

UK Climate Risk
Independent Assessment
(CCRA4)

Technical Report

Chapter 5: Health and Wellbeing

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14 5.1 Chapter summary

Headlines

- Risks to Health and Wellbeing identified in previous Climate Change Risk Assessment Technical Report, CCRA3-IA-TR, persist and the need for action to address them is now more urgent, based on new evidence.
- For Health and Wellbeing, the highest urgency risk is from heat (H1), where critical action is needed.
- Risks to the health and wellbeing of people also come from air quality (H3), where 'Critical Investigation' is needed, and from other extreme weather (H2), climate-sensitive infectious diseases (H4) and to health and social care delivery (H6), where more action is needed.
- Across all risks to Health and Wellbeing, heat (H1) acts as a compounding hazard.
- Young children, elderly people, pregnant women, and people with underlying health conditions were consistently the most vulnerable groups to all risks assessed as 'Critical Action Needed'.
- Evidence was weaker for cause-specific mortality (how many deaths are caused by a specific factor), or major and minor health impacts. Evidence was also much weaker for delayed, or long-exposure health impacts, which includes mental health, or how continuous exposure to small changes in climate can impact later life health.

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16

17 **Risks to Health and Wellbeing identified in CCRA3-IA-TR persist and the need for action to address them is**
18 **now more urgent.** This is because of new evidence linking poor health and wellbeing to climate change, and
19 because the increased warming in the last five years has led to stronger evidence linking climate change and
20 health issues. Changes in substantial action to mitigate the risks have been limited or absent. While the
21 evidence base has evolved, there are still many gaps in our understanding.

22 **Risks arising from heat (H1) have been assessed as 'critical action needed' for the UK.** Increases in heat and
23 heat extremes pose a significant health threat, with specific evidence for England, Scotland, and Wales. This
24 threat is apparent in outdoor and indoor settings, and can threaten health and social care delivery.

25 **It was determined there is 'more action needed' across the UK for risks from other types of extreme weather**
26 **(H2), climate-sensitive infectious diseases (H4), and health and social care delivery (H6).** The UK is also facing
27 an increased risk of flooding, which poses significant health risks to both physical and mental health. Detection
28 of new health-relevant pathogens and vectors in the last five years, especially in England, points toward a
29 growing risk of future outbreaks of diseases, including West Nile virus, dengue, and tick-borne encephalitis.
30 Given a strong association between certain food-borne and water-borne diseases with temperature, the risk of
31 outbreaks for these types of diseases is expected to increase as temperatures in the UK rise.

32 **The evidence base gathered was considered comprehensive for the health risks related to heat (H1), other**
33 **extreme events (H2), and health and social care delivery (H6).** The highest quality of evidence focused on
34 population exposures, or overall deaths related to these risks. However, this evidence generally did not specify

35 the cause of death, such as respiratory or heart failure. Evidence was considerably weaker for non-lethal health
36 impacts, or delayed health impacts associated with long climate exposures.

37 **There is more evidence to constrain the magnitude and trend for risks in the current climate than for future**
38 **scenarios, especially when considering adaptation.** There is an urgent need for studies projecting health
39 hazards under future climate scenarios, especially for climate-sensitive infectious diseases (H4), and to a lesser
40 extent for food safety and nutrition (H5). Scenarios that include different potential adaptation pathways are
41 extremely difficult to construct, and as such are largely absent across risks.

42 **Across all risks to health, heat (H1) acts as a compounding hazard.** Indoor and outdoor adaptation strategies
43 that address this risk will, in general, reduce the other health threats explored across this chapter. Heat changes
44 land processes, increasing flooding and drought exposure (H2), altering air quality contaminants and exposure
45 (H3), helping infectious diseases spread and grow (H4), including through food safety (H5), and disrupting health
46 and social care delivery (H6).

47 **Critical action for adaptation was identified in the most vulnerable groups across all risks. These include young**
48 **children, elderly people, pregnant women, people with outdoor livelihoods, and people with underlying**
49 **health conditions.** Adaptation measures that target these groups are needed, including associated infrastructure
50 such as childcare facilities, schools, hospitals, and social care.

51 **Adaptation interventions which promote use of green and blue spaces create opportunities for better physical**
52 **and mental health (H7).** Green spaces can serve as natural buffers against climate change and extreme weather,
53 reducing higher temperatures felt in built-up areas (known as urban heat island effects), reducing the risks of
54 surface flooding, and filtering out harmful air pollutants. Climate adaptation strategies that enhance the quality
55 and access of green infrastructure can act as a dual solution for climate resilience and public health.

Table 5.1: List of risks and urgency scores for Health and Wellbeing. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation. MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action. Details of how the urgency scores are calculated is provided in the Methods Chapter. Where insufficient evidence is available to provide urgency scores at an individual country level, a single score is provided at the UK level in a merged box.

ID	Risk		Present	2030	2050	2080	Urgency
H1	Risks to people from heat	UK	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	CAN
		England	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	CAN
		Northern Ireland	+ (M)	+ (M)	+ (H)	+ (H)	CI
		Scotland	+ (H)	++ (VH)	++ (VH)	++ (VH)	CAN
		Wales	++ (H)	++ (VH)	++ (VH)	+ (VH)	CAN
H2	Risks to people from extreme weather, excluding heat	UK	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
		England	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
		Northern Ireland	+++	+++	+++	+++	MAN

			(H)	(H)	(H)	(H)	
		Scotland	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
		Wales	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
H3	Risks to people from changes in air quality	UK	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
		England	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
		Northern Ireland	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
		Scotland	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
		Wales	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
H4	Risks to people from climate-sensitive infectious diseases	UK	+++ (M)	+ (M)	+ (M)	+ (M)	MAN
		England	+++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Northern Ireland	++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Scotland	++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Wales	++ (M)	+ (M)	+ (M)	+ (M)	MAN
H5	Risk to food safety and nutrition	UK	+ (M)	+ (M)	+ (M)	+ (M)	FI
		England	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Northern Ireland	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Scotland	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Wales	+ (M)	+ (M)	+ (M)	+ (M)	FI
H6	Risks to health and social care delivery	UK	++ (H)	++ (M)	+++ (H)	++ (H)	MAN
		England	++ (H)	++ (M)	+++ (H)	++ (H)	MAN
		Northern Ireland	++ (M)	++ (M)	++ (M)	++ (H)	MAN
		Scotland	++ (M)	++ (M)	++ (M)	++ (H)	MAN
		Wales	++ (M)	++ (M)	++ (M)	++ (H)	MAN
H7	Opportunities for health and wellbeing	UK	+ (L)	+ (L)	+ (L)	+ (M)	FI
		England	+ (L)	+ (L)	+ (L)	+ (M)	FI

		Northern Ireland	(L) +	(L) +	(L) +	(L) +	FI
		Scotland	(L) +	(L) +	(L) +	(L) +	FI
		Wales	(L) +	(L) +	(L) +	(L) +	FI

56

Draft for Community Review

5.2 Risks to Health and Wellbeing

5.2.1 Risk to people from heat – H1

59 This risk considers the current and future risk from extreme heat to the health and wellbeing of individuals. The
60 risk from extreme heat to health and social care delivery (H6), and to buildings and communities (BE1), are
61 considered separately. Risks from other extreme weather (flooding, drought, wildfire and cold) are covered in
62 H2.

Headlines

- Annual heat-related deaths range from 1,400 to 3,000 currently. Heat poses the largest future health threat to the UK population, with annual heat-related deaths projected to be 1,500-4,000 in the 2030s, 3,000-10,000 in the 2050s, and around 9,000 in the 2080s. Population change could double or triple these estimates at the end of the century. The exponential increase in the number of deaths is expected due to climate projections based on built-in greenhouse gas emissions and continued use of fossil fuels globally.
- Evidence for all-cause mortality risk is strong, and evidence for some disease-specific causes is strengthening, such as cardiovascular, renal, respiratory, dementia, and acute mental health conditions. Linking primary care and health cohort data to weather and climate exposure data is needed to assess the evidence base for other diseases.
- Over-65s, young children, urban residents, the socioeconomically deprived, pregnant women, those with underlying health conditions, and outdoor workers are the most vulnerable groups in the population.
- Adverse Weather and Health Plans are in place in England and Scotland and are likely to be advantageous for Wales and Northern Ireland.
- The magnitude and urgency score of this risk has mostly increased since CCRA3-IA-TR. This is primarily due to the introduction of a new risk category, and, to a lesser extent, stronger evidence on disease-specific health outcomes.

63

Table 5.2: Urgency scores for risks to people from heat – H1. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the urgency scores are calculated is provided in the Methods Chapter. Where insufficient evidence is available to provide urgency scores at an individual country level, a single score is provided at the UK level in a merged box.

ID	Risk		Present	2030	2050	2080	Urgency
H1	Risks to people from heat	UK	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	CAN
		England	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	CAN
		Northern Ireland	+ (M)	+ (M)	+ (H)	+ (H)	CI
		Scotland	+ (M)	++ (M)	++ (M)	++ (M)	CAN

		(H)	(VH)	(VH)	(VH)	
	Wales	++	++	++	+	CAN
		(H)	(VH)	(VH)	(VH)	

64 NB: Current estimates are based on all the evidence currently available on estimates of heat-related deaths. This
65 may include data from the past few decades.

66

67 5.2.1.1 Evidence relevant to the entire United Kingdom

68 Current and future drivers of risk

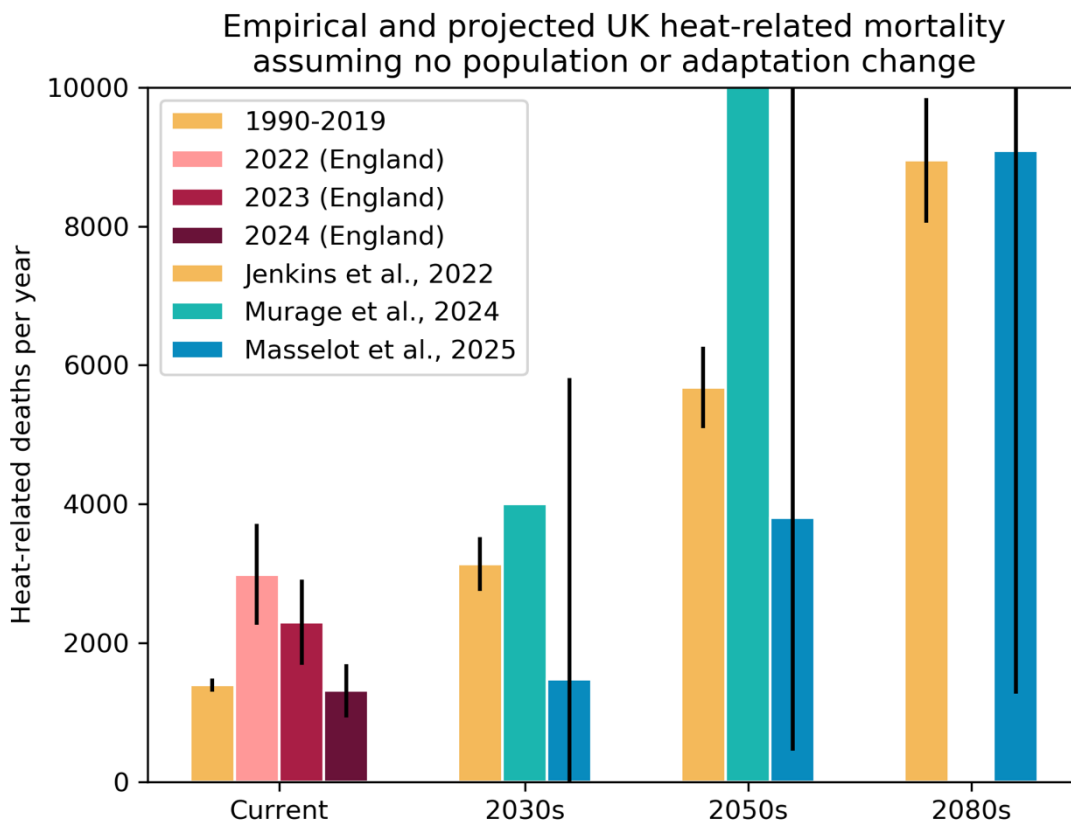
69 High temperatures can contribute to diseases (e.g., cardiovascular, respiratory, renal, skin) (Parker, Mo and
70 Goodman, 2022; Mitchell et al., 2024) and can lead to thousands of deaths in the UK every year. They can also
71 influence the efficacy of medications (e.g., antidepressants), impact wellbeing via altering socialising and sleep
72 patterns (Godwin et al., 2025) and increase domestic and societal violence rates (Hanlon et al., 2021). Heat
73 increases suicide risk (twice the risk at 32 °C versus 22 °C) and can exacerbate the symptoms and medication
74 side effects of psychiatric illness, an illness that affects 16% of the UK population (Environmental Audit
75 Committee, 2023). Heat risks to people’s health and wellbeing are increasing due to climate change (as
76 heatwaves become more frequent and intense; see State of the Climate Chapter), increasing exposure (e.g., more
77 people in cities or "urban heat islands" that are hotter than rural areas), and increasing population vulnerability
78 (e.g., due to ageing). Hot “summer days” and “tropical nights” (where overnight temperature remains above 20
79 °C) pose risks to human health and wellbeing, and they are increasing. At 4 °C global mean warming, southern
80 England and Wales are projected to have up to five tropical nights a year (Hanlon et al., 2021).

81 Vulnerability: The very young, older people, and pregnant people are more vulnerable to heat due to having
82 lower physiological (e.g., sweating) and behavioural capacity (e.g., immerse hands in water, use light clothing,
83 drink plenty of fluids) to control their body temperature. Heat also increases the risk of adverse pregnancy
84 outcomes. People who have disabilities or underlying health conditions (e.g., cardiovascular, lung, heart, and
85 kidney diseases, diabetes, multiple sclerosis, autonomic nervous system issues, and spinal cord injuries) are also
86 vulnerable (NPC et al., 2023). Those older than 75 are more likely to have pre-existing health conditions, making
87 them vulnerable due to both old age and underlying disease. Low-income communities are also vulnerable, as
88 they tend to live in areas with less green space (which helps reduce heat exposure), and they may have less
89 resources to afford fans or air conditioners compared to wealthier communities. Those who undertake hard
90 labour, especially when working outdoors, are also vulnerable (Autonomy Institute, 2023). In addition, there is
91 increasing evidence of socioeconomic inequalities in the impact of heat, which are strongly associated with
92 differences in housing and working conditions. Population groups experiencing deprivation, such as ethnic
93 minorities, may be more exposed to heat due to their housing and working environments (Thompson et al.,
94 2025).

95 Risk Interactions: Heat exacerbates poor air quality (H3), increases the spread of some infectious diseases (H4),
96 threatens food safety (H5), and can affect healthcare delivery (H6). Prolonged heat when combined with lack of
97 precipitation can also lead to drought, which carries additional health risks, mainly due to the impact on drinking
98 water supplies. People's physical exercise may be restricted by extreme heat, and those undertaking or
99 spectating it face a higher risk of heat stress and heat stroke (DCMS Communication, 2024). However, moderate
100 increases in temperature may benefit outdoor activity and increase usage of green and blue spaces (H7).

101 Assessment of current magnitude of risk

102 The current magnitude of the risk is Very High for England, High for Scotland and Wales, and Medium for
 103 Northern Ireland, justified primarily by three independent empirical heat-related mortality estimates. UK annual
 104 heat-related mortality was, on average, 1,400 deaths a year in the period 1990-2019 (Figure 5.1) (Jenkins et al.,
 105 2022), with around 800 in England and Wales (2000-2019 period) (Gasparrini et al., 2022).



106 *Figure 5.1. Empirical and projected UK heat-related mortality, assuming no population or adaptation change in future. The 1990-2019 value*
 107 *is based on Jenkins et al., 2022, whereas England values in 2022, 2023 and 2024 are from the corresponding UKHSA annual reports.*
 108 *Projections relate to the high warming scenarios in the 2030s, 2050s and 2080s under the CCRA4 climate framing, and are based on Jenkins*
 109 *et al., 2022; Murage et al., 2024; Masselot et al., 2025. Error bars indicate the 95% confidence intervals.*

111

112 **Assessment of future magnitude of risk**

113 In the 2030s central heating scenario, annual UK heat-related deaths are projected to rise to around 2,400
 114 (Jenkins et al., 2022). Population growth would increase this to 2,500 deaths, but adaptation could limit this
 115 increase to 1,500 deaths. In the 2030s high scenario, heat-related deaths are projected to be 1,500-4,000 a year,
 116 assuming no population or adaptation change (Figure 5.1). Population growth would amplify this, and
 117 adaptation would decrease this (Jenkins et al., 2022).

118 No heat-mortality estimates are available for the 2050s central scenario, so the urgency score is based on
 119 interpolation between other scenarios in the 2030s and 2050s. In the 2050s high scenario, annual heat-related
 120 deaths are projected to be 3,800-10,000 a year (Figure 5.1). High population growth would increase this number,
 121 but adaptation would reduce this to 2,200 even with population growth (Jenkins et al., 2022).

122 No estimates are available for the 2080s low and central scenarios, but annual heat-related deaths are expected
123 to be in the high thousands given the other values in the 2050s and 2080s. In the 2080s high scenario, annual
124 heat-related deaths are projected to be around 9,000 assuming no population or adaptation change (Figure 5.1).
125 Demographic change or population growth would increase this to 10,000-18,000, suggesting a doubling or even
126 tripling of mortality (Cole et al., 2023). Adaptation on pace with warming would reduce this number to around
127 3,400 (Jenkins et al., 2022).

128 Studies show that among all heat-related causes of mortality, heat related-cardiovascular and respiratory
129 disease will have the largest future increases, followed by renal disease, drowning and mental health problems
130 (small to medium increases) (Mitchell et al., 2024). Renal disease, sleep and cognitive disorders, and skin cancer
131 may be particularly susceptible to persistent exposure to heat over years or decades, and more research is
132 needed to understand the health long-term impacts and repeated or chronic exposure longer-exposure
133 timescales (Mitchell, 2025).

134 **Level of preparedness for risk**

135 The National Adaptation Programme (NAP) is an important mechanism to inform and promote the actions
136 needed to increase heat adaptation (Defra, 2024b), but NAP3 does not define actions at scale to adapt and
137 instead focuses on research needs. While England and Scotland have implemented Adverse Weather and Health
138 Plans (Public Health Scotland, 2024; UKHSA, 2025 (AWHP)), their effectiveness remains to be evaluated, and
139 Wales and Northern Ireland do not have equivalent plans. The Office for National Statistics (ONS) is leading a
140 Climate and Health in Official Statistics project (2022-2026) with UKHSA (ONS, 2024), to estimate local-level
141 impacts, from e.g., extreme weather events, heat-related mortality, non-communicable diseases, respiratory
142 illnesses, and mental health.

143 Policies and plans to address heat risks to people are mostly reactive rather than proactive (Howarth, 2024). The
144 public, and specifically the vulnerable, often do not recognise their risk and there is limited awareness of
145 protective behaviours against heat (British Red Cross, 2021, 2023).

146 **Assessment of the evidence base and evidence gaps**

147 The risk scores are informed by heat-mortality evidence, but not evidence on morbidity. This is mostly due to
148 data scarcity of e.g., GP data. There is limited evidence of the health impacts of chronic heat exposure, and long
149 datasets will be needed to study them. Future projections focused on changes in exposure and vulnerability are
150 missing, (UKHSA, 2024 (HECC chap.2)).

151

152 **5.2.1.2 England**

153 **Assessment of current magnitude of risk**

154 Current risk is Very High, up from High in CCRA3-IA-TR, primarily because of a new Very High category in this
155 assessment. There are thousands of heat-related deaths per year (3,000 in 2022; 2,300 in 2023; 1,300 in 2024)
156 (UKHSA, 2024f, 2025e, 2025f), equivalent to two to five heat deaths per 100,000 people a year. The leading
157 causes for heat-mortality in 2024 were the exacerbation of 'all circulatory diseases', 'dementia and Alzheimer's',
158 and 'influenza and pneumonia' (UKHSA, 2025f). Heat-related mortality is generally higher in London and South
159 East England due to a combination of climate, urban heat island, and socioeconomic factors e.g., deprivation and
160 inequalities in greenspace access (Gasparrini et al., 2022; Konstantinou et al., 2022; Cole et al., 2024; Jackson
161 and Noushad, 2024; Simpson et al., 2024).

162 Hospital admissions for infectious, metabolic, cardiovascular, respiratory and renal diseases, dementia, cancer,
 163 and injuries, increased with high temperatures (Gong et al., 2022; Rizmie et al., 2022; Agewall et al., 2023; Hajat
 164 et al., 2024). In particular, there were 110 to 120 heat-related dementia hospital admissions in 2009 (Gong et al.,
 165 2022). While this is based on England’s evidence, similar trends may apply to the other devolved administrations
 166 (ONS, 2022).

167 **Assessment of future magnitude of risk**

168 Future risk remains Very High. In the 2030s high scenario, assuming no population change or adaptation,
 169 projected heat-related mortality is 3,100 deaths a year (i.e., 6 per 100,000 people; Murage et al., 2024). This
 170 represents a 41% increase from the average annual heat mortality in the period 2022-2024. Regions most at risk
 171 include Greater London, the South East, East of England, the West Midlands, Yorkshire, and Greater Manchester
 172 (Jenkins et al., 2022; Murage et al., 2024). Considering a high climate change scenario, and assuming an increase
 173 in prevalence of dementia but no increases in adaptation, dementia hospital admissions are projected to
 174 increase to around 400-500 a year (Gong et al., 2022). Most of these increases come from the 75-84 and 85+ age
 175 groups.

176 In the 2050s high scenario, heat-related mortality is projected to be around 7,500 a year (i.e., 13 deaths per
 177 100,000 people), with the highest mortality rate in the East of England (Murage et al., 2024). In the 2080s high
 178 scenario, climate change and urban sprawl combined with the expected population increase mean regions in
 179 Southern and Central England will likely experience 13,400 more annual heat-related deaths than the recent
 180 past (Jenkins et al., 2022).

181 **Preparedness and adaptation**

182 England's Adverse Weather and Health Plan (UKHSA, 2025a) includes the Heat-health Alert Service, jointly
 183 provided by UKHSA and the Met Office from June to September, to forewarn health and social care professionals
 184 of high temperatures that may affect public health. However, awareness of the alerts varies, and the health
 185 sector’s response to heatwaves is affected by competing priorities e.g., infection control, electric fan usage and
 186 patient safety (Brooks et al., 2023a). Evidence on the effectiveness of the plan is lacking. Adaptation in prisons
 187 and schools has been required by the Ministry of Justice (2024) and the Department for Education (School
 188 Building Requirements for resilience to 2 °C and adaptation to 4 °C warming), respectively.

189 **Evaluation of urgency score**

190 There is less information on planned adaptation from the 2050s onwards. Due to the Very High projected risk
 191 and the fragmented policy responses, critical action is needed. This score is given with high confidence, given the
 192 quantitative evidence from past heatwave impacts in England and robust projections on future impacts.

193 *Table 5.3: Urgency scores for H1 Risks to people from heat for England. Key to the magnitude scores: very light purple (L) = Low, light
 194 purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.
 195 Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =
 196 Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the
 197 Methods Chapter.*

England				
H1	Risks to people from heat.			
	Present	2030	2050	2080

		Central	High	Central	High	Low	Central	High
No adaptation	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)
With adaptation	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)	+++ (VH)
Urgency scores	CAN	CAN		CAN			MAN	
Overall urgency score	CAN							

198

199 5.2.1.3 Northern Ireland

200 Assessment of current magnitude of risk

201 Current risk is Medium due to evidence showing around seven heat-related deaths in the July 2018 heatwave
 202 and, on average, two deaths a year in the 1981-2000 period (Kennedy-Asser et al., 2025). These numbers are
 203 equivalent to 0.1 to 0.4 heat deaths per 100,000 people. Another study suggested potentially no heat-related
 204 deaths in summers 1991-2018, but with uncertainty (Huang et al., 2020).

205 Assessment of future magnitude of risk

206 Future magnitude is High. In the 2050s, heat-related mortality is projected to be around 16 deaths a year (0.8
 207 per 100,000 people), considering both climate and population change (Kennedy-Asser et al., 2025). In the 2080s,
 208 this is projected to increase to 22 deaths a year (0.8 per 100,000) in a low climate scenario, and 98-108 deaths
 209 (about 4 per 100,000 people) in a high climate scenario (Jenkins et al., 2022; Kennedy-Asser et al., 2025).

210 Preparedness and adaptation

211 There is no heatwave plan in Northern Ireland. The Building Regulations, under review by the Building
 212 Regulations Advisory Committee convened by the Department for Finance, limit internal thermal gains and
 213 require adequate ventilation in all buildings (Department of Finance, 2023). The Department of Communities is
 214 developing a new Housing Strategy that will set out targets for new homes. Housing retrofitting is being
 215 explored by cities including Belfast City Council (Belfast City Council, 2024). These consultations and strategies
 216 remain to be concluded and finalised. The urgency scores are unchanged unless these are implemented.

