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Climate and Health

A summary of knowledge

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Contents

1 Background

The effects of climate change are becoming increasingly clear. The impacts of climate change on human health are significant: the availability of food and clean water are affected; the spectrum of infections is changing; and extreme weather events are becoming increasingly common. Indirectly, this may lead to dramatic societal changes, such as larger movements of refugees. The likely scenarios are alarming. There is still an opportunity to influence this trend, but there is no time to waste!

The measures that are most effective in reducing climate impact also contribute to better health, thus creating a "win-win" situation. The aim of this report is therefore to highlight measures that can significantly reduce the risk of serious climate change and improve human health at the same time. In particular, it draws attention to the health impacts of burning fossil fuels, and the health benefits of reducing meat consumption. We outline the causes of climate change and summarise current scientific literature on how a changing climate will affect public health unless effective measures are taken, first and foremost to reduce temperature rise, and to prepare for a warmer climate. We also intend to present possible measures that can be taken in the healthcare sector to reduce climate impacts.

Action that helps to reduce climate impact, known as mitigation, is clearly the wisest and most economical course of action and, as this report shows, has other positive effects on public health. But this should not prevent us from preparing for higher temperatures now, in order to avoid or at least limit the alarming health scenarios that may be expected if the temperature is allowed to rise 1.5°C or more, according to forecasts by leading climate scientists in Europe.

This report is based primarily on the latest reports of the IPPC [1, 2]; conclusions from the "Lancet Commission on Health and Climate Change" [3, 4]; the report "The imperative of climate action to protect human health in Europe" published by the European Academies' Science Advisory Council (EASAC) [5]; and a summary of priorities for protecting health from climate change in the WHO European Region [6]; as well as a number of recent reference publications.

2 Climate change

The temperature on Earth is primarily controlled by the greenhouse effect, which means that the energy of the sun is prevented from radiating back out into space by greenhouse gases. The burning of fossil fuels changes the composition of gases in the atmosphere, leading to higher levels of the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and dinitrogen monoxide (N_2O). Human activity has also produced halogenated hydrocarbon gases that are new to the atmosphere.

Measurements show that the level of CO_2 in the atmosphere is now higher than in at least the past 800,000 years. In comparison with pre-industrial times (1881–1910), the concentration of CO_2, the most significant of the greenhouse gases, has risen by around 35 percent. The sharp rise in emissions of greenhouse gases into the Earth's atmosphere is already leading to powerful changes in our climate that could potentially be irreversible [7].

The fifth assessment report of the UN Intergovernmental Panel on Climate Change (IPCC), which is made up of 1,300 independent scientific experts from around the world, states that the probability that human activity over the last 50 years has warmed our planet is greater than 95 percent [8]. It is calculated that the temperature on Earth has risen on average by 0.85°C over the past half century, and if we continue emitting greenhouse gases at the same rate as we do today we are heading towards an increase in excess of 4°C by the year 2100 [7]. This will have serious effects on our health if we do not take drastic action to rapidly reduce and in the long term minimise our greenhouse gas emissions. At the same time, we must adapt to global heating and the resulting changes that are already happening.

If we do not succeed in halting temperature rise and developing solutions to reduce the effects of a warmer climate we can expect around 250,000 premature deaths per year globally between 2030 and 2050 due to climate-related illnesses, according to the World Health Organization (WHO), although this figure is uncertain [9]. Sweden is likely to be less

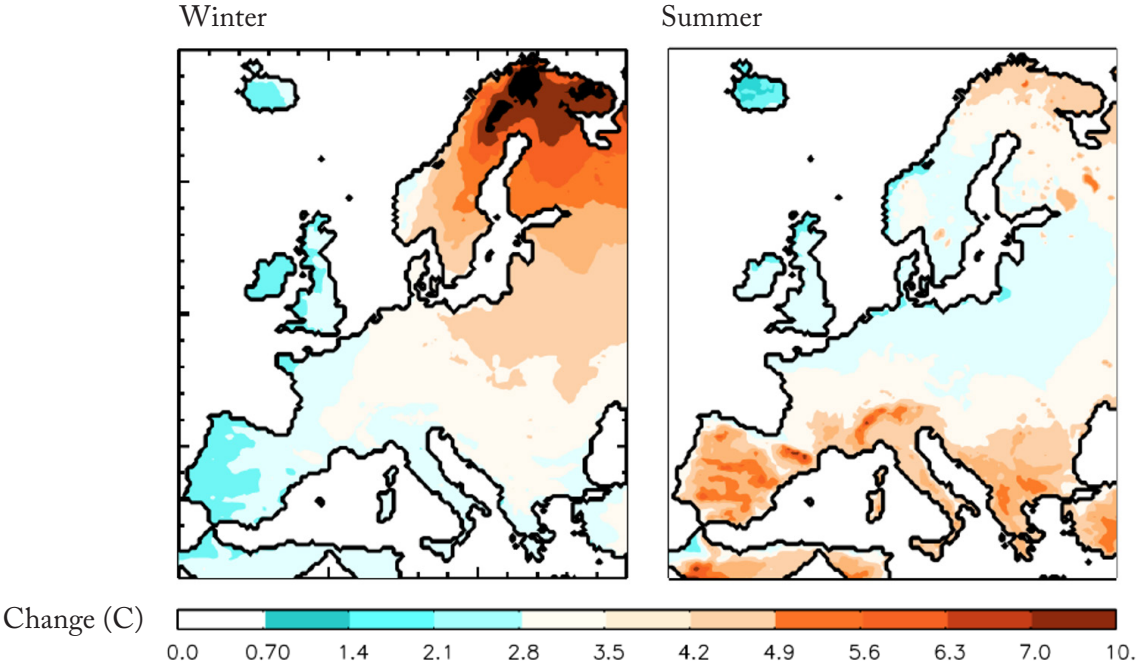

Figure 1.

Modelled change in mean temperatures across Europe during summer and winter, according to a climate scenario from the IPPC (A1B), adapted from Dosio A, Paruolo P and Rojas R. "Bias correction of the ENSEMBLES high resolution climate change projections for use by impact models: Analysis of the climate change signal", J. Geophys. Res. 2012; 117: D171110, which also describes uncertainties in the modelling.

seriously affected than many other countries, but because we live in a global world we will be affected both directly and indirectly. Such effects include greater risk of conflicts around the world due to competition for natural resources, damage to infrastructure, and reduced availability of food and water that will lead to increased conflicts, larger numbers of refugees and impact on the global economy. Climate change poses the risk of undermining the health gains of the last 50 years, which have contributed to significant improvements in health for a large majority of the world's population.

