HOUSE OF LORDS Library Briefing

Global Effects of Climate Change on Health Debate on 21 December 2017

Summary

On 21 December 2017, the House of Lords is scheduled to debate a motion moved by Baroness Walmsley (Liberal Democrat) that: "this House takes note of the global effects of climate change on health".

Climate change has been described as one of the greatest challenges of our time, one which requires an international approach to contain. The first international agreement to reduce greenhouse gas (GHG) emissions, the Kyoto Protocol, came into effect in 1997. Its impact was restricted due to the omission of emerging economies such as China. However, it has been succeeded by the Paris Agreement, the first truly global agreement—ratified by 170 parties, including China—to reduce emissions.

At present climate change policy in the UK is largely driven by EU law. The EU also represents the UK and other member states in the negotiation and implementation of international agreements relating to the environment, such as the Paris Agreement. The UK's measures to tackle climate change are embedded in national legislation through the Climate Change Act 2008. The 2008 Act stands irrespective of the UK's membership of the EU and as such its main targets and overall approach will remain in a post-Brexit UK.

The Climate Change Act 2008 provided a legally binding framework to cut UK GHG emissions and various other measures to support implementation. It includes a requirement for a climate change risk assessment to be carried out. The latest risk assessment, published in 2017, noted a number of potential risks that have the potential to affect public health in the UK, including heatwaves, flooding and droughts.

The World Health Organisation (WHO) notes that the health effects of a changing climate are likely to be overwhelmingly negative due to how it impacts basic human needs: clean air; safe drinking water, and access to food and shelter. Impacts of climate change such as temperature-related illness, extreme weather events and disease are all predicted to increase. These are likely to disproportionally impact less developed nations and the most vulnerable in society. However, the UK will not be immune to these effects and, it is argued, climate change policy must reflect this. The UK Government has identified poor air quality as the largest environmental risk to public health in the UK. Exposure to air pollutants has been linked to cancer, asthma, stroke and heart disease, diabetes, obesity, and changes linked to dementia.

Table of Contents

Des McKibbin | Suzie Cave
14 December 2017

Table of Contents

---

1. Introduction

On 21 December 2017, the House of Lords is scheduled to debate a motion moved by Baroness Walmsley, the Liberal Democrat Spokesperson on Health, that: "this House takes note of the global effects of climate change on health".

As Co-Chairperson of the All Party Parliamentary Health Group (APPHG), Baroness Walmsley recently co-chaired a joint event hosted by the APPHG, the All Party Parliamentary Group on Climate Change (APPGCC), the Lancet Countdown on Health and Climate Change, and the UK Health Alliance on Climate Change which addressed the potential impact of climate change on health, mortality and frontline NHS services.[1]

The event drew on findings from the 2017 Lancet countdown report,[2] an independent assessment of the health effects of climate change, produced by a global, multi-disciplinary collaborative of leading experts from 24 academic institutions and intergovernmental organisations. The countdown was launched following the 2015 Lancet Commission on Health and Climate Change, which concluded that, left unmitigated, climate change would undermine 50 years of public health gains, whilst responding to it could represent "the greatest global health opportunity of the 21st century".[3]

The 2015 Lancet countdown report noted climate change posed a range of threats to human health and survival in multiple, interacting ways and that impacts can be direct (eg heatwaves and extreme weather events such as a storm, forest fire, flood, or drought) or indirectly mediated through the effects of climate change on ecosystems (eg agricultural losses and changing patterns of disease), economies, and social structure (eg migration and conflict).[4] Those already affected by poverty or discrimination were often most vulnerable to these effects.[5] This included vulnerable groups in the UK, such as disabled people, children in need, and homeless people.

The linkage between climate change and human health is now widely recognised at both the global level, by the World Health Organisation (WHO)[6] and the European Commission,[7] and the more local level by the UK

---

[1] All Party Parliamentary Climate Change Group, '*Climate Change in the UK: What will be the Impact on Health, Mortality and Frontline NHS Services?*', accessed 6 December 2017.
[2] Nick Watts et al, 'The *Lancet* Countdown on Health and Climate Change: From 25 Years of Inaction to a Global Transformation for Public Health', *Lancet,* 30 October 2017.
[3] Nick Watts et al, 'Health and Climate Change: Policy Responses to Protect Public Health', *Lancet*, 7 November 2015, vol 386 no 10006, pp 1861–914.
[4] ibid, p 1864.
[5] Lancet, *The Lancet Countdown: EU Policy Briefing*, 31 October 2017.
[6] World Health Organisation, *Climate and Health Country Profiles 2015: A Global Overview*, November 2015.
[7] European Commission Joint Research Centre, *Human Health Impacts of Climate Change in Europe*, 2014.

Government.[8] This Library Briefing sets out the approaches taken to mitigate the impacts of climate change more widely before providing a discussion on the main health impacts identified in the literature across four common themes: temperature change; extreme events; disease; and air pollution.

2. Climate Change Policy

2.1 Causes of Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC), the leading international body for the assessment of climate change, anthropogenic emissions of greenhouse gases represent the dominant cause for the warming of the planet:

> Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.[9]

While most scientists agree the main cause of the current global warming trend is human expansion of the "greenhouse effect",[10] there are is also acceptance of a number of natural factors, such as orbital change and the sun's energy that influence climate.[11] According to National Aeronautics and Space Administration (NASA), for example, a decrease in solar activity is thought to have triggered the Little Ice Age between approximately 1650 and 1850, when Greenland was largely cut off by ice from 1410 to the 1720s and glaciers advanced in the Alps.[12] The purpose of this Library Briefing is to inform debate on the health impacts of climate change, and the appropriate policy response. It is not intended to add to or inform the wider debate about climate change.