217 Evaluation of urgency score

218 For current and the 2030s, this projection has changed from High in CCRA3-IA-TR, to Medium, due to two new
 219 studies both projecting fewer than 10 heat-related deaths per year. Before, there was one study that showed
 220 around 20 heat-related deaths (Hajat et al., 2014). Confidence is Low reflecting this disagreement and a small
 221 number of studies.

222

223 Table 5.4: Urgency scores for H1 Risks to people from heat for Northern Ireland. Key to the magnitude scores: very light purple (L) = Low,
 224 light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.
 225 Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =
 226 Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the
 227 Methods Chapter.

Northern Ireland								
H1	Risks to people from heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (M)	+ (M)	+ (M)	+ (H)	+ (M)	+ (H)	+ (H)	++ (H)
With adaptation	+ (M)	+ (M)	+ (M)	+ (H)	+ (M)	+ (H)	+ (H)	++ (H)
Urgency scores	FI	FI		CI			FI	
Overall urgency score	CI							

228

229 5.2.1.4 Scotland

230 Assessment of current magnitude of risk

231 Current risk is High. A 4% increase in mortality, equivalent to tens of deaths, is observed during extreme heat
 232 (Wan et al., 2022). Worsened air quality (H3) was recorded in Scotland in recent heatwaves (Scottish
 233 Environment Protection Agency, 2022), which could have exacerbated the health impact of heat.

234 Assessment of future magnitude of risk

235 Future risk is Very High. In the 2030s, assuming no population change, heat-related mortality is projected to be
 236 around 150 deaths a year (three deaths per 100,000 people; Murage et al., 2024). In the 2050s, this is projected
 237 to increase to 410 deaths a year (8 deaths per 100,000 people; Murage et al., 2024). In the 2080s, Scotland is
 238 projected to have around 420 more annual heat deaths than in the past few years (Jenkins et al., 2022).

239 Preparedness and adaptation

240 Public Health Scotland has an Adverse Weather and Health Plan for 2024-2027 that covers heat (Public Health
 241 Scotland, 2024). It includes developing a real-time surveillance system, scoping potential development of heat-
 242 health alerts, developing a collection of guidance for health professionals and training staff, among others. The
 243 third Scottish National Adaptation Plan (SNAP3) (Scottish Government, 2024b), sets out other on-going activities,
 244 including regulating the design and construction of new homes or buildings to avoid overheating; building
 245 resilience of school estates through the £2 billion Learning Estate Investment Programme (LEIP); and providing
 246 heat adaptation information for households and businesses on the Ready Scotland website.

247 **Evaluation of urgency score**

248 Very High risk for all future time periods, with Low to Medium confidence due to limited evidence. Implemented
 249 adaptation is limited, critical action is needed.

250 *Table 5.5: Urgency scores for H1 Risks to people from heat for Scotland. Key to the magnitude scores: very light purple (L) = Low, light
 251 purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.
 252 Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =
 253 Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the
 254 Methods Chapter.*

Scotland								
H1	Risks to people from heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (H)	++ (VH)	++ (VH)	++ (VH)	++ (VH)	+ (VH)	++ (VH)	++ (VH)
With adaptation	+ (H)	++ (VH)	++ (VH)	++ (VH)	++ (VH)	+ (VH)	++ (VH)	++ (VH)
Urgency scores	CI	CAN		CAN			MAN	
Overall urgency score	CAN							

255

256 **5.2.1.5 Wales**

257 **Assessment of current magnitude of risk**

258 Current risk is High. There are around 30 heat-related deaths per year (Gasparrini et al., 2022).

259 **Assessment of future magnitude of risk**

260 Future risk is assessed to be Very High. In the 2030s high scenario, assuming no population change, heat-related
 261 mortality is projected to be around 240 deaths a year (eight deaths per 100,000 people; Murage et al., 2024). In
 262 the 2050s high scenario, this will increase to 590 deaths a year (19 per 100,000 people). In the 2080s high
 263 scenario, Wales is projected to have 710 more annual heat deaths than in the near past (Jenkins et al., 2022).
 264 Urban areas exposed to direct sunlight will particularly have 4.5 °C increase in ‘peak heat stress’ (Huang et al.,
 265 2024).

266 **Preparedness and adaptation**

267 Public Health Wales provides hot weather public health guidance on their website to target groups, is improving
 268 climate-health surveillance, and developing guidance on overheating on trains (Welsh Government, 2024b)

269 (Government Climate Adaptation Strategy, 2024). Transport for Wales plans to develop heatwave
 270 communication plans for customers and colleagues and consider nature-based methods to prevent stations
 271 from overheating (Transport for Wales, 2023). The Welsh building regulations require overheating mitigation in
 272 new residential buildings. The Welsh Government is exploring extending requirements to existing buildings in
 273 their current Climate Change Adaptation Strategy (Welsh Government, 2024b). The Welsh Housing Quality
 274 Standard (Welsh Government, 2023), requires social landlords to consider the impact of future overheating and
 275 install water butts where appropriate. Research has been commissioned to inform Business Wales on employee
 276 safety in high temperatures.

277 **Evaluation of urgency score**

278 We assess Very High risk across future periods, with Low to Medium confidence due to limited evidence.
 279 Fragmented policy actions and a lack of a national heatwave plan mean critical action is needed.

280 *Table 5.6: Urgency scores for H1 Risks to people from heat for Wales. Key to the magnitude scores: very light purple (L) = Low, light purple
 281 (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where
 282 urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further
 283 Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the
 284 Methods Chapter.*

Wales								
H1	Risks to people from heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (H)	++ (VH)	++ (VH)	++ (VH)	++ (VH)	+ (VH)	+ (VH)	++ (VH)
With adaptation	++ (H)	++ (VH)	++ (VH)	++ (VH)	++ (VH)	+ (VH)	+ (VH)	++ (VH)
Urgency scores	MAN	CAN		CAN			FI	
Overall urgency score	CAN							

285

5.2.2 Risk to people from extreme weather, excluding heat – H2

287 This risk covers extreme weather where there is evidence for an impact on human health and wellbeing in the
 288 UK. The risks covered are flooding, drought, storms (including wind, hail and thunder), wildfire, and cold. Heat is
 289 not included here but is covered separately in [H1](#) due to its relevance to the UK. Water quality impacts on health
 290 related to flooding including risks from exposure to pathogens are covered in [H4](#). While extreme cold
 291 temperatures are considered within this risk (see Box 1), they are not used to inform the overall urgency scoring.
 292 This is because though cold is an important weather risk that will continue to shape winter mortality into the
 293 2070s, it is not expected to increase with climate change in the ways that other weather extremes will.

Headlines

- The magnitude score is High reflecting fewer deaths from flooding, drought and wildfire, compared with heat (H1), but widespread health risks, mostly from flooding.
- The most comprehensive evidence on mental and physical health impacts comes from studies based on flood events and cold exposure, while the health risks of wildfire and drought are less well documented in the UK context.
- Negative health outcomes from future floods and droughts are expected to increase, as a larger percentage of the population become exposed over time – partly due to increased flood and drought risk.
- Moderate, rather than extreme, cold weather is the greatest risk for health and mortality in the UK. The negative health outcomes and deaths from cold are expected to continue until late in the century (2070s), and any reductions will not offset increased consequences of extreme heat. While heat risk will increase mortality and negative health impacts in summers, moderate cold weather will continue to pose significant health risks in winters.
- Across the UK, for all extreme weather types considered in H2, there is a lack of evidence on both mortality and morbidity rates, especially for future risks. New studies for health implications during extreme events, and in the months, years, and decades following are needed.
- Overall combined risks from extreme weather remain high throughout the UK, with new evidence since CCRA3-IA-TR confirming current risks and future potential trends and risks.

294

Table 5.7: Urgency scores for H2 Risks to people from extreme weather, excluding heat. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ = High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H2	Risks to people from extreme weather, excluding heat	UK	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
		England	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
		Northern Ireland	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN

	Scotland	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN
	Wales	+++ (H)	+++ (H)	+++ (H)	+++ (H)	MAN

295

296 5.2.2.1 Evidence relevant to the entire United Kingdom

297 Current and future drivers of risk

298 Key climate drivers are increasingly influencing the risk, severity, and frequency of extreme weather in the UK,
 299 including hazards such as wildfire, cold, hail, ice, flooding (pluvial, fluvial, and coastal), storms, high winds, and
 300 drought. These weather risks are often interconnected: the initial hazard, such as flooding, can trigger wider
 301 disruptions to critical infrastructure, including transport, energy, and telecommunications systems, thereby
 302 amplifying societal impacts, including health risks. Moreover, individual extreme weather events create multiple
 303 hazards. The co-occurrence of wind and rainfall can significantly increase the scale and complexity of impacts
 304 compared to each hazard occurring in isolation (Manning et al., 2024). Interactions further compound risks:
 305 upstream, reduced water quality can impair water supply availability, while downstream, flooding and drought
 306 can pollute vital water sources used for drinking and recreation, leading to potential health risk (see I9).
 307 Additionally, wildfires can mobilise harmful chemicals, contaminating reservoirs and watercourses and having
 308 potential impacts on health (see I9) over and above the air quality-based risks. The impact of such hazards is
 309 socially patterned because of differential vulnerability associated for example with quality of housing and other
 310 protective factors or pre-existing ill health. The impact is also likely to be greater for people living with disability.

311 Assessment of current magnitude of risk

312 Current risk is assessed as High across the UK. This assessment suggests highest impacts from flood exposure,
 313 which is in the low hundreds of thousands of people affected, with additional risks coming from drought and
 314 other extreme events.

315 Flooding: This considers the risk from flooding to the health and wellbeing of individuals. The risk from flooding
 316 for buildings and communities is covered separately in BE2. Health impacts of flooding are both immediate (such
 317 as injuries, exposure to contaminated water, and disruption to healthcare services) and long-term (including
 318 persistent mental health issues like anxiety, depression, and post-traumatic stress). The magnitude for this risk
 319 remains High, in line with CCRA3-IA-TR. Annual estimates of the numbers exposed to surface water or river and
 320 coastal flooding are in the low hundreds of thousands at present, with mental health consequences being
 321 potentially significant. New evidence since 2020 confirms significant flood risk to the UK and negative health
 322 consequences, supporting a confidence assessment of High based on studies with multiple lines of evidence and
 323 using multiple methods.

324 Increased UK flood risk from high river flows is in line with trends across northwest Europe in recent decades
 325 (Blöschl et al., 2019). There is evidence that the increased likelihood of flood events is due to both increased
 326 rainfall and deteriorating urban infrastructure (O'Donnell & Thorne, 2020), and that this amplifies health
 327 inequalities (Sayers, Penning-Rowsell and Horritt, 2018; Kew et al., 2024). Previously low-likelihood or
 328 unprecedented flood extremes are now assessed more likely (Kent et al., 2022; Kay et al., 2024).

329 The primary direct health effects linked with flooding in the UK are drowning, physical trauma, and infections
 330 from exposure to contaminated flood water (Parker et al., 2022). The principal longer term health effects include
 331 mental health issues (such as anxiety and post-traumatic stress disorder), respiratory illness from damp and

332 mould, and less likely and prevalent risks, such as those from rodent borne diseases (MHCLG et al., 2024). For
333 mental health impacts, evidence suggests flood victims experience these outcomes 4-8.7 times more frequently
334 than non-affected populations (Cruz et al., 2020). Other causes of negative health outcomes from flooding
335 include, community displacement, property damage, dealing with administrative bureaucracy, such as that
336 linked with insurance claims, and the associated financial and mental burden of recovery (UKHSA, 2024 (HECC,
337 chap.3)). Some of these aspects can be persistent over years because of home damage from damp and mould
338 (Mulchandani et al., 2020), unrecoverable financial losses, or more acute from disrupted access to health
339 services in the aftermath of flood events (Dodd et al., 2024). Such impacts exacerbate health inequalities:
340 individuals with lower incomes, unemployed, women and those with pre-existing medical conditions are more
341 highly susceptible to negative health outcomes.

342 Health impacts and associated personal health costs for affected populations are well correlated with flood
343 depth, with a flood of up to 30cm depth costing £1,900 per adult, and one of up to 1m costing approximately
344 £4,100 per adult (2018 prices)(Environment Agency, 2021). These figures are per affected adult and encompass
345 treatment expenses, including hospitalisation, general practitioner care, and medication, as well as work-related
346 losses due to absenteeism. (Mulchandani et al., 2020; Findlater et al., 2023). Drawing on these estimates, the
347 costs of floods in terms of mental health are in the hundreds of millions of pounds annually.

348 Indirect impacts of flooding include disruption to ecosystems, often displacing insects and animals, which
349 increases human exposure to bites, stings, and potential infections (see H4) as well as decreasing access to green
350 space for residents. Given the increase in flood trends, the physical and mental health costs of floods are also
351 shown to be increasing (Mulchandani et al., 2020; Findlater et al., 2023).

352 Drought: Drought-health effects in the UK include risks through both direct and indirect pathways. Direct
353 pathways include limited water supply, loss of crops, damage to infrastructure and injury, whereas indirect
354 pathways include ecosystem changes such as change in breeding conditions for vectors, loss of biodiversity,
355 supply chain disruption leading to potential food insecurity and malnutrition. All of these may have
356 consequences for health. The Health Effects of Climate Change (HECC) in the UK report (UKHSA, 2024), highlights
357 the UK's vulnerability to prolonged hydrological droughts, though impacts vary geographically. The report also
358 discusses the health impacts of meteorological, agricultural and socioeconomic droughts – all of which are likely
359 to influence health in different ways. Attributing health effects to drought is challenging due to their slow onset,
360 long exposure windows (potentially from seasons to years), and the influence of concurrent weather events such
361 as heatwaves and wildfires. In addition, there is limited evidence in the UK specific context, with that which
362 exists being largely qualitative (Bryan et al., 2020; Emma L Gillingham et al., 2023). There is insufficient
363 quantified evidence to alter the current risk magnitude from Medium, and the confidence assessment is Low.

364 There is no evidence for the UK of direct mortality from physiological outcomes during droughts. The evidence is
365 based around morbidity and mental health assessments. This includes through reduced water quality, reduced
366 hygiene, food and air quality, algae blooms, transport disruption, vector borne disease shifts, and the impacts on
367 health from fishery, crop, or livestock losses (Bryan et al., 2020; Barker et al., 2024). Mental health in rural
368 communities around periods of drought are a particular concern, with a recent survey finding that nine in ten
369 farmers expressed having anxiety during recent periods of extreme weather in the UK context, with 60% that
370 they were depressed and 6% very depressed (Energy & Climate Intelligence Unit, 2025b).

371 Other extreme events: In addition to the extreme weather types already discussed, the UK experiences changes
372 in health and wellbeing from storms, lightning, hail, thunderstorm asthma (see H3), wildfire burns, and
373 respiratory impacts of wildfires (Mitchell et al., 2024). Extreme weather may lead to power outages, which
374 impact on health, with those in vulnerable groups being particularly at risk (Cox, 2021).

375 Lightning in the UK poses a low annual fatality risk, with an average of two deaths per year, mostly associated
376 with outdoor leisure and sports activities. Over the last two decades high winds and maximum gust speeds show
377 a downward trend, and with heavy rainfall showing a slight upward trend (Kendon et al., 2024). Both influence
378 injuries and deaths, including those from road traffic accidents, through wind pressures, flying debris, and
379 reduced visibility, especially during storms.

380 The effects of wildfire on human health and wellbeing are largely due to inhalation of particulate matter (see
381 H3), pollutant impacts on skin conditions, burns and injuries, and longer-term mental wellbeing (Eisenman &
382 Galway, 2022). There is limited evidence on fatalities and injuries from UK wildfires (UKHSA, 2024d (HECC
383 chap.10)), although some studies exist on the health impacts through inhalation. Confidence is therefore rated
384 as Medium as more insight and data are required.

385

Box 1 - Cold

While the health impacts of cold are considered here, they are not used to inform the overall urgency scoring because they are not expected to increase with climate change in the ways that other weather risks will. However, they are also not expected to reduce significantly until later in the century (2070s) and any reductions will not offset increased health consequences of other weather risks.

Assessment of current magnitude of risk: There is robust evidence for thousands of deaths attributed to moderate and extreme cold each year, with estimates ranging between 13,400-28,000 depending on the years and methods used (Masselot et al., 2023; ONS, 2023; UKHSA, 2024 (HECC chap.2)). Though moderate and extreme cold risk is decreasing with fewer frost and ice days, it remains a Very High current risk with thousands of deaths from cold with the highest number of these attributed to respiratory and cardiovascular diseases (HECC chap.2). Other health impacts include poor mental health, poor sleep quality, arthritic and mobility issues, allergies and dermatological issues, suppressed immune function, and pulmonary, respiratory and cardiovascular diseases (Institute of Health Equity, 2024; Janssen et al., 2023; UKHSA, 2024 (HECC chap.2)). Indirect effects include snow and ice disrupting healthcare services, fuel poverty, social isolation, poor mental health or carbon monoxide poisoning from poorly maintained or ventilated boilers, and cooking and heating appliances with combustion sources (UKHSA, 2025 (AWHP)).

These health impacts pose a disproportionate risk to young children and babies (birth-six years of age), older people (65+), and those with pre-existing long-term mental and physical health conditions, such as cardiovascular or respiratory disease (Lee et al., 2022; Janssen et al., 2023; UKHSA, 2025a (AWHP)). Disabled people, UK minority ethnic groups, pregnant people, and low-income households, as well as those living in rented housing or experiencing homelessness have also been identified as groups with greater risk of exposure to cold (Snell, Bevan and Thomson, 2015; Lee et al., 2022; UKHSA, 2025a (AWHP)).

Assessment of future magnitude of risk: Future risk for cold remains Very High magnitude for all nations for 2030 and 2050 time periods, when considering both moderate and extreme cold. The risk of extreme winter weather remains very high until 2070, and cold risk is expected to continue to lead to deaths in the 1000s until the end of the century.

Extreme cold-related deaths are projected to increase for a period peaking in 2030 before declining by the mid-century (Murage et al., 2024; UKHSA, 2024 (HECC chap.2)). However, moderate and extreme cold combined is expected to remain a substantial mortality burden, and the total burden from moderate cold is projected to still exceed that from heat well into the 2070s (Masselot et al., 2023; UKHSA, 2024 (HECC chap.2)). Reductions in cold remain similar with limited realisation of these through to the end of the century and potential for any benefits during that time to be counteracted owing to an ageing population and increasingly wet conditions continuing to affect indoor environments (HSA, 2024). The modelled assessments for cold risk increasing out to 2070, are largely driven by population changes, particularly ageing.

386

387 **Assessment of future magnitude of risk**

388 The future risk is assessed as High across the UK. Highest impacts are from flood exposure which is in the low
389 hundreds of thousands of people affected. While this number increases for future time periods, it never reaches
390 the millions of people affected that would change the magnitude to Very High.

391 Flooding: Increased spatial and temporal resolution flood risk estimates for the UK have shown that risks are
392 likely to increase, and that the responsiveness to expected annual damages is more responsive to climate than
393 previously measured (Bates et al., 2023). Increases are expected in surface, ground, river, and coastal flooding.
394 For instance, coastal flooding at the end of the century could lead to 120,000-160,000 properties potentially
395 needing to be relocated, if the hold the line policy is abandoned and with increased sea level and storminess
396 associated with >2 °C warming (Sayers et al., 2022). Housing development on floodplains, poor land-use
397 practices, and growing population pressures exacerbate the issue, ensuring the risk remains persistently high.
398 Projected UK demographic changes, population growth and increasingly ageing populations will likely amplify
399 the risk, with current estimates of 6.1 million people exposed to flood risk that are projected to rise by 61% in
400 2050 under a 2 °C scenario, and 118% in a 4 °C scenario (UKHSA, 2024c, chap. 3). The estimated annual numbers
401 of people likely exposed to flooding in the future remain in the hundreds of thousands, with the economic costs
402 of mental health being in the hundreds of millions. In terms of mortality, estimates suggest that for England
403 there is a likely increase in the number of deaths from flooding from 18 per annum to 20 per annum (range 6 to
404 34) (with no population growth) or 29 per annum (range 8 to 49) (with population growth) in the 2050s (UKHSA,
405 2024c, chap. 3).

406 Drought: Droughts are expected to become more frequent and intense due to rising global temperatures and
407 shifting rainfall patterns, with risks expected to grow as climate change progresses (Arnell et al., 2021). The
408 numbers of households impacted by water shortages will increase, with associated health impacts (particularly
409 for vulnerable groups). Existing estimates on future risks to agricultural productivity associated with drought are
410 projected to increase but are likely to remain at a Medium/High level across different scenarios (N6), with
411 associated mental health risks for farmers. The health impacts of droughts are complex and often delayed, and
412 there is emerging evidence for critical exposure periods, for instance changes in blood pressure are observed in
413 adults decades after they were exposed, in utero, during hot dry conditions (Griffith et al, 2025; Lawson et al,
414 2008), although this relationship is complex. Other significant changes come from potential diminished
415 bacteriological quality of private water supplies and air quality through wind-blown dust (such as Fen blows in
416 East Anglia and stours in Scotland) (Bryan et al., 2020).

417 Other extreme events: Thunderstorms and lightning are poorly represented in conventional climate models
418 resulting in high uncertainty in their future trends (Finney et al., 2018; Kahraman et al., 2022). Longer term
419 implications of most extreme weather conditions can increase psychological distress, worsen existing mental
420 health conditions, and strain healthcare services (Green Alliance, 2024b), or can have compounded health

421 impacts from longer exposures, including from societal or economic changes, although much of this work is not
422 quantified yet.

423 **Level of preparedness for risk**

424 The UK Government has made commitments to improve understanding of the risks of extreme weather and its
425 impact on health and wellbeing, such as plans to conduct an annual survey of public perceptions of risk, and
426 preparedness, along with tracking socio-economic resilience (House of Commons Public Accounts Committee,
427 2024). The process of naming storms currently enhances the communication of extreme weather risks. The UK
428 Government Resilience Framework (Cabinet Office, 2022) outlines a comprehensive approach to strengthening
429 national resilience, including extreme weather, and the establishment of the National Situation Centre to
430 monitor and manage risks. The Cabinet Office has also created a resilience directorate and established a senior-
431 level Climate Resilience Board.

432 The UKHSA Adverse Weather and Health Plan (AWHP), first published in April 2023, focuses on addressing the
433 health effects of adverse weather and has undergone an equity review and impact assessment to evaluate its
434 impact on various populations (UKHSA, 2025a). The AWHP consolidates guidance on health impacts from
435 flooding, drought and cold (and heat), flagged by the UK National Risk Register (NRR) (HM Government 2025), as
436 well as thunderstorm asthma.

437 Much preparedness relies on local government and third sector action. The Severe Weather Emergency Protocol
438 (SWEP) supports rough sleepers and people experiencing homelessness to receive emergency accommodation
439 during periods of cold temperatures. Responses to cold weather risks come from across civil society and local
440 government – as evidenced by the implementation of community-led warm spaces following high energy prices
441 and cold weather in 2022. National retrofit programmes and fuel poverty support from government also
442 improve preparedness for cold risks.

443 **Assessment of the evidence base and evidence gaps**

444 For the majority of extreme weather events in the UK, there is low consensus about the health consequences
445 (Mitchell et al., 2024). There is High confidence on flood risks and their health consequences presently as the
446 evidence comes from multiple sources using multiple methods and datasets. For other aspects of storms more
447 generally, and for droughts, morbidity impacts remain underexplored and require further attention (UKHSA,
448 2024a). Further research is also needed to understand how health inequalities intersect with climate change and
449 extreme weather (Dodd et al., 2024).

450 **5.2.2.2 England**

451 Where sub-risks (flooding, drought, other extreme events) are not presented, no additional information was
452 available and evidence for the UK (5.2.2.1) was used to assess risk.

453 **Assessment of current magnitude of risk**

454 Current risk is assessed as High for England. This assessment suggests highest impacts from flood exposure
455 which is in the low hundreds of thousands of people affected, with additional risks coming from drought and
456 other extreme events.

457 Flooding: Flood risk remains high across England, despite flood risk investments. Annual estimates of the
458 numbers exposed to surface water or river and coastal flooding are in the low hundreds of thousands at present
459 in England, with mental health consequences being potentially significant (EA, 2024). Flood-related mortality is

460 estimated to be 18 deaths per year on average (HECC 2023). The majority of the projected coastal flooding and
461 inland flood risk increases are in England (Sayers et al, 2022; UKHSA, 2024).

462 Drought: The drought in Summer 2022 was the driest in England since 1935 (Met Office) and had a range of
463 health-relevant impacts, including algal blooms, fish kills, wildfires, low crop yields and impacts on livestock,
464 transport disruption and water restrictions (Barker et al., 2024). There is increasing evidence of compound
465 drought-flood risks in the literature (Parry et al, 2023). Quantification of the health impact is limited, though
466 with the anticipated increase in water shortages there are likely to be increases in the risks to vulnerable groups
467 in particular. Risks to the mental health of farmers of drought will likely increase, depending on adaptation in the
468 agricultural sector.

