Climate Risk to the Health and Social Care Sector: a literature review

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Contents

1. The relationship between Climate Change and Health

'There are several levels of uncertainty inherent in the process of estimating climate change health risks' Campbell-Lendrum & Woodruff, 2006.

Physical, economic, and social impacts of climate change are already being felt locally and globally. The effects of climate change include, but are not limited to, shifts in seasonal and rainfall patterns; increases in the frequency and magnitude of extreme weather events; glacier and ice sheet melting; thawing of permafrost; sea-level rise; acidification of the oceans and temperature increase (McCoy and Watts, 2014). The 'scale and magnitude of impact will depend on the pattern of future greenhouse gas emissions' and give some examples of the consequences for human health and wellbeing; including 'the direct impacts of heat and extreme weather events; access to the essentials of life such as clean water, nutritious food and shelter; forced migration, conflict and societal disruption; and loss of biodiversity' (McCoy and Watts, 2014). Climate change may also increase physical and mental stress from flooding; cold and heat related mortality and the prevalence of vector-borne diseases, while negatively affecting people with respiratory diseases (Haines, 1991; Frumkin et al, 2008).

The Department of Health concluded in a 2002 report that 'far too little is known' of the impact of climate change on health in the UK. This prompted several studies and reviews to better understand the impacts relationship between climate change and human health, as well as changes to health and social care service provision to increase resilience to climate change. An updated report, published in 2012 by the Health Protection Agency (HPA), found that London, the South East, the Midlands and the East and South West of England were the most vulnerable to health impacts from climate change. The chairman of the HPA, Dr D Heyman noted that 'for those in health protection, planning for those climate-related changes and, where possible, adapting to their likely effects is critical' (HPA, 2012; 6). The 2012 HPA report projected that:

- Heat related mortality will increase sharply; by 70% in the 2020, rising to 260% in the 2050s compared to 2000.
- Cold related mortality will remain higher than heat related mortality until the 2050s, when it may decline by 2% compared to 2000.
- Those over 85 are more vulnerable to heat impacts, an issue that may be amplified by an ageing population.
- Physiological, behavioural and planned adaptation will play a major role in determining the impacts of extreme temperature in the UK.

- Increases in flooding will pose a significant health risk to the population in flood prone areas.
- Establishment of ‘exotic’ tick species in the UK becomes more likely with rising temperatures, while the range and distribution of ‘native’ tick species will also change, particularly with the creation of new wetland habitats to mitigate sea level rise and flood risk.
- Climate change may impact food preparation in the home, and may inflate prices of ‘healthier’ foods, but is unlikely to have a significant effect on human health.
- Measures taken to reduce the rate of climate change by reducing greenhouse gas emissions could produce secondary beneficial effects on health.

In 2012, Climate South East published ‘A Summary of the Climate Change Risks for South East England’ that found several risks that climate change may pose to health and healthcare provision in the South East, including:

- Increased flooding may lead to increased deaths, injuries and mental health issues, as well as exacerbating rural isolation issues.
- Increase in the Urban Heat Island effect.
- An increase in heat related deaths, particularly for the South East in those over 75 years old.
- Increase in respiratory illness due to more ‘hot’ periods, and increased ground level concentrations of O^3.
- Increase in instances of melanoma.
- Increased strain on health services as a result of more frequent extreme weather events.

Climate South East also note the potential benefits of climate change as fewer deaths from cold weather and improvements in physical and mental health as a result of increased outdoor activity (Climate South East, 2012).

In 2017, the Committee on Climate Change (CCC) published its latest Climate Change Risk Assessment (CCRA), which is compiled every five years for the Government as required under the Climate Change Act of 2008. The CCRA 2017 takes a risk-based approach to climate change’s impact on the United Kingdom, identifying 5 key risks and one research priority (Figure 1). These risks will significantly impact individuals and communities across the UK, having both positive and negative effects on human health and wellbeing. As such, there will both be direct and indirect implications for the health and social care sectors.