3 Health benefits of climate action

"Tackling climate change could be the greatest global health opportunity of the 21st century," stated a report published in The Lancet in 2015 [10]. Measures to halt climate change would thus also lead to a series of benefits for public health. The single most important measure for slowing down climate change is to phase out the use of fossil fuels, which would at the same time reduce the significant excess mortality that results from exposure to combustion emissions.

Achieving this will require simultaneous measures to promote a sustainable lifestyle, including changes in urban planning and infrastructure, and smart urban planning that encourages active travel over sedentary travel in vehicles, such as making bike paths and pedestrian paths wider and safer. We also need to take full advantage of the green spaces in cities to keep temperatures down in summer and to improve air quality and encourage physical activity. If this can be achieved it increases the chances of building a healthier and more active population.

Fossil fuels and health impacts

Since the industrial revolution began in the 18th century, fossil fuels have been used to generate energy and heat, and have played a central role in social development and hence the improved welfare of people all over the world. Fossil fuels are organic substances created from the remains of flora and fauna that were subjected to enormous pressure and heat deep under the surface of the Earth for millions of years. Oil, coal and natural gas are the primary fossil fuels, and for a long time seemed to be the perfect energy source. But as we have gradually become more and more dependent on this cheap and efficient fossil energy, we are now also seeing the negative side of its use. According to the World Energy Council in 2018, fossil fuels accounted for 81 percent of the total primary energy supply globally in 2014 [11].

Air pollution mainly arises from burning fossil fuels (coal, petrol, oil and natural gas) in motor vehicles, industry, power plants and heating plants, as well as small-scale domestic heating [10]. This combustion produces particulate matter (PM), which includes black carbon, polycyclic aromatic hydrocarbons (PAH), other hydrocarbons such as methane and aldehydes, metals such as mercury, and gases such as nitrogen dioxide (NOx), sulphur dioxide (SO_2) and carbon monoxide (CO). All these substances have been associated with adverse health

effects. In addition to atmospheric air pollution, combustion particles are a serious health risk for approximately three billion people who cook and heat their homes with biofuels and coal [12].

The fine fraction of particles (PM2.5) is believed to affect more people than any other air pollutant. From the health point of view, the most significant types of particles are sulphate and nitrate particles formed in the atmosphere by the gases SO_2 and NO2, ammonia, soot and mineral dust from roads and soils. Substances that bind to the surface of these particles can be very reactive and thus harmful to health. Small particles probably pose the greatest danger to health, because they can penetrate deep into the lungs. It is still unclear whether the finest particles of all, those with a diameter of <0.1 microns, are the most dangerous. Some studies suggest they can cross the barrier between the pulmonary vesicles and the bloodstream, and thus affect a variety of organ systems. Recently published data also indicate that they can pass from mother to foetus via the placenta [13]. Dark soot particles are both harmful to health and promote global heating, while light particles such as sulphates and organic carbon have a cooling effect that has so far masked some of the effects of greenhouse gases.

In 2014, 92 percent of the world's population lived in locations where WHO air quality guidelines were not met [12]. Current calculations indicate that fine particles (PM2.5) from all outdoor sources worldwide may be responsible for almost nine million premature deaths per year [14]. Using an emission-based model, it has been estimated that air pollution in the form of particles and ozone arising from the use of fossil fuels leads to about 3.6 million premature deaths around the world each year [15]. In large parts of Sweden, regional background particulate levels account for around half the concentration of PM2.5, and a significant proportion of these particles come from fossil fuels [16]. In urban areas especially, this is combined with PM2.5 emissions from road traffic, which are generated more by road and vehicle wear than from exhaust fumes.

The benefits of phasing out fossil fuels would be greatest in North America and Europe, while high levels of air pollutants in countries such as Africa are also caused by the burning of biomass and exposure to mineral dust.

Air pollutants have both acute and long-term effects on health; the effects of high levels of exposure can be seen within hours or days in the form of myocardial infarction, stroke, aggravation of asthma and chronic obstructive pulmonary disease (COPD), and increased risk of acute respiratory tract infections. The effects of long-term exposure include cancers, as well as the onset of asthma and COPD, effects on pregnancy outcomes (reduced birth weight) and increased risk of eclampsia [17]. Recent studies also suggest that air pollution affects cognitive development in children [18] and increases the risk of dementia in later life [19].

The effects of particle exposure do not appear to have a threshold value, instead the relationship is linear even at low levels and may flatten out somewhat at

higher levels [14]. This means that the lower the level of air pollution, the better the cardiovascular and respiratory health of the population in the short term and long term.

Climate and food

What we eat also affects greenhouse gas emissions. Multiple studies consistently show that diets based on cereals, fruit and vegetables lead to lower emissions compared with diets based on fish and meat.

Agriculture currently accounts for around 30 percent of global greenhouse gas emissions, of which about half can be linked to food production, and the rest to changes in land use [20]. Almost half of all arable land in Europe is used to grow animal feed. Livestock farming also produces methane gas emissions, which contribute to the greenhouse effect.

Reducing our intake of animal products has a number of health benefits, including reduced risk of cardiovascular disease, diabetes and mortality in general. This is linked to the following effects:

- Daily consumption of red meat or meat products is associated with increased mortality from cancers and cardiovascular diseases.
- vegetables are high in fibre and reduce the risk of obesity, and hence diabetes.
- saturated fat intake is linked to elevated risk of cardiovascular disease.

Increasing the proportion of vegetables and fruit in our diets and reducing the amount of meat we eat is yet another example of a "win-win" situation, in which we can cut greenhouse gas emissions and improve public health at the same time.

It is difficult to find precise data on the benefits that such a dietary change would have on health. In the UK, Milner et al. calculated that if our diet was modified in line with WHO recommendations, greenhouse gas emissions would fall by 17 percent, and almost 7 million person-years would be saved over a 30-year period [21]. Based on the available scientific evidence, models have been used to determine which diet is associated with the lowest morbidity and premature mortality [22]. This turned out to be a diet which, compared with the average diet, contains less fish and poultry and much less red meat, combined with a high proportion of vegetables, legumes, whole grains, fruit and nuts. Such a diet could reduce the number of premature deaths by around 20 percent per year [22]. Although some criticism has been levelled at this diet for various reasons, it is still a serious attempt to find an optimum healthy diet that would also greatly benefit the climate and ecosystems [23].

According to the UN Food and Agriculture Organization (FAO) about one-third of all the food that we produce is thrown away. It is therefore important to tackle this food waste issue if we are to feed the entire global population, which is forecast to grow to just under 11 billion by 2100.