469 Other extreme events: The proportion of high and very high wildfire days has increased over the last 50 years in
470 England, with a 50% increase in the number of high-risk days and a 240% increase in the number of very high-
471 risk days (Thompson et al., 2025). No explicit analysis has linked that to health and wellbeing yet.

472 **Assessment of future magnitude of risk**

473 The future risk is assessed as High. Highest impacts will be from flood exposure, which is in the low hundreds of
474 thousands of people affected, with additional risks coming from drought and other extreme events. While the
475 number of people affected increases for future time periods, it never reaches the millions of people affected
476 that would change the magnitude to Very High. The confidence is high, which is dominated by the confidence in
477 the flooding impacts on health.

478 Flooding: In the 2030s/2050s, the evidence suggests a relatively modest increase in deaths from flooding
479 (covering inland, coastal and storm related flooding), to a range of 20 or 30 deaths per year depending on the
480 climate scenario (HECC, 2023). However, wider health impacts from floods are expected to increase in line with
481 increased exposure. The magnitude of the risk is assessed as High.

482 In the 2080s, the scale and scope of flood risk is likely to remain High. New future flood risk estimates coupled
483 with insured economic costs for UK scenarios suggest that estimates of future outcomes depend on global and
484 UK mitigation efforts (Bates et al., 2023). Implementing actions that lead to climate futures with decarbonisation
485 (e.g., implementing Paris Agreement) still means 23-37% increase in flood economic losses by 2070. Current
486 estimates of 6.1 million people living in flood prone areas rise by 118 percent in a 4°C scenario (UKHSA, 2024
487 (HECC chap.3)). This increased exposure may lead to a greater number of people impacted by flooding and
488 adversely affecting their health and wellbeing. Annually, the numbers of people exposed to floods will be in the
489 hundreds of thousands - with potential economic costs of mental health running into the hundreds of millions.

490 Drought: The risk of disruption to water supplies due to drought remains High under this scenario (see I9, this
491 report). There is limited additional evidence of the future level of risk to health and wellbeing compared to
492 CCRA3-IA-TR, despite increased understanding of the direct and indirect pathways from drought to health and
493 wellbeing (Bryan et al., 2020; UKHSA, 2024e (HECC chap.11)).

494 In the 2050s, the risk of disruption to water supplies is considered High in I9 across the different scenarios for
495 England. For the 2080s, the magnitude of risks of supply disruption from drought to water supplies in this
496 scenario for England is very high (I9, this report) but the impact on health of drought, including both direct and
497 indirect pathways, has not been quantitatively estimated.

498 **Preparedness and adaptation**

499 The Flood Forecasting Centre (FFC) provides data, forecasts, and information to help plan for flood response.
 500 Ofwat oversees the climate resilience of water companies' supply and wastewater systems in England and
 501 Wales.

502 **Evaluation of urgency score**

503 *Table 5.8: Urgency scores for H2 Risks to people from extreme weather, excluding heat, for England. Key to the magnitude scores: very*
 504 *light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++*
 505 *= Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More*
 506 *Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were*
 507 *calculated are in the Methods Chapter.*

England								
H2	Risks to people from extreme weather, excluding heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
With adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

508

509 **5.2.2.3 Northern Ireland**

510 Where sub-risks (flooding, drought, other extreme events) are not presented, no further data was available and
 511 evidence for the UK (5.2.2.1) was used to assess risk.

512 **Assessment of current and future magnitude of risk**

513 Current risk is assessed as High. Highest impacts are from flood exposure, which is in the tens of thousands of
 514 people affected, with additional risks coming from drought and other extreme events. While the number
 515 increases for future time periods, it never reaches the hundreds of thousands of people affected which would
 516 change the risk to Very High. The confidence is high, reflecting the confidence in the estimates of the health
 517 impacts of flooding which dominate the magnitude scores. For other sub-risks the confidence would be low.

518 The evidence for extreme weather impacts on health specifically for Northern Ireland is very sparse since CCRA3-
 519 IA-TR. There is recent evidence relating to the use of private water wells, which is more common in Ireland than
 520 England, and these can be susceptible to contamination from flooding. Research from the Republic of Ireland
 521 may highlight shared risks in Northern Ireland. Musacchio et al. (2021) found that private well users in the

522 Republic of Ireland are not well prepared for flood-related contamination with underestimations of risk and
 523 high percentage of people not undertaking proactive measures.

524 **Preparedness and adaptation**

525 The flood risk management plan is a requirement of The Water Environment Regulations (Northern Ireland)
 526 2017 (DAERA, 2017), with one of the current (2021-2027) objectives being “to reduce the risk to life, health and
 527 wellbeing”. Northern Ireland Water have a climate change strategy (Northern Ireland Water, 2023) that includes
 528 improving sewer system informed by rainfall projects to reduce storm overflows, including keeping storm water
 529 out of sewers where feasible and flowing of rainwater flow with ponds and storage to avoid system being
 530 overwhelmed.

531 **Evaluation of urgency score**

532 *Table 5.9: Urgency scores for H2 Risks to people from extreme weather, excluding heat, for Northern Ireland. Key to the magnitude scores:*
 533 *very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + =*
 534 *Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN =*
 535 *More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table*
 536 *were calculated are in the Methods Chapter.*

Northern Ireland								
H2	Risks to people from extreme weather, excluding heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
With adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

537

538 **5.2.2.4 Scotland**

539 Where sub-risks (flooding, drought, other extreme events) are not presented, no further data were available and
 540 evidence for the UK (5.2.2.1) was used to assess risk.

541 **Assessment of current magnitude of risk**

542 Current risk is assessed as High. Highest impacts are from flood exposure, which is in the tens of thousands of
 543 people affected, with additional risks coming from drought and other extreme events.

544 Flooding: Only a small number of studies have focused on the impacts of flooding for people and communities in
545 Scotland on both physical and mental health. A Centre of Expertise for Waters (CREW) (2024) study found long-
546 term negative impacts on physical and emotional wellbeing of those affected by floods. Factors that make
547 Scotland's population at greater risk of health related impacts of flooding compared to UK average include; (i)
548 aging population, (the proportion of the population of pensionable age is expected to increase from about 20%
549 to 25% by 2033); (ii) areas of greater deprivation and lower life expectancy than the rest of the UK; and (iii) a
550 majority of the landmass classified as rural with a dispersed population (CREW, 2024).

551 Drought: The risk of disruption to supplies in Scotland is considered to be high (see risk I9), and likely to have
552 knock on health implications. A range of health impacts were identified in the Eden catchment in Scotland
553 including from loss of recreational activities in inland waters to "stours" (events with dust in the air) and impacts
554 on sports injuries (Bryan et al., 2020). Based on expert judgement, and in line with CCRA3-IA-TR, the overall
555 health impacts of droughts in Scotland are likely to be Medium in this scenario.

556 **Assessment of future magnitude of risk**

557 Current risk is assessed as High. Highest impacts are from flood exposure, which is in the tens of thousands of
558 people affected, with additional risks coming from drought and other extreme events. While the number of
559 people affected increases for future time periods, it never reaches the hundreds of thousands of people which
560 would change the risk to Very High. The confidence level is high, based on understanding of the health impacts
561 of flooding and the dominance of this risk for the magnitude (the confidence in other sub-risks is low).

562 Flooding: The magnitude of flood risks is likely to remain high within Scotland, based on UK wide scenarios of
563 flood risk and the specific challenges of Scotland's dispersed population and demographic profile of social
564 disadvantage and population health (CREW, 2024), and quoted projections of doubling of populations exposed
565 to flood risk (Dow, 2025).

566 Drought: Following a similar justification as above, the magnitude of impacts for I9 (Risks to water supply and
567 wastewater systems) in terms of disruption to water supply under this scenario are considered high under this
568 scenario (see I9). Based on expert judgement, and following CCRA3-IA-TR, the likely health impacts of droughts
569 in Scotland in the 2030s are likely to be Medium in magnitude.

570 **Preparedness and adaptation**

571 In 2024, Scotland published an adverse weather and health plan, which includes heat, cold, flooding and drought
572 (Public Health Scotland, 2024). The NHS Scotland Climate Emergency & Sustainability Strategy 2022-2026
573 identifies the need to prepare and adapt to extreme weather. The NHS Scotland Standards for Organisational
574 Resilience also requires that consideration is given to the non-traditional disaster response role of community
575 healthcare settings. Plans should be in place to provide a healthcare response to people in the community
576 following extreme weather events, especially those who are vulnerable, as part of the local multiagency
577 recovery plan.

578 The Scottish Government's 2024 National Flood Resilience Strategy outlines a comprehensive approach through
579 2045 and beyond. It highlights physical and mental health as a key outcome target in creating flood resilience.
580 Scottish Water have a new climate change adaption plan (Scottish Water, 2024). Water quality adaptations
581 include completing a capability assessment of over 200 wastewater treatment works, followed by planning and
582 implementing improvements. There appears to be a particular focus on the impact of low flow rather than high
583 flow events on sewage.

584 **Evaluation of urgency score**

585 Table 5.10: Urgency scores for H2 Risks to people from extreme weather, excluding heat, for Scotland. Key to the magnitude scores: very
 586 light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++
 587 = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More
 588 Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were
 589 calculated are in the Methods Chapter.

Scotland								
H2	Risks to people from extreme weather, excluding heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
With adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

590

591 5.2.2.5 Wales

592 Where sub-risks (flooding, drought, other extreme events) are not presented, no additional data was available
 593 and evidence for the UK (5.2.2.1) was used to assess risk.

594 Assessment of current magnitude of risk

595 Current risk is assessed as High. Highest impacts are from flood exposure, which is in the tens of thousands of
 596 people affected, with additional risks coming from drought and other extreme events.

597 Flooding: Flooding from rivers is a current risk for approximately 243,000 people (Natural Resources Wales,
 598 2023), and from the sea an estimated further 191,055 people are exposed. Nine areas in Wales are designated
 599 as National Flood Risk Areas due to the risks to health, the economy, and the environment (Public Health Wales
 600 & WHO, 2023).

601 Drought: The magnitude of risk of low water supply is High (see I9 in this report). The health impacts on
 602 vulnerable communities may be reduced significantly by response measures (e.g. use of standpipes and other
 603 mechanisms to deliver water), wider implications of drought on health exist (Bryan et al., 2020; UKHSA, 2024
 604 (HECC chap.11)). For the Ebbw catchment, there have been reported impacts on recreation (particularly for
 605 people with disabilities), issues with bottled water quality for infants using formula milk, loss of livelihood, and
 606 farmer's mental health issues (Bryan et al., 2020).

607 Assessment of future magnitude of risk

608 Current risk is assessed as High. Highest impacts are from flood exposure, which is in the tens of thousands of
 609 people affected, with additional risks coming from drought and other extreme events. While the number
 610 increases for future time periods, it never reaches the hundreds of thousands of people affected which would
 611 change the risk to Very High. The confidence is high, associated with the level of confidence in the flooding
 612 related health impacts (while confidence in the estimates of other sub-risks is low).

613 Flooding: The number of people exposed to frequent flooding is projected to rise significantly by 2050 (Natural
 614 Resources Wales, 2023).

615 Preparedness and adaptation

616 Wales uses the same Flood Forecasting Centre as England. Wales also has a Flood and Coastal Erosion Risk
 617 Management programme (Welsh Government, 2020) designed to protect people, property, and the
 618 environment from flooding and coastal erosion, not only addressing physical flood risk but also examining the
 619 mental health impacts. The Water Health Partnership for Wales brings together public health professionals to
 620 work on issues across private and public drinking water supplies.

621 Key policy relevant to managing flood and coastal erosion risk in Wales include legislation like the Flood and
 622 Water Management Act 2010 (UK Government, 2010), strategic plans such as the National Strategy for Flood
 623 and Coastal Erosion Risk Management in Wales (Welsh Government, 2020), Shoreline Management Plans, and
 624 Planning Policy Wales (Welsh Government 2024), which includes additional tools like Technical Advice Notes
 625 (TANs) which guide national and local planning, development, and flood risk management to mitigate the
 626 impacts of flooding on communities and infrastructure.

627 Evaluation of urgency score

628 *Table 5.11: Urgency scores for H2 Risks to people from extreme weather, excluding heat, for Wales. Key to the magnitude scores: very*
 629 *light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++*
 630 *= Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More*
 631 *Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were*
 632 *calculated are in the Methods Chapter.*

Wales								
H2	Risks to people from extreme weather, excluding heat.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
With adaptation	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)	+++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

633

634 **5.2.3 Risk to people from changes in air quality – H3**

635 This section explores the current and future risks that climate change poses to air quality in the UK and in
 636 England, Scotland, Wales and Northern Ireland. It will describe both the progress that has been made in
 637 reducing anthropogenic emissions of air pollution and the significant burden poor air quality continues to have
 638 on public health. The multiple ways that climate patterns are and will likely influence air quality and associated
 639 health effects are explored. Air pollution and climate change are however deeply connected in that (a) they are
 640 often caused by the same sources and (b) their effects on each other are bidirectional. For these reasons, they
 641 are most effectively tackled together, whether that is by mitigation or adaptation. This will yield co-benefits, as
 642 well as avoiding dis-benefits, and achieve greater progress. As a consequence, when assessing the risk to human
 643 health caused by the impact of climate change on poor air quality (as well as what is being done to lessen this
 644 risk), the focus here is on the risk to human health caused by air pollution as a whole, highlighting (where
 645 possible) the component that climate change has, or will contribute in the future. It should also be clarified that
 646 owing to the interconnectedness of these two environmental stressors, the climate component could feasibly be
 647 the consequence (or at least part) of primary/secondary emissions of air pollution.

Headlines

- Whilst the current and future risk to people from poor air quality (as a consequence of source emissions plus the additional contribution from climate change) has been scored as Very High (based primarily on mortality) there is low confidence (due to a limited evidence base) over how much climate change contributes to this risk. This holds true for the UK as a whole, and for each of the devolved administrations.
- While phasing out the vast majority of fossil fuels and changes to agricultural practices will reduce emissions, changes in weather and climate patterns have the potential to exacerbate existing air quality risks in multiple ways.
- The future mix of air pollutants in the UK is unclear, as is how harmful they will be for human health. This is especially true when multiple air quality and weather stressors interact together.
- The risk magnitude has changed from High to Very High since CCRA3-IA-TR. This is primarily due to the assessment of total air pollution rather than just the climate component in CCRA4-IA-TR. However, it also reflects new evidence on health impacts of long-term exposure to very low levels of air pollution. In recognition of this, the revised World Health Organisation (WHO) air quality guidelines set more stringent limits.

648

Table 5.12: Urgency scores for H3 Risks to people from changes in air quality. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ = High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H3	Risks to people from changes in air quality	UK	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI
		England	+ (VH)	+ (VH)	+ (VH)	+ (VH)	CI

	Northern Ireland	+	+	+	+	CI
	Scotland	+	+	+	+	CI
	Wales	+	+	+	+	CI

649

650 5.2.3.1 Evidence relevant to the entire United Kingdom

651 Current and future drivers of risk

652 Climate Hazards: High temperatures enhance the formation of ground-level ozone and particulate matter (PM).
 653 This occurs because of increased emissions of natural precursors (e.g. biogenic volatile organic compounds,
 654 ammonia) of air pollutants from vegetation and agricultural land, greater chemical reaction rates of air
 655 pollutants formed in the atmosphere and build-up of local emissions under stagnant meteorological conditions.
 656 Intense temperatures can lead to more wildfires that release large quantities of particularly toxic air pollutants
 657 such as PM, oxides of nitrogen (NOx), ozone and volatile organic compounds (VOCs). Inside buildings, high
 658 temperatures increase the emission of VOCs from indoor sources but may reduce the risk of mould (see BE5).

659 Droughts increase concentrations of PM through wind-driven emission of soil and dust, favour wildfires, and
 660 reduce the capacity of vegetation to uptake ozone because of stomatal closure. Heavy rainfall removes
 661 pollutants. Sea level rise and heavy rainfall increase the duration and frequency of flooding, which increases the
 662 risk of indoor mould growth (Pakdehi et al., 2025) (see BE5). Thunderstorms can rupture pollen and fungal
 663 spores (types of biological air pollutants), making them more respirable and this can trigger asthma epidemics
 664 among sensitised atopic asthmatic individuals (Elliot et al 2021; UKHSA 2022).

665 Strong winds can dilute and remove pollutants. Low wind speeds can trap and accumulate pollutants. Wind also
 666 transports to the UK, human-made pollutants from mainland Europe, Saharan dust and volcanic ash from
 667 Iceland.

668 Outdoors, higher humidity can reduce ozone concentrations but promote secondary PM formation (i.e. PM that
 669 is formed in the atmosphere rather than directly emitted from a source). Indoors, rising humidity supports
 670 dampness and mould growth particularly in poorly ventilated housing (see BE5). Atmospheric water vapour
 671 levels are high in the UK compared to other parts of the world, making UK homes particularly vulnerable.

672 Vulnerability: Air pollution does not affect everyone equally owing to differences in both physiological
 673 susceptibility and risk of exposure. Children face disproportionately high risks from air pollution, owing to their
 674 developing organ systems and higher respiratory rates (Sheridan et al., 2019; Defra, 2023). Pregnant women,
 675 and their unborn children face increased risks. PM exposure is linked to low birth weight and reduced lung
 676 function in childhood (Smith et al., 2017; Cai et al., 2020; Chen et al., 2021; Deguen et al., 2021; RCOG, 2021;
 677 COMEAP, 2022). People's exposure will be greater if they live, work or study in locations (e.g. urban areas with
 678 high traffic density) with high concentrations of air pollution. Physiological susceptibility and greater risk of
 679 exposure can overlap e.g. people in lower socio-economic groups are more likely to (a) have pre-existing health
 680 conditions that constitute physiological susceptibility (Marmot et al., 2020) and (b) be exposed to poor in- and
 681 outdoor air quality because deprived neighbourhoods often have higher concentrations of air pollution (ONS,
 682 2020; Osborne et al., 2021; Williamson, Nunn and Pearce, 2021).

683 International elements: Pollutants generated outside the UK contribute to air pollution in the UK, when weather
684 patterns are favourable for this to occur. These include human made emissions from Europe (Stirling et al.,
685 2020), smoke from wildfires (Augusto et al., 2020), large dust events from the Sahara (Vieno et al., 2016), and
686 volcanic eruptions from Iceland (Elliot et al., 2010; Twigg et al., 2016).

687 **Assessment of current magnitude of risk**

688 The outdoor air pollutants with the greatest effect on the health of the UK population are PM, nitrogen dioxide
689 (NO₂) and ozone. The main sources of PM and NO₂ are human made, with combustion from industry, transport
690 and domestic sources playing a major role. The greatest effects are attributable to PM, measured as PM_{2.5}
691 (particles smaller than 2.5 µm diameter) and PM₁₀ (particles smaller than 10 µm diameter). Ozone is formed by
692 chemical reactions in the atmosphere and concentrations are determined by complex relationships between
693 NO_x, VOCs and sunshine. The latest (2019) government estimates of the mortality burden of air pollution in the
694 UK are 29,000–43,000 deaths (central estimate 36,000) per year for PM_{2.5} and NO₂ combined (Mitsakou,
695 Gowers and Exley, 2022). Reductions in pollutant concentrations since 2019 will have reduced these numbers,
696 towards a central estimate of approximately 30,000 deaths per year (Royal College of Physicians (RCP), 2025).
697 Air pollution also increases the risk of cardiorespiratory disease, adverse pregnancy outcomes (Cai et al., 2020;
698 RCOG, 2021; COMEAP, 2022), diabetes (GBD 2019 Diabetes and Air Pollution Collaborators et al., 2022), and a
699 decline in mental ability and an increase in dementia (COMEAP, 2022). Conversely, improvements in air quality
700 are associated with improved health outcomes (Evangelopoulos et al., 2022). The health effects of outdoor air
701 pollution can occur at very low concentrations (e.g. for PM_{2.5}, as low as 4 µg/m³) (Brauer et al., 2019; Dominici
702 et al., 2022; Stafoggia et al., 2022). In the UK, the risk of cardiovascular disease increases even at PM_{2.5}
703 concentrations below 12-15 µg/m³ i.e. below PM_{2.5} air quality standards across the UK (Vanoli et al., 2024).

704 Over recent decades there has been a decreasing trend in the concentrations of PM_{2.5} and NO₂ in the UK,
705 reflecting considerable reductions in road vehicle exhaust emissions through improved technology and more
706 electric vehicles. PM emissions from tyre, brake and road wear friction still occur however and may be more
707 harmful to the lung than diesel exhaust PM (Parkin et al., 2025).

708 Indoor air quality is influenced by indoor sources such as smoke from solid fuels (e.g. wood, coal), NO₂ from gas
709 cooking and boilers, VOCs from consumer products and mould as well as outdoor air pollution (see BE5). These
710 air pollutants are associated with respiratory, cardiovascular, neurological and carcinogenic health effects
711 (eClinicalMedicine 2022; Guercio et al., 2021; Guercio et al., 2022; Halios et al., 2022; Clark et al., 2023; Delgado-
712 Saborit et al., 2024). Ventilation is crucial in reducing concentrations of indoor pollutants (Petrou et al., 2022)
713 (see BE5) but evidence suggests it is usually inadequate to ensure good air quality in the majority of UK homes
714 (Dimitroulopoulou 2012; Ministry of Housing 2019).

715 Climate change can increase the risks to health from poor air quality by increasing concentrations of several air
716 pollutants including PM, NO₂ and ozone (See Figure 5.2 and 5.3.2.1) but a very limited evidence base prevents
717 this climate component from being quantified. During heatwaves, an increase in outdoor ozone concentrations
718 is observed (Scotland's Environment, 2022; Defra, 2024a), and co-exposure to air pollutants (PM, ozone) and
719 high temperatures may amplify individual health risks (Stafoggia et al., 2023; Zhang et al., 2024; Gao et al.,
720 2025). The key emissions from wildfires include both PM and NO₂ whilst ozone is also generated in the
721 atmosphere during such events. PM from wildfire smoke may be more harmful to human health than non-fire
722 PM, especially for cardiorespiratory health, owing to the presence of more fine and ultrafine particles and toxic
723 gases (Ghetu et al., 2022; Alari et al., 2024). Associations exist between higher concentrations/earlier starts to
724 the season of some pollen & fungal spores and higher temperatures in the UK (Adams-Groom et al., 2022;
725 Büntgen et al., 2022; Lam et al., 2024; UKHSA, 2024a (HECC chap.6)).

Climate process	Surface concentrations over UK					Impacts
	NO _x	VOCs	NH ₃	PM	O ₃	
Wildfires	+	+		+	+	Affect global O ₃ and PM, and local PM, NO _x , VOC and O ₃
Wetlands/Permafrost					+	Increased CH ₄ increases global O ₃
Lightning NO _x emissions	+/-				+/-	Affects global O ₃ , but magnitude and sign of changes uncertain
Soil emissions	+				+	Increased NO increases global and local O ₃
Vegetation emissions		+	+	+	+	Increased global and local O ₃ , local NH ₃ , VOC and PM
Stratospheric O ₃ influx					+	Increased transport of O ₃ from stratosphere
Stratospheric O ₃ recovery					+/-	Slower tropospheric O ₃ photochemistry due to O ₃ recovery in the stratosphere
Higher temperatures	+	+	+	+	+	Higher emissions, greater PM and O ₃ formation
Higher rainfall			-	-		More effective scavenging of PM
Higher humidity				+	-	Lower O ₃ from Atlantic; greater PM growth
Changes in stagnation	+/-	+/-	+/-	+/-	+/-	Pollutants build up more, but changes in occurrence very uncertain
Regional transport				+/-	+/-	Changes in European influx uncertain; more dust, fires
Summertime drought	+	+		+	+	Reduced deposition of pollutants; more dust

726

727

Figure 5.2: Summary of the impacts of climate change on air quality in the UK (Taken from Royal Society, 2021).

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Assessment of future magnitude of risk

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Outdoor concentrations of PM_{2.5} & NO₂ are anticipated to further decline in coming decades in response to reduced emissions following changes to regulations, technology, urban planning, agricultural practices, and broader societal behaviour. Improvements in air quality will also inevitably begin to slow as many of the largest and most readily abated sources are addressed. An analysis of the impacts of interventions and policies relating to air quality indicate that compared to a 2018 baseline, by 2030 and 2050, exposure to PM_{2.5} will likely decrease by 24-30% and 28-36% respectively; NO₂ exposure will decrease in 2030 and 2050 by 33-41% and 35-49% respectively (Macintyre et al., 2023b). Allowing for population projection growth, annual mortality attributable to long-term exposure to PM_{2.5} and NO₂ is projected to decrease from 29,000-43,000 in 2018 to 18,887-32,342 in 2030 and 18,732-32,220 in 2050 (Macintyre et al., 2023b).