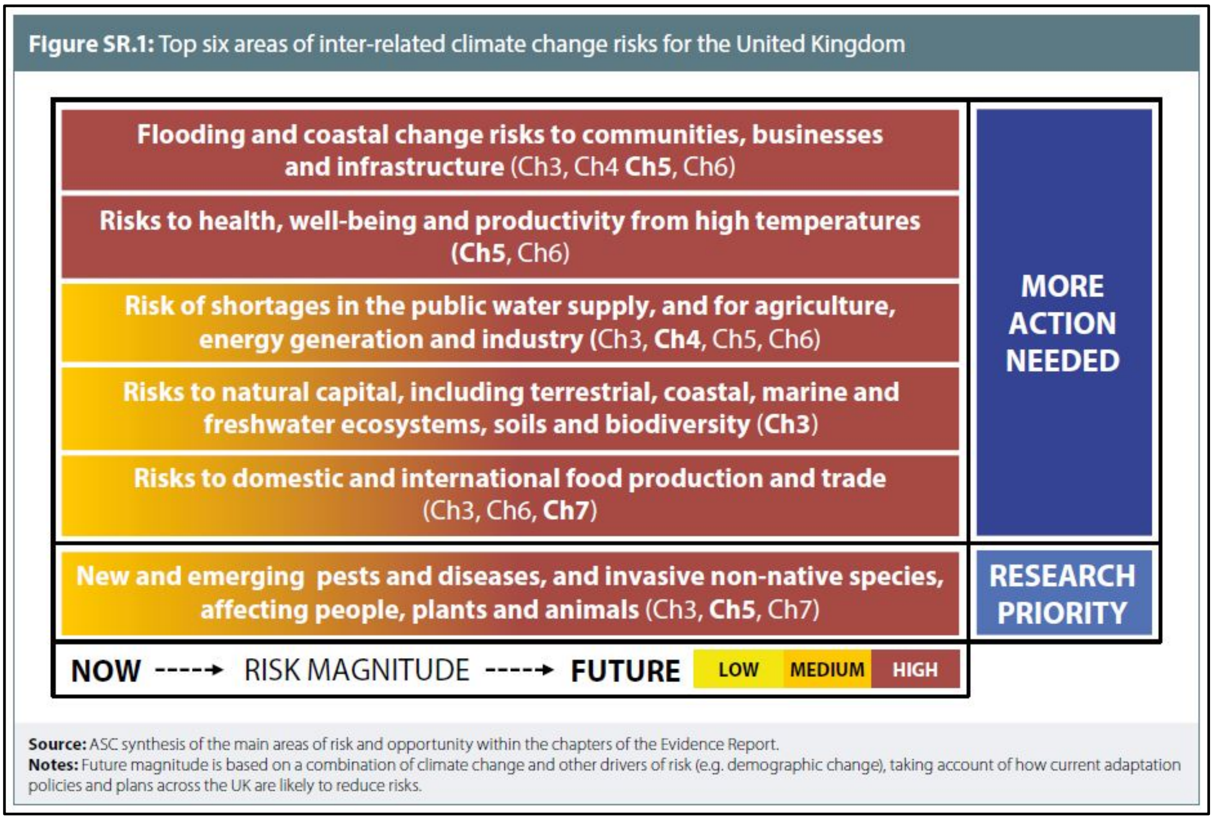

Figure SR.1: Top six areas of inter-related climate change risks for the United Kingdom

Figure 1: Top 6 risks identified in the 2017 CCRA

This report summarises findings from current literature available on each of the six key areas of climate change risk identified in the CCRA 2017 and their impacts on health, social care and where possible, how this may affect Kent.

