning through the water supply but also through the food-chain and consumption of contaminated fish (Zanchett & Oliveira-Filho, 2013). An additional area of concern is the production of seafood in aquaculture, which takes place in coastal zones (De Silva & Soto, 2009).
- Drought may lead to the use of less safe alternative water sources. Any saltwater intrusion into drinking-water sources can increase water treatment costs for salt removal (Jiménez Cisneros et al., 2014).
- The other extremity of extreme weather is also expected to occur: higher frequencies of torrential rains, leading to rapid runoff (or ingress to groundwater sources) and poor water quality (Jiménez Cisneros et al., 2014).

Climate change is also likely to affect the quality of coastal waters, by changing either natural ecosystems or the quality of the waters draining into coastal zones. Recreational users of bathing waters, including tourists, may face poorer water quality and a higher risk of infection (Sinisi & Aertgeerts, 2011; Jiménez Cisneros et al., 2014).

Policy options and strategies to reduce water-related diseases

In the WHO European Region the primary policy instrument in the water, sanitation and health domain is the joint WHO and United Nations Economic Commission for Europe (UNECE) Protocol on Water and Health. This aims to prevent, reduce and control waterborne diseases by ensuring access to safe drinking-water and sanitation services, establishing common standards for surveillance systems and contingency plans to detect and prevent waterborne disease outbreaks (UNECE & WHO Regional Office for Europe, 1999). By adopting the Protocol, countries agree to take all appropriate measures to:

- ensure adequate supplies of wholesome drinking-water;
- secure adequate sanitation of a standard that sufficiently protects human health and the environment;
- protect water resources used as sources of drinking-water, and their related water ecosystems, from pollution;
- provide adequate safeguards for human health against water-related diseases;
- establish and maintain effective national and local surveillance and early warning systems for monitoring and responding to outbreaks or incidents of water-related diseases.

The Protocol has supported remarkable progress in water, sanitation and health in recent years in the Region. Between 2010 and 2015, 39 million people gained access to piped water on the premises and 17 million people gained access to basic sanitation. The annual number of deaths

from diarrhoeal diseases attributed to poor water, sanitation and hygiene also dropped between 2002 and 2012, from 15 000 to 5000 (see Box 10, illustrating the development of small-scale water safety plans (WSPs)).

Progress can still be made, however. The Meeting of the Parties to the Protocol in November 2016 discussed how to implement the Sustainable Development Goals at national levels, specifically Goal 6 – “Ensure availability and sustainable management of water and sanitation for all” – and relevant targets under Goal 3 – “Ensure healthy lives and promote well-being for all at all ages”. Achieving increasing resilience to climate change was also considered relevant.

Box 10. Development of WSPs for small communities in Tajikistan

Despite its abundance of water resources, Tajikistan has an underdeveloped drinking-water supply system. In 2011 only about 58% of the population had access to improved drinking-water sources such as centralized piped systems, boreholes and protected springs. Considering water quality and safety a priority, the government adopted a programme in 2006 to improve the provision of safe drinking-water to the Tajik population for 2008–2020.

The WSP approach is the most effective way of managing water supplies. Its emphasis is on prevention, identification and management of risks that may threaten the supply, thus supporting communities in dealing with the everyday challenges of maintaining a reliable, safe supply. Based on the positive experiences in Tajikistan, the WHO Regional Office for Europe developed a field guide to support more communities with implementation of the WSP approach. This lists a number of advantages of implementing a community WSP, including:

- creation of a better understanding of the water supply system – particularly the risks that may affect water quality and health;
- improvement of the day-to-day management and operation of the water supply;
- encouragement of a team-based approach, as it brings together all those who share responsibility for, interest in and knowledge of the community water supply system;
- involvement of members of the community in the process, leading to better awareness of health and hygiene issues and improved sanitation behaviour;
- identification of improvement needs and opportunities for “quick wins”;
- development of an incremental improvement plan – particularly when community resources are limited, this provides the evidence for the improvements required.

Sources: Rickert et al. (2014).