2.2 Global Policy Response

The United Nations (UN) describes climate change as "one of the greatest challenges of our time […] undermining the ability of all countries to achieve

---

[8] Health Protection Agency, *Health Effects of Climate Change*, September 2012.

[9] Intergovernmental Panel on Climate Change, *Climate Change 2014 Synthesis Report, Summary for Policymakers*, 2014

[10] ibid, p 2.

[11] Committee on Climate Change, 'What is causing climate change?', accessed 12 December 2017.

[12] National Aeronautics and Space Administration, 'Global Climate Change: A Blanket Around the Earth', accessed 12 December 2017.

sustainable development".[13] According to the UN:

> Increases in global temperature, sea level rise, ocean acidification and other climate change impacts are seriously affecting coastal areas and low-lying coastal countries, including many least developed countries and small island developing States. The survival of many societies, and of the biological support systems of the planet, is at risk.[14]

Managing the impacts of climate change requires a global response. For this reason, there has been increasing international cooperation on climate change mitigation strategies since the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992.[15]

The UNFCCC was created in 1992 as the main forum for international action on climate change. UNFCCC negotiations led to the Kyoto Protocol in 1997—the first international treaty to mandate country-by-country reductions in greenhouse gas emissions. Targets established in the Kyoto Protocol were met successfully and the 37 industrialised countries reduced emissions by over 10 percent.[16] However, this was not enough to offset the increasing emissions from other industrialising countries (such as China), meaning total global emissions grew over the period.[17]

Paris Agreement

Agreement was reached at the 2015 Paris Climate Change Conference on a successor to the Kyoto Protocol. Unlike Kyoto, which focused on industrialised countries, the Paris Agreement has seen 170 UNFCCC members make voluntary pledges to reduce emissions up to 2030, including China, the US and the European Union (on behalf of the UK and other EU nations). These pledges are known as nationally determined contributions (NDCs). NDCs reflect each country's plan to reduce national emissions and adapt to the impacts of climate change.[18] The main aim of the Paris Agreement is to hold the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit warming to 1.5°C.[19]

---

[13] United Nations, 'Transforming our World: the 2030 Agenda for Sustainable Development', accessed 7 December 2017.
[14] ibid.
[15] Alex Bowen and James Rydge, *Climate Change Policy in the United Kingdom*, Centre for Climate Change Economics and Policy, August 2011.
[16] Committee on Climate Change, 'Global Action on Climate Change', accessed 6 December 2017.
[17] ibid.
[18] United Nations Framework Convention on Climate Change, 'Nationally Determined Contributions (NDCs)', accessed 6 December 2017.
[19] Committee on Climate Change, 'Global Action on Climate Change', accessed 6 December 2017.

Further background on the Paris Conference and subsequent agreement is available in the House of Commons Library Briefing Paper, *The Paris Climate Change Conference* (27 September 2017).

A further House of Commons Library briefing provides details on the ratification of the agreement as well details from the implementation (Marrakesh) conference, which focused on developing rules for monitoring and reporting of countries' NDCs: *Paris Agreement and Marrakech Climate Conference* (25 November 2016).

2.3 European Union

The EU has powers, conferred by various Treaties, to develop policy and legislate on issues relating to the environment and climate change.[20] By Treaty, environmental protection principles are required to be integrated in all activities and decisions within the EU.[21] The EU represents the UK and other member states in the negotiation and implementation of international agreements relating to the environment.[22]

The EU and its member states as well as Norway and Iceland will act together to implement the Paris Agreement. The EU's NDC pledge is based on commitments made in its 2030 Framework for climate and energy,[23] which includes a binding target of at least a 40 percent domestic reduction in economy-wide greenhouse gas (GHG) emissions by 2030 compared to 1990.[24] Under the EU's 2020 Climate and Energy Package, the target to reduce GHG emissions by at least 20 percent below 1990 levels by 2020[25] was exceeded in 2014.[26]

UK's Targets and Brexit

Whilst the UK's climate change policy currently derives from EU environmental law, the UK's measures to tackle climate change are based on the Climate Change Act 2008. The Act stands irrespective of the UK's membership of the EU and as such its main targets and overall approach will remain in a post-Brexit UK.[27] The UK will still be a party to the UNFCCC, and will still be a signatory

---

[20] HM Government, *Review of the Balance of Competences between the United Kingdom and the European Union: Environment and Climate Change*, February 2014.
[21] European Commission, 'Environmental Integration', accessed 7 December 2017.
[22] HM Government, *Review of the Balance of Competences between the United Kingdom and the European Union: Environment and Climate Change*, February 2014.
[23] Council of the European Union, *Council Decision on the Conclusion, on Behalf of the European Union, of the Paris Agreement adopted under the United Nations Framework Convention on Climate Change*, 27 September 2016.
[24] European Commission, '2030 Energy Strategy', accessed 7 December 2017.
[25] European Commission, 'Europe 2020 Strategy', accessed 7 December 2017.
[26] European Environment Agency, 'Overall Progress towards the European Union's '20-20-20' Climate and Energy Targets', accessed 7 December 2017.
[27] Committee on Climate Change, *Meeting Carbon Budgets—Implications of Brexit for UK Climate Policy*, October 2016.

to the Paris Agreement, regardless of its relationship with the EU.[28] According to representatives from the Grantham Research Institute on Climate Change and the Environment, "exiting the EU will mean that the UK will need to make a separate submission of its nationally determined contribution (NDC) to the Paris Agreement".[29] The UK's domestic target for 2030 exceeds the EU target, therefore researchers from the Institute have suggested Brexit will make it more difficult for the EU to achieve its target of reducing annual emissions.