2. Flooding and coastal change risks to communities, business and infrastructure

> ***"[Flooding is] expected to increase over the next 50-100 years owing to the effects of global warming" -Tapsell et al, 2007.***

Since 1998, flooding in England and Wales has become more frequent and severe. An estimated two million properties and over four million people are potentially at risk from river, estuarine or coastal flooding (Tapsell et al, 2007). In Kent, there are approximately 64,000 properties at risk of coastal and fluvial flooding, and 24,000 at risk of flooding from surface runoff (Kent County Council, 2017). Over the last ten years, the UK has seen significant flooding and nearly 1 in 6 households in England is at some risk of flooding (England & Knox, 2016). As a result of climate change, the frequency, distribution and severity of flooding may change, and areas that have not been affected by flooding previously may be at risk from flooding in the future (CCC, 2016). In Kent, users of the Severe Weather Impacts Monitoring System (SWIMS) have recorded 19 flood events between 2012 and 2018, with a total reported cost of £1.05 million to public services. An increase in the occurrence of severe winter gales is noted as a likely cause for concern, and it is highlighted that the risk of severe flooding of coastal areas is likely to increase as a result of rising sea levels and increased storm surges' (CCC, 2016).

2.1. Flood vulnerability

The context of the hazard is important when understanding the relationship between flooding and health, as it includes more than just the physical risk, or 'the probability of occurrence of an extreme event'; instead it 'include[s] factors that constrain the ability of the population to respond[.] [People's] wealth can in certain situations purchase safety and freedom from risk' (ibid: 136).

Vulnerability to flooding is typically described as being 'derived from the political, social and economic context' (Tapsell et al, 2008: 135), and is perceived as both a biophysical risk [and] a social response'. It is 'the interaction between nature and society that produces the vulnerability of places to events such as floods' (ibid: 135-136). Sayers *et al*, (2017) in a report produced for Climate Just defines social vulnerability to the impacts of flooding as a combination of factors including:

- **Susceptibility to flooding** – how likely someone is to experience a loss of wellbeing due to a flood.
- **Ability to prepare** – personal actions someone is able to take to reduce the harm suffered if a flood occurs.
- **Ability to respond** – why some people may act more effectively during a flood event.
- **Ability to recover** – how much someone can aid their own recovery from a flood.
- **Community support** – the availability and quality of emergency and healthcare systems.

Various manifestations of flood vulnerability are noted in a 2005 DEFRA report, in which it is observed - via first-hand research - that 'some sections of the older population [...] were reportedly bewildered and frightened by people banging on their front doors to alert them to imminent flooding' (DEFRA/Environment Agency, 2005: 9). Families with young children were more vulnerable, as children became distressed, or because of 'adults being unable to take necessary action with youngsters in tow' (ibid). Disabilities were also 'said to impede effective response; deaf people were [at] risk of not receiving telephone warnings' (ibid).

Drawing a parallel with wealth disparities in global food systems (Myers et al, 2017: 268), observed that the fact that those with greater wealth are able to protect themselves has important implications when discussing the impacts of flooding on communities, as it provides key insights as to those affected, and how vulnerable they are. Heger (nd) explored 'the poverty dimensions of floods' focusing 'on identifying geographic hotspots that are both poor and deprived, and also battered by floods' (Heger, nd: 1), demonstrating that there is 'inequality in that the more deprived households have been struck by disasters more frequently' (ibid). It is observed that 'the least deprived neighbourhoods are less affected by floods than their average counterparts' (ibid: 9), and in London specifically, 'neighbourhoods with higher housing prices are substantially less affected by floods than their below-average housing price counterparts' (ibid: 11), acknowledging overall that 'floods disproportionately impact the lower half of the deprivation distribution' (ibid: 12).

Additionally, people who are vulnerable can be flood disadvantaged: a concept which emerges when community members who are socially vulnerable are exposed to a climate hazard, such as flooding, leading to a greater loss of wellbeing than elsewhere (Sayers et al, 2017). The implications of this, and where such a disadvantage relates most to the health and social care sector, is that people in vulnerable communities are 'likely to experience worse effects on their health and wellbeing due to their personal, social or economic circumstances' (England & Knox, 2016). When combined with factors that influence the capacity people have to adapt, flood disadvantage increases further. For example, people on lower incomes may not always have flood insurance and may not have the resources to deal with the loss of possessions.

2.2. Flood preparation, response and recovery

In addition to the factors noted in the previous section, other factors including social isolation, language barriers and cultural backgrounds may also make people more vulnerable and less able to cope in an emergency (England & Knox, 2016; Department for the Environment Food and Rural Affairs (DEFRA), 2014).