3.2.6 Ensuring food safety in a changing climate

A safe and nutritious food supply is essential for good health. Unsafe food can lead to a range of health problems. Climate-related factors may affect food safety through multiple pathways: changes in temperature and precipitation patterns, increased frequency and intensity of extreme

weather events, ocean warming and acidification and changes in contaminants' transport pathways. Climate change may also affect socioeconomic aspects that influence food safety. Through the course of the food-chain, from production to consumption, food safety may be compromised by variability caused by climate change (Tirado et al., 2010).

Despite the multiple pathways through which climate change can affect food safety, contamination with bacterial pathogens is a major concern. Increases in temperature and humidity and extreme weather conditions affect the ability of many bacterial foodborne pathogens to survive and/or grow.

- 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). A study in Kazakhstan found a 5.5% increase in the incidence of salmonellosis with a 1 °C increase in the mean monthly temperature; an increase in precipitation was also associated with an increase in salmonellosis incidence, with a lag time of up to two months (Grjibovski, Kosbayeva & Menne, 2014). The incidence of campylobacteriosis in humans is positively associated with mean monthly temperature, with a lag time of up to one month (Jore et al., 2010).
- For the period 2071–2100, assuming a population growth of 8% by 2080, salmonellosis may increase by 40 000 reported cases per year in countries of the EU. The estimated economic cost would conservatively be €284 million per year (Watkiss et al., 2009). An increase in the risk of campylobacteriosis is also predicted (Kistemann et al., 2012).
- Floods and heat-waves may threaten the safety of drinking-water (Menne et al., 2008; EEA, 2012). Droughts are predicted to increase, threatening fresh water supplies, particularly in southern areas of the WHO European Region (IPCC, 2007; Pachauri & Meyer, 2007).
- Other potential impacts of climate change include emergence of new microbial hazards due to changes in the types of crops cultivated and the associated agricultural practices for crops (such as increased use of untreated animal waste to fertilize crops) and increases in antibiotic-resistant pathogens due to greater use of veterinary medicines in farm animals (Review on Antimicrobial Resistance, 2015).
- The production of toxins, such as mycotoxins or marine biotoxins, may also be affected by temperature and moisture conditions (Paterson & Lima, 2010).

Policy options and strategies for better food safety

It is vital to ensure that the food safety infrastructure currently in place in countries in the WHO European Region is not only maintained but also reviewed and improved (see Box 11). This requires continued surveillance and monitoring of food safety, coupled with risk assessment, management and communication.

Robust frameworks to guide optimal adaptation to the effects of climate change on health are essential. The need to both minimize and prevent adverse climate change-related health outcomes highlights the inclusion of health as a consideration in all policies, across all sectors. WHO supports countries in protecting food safety with the Codex Alimentarius, a collection of international food standards, guidelines and codes of practice covering all the main foods and processes. Together with FAO, WHO alerts countries to food safety emergencies through an international information network. The WHO Regional Office for Europe gives priority to building national capacity to manage food safety challenges through targeted training courses and projects.

Box 11. World Health Day 2015: food safety

World Health Day 2015 was an opportunity to recognize the important role of food safety in all stages of food production. It was used to strengthen collaboration and coordination between the agriculture, veterinary and health sectors to prevent, detect and respond to foodborne diseases. Changes in food production, processing, distribution and consumption, changes to the environment, new and emerging bacteria and contaminants and antimicrobial resistance all pose challenges to national food safety systems.

Source: WHO (2015c).



3.2.7 Protecting nutrition and food security in a changing climate

Climate change affects food security and nutrition through changing water availability, food production, trade, stability of food supplies, access to food, food safety and food utilization (Schmidhuber & Tubiello, 2007; Tirado et al., 2010; Wheeler, 2015). In addition, increasing concentrations of CO₂ in the atmosphere reduce the nutritional value of important staple crops (Müller, Elliot & Leverman, 2014). Climate extremes, variability and change can influence the three key determinants of undernutrition of vulnerable populations: household food security, maternal and child care, and access to health services and environmental health (Tirado et al., 2013). This undermines climate resilience and adaptive capacity of populations.