2.4 United Kingdom

The UK is a global leader in attempts to tackle climate change on the basis of its stringent national greenhouse gas emissions targets and the adoption of climate change legislation.[30]

Climate Change Act 2008

The Climate Change Act 2008 (the Act) is the basis for the UK's approach to tackling and responding to climate change. The Act:

- provided a legally binding framework to cut UK GHG emissions;
- established the Committee on Climate Change (CCC) to ensure that emissions targets are evidence-based and independently assessed;
- requires the UK Government to produce a UK Climate Change Risk Assessment (CCRA) every five years; and
- requires the UK Government to produce a National Adaptation Programme (NAP).[31]

Emission Targets

The Act commits the UK to reducing emissions:

- by at least 34 percent compared to the 1990 baseline by 2020;
- by at least 57 percent compared to the 1990 baseline by 2030; and
- by at least 80 percent below 1990 baselines by 2050.

---

[28] Camilla Born, *Brexit and the Paris Agreement*, E3G, June 2016.

[29] Bob Ward and Maria Carvalho, *'Submission to Inquiry by the House of Commons Select Committee on Business, Energy and Industrial Strategy Committee on 'Leaving the EU: Negotiation Priorities for Energy and Climate Change Policy'*, December 2016.

[30] Samuela Bassi and Chris Duffy, *UK Climate Change Policy: How Does it Affect Competitiveness?* May 2016.

[31] Committee on Climate Change, 'Legal Duties on Climate Change', accessed 7 December 2017.

The Act also introduced carbon budgets, which set legally binding limits on the total amount of GHG emissions the UK can emit for a given five-year period:

- The first three carbon budgets were set in law in May 2009 and require emissions to be reduced by at least 34 percent below base year levels in 2020.[32]
- The fourth carbon budget, covering the period 2020–27, was set in law in June 2011 and requires emissions to be reduced by 50 percent below 1990 levels.[33]
- The fifth carbon budget was enshrined in law on 20 July 2016. It requires a reduction in emissions of 57 percent by 2030 compared to the levels in 1990.[34]

An independent statutory body, the Committee on Climate Change (the CCC), was established under the Act to advise the UK Government and devolved administrations on emissions targets and report to Parliament on progress made in reducing greenhouse gas emissions and preparing for climate change.

Devolved Administrations

There are no specific targets for the devolved administrations under the Climate Change Act, however they have to contribute to the overall UK target of 80 percent. The devolved administrations have set their own targets:

The Climate Change (Scotland) Act 2009 requires emissions to be reduced by 42 percent by 2020.[35]

- The Environment (Wales) Act 2016 requires emissions to be 80 percent below 1990 levels by 2050 and it places a duty on Welsh Ministers to set interim targets.[36]
- The Northern Ireland Executive, in its Programme for Government (2011–2015) set a target to reduce GHG by at least 35 percent on 1990 levels by 2025. There is currently no target in place.[37]

Climate Change Adaptation

The Climate Change Act provides a framework for building the UK's ability

---

[32] HM Government, '*The Carbon Plan: Delivering our Low Carbon Future*', December 2011.
[33] ibid, p 3.
[34] Committee on Climate Change, *The Fifth Carbon Budget*, November 2015.
[35] Scottish Government, *Meeting the Emissions Reduction Targets 2013–27*, June 2013.
[36] Welsh Government, *Environment (Wales) Act 2016 Factsheet: Climate Change*, March 2016.
[37] Committee on Climate Change, *The Appropriateness of a Northern Ireland Climate Change Act*, December 2015.

to adapt to the changing climate. In terms of adaptation, the Act requires:

- A UK-wide assessment of the risks and opportunities for the UK arising from climate change. This must take place every five years. The first UK Climate Change Risk Assessment (CCRA1) was published in January 2012,[38] the second (CCRA2) was published in January 2017.[39]
- A programme for adaptation to climate change to address the identified risks so as to deliver resilience to climate change on the ground. This must be put in place and reviewed every five years, and must set out the UK Government's objectives, proposals and policies for responding to the risks identified in the Risk Assessment. The first *National Adaptation Programme: Making the Country Resilient to a Changing Environment* was published in July 2013.[40]

3. UK Climate Change Risk Assessment

In addition to the Committee on Climate Change, the Act also established the CCC's Adaptation Sub-Committee (ASC) specifically to provide advice to the UK and devolved governments on climate change risks and opportunities, and to report to the UK Parliament on the progress being made by the National Adaptation Programme.