This suggests that those who are less able to adapt are more likely to rely on services provided by local authorities, the health and social care sector, and health services, in the case of exacerbated illnesses. However, the ability of people to access such relief is key when considering the extent to which community members are affected.

Vulnerabilities extend throughout and beyond the flood itself, as those 'with fewer resources tended to be especially vulnerable [and the last to return] to their homes since contractors tended to work more quickly for the more assertive flood victims' (DEFRA/EA, 2005: 10).

Within Kent, communities of travellers can be affected by flooding more so than other communities. Caravans are often uninsured and flood damage frequently results in irreparable damages, making the caravan a 'total loss' (Summer 2017, personal communication). These problems can be exacerbated because such communities are often on the margins of societies, separated from mainstream communities and from subsequent relief services. In some areas of Kent, there are other communities that may be more affected by flooding due to lower levels of English or as they are new to the area or to the country. These residents may not have any experience of flooding and therefore not know how to prepare or respond appropriately.

2.3. Risks to physical & mental health

The WHO (2014) note that, in developed countries, well maintained flood defences, sanitation systems and public health monitoring provide significant protection against outbreaks of disease after a flood, which can reduce mortality. The 2013/14 flooding in the UK showed that floods also have a major impact in developed countries. Research has also found that flooding places additional burden on the social care system, which may itself be at risk from flooding. Demand on health and social services is likely to increase with the increase in frequency and magnitude of flood events and the changing demographic profile of an area.

Both the physical impacts of flooding and the increased risks to mental health, have the potential to cause increased utilisation of NHS services – both physical and psychological - following floods.

2.3.1. Physical health

The risks to physical health from flooding are poorly characterised (Tapsell et al, 2008), but the impacts that are observable in developed countries include risks such as (WHO, 2014):

- death and injury from drowning
- severe injury from being swept against hard objects
- health afflictions from minor injuries
- respiratory disease
- psychological impacts

Reviewing research on flooding in Lewes in 2000, Tapsell et al note that there was ‘a significant increase in [the] risk of gastroenteritis [...] along with worsening asthma and other respiratory illnesses, earache and skin rashes’, along with the likely disruption of normal health care provision and social programmes’ (Tapsell et al, 2008, *cf* Reacher et al, 2004).

In addition to the direct physical health risks from flooding, there are a variety of indirect risks associated with flooding that become increasingly prevalent in the elderly and populations with care needs. Cummings stated that ‘No matter how old a patient is, they will lose muscle strength during their stay’ (Cummings, 2017), and notes the findings of Hoenig & Rubenstein (1991) that 1 week of bed rest results in a 10% loss of strength. As Cummings goes on to explain ‘for an older person who is at threshold strength for climbing the stairs at home, getting out of bed or even standing up from the toilet, a 10% loss of strength may make the difference between dependence and independence'.

As a result of the 2013/14 winter floods in Kent, at least 4 elderly residents had to be moved into care facilities as their property had flooded. Of those 4, two were still in care 8 weeks after the floods, and one did not return home (personal communication, 30 July 2018).

2.3.2. Mental health

As Tapsell & Tunstall found in their 2008 case study, much of the ongoing impact of flooding on individuals is on their mental health, and particularly a feeling that they have been abandoned, which is arguably exacerbated by a sense of "otherness" that is felt when compared with wealthier members of the population that can afford to mitigate the risks.

In the UK, flooding and other traumatic life events are frequently associated with increased rates of anxiety and depression, and adults in flooded households have been found to have four-fold higher risk of psychological distress when compared with non-flooded. Disruption to people's lives post-flood has been described as the most significant stressor affecting people's health. In some cases, flooding has disrupted the relationship between people and place, and 'extreme flood events may radically change a locality making it impossible to rebuild in the area' (Tapsell et al 2002; 2008).

The EA report on the 2013/14 winter flooding found that using the estimate of 3,856 households experiencing an increase in psychological distress due to flooding during the 2013 to 2014 winter period and assuming a welfare cost of £6,400 per household gives a total mental health cost of £25 million' (EA, 2016: 183). However, this was likely to be a significant underestimation.

The