The pathways through which climate change can affect food security and nutrition are complex. Changes and increased variability in climate and non-climate drivers – such as political structures, economics and food price volatility, among others – affect food security by varying food production and impacts on food trade and access. It is predicted that temperature and precipitation changes, regardless of the effects of CO₂, will contribute to the projected 2050 global food price increase. (Porter et al., 2014).

Rising food prices push populations to limit food intake by reducing either the quality or the quantity of food they consume. These populations may be pushed to the limits of hunger and starvation. The consequences of these practices range from micronutrient malnutrition to obesity (Luber & Lemer, 2015). At the same time, increasing global food demand, food production and changing dietary patterns contribute to environmental degradation, greenhouse gas emissions and climate change.

An increase in global temperature of around 4 °C compared to late-20th-century levels, compounded with rising global food demand, increases the likelihood of food insecurity globally and regionally (Porter et al., 2014). Although increasing atmospheric CO₂ may increase plant growth and water utilization, it may also reduce the nutritional value of these crops by reducing plant mineral and protein content (Elbehri, Elliott & Wheeler, 2015). Globally, 138 million children (3.7 million in Europe) would be more affected: the number of malnourished children

is approximately 20% higher in a climate change world versus no climate change; children in sub-Saharan Africa would be the most affected by this projection (Nelson et al., 2009). While crop yield may increase in some areas of the WHO European Region, a higher frequency of extreme events such as droughts, heat-waves and floods in certain areas may lead to loss of food production and contribute to malnutrition of vulnerable populations.

- Southern Europe is likely to experience significant food production losses (of up to 25% in a 5.4 °C temperature increase scenario), while food production in some areas in northern Europe is likely to increase, owing to a prolongation of the growing season with warmer temperatures (Ciscar et al., 2011).
- Increasing frequency of extreme climate events will pose an increasing threat to the security of the Russian Federation's food system (Hijioka et al., 2014).
- Crop yields could decrease by up to 30% in central Asia by 2050 (Parry et al., 2007). Climate impacts on food security are a particular concern in central Asia, where droughts may affect child undernutrition and growth. A study in Uzbekistan, carried out under a seven-country initiative by the WHO Regional Office for Europe, showed that droughts over many years since 1965, for example, affected household food access, making inhabitants vulnerable to anaemia, tuberculosis and stunting in children aged less than 5 years (Menne, Kendrovski & Creswick, 2015).
- Calorie availability in 2050 is likely to decline throughout the developing world, resulting in an additional 25 million undernourished children (Nelson et al., 2009).
- Using the climate change scenario of a 2.0–5.4 °C increase by 2050, the results from the model show that agriculture and human well-being will be negatively affected by climate change. Crop yields will decline, production will be affected, crop and meat prices will increase and consumption of cereals will fall, leading to reduced calorie intake and increased child malnutrition (Nelson et al., 2009).

The agriculture sector is a major source of greenhouse gas emissions. Agriculture, land use, land use change and forestry account for some 24% of the greenhouse gas emissions contributing to climate change (Watts et al., 2015). The expansion of livestock and biofuel sectors plays a major role in deforestation and land degradation, and contributes to climate change. Additional greenhouse gas emissions are released through agriculture-induced land use change – especially deforestation. Other greenhouse gas emissions stem from fossil fuel use in the field and across the whole food continuum, including transport, storage, cold chain, processing and food waste (Popp et al., 2014). Food waste comprises roughly one third of food produced for human consumption; about 1.3 billion tonnes per year are lost or wasted globally (FAO, 2011).

Projected impacts of temperature increases on crop production vary according to crop variety, region, adaptation and climate change scenarios. Production of major crops such as wheat, rice and maize in tropical and temperate regions is projected to decrease with local temperature increases of 2 °C or more above late-20th-century levels with no adaptation (Nelson et al., 2009).

Policy options and strategies towards food security in a changing climate

The Second International Conference on Nutrition recognized the need to address the impacts of climate change on food security and nutrition – in particular on the quantity, quality and diversity of food produced, taking appropriate action to tackle negative effects (FAO & WHO, 2014). These issues need to be considered within the context of the IPCC and UNFCCC frameworks and the 2030 Sustainable Development Agenda.