The ASC was responsible for producing the evidence report that informed the second Climate Change Risk Assessment (CCRA2) published in January 2017. The evidence report comprises eight chapters written by leading academics, consultants and other experts in the public and private sectors and civil society representing organisations across Great Britain and Northern Ireland. The evidence was peer-reviewed by a panel led by Professor Nigel Arnell of the University of Reading.[41]

The report observed a number of changes in the UK climate:

- UK average temperatures and sea levels have risen in line with global changes. Annual average UK land temperature was 0.9°C higher during the period 2005–2014 compared to 1961–1990, with 2014 being the warmest individual year.
- Average UK sea levels have risen at a rate of around 1.4 +/- 0.2 mm per year since 1901, close to the global average rate of change.

---

[38] HM Government, *UK Climate Change Risk Assessment: Government Report*, January 2012.

[39] HM Government, *UK Climate Change Risk Assessment 2017*, January 2017.

[40] HM Government, *The National Adaptation Programme: Making the Country Resilient to a Changing Climate*, July 2013.

[41] Committee on Climate Change, *UK Climate Change Risk Assessment 2017: Synthesis Report*, July 2016.

- There has been a significant upward trend in annual rainfall over Scotland, to a level more than 10 percent above the average during the early decades of the 20th century. Smaller, non-statistically significant increases in annual rainfall have also occurred over Northern Ireland, England and Wales in recent decades.
- The frequency of severe autumn and winter wind storms increased between 1950 and 2003 although storminess in recent decades is not considered unusual in the context of longer European records dating back to the early 20th century.[42]

The risk assessment noted that not all extreme weather can be linked to climate change, citing the example of the consecutive wet summers in the UK from 2007 to 2012, which are in part attributed to "natural variability in the Earth's atmosphere".[43] The risk assessment does however point to a number of climate change attribution studies in which positive attribution has been possible. The risks attributable to climate change include:

- **Heatwaves**: Climate change has already at least doubled the chance of a severe heatwave in Europe;
- **Flooding**: Studies suggest flood events and extremely wet winters have become more likely;
- **Droughts**: Whilst a change in the likelihood of drought in the UK has not been detected, changes in the frequency of drought have been detected in other parts of the world; and
- **Cold snaps**: Cold weather in the UK is likely to be less severe, occur less frequently, and last for a shorter period of time than was historically the case. However, cold conditions will still occur due to natural variability in the weather from year to year.[44]

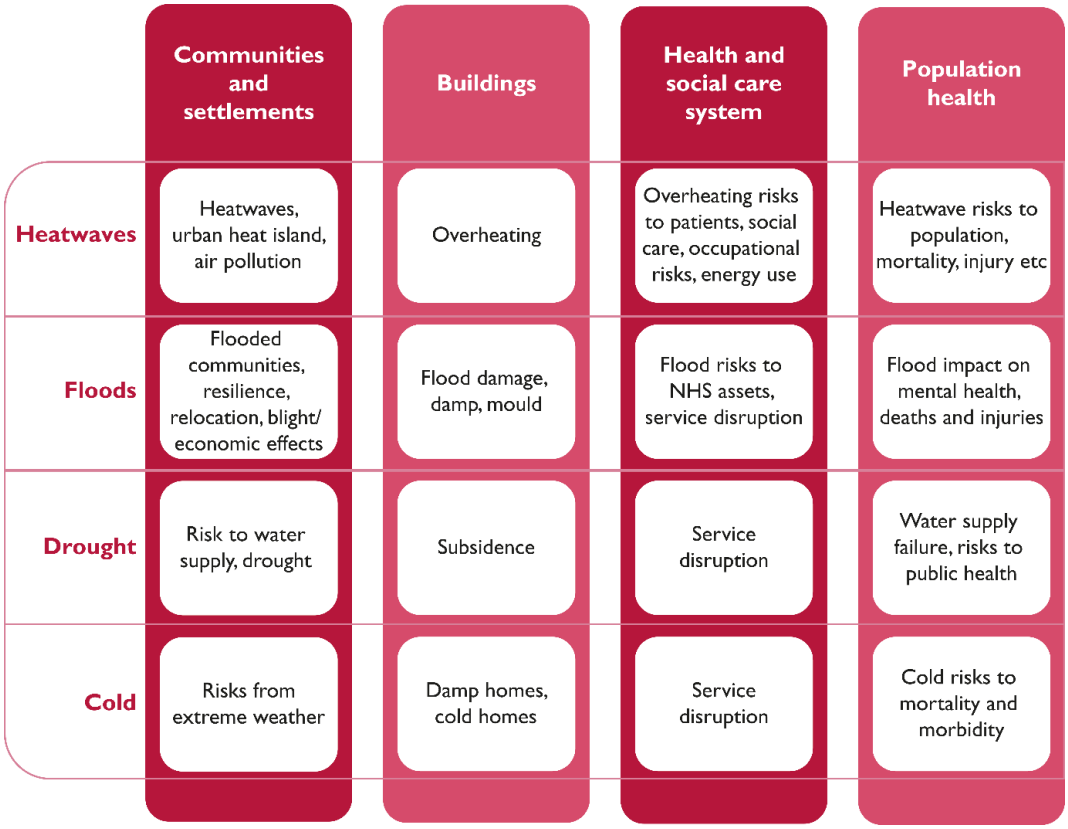
4. Effects of Climate Change on Public Health

According to the World Health Organisation (WHO), while climate change may have minor localised benefits, the overall health effects of a changing climate are likely to be overwhelmingly negative due to how it impacts our basic needs: clean air; safe drinking water, and our access to food and shelter.[45] The risks of climate change interact across multiple levels—communities, buildings, health systems and individuals—are shown below.[46]

---

[42] Committee on Climate Change, *UK Climate Change Risk Assessment 2017: Synthesis Report*, July 2016, p 21.
[43] ibid, p 23.
[44] ibid, p 23.
[45] World Health Organisation, 'Climate Change and Health', accessed 11 December 2017.
[46] Committee on Climate Change, *UK Climate Change Risk Assessment 2017 Evidence Report: People and the Built Environment*, 2017.