738

739

740

Concentrations of ozone in urban areas are likely to rise as local NO_x emissions fall (Defra Air Quality Expert Group (AQEG), 2021; Grange et al., 2021). This is because pollutants such as NO_x that are more prevalent in urban areas react with or "mop up" ozone thus reducing its concentration. Consequently, estimated emergency

741 respiratory hospital admissions associated with short-term effects from ozone exposure under the business-as-
742 usual emission policies are projected (including future population growth) to increase by 4.6% by 2030 and
743 11.7% by 2050 from a 2018 baseline of 60,488 (Macintyre et al., 2023a). Under a high emission scenario, for
744 England, Scotland and Wales, and accounting for future population projections, estimated attributable deaths in
745 2050 associated with long-term exposure are 28,475 for PM2.5, 15,860 for NO2 and 13,101 for ozone (Fenech et
746 al., 2021).

747 There is low confidence in the future magnitude of risk to health owing specifically to changes in outdoor air
748 quality from climate change, owing to considerable uncertainty over the net impact of the broad mix of climate
749 impacts (see Figure 5.2 and 5.3.2.1). Another uncertainty is that although we now know that there is no safe
750 level of the current mix of anthropogenic-based PM2.5 that populations are currently exposed to, we do not yet
751 know whether this will still be the case as sources of pollution shift in a changing environment. It is, however,
752 likely that improvements in air quality (through reduced emissions) will be slowed or temporarily reversed by
753 climate change, increasing risks to health once more.

754 Indoors, under SSP2-4.5 and SSP5-8.5 emission scenarios, limonene (a citrus scent used in many household
755 products that can react with ozone to produce harmful air pollutants), and mould growth increase in indoor
756 environments, whilst ozone rose under SSP5-8.5 (Zhao et al., 2024, 2025). Increased concentrations of limonene
757 are attributed to a higher emission rate from furniture and building materials due to temperature increases (see
758 BE5, 3.2.5). The risk of mould growth increases under high humidity. For some species of pollen and fungal
759 spores, a warmer and wetter climate are expected to further increase seasons, production and potency
760 (Kurganskiy et al., 2021; UKHSA, 2024d (HECC chap 10)).

761 **Level of preparedness**

762 Air quality limit values are legal maximum concentrations for outdoor air pollutants. Limit values for PM, NO2
763 and ozone across England, Scotland, Wales, and Northern Ireland are broadly aligned but not identical, due to
764 devolved powers and differing policy approaches. No national government has, however, aligned their air quality
765 standards with the WHO's 2021 air quality guidelines. The Daily Air Quality Index (DAQI) is the national alert
766 system that provides information to the public about outdoor air pollution levels in local areas as well as
767 recommended actions and health advice. However, it is recognised that Defra air pollution forecasts are typically
768 county-to-regional in geographic scope and lack street or postcode-level details that may help support direct
769 behavioural adjustments; for example, providing guidance on the avoidance of hotspots in cities or by roads.
770 Policy relating to indoor air pollutants crosses the interfaces of multiple government departments and agencies,
771 leading to a fragmented regulatory framework and a lack of ownership.

772 Local initiatives to reduce air pollution integrate actions that include transport (e.g. clean air zones, low traffic
773 neighbourhoods), urban planning and design, reducing pollution around schools and monitoring (DHSC CMO,
774 2022; Greater London Authority, 2025). UK100, a network of councils across the UK that supports a local-led
775 rapid transition to Net Zero and Clean Air (UK100, 2023).

776 Non-governmental adaptation occurs through the activities of networks and charitable organisations. This
777 includes Asthma & Lung UK, Mums for Lungs, Global Action Plan. There is guidance for local authorities on
778 integrating action on air quality and climate change by the Institution of Environmental Sciences (2024).

779 **Assessment of the evidence base and evidence gaps**

780 Information is missing on the extent to which a changing climate will affect the risk to health caused by poor air
781 quality, specifically: health effects of interactions between air pollutants and a changing climate; harm to health
782 of a future pollutant mix under the influence of climate change; how climate change-driven behaviours could

783 modify personal exposure to air pollution; effects of home decarbonisation (in new buildings and retrofitted
784 infrastructure) on concentrations of indoor air pollutants and consequential health benefits; an understanding of
785 the composition of UK wildfire smoke and its short-term and long-term impact on mortality and morbidity.

786 5.2.3.2 England

787 Assessment of current magnitude of risk

788 The current magnitude of risk caused by total air pollution (i.e. source emissions plus the additional contribution
789 from climate change) is Very High. This is based on a total of 26,000 to 38,000 annual deaths (46-68 deaths per
790 100,000) attributed to outdoor anthropogenic air pollution (Mitsakou, Gowers and Exley, 2022). The confidence
791 of this magnitude score is low for this risk to health, owing to uncertainty in changes in air quality from climate
792 change (due to a limited evidence base).

793 Assessment of future magnitude of risk

794 There is a particular risk of wildfires over the moorland regions of northern England, affecting surrounding
795 regions including population centres. Southeast England is more likely to be affected by heatwaves and droughts
796 and with that, greater exposure to pollutants (particularly PM and ozone) from UK sources and inflow from
797 Europe (Royal Society 2021). An analysis of air quality, ambient temperatures, and climate change adaptation
798 plans in 30 UK cities (covering around 17.3 million of the UK population and including the capitals of England,
799 Northern Ireland, Scotland and Wales) found that London and Cambridge exhibit the highest risk of both
800 extreme temperature and air pollution (Chauhan et al., 2025). The air of western coastal regions may be
801 cleansed by stronger westerly flow and greater wintertime rainfall.

802 2030s, central warming scenario:

803 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
804 without adaptation (i.e. air pollution emission policies) is Very High. This is based on a total of 28,701 to 41,948
805 annual deaths (46-68 deaths per 100,000) attributed to outdoor air pollution arising from anthropogenic
806 emissions. Number of deaths calculated by extrapolating, using the 10.39% increase in population from 2019 to
807 2035 (ONS 2020, 2025), the mortality burden in 2019 (Mitsakou et al 2022) to that in 2035. The risk with
808 adaptation is Very High. This is based on a total of 15,284-26,002 deaths (25-42 deaths per 100,000) attributable
809 to the effects of long-term exposure to PM2.5 & NO2 (Macintyre et al., 2023b) and 50,101 annual total of daily
810 emergency respiratory admissions associated with short-term ozone exposure (Macintyre et al., 2023a) under
811 current UK & European emission policies. There is however low confidence (due to a limited evidence base) in
812 this risk to health owing to changes in air quality from climate change, and this is the case without and with
813 adaptation.

814 2050s, central warming scenario:

815 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
816 without adaptation is Very High. This is based on a total of 30,830-45,060 annual deaths (46-68 deaths per
817 100,000) attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated
818 by extrapolating, using the 18.58% increase in population from 2019 to 2055 (ONS 2020, 2025), the mortality
819 burden in 2019 (Mitsakou et al 2022) to that in 2055. A total of 14,251-24,400 deaths (22-37 deaths per 100,000)
820 attributable to the effects of long-term exposure to PM2.5 & NO2 (Macintyre et al., 2023b) and 52,319 annual
821 total of daily emergency respiratory admissions associated with short-term ozone exposure (Macintyre et al.,
822 2023a) under current UK & European emission policies (no account of climate change). There is however low

823 confidence (due to a limited evidence base) in this risk to health owing to changes in air quality from climate
824 change, and this is the case without and with adaptation.

825 2080s, central warming scenario:

826 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
827 without adaptation is Very High. This is based on a total of 32,479–47,470 annual deaths (46–68 deaths per
828 100,000) attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated
829 by extrapolating, using the 24.92% increase in population from 2019 to 2085 (ONS 2020, 2025), the mortality
830 burden in 2019 (Mitsakou et al., 2022) to that in 2085. In the absence of projections, the prediction of risk with
831 adaptation involves expert judgment where there is a high level of agreement. While air quality in the late
832 century will substantially benefit from the phasing out of the vast majority of fossil fuels and changes to
833 agricultural practices, increases in heatwaves, sea level rise, heavy rainfall and thunderstorms will worsen
834 outdoor air quality and in turn, the quality of indoor air (see BE5). It will also bring about risk of damp buildings,
835 increased growth of indoor mould and increase asthma epidemics among sensitised atopic asthmatic individuals
836 (see BE5). Without response planning, particularly within urban areas there is potential for the risk to remain
837 Very High. There is however low confidence (due to a limited evidence base) in this risk to health owing to
838 changes in air quality from climate change, and this is the case without and with adaptation.

839 **Preparedness and adaptation**

840 Reduction of air pollutant emissions. There are two air quality targets for PM2.5 in England: a legal target to
841 meeting an annual average 10 µg/m³ limit value by 2040; an interim target of 12 µg/m³ by the end of January
842 2028 (Clean Air Strategy (Defra, 2019); The Environment Act 2021 (HM Government, 2021). Additional
843 anthropogenic emission adaptation to that currently in place is needed to meet the target limit value of PM2.5
844 of 10 µg/m³ (Defra, 2022).

845 Approved Document F includes a methodology that helps maintain adequate levels of ventilation when energy
846 efficiency measures are installed (MHCLG 2021). The Air Quality (Domestic Solid Fuels Standards) (England)
847 Regulations 2020 (HM Government, 2020), banned the sale of traditional house coal completely in England from
848 May 2023 (although ‘smokeless’ fuels are still permitted) and introduced regulation of the sale of wood fuel to
849 control its moisture content in order to reduce PM2.5 emissions when burned.

850 Reduction in a worsening of air quality owing to climate change. A Centre for Climate and Health Security has
851 been established within the UKHSA to protect health in the context of a changing climate. Activities include:
852 systematic review on the evidence for the health effects due to exposure to short-term ozone being modified by
853 increases in temperature (UKHSA 2023b); planning and response to and awareness of wildfires as well as
854 strengthening the evidence base on wildfires and health (UKHSA 2023a), research into aeroallergens (UKHSA,
855 2024a (HECC chap.6)) and publication of guidance on damp and mould for rented housing providers (MHCLG,
856 DHSC, UKHSA 2024).

857 **Evaluation of urgency score**

858 Due to the Very High projected magnitude for the risk caused by total air pollution (i.e., source emissions plus
859 the additional contribution from climate change) but low confidence (due to a limited evidence base) in the size
860 of the contribution from the climate change component, this risk has been scored as critical investigation.

861 N.B. The High magnitude score for a low warming 2080 scenario is based on expert opinion: improved air
862 quality because of (a) the phasing out of the vast majority of fossil fuels and improved agricultural practices and
863 (b) lower warming outcomes (e.g., heatwaves, sea level rises).

864 Table 5.13: Urgency scores for H3 Risks to people from changes in air quality for England. Key to the magnitude scores: very light purple (L)
 865 = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium,
 866 +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed,
 867 FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in
 868 the Methods Chapter.

England								
H3	Risks to people from changes in air quality.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)
With adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (H)	+ (VH)	+ (VH)
Urgency scores	CI	CI		CI			FI	
Overall urgency score	CI							

869

870 5.2.3.3 Northern Ireland

871 Assessment of current magnitude of risk

872 The current magnitude of risk caused by total air pollution (i.e. source emissions plus the additional contribution
 873 from climate change) is Very High. This is based on a total of 470 to 730 annual deaths (25-39 deaths per
 874 100,000) attributed to outdoor anthropogenic air pollution (Mitsakou, Gowers and Exley, 2022). The confidence
 875 of this magnitude score is low for this risk to health, owing to uncertainty in changes in air quality from climate
 876 change (due to a limited evidence base).

877 Assessment of future magnitude of risk

878 2030s, central warming scenario:

879 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
 880 without adaptation (i.e. air pollution emission policies) is Very High. This is based on a total of 484 to 752 annual
 881 deaths (25-39 deaths per 100,000) attributed to outdoor air pollution arising from anthropogenic emissions.
 882 Number of deaths calculated by extrapolating, using the 2.97% increase in population from 2019 to 2035 (ONS
 883 2020, 2025), the mortality burden in 2019 (Mitsakou et al 2022) to that in 2035. The risk with adaptation is Very
 884 High. This based on a total of 275-538 deaths (14-28 deaths per 100,000) attributable to the effects of long-term
 885 exposure to PM2.5 & NO2 (Macintyre et al., 2023b) and 3,269 annual total of daily emergency respiratory
 886 admissions associated with short-term ozone exposure (Macintyre et al., 2023a) under current UK & European
 887 emission policies (no account of climate change). There is however low confidence (due to a limited evidence
 888 base) in the risk to health owing specifically to changes in air quality from climate change, and this is the case
 889 without and with adaptation.

890 2050s, central warming scenario:

891 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
892 without adaptation is Very High. This is based on a total of 473 to 735 annual deaths (25-39 deaths per 100,000)
893 attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by
894 extrapolating, using the 0.7% increase in population from 2019 to 2035 (ONS 2020, 2025), the mortality burden
895 in 2019 (Mitsakou et al 2022) to that in 2055. The risk with adaptation is Very High based on a total of 263-507
896 deaths (14-27 deaths per 100,000) attributable to the effects of long-term exposure to PM2.5 & NO2 (Macintyre
897 et al., 2023b) and 3,270 annual total of daily emergency respiratory admissions associated with short-term
898 ozone exposure (Macintyre et al., 2023a) under current UK & European emission policies (no account of climate
899 change). There is however low confidence (due to a limited evidence base) in the risk to health owing specifically
900 to changes in air quality from climate change, and this is the case without and with adaptation.

901 2080s, central warming scenario:

902 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
903 without adaptation is Very High. This is based on a total of 422 to 655 annual deaths (25-39 deaths per 100,000)
904 attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by
905 extrapolating, using the 10.23% decrease in population from 2019 to 2085 (ONS 2020, 2025), the mortality
906 burden in 2019 (Mitsakou et al 2022) to that in 2085. In the absence of projections, the prediction of risk with
907 adaptation involves expert judgment where there is a high level of agreement: while air quality in the late
908 century will substantially benefit from the phasing out of the vast majority of fossil fuels and changes to
909 agricultural practices, increases in heatwaves, sea level rise, heavy rainfall and thunderstorms will worsen
910 outdoor air quality and in turn, the quality of indoor air (see BE5). It will also bring about risk of damp buildings,
911 increased growth of indoor mould and increase asthma epidemics among sensitised atopic asthmatic individuals
912 (see BE5). Without response planning, particularly within urban areas there is potential for the risk to remain
913 Very High. There is however low confidence (due to a limited evidence base) in the risk to health owing
914 specifically to changes in air quality from climate change, and this is the case without and with adaptation.

915 **Preparedness and adaptation**

916 Reduction of air pollution emissions and a worsening of air quality owing to climate change. The first Clean Air
917 Strategy for Northern Ireland (due to be published in 2025) cites the need for integrated and coordinated
918 strategies on air quality and carbon reduction to be coordinated (DAERA, 2020); Environmental Improvement
919 Plan for Northern Ireland (DAERA, 2024a); Draft Green Growth Strategy for NI (DAERA, 2021). Climate Northern
920 Ireland have an online tool kit to support the first phase of climate adaptation planning in local councils (Climate
921 Northern Ireland, 2025).

922 **Evaluation of urgency score**

923 Due to the Very High projected magnitude for the risk caused by total air pollution (i.e. source emissions plus the
924 additional contribution from climate change) but low confidence (due to a limited evidence base) in the size of
925 the contribution from the climate change component, this risk has been scored as critical investigation.

926 N.B. The High magnitude score for a low warming 2080 scenario is based on expert opinion: improved air
927 quality because of (a) the phasing out of the vast majority of fossil fuels and improved agricultural practices and
928 (b) lower warming outcomes (e.g. heatwaves, sea level rises).

929 *Table 5.14: Urgency scores for H3 Risks to people from changes in air quality for Northern Ireland. Key to the magnitude scores: very light*
930 *purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ =*
931 *Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action*

932
933

Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Northern Ireland								
H3	Risks to people from changes in air quality.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)
With adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (H)	+ (VH)	+ (VH)
Urgency scores	CI	CI		CI			FI	
Overall urgency score	CI							

934

935 5.2.3.4 Scotland

936 Assessment of current magnitude of risk

937 The current magnitude of risk caused by total air pollution (i.e. source emissions plus the additional contribution
938 from climate change) is Very High. This is based on a total of 1,800 to 2,700 annual deaths (33-49 deaths per
939 100,000) attributed to outdoor anthropogenic air pollution (Mitsakou, Gowers and Exley, 2022). The confidence
940 of this magnitude score is low for this risk to health, owing to uncertainty in changes in air quality from climate
941 change (due to a limited evidence base).

942 Assessment of future magnitude of risk

943 There is a particular risk of wildfires over the moorland regions of Scotland, affecting surrounding regions
944 including population centres. The air of western coastal regions may be cleansed by stronger westerly winds and
945 greater wintertime rainfall (Royal Society, 2021).

946 2030s, central warming scenario:

947 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
948 without adaptation (i.e. air pollution emission policies) is Very High based on a total of 1,880 to 2,820 annual
949 deaths (25-39 deaths per 100,000) attributed to outdoor air pollution arising from anthropogenic emissions.
950 Number of deaths calculated by extrapolating, using the 4.44% increase in population from 2019 to 2035 (ONS
951 2020, 2025), the mortality burden in 2019 (Mitsakou et al 2022) to that in 2035. The risk with adaptation is Very
952 High based on a total of 1131-1898 deaths (20-33 per 100,000) attributable to the effects of long-term exposure
953 to PM2.5 & NO2 (Macintyre et al., 2023b) and 8,644 annual total of daily emergency respiratory admissions
954 associated with short-term ozone exposure (Macintyre et al., 2023a) under current UK & European emission
955 policies (no account of climate change). There is however low confidence (due to a limited evidence base) in the

956 risk to health owing specifically to changes in air quality from climate change, and this is the case without and
957 with adaptation.

958 2050s, central warming scenario:

959 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
960 without adaptation is Very High based on a total of 1,905 to 2,857 annual deaths (25-39 deaths per 100,000)
961 attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by
962 extrapolating, using the 5.83% increase in population from 2019 to 2055 (ONS 2020, 2025), the mortality burden
963 in 2019 (Mitsakou et al 2022) to that in 2035. The risk with adaptation is Very High based on a total of 1075-1805
964 deaths (19-31 per 100,000) attributable to the effects of long-term exposure to PM2.5 & NO2 (Macintyre et al.,
965 2023b) and 8,644 annual total of daily emergency respiratory admissions associated with short-term ozone
966 exposure (Macintyre et al., 2023a) under current UK & European emission policies (no account of climate
967 change). There is however low confidence (due to a limited evidence base) in the risk to health owing specifically
968 to changes in air quality from climate change, and this is the case without and with adaptation.

969 2080s, central warming scenario:

970 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
971 without adaptation is Very High based on a total of 1,893 to 2,839 annual deaths (25-39 deaths per 100,000)
972 attributed to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by
973 extrapolating, using the 5.14% increase in population from 2019 to 2055 (ONS 2020, 2025), the mortality burden
974 in 2019 (Mitsakou et al., 2022) to that in 2085. In the absence of projections the prediction of risk with
975 adaptation involves expert judgment where there is a high level of agreement: while air quality in the late
976 century will substantially benefit from the phasing out of the vast majority of fossil fuels and changes to
977 agricultural practices, increases in heatwaves, sea level rise, heavy rainfall and thunderstorms will worsen
978 outdoor air quality and in turn, the quality of indoor air (see BE5). It will also bring about risk of damp buildings,
979 increased growth of indoor mould and increase asthma epidemics among sensitised atopic asthmatic individuals
980 (see BE5). Without response planning, particularly within urban areas there is potential for the risk to remain
981 Very High. There is however low confidence (due to a limited evidence base) in the risk to health owing
982 specifically to changes in air quality from climate change, and this is the case without and with adaptation.

983 **Preparedness and adaptation**

984 Reduction of air pollution emissions and a worsening of air quality owing to climate change. Scotland has air
985 quality target for PM2.5 of 10µg m³. Cleaner Air for Scotland 2 (Scottish Government, 2021) includes an
986 'Integrated Policy' in which it states that strategies, policies and plans being developed by central government
987 for climate change mitigation and adaptation should be closely coordinated and aligned with those for air quality
988 to maximise co-benefits. Air quality is included in the Climate Ready School Grounds guidance (Architecture &
989 Design Scotland, 2023). The New Build Heat Standard designed to reduce emissions from domestic heating was
990 heavily scaled back following publication (Scottish Government, 2025a).

991 **Evaluation of urgency score**

992 Due to the Very High projected magnitude for the risk caused by total air pollution (i.e. source emissions plus the
993 additional contribution from climate change) but low confidence (due to a limited evidence base) in the size of
994 the contribution from the climate change component, this risk has been scored as critical investigation.

995 N.B. The High magnitude score for a low warming 2080 scenario is based on expert opinion: improved air
 996 quality because of (a) the phasing out of the vast majority of fossil fuels and improved agricultural practices and
 997 (b) lower warming outcomes (e.g. heatwaves, sea level rises).

998 *Table 5.15: Urgency scores for H3 Risks to people from changes in air quality for Scotland. Key to the magnitude scores: very light purple*
 999 *(L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium,*
 1000 *+++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed,*
 1001 *FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in*
 1002 *the Methods Chapter.*

Scotland								
H3	Risks to people from changes in air quality.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)
With adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (H)	+ (VH)	+ (VH)
Urgency scores	CI	CI		CI			FI	
Overall urgency score	CI							

1003

1004 5.2.3.5 Wales

1005 Assessment of current magnitude of risk

1006 The current magnitude of risk caused by total air pollution (i.e. source emissions plus the additional contribution
 1007 from climate change) is Very High based on a total of 1,200 to 2,000 annual deaths (38-63 per 100,000)
 1008 attributed to outdoor anthropogenic air pollution (Mitsakou, Gowers and Exley, 2022). The confidence of this
 1009 magnitude score is low for this risk to health, owing to uncertainty in changes in air quality from climate change
 1010 (due to a limited evidence base).

1011 Assessment of future magnitude of risk

1012 There is a particular risk of wildfires over the moorland regions of Wales, affecting surrounding regions including
 1013 population centres.

1014 2030s, central warming scenario:

1015 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
 1016 without adaptation (i.e. air pollution emission policies) is Very High based on a total of 1,275 to 2,124 annual
 1017 deaths (38-63 per 100,000) attributed to outdoor air pollution arising from anthropogenic emissions. Number of
 1018 deaths calculated by extrapolating, using the 6.22% increase in population from 2019 to 2035 (ONS 2020, 2025),

1019 the mortality burden in 2019 (Mitsakou et al 2022) to that in 2035. The risk with adaptation is Very High based
1020 on a total of 759-1442 (23-43 per 100,000) deaths attributable to the effects of long-term exposure to PM2.5 &
1021 NO2 (Macintyre et al., 2023b) and 3,480 annual total of daily emergency respiratory admissions associated with
1022 short-term ozone exposure (Macintyre et al., 2023a) under current UK & European emission policies (no account
1023 of climate change). There is however low confidence (due to a limited evidence base) in the risk to health owing
1024 specifically to changes in air quality from climate change, and this is the case without and with adaptation.

1025 2050s, central warming scenario:

1026 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
1027 without adaptation is Very High based on a total of 1,334 to 2,224 annual deaths (38-63 per 100,000) attributed
1028 to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by extrapolating,
1029 using the 11.2% increase in population from 2019 to 2055 (ONS 2020, 2025), the mortality burden in 2019
1030 (Mitsakou et al 2022) to that in 2055. The risk with adaptation is Very High (VH) based on a total of 714-1348
1031 deaths (20-38 per 100,000) attributable to the effects of long-term exposure to PM2.5 & NO2 (Macintyre et al.,
1032 2023b) (Macintyre et al., 2023b) and 3,556 annual total of daily emergency respiratory admissions associated
1033 with short-term ozone exposure (Macintyre et al., 2023a) under current UK & European emission policies (no
1034 account of climate change). There is however low confidence (due to a limited evidence base) in the risk to
1035 health owing specifically to changes in air quality from climate change, and this is the case without and with
1036 adaptation.

1037 2080s, central warming scenario:

1038 The risk caused by total air pollution (i.e. source emissions plus the additional contribution from climate change)
1039 without adaptation is Very High based on a total of 1,354 to 2,258 annual deaths (38-63 per 100,000) attributed
1040 to outdoor air pollution arising from anthropogenic emissions. Number of deaths calculated by extrapolating,
1041 using the 12.88% increase in population from 2019 to 2085 (ONS 2020, 2025), the mortality burden in 2019
1042 (Mitsakou et al 2022) to that in 2085. In the absence of projections the prediction of risk with adaptation involves
1043 expert judgment where there is a high level of agreement: while air quality in the late century will substantially
1044 benefit from the phasing out of the vast majority of fossil fuels and changes to agricultural practices, increases in
1045 heatwaves, sea level rise, heavy rainfall and thunderstorms will worsen outdoor air quality and in turn, the
1046 quality of indoor air (see BE5). It will also bring about risk of damp buildings, increased growth of indoor mould
1047 and increase asthma epidemics among sensitised atopic asthmatic individuals (see BE5). Without response
1048 planning, particularly within urban areas there is potential for the risk to remain Very High. There is however low
1049 confidence (due to a limited evidence base) in the risk to health owing specifically to changes in air quality from
1050 climate change, and this is the case without and with adaptation.