Among the wide range of climate change mitigation and adaptation strategies, a combination of nutrition-sensitive, climate-smart strategies and technological developments in agriculture and

food sectors, social protection, community-based disaster risk reduction, education, financing, governance and institutional and cross-sectoral collaboration can contribute to address food and nutrition security in a changing climate (Tirado et al., 2013).

Food and nutrition security needs to be addressed in climate-resilient agriculture development and in national adaptation plans. Nutrition-sensitive climate mitigation measures are also urgently needed in the agriculture, food, transport, energy and other sectors to reduce the impacts of climate change on food and nutrition security; these should be addressed within nationally appropriate mitigation action plans (Tirado et al., 2013).

In areas particularly affected by droughts in central Asia, use of early warning systems and improved emergency assistance to protect the population from severe climatic extremes were identified as strategies to cope with climatic variation (Lioubimtseva & Henebry, 2009). These multifaceted strategies encompass empowering women and communities to adapt to climate change, improving food access and nutrition, assisting farmer resilience through agricultural insurance, promoting diversified food production and effective water management, fostering greater support from international organizations in disaster preparedness and climate mitigation strategies and, last but not least, strengthening health systems and cross-sectoral collaboration (See Box 12).

Box 12. Education initiatives on climate-resilient indigenous strategies and restoring indigenous landscapes in Tajikistan

World Farmers in central Asia are reviving threatened, indigenous species of fruit and nuts that are high in mineral content and more resistant and adaptable to climate change. In Tajikistan, the non-profit group Zan va Zamin, established by female teachers, scientists and doctors, collaborates with farmers on climate-resilient indigenous strategies – diversifying crop and fruit production and restoring indigenous landscapes. The group runs nurseries and school programmes and recognizes women and elders for preserving cultural heritage. Educational materials are prepared and disseminated within communities. Zan va Zamin has developed seed banks, funding opportunities, field schools, diverse community orchards, training on energy efficiency and construction of greenhouses for early crop production, and has established climate change information centres. These activities foster resilient ecosystems, reduce food shortages and improve livelihoods

Source: WHO (2015c).



The Rome Declaration from the Second International Conference on Nutrition in 2014 recognizes that the progressive realization of the right to adequate food in the context of national food security is fostered through sustainable, equitable, accessible and resilient food systems. These – including all components of production, processing and distribution – should be sustainable, resilient and efficient in providing more diverse foods in an equitable manner, with due attention paid to assessing environmental and health impacts (FAO & WHO, 2014). Integration of these

key issues in the climate and sustainable development agendas through effective, transparent partnerships is fundamental to moving towards nutrition-sensitive and climate-smart agriculture, food and social protection systems that ensure food and nutrition security and promote health.

3.2.8 Dealing with reactions to aeroallergens

Prevalence of allergic rhinitis and bronchial asthma has increased over the last three decades. The main diseases of concern are asthma, rhinosinusitis, chronic obstructive pulmonary disease and respiratory tract infections. The European Federation of Allergy and Airways Diseases Patients' Associations estimates 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).

One of the most widespread types of allergy is 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. In Europe, the economic costs of asthma are estimated at €17.7 billion per year, including the cost of lost productivity of about €10 billion per year (WHO & WMO, 2012).

Climate change affects the production, distribution, dispersion and allergenicity of aeroallergens, as well as the growth and distribution of weeds, grasses and trees that produce them. These changes in aeroallergens and subsequent human exposures could affect the prevalence and severity of allergic symptoms; the symptoms and disorders create a significant burden, especially on children (WHO & WMO, 2012; Cramer et al., 2014; Smith KR et al., 2014). Some details from the evidence include the following.