Figure 1: Climate Change Hazards affecting People and the Built Environment



(Source: Committee on Climate Change, *UK Climate Change Risk Assessment 2017 Evidence Report: People and the Built Environment*, 2017)

Even by achieving commitments set in the Paris Agreement, it is estimated there will be an increase in mean global surface temperature of 2.7°C by 2100, resulting in significant environmental change.[47] However, if the targets are not achieved, 4.1–4.8°C is possible, with a 6°C rise plausible.[48] The potential ramifications of not making these targets are therefore profound:

- At present an estimated 1.8 million people are living in areas of the UK at significant risk of river, surface water or coastal flooding. This would increase to 2.6 million by the 2050s under a 2°C scenario and 3.3 million under a 4°C scenario.
- A 0.5 to 1 metre of sea level rise could make some 200km of coastal flood defences in England highly vulnerable to failure in storm conditions.
- The number of heat-related deaths in the UK is projected to increase by around 250 percent by the 2050s (median estimate),

[47] Public Health England, 'What does the UK Climate Change Risk Assessment mean for Public Health?', accessed 11 December 2017.
[48] ibid.

due to climate change, population growth and ageing, from a current annual baseline of around 2,000 heat-related deaths per year.

- Climate change is projected to reduce the health risks from cold, but the number of cold-related deaths is projected to decline only slightly due to the effects of a growing, ageing population increasing the number of vulnerable people at risk.
- The effects of climate change on local air quality are complex and uncertain, as they are likely to depend on topography, atmospheric chemistry and emissions from transport systems.
- Health services will be vulnerable to an increase in the frequency and intensity of extreme weather events.
- Higher temperatures in the future may lead to the expansion of insect vectors for certain diseases. For example, Culex modestus has recently been found in south-east England and is a vector for West Nile virus. Higher temperatures in the future will also increase the suitability of the UK's climate for invasive mosquito species.[49]

The remainder of this section will draw on the prevailing body of literature in order to highlight some of the main health impacts at the global and UK level in relation to four identified common themes: temperature change; extreme events; disease; and air pollution.

4.1 Temperature-related Illness

Temperature change is considered to be a direct impact of climate change which can lead to temperature-related illness and death. According to the Intergovernmental Panel on Climate Change's 2013 *Summary for Policymakers*:

> Each of the last three decades have been successively warmer at the Earth's surface than any preceding decade since 1850; in the northern hemisphere, 1983–2012 was likely the warmest 30 year period of the last 1400 years.[50]

According to the *Lancet Countdown Report 2017*, the number of vulnerable people exposed to heatwave events has increased by around 125 million.[51] The World Health Organisation (WHO) projects that there will be an increase in the number of warm days and nights with an increase in the frequency of heat waves and fire risk in low rainfall conditions.[52] According

[49] Committee on Climate Change, *UK Climate Change Risk Assessment 2017 Evidence Report: People and the Built Environment*, 2017.
[50] Intergovernmental Panel on Climate Change, *Summary for Policymakers*, 2013, p 5.
[51] Lancet, *The Lancet Countdown Report 2017*, October 2017, p 6.
[52] World Health Organisation, *Climate and Health Country Profiles—2015: A Global Overview*, November 2015, p 8.

to the WHO this will lead to an increase in heat exhaustion and heat stroke, particularly for outdoor labourers, the elderly and those with cardio-vascular and respiratory problems, all of which will contribute to increased excess heat-related mortality.[53]

At the UK level, a Health Protection Agency (HPA) report, commissioned by the UK Government, stated in 2012 that heat-related mortality caused around 2,000 premature deaths per year.[54] As well as heat, according to the most recent *Climate Change Risk Assessment (CCRA) Evidence Report*, cold-related deaths also present problems in the UK with between 35,800 and 49,700 cold-related deaths per year on average.[55] However, according to the HPA, climate change is projected to reduce the health risks from cold during the second half of the 21st century, with a decrease of 2 percent to 12 percent from 2050 to 2080.[56] At the same time there is expected to be a steep rise in heat-related mortality in the UK from a 70 percent increase in the 2020s to a 540 percent increase in the 2080s.[57]

According to the 2009 UK Climate Change Projections (UKCP09):

> Central England Temperature has increased by about 1°C since the 1970s; it is likely that global emissions of man-made greenhouse gases have contributed significantly to this rise.[58]

The UKCP09 projections expect that in the 2080s, under a medium emissions scenario, all areas of the UK will warm on average more so in the summer, relative to the 1961–90 baseline.[59]

Similar to the WHO[60] and the Lancet countdown report 2017, the HPA highlighted that those most likely to suffer health impacts from any extremes in temperature change are the most vulnerable including the elderly, sick, those working outdoors, and the socioeconomically deprived.[61]