4 Health impacts of climate change

As the climate changes, extreme weather events will become more frequent and more destructive. Our health and well-being are affected both directly and indirectly by extreme weather events such as torrential rain, floods, storms and drought, as well as temperature-related extremes of weather such as sustained heatwaves and freezing conditions. The effects on health are a function of risk, exposure and vulnerability [5].

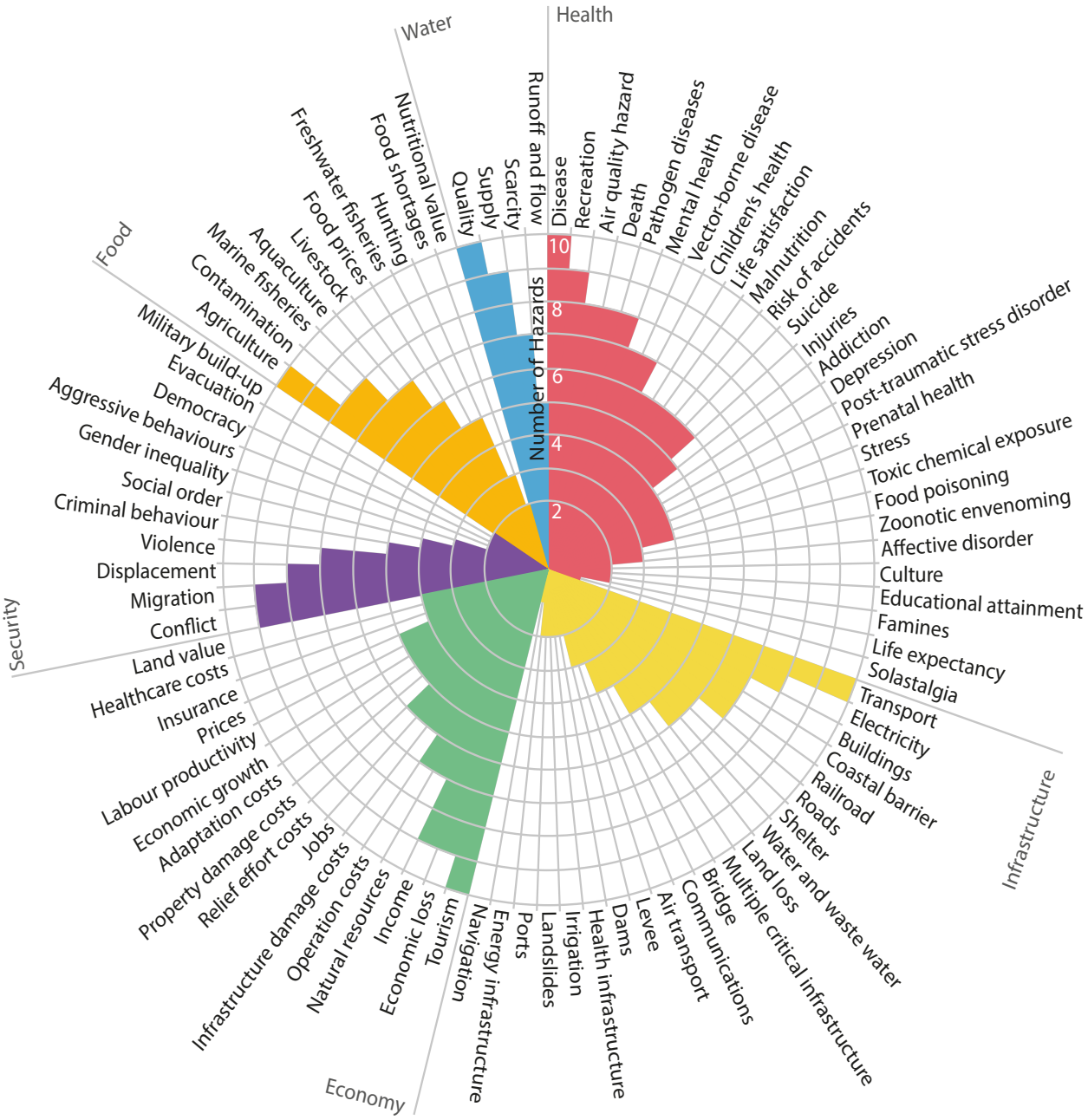

Figure 2.

Societal effects of climate change based on observed changes in temperature and precipitation, occurrences of heatwaves, droughts, floods and fires, and changes in land cover and ocean chemistry. Impacts on six different sectors were analysed: health, food, water, infrastructure, economy and security. The heights of the bars indicate the number of hazards implicated in the impacts (1–10) for each factor. Source: EASAC 2019(5).

High temperatures and heatwaves

The health effects that we hear about most often in relation to climate change occur during periods of high temperatures and heatwaves. Heatwaves are expected to become more frequent and more severe in many metropolitan regions. One example was the deadly heatwave in Europe in 2003, when almost 70,000 deaths were attributed to the extreme heat [24-26]. France was hit hardest of all and had increased mortality across all age groups. In some cities, ozone levels were unusually high at the same time, which also contributed to the high mortality rate.

Based on the climate scenario of a 2°C rise in temperature, the health risks associated with heatwaves in the EU have been estimated at an alarming figure of around 132,000 premature deaths per year from 2100 [27]. Large cities where temperatures tend to be locally higher will be hit hardest if adaptation measures are not taken.

It has long been known that temperatures that are extreme for a region, such as the two-percent hottest day, lead to increased mortality. The graph showing the relationship between daytime temperature and number of deaths is often described as having a soft V-shape, usually with the lowest mortality close to the 80th percentile for 24-hour temperatures [28]. On the high-temperature side there is usually a sharp rise in mortality as temperatures climb, while on the cold temperature side the rise in mortality as temperatures fall is generally weak. The "ideal" temperature varies greatly between different parts of the world, depending on the local climate and how well society and the population are adapted to the climatic conditions. During heatwaves, the rise in mortality seems to be due mainly to the heat alone, but simultaneous exposure to pollutants such as ozone and particles can also contribute to increased mortality, since the groups that are most vulnerable groups to such conditions are largely the same, primarily older people.