1051 **Preparedness and adaptation**

1052 Reduction of air pollution emissions and a worsening of air quality owing to climate change. The Environment
1053 (Air Quality and Soundscapes) (Wales) aims to establish a PM2.5 target by February 2027 (Welsh Government
1054 2023). There are actions to ensure that a risk from climate change is considered in future policy development to
1055 improve air quality (Welsh Government, 2024a). Update to the Building Regulations part F (ventilation)
1056 addresses overheating and indoor air quality (Welsh Government 2022).

1057 **Evaluation of urgency score**

1058 Due to the Very High projected magnitude for the risk caused by total air pollution (i.e. source emissions plus the
1059 additional contribution from climate change) but low confidence (due to a limited evidence base) in the size of
1060 the contribution from the climate change component, this risk has been scored as critical investigation.

1061 N.B. The High magnitude score for a low warming 2080 scenario is based on expert opinion: improved air
 1062 quality because of (a) the phasing out of the vast majority of fossil fuels and improved agricultural practices and
 1063 (b) lower warming outcomes (e.g. heatwaves, sea level rises).

1064 *Table 5.16: Urgency scores for H3 Risks to people from changes in air quality for Wales. Key to the magnitude scores: very light purple (L) =*
 1065 *Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++*
 1066 *High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
 1067 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
 1068 *Methods Chapter.*

Wales								
H3	Risks to people from changes in air quality.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)
With adaptation	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (VH)	+ (H)	+ (VH)	+ (VH)
Urgency scores	CI	CI		CI			FI	
Overall urgency score	CI							

1069

5.2.4 Risk to people from climate-sensitive infectious diseases – H4

Climate-sensitive infectious diseases are diseases caused by pathogens (such as bacteria, viruses, and parasites) whose transmission, incidence or spatial distribution is influenced by weather patterns or climate conditions. Climate change is influencing the risk of transmission of many of these diseases. Climate-sensitive infections have different transmission pathways that can be useful for understanding policy and adaptation solutions, including but not limited to 1) vector-borne (infections caused by parasites, viruses and bacteria which are transmitted by blood-feeding arthropod vectors), 2) water- and food-borne and 3) air-borne. In our summaries, we use these categorisations, but in the main evidence base we sort by individual pathogen, as many of them have multiple routes of transmission (E L Gillingham, Lake, et al., 2023). Whilst other health-related issues linked to climate-sensitive diseases, such as those from antimicrobial resistance (AMR), are discussed in this risk, only the risk to people from climate-sensitive infectious diseases is included in the urgency scores.

Headlines

- West Nile virus and tick-borne encephalitis have recently been detected in the UK for the first time. Outbreaks of dengue fever are now being reported in neighbouring countries, such as France and Spain.
- There is strong evidence for the impact of weather and climate on some pathogens such as *Campylobacter*, *Salmonella* and *Vibrio*, but for many others the evidence is currently lacking. Enhanced pathogen monitoring is the first step to strengthening this evidence and helping identify adaptation strategies.
- There is a lack of modelling studies projecting future risk from all climate-sensitive infectious diseases for the UK.
- The magnitude of this risk has not changed since CCRA3-IA-TR, even with the detection of new pathogens. This is because the evidence is too new for geographical and future projection analyses to have been performed.

Table 5.17: Urgency scores for H4 Risks to people from climate-sensitive infectious disease. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H4	Risks to people from climate-sensitive infectious diseases	UK	+++ (M)	+ (M)	+ (M)	+ (M)	MAN
		England	+++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Northern Ireland	++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Scotland	++ (M)	+ (M)	+ (M)	+ (M)	MAN
		Wales	++ (M)	+ (M)	+ (M)	+ (M)	MAN

5.2.4.1 Evidence relevant to the entire United Kingdom

Current and future drivers of risk

The response of climate-sensitive infectious diseases to changes in weather and climate patterns depends on a complex mixture of human behaviour, host behaviour, human physiology, and pathogen sensitivity. Increased heatwaves and warmer annual temperatures can facilitate development, geographical spread, and active season of vectors like mosquitoes and ticks, raising the risk of diseases such as Lyme disease and dengue, and enhance bacterial proliferation, heightening incidences of food and water-borne illnesses. Hotter periods, including milder winters, can accelerate pathogen development rate and extend or lengthen the period of the year when infection risk is greatest. For instance, cases of food-borne disease infections such as *Salmonella* and *Campylobacter* are highest during the summer but may become common in spring/autumn or even during warmer-than-average winters seasons (Kuhn et al., 2020). Sustained changes in climate patterns may allow for the establishment and survival of non-native vectors, as well as warm water-related pathogens such as *Vibrio* spp. and blue-green algae. However, depending on the level of warming, some areas may become too hot or dry and thus unsuitable for survival of these vectors and pathogens. Climate change may also alter human behaviour, which can increase exposure to pathogens and vectors. For example, storing water in open containers can unintentionally create mosquito habitats, increasing the risk of biting, and visiting greenspaces may bring people into closer contact with ticks. Similarly, during extended periods of hot, dry weather, people may be more likely to swim in bodies of water such as rivers and lakes, whilst pollutants such as agricultural runoff and untreated sewage are less likely to be diluted due to a lack of rainfall, increasing the risk of pathogen exposure.

Beyond temperature, other weather changes may also be important. For example, changing humidity may alter pathogen and vector survival rates and changing rainfall may affect transmission pathways. *Aedes vexans* is a native mosquito species and although it is a potential vector for West Nile virus, it is considered one of the most prolific nuisance biting species. Extreme rainfall and river flooding during summer months in England has resulted in extremely high densities of mosquitoes, causing nuisance biting to local residents (Vaux et al., 2021).

Certain vulnerable groups face heightened risks from climate-sensitive diseases, including older adults, young children, pregnant women, individuals with chronic health conditions, socio-economically disadvantaged populations, and communities with limited healthcare access (Paavola, 2017). Those who live or work rurally, as well as people taking part in certain work, sports and recreations may be at risk, including outdoor workers, hikers and recreational water users (such as wild swimmers or surfers). In addition, people living in flood-prone areas may be at risk from mosquitoes and waterborne pathogens following floods.

Risk interactions: Climate change will have effects on infectious diseases in many countries outside of the UK. International trade and travel are key pathways through which these global effects may impact the UK through the introduction of diseases and vectors into the UK (Reisen et al., 2009), especially if climate change creates local conditions which are suitable for the vector's establishment. The development of adaptative measures such as urban greening and increasing biodiversity can offer opportunities for improved health and wellbeing (H7), but if these spaces are inadequately developed, they may inadvertently create favourable habitats for disease-transmitting mosquitoes and ticks and bring people into closer contact with them (Smith et al., 2024).

Higher infection rates may increase health service demand (H6), leading to delays in care for other conditions and impacting overall health outcomes for the population. Treatment may require antibiotics, which may increase opportunities for anti-microbial resistance to arise. Changes to the geographical spread and prevalence of pathogens may impact food security (N11). Flooding and drought (H2) increase the risk of bathing and drinking water sources being contaminated with pathogens.

1126 Assessment of current magnitude of risk

1127 The incidence of many infectious diseases has changed over time, but it is unclear to what degree these changes
1128 can be attributed directly to climate change as food hygiene practices have improved (Lake et al., 2009),
1129 vaccination programmes have been introduced (for example, rotavirus (Atchison et al., 2016) and trade, travel
1130 and urbanization have impacted disease spread.

1131 For some climate-sensitive infectious diseases (such as *Salmonella*, *Campylobacter* and *Vibrio*) there is good
1132 evidence of the climatic impact on an increase in case numbers and/or pathogen presence, even if absolute
1133 numbers are hard to establish. However, there are some pathogens where the relationship between weather
1134 variables and disease is lacking, particularly for different regions of the UK (see below sections). There is good
1135 evidence of the impact of weather on vectors and vector-borne diseases, although it is incredibly difficult to
1136 ascertain the impact of weather alone. For example, the impact on health from reduced recreational water
1137 quality is considered low, which is largely based on the lack of evidence for deaths in systematic or semi-
1138 systematic synthesis of both observational and non-observational studies.

1139 As such, the current magnitude scores for all four nations have been assessed as medium, reflecting the current
1140 burden of climate sensitive diseases. The confidence around the magnitude score for most nations is medium,
1141 although Northern Ireland is scored a low due to the lack of studies based in Northern Ireland compared with
1142 the other nations.

1143 Foodborne and waterborne infections

1144 *Campylobacter*: Bacteria that cause diarrheal illness and is often associated with foodborne transmission
1145 (Fischer et al., 2024), although wider environmental exposures may also be important. Many UK-based studies
1146 show *Campylobacter* incidence increases as temperatures increase, up to a threshold, but uncertainty remains in
1147 the literature as to the casual mechanism with some conflicting results (Louis et al., 2005; Tam et al., 2006; I.
1148 R.Lake et al., 2009; Sanderson et al., 2018; Djennad et al., 2019; Lake et al., 2019; Lo Iacono et al., 2024).

1149 *Salmonella*: Bacteria that cause food poisoning from contaminated meat, eggs, or water, and prevalence
1150 increases with temperature (Kovats et al., 2004; I. R. Lake et al., 2009). For example, in Scotland, there was a
1151 4.7% increase in *Salmonella* cases for every degree rise over a 3°C threshold (95% CI: 2.1-7.3), whilst in England
1152 and Wales there was a 12.4% increase in *Salmonella* cases per every degree rise over a 5°C threshold (95% CI:
1153 11.6-13.3) (Kovats et al., 2004). Similarly, there was a positive association with cases of the two most reported
1154 types of *Salmonella* (serovars) (*Salmonella* Enteritidis and *Salmonella* Typhimurium) and temperature (current
1155 and previous week) in England and Wales (I. R. Lake et al., 2009).

1156 *Vibrio*: Bacteria that cause severe skin and gastrointestinal infections, naturally found in coastal waters that
1157 thrive and multiply in warm waters (Vezzulli et al., 2016). Infection can occur following consumption of raw or
1158 undercooked seafood or fish, as well as ingestion or exposure to contaminated water. Increases in coastal water
1159 temperatures have resulted in the detection of some vibrio species in UK shellfish samples (Harrison et al.,
1160 2022). During the 2018 heatwave event and into 2019, *Vibrio parahaemolyticus*, *Vibrio vulnificus* and *Vibrio*
1161 *cholerae* were present at high concentrations in water samples from one UK estuarine site, with greater
1162 abundances corresponding to higher water temperatures and lower salinity (Ford et al., 2020).

1163 Shiga toxin-producing *Escherichia coli* (STEC): A group of *E. coli* bacteria normally transmitted through
1164 contaminated food, that produce harmful toxins, which cause severe infection in humans (ECDC, 2025). An
1165 outbreak in 2022 was likely caused by UK-grown lettuce crops becoming contaminated during an adverse
1166 flooding event, where following drought-like conditions, two months of rain fell in the region over a 24-hour
1167 period (Cunningham et al., 2024).

1168 *Cryptosporidium*: A water-borne and food-borne parasite that causes cryptosporidiosis (UKHSA, 2024h). One
1169 study using data from the 1990s reported a 27% increase in cases if the cumulative rainfall in the preceding
1170 week was high (Naumova et al., 2005). However, in the early 2000s, drinking water regulations were
1171 strengthened and many recent outbreaks, such as the outbreak of >100 cases in Devon, are associated with
1172 faulty infrastructure (Barnes, 2024). However, such system vulnerabilities can be amplified by adverse weather
1173 events (further information in I9: risks to water supply and wastewater systems).

1174 Norovirus: A virus, often spread through contaminated food, that causes vomiting and diarrhoea (NHS, 2024).
1175 For England and Wales, one study found a 15% reduction in norovirus reports if the month preceding was 1°C
1176 warmer, whereas a 1% increase in relative humidity led to a 2% decrease in reports (Lopman et al., 2009).

1177 Rotavirus: A virus that primarily causes gastroenteritis, particularly severe diarrhoea, vomiting, fever, and
1178 abdominal pain in infants and young children (CDC, 2024). An inverse relationship with temperature has been
1179 reported (Atchison et al., 2010). The effect of temperature was broadly similar in England, Wales and Scotland,
1180 ranging from 7%-16% decrease in cases per 1°C rise in mean weekly temperature (Atchison et al., 2010).

1181 Air-borne infections

1182 *Legionella*: A bacterium that can cause respiratory illnesses in humans through inhalation of contaminated
1183 airborne water droplets (NHS, 2023), with increases in risk associated with increases in temperature in the
1184 preceding 2 months and increases in rainfall in the preceding week (Halsby et al., 2014).

1185 Airborne viruses: For some pathogens, such as adenoviruses, respiratory syncytial virus (RSV), influenza A and B
1186 viruses and human metapneumovirus, temperatures were significantly colder on days when the pathogens were
1187 detected compared with days where they were not, and in some cases increased temperatures causes
1188 shortened infection seasons (G. C. Donaldson, 2006). In contrast, there were other pathogens such as
1189 rhinoviruses and human parainfluenza viruses where there was no significant difference in abundance between
1190 warmer and colder days (Price, Graham and Ramalingam, 2019). Seasonal coronavirus cases (not including SARS-
1191 COV-2) were significantly higher when air temperatures were below 10°C and relative humidity was above 84%
1192 in the two weeks preceding diagnosis (Nichols et al., 2021a).

1193 Vectors and vector-borne diseases

1194 Ticks and associated diseases: In the UK, the sheep tick (*Ixodes ricinus*) is the most widely distributed tick
1195 species, and most likely to bite people and carries the bacteria which causes Lyme disease. It is found in a range
1196 of habitats including woodland, heathland, grazed and scrub grassland, urban parks and gardens. Passive
1197 surveillance conducted by the UK Health Security Agency suggests tick distribution has expanded across much of
1198 the UK in recent years, which may be driven by several factors including changes in weather and climate, but
1199 also woodland cover and connectivity, deer densities and human behaviour (Gandy, Hansford and Medlock,
1200 2023). The number of ticks infected with the Lyme disease bacteria is also different across habitats (Cull et al.,
1201 2021; Medlock et al., 2022). This highlights the importance of considering that biodiversity initiatives to increase
1202 woodland cover through planting trees, woodland regeneration and rewilding could alter the microclimate and
1203 increase habitat availability for ticks and hosts (Gillingham and Medlock, 2023).

1204 Since 2019, tick-borne encephalitis virus (TBEv) has been detected 21 times in the UK, with more than half of the
1205 cases occurring in 2023 (Kreusch et al., 2019; Mansbridge et al., 2022; Callaby et al., 2025). Deer were more
1206 likely to be positive for TBEv in sites with a high percentage cover of coniferous woodland, and higher rate of
1207 spring warming or mean annual surface temperature (Hassall et al., 2025).

1208 *Hyalomma marginatum* is a non-native tick species found in southern Europe that carries Crimean-Congo
1209 haemorrhagic fever virus (CCHFV) (Walker et al., 2003; Choubdar et al., 2019). Migratory birds are important
1210 hosts of immature stages and can transport individual ticks over several thousand miles during spring migration.
1211 There have been several detections of this tick in England, including the most recent detection of a person with
1212 no history of travel (McGinley et al., 2021). It was hypothesised that this was due to high temperatures
1213 facilitating the migration of birds as hosts (McGinley et al., 2021).

1214 **Mosquitoes and associated diseases**

1215 As the UK experiences warmer temperatures and changing rainfall patterns due to climate change, conditions
1216 may become more conducive for mosquitoes to survive and breed. The mosquitoes of primary concern for
1217 disease transmission currently and in a changing climate include species belonging to the *Anopheles*, *Aedes* and
1218 *Culex* genera. *Culex modestus*, a vector for West Nile Virus, is being found in more locations around the UK,
1219 especially in the south, but also as far north as Suffolk (Vaux et al., 2024). West Nile Virus was detected in UK
1220 mosquitoes (*Aedes vexans*) for the first time in July 2023 (UKHSA, 2025d). Evidence from the USA, where the
1221 first detection of West Nile Virus was in New York in 1999, suggests it spreads geographically at a fast rate, and is
1222 extremely difficult to eradicate (Colpitts et al., 2012). Eggs of *Aedes albopictus*, a vector for several infections
1223 including dengue, were first detected in a motorway service station in Kent in September 2016 (Medlock et al.,
1224 2017), and further eggs and larvae were detected in the southeast over the following 3 years (Vaux et al., 2019).
1225 Locally transmitted dengue outbreaks have now occurred in neighbouring countries, including in parts of
1226 northern France (Arulmukavarathan et al., 2024), emphasising the importance of preventing this species
1227 becoming established. Whilst *Anopheles* species, a vector for malaria, are present in the UK, only imported
1228 malaria cases are regularly reported. Due to an effective UK treatment and monitoring system, malaria is
1229 unlikely to re-establish.

1230 Antimicrobial resistance: Antimicrobial resistance (AMR) refers to the capacity of microorganisms to withstand
1231 the effects of antimicrobial treatments, such as antibiotics. It is a leading cause of deaths, and it has been
1232 estimated that globally in 2021 there were 1.14 million deaths directly attributed to bacterial AMR and 4.71
1233 million deaths associated with it (Naghavi et al., 2024). Changes in infectious diseases from weather and climate
1234 patterns interact with changes in antibiotic usage, and therefore potentially affect AMR. However,
1235 understanding of the impact that climate change is having on AMR is currently limited and requires further
1236 research (van Bavel et al., 2024).

1237 **Assessment of future magnitude of risk**

1238 There are only a small number of studies, predominately focusing on vectors and vector-borne diseases which
1239 have quantified future risk; if infections are not mentioned in the proceeding sections, then it is because there
1240 are currently no studies quantifying future risk. Unless stated otherwise, all studies have used a high scenario
1241 (RCP8.5) and are described in the following section. Magnitude scores for low or central scenarios are often
1242 inferred from the high scenario, thereby decreasing our confidence in that evidence. Many of the pathogens
1243 mentioned in the previous sections have not been looked at under any climate scenario, so are omitted from the
1244 below.

1245 *Vibrio*: As temperatures increase, UK coastal waters will become more favourable for the growth of *Vibrio* and
1246 the risk of outbreaks is likely to increase (Baker-Austin et al., 2017). Modelling studies using both medium
1247 (SSSP2-4.5) and high scenarios suggest that in future, there will be an increase in the UK coastline which is
1248 suitable for the growth and survival of *Vibrio* compared with current conditions (Trinanes and Martinez-Urtaza,
1249 2021).

1250 *Aedes albopictus* and associated diseases: Climate modelling suggests that the London area is already suitable
1251 for *A. albopictus*, and it has been estimated using a high scenario that most of England becoming suitable for
1252 established populations as early as the 2040s or 2050s, and most of Wales, Northern Ireland, and parts of the
1253 Scottish Lowlands becoming suitable as early as the 2060s or 2070s (Gillingham and Medlock, 2023). (Gillingham
1254 and Medlock, 2023) Dengue could become endemic in London during the 2060s under a high scenario (Liu-
1255 Helmersson et al., 2016). Modelling suggests that during 2000-2022, temperatures were warm enough during
1256 some years for potential transmission of chikungunya to occur in London and parts of the East of England
1257 (Gillingham and Medlock, 2023). In the future as temperatures continue to increase, modelling using a high
1258 scenario suggests that more areas across the UK are predicted to exceed the threshold temperatures, with many
1259 parts of England and Wales predicted to be warm enough for potential transmission during three consecutive
1260 months and reaching four months in London by the 2070s (Gillingham and Medlock, 2023).

1261 *Hyalomma marginatum*: Climate projection data using a high scenario suggests that whilst UK temperatures will
1262 increase in future, autumn temperatures on average are likely to remain too cold for nymphs to moult to adults
1263 during the autumn and affect survival over the winter, although there were variations between different model
1264 runs (E L Gillingham, Medlock, et al., 2023).

1265 West Nile Virus: Modelling studies of future risks using a high scenario show the spread of *Culex* spp. in future
1266 warmer climates to most of southern England and parts of the Midlands by mid-century (Ewing et al., 2021;
1267 Withers et al., 2024). The risk of infection with the virus is currently low but is predicted to increase into the
1268 second half of this century throughout lowland England and parts of Wales (Ewing et al., 2021).

1269 **Level of preparedness for risk**

1270 The UK Biological Security Strategy (Cabinet Office, 2025) provides the framework to make the UK resilient to
1271 biological threats. Its mission is to understand current and future biological risks, prevent risks from emerging
1272 where possible or threatening the UK, detect and respond to risks to lessen the impact on the UK.

1273 UK policy on managing emerging infections is addressed through the multi-agency cross-government horizon
1274 scanning and risk assessment Human Animal Infections Risk Surveillance (HAIRS) group (UKHSA, 2025g). The UK
1275 government launched the Third National Adaptation Programme (NAP3) in 2023 (Defra, 2024b), which includes
1276 enhancing surveillance, undertaking horizon scanning and conducting research to monitor changes in vector-
1277 borne disease distribution in the UK and worldwide. Within the NAP, UKHSA has a remit to update the evidence
1278 base for the impacts of climate change on health in the UK, which includes infectious diseases.

1279 The Food Standards Agency (FSA) is responsible for food safety and food hygiene in England, Wales, and
1280 Northern Ireland. Their Food System Strategic Assessment 2023 (Food Standards Agency, 2023) recognised that
1281 foodborne and zoonotic diseases may increase in the UK over the next decade and suggested actions in more
1282 comprehensive and regular global monitoring and data sharing as well as stronger food safety enforcements
1283 along supply chains. FSA are developing a new Area of Research Interest (ARI) to focus on understanding the
1284 potential impacts on the UK of changing food availability, food security and food safety risks (Food Standards
1285 Agency, 2024b).

1286 **Assessment of the evidence base and evidence gaps**

1287 There is currently a lack of studies attributing the burden of infectious diseases to specific weather and climate
1288 factors in the UK. There needs to be more studies that project future infectious disease risk, including
1289 emergence of novel infections, using a combination of different warming and adaptation scenarios. There is also
1290 a relative lack of studies, across these diseases in individual countries of the UK especially Northern Ireland.

5.2.4.2 England

Additional evidence specific to England. Where diseases are not mentioned, no additional information was available and evidence for the UK (5.2.4.1) was used to assess risk.

Assessment of current magnitude of risk

For the risk posed by recreational seawater, a crude estimate can be made from the only randomised controlled trial conducted in the UK (England and Wales) between 1989-1992. The results of this trial indicated that the largest differences in seawater quality – defined as seawater with 0-13 ml faecal streptococci (an indicator of sewage pollution) versus 50-158 ml faecal streptococci - are associated with approximately 15,000 more gastrointestinal infections per 100,000 outdoor seawater users every year (Fleisher et al., 1993, 1996, 1998; Kay et al., 1994; Fleisher and Kay, 2006). Therefore, the magnitude of current effects on recreational water users would be expected to fall in the low-to-medium range. However, it is difficult to be more specific and disentangle the current effects of weather and climate change, versus existing waste management processes and infrastructure in the UK (e.g. combined sewerage, regulation of water industry). Higher sea-surface temperatures and lower salinity have also resulted in the detection of more novel human pathogenic *Vibrio* species in shellfish sampled from English coastline sites (Ford et al., 2020; Harrison et al., 2022). An equivalent UK randomised trial does not exist for freshwater and *Vibrio* risk does not apply to freshwaters, though the results of a trial conducted in Germany suggest that risks attributable to reduced freshwater quality are similarly on the order of thousands per 100,000 (Wiedenmann et al. 2006).

There has been a reduction in rotavirus reports in England, Wales and Scotland with increasing mean temperature (Atchison et al., 2010). Lastly, there is evidence of an increase in cryptosporidiosis rate by 27% in northern England if cumulative rainfall for prior week was in 75th percentile (Naumova et al., 2005).

Higher seasonal coronavirus cases are observed during low temperature, high humidity periods in England (Nichols et al., 2021b). Higher temperatures due to climate change may reduce the risk of norovirus transmission of as a 15% reduction in norovirus reports if the month preceding was 1°C warmer, whereas a 1% increase in relative humidity led to a 2% decrease in reports in England and Wales (Lopman et al., 2009). Similarly, lower rotavirus cases have been reported at higher temperatures in England after controlling for trend, seasonality, public holidays, relative humidity and rainfall (Atchison et al., 2009). Data from England and Wales suggests that the RSV season ended at a rate of 3.1 weeks earlier per 1 °C temperature rise, suggesting that warmer temperatures shorten the season (Donaldson, 2006).

Culex modestus has spread from North Kent salt marshes and Essex coast, to along the Thames Estuary in Kent, on the opposite bank in Essex and in the coastal wetlands of Essex.

Assessment of future magnitude of risk

2030s:

A low warming scenario (RCP2.6) leads to a 6.2% increase for non-tuberculous mycobacteria infections across UK, and a 33.8% increase in infection rates to 10.2 cases per 100,000 people from 2023 to 2033 (Campbell, Willis and Parsons, 2024). Secondly, an increase in UK coastline suitable for *Vibrio* is predicted (Trinanes and Martinez-Urtaza, 2021). For vector-borne diseases, modelling using high warming scenarios (RCP8.5) suggests most of England and parts of Wales could become suitable for established populations of *Aedes albopictus* by the 2050s (Gillingham and Medlock, 2023). High warming scenarios suggest that temperatures may be warm enough for potential chikungunya transmission during 1-2 consecutive months (Gillingham and Medlock, 2023).