---

[53] World Health Organisation, *Climate and Health Country Profiles—2015: A Global Overview*, November 2015, p 8.
[54] Health Protection Agency, *Health Effects of Climate Change*, September 2012, p 5.
[55] Climate Change Risk Assessment, 'Evidence Report: People and the Built Environment', accessed 11 December 2017.
[56] Health Protection Agency, *Health Effects of Climate Change*, September 2012, p 32.
[57] ibid.
[58] Department for Environment, Food and Rural Affairs et al, 'UKCP09 Briefing Report', June 2009, p 5.
[59] ibid, p 6.
[60] World Health Organisation, *Climate and Health Country Profiles—2015: A Global Overview*, November 2015, p 8.
[61] Health Protection Agency, *Health Effects of Climate Change*, September 2012, pp 32, 43, 47 and 97

The issue of overheating has also been highlighted by the CCC in its 2017 progress report to Parliament,[62] and its subsequent article: *The Hidden Problems of Overheating*.[63] It suggested that the UK Government should do more to address the issue of exposure to indoor overheating of homes and buildings. Not only was this contributing to the 2,000 premature heat-related deaths per year in the UK, but there were also significant associated economic costs. The CCC makes reference to the first UK Climate Change Risk Assessment (CCRA) by the Department for Environment, Food and Rural Affairs in 2012, which states that costs from heat-related mortality due to climate change could increase from £10–50 million per year to £25–150 million per year by 2050 and £40–350 million by 2080.[64] Overheating risks to health was identified as one of the top six key risks requiring more action in the more recent CCRA evidence report.[65]

4.2 Extreme Events

The increased risk of extreme weather events has been positively linked to global temperature increases. Predictions and modelling from the Intergovernmental Panel on Climate Change (IPCC) predict increases in extreme weather events over the 21st century and it attributes this to climate change as a result of greenhouse gas emissions causing rising surface temperatures.[66]

The WHO predicts a 3.7°C rise in global mean surface temperatures by the 2090s compared to 1986 to 2005 temperatures. It predicted such a temperature increase would lead to severe changes to precipitation patterns and frequency and intensity of extreme weather events such as heat waves, flooding and storm surges.[67]

The *Lancet Countdown Report 2017* states that worldwide, a 46 percent increase in annual weather-related disasters, such as floods and storms (based on EM-DAT database figures) was observed between 2007 and 2016, compared with the 1990–99 average.[68] In fact, the 2015 Lancet Commission estimated that an additional 1.4 billion drought exposure events and 2.3 billion flood exposure events will occur by the end of the century.[69]

---

[62] Committee on Climate Change, *2017 Report to Parliament—Progress in Preparing for Climate Change*, June 2017.
[63] Committee on Climate Change, 'The Hidden Problem of Overheating', Committee on Climate Change Blog, accessed 11 December 2017.
[64] Department for Environment, Food and Rural Affairs, *UK Climate Change Risk Assessment 2012*, 2012.
[65] Climate Change Risk Assessment, 'Evidence Report: People and the Built Environment', accessed 11 December 2017.
[66] Intergovernmental Panel on Climate Change, *Climate Change Synthesis 2014 Report*, 2014.
[67] World Health Organisation, *Climate and Health Country Profiles—2015: A Global Overview*, November 2015.
[68] Lancet, *The Lancet Countdown Report 2017*, October 2017, pp 7–8.
[69] ibid, p 8.

It also stated that weather-related events have been associated with more than 90 percent of all disasters worldwide in the past 20 years with 2,843 events recorded between 1990 and 2016, affecting 4.6 billion people and killing 505,013 people.[70] However, the *Lancet Countdown 2017 Report* recognised that information systems have improved over the last 35 years and data is more readily available which may account for better reporting and recording of events.[71]

The *Lancet Countdown 2017 Report: Briefing for UK Policymakers* states that the number affected by weather-related disasters, mainly floods and storms, varies significantly year-on-year; for example, over 340,000 people were affected by flooding in 2007, while in 2006 there were no major incidences of flooding.[72] According to the CCRA evidence report by the CCC, research conducted to support the CCRA suggests that:

- At present an estimated 1.8 million people are living in areas of the UK at significant risk of river, surface water or coastal flooding. The population living in such areas is projected to rise to 2.6 million by the 2050s under a 2°C scenario and 3.3 million under a 4°C scenario, assuming low population growth and a continuation of current levels of adaptation.
- 0.5 to 1 metre of sea level rise could make some 200km of coastal flood defences in England highly vulnerable to failure in storm conditions. Sea level rise and increased wave action will make it increasingly difficult and costly to maintain current sea defence lines in some areas.[73]

Health Effects of Flooding

According to the HPA the health effects of flooding are both direct and indirect:

- Direct health effects are those caused by the immediate effects of flood water, including drowning and physical trauma.
- Indirect health effects are the consequences of flooding and include the impacts from damage to infrastructure, water supplies, displacement and disruption to people's lives.[74]

The deaths of over 200,000 people have been attributed to flooding over the past 30 years, 2.8 billion have affected by flooding worldwide in the same

---

[70] Lancet, *The Lancet Countdown Report 2017*, October 2017, p 7.
[71] ibid, p 8.
[72] Lancet, *Lancet Countdown 2017 Report: Briefing for UK Policymakers*, October 2017.
[73] Climate Change Risk Assessment, 'Evidence Report: People and the Built Environment', accessed 11 December 2017.
[74] Health Protection Agency, *Health Effects of Climate Change in the UK 2012*, September 2012.