In modern society the increase in mortality during heatwaves is highest among older people. Ageing brings about physiological changes in the ability of our bodies to regulate temperature and maintain fluid balance, which means that the elderly cannot compensate for high temperatures as well as younger people. Exposure to heat leads to increased sweating, peripheral vasodilation, increased heart rate and cardiac output, increased blood flow to the skin for cooling, and more rapid respiration. Increased sweating can cause fluid and electrolyte imbalance. Dehydration and greater demand on blood circulation and lung function mean higher risk of myocardial infarction, stroke, organ disorders and death in risk groups [29]. Older people are also more susceptible to illnesses that increase sensitivity to heat, primarily cardiovascular disease, respiratory disease, diabetes and impaired renal function [24, 30-32]. In addition, medicines that are used by many older people can affect heat regulation, circulation and fluid balance.

Sustained high temperatures at night can lead to disrupted sleep, which in itself is a risk factor for cardiovascular disease. The occurrence of kidney stones can

also be affected by temperature, probably due to relative dehydration and concentration of the urine. Research on the interaction between heat exposure and factors such as dehydration, which can potentially threaten health, is a growing field of study [5].

Children can also be affected more severely because their body temperature control is not as effective as that of adults. An increased risk of premature delivery in pregnant women has also been observed at temperatures above 36°C prior to delivery.

In European cities, for example, it is reported that for each degree Celsius above the threshold of the normal maximum temperature in each country, the number of hospital admissions for respiratory diseases rises by up to 4.5 percent [24]. It is therefore expected that both the number of hospital admissions due to respiratory disease and the number of heat-related deaths will increase. On the other hand it is initially expected that there will be a reduction in the incidence of cold-related illnesses, but from around 2080 between 50,000 and 160,000 extra deaths per year are expected due to heatwaves, so the overall effect is negative.

Knowledge of the effects in Sweden is more limited. A study in Stockholm found that people over the age of 50 who had previously been hospitalised with a diagnosis of mental illness, myocardial infarction, COPD or heart failure had an increased risk of dying during a heatwave compared to others of the same age [33]. The heatwave in Sweden during summer 2018 was unusually extreme and is estimated to have resulted in at least 600 premature deaths in Sweden [34]. Neighbouring countries such as Finland and Estonia also reported high mortalities over the same period.

For much of the world, there are few scientific studies on the effects of heatwaves. One study in India and Pakistan concerns the heatwave in the Indian city of Ahmedabad in May 2010 [35]. The temperature reached 46.8°C in the city, which has a population of six million, and the extreme heat led to a 43 percent increase in mortality rate, resulting in just over 1,300 deaths. It is not known how the region as a whole was affected.

Higher temperatures also lead to drought and hence greater risk of forest fires [36]. Forest fires are not just a direct health hazard, they are also a major source of particulate matter and are linked with exposure to volatile organic compounds, nitrogen oxides and sulphur dioxide, which are associated with allergies and respiratory disease. One example was the heatwave in Russia in 2010, which not only led to 44 days of extreme high temperatures, but also forest fires that resulted in prolonged exposure to air pollution well above the recommended limit values. The heatwave and exposure to smoke are estimated to have caused up to 11,000 deaths in the Moscow area alone, and many times more in the region as a whole, as particle levels spiked due to the forest fires [37]. The analysis of mortality figures showed a link between high temperature and particle levels.

Health impacts of floods and drought

There are many mechanisms that contribute to flooding as a consequence of climate change. These include sea level rise, more intense precipitation and the melting of glaciers. Melting ice cover at the poles leads to higher sea levels and changes in ocean currents [38]. The global sea level rose 17 cm during the last century, and is likely to rise even faster during this century. The UN Intergovernmental Panel on Climate Change (IPPC) estimates that sea levels will rise by between 26 and 98 cm by the end of the 2080s. This could submerge 22 percent of the world's coastal areas [38]. Some areas are more vulnerable than others, including densely populated cities and coastal regions. Areas where the natural environment has been destroyed through deforestation, eutrophication, coral death and mangrove decay are also more susceptible, as they have less natural protection from such events [38].

The main health impacts of flooding are reported to be cardiac and vascular events, personal injury, infections, exposure to chemical substances and effects on mental health.

Other examples of health effects due to flooding include injuries and deaths from drowning. Aggravating circumstances that may increase vulnerability can include disruptions to social services, including healthcare, access to clean drinking water, effective sewage treatment and transport.

More than 2,500 deaths were reported and over 5.5 million people were affected by inland and coastal flooding in the EU between 1980 and 2011 [39]. According to projections, the risk of coastal and river flooding is expected to rise in several European regions in the future, with accompanying health risks. If global temperature rise exceeds 2°C, the resulting sea level rise could lead to a five-fold increase in coastal flood damage in the EU and three times as many people would be exposed to flooding [27]. Projections concerning the extent of flooding do however involve some uncertainties, so they should be interpreted with some caution.

The indirect effects of extreme weather include, for example, outbreaks of infectious diseases transmitted by water, food, rodents and other vectors following floods and storms. Waterborne infections and diarrhoea can increase after heavy rainfall and flooding, and higher temperatures may be linked to increased antibiotic resistance in pathogens such as E. coli. Higher temperatures increase the replication rate of Salmonella and its spread in food, and hence the risks of food poisoning. An increase in Norovirus infections can also occur following heavy rain and flooding. In addition to climate change, globalisation and changes in people's lifestyles lead to greater threat from infectious diseases [5].

A warmer climate with more periods of drought also increases the risk of forest fires that can threaten life and health both directly, through catastrophic events, and indirectly, through increased air pollution that can aggravate cardiovascular

and respiratory diseases (see above 5). Forest fires are becoming more frequent in countries that rarely experienced them before, and are happening outside the usual season for forest fires [36]. The total area of scorched land in the Mediterranean area is expected to increase by about 66-140 percent in 2071-2100 according to calculations based on various climate scenarios.

Climate-related infectious diseases

Changes in the climate that include higher temperatures, changing seasons and altered precipitation patterns affect ecosystems and thus the occurrence of climate-sensitive infectious diseases. The biggest change in Europe is seen in what are known as vector-borne diseases – diseases that are spread by arthropods (vectors such as mosquitoes, sand-flies and ticks) and rodents (such as rats, mice and voles). Other factors that affect the spread are vegetation, human behaviour, the presence of non-human hosts such as deer, and the availability of vaccination programmes

[40]. Several vector-borne diseases will be affected by climate change. The most relevant in Europe are malaria, West Nile fever, Chikungunya and Dengue fever [40]. There is some debate about whether recent outbreaks of the viral diseases Ebola and Zika were climate-related, but this is not yet clear.