1331 2050s and 2080s:

1332 There is currently a scarcity of evidence showing the impact of low and central warming scenarios on climate-
1333 sensitive infectious diseases in England.

1334 By 2080, high warming scenarios suggest that England could become suitable for *Aedes albopictus* (Gillingham
1335 and Medlock, 2023) with one study estimating that dengue could become endemic in London during the 2060s
1336 (Liu-Helmersson et al., 2016). Many parts of England and Wales are predicted to be warm enough for potential
1337 chikungunya transmission for 3-4 consecutive months by 2080 (Gillingham and Medlock, 2023). However, high
1338 warming scenarios suggest that the threshold for self-sustaining populations of the tick species *Hyalomma*
1339 *marginatum* will not be met (E L Gillingham, Medlock, et al., 2023).

1340 **Preparedness and adaptation**

1341 The UKHSA’s mission is to prepare for, prevent and respond to health threats, save lives and protect livelihoods
1342 (UKHSA, 2023). There are specific priorities of UKHSA which all contribute to preparedness in the threat of
1343 climate change: be ready to respond to all hazards to health; reduce the impact of infectious diseases and
1344 antimicrobial resistance; protect health from threats in the environment; and improve action on health security
1345 through data and insights. The impact of infectious diseases is also included within the National Risk Register
1346 (Cabinet Office, 2025a).

1347 UKHSA regularly monitors infectious diseases in England (UKHSA, 2025g) and wider through horizon scanning.
1348 The UKHSA preparedness plan (UKHSA, 2025h) highlights incident response plans, including levels for
1349 escalation/de-escalation, which is relevant to infectious disease outbreaks. The ‘Communicable disease outbreak
1350 management guidance’ (UKHSA, 2025c) provides health protection organisations in England with principles to
1351 support local health protection responses to communicable disease outbreaks, with the aim of preventing harm
1352 from such outbreaks. In 2025, the ‘Priority pathogen families reference tool’ (UKHSA, 2025i) was published,
1353 highlighting 24 pathogen families where further research is most needed in the interests of biosecurity. The tool
1354 also included a measure of climate sensitivity of pathogens, with many highlighting additional research is
1355 required. UKHSA has also published guidance on disease outbreak management to support local health
1356 protection systems (UKHSA, 2025b).

1357 Invasive mosquito surveillance at ports was instigated in 2010 and between 40 and 60 trapping locations are
1358 currently maintained and coordinated through a collaboration between UKHSA and local and port health
1359 authorities. The National Contingency Plan for Invasive Mosquitoes is a cross-government document which
1360 outlines local level actions to be taken in the event of a non-native mosquito detection (UKHSA, Defra and DHSC,
1361 2020). UKHSA also runs a Tick Surveillance Scheme (TSS) and has developed a tick awareness toolkit (UKHSA,
1362 2024g), and resources for local authorities to raise awareness of ticks and tick-borne diseases in England. UKHSA
1363 works to provide evidence-based guidelines on adaptation for vectors and VBDs in England (Hawkes et al.,
1364 2020). One of UKHSA’s strategic priorities for 2023-2026 is to ‘reduce the impact of infectious diseases and
1365 antimicrobial resistance (UKHSA, 2023). UKHSA works with local authorities, who in turn may support
1366 community-led or citizen science approaches to improving awareness and reducing the risk to health from VBDs.
1367 Surveillance and research partnerships are in place with UK academic institutions. Proactive habitat
1368 management also occurs, through a range of organisations and partnerships.

1369 In September 2024, the ‘Water (Special Measures) Bill’ was announced to target water company-related
1370 pollution of outdoor bathing waters in England and Wales. Amongst other measures, this bill increases the
1371 ability of the Environment Agency to fine and criminally charge law breaking (Defra and Reed, no date). The
1372 Environment Agency measure water quality regularly and advise on outdoor swimming in key locations in
1373 England.

1374 **Evaluation of urgency score**

1375 The overall risk in England is assessed as Medium for the current climate and future periods. This is based on the
 1376 number of people exposed to harmful vector-borne, water-borne, and food-borne diseases, rather than air-
 1377 borne diseases, which is likely to result in tens of deaths, hundreds of major health impacts and tens of
 1378 thousands of people affected. This estimate is made from correlations of cases with temperatures, but no
 1379 studies show actual population exposure to these diseases, so our confidence in the magnitude scores is Low.
 1380 There is some modelling evidence around future vector-borne disease risk, but the evidence for other infections
 1381 is much weaker. Confidence is low for future risks, due to limited evidence of explicit climate drivers and a lack
 1382 of England-specific projections. There is limited evidence of effective implementation and potential for other
 1383 adaptation measures to inadvertently worsen the risk. These scores do not include the impact of climate change
 1384 on AMR, which although is listed as an international element above also affects UK populations.

1385 *Table 5.18: Urgency scores for H4 Risks to people from climate-sensitive infectious diseases for England. Key to the magnitude scores: very*
 1386 *light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++*
 1387 *= Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More*
 1388 *Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were*
 1389 *calculated are in the Methods Chapter.*

England								
H4	Risks to people from climate-sensitive infectious diseases.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	+++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	MAN	FI		FI			FI	
Overall urgency score	MAN							

1390

1391 **5.2.4.3 Northern Ireland**

1392 Additional evidence specific to Northern Ireland. Where diseases are not mentioned, no additional information
 1393 was available and evidence for the UK (5.2.4.1) was used to assess risk.

1394 **Assessment of current magnitude of risk**

1395 There is currently a lack of evidence relating specifically to climate-sensitive diseases in Northern Ireland.
 1396 However, it is likely that correlations between disease cases and weather than have been seen in other UK
 1397 nations will also apply in Northern Ireland, although temperature thresholds for diseases/vectors may be
 1398 different.

1399 **Assessment of future magnitude of risk**

1400 A low warming scenario is predicted to result in a 7.5% increase in non-tuberculous mycobacteria infection rates
1401 in Northern Ireland by 2033 (Campbell, Willis and Parsons, 2024). In addition, the coastline around Northern
1402 Ireland which is suitable for *Vibrio* is predicted to increase by 2100 (Trinanes and Martinez-Urtaza, 2021).

1403 For vector-borne diseases, modelling using high warming scenarios suggests that parts of Northern Ireland could
1404 become suitable for the establishment of *Aedes albopictus* by the 2060s or 2070s (Gillingham and Medlock,
1405 2023). High warming scenarios suggest that temperatures are unlikely to be warm enough for potential
1406 chikungunya transmission, even by 2080 (Gillingham and Medlock, 2023).

1407 **Preparedness and adaptation**

1408 The Health Protection Service within the Northern Ireland Public Health Agency (PHA) has the lead role in
1409 protecting the population from infection and undertakes surveillance and monitoring of pathogens. Whilst the
1410 second Northern Ireland Climate Change Adaptation Programme (Daera, 2019), reports on actions to address
1411 disease risks for plants and wildlife, but no actions are listed for human pathogens.

1412 The second Northern Ireland Climate Change Adaptation Programme (NICCAP2, Daera 2019) highlights that
1413 some evidence has pointed to recent declines in bathing water quality in Northern Ireland and mentions the
1414 ‘System for Bathing Water Quality Monitoring’ (SWIM) that will investigate and model the linkage between
1415 heavy rainfall events and poor bathing water quality. It also refers to ‘Sustainable Water – A Long-Term Water
1416 Strategy for Northern Ireland (2015–2040)’, which recognises that all policies must factor in the future
1417 implications of climate change on both quality and quantity of water resources. It also notes that the ‘Drinking
1418 Water and Health Guidance’ is reviewed annually and contains action to be taken should drinking water quality
1419 fall below health-based criteria. Northern Ireland’s ten year ‘Making Life Better’ strategy for health and
1420 wellbeing has an objective to provide safe and clean drinking water. The SWIM project is now complete for six
1421 sites, and water quality predictions are delivered during the bathing season on the ‘SWIM NI’ app.

1422 **Evaluation of urgency score**

1423 The overall risk in Northern Ireland is assessed as Medium for the current climate and future periods. This is
1424 based on the number of people exposed to harmful vector-borne, water-borne, and food-borne diseases, rather
1425 than air-borne diseases, which is likely to result in tens of deaths, hundreds of major health impacts and tens of
1426 thousands of people affected. There is some modelling evidence around future vector-borne disease risk, but
1427 the evidence for other infections is much weaker. Confidence is low for future risks, due to limited evidence of
1428 explicit climate drivers and a lack of Northern Ireland-specific projections. There is limited evidence of effective
1429 implementation and potential for other adaptation measures to inadvertently worsen the risk. These scores do
1430 not include the impact of climate change on AMR which, although listed as an international element above, also
1431 affects UK populations.

1432 *Table 5.19: Urgency scores for H4 Risks to people from climate-sensitive infectious diseases for Northern Ireland. Key to the magnitude*
1433 *scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence*
1434 *scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical*
1435 *Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how*
1436 *the scores in this table were calculated are in the Methods Chapter.*

Northern Ireland	
H4	Risks to people from climate-sensitive infectious diseases.

	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	+	+	+	+	+	+	+
With adaptation	++ (M)	+	+	+	+	+	+	+
Urgency scores	MAN	FI		FI			FI	
Overall urgency score	MAN							

1437

1438 **5.2.4.4 Scotland**

1439 Additional evidence specific to Scotland: Where diseases are not mentioned, no additional information was
 1440 available and evidence for the UK (5.2.4.1) was used to assess risk.

1441 **Assessment of current magnitude of risk**

1442 A mean temperature increase of 1 °C reduces the odds of detecting adenovirus (2.8%), RSV (17.3%), influenza A
 1443 (13.7%) and influenza B (13%) viruses and human metapneumovirus (9.9%) in Scotland (Price, Graham and
 1444 Ramalingam, 2019). Cases of some respiratory diseases also linked with relative humidity including human
 1445 metapneumovirus, RSV, influenza A virus in Scotland (Price, Graham and Ramalingam, 2019). Higher rotavirus
 1446 cases have been reported at lower temperatures in Scotland after controlling for trends, seasonality, public
 1447 holidays, relative humidity and rainfall (Atchison et al., 2009).

1448 **Assessment of future magnitude of risk**

1449 A low warming scenario is predicted to result in a 9.5% increase in non-tuberculous mycobacteria infection rates
 1450 in Scotland by 2033 (Campbell, Willis and Parsons, 2024). In addition, the length of coastline around Scotland
 1451 which is suitable for *Vibrio* is predicted to increase by 2100 (Trinanes and Martinez-Urtaza, 2021).

1452 For vector-borne diseases, modelling using high warming scenarios suggests that parts of the Scottish Lowlands
 1453 could become suitable for the establishment of *Aedes albopictus* by the 2060s or 2070s (Gillingham and
 1454 Medlock, 2023). High warming scenarios suggest that temperatures are unlikely to be warm enough for
 1455 potential chikungunya transmission in Scotland, even by 2080 (Gillingham and Medlock, 2023).

1456 **Preparedness and adaptation**

1457 Preparedness and adaptation efforts have a particular focus on Lyme disease due to its increasing public health
 1458 relevance in Scotland. The Scottish Government published the Scottish National Adaptation Plan 2024 – 2029
 1459 (Scottish Government, 2024b), known as SNAP 3, and an associated monitoring and evaluation framework
 1460 (Scottish Government, 2025b). SNAP 3 recognises that climate change is already affecting VBD transmission and
 1461 spread; and that policy responses to climate change, including nature-based adaptation solutions could create
 1462 habitats more suitable for vectors. The Scottish Government have led a multi-media communications campaign,
 1463 ‘Find a tick remove it quick’, over consecutive summers (2023/2024), which have helped raise the profile of VBD

1464 threats in Scotland. SNAP 3 has committed over the 5-year plan to mapping the risk of emergent VBD due to
 1465 climate change, scoping enhanced surveillance, scoping adoption of VBD contingency plans for England and
 1466 horizon scanning for VBD of livestock, and the Scottish Government continues to work with partners to progress
 1467 these commitments. Health Protection Scotland published updated information on ticks and Lyme disease in
 1468 Scotland in 2018, including guidance on prevention and treatment.

1469 SEPA monitors and publishes the general microbiological quality of the water at outdoor swimming sites during
 1470 bathing season. PHS manage the Scottish Environmental Incident Surveillance System (SEISS), a database holding
 1471 details of incidents reported by participating agencies, where there may be a risk to public health due to the
 1472 release into the environment of chemical, microbiological, radiation or other physical agents.

1473 **Evaluation of urgency score**

1474 Across climate sensitive diseases assessed, the magnitude scores are the same as other UK nations. The overall
 1475 risk in Scotland is assessed as Medium for the current and future periods, this is based on an estimate of the
 1476 number of people exposed to harmful vector-borne, water-borne, and food-borne diseases, which is likely to
 1477 result in tens of deaths, hundreds of major health impacts and tens of thousands of people affected. This
 1478 estimate is made from correlations of cases with temperatures, but no studies show actual population exposure
 1479 to these diseases, so our confidence in the magnitude scores is low. There is some modelling evidence around
 1480 future vector-borne disease risk, but the evidence for other infections is much weaker. Confidence is low for
 1481 future risks, due to limited evidence of explicit climate drivers and a lack of Scotland-specific projections. There
 1482 is limited evidence of effective implementation and potential for other adaptation measures to inadvertently
 1483 worsen the risk. These scores do not include the impact of climate change on AMR which, although listed as an
 1484 international element above, also affects UK populations.

1485 *Table 5.20: Urgency scores for H4 Risks to people from climate-sensitive infectious diseases for Scotland. Key to the magnitude scores: very*
 1486 *light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++*
 1487 *= Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More*
 1488 *Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were*
 1489 *calculated are in the Methods Chapter.*

Scotland								
H4	Risks to people from climate-sensitive infectious diseases.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	MAN	FI		FI			FI	
Overall urgency score	MAN							

1490

5.2.4.5 Wales

Additional evidence specific to Wales: Where diseases are not mentioned, no additional information was available and evidence for the UK (5.2.4.1) was used to assess risk.

Assessment of current magnitude of risk

Higher seasonal coronavirus cases are observed during low temperature, high humidity periods in Wales (Nichols et al., 2021b). A 15% reduction in norovirus reports if the month preceding was 1 °C warmer, whereas a 1% increase in relative humidity led to a 2% decrease in reports in England and Wales (Lopman et al., 2009). Similarly, higher rotavirus cases have been reported at lower temperatures in Wales after controlling for trend, seasonality, public holidays, relative humidity and rainfall (Atchison et al., 2009). Data from England and Wales suggests that the RSV season ended at a rate of 3.1 weeks earlier per 1 °C temperature rise, suggesting that warmer temperatures shorten the season (Donaldson, 2006). For recreational (sea)water quality risks, the discussion for England above is also relevant here since the randomised trial mentioned was also conducted in Wales and the two regions are climatologically similar and hence may respond similarly to emerging *Vibrio* pathogens too.

Assessment of future magnitude of risk

A low warming scenario is predicted to result in a 0.9% increase in non-tuberculous mycobacteria infection rates in Wales by 2033 (Campbell, Willis and Parsons, 2024). In addition, the coastline around Wales which is suitable for *Vibrio* is predicted to increase by 2100 (Trinanes and Martínez-Urtaza, 2021).

For vector-borne diseases, modelling using high warming scenarios suggests most of Wales could become suitable for the establishment of *Aedes albopictus* by the 2060s or 2070s (Gillingham and Medlock, 2023). High warming scenarios suggest that temperatures in parts of South Wales could be warm enough for potential chikungunya transmission for 1-3 consecutive months by 2080 (Gillingham and Medlock, 2023). However, high warming scenarios suggest that the threshold for self-sustaining populations of the tick species *Hyalomma marginatum* will not be met (E L Gillingham, Medlock, et al., 2023).

Preparedness and adaptation

The Climate Adaptation Strategy for Wales (Welsh Government, 2024b) mentions a 'One Health' approach to minimise the threat of transmission of domestic animal diseases to wildlife and vice versa. This includes collaborating on the surveillance of vectors and diseases, real-time assessment of threats from diseases in other countries, and developing preparedness and response capability for exotic diseases, including horizon-scanning for emerging threats overseas. In addition, Public Health Wales (PHW) are incorporating climate indicators into routine gastrointestinal surveillance reports and have produced a Wales-specific non-foodborne zoonoses report focusing on climate-sensitive pathogens (not publicly available). A health and social care climate adaptation toolkit (Welsh Government, 2024d) has been produced, which includes climate-sensitive diseases as a risk that needs to be understood and considered during planning.

The climate related risk from vector-borne pathogens is recognised in the Welsh Government's adaptation plan, Prosperity for All: A Climate Conscious Wales (Welsh Government, 2019). One particular action seeks to increase understanding of the risk, with continued monitoring at ports and airports, and efforts to increase understanding of the risk, particularly from Lyme disease, with healthcare professionals. The plan commits to research what other action is needed and to survey where vectors are entering Wales in the future. There is a recognition that increased use of blue / green infrastructure as nature-based solutions to other climate threats could increase the problem with native vectors, and therefore there is a commitment to work on avoiding this

1532 issue, working with Natural Resources Wales and other experts. This will include putting in place effective
 1533 measures for urban and peri-urban blue and green space to prevent habitats for vectors. PHW are also
 1534 collaborating with UKHSA and working closely with local authorities to extend mosquito surveillance in Wales.

1535 Prosperity for All: A Climate Conscious Wales highlighted the Welsh Government’s Water Strategy for Wales,
 1536 which was published in 2015, and aims to maintain high levels of water quality and protect the health of people
 1537 in Wales. The strategy identifies the risks from climate change and is underpinned by an all-Wales action plan. In
 1538 addition, the Water Health Partnership for Wales is an initiative that brings together relevant agencies to work
 1539 together more effectively to protect public health by ensuring the provision of safe drinking water. Agencies in
 1540 the Partnership include the Drinking Water Inspectorate, Welsh Government, local authority public and
 1541 environmental health, the water companies and Public Health Wales. Natural Resources Wales is the regulatory
 1542 body responsible for managing water resources in Wales. They provide oversight of both Bathing and Drinking
 1543 Water in Wales through a wide range of strategies and plans and regulatory activity. Water companies also
 1544 report annually on bathing water quality in Wales (NRW, 2018).

1545 PHW’s Climate Change Programme Board (CCPB) has established the Climate Change Surveillance Sub-Group,
 1546 consisting of internal and external partners, including the Welsh Government and the Office for National
 1547 Statistics. The CCPB’s programme strategic decisions are informed by and shared with the Welsh Government
 1548 Adaptation National Project Board and Health Protection Advisory Group Environmental Public Health Subgroup.
 1549 The PHW Climate Change Surveillance Sub-Group will initially focus on the development of heat morbidity and
 1550 mortality surveillance.

1551 **Evaluation of urgency score**

1552 The overall risk in Wales is assessed as medium for current and future periods. This is based on the number of
 1553 people exposed to harmful vector-borne, water-borne, and food-borne diseases, rather than air-borne diseases,
 1554 which is likely to result in tens of deaths, hundreds of major health impacts and tens of thousands of people
 1555 affected. There is some modelling evidence around future vector-borne disease risk, but the evidence for other
 1556 infections is much weaker. Confidence is low for future risks, due to limited evidence of explicit climate drivers
 1557 and a lack of Wales-specific projections. There is limited evidence of effective implementation and potential for
 1558 other adaptation measures to inadvertently worsen the risk. These scores do not include the impact of climate
 1559 change on AMR which, although listed as an international element above, also affects UK populations.

1560 *Table 5.21: Urgency scores for H4 Risks to people from climate-sensitive infectious diseases for Wales. Key to the magnitude scores: very*
 1561 *light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++*
 1562 *= Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More*
 1563 *Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were*
 1564 *calculated are in the Methods Chapter.*

Wales								
H4	Risks to people from climate-sensitive infectious diseases.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	++ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)

Urgency scores	MAN	FI		FI			FI	
Overall urgency score	MAN							

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1566

Draft for Community Review

1567 **5.2.5 Risk to food safety and nutrition – H5**

1568 Risk to food safety and nutrition includes risk to the nutritional content and quality of food produced, as well as
 1569 to equitable access to and intake of safe and nutritious diets. This topic is inherently linked to food security,
 1570 which is covered in the Land, Food and Nature chapter (N11). An important component of food safety is
 1571 infection caused by specific food-borne pathogens, some of which are climate sensitive. These are discussed and
 1572 included in magnitude scores in the infectious diseases risk (H4) (see also Box 2 below). CCRA4-IA-TR expands on
 1573 CCRA3-IA-TR by considering nutrition alongside food safety, and in addition to food security. This recognises the
 1574 importance of both food and nutrition security (quantity and quality of food), and the health and social value of
 1575 food above and beyond the provision of sufficient calories and food as a tradable commodity. Evidence on the
 1576 impact of climate change on nutrition and diet-related health outcomes in the UK, however, is scarce.

Headlines

- Further investigation is needed to assess urgency due to limited evidence directly linking climate change to UK food safety and diet-related morbidity and mortality.
- Inequality in accessing safe and nutritious food is likely, especially for fresh fruits and vegetables, due to a reliance on imported food and increased global climate-related food production shocks and food trade/price volatility.
- Devolved administrations have adaptation plans in place or in development. How these will be implemented or impact food safety and nutrition security, is uncertain.
- The urgency score (further investigation) remains unchanged from CCRA3-IA-TR, despite the remit of this risk no longer including food security.

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Table 5.22: Urgency scores for H5 Risks to food safety and nutrition. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H5	Risk to food safety and nutrition	UK	+ (M)	+ (M)	+ (M)	+ (M)	FI
		England	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Northern Ireland	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Scotland	+ (M)	+ (M)	+ (M)	+ (M)	FI
		Wales	+ (M)	+ (M)	+ (M)	+ (M)	FI

1578

1579 **5.2.5.1 Evidence relevant to the entire United Kingdom**

1580 **Current and future drivers of risk**

1581 The impact of changes in climate or climate induced extreme weather events on UK food safety, diets, and
1582 nutrition can be complex, with limited evidence available to quantify or qualify direct or compounding and
1583 cascading risks. Extreme weather events and other changes related to climate change may impact the quantity,
1584 quality, diversity, and accessibility of foods in the UK via different pathways throughout global and domestic
1585 food systems. These effects may in turn increase the risk of consuming foods that are unsafe and can make it
1586 more challenging to consume diets which meet national nutritional guidelines.

1587 Hotter environments increase the likelihood of food spoilage and proliferation of pathogens (Damtew et al.,
1588 2024). High humidity, especially in warmer seasons, can worsen the risk of fungal growth, such as moulds, and
1589 lead to spoilage of non-refrigerated stored food products. Waterlogging is linked to crop losses and reduced
1590 quality of crops in terms of nutrition and toxicology. Rising atmospheric CO₂ concentrations may increase yields
1591 but also reduce the nutritional quality of certain crops. Flooding, storms, and sea water intrusion can
1592 contaminate crops, food, and water sources, disrupt food storage and cold chain systems and increase the
1593 proliferation of specific food-borne pathogens, (see also H4,5.2.4). Disruption of infrastructure necessary for
1594 food handling and storage, such as cold chain systems, can exacerbate these risks. Changes to hygiene practices
1595 or pest and disease distributions across food systems because of climate change can pose a risk to food safety
1596 for UK populations if sufficient controls are not in place (UKHSA, HECC, 2024). Figure 5.3 shows how climate
1597 change can affect food safety and nutrition through multiple pathways.



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Figure 5.3: The potential interactions of rising CO₂ and climate change on food safety and nutrition from 'farm to table'. (Taken from Maggiore et al., 2020).

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Assessment of current magnitude of risk

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The current magnitude of the risk is Medium across the UK based on limited evidence that current climate conditions may impair the nutritional quality of key foods; overall intakes of diverse and nutrient dense foods; or increase the risk of food safety incidents, all of which could in turn increase rates of illness for large numbers of people. Regarding the nutritional quality of foods, although rising levels of CO₂ increases some crop yields, they have a detrimental effect on the nutritional density of some plants and their harvestable parts (Ebi et al., 2018; Hoegh-Guldberg et al., 2019; Mbow et al., 2019). For example, rising CO₂ levels have been associated with reduced concentrations of nutrients in staple cereal crops (micronutrient or protein concentrations in wheat) (Myers et al., 2014; Ekele et al., 2025). These foods make a large contribution to intakes, so any reduction in nutrient density could have a major impact, especially in households with limited dietary diversity who are at risk of food insecurity or who are experiencing a high burden of diet-related poor health outcomes.

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There is very little research directly attributing diet-related health outcomes to climate change or extreme weather events. Of the evidence available, the majority is related to undernutrition (undernourishment/hunger, stunting, wasting) in climate vulnerable regions such as Sub-Saharan Africa, with some work focussing on dietary diversity, micronutrient deficiency, diet-related NCD, or considering overweight or obesity (Salm, 2020; Fanzo, 2025). None of these studies specify the risk to UK populations at present, however they identify pathways to ill-health that may become relevant to the UK. For example, a study in the Pacific Islands linked climate change with trends in being overweight due to reduced availability of fruits and vegetables and over reliance on imported and processed food, showing how climate change effects can change food environments and health outcomes (McIver, 2016).