period.[75] According to the WHO, two thirds of the deaths associated with flooding are from drowning, and the other third are from physical trauma, heart attacks, electrocution, carbon monoxide (CO) poisoning and fire. Often the impacts are likely to be underestimated as only immediate traumatic deaths from flooding are recorded.[76]

Research by the British Red Cross into the experience of flooding in the UK found that "the impact on health, both physical and psychological, can be both profound and long-lasting".[77] Physical health impacts included fatalities, injuries and the occurrence of disease, although the number of fatalities and incidences of disease outbreak have been relatively low in the UK.[78] Reported psychological health issues include acute stress, clinical depression and anxiety, and post-traumatic stress disorder.[79]

4.3 Disease

According to the WHO, higher temperatures and humidity create the ideal conditions for increased microbial growth, survival and transmission of food- and water-borne disease and vector-borne disease from parasites and insects etc.[80] The *Lancet Countdown 2017 Report* states that vectoral capacity for the transmission of dengue fever by *Aedes aegypti* and *Aedes albopictus* has increased by 9.4 percent and 11.1 percent respectively, due to climate trends since the 1950s.[81]

At the UK level the HPA warns that the activity and vector potential of ticks and mosquitoes will increase across the UK by the 2080s.[82] Of concern is the introduction of exotic species and pathogens due to milder winters and warmer summers in accordance with UKC09 projections.[83] The HPA also warns that climate change may impact the incidence of certain water and food-borne diseases, such as salmonella, increased algae and cyanobacterial blooms, due to warmer, wetter conditions.[84] It also adds that climate change adaptation strategies, such as the creation and expansion of inland wetlands and coastal marshes, can contribute to the impact.[85]

---

[75] World Health Organisation, *Floods in the European Region: Health Effects and Their Prevention*, 2012.
[76] ibid, pp VII and 83.
[77] British Red Cross, *The Experience of Flooding in the UK: Research Study*, August 2009, p 16.
[78] ibid, p 15.
[79] ibid, p 16.
[80] World Health Organisation, *Climate and Health Country Profiles—2015: A Global Overview*, November 2015, p 8.
[81] Lancet, *The Lancet Countdown Report 2017*, October 2017, pp 1 and 9.
[82] Health Protection Agency, *Health Effects of Climate Change*, September 2012, p 159.
[83] ibid.
[84] ibid, pp 200 and 203.
[85] ibid, p 159.

According to the CCRA 2017, culex modestus has recently been found in south-east England and is a vector for West Nile virus. Higher temperatures in the future would also increase the suitability of the UK's climate for invasive mosquito species.[86]

4.4 Air Pollution

Air quality can be impacted by climate change and, conversely, climate change can impact air quality. According to the Air Quality Expert Group, a body set up to provide independent scientific advice on air quality to the UK Government and devolved administrations, in principle, any pollutant that contributes to both local and regional pollution problems has the potential to affect climate change. Fine particles of black carbon (soot) from diesel and biomass combustion and ground level ozone are leading examples:

- Black Carbon is a "short-lived climate pollutant" (SLCP) that is a major component of health-harmful PM2.5 air pollution—particularly from diesel vehicles, diesel engines, coal and biomass stoves and waste incineration. Since black carbon persists for only a short time in the atmosphere, reducing black carbon emissions can have significant near-term climate and health benefits.
- Ground-level Ozone is also an SLCP, formed by a mix of air pollutants typically emitted over cities or nearby rural areas, including methane (another SLCP) from urban sewage, waste, and agriculture, as well as NOx from vehicles. Along with being a key factor in respiratory illness, ozone decreases crop yields and contributes to climate change. [87]

According to the European Commission, combined policies for better tackling of climate change and air pollution can provide mutual benefits: climate change mitigation actions can help reduce air pollution, and clean air measures can help reduce GHG emissions leading to reductions in global warming.[88]

Health Impacts

According to the WHO, "air pollution is the contamination of the environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere".[89] It is primarily caused by the combustion of fossil fuels, motor vehicles and industrial facilities.

---

[86] Committee on Climate Change, *UK Climate Change Risk Assessment 2017 Evidence Report: People and the Built Environment*, 2017.
[87] World Health Organisation, *Air Pollution, Climate and Health*, accessed 12 December 2017.
[88] European Commission, *Air Pollution and Climate Change*, November 2010.
[89] World Health Organisation, 'Air Pollution', accessed 11 December 2017.

The Department for Environment, Food and Rural Affairs describes poor air quality as "the largest environmental risk to public health in the UK".[90] The effects of exposure to air pollutants include:

- Particulate matter (PM) can cause respiratory effects such as wheezing and coughing and can worsen asthma and chronic bronchitis. Fine particulate matter, PM2.5, is of particular health concern due to penetrating deep into lungs and other tissues, including the brain, with a range of negative health effects from both long and short-term exposure, such as increased levels of fatal cardiovascular and respiratory diseases.
- Nitrogen oxides (NOx) cause inflammation of the airways and are associated with reductions in lung function. NOx emissions include both primary NO_2 and nitric oxide (NO) with the latter reacting in the atmosphere to produce secondary NO_2.
- Carbon monoxide (CO) reduces the blood's capacity to carry oxygen through the body and blocks biochemical reactions in cells.
- Sulphur dioxide (SO_2) and Ozone (O_3) are both respiratory irritants and exacerbate asthma.[91]