- Warmer conditions associated with climate change favour the production and release of airborne allergens, pollen and mould, and are therefore linked to increases in diseases such as asthma and allergic rhinitis (Beggs, 2010; Makra, Matyasovszky & Deák, 2011).
- Warmer temperatures and increased CO₂ concentrations also enable many plants to produce more pollen (Ziello et al., 2012; Cariñanos et al., 2014). Further, increasing atmospheric CO₂ concentrations increases the amount and allergenicity of pollens (Singer et al., 2005; Albertine et al., 2014; El Kelish et al., 2014).
- An increase in the concentration of *Ambrosia artemisiifolia* (ragweed) pollen by 10 grains per m³ may increase hospital admissions for respiratory disorders by one quarter (Matyasovszky et al., 2011). Significant associations have been identified between springtime pollen concentrations and emergency calls concerning asthma exacerbation among children (Tosca et al., 2014).

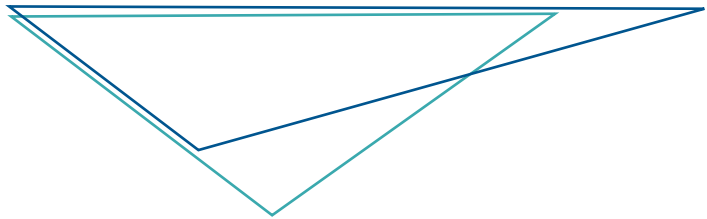
Policy options and strategies to minimize the health effects of aeroallergens

Preparedness of health systems can be strengthened through heat-wave and pollen warning systems (see Box 13), for example, as well as through preparedness of health professionals and health services. The population should be informed of observed and projected changes in environmental exposures such as earlier pollen season and geographical distribution of plant species. Education and awareness-raising should be organized for health professionals, patients and caregivers. Suggested measures to minimize the health effects of aeroallergens include the following: encouraging policies to promote access to renewable energy, reducing the private traffic in cities by improving public transport, reducing the use of fossil fuels and avoiding the planting of highly allergenic species of trees in cities (D'Amato et al., 2011).

Box 13. Polleninfo

European aerobiologists have created a network of institutions called the European Aeroallergen Network (EAN) covering 39 countries and 400 active pollen-monitoring stations over whole Europe. The aim of the network is to provide the most accurate information about pollen loads across Europe. The database can also be accessed by individuals, who can receive personalized advice for their well-being and planning of leisure activities. The webpage www.polleninfo.org offers all links to the most reliable national services across Europe.

Source: EAN (2017).



4. Key messages and conclusion

Since the 2007 IPCC report and World Health Day 2008 on climate change and health, protecting health from climate change has developed from a niche topic to an activity requested through high-level agreements such as the Paris Agreement and the Sustainable Development Goals. Increasingly, the call to integrate health into all policies and the need to consider climate change in all policies are being recognized and implemented.

The present collection of material and evidence shows that the climate is changing in the WHO European Region as well as globally. The impacts of climate change and variability are being observed in the Arctic, central Asian countries and southern and south-eastern Europe, but also in urban and coastal areas of all other countries in the Region. Some population groups are more exposed to specific risks areas or are more vulnerable due to age, health or social status or limited access to resources.

Measures to reduce greenhouse gas emissions can have great health co-benefits, and the health sector can lead by example in reducing the health sector's greenhouse gas emissions. Adaptation to the ongoing changes and impacts has also made progress since the European Regional Framework for Action to protect health from climate change was put in place.

The European Environment and Health Process provides an ideal platform to advocate further mitigation and adaptation action, monitor developments and share lessons learnt. This publication can be of use especially for the Working Group on Health in Climate Change of the Environment and Health Task Force; it will also support countries by providing recent scientific evidence and links to relevant policies to strengthen national intersectoral action. The key messages can be summarized as follows.

1. Climate change is affecting health now, and will continue to do so.

Climate change threatens global health through many direct and indirect impacts. These include extreme weather events, changing infectious disease distribution and patterns of noncommunicable disease. Climate change has serious adverse effects on health and on future economic prosperity, political stability and societal productivity. A WHO quantitative risk assessment concluded that climate change is expected to cause over 250 000 additional deaths per year between 2030 and 2050 (Hales et al., 2014).