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The UK population consistently misses targets for recommended fruits, vegetables, and fibre intake, with only one in ten adults consuming five fruits and vegetables a day. On average, the UK population derives approximately 40 % of energy intake from Ultra Processed Foods (OHID, 2025) (Chang, 2024). Maintaining the accessibility and affordability of good quality food including fresh fruits and vegetables and minimising any requirements to substitute these with Ultra Processed Foods is, therefore, a key priority to protect populations against diet-related disease (diet-related NCD or micronutrient deficiency diseases).

Box 2 - Food Poisoning

Some pathogens (bacteria, viruses and parasites), which cause infection or irritation of the digestive system when consumed in contaminated food, are known to be sensitive to changes in climate (also see H4). While the health impacts of these food-borne pathogens are outline here, they are not used to inform the overall urgency scoring for this risk.

Campylobacter: Bacteria that cause diarrheal illness and is often associated with foodborne transmission (Fischer et al., 2024), although wider environmental exposures may also be important. Many UK-based studies show *Campylobacter* incidence increases as temperatures increase, up to a threshold, but uncertainty remains in the literature as to the casual mechanism with some conflicting results (Louis et al., 2005; Tam et al., 2006; I. R.Lake et al., 2009; Sanderson et al., 2018; Djennad et al., 2019; Lake et al., 2019; Lo Iacono et al., 2024).

Salmonella: Bacteria that cause food poisoning from contaminated meat, eggs, or water, and prevalence increases with temperature (Kovats et al., 2004; I. R. Lake et al., 2009). For example, in Scotland, there was a 4.7% increase in *Salmonella* cases for every degree rise over a 3°C threshold (95% CI: 2.1-7.3), whilst in England and Wales there was a 12.4% increase in *Salmonella* cases per every degree rise over a 5°C threshold (95% CI: 11.6-13.3) (Kovats et al., 2004). Similarly, there was a positive association with cases of the two most reported types of *Salmonella* (serovars) (*Salmonella* Enteritidis and *Salmonella* Typhimurium) and temperature (current and previous week) in England and Wales (I. R. Lake et al., 2009).

Vibrio: Bacteria that cause severe skin and gastrointestinal infections, naturally found in coastal waters that thrive and multiply in warm waters (Vezzulli et al., 2016). Infection can occur following consumption of raw or undercooked seafood or fish, as well as ingestion or exposure to contaminated water. Increases in coastal water temperatures have resulted in the detection of some vibrio species in UK shellfish samples (Harrison et al., 2022). During the 2018 heatwave event and into 2019, *Vibrio parahaemolyticus*, *Vibrio vulnificus* and *Vibrio cholerae* were present at high concentrations in water samples from one UK estuarine site, with greater abundances corresponding to higher water temperatures and lower salinity (Ford et al., 2020).

Shiga toxin-producing *Escherichia coli* (STEC): A group of *E. coli* bacteria normally transmitted through contaminated food, that produce harmful toxins, which cause severe infection in humans (ECDC, 2025). An outbreak in 2022 was likely caused by UK-grown lettuce crops becoming contaminated during an adverse flooding event, where following drought-like conditions, two months of rain fell in the region over a 24-hour period (Cunningham et al., 2024).

Norovirus: A virus, often spread through contaminated food, that causes vomiting and diarrhoea (NHS, 2024). For England and Wales, one study found a 15% reduction in norovirus reports if the month preceding was 1°C warmer, whereas a 1% increase in relative humidity led to a 2% decrease in reports (Lopman et al., 2009).

1627

1628 Assessment of future magnitude of risk

1629 Based on limited evidence the future risk is assessed as Medium across 2030s, 2050s and 2080s for all areas of
1630 the UK. The Food Standards Agency (2024a) published a report on climate impacts on UK food systems and
1631 determined that in the near-term future (e.g. next five years), environmentally driven changes will result in
1632 increased volatility for supply chains; increased risks to the accessibility of diverse and nutritious foods

1633 exacerbating inequalities in food insecurity; and increased food safety risks across supply chains. These effects
1634 will make it more difficult to increase the proportion of the UK population who meet government dietary
1635 recommendations (especially in lower income and underserved or vulnerable households).

1636 **Level of preparedness for risk**

1637 All four of the UK nations have a cross-departmental food strategy, with England being the latest to release their
1638 report in 2025 (DEFRA, 2025). Responsibility for adaptation lies with government bodies, public health agencies,
1639 and key sectors including agriculture, health, and food safety authorities, each working to address specific
1640 regional challenges while aligning with national strategies. The monitoring and surveillance of food safety and
1641 nutrient security is part of an obligation for DEFRA to report on food security every year (UK Agriculture Act
1642 2020). Diets are also monitored across the UK through a variety of national surveys, some of which are
1643 conducted on a rolling basis (e.g., The National Diet and Nutrition Survey, NDNS). Agreements to work across
1644 government as well as infrastructure to monitor and survey risks can assist with stabilising the magnitude of risk
1645 going forwards. The third National Adaptation Programme (NAP3) launched in 2023, includes measures to
1646 safeguard food supply chains and food safety from climate disruptions. The programme is currently being
1647 implemented. The FSA, along with co-funders, is investing in the new UK Food Safety Network which aims to
1648 implement effective measures for enhancing food safety. A National Preparedness Report (NPC, 2025) highlights
1649 food contamination is one of the key risks on the National Risk Register, however until recently little attention
1650 has been given to food resilience with an overreliance on market forces to protect the UK from shocks, climate
1651 or other.

1652 Measures to safeguard UK nutrient security have received less attention, compared with adaptation measures to
1653 minimise the environmental impact on UK food systems. These latter measures include an emphasis on
1654 sustainable sources in government buying standards for food and catering services, or the UK's national food-
1655 based dietary guidelines (Eatwell Guide). Such guidelines encourage, for example, sustainable sources of fish and
1656 palm oil as well as eating seasonally. Many positive health outcomes are associated with sustainable dietary
1657 practices and if we were to meet current dietary guidelines it is highly likely we would also reduce the
1658 environmental impacts of diets (Springmann, 2020). For example, by lowering intakes of red and processed
1659 meats and substituting these with plant sources of protein or fruits and vegetables this would reduce the risks of
1660 diet-related NCD (e.g., blood pressure from lowering sodium/salt intakes), whilst simultaneously reducing the
1661 greenhouse gas emissions and land use change impacts associated with different livestock practices. Any future
1662 change to the nutritional content of food supplies or the availability and accessibility of food, due to climate
1663 change, however, would need to be more directly reflected in national nutrition risk assessments, especially to
1664 protect vulnerable or disadvantaged populations, which may have specific needs or already be at risk of poor
1665 diets and experiencing a disproportionately higher burden of diet-related poor health status or disease (e.g.,
1666 overweight and obesity, diabetes, vascular conditions and certain cancers).

1667 **Assessment of the evidence base and evidence gaps**

1668 The low confidence level for current risks represents the low certainty, high variability and many gaps in the
1669 available evidence linking climate change to food safety incidents and diet-related mortality and morbidity in the
1670 UK. There is also an urgent need to improve the available evidence in other areas including the impact of climate
1671 change on aquaculture and wild fisheries and the role of climate change as a cause of malnutrition in all its forms
1672 (undernutrition, micronutrient deficiency diseases, and overweight/obesity/diet-related NCD).

1674 **5.2.5.2 England**

1675 **Assessment of current and future magnitude of risk**

1676 There is no additional evidence specific to England. Evidence for the UK (5.2.5.1) was used to assess risk. Current
 1677 and future risk was assessed as Medium as tens of thousands of people will be affected.

1678 **Preparedness and adaptation**

1679 The National Preparedness Commission report identified a lack of cohesion in food security policy and
 1680 preparedness for food resilience in England from food shocks due to climate change or other (NPC, 2025). The
 1681 report highlighted a complacency in being able to source sufficient food based on meeting energy needs (kcal
 1682 per person per week), rather than considering food and nutrient security, and an overreliance on business to
 1683 find alternative supply during periods of disruption. It also highlighted that the 2023 National Risk Register
 1684 includes risks from contamination of food supply but does not consider risks to nutrient security. The FSA is
 1685 expected to update its review of climate change impacts on food safety and security, in line with the newly
 1686 released cross-departmental National Food Strategy for England (DEFRA, 2025).

1687 **Evaluation of urgency score**

1688 *Table 5.23: Urgency scores for H5 Risks to food safety and nutrition for England. Key to the magnitude scores: very light purple (L) = Low,*
 1689 *light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.*
 1690 *Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
 1691 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
 1692 *Methods Chapter.*

England								
H5	Risk to food safety and nutrition.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	FI	FI		FI			FI	
Overall urgency score	FI							

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1694 **5.2.5.3 Northern Ireland**

1695 **Assessment of current and future magnitude of risk**

1696 Current and short-term future risk (2030s) is assessed to be Medium based on evidence for the UK with
 1697 thousands of people affected. Northern Ireland has a higher proportional share of the most deprived areas in

1698 the UK, especially for health with nearly 28% of areas in Northern Ireland ranked within the most deprived 10%
 1699 by poor health across the UK (UKDI briefing upcoming). This could make Northern Ireland more vulnerable to
 1700 many climate-related health risks including nutrition and food safety risks, although this was not considered to
 1701 be sufficient to move the current risk from Medium to High magnitude.

1702 **Preparedness and adaptation**

1703 The NI Food Strategy Framework Action Plan 2025-2027 (DAERA, 2024c) represents a whole of government
 1704 approach to food, recognising the impact of climate change on food safety and nutrition. This action plan was
 1705 developed in partnership with the Food Safety Agency in NI, who work closely with Safefood to promote food
 1706 safety and nutrition across Northern Ireland (DAERA, 2024).

1707 A draft third Northern Ireland Climate Change Adaptation Programme (NICCAP3) (DAERA, 2025) was released for
 1708 consultation in Jun-Aug 2025 and includes food security actions to protect the economy, communities, and
 1709 environment from climate change impacts in the near term. For example, to become more resilient against food
 1710 supply shocks such as the disruption to transport and distribution from Storn Debi in 2023 (NICCAP3, 2025).

1711 **Evaluation of urgency score**

1712 *Table 5.24: Urgency scores for H5 Risks to food safety and nutrition for Northern Ireland. Key to the magnitude scores: very light purple (L)*
 1713 *= Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium,*
 1714 *+++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed,*
 1715 *FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in*
 1716 *the Methods Chapter.*

Northern Ireland								
H5	Risk to food safety and nutrition.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	FI	FI		FI			FI	
Overall urgency score	FI							

1717

1718 **5.2.5.4 Scotland**

1719 **Assessment of current and future magnitude of risk**

1720 There is no additional evidence specific to Scotland. Evidence for the UK (5.2.5.1) was used to assess risk.
 1721 Current and future risk was assessed as Medium as thousands of people will be affected.

1722 **Preparedness and adaptation**

1723 A number of policies have been introduced by the Scottish Government in support of farming and food
 1724 production in Scotland. These include the Good Food Nation (Scotland) Act 2022 (Scottish Parliament, 2022)
 1725 which aims to benefit wellbeing through ensuring access to good quality food, and the Vision for Agriculture
 1726 which promotes sustainable farming practice and provides financial support for adaptation from 2025. The
 1727 Agriculture Reform Programme also explores funding options to support farmers to reduce exposure to climate
 1728 hazards. Scottish Government has introduced a Local Food Strategy to promote local supply of food and reduce
 1729 barriers to a healthy diet among disadvantaged groups. These policies are helpful in safeguarding access to an
 1730 affordable healthy diet in general, although they do not currently directly address the nutritional impact of
 1731 climate change.

1732 Scotland has also prioritised food production from sustainable food systems, for example with additional
 1733 sampling for mycotoxins and monitoring the health of shellfish harvesting areas. It seems likely but yet
 1734 unconfirmed that increased adoption of similar sustainable farming approaches will make food supply and
 1735 nutritional quality more resilient to the impacts of climate change (Altieri et al., 2015).

1736 **Evaluation of urgency score**

1737 *Table 5.25: Urgency scores for H5 Risks to food safety and nutrition for Scotland. Key to the magnitude scores: very light purple (L) = Low,*
 1738 *light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.*
 1739 *Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
 1740 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
 1741 *Methods Chapter.*

Scotland								
H5	Risk to food safety and nutrition.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	FI	FI		FI			FI	
Overall urgency score	FI							

1742

1743 **5.2.5.5 Wales**

1744 **Assessment of current and future magnitude of risk**

1745 There is no additional evidence specific to Wales. Evidence for the UK (5.2.5.1) was used to assess risk. Current
 1746 and future risk was assessed as Medium as thousands of people will be affected.

1747 **Preparedness and adaptation**

1748 The Wales Community Food Strategy released in 2025 is designed to build healthier and more resilience food
 1749 systems in Wales to make healthier food accessible to all. The strategy aligns with the Healthy Weight: Healthy
 1750 Wales plan and the 2024 Child Poverty Strategy, as well as focusing on local food partnerships and increasing
 1751 public sector spending on Welsh food and suppliers.

1752 Climate change impacts on food security (see N11) and nutrition are being explored through a Climate Change
 1753 Health Impact Assessment commissioned by (Public Health Wales, 2023b (HIA D1)). High levels of carbon dioxide
 1754 are thought to have reduced the nutrient content on some crops in Wales (Public Health Wales, 2023b (HIA D1)).

1755 **Evaluation of urgency score**

1756 *Table 5.26: Urgency scores for H5 Risks to food safety and nutrition for Wales. Key to the magnitude scores: very light purple (L) = Low,
 1757 light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High.
 1758 Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =
 1759 Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the
 1760 Methods Chapter.*

Wales								
H5	Risk to food safety and nutrition.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
With adaptation	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)	+ (M)
Urgency scores	FI	FI		FI			FI	
Overall urgency score	FI							

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5.2.6 Risk to health and social care delivery – H6

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The UK health system includes primary, secondary and tertiary care facilities which are coordinated by devolved national health services. The provision of social care has more complex governance, with public and private providers of services to support vulnerable individuals, including children, adults and older persons in their own home, as well as in residential or nursing homes. Climate risks are known to interrupt the supply of health services, undermine access to services, affect the quality of service delivery (quality of care), impact health and social care staff, disrupt supply chains and adversely affect health outcomes for those receiving care. Climate change may also affect demand for health care through changes to infectious disease patterns and the exacerbation of symptoms for persons with chronic (non-communicable) diseases (NCDs).

Headlines

- Significant disruption to health delivery from flooding of all types will increase in the future.
- Overheating in health facilities is an increasing issue with significant impacts on the quality of care, patients and staff. Damage to infrastructure, including IT systems, has been significant.
- There is more evidence since CCRA3-IA-TR on overheating in care homes and the cost-effectiveness of active and passive cooling measures, and behaviour change in reducing negative impacts on health of residents.
- Some progress in developing adaptation planning at the hospital level, but there is a lack of investment and regulation to support adaptation in the health and social care sector.

1771

Table 5.27: Urgency scores for H6 Risks to health and social care delivery. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H6	Risks to health and social care delivery	UK	++ (H)	++ (M)	+++ (H)	++ (H)	MAN
		England	++ (H)	++ (M)	+++ (H)	++ (H)	MAN
		Northern Ireland	++ (M)	++ (M)	++ (M)	++ (H)	MAN
		Scotland	++ (M)	++ (M)	++ (M)	++ (H)	MAN
		Wales	++ (M)	++ (M)	++ (M)	++ (H)	MAN

1772

5.2.6.1 Evidence relevant to the entire United Kingdom

1773

Current and future drivers of risk

1774

1775 Climate risks disrupt health and social care delivery. The impacts of climate risks are compounded by the
1776 fragmentation of services and limited general resilience within local and regional systems. Climate risks are
1777 broadly the same across all countries in terms of impacts, with heat risks a greater issue in England and Wales.

1778 The increased risk of flooding and storm events are likely to increase the disruption of health and social care
1779 service access and delivery (see BE2 Flooding and BE3 Coastal change impacts on buildings, for more detailed
1780 information on regional impacts). Health and social care services are very reliant on critical infrastructure,
1781 including water and power supplies (see I3, I1 and I8); and emergency planning (BE8). The health system relies
1782 heavily upon domestic and international supply chains which are likely to be affected by climate change (E3).
1783 High indoor temperatures are increasingly affecting health and social care services (see also H1: risks to people
1784 from heat and BE1: risks to buildings and communities from heat). There is an emerging risk from wildfires to
1785 health facilities. Currently, flooding, storms and heatwaves represent the biggest climate risks.

1786 **Assessment of current magnitude of risk**

1787 The magnitude of the current risk is High due to economic, social and health costs of disruption to health
1788 services from flooding and heatwaves, and other extreme weather. The economic costs of impacts (damage to
1789 infrastructure) and disruption to services are primarily considered within this assessment, as well as the costs to
1790 population health (in terms of damage to health from loss or poor quality of services) which falls in the hundreds
1791 of millions of pounds damage (economic) or foregone opportunities.

1792 Heatwaves are associated with short term (acute) increases in health service demand (ambulance call outs, A&E
1793 visits and emergency hospital admissions) (Rizmie et al., 2022). Heat impacts cause increased emergency
1794 admissions for 'high admission cost' conditions such as kidney injury and dementia (Hajat et al. 2024).
1795 Unplanned care resulting from heat-related illness is significantly more expensive than planned care, especially
1796 for older people. Heat impacts may also cause delays in discharge of patients (Brooks et al., 2023).

1797 Overheating in health facilities has caused the cancellation of inpatient and outpatient health services. During
1798 the heatwave in 2022, elective surgeries were cancelled as a result of staff shortages, and overheating in surgical
1799 theatres in England (Picciochi et al., 2023; POST, 2024). Overheating has been reported in a range of health
1800 service types, including antenatal care, outpatient services and inpatient wards.

1801 The impact of heatwaves on equipment is increasing (failure of essential refrigeration systems including morgue
1802 facilities, IT systems, other equipment) leading to loss of services, and loss of medicines (Brooks et al., 2023b).
1803 Extreme high temperatures (40°C) in 2022 caused a critical incident due to the sustained loss of all clinical IT
1804 services at a large hospital (Guy's and St Thomas' NHS Foundation, 2023).

1805 Occupational heat stress, staff discomfort, and absenteeism increase during hot weather and causes significant
1806 impacts on staff wellbeing and service delivery (Brooks et al., 2023b; Davey et al., 2024). A UK-wide survey found
1807 that over 90% of respondents, mainly nurses, perceived that occupational heat strain impaired their
1808 performance, especially when using personal protective equipment, and 20% reported heat-related absenteeism
1809 (Davey et al., 2024).

1810 High temperatures present a risk to social care delivery, both in care homes and in the community. A significant
1811 proportion of social care is delivered in the home, and also by informal or unpaid carers (Health and Social Care
1812 Committee, 2025). Climate change represents a range of risks to social care delivery at home (Young and
1813 Bergseng, 2020).

1814 The climate risk to residents in care homes is well established, with an increase in research evidence on the
1815 prevalence and risks from overheating associated with high outdoor temperatures. Power outages during

1816 extreme heat further compound risks, especially for patients relying on cooling devices or refrigerated
1817 medications (Al-Marwani, 2023).

1818 Flooding and extreme rainfall have also disrupted health and social care services through damage to equipment
1819 and buildings. Storm damage to health facility buildings is costly, may lead to the cancellation of services, and
1820 can require relocation or evacuation of inpatients. Damage by heavy rainfall events is made worse by the poor
1821 state of many hospital buildings.

1822 Flooding and storm events prevent staff and patients from accessing health facilities. There have been several
1823 flood events that have damaged health and social care facilities, such as evacuation of a care home during Storm
1824 Babet in 2023, or major disruption to services. The July 2021 flooding at Whipps Cross hospital in London lead to
1825 approximately 100 inpatients being evacuated, and a major incident was declared (Barts Health NHS Trust,
1826 2021).

1827 Health service delivery relies on significant domestic and international supply chains for medicines and
1828 consumables. Floods can also cause disruption of domestic supply chains. In 2012, flooding of the NHS Blood and
1829 Transplant Centre in Bristol caused national disruption of blood product (Sheridan, 2019).

1830 **Assessment of future magnitude of risk**

1831 Flood projections indicate an increase in flood risk for health system assets, including hospitals, care homes, GP
1832 surgeries and emergency services (see BE2, CCRA3-IA-TR, Sayers et al. 2020). The updated national flood and
1833 coastal risk assessment (Environment Agency, 2025) estimates that currently 26% of hospitals are at flood risk
1834 from multiple sources and that this risk will increase to 32% with climate change in 2050s.

1835 Temperature projections (see SOTC chapter) indicate an increased risk of overheating in health and social care
1836 buildings. A few studies have projected future indoor temperatures in hospitals and care homes (Gupta R et al.,
1837 2021; Tsoulou et al., 2021) and these indicate significant increases in risk without effective adaptation. No new
1838 projections of overheating in health facilities have been published.

1839 **Level of preparedness for risk**

1840 The health and social care systems in the UK are devolved and also complex in terms of the multiple agencies
1841 delivering care. There are national regulators who are responsible for standards of care in hospitals, care homes
1842 and other related services. Local authorities are responsible for commissioning some community care services.

1843 Adaptation action in the healthcare sector is challenged because of a widely noted ‘fragmentation between
1844 tertiary, primary and social care services’ (UKHSA and NHS England, 2021, 2025).

1845 Common passive cooling strategies may not adequately mitigate overheating risk in care homes in the 2050s and
1846 2080s (Gupta et al., 2021). Further research has shown that passive cooling measures and air conditioning can
1847 be cost-effective in a range of care home settings (Ibbetson et al. 2025). It is not currently possible to assess the
1848 implementation of active or passive cooling across the NHS Estate.

1849 The National Health Service (NHS) and Greener NHS lead the NHS system transition (Huang et al., 2024). All NHS
1850 Trusts and Integrated Care Boards are required to produce Green Plans that describe their decarbonisation and
1851 adaptation planning. Green Plans should be approved by the organisation’s board or governing body (NHS
1852 England, 2025b). These commitments gained legislative footing with the Health and Care Act 2022 (HM
1853 Government, 2022).

1854 Assessment of the evidence base and evidence gaps

1855 Confidence is Medium as there are several sources of high-quality independent evidence for present risk. The
1856 Fourth Health and Climate Adaptation Report highlights key evidence gaps that, if addressed, could strengthen
1857 climate resilience in the health sector to current and future risks. There is a need for greater evidence on cooling
1858 strategies and behaviour change in care home settings (Gupta et al., 2021).

1859 5.2.6.2 England

1860 Assessment of current and future magnitude of risk

1861 Reports of incidents of flooding have increased. The NHS Estates dataset (ERIC) has reported on flooding
1862 incidents since 2021. Flooding incidents have increased 103% (176 to 358) (NHS England Digital 2024). An
1863 incident is defined as an event that has a significant impact on health service delivery. It's worth noting that the
1864 events recorded in ERIC will under-estimate the true impact of flooding on health services.

1865 Overheating in hospital buildings has also increased in recent years and is also recorded in ERIC (NHS England
1866 Digital, 2023, 2024). These data show a 53% increase in overheating incidents from 2016 to 2023-24, with a peak
1867 in 2022/2023 reflecting the extreme hot summers [NHS England Digital, 2025]. Around 450 heat-related deaths
1868 were estimated in hospitals, and around 500 in care homes, in 2024 [UKHSA, 2025]. During the July 2022
1869 heatwave, cooling system failures at two data centres supporting London's largest NHS trust led to major IT
1870 outages at Guy's, St Thomas', and Evelina London hospitals. This forced a temporary switch to paper-based
1871 systems, caused over 100 treatment delays, including a missed organ transplant, and resulted in £1.4 million in
1872 additional costs, while also placing significant strain on staff morale (Guy's and St Thomas' NHS Foundation,
1873 2023).

1874 Monitoring of a range of care home types has demonstrated high indoor temperatures and limitations in
1875 training of staff around heat risks (Gupta et al., 2021). Monitoring of 3 care homes in England during the hot
1876 summer of 2019, found that temperatures frequently exceeding 30 °C which is well above indicative threshold of
1877 26 °C (Gupta and Howard, 2022). A study in two London care homes, showed that indoor temperatures
1878 frequently exceeded 26 °C, with newly built homes more likely to overheat (Tsoulou et al., 2021). Even during
1879 non-extreme summers, overheating still occurs but awareness of the level of risk is low among those managing
1880 care homes (Gupta et al., 2021a; 2021b).

1881 The CLIMACARE project has quantified overheating risks in over 50 care homes in England (Ibbetson et al. 2025).
1882 Modelling shows that building modifications and/or behaviour changes are cost-effective to reduce heat-related
1883 mortality across a range of care home types (Ibbetson et al. 2025).