According to the Royal College of Physicians (RCP), each year in the UK around 40,000 deaths are attributable to exposure to outdoor air pollution, with more also linked to exposure to indoor pollutants. Air pollution has been linked to cancer, asthma, stroke and heart disease, diabetes, obesity, and changes linked to dementia.[92]

Internationally, research has shown that exposure to ambient air pollution increases mortality and morbidity from cardiovascular and respiratory disease and lung cancer and shortens life expectancy.[93] According to the Global Burden of Diseases, Injuries, and Risk Factors Study 2015, air pollution is a leading cause of global disease burden, especially in low-income and middle-income countries.[94] The study estimated that long-term exposure to ambient air pollution caused 4.2 million deaths and 103.1 million lost years of healthy life in 2015.[95] A 2012 WHO study, which used the same exposure estimates, attributed around 3 million premature deaths to air

---

[90] Department for Environment, Food and Rural Affairs, 'Plan for Roadside NO2 Concentrations Published', 26 July 2017.
[91] National Audit Office, *Air Quality*, November 2017.
[92] Royal College of Physicians, 'Every Breath We Take', February 2016.
[93] World Health Organisation, *WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide*, 2006
[94] Aaron J Cohen et al, 'Estimates and 25-year Trends of the Global Burden of Disease Attributable to Ambient Air Pollution: An Analysis of Data from the Global Burden of Diseases Study 2015', *Lancet,* 13 May 2017, vol 389 no 10082, pp 1907–18.
[95] ibid, p 1914.

pollution.[96] The problem is particularly acute in cities within developing countries with 98 percent not currently meeting accepted air quality standards.[97]

Both studies highlighted the importance of collective action being undertaken by municipal, national and international policymakers in sectors like transport, energy waste management, buildings and agriculture. Examples of policies that have reduced air pollution include:

- For industry: clean technologies that reduce industrial smokestack emissions; improved management of urban and agricultural waste, including capture of methane gas emitted from waste sites as an alternative to incineration (for use as biogas).
- For transport: shifting to clean modes of power generation; prioritising public transport, walking and cycling networks in cities as well as rail interurban freight; shifting to cleaner heavy duty diesel vehicles and low-emissions vehicles and fuels, including fuels with reduced sulfur content.
- For urban planning: improving the energy efficiency of buildings and making cities more compact, and thus energy efficient.
- For power generation: increased use of low-emissions fuels and renewable combustion-free power sources (like solar, wind or hydropower); co-generation of heat and power; and distributed energy generation (eg mini-grids and rooftop solar power generation).
- For municipal and agricultural waste management: strategies for waste reduction, waste separation, recycling and reuse or waste reprocessing; as well as improved methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste. Where incineration is unavoidable, then combustion technologies with strict emission controls are critical.[98]

A wider discussion on the impacts of air quality on public health is provided in the House of Lords Library Briefing: *Impact of Air and Water Pollution on the Environment and Public Health* (23 October 2017).

Policy Framework

Action to manage and improve air quality is largely driven by European Union legislation. The 2008 Ambient Air Quality Directive (2008/50/EC) sets

[96] World Health Organisation, 'Ambient (Outdoor) Air Quality and Health', accessed 11 December 2017.
[97] Lancet Commission, *Implications for the Science of Air Pollution and Health*, October 2017.
[98] World Health Organisation, 'Ambient (Outdoor) Air Quality and Health', accessed 11 December 2017.

legally binding limits for concentrations in outdoor air of major air pollutants that impact public health such as particulate matter (PM10 and PM2.5) and nitrogen dioxide (NO_2).[99]

The UK is currently required to report air quality data on an annual basis under the following European Directives:

- The Council Directive on ambient air quality and cleaner air for Europe (2008/50/EC).
- The Fourth Daughter Directive (2004/107/EC) under the Air Quality Framework Directive (1996/62/EC).[100]

According to the National Audit Office, the UK has made significant progress in reducing emissions of air pollutants over the past few decades.[101] For example, NO_x and $PM_{2.5}$ fell by 69 percent and 76 percent respectively from 1970 to 2015.[102] This has been achieved through legislation on industrial emissions, European vehicle emission standards and a shift in the UK fuel mix away from coal, among other measures.[103]

Policy: Air Quality Plan for Nitrogen Dioxide (NO_2) in UK (2017)

The UK meets European air quality standards for nearly all pollutants. However, in 2016 37 of the UK's 43 air quality zones exceeded the annual NO_2 limit.[104] Nitrogen dioxide pollution occurs alongside roads in cities and towns. As a result, in 2017 the Government launched a statutory air quality plan, setting out how the UK will be reducing roadside NO_2 concentrations.[105] Measures to improve air quality include banning the use of conventional cars by 2040, investing in ultra-low emission vehicles, promoting and investing in greener transport and publishing a clean air strategy in 2018.[106]

---

[99] Department for Environment, Food and Rural Affairs, *Air Pollution in the UK 2015*, September 2016.
[100] ibid, p 3.
[101] National Audit Office, *Air Quality*, November 2017.
[102] ibid, p 14.
[103] ibid, p 14.
[104] ibid, p 17.
[105] Department for Environment, Food and Rural Affairs, 'UK Plan For Tackling Roadside Nitrogen Dioxide Concentrations', July 2017.
[106] ibid, p 5.