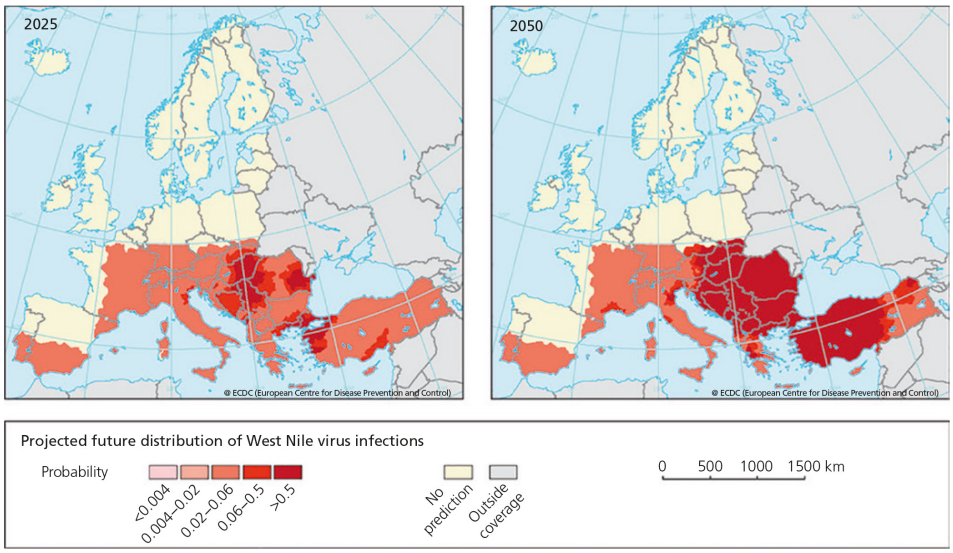

Figure 3.

Projected distribution of West Nile Fever, a viral infection, for the years 2025 and 2050, in a medium-high climate change scenario, from EASAC (5).

The main change we see in Sweden is a northward spread of the tick-borne diseases Borrelia and TBE [41]. One potentially serious climate-related disease that is spread in sea water or brackish water is vibriosis, which became a notifiable disease in 2004. Vibriosis is caused by vibriobacteria that occur naturally in low levels in the Baltic Sea and certain lakes. The growth of these bacteria is temperature dependent and large-scale growth occurs only when water has maintained a temperature above 20°C for several days. Vibriobacteria can cause ear, nose and throat infections, but exposure of wounds to infected water can lead to more serious infections and, in rare cases, blood poisoning [42]. It can be expected that cases of climate-sensitive indigenous diseases, such as TBE, will increase, and that diseases that have not previously occurred in Sweden could spread to the country.

The risk of increased spread of infectious diseases in drinking water, irrigation water and bathing sites is expected to increase, due to higher temperatures and increased precipitation. Higher temperatures can promote the growth of microorganisms, and heavier precipitation increases the risk of flooding and leads to pathogens being carried into clean water sources (see above). In addition to greater risk of infection, higher temperatures also lead to more frequent toxic algal blooms in various bodies of water, including the Baltic Sea. Toxins from these blooms are usually formed by cyanobacteria and have the potential to seriously damage the liver and nervous system. Higher temperatures can also affect the growth of microorganisms in food, which puts greater demands on food safety.

Allergies

Climate change has a direct impact on the length of the pollen season, the amount of pollen that plants produce and the geographical distribution of plants [43]. For example, increased levels of carbon dioxide in the air have been shown to increase the amount of pollen produced by certain grass species. Pollen can be carried by the wind over long distances and affect people who are far away from the source.

In urban environments, the combined effects of air pollution and pollen have been shown to promote the development of allergies and increase the severity of allergy symptoms [44]. In Sweden, the pollen season begins with deciduous trees (hazel, elm, birch and oak) and ends with grass and mugwort. A recent study in the Stockholm area showed that deciduous trees now start producing pollen about two weeks earlier than they did 40 years ago, while grass and mugwort stop producing pollen one or two weeks later than they did 40 years ago [45].

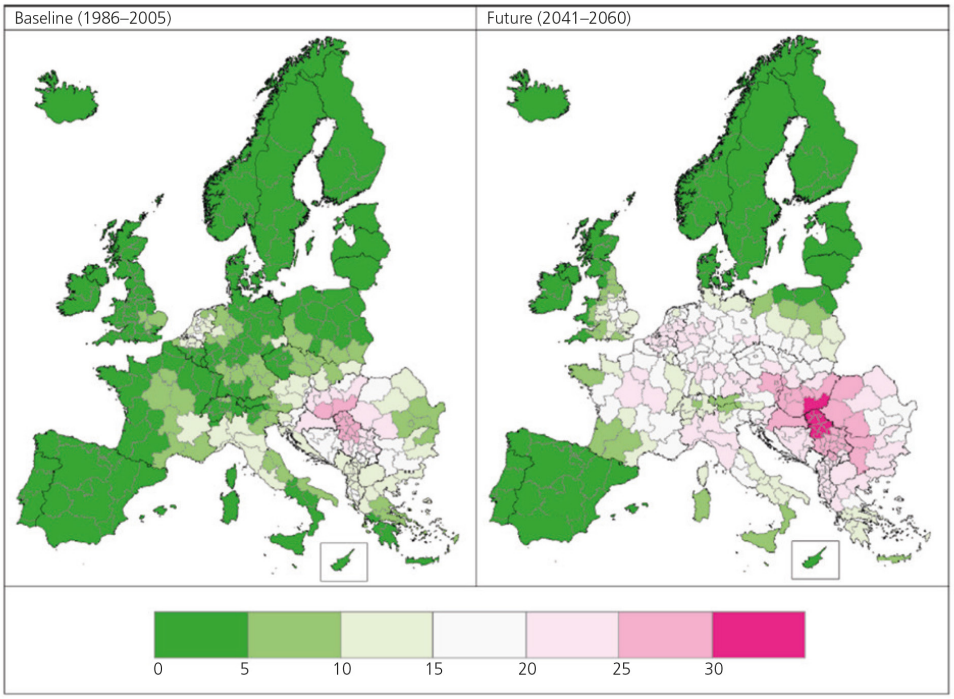

Figure 4.

Percentage of population (%) sensitised to ragweed pollen (Ambrosia artemisiifolia), at present and in 2041–2060. Source: EASAC 2019(5).

Impacts on mental health

Effects on mental health have been reported among people living in disaster-prone areas and can arise, for example, through exposure to extreme weather events, forced migration and greater poverty. Following natural disasters such as floods, studies have reported an increase in symptoms of mental ill health among those whose homes have been affected [46]. Increased prescribing of antidepressant drugs has also been reported after floods [47]. It has also been reported that people who worked as first responders during climate-related disasters were at higher risk of adverse psychological effects [48].