1884 There is concern that power failures present additional risk for heat impacts in care homes that rely on air
1885 conditioning. A study of three care home buildings during the 2022 heatwave found that indoor temperatures
1886 initially increased rapidly (up to 4 °C in an hour in the worst case) as the building fabric was warmer than the
1887 indoor air, and most modelled bedrooms overheated (exceeding the CIBSE overheating threshold of 26 °C
1888 operative temperature) (Simpson et al. 2025).

1889 Under all future warming scenarios, it is very likely that overheating in hospitals and care homes will increase.
1890 Building models provide robust evidence for the likelihood of future indoor temperature increases under a range
1891 of climate scenarios, with assumptions about adaptations in terms of building interventions.

1892 There have been several studies that estimate future increases in indoor temperatures in care homes.
1893 Temperature projections indicate an increase of 6-10°C compared to the monitored data from 2019 (Tsoulou et

1894 al., 2021). By 2050, in a high-emission scenario, it is expected that nearly all bedrooms could exceed 26 °C during
1895 summer (Tsoulou et al., 2023). For a 2080s high-emission scenario, indoor temperatures in two London care
1896 homes were projected to all exceeded 32 °C, with peak temperatures reaching up to 40 °C in some locations,
1897 particularly in the newer care home (Gupta et al., 2021).

1898 **Preparedness and adaptation**

1899 The Greener NHS initiative focuses on adjusting healthcare systems and infrastructure to operate effectively
1900 amidst climate change (NHS England, 2025). Trusts and Integrated Care Boards (ICBs) are required to develop a
1901 Green Plan, which involves adaptation plans, under the Health and Care Act (2022). All NHS Trusts (n=212) have
1902 had Green Plans in place since June 2022 (NHS England, 2022). Adaptation planning was strengthened in the
1903 recently published Green Plan Guidance (NHS England, 2025). It is too early to evaluate the impacts of the Green
1904 Plans and the strategies within. The NHS has published its CCRA tool for Trusts and ICBs to ascertain the climate
1905 change risks to their sites and services and a Climate Adaptation Framework (NHS England, 2025a) to support
1906 NHS organisations to adapt to climate change. ERIC (NHS England Estates Returns Information Collection), has
1907 now published data for 2023 on overheating incidents and flooding incidents.

1908 The NHS published a Net Zero Building Standard in 2023 for new buildings and large retro-fits. The current
1909 version of the Net Zero Building Standard promotes passive cooling techniques and recommends a thermal
1910 comfort assessment to be carried out for all occupied spaces. NHS England has committed to strengthening
1911 adaptation within future iterations of the Net Zero Building Standard. Furthermore, climate adaptation planning
1912 is included within the NHS core standards for emergency preparedness, resilience and response guidance (NHS
1913 England, 2023).

1914 **Evaluation of urgency scores**

1915 The magnitude of this is assessed as high for the current and future scenarios, based primarily on hundreds of
1916 heat-related deaths in care homes and hospitals. Whilst the evidence base on quantified impacts upon health
1917 service delivery remains fragmented, the limited evidence, coupled with available monitoring data indicates an
1918 increasing risk in both current and future climates. The magnitude of the current risk has increased due to the
1919 impacts of recent extreme weather on services. UK healthcare expenditure in 2024 was approximately £317
1920 billion, or 11.1% of gross domestic product (ONS, 2025). The score considers the economic costs of impacts
1921 (damage to infrastructure) as well as the costs to population health.

1922 The magnitude of this is assessed as high for the current and future scenarios, based primarily on hundreds of
1923 heat-related deaths in care homes and hospitals. Whilst the evidence base on quantified impacts upon health
1924 service delivery remains fragmented, the limited evidence, coupled with available monitoring data indicates an
1925 increasing risk in both current and future climates. The magnitude of the current risk has increased due to the
1926 impacts of recent extreme weather on services. UK healthcare expenditure in 2024 was approximately £317
1927 billion, or 11.1% of gross domestic product (ONS, 2025). The score considers the economic costs of impacts
1928 (damage to infrastructure) as well as the costs to population health.

1929 *Table 5.28: Urgency scores for H6 Risks to health and social care delivery for England. Key to the magnitude scores: very light purple (L) =*
1930 *Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++*
1931 *High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
1932 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
1933 *Methods Chapter.*

England

H6 Risks to health and social care delivery.								
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (H)	++ (H)	+++ (H)	++ (H)	+++ (H)	++ (H)	++ (H)	++ (H)
With adaptation	++ (H)	++ (M)	+++ (H)	+++ (H)	+++ (H)	++ (H)	++ (H)	+++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

5.2.6.3 Northern Ireland

Assessment of current and future magnitude of risk

There is limited research on heat impacts on hospitals in Northern Ireland and no mechanisms for reporting overheating. However, it is likely that negative impacts of high temperature on health service delivery have occurred. There are several reports on flooding and storm events causing damage to hospitals and health facilities in Northern Ireland. For example, Storm Ciaran in November 2023, caused flood damage at the Ulster Hospital that caused a ward to be closed and patients moved.

High indoor temperatures have been reported in larger care homes in Northern Ireland, leading to discomfort among residents and care workers (Kennedy-Asser, 2022). There is enough evidence to assess a magnitude score for Northern Ireland based on information from England where care home settings are similar although the climate is cooler in Northern Ireland.

Preparedness and adaptation

The latest version of the Northern Ireland Climate Change Adaptation Programme (2024-2029) has undergone public consultation and publication is forthcoming. There is currently no evidence to suggest that the health system in Northern Ireland is required to publish climate change adaptation plans. In care settings, precautions including monitoring fluid intake and longer break time are recommended for both staff and residents (Kennedy-Asser, 2022).

Evaluation of urgency score

The risk magnitude is assessed as medium for present and future scenarios, except the assessment of high for the low and central 2080s scenarios. The overall urgency is More Action Needed.

Table 5.29: Urgency scores for H6 Risks to health and social care delivery for Northern Ireland. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action

1958
1959

Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Northern Ireland								
H6	Risks to health and social care delivery.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (M)
With adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (M)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

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5.2.6.4 Scotland

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Assessment of current and future magnitude of risk

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Each NHS board in Scotland has identified risks that could impact their assets and service provision, recognising a total of 952 potential climate risks across all twenty-two NHS boards. The key climate risks identified by the NHS boards, include “extended periods of hot weather”, “combined climatic effects”, and “flooding” (National Services Scotland, 2025). The current risk magnitude is assessed as Medium as there are likely to be hundreds of deaths, thousands of major health impacts, and hundreds of thousands of people affected. In the 2050s, risk remains Medium but increases in the 2080s to High.

1969

Preparedness and adaptation

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1971
1972
1973
1974

Both NHS Scotland (NHS Scotland, 2022) and Public Health Scotland (PHS, 2023) have climate emergency and sustainability strategies to 2026. In addition, the Health and Social Care Alliance Scotland is actively working on climate change and adapting the sector in Scotland. The Health and Social Care Academy calls for collaborative efforts from government, local authorities, health and social care partnerships, and care providers to address the sector’s contribution to and vulnerability to climate change.

1975
1976

A review by Young and Bergseng (2020) found that no local authorities considered climate risks within plans for delivering care at home.

1977

Evaluation of urgency score

1978
1979

The risk magnitude is assessed as medium for present day, 2030s and 2050s, increasing to high for the 2080s. The overall urgency is More Action Needed.

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1981
1982
1983
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Table 5.30: Urgency scores for H6 Risks to health and social care delivery for Scotland. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ = High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Scotland								
H6	Risks to health and social care delivery.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (H)
With adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

1985

5.2.6.5 Wales

1986

1987

Assessment of current and future magnitude of risk

1988

The Climate Change in Wales: Health Impacts Report (2023) highlights several key risks for older persons and children in care settings. Higher temperatures have been impacting on IT infrastructure, equipment and medicines, and workforce health (Public Health Wales, 2023a, sec. D7.1).

1989

1990

Preparedness and adaptation

1991

Wales has a health and social care climate emergency national programme (Welsh Government, 2025). In response to CCRA3-IA-TR, a toolkit was developed that recommended securing long-term funding to adapt hospitals and care homes, integrating adaptation actions into decarbonisation plans, and developing cross-sector approaches to address risks in the social care sector (Welsh Government, 2024c). The Welsh government's adoption of the Well-being of Future Generations (Wales) Act in 2015 may further support adaptation efforts in the health sector (National Assembly for Wales, 2015).

1992

1993

Evaluation of urgency score

1994

The current risk magnitude is assessed as Medium as there are likely to be a few heat-related deaths in care homes and hospitals, based on interpreting the analysis for England, and comparisons with similar heat-mortality statistics from H1. In the 2050s, risk remains Medium but increases in the 2080s to High. The Government of Wales undertook a health impact assessment and assessed several risks in hospitals and care settings. The mechanisms of impact will be like those in England for which there is more direct evidence.

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2007
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Table 5.31: Urgency scores for H6 Risks to health and social care delivery for Wales. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ = High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Wales								
H6	Risks to health and social care delivery.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (H)
With adaptation	++ (M)	++ (M)	++ (M)	++ (M)	++ (M)	++ (H)	++ (H)	++ (H)
Urgency scores	MAN	MAN		MAN			MAN	
Overall urgency score	MAN							

2009

Draft for Comment

5.2.7 Opportunities for health and wellbeing – H7

As the UK adapts to a changing climate, a growing body of evidence suggests that some health and wellbeing benefits can emerge. These arise via reducing risks and taking advantage of opportunities associated with our changing climate. One area for such opportunity is adaptation to support increased use of and access to green and blue spaces. Green spaces include parks, gardens and forests, while blue space refers to rivers, lakes, canals and coasts. Adaptation measures can serve to help maximise the health and wellbeing benefits of green and blue spaces as the climate changes. It is important to highlight that whilst these co-benefits and opportunities exist, the overarching impacts of climate change on health are largely adverse (H1-H6 in this chapter). Though cold risk is decreasing with fewer frost and ice days, it remains a very high current risk for health and wellbeing in the UK (see H2).

Headlines

- The strongest evidence for maximising physical and mental health benefits from adaptation to climate change is through increased use of green and blue spaces, particularly with trees.
- Adaptation policies that have utilised, preserved and enhanced green and blue spaces have been the most beneficial to health. These include urban greening programmes, access to inland and coastal outdoor swimming locations, and access to parks and woodlands.
- Potential mental and physical health benefits of adaptation measures are likely to be similar across the UK, but there is limited evidence on how outdoor recreation might be best supported through adaptation.

Table 5.32: Urgency scores for H7 Opportunities for health and wellbeing. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

ID	Risk		Present	2030	2050	2080	Urgency
H7	Opportunities for health and wellbeing	UK	+ (L)	+ (L)	+ (L)	+ (M)	FI
		England	+ (L)	+ (L)	+ (L)	+ (M)	FI
		Northern Ireland	+ (L)	+ (L)	+ (L)	+ (L)	FI
		Scotland	+ (L)	+ (L)	+ (L)	+ (L)	FI
		Wales	+ (L)	+ (L)	+ (L)	+ (L)	FI

2022 5.2.7.1 Evidence relevant to the entire United Kingdom

2023 Current and future drivers of opportunity

2024 Climate change adaptations that increase access to green and blue spaces present both opportunities and risks
2025 for health and wellbeing, particularly through increased potential for outdoor recreation and active travel.
2026 Warmer weather may encourage greater use of natural spaces; however, antagonistic effects, such as increased
2027 rainfall and stronger winds, could reduce this trend. Adaptation measures may therefore support increased
2028 opportunities for associated health and wellbeing benefits and/or help to mitigate adverse impacts of climate
2029 change on outdoor recreation and active travel. Adaptation measures may also interact with existing
2030 vulnerabilities, including significant potential to exacerbate health inequalities. For example, accessibility of
2031 green and blue spaces tends to be lower for ethnic minority and low-income communities. While the (limited)
2032 current evidence available for the UK suggests a linear association with warmer days associated with greater
2033 physical activity through outdoor recreational visits to natural environments, extreme heat (H1) is likely to act as
2034 a deterrent to this activity (and similarly for active travel), especially for more vulnerable groups such as older
2035 people. It is not as clear how many of the other weather patterns could change outdoor physical activities, but
2036 there are feasibly several links.

2037 Assessment of current magnitude of opportunity

2038 Increased access to blue and green spaces offers significant co-benefits. Green and blue space access can deliver
2039 a range of physical and mental health benefits such as reducing chronic stress and encouraging exercise (White
2040 et al., 2020; Browning et al., 2022). The scope of H7 is where co-benefits are from only the health-promoting
2041 green/blue space accessibility components. For instance, benefits arising from promoting physical activity, and
2042 decreasing anxiety, rather than those from reducing the urban heat island effect. Interventions relating to urban
2043 greening include increasing the quantity of green infrastructure such as urban trees, parks and gardens as well as
2044 creating a network of connected parks and green spaces (Sharifi et al., 2021). Physical activity during leisure visits
2045 to natural environments increases with rising temperature, while wind speed has a negative impact, and
2046 precipitation shows no clear association (Elliott et al., 2019). Evidence of improved health related to green
2047 spaces from other countries found lower rates of cardiovascular disease, stroke, and mood disorders, with
2048 exposure to trees being particularly important (Nutsford, Pearson and Kingham, 2013; Astell-Burt and Feng,
2049 2019; Seo et al., 2019). While warmer temperatures may initially encourage more physical activity, this may
2050 reverse under extreme heat (see H1), especially for vulnerable groups such as older adults (An et al., 2020;
2051 Bernard et al., 2021). Forest exposure in particular offers notable health benefits, including reductions in blood
2052 pressure, heart rate and cortisol and improvements in negative emotions such as anger, confusion, depression,
2053 and fatigue (Akpınar, Barbosa-Leiker and Brooks, 2016; Cheng et al., 2021).

2054 Increased recreational visits to blue spaces also creates health and wellbeing benefits . ‘Blue spaces’ refers to
2055 spending time on, in, or near to water bodies.

2056 Assessment of future magnitude of opportunity

2057 Given the limited evidence, confidence is low for magnitudes of the opportunity in 2050s and 2080s. There is no
2058 specific evidence to inform this, but there may be a higher magnitude of opportunity by 2080s, as overall higher
2059 temperatures by this time could lead to greater opportunities via outdoor recreation and active travel (although
2060 the net effect accounting for any adverse impacts of extreme heat (H1) is unknown).

2061 Level of preparedness for opportunity

2062 There are likely to be health benefits of adaptation specific to this opportunity, for example in terms of ensuring
2063 the quality and public trust in outdoor swimming waters, given that perception of quality impacts on
2064 recreational use. There are also well-established barriers to green/blue space access, including physical
2065 constraints and broader social determinants. Delivering social and physical environmental adaptations that serve
2066 to improve accessibility would be likely to capitalise on the opportunities presented.

2067 **Assessment of the evidence base and evidence gaps**

2068 Urban green and blue spaces offer critical adaptation functions, and there is a large volume of evidence on how
2069 increased green/blue space accessibility might deliver health and wellbeing benefits.

2070 Interventions can involve environmental/infrastructure changes and/or social, educational or health service
2071 programmes (Hunter et al., 2019). Nature-based social prescribing programmes provide pathways to promote
2072 and support green/blue space access and related activities for individuals with a range of health conditions or
2073 risk factors, and recent large-scale evaluations indicate effectiveness for mental health specifically (Defra,
2074 2024b). For example, the NHS Forest Print delivers an array of interventions aimed at increasing green/blue
2075 spaces, biodiversity and tree cover on healthcare sites to promote wellbeing (NHS Forest, n.d.).

2076 However, further evidence on the complex interaction of different weather conditions, including wind and rain,
2077 on nature access, outdoor recreation and active travel is required. Given the importance of local environments,
2078 cultures and socio-economic characteristics in shaping these relationships, evidence is required that is specific to
2079 the UK and the devolved administrations.

2080 **5.2.7.2 England**

2081 **Assessment of current and future magnitude of risk**

2082 As mentioned above, it is possible that higher temperatures that England will experience could lead to greater
2083 opportunities (notwithstanding adverse impacts of extreme heat), leading to some Medium magnitude scores
2084 under future scenarios, but with Low confidence due to lack of evidence.

2085 **Preparedness and adaptation**

2086 There are ongoing efforts in England to improve the quality and access of blue and green spaces. The
2087 Environment Improvement Plan (Defra, 2023) for England is underway, with notable progress through the Green
2088 Infrastructure Framework (Natural England, 2023) and associated Standards. A key recommendation is that all
2089 residents should live within a 15-minute walk of high-quality green or blue space (Defra, 2023). In parallel, the
2090 National Planning Policy Framework (DLUHC, 2024) was revised in response to the Levelling-up and
2091 Regeneration Act 2023 (HM Government, 2023), further aligning spatial planning policy with climate resilience
2092 and social equity goals. The framework recognises economic, social (e.g., healthy communities) and
2093 environmental (e.g., adapting to climate change) objectives as equally important and outlines how planning and
2094 decision-making should be made to favour sustainable development. Together, these initiatives support climate
2095 adaptation while enhancing public health, wellbeing, and environmental quality.

2096 **Evaluation of urgency score**

2097 There is a lack of specific evidence on this opportunity, so confidence is Low throughout. Magnitudes are
2098 generally anticipated to be Low given the potential scale of public health benefit in the context of the magnitude
2099 of risks described in H1-H6. However, in England, higher temperatures could lead to Medium magnitude if the

2100 opportunities are more substantial, but confidence for this is still Low. Further investigation is required to
 2101 evaluate the current and future opportunities presented.

2102 *Table 5.33: Urgency scores for H7 Opportunities for health and wellbeing for England. Key to the magnitude scores: very light purple (L) =*
 2103 *Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++*
 2104 *High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
 2105 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
 2106 *Methods Chapter.*

England								
H7	Opportunities for health and wellbeing.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
With adaptation	(L) +	(L) +	(M) +	(L) +	(M) +	(L) +	(M) +	(M) +
Urgency scores	FI	FI		WB			FI	
Overall urgency score	FI							

2107

2108 **5.2.7.3 Northern Ireland**

2109 **Assessment of current and future magnitude of opportunity**

2110 Evidence from the Connswater Community Greenway in Belfast suggests there are mental and physical health
 2111 benefits of urban green/blue space accessibility in the context of urban greenways, including facilitating physical
 2112 activity (Wang et al., 2023, 2024).

2113 **Preparedness and adaptation**

2114 The Environmental Improvement Plan for Northern Ireland (DAERA, 2024b) aims for everyone to connect with
 2115 and enjoy greenspaces. By 2028, the aim is to have a community trail network and green/blue places plan in all
 2116 district council areas, along with new fit for purpose outdoor recreation legislation.

2117 **Evaluation of urgency score**

2118 There is a lack of specific evidence on this opportunity, so confidence is Low throughout. Magnitudes are
 2119 generally anticipated to be Low given the potential scale of public health benefit in the context of the magnitude
 2120 of risks described in H1-H6. Further investigation is required to evaluate the current and future opportunities
 2121 presented.

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Table 5.34: Urgency scores for H7 Opportunities for health and wellbeing for Northern Ireland. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Northern Ireland								
H7	Opportunities for health and wellbeing.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
With adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
Urgency scores	FI	FI		WB			WB	
Overall urgency score	FI							

2127

5.2.7.4 Scotland

2128

2129

Assessment of current and future magnitude of risk

2130

A Public Health Scotland study on access to greenspace during the COVID-19 pandemic brought together surveys which registered between 70% and 90% agreement that greenspaces benefit mental health, regardless of income group (Public Health Scotland, 2022). But there are inequalities in accessibility of coastal blue space specifically. There is evidence from England that physical activity in green spaces increases with increasing temperature, and it's reasonable to believe this will be the same in Scotland.

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2135

Preparedness and adaptation

2136

The Scottish National Planning Framework (Scottish Government, 2024a) supports planning and development of 'liveable places' which aim to improve lifelong health and wellbeing and reduce health inequalities. One of four priorities for the National Transport Strategy (Transport Scotland, 2020) is to improve health and wellbeing by supporting people to choose active travel.

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Evaluation of urgency score

2141

There is a lack of specific evidence on this opportunity, so confidence is Low throughout. Magnitudes are generally anticipated to be Low given the potential scale of public health benefit in the context of the magnitude of risks described in H1-H6. Further investigation is required to evaluate the current and future opportunities presented.

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Table 5.35: Urgency scores for H7 Opportunities for health and wellbeing for Scotland. Key to the magnitude scores: very light purple (L) = Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++ = High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI = Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the Methods Chapter.

Scotland								
H7	Opportunities for health and wellbeing.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
With adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
Urgency scores	FI	FI		WB			WB	
Overall urgency score	FI							

2150

2151 **5.2.7.5 Wales**

2152 **Assessment of current and future magnitude of risk**

2153 The Green and Blue Spaces e-cohort was established to understand the impact of green and blue spaces on
2154 mental health and wellbeing in Wales (Geary et al., 2023). It used electronic health record data sources from
2155 2008-2019, comprising nearly 3 million people. The study found that those with greater access to green space in
2156 their neighbourhood had lower odds of seeking help for common mental health disorders. This suggests that
2157 living close to green and blue spaces is associated with positive impacts on mental health.

2158 **Preparedness and adaptation**

2159 Planning Policy Wales requires all levels of the planning process to develop Green Infrastructure Assessments to
2160 guide planning decisions (Welsh Government, 2024c). These assessments can identify opportunities for
2161 green/blue infrastructure development that may take advantage of any increased recreational opportunity and
2162 that serve to reduce associated inequalities. Transport for Wales and Ramblers Cymru (2023), launched an
2163 initiative called ‘Train, talk, walk’ which will encourage people to use local train services to access new family-
2164 friendly walking routes.

2165 **Evaluation of urgency score**

2166 There is a lack of specific evidence on this opportunity, so confidence is Low throughout. Magnitudes are
2167 generally anticipated to be Low given the potential scale of public health benefit in the context of the magnitude

2168 of risks described in H1-H6. Further investigation is required to evaluate the current and future opportunities
 2169 presented.

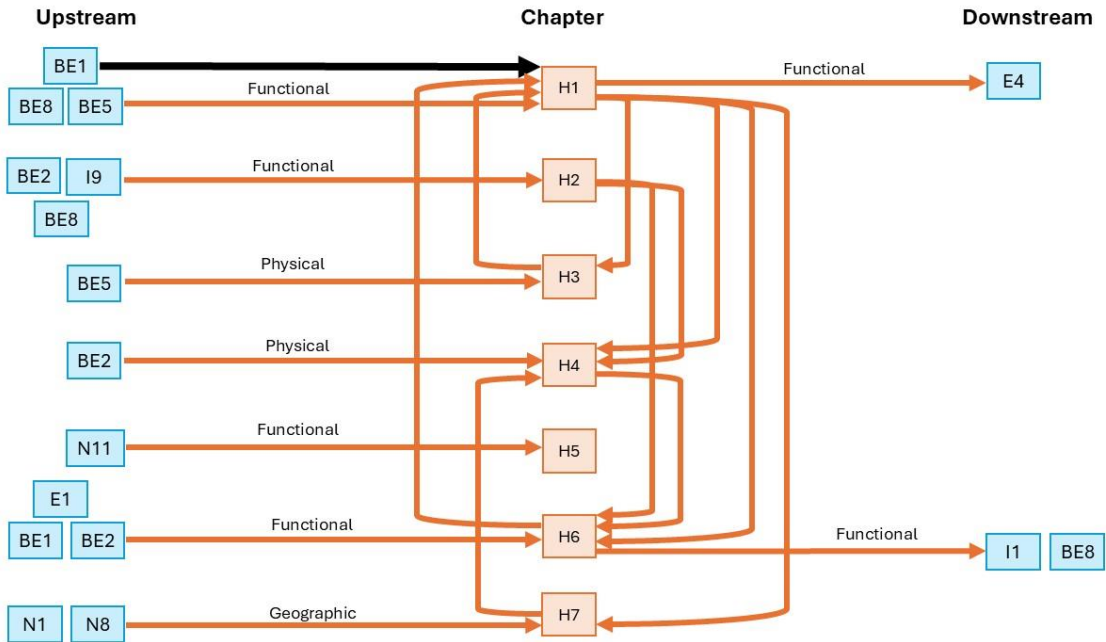
2170 *Table 5.36: Urgency scores for H7 Opportunities for health and wellbeing for Wales. Key to the magnitude scores: very light purple (L) =*
 2171 *Low, light purple (M) = Medium, purple (H) = High, dark purple (VH) = Very High. Key to the confidence scores: + = Low, ++ = Medium, +++*
 2172 *High. Where urgency scores are represented by: CAN = Critical Action Needed, CI = Critical Investigation, MAN = More Action Needed, FI =*
 2173 *Further Investigation, SCA = Sustain Current Action, WB = Watching Brief. Details of how the scores in this table were calculated are in the*
 2174 *Methods Chapter.*

Wales								
H7	Opportunities for health and wellbeing.							
	Present	2030		2050		2080		
		Central	High	Central	High	Low	Central	High
No adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
With adaptation	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +	(L) +
Urgency scores	FI	FI		WB			WB	
Overall urgency score	FI							

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Draft for Comment

5.3 Connections between risks



5.4 References

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