2. Mitigating climate change brings large and immediate benefits for health, the economy and other societal goals.

Reducing greenhouse gas emissions to limit global warming to 2 °C relative to pre-industrial levels is still possible, but it requires substantial technological, economic, institutional and behavioural changes. The good news is that acting to reduce greenhouse gas emissions protects human health from direct and indirect impacts of climate change. The cost savings of the beneficial collateral effects (health co-benefits) achieved by policies to cut greenhouse gas emissions could be large. Examples of health co-benefits include:

- reduced air pollution, as nearly all non-CO₂ air pollutants that alter climate (such as black carbon and ozone-producing gases) have direct effects on health: 3.7 million deaths globally (482 000 in the WHO European Region) were attributable to ambient air pollution in 2012;

- promoting active transport resulting in increased physical activity and reduced noise due to reduced car use, with the added benefit of reduced air pollution: in Austria, the modal share of cycling was 5% in 2009, with an average trip length of 2 km, and it was estimated that this level of cycling saves 412 lives every year through regular physical activity – achieving a 10% cycling share would double the savings (WHO Regional Office for Europe, 2017g);
- reduced dietary saturated fat consumption from animal products, improving nutrition and reducing cardiovascular disease, since production of animal products releases a lot of CO₂ and methane: a 30% reduction in the adult consumption of saturated fat from animal sources would reduce heart disease in the United Kingdom population by around 15% (Friel et al., 2009).

3. Health professionals can be champions of change.

Health systems can lead by example in several areas. Health professionals should aim to:

- mitigate emissions, as health services in some developed countries are responsible for between 5% and 15% of carbon emissions – energy efficiency, shifting to renewables and greener procurement and delivery chains can improve services and business continuity, cut carbon emissions and improve the climate resilience of health systems;
- promote adaptation, since health professionals are respected and trusted members of communities, who can educate patients and peers on the health effects of climate change and promote behavioural adaptation at all levels (including heat-wave preparedness, enhanced surveillance and disaster response capacity);
- advocate for health through health professionals' organizations and associations, which can use health arguments to advocate climate change adaptation and mitigation that should be central to climate change policy, debates and planning.

4. Health protection is a priority for investment.

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. The evidence suggests that there is a very high benefit–cost ratio for health adaptation, and that higher benefits are achieved with early adaptation action.

5. Countries are already taking important action, but ambition needs to continue and be raised.

In the WHO European Region 24 of the 53 Member States include health in their national adaptation strategies. Measures for health protection involve:

- enhancing disease surveillance, especially for climate-sensitive vector-borne diseases;
- monitoring and modelling changes in environmental exposures such as air pollution;
- ensuring essential medical supplies and health service provision during disasters;
- improving preparedness, planning and response for heat-waves and other extreme events;
- facilitating coordination between health and other sectors to deal with changes in the incidence and geographical range of diseases.

Glossary

The definitions in this glossary are extracted from the glossaries of the working group reports to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
Anthropogenic	Resulting from or produced by human activities.
Atmosphere	The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium and radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio) and ozone. In addition, the atmosphere contains the greenhouse gas water vapour, whose amounts are highly variable but are typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.
Attribution	<p>Evaluating the relative contributions of multiple causal factors to an observed change or event with an assignment of statistical confidence.</p> <ul style="list-style-type: none">• Attribution of climate change to causes (such as greenhouse gas emissions) quantifies the links between observed climate change and human activity, as well as other natural climate drivers. Results from studies attributing climate change to causes provide estimates of the magnitude of warming in response to changes in radiative forcing and hence support projections of future climate change.• Attribution of observed impacts to climate change considers the links between observed changes in natural or human systems and observed climate change, regardless of its cause. Results from studies attributing impacts to climate change provide strong indications for the sensitivity of natural or human systems to future climate change.
Capacity-building	The practice of enhancing the strengths and attributes of and the resources available to an individual, community, society or organization to respond to change.
Climate	In a narrow sense usually defined as the average weather, or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