A form of mental distress termed solastalgia has been mentioned in connection with environmental and climate change. It has been described as a sense of loss linked to the destruction of one's land, loss of resources and the lack of reassurance and relaxation that was previously experienced in the home environment [49]. The terms climate anxiety, climate turmoil and pre-traumatic stress are used increasingly often.

The above challenges interact with many social and environmental factors that affect health, and thus pose a threat to global health. The effects of climate change also interact with factors such as an ageing population and growing urbanisation. The risks are unevenly distributed around the world and are influenced by social and economic development as well as the availability and quality of healthcare. This creates challenges for health systems and emphasises the need for long-term, cost-effective and sustainable adaptation measures for society as a whole, in several different social sectors. Such measures should include improvements to systems for monitoring and responding to disease.

5 Availability of food and water

Climate change will affect the availability of food and clean water. If we do not succeed in halting the trend we will see a decrease in the availability of food and water due to drought and loss of arable land. Drought and flooding are already affecting agriculture in several parts of the world. Since 2014, there has been an increase in the extent of malnutrition globally [4]. The availability of food will decrease by up to three to four percent under various climate scenarios [10].

Melting glaciers are a serious threat to the availability of clean water in large parts of Asia and South America. This, combined with a growing population, will mean a poorer diet and increased risk of malnutrition. It is also likely to result in more conflicts and, again, a sharp increase in numbers of refugees.

Arid areas make up 41 percent of the Earth's surface [50]. This proportion is expected to grow as the climate changes and once-fertile land becomes unusable for cultivation. Rainfall will become less predictable and this in turn will aggravate food production problems in some regions. Crops and infrastructure may be destroyed and restrict the availability of food and provisions. In the longer term, rising temperatures will affect agricultural yields. Each 1.5°C rise in temperature has been shown to reduce wheat production by 6 percent in areas that now produce wheat [3], and changes in patterns of agriculture are predicted across regions.

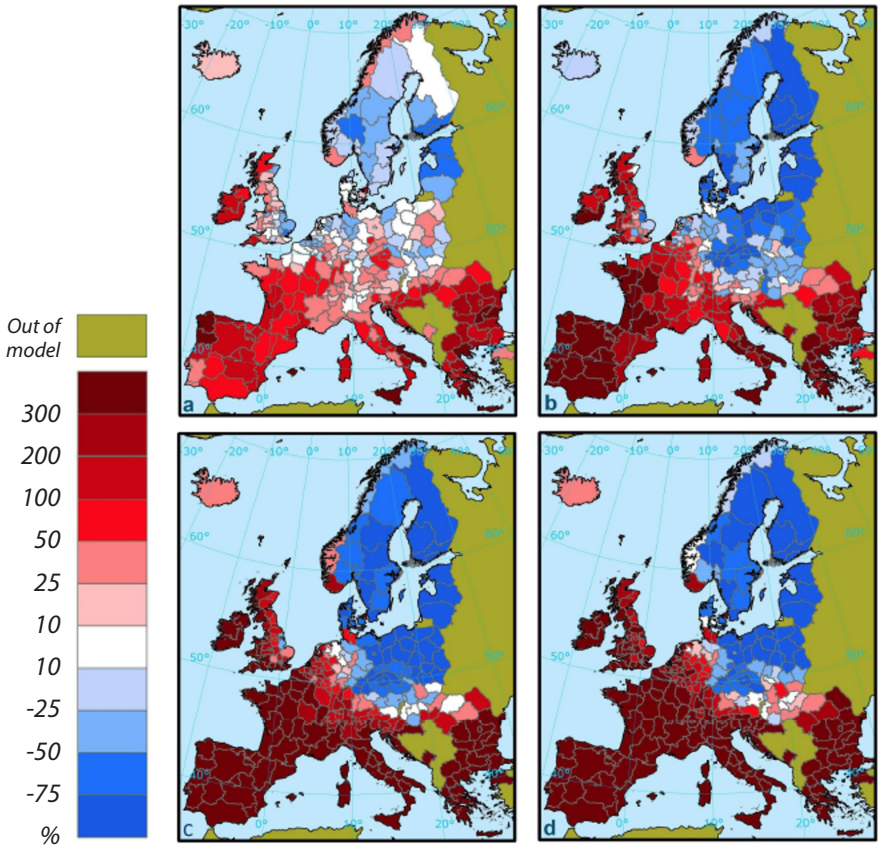

Figure 5.

Areas at risk of drought events due to climate change, (a) at present, (b) 2020–2030, (c) 2050 and (d) 2080. (Based on IPCC's A1B scenario), taken from Forzieri G et al.

In Sweden, the growing season will be extended and agricultural production could consequently increase [51]. Agricultural yield in the province of Västerbotten is projected to rise by 50 per cent, and by 20 percent in the area around Lake Mälaren. A longer grazing season also increases livestock productivity. Under the present agricultural system this increased yield will lead to greater use of artificial fertilisers and antibiotics, the need for which would also increase due to rising numbers of insects as temperatures rise.

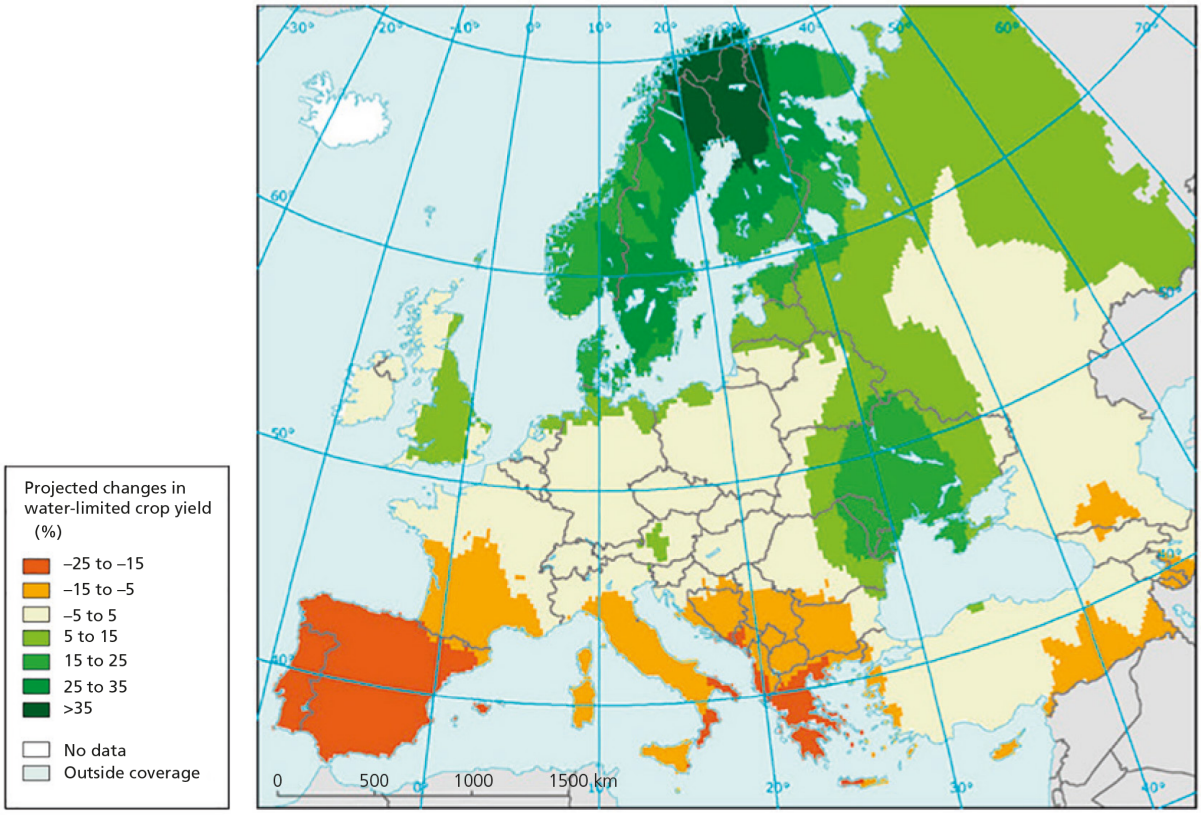

Figure 6.

Projected changes in crop yields by 2050 compared with the period 1961–1990, due to changes in the availability of water, for a medium–high climate change scenario. Source EASAC 2019(5).

An increase in food-related diseases may also arise due to greater need for food hygiene as the climate becomes warmer. Food-related diseases such as Salmonella, Campylobacter and Verocytotoxigenic Escherichia coli (VTEC) could become more widespread if the refrigeration chain is not maintained [51].

Higher temperatures and less predictable weather will have a negative impact on the availability and quality of water in Sweden. Increases in the frequency of drought as well as precipitation and floods are forecast. One of the likely consequences is a decrease in the availability of water in southwestern Sweden and an increase in the rest of the country [51].

Reduced rainfall in some areas will lead to reduced availability of drinking water during the summer months [38], which will necessitate local water

conservation measures, such as irrigation bans. Rising temperatures are likely to increase demand for water at the same time, and place greater strain on resources.

Changes in the availability of fresh water also affect agriculture, forestry and the energy sector, for example by restricting irrigation and hydropower. The growing population in Sweden and in the rest of the world means more demand for agriculture and hence for irrigation. And as countries become more prosperous, water demand for appliances such as washing machines also rises.

More rainfall between autumn and spring will lead to flooding that will also affect arable land, which could contaminate water reservoirs. Inundations of this type can increase the risk of transmission of waterborne diseases such as Salmonella [52]. Heavy rainfall events have been shown to be associated with outbreaks of Cryptosporidium, and non-cholera Vibrio is more prevalent in coastal waters during hot summers [53].

Rising sea levels will also affect the availability of water and agricultural land in low-lying coastal areas, and affect the quality and quantity of crops. Rural areas will be worst affected [2]. As resources become scarce, prices may rise. The less affluent will suffer the most. As is often the case with climate change, vulnerable populations, such as those suffering from malnutrition, will be hardest hit. The World Bank estimates that nearly 800 million people in the world are malnorished, almost 11 percent of the world's population [54].

6 Ability to work

Higher temperatures also pose a threat to people's ability to work, as they reduce productivity and efficiency, seriously affecting the livelihoods and standard of living of people in the worst-affected areas. According to the 2019 Lancet Countdown report, the number of lost working hours increased by 45 billion hours between the years 2000 and 2018 [4]. These problems are most apparent in the agricultural sector, where the impacts are dramatic, but they also affect cognitive ability, and reduced productivity has been reported in all sectors of society. According to a recent analysis by the French Agency for Food, Environmental Occupational Health and Safety (ANSES), professionals in most sectors and in all European countries will be affected by 2050 [5].

7 Migration and conflicts

If climate change continues, growing pressure on resources is likely to lead to more poverty and conflicts. The consequences of climate change, such as lack of water in hot climates, frequent severe flooding, and damage or loss of land and property, are situations that may force people to migrate. Such migration may be temporary or permanent, within one's own country or to other countries.

There are varied estimates of how many people may be forced to migrate due to climate change. The UN estimates that increasing water shortages in already arid areas will lead to the displacement of between 24 and 700 million people [55]. The 2017 Lancet Countdown report estimated that over a billion people will be forced to migrate within the next 90 years unless measures are taken to prevent the polar ice sheets from melting [56]. One of the areas that is likely to be among the worst affected is the Sahel, where it is estimated that up to hundreds of millions of people may be forced to migrate by the end of this century [57]. Dramatic weather events also have psychological consequences, as the changing environment poses a threat to emotional well-being. For example, higher rates of anxiety and depression were reported in children affected by Hurricane Katrina in 2005 [58].

More human conflict is likely to occur as a result of climate change, due to loss of land and infrastructure. The reduced capacity of nations to secure access to food, and reduced nutritional security as a result of drought, are reported to have led to conflicts and forced migration within countries and to other countries.

There are scientific challenges in understanding the causes, dynamics and extent of conflicts and migration problems that will arise as a result of climate change. Understanding the role of climate change in driving migration is often hampered by the complexity of forecasting and by the challenge of correctly estimating the size of population increases and population movements [5].

8 Sustainable healthcare

The purpose of sustainability is to preserve the conditions for future generations to live a good life. This involves several overlapping dimensions: ecology, social justice and economics. Healthcare is both part of the problem and part of the solution.

On the one hand, the global healthcare sector is responsible for 4.4 percent of global net greenhouse gas emissions, making it the fifth largest emitter by sector [59]. These emissions are also rising as healthcare is expanded [60]. The main source of emissions is purchased goods and services, such as disposable items and pharmaceuticals (70%) [59]. In Sweden, healthcare accounts for just over 20 percent of public sector emissions and 4.4 percent of total emissions, which is higher than the global per capita average [59]. This means that sustainable healthcare must include measures to reduce emissions.