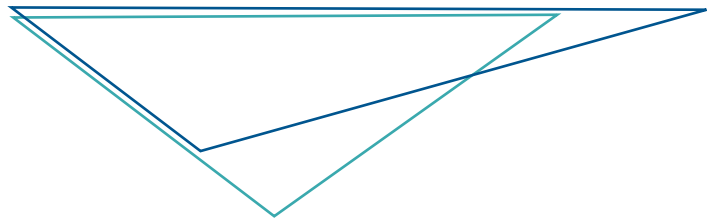
Climate change	A change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period – typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC) in Article 1 defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods”. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.
Climate change commitment	Due to the thermal inertia of the ocean and slow processes in the cryosphere and land surfaces, the climate would continue to change even if the atmospheric composition were held fixed at today’s values. Past change in atmospheric composition leads to a committed climate change, which continues for as long as a radiative imbalance persists and until all components of the climate system have adjusted to a new state. The further change in temperature after the composition of the atmosphere is held constant is referred to as the “constant composition temperature commitment” or simply “committed warming” or “warming commitment”. Climate change commitment includes other future changes – for example, in the hydrological cycle, in extreme weather events, in extreme climate events and in sea level change. The constant emission commitment is the committed climate change that would result from keeping anthropogenic emissions constant; the zero emission commitment is the climate change commitment when emissions are set to zero.
Climate projection	The simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.
Climate scenario	A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as the observed current climate. A climate change scenario is the difference between a climate scenario and the current climate.

Climate system	The highly complex system consisting of five major components – the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere – and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land use change.
Climate variability	Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).
Equivalent carbon dioxide (CO ₂) emission	The amount of CO ₂ emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a greenhouse gas or a mixture of greenhouse gases. The equivalent CO ₂ emission is obtained by multiplying the emission of a greenhouse gas by its global warming potential for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent CO ₂ emissions of each gas. Equivalent CO ₂ emission is a common scale for comparing emissions of different greenhouse gases but does not imply equivalence of the corresponding climate change responses.
Extreme weather event	An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called “extreme weather” may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (such as drought or heavy rainfall over a season).
Greenhouse gases	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth’s surface, the atmosphere itself and clouds. This property causes the greenhouse effect. Water vapour (H ₂ O), CO ₂ , nitrous oxide (N ₂ O), methane (CH ₄) and ozone (O ₃) are the primary greenhouse gases in the Earth’s atmosphere. Moreover, a number of entirely human-made greenhouse gases are in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO ₂ , N ₂ O and CH ₄ , the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF ₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Hazard	The potential occurrence of a natural or human-induced physical event or trend or a physical impact that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. In this report, the term “hazard” usually refers to climate-related physical events or trends or their physical impacts.
Human security	A condition that is met when the vital core of human lives is protected, and when people have the freedom and capacity to live with dignity. In the context of climate change, the vital core of human lives includes the universal and culturally specific material and non-material elements necessary for people to act on behalf of their interests and to live with dignity.
Human system	Any system in which human organizations and institutions play a major role. Often, but not always, the term is synonymous with a society or social system. Systems such as agricultural, political, technological and economic systems are all human systems in the sense applied in this report.
Mitigation [of climate change]	A human intervention to reduce the sources or enhance the sinks of greenhouse gases.
Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure and hazard. In this report, the term “risk” is used primarily to refer to the risks of climate change impacts.
Transformational change	According to Denton et al. (2014), transformational change is described as “a fundamental change in a system, its nature and/or its location that can occur in human institutions, technological and biological systems and elsewhere. It most often happens in responding to significantly disruptive events or concerns about them. For climate-resilient pathways for development, transformations in social processes may be required in order to get voluntary social agreement to undertake transformational adaptations that avoid serious disruptions of sustainable development.”
United Nations Framework Convention on Climate Change (UNFCCC)	The UNFCCC was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. It contains commitments for all Parties. Under the Convention, Parties included in Annex I (all OECD countries and countries with economies in transition) aimed to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention

entered in force in March 1994. In 1997, the UNFCCC adopted the Kyoto Protocol. The Paris Agreement was adopted in December 2015 as the first ever universal legally binding global climate deal.

Vulnerability The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.



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