On the other hand, healthcare plays a vital role in preventing and treating all the climate-related health problems that have already arisen and will arise as we adapt to climate change. In recent years, WHO and the World

Bank Group have highlighted the need to develop healthcare globally to meet these sustainability and resilience requirements [60, 61]. The concept of climate-smart healthcare has been introduced to meet both these sets of requirements and achieve cost effectiveness [60].

Reducing emissions

Greenhouse gas emissions from healthcare arise mainly from the use of materials – primarily all the disposable items that are used in care. Pharmaceuticals are also a large source of emissions, as is energy for heating, cooling and running facilities. Other sources include the transport of goods and laundry, as well as commuting by patients and staff [59]. Only one full-scale assessment of the effects of emission reductions has been conducted in a national healthcare system and this was in the UK (see fact box).

Sustainable healthcare: the case of the UK [62]

The Climate Change Act was introduced in 2008 and a project was set up to increase sustainability in the National Health Service (NHS). First goal: Reduce total greenhouse emissions by 10% within 8 years.

Approach: A clear national strategy with top-level leadership that focused on clear communication of the relevant goals and on generating engagement throughout the organisation. One priority measure was to gather good ideas from employees at various levels and help them to implement those ideas. Considerable resources were invested in setting up guidelines and information, and conducting surveys to monitor attitudes and opinions of healthcare employees and the general public about the ongoing efforts. Good examples were highlighted and rewarded.

Sustainable Development Unit: This unit ensured that plans were implemented, and monitored developments at every level of care. Results were also compiled by the unit.

Results: Carbon dioxide emissions from healthcare were reduced by 18.5% in 10 years. According to key indicators, clinical activity increased by 27%. Emissions due to energy consumption, business travel and medical gases fell by 18.5%. Total savings over the 10-year period were £1.8 billion.

A very different approach is taken in Sweden. Here, a national goal has been set to reduce total greenhouse gas emissions to zero by 2045 [63]. Coordinated efforts are made through the Swedish Association of Local Authorities and Regions (SALAR) to develop better national indicators for greenhouse gas emissions. Many regions are implementing key projects that will contribute to these ongoing efforts. Some of these projects are described in a theme issue on Sustainable Healthcare in Läkartidningen, the journal of the Swedish Medical Association [64].

In the Västra Götaland region it has been shown that greenhouse gas emissions from national healthcare account for 21 percent of public sector emissions and that very large amounts of disposable items and packaging are used during surgery [64]. This can be reduced through better planning and by adapting surgical methods. Emissions can also be reduced by switching to reusable items. Electricity consumption in healthcare facilities can be reduced, as can food waste.

In the Skåne region, a method has been developed and published for measuring and reducing greenhouse gas emissions from two clinical facilities [64]. Substantial reductions in emissions were achieved by minimising waste, using fossil-free products or reusable items and organising healthcare to minimise the use of resources.

Adapting to a changing climate

Section 4 describes the effects of climate change on health that have already been observed. Efforts to adapt healthcare to counteract these effects are also applicable in Sweden. The measures needed to counter the health impacts of heatwaves are based on WHO recommendations [65]. The Swedish Meteorological and Hydrological Institute (SMHI) has set up a warning system for expected heatwaves and there are contingency plans for various levels of risk in society and healthcare [66]. Where climate change has impacts on air quality and raises the risk of spreading infectious diseases, the authorities are required to inform the public and to ensure that healthcare personnel and other professionals who work with vulnerable individuals receive relevant training. This applies to children, the elderly and people with chronic serious illnesses as well as those who are socio-economically vulnerable.

9 Summary

In summary, we believe that climate change is a major threat to our health. The greatest direct threats are:

- Lack of food and clean water
- Heatwaves
- Changing spectrum of disease

Secondary effects may be at least as serious, and include increased risk of conflicts due to lack of food, water and arable land, as well as increased migration. The effects on people's mental health are also likely to be significant; primarily among those who are directly affected by extreme weather events, for example, but also in the form of greater worry and anxiety about the consequences of a changing climate.

Globally, the effects are very unevenly distributed, and rising temperatures will hit poor countries hardest of all, while in the Nordic region the effects are likely to be less serious from the global perspective. Nevertheless, we are already seeing the effects of a warmer climate in the shape of increased risk of heatwaves and forest fires. We still have a lot to gain in this part of the world from limiting climate impact as much as possible!

In autumn 2019 the European Academies' Science Advisory Council (EASAC) published a summary of the scientific evidence on the expected health effects of climate change, focusing on Europe. It paints an alarming picture. For example,

with an average temperature rise of 2°C we can expect an excess mortality rate of just over 130,000 people per year in Europe, solely due to heatwaves in 2100. But EASAC also concludes that rapid and decisive measures to reduce greenhouse gas emissions and restrict temperature rise to less than 2°C above pre-industrial level would reduce the risks of the worst effects on health.

The good news is that key measures to counter climate change also have positive effects on health, and phasing out fossil fuels is one of the most urgent priorities. These fuels currently account for the largest proportion of greenhouse gas emissions, and also affect our health. The use of fossil fuels has been estimated to give rise to 3.6 million premature deaths per year globally [15]. According to the latest UNEP report, greenhouse gas emissions must fall by 7.6 percent per year between 2020 and 2030 globally in order to achieve the 1.5°C target [67].

Changes in eating habits that include eating less meat and eating more fruit and vegetables also reduce greenhouse gas emissions and have substantial benefits for our health. From a global perspective, food production is also one of the main sources of greenhouse gas emissions. The way that food that is currently produced, processed and marketed is also a significant contributor to ill health, since it promotes a diet that is too high in fat, sugar and salt, and leads to high calorie intake and overconsumption of red meat and processed meat products [68]. An optimised climate-smart diet could reduce the number of premature deaths by about 20 percent per year [22].

Solutions are therefore within our reach and much can be done based on existing knowledge. As EASAC also points out, the scientific community has an important role to play in raising awareness of the effects of climate change on health, as well as the urgent need for change and measures to limit the rise in temperature. Strong public support for such measures is essential in order for the necessary measures to be implemented at political level. Raising awareness of the effects of a changing climate is therefore an important step. We have not faced a greater threat to public health in the modern age. Within the healthcare sector we therefore have an especially important role in raising awareness and preventing the worst effects. We also need to set good examples, for example, by reducing the waste of resources in healthcare, and helping to reduce our climate footprint.

We live in an age of greater global welfare. Never before have so many people had such good opportunities for good health. If we fail to solve the climate crisis, we will be unable to achieve a good and fair standard of health for everyone. To ensure good health it is vital that we have access to food, clean water, education, ecosystem services, justice and peace. This is all at risk if we do not adapt and take action to counter climate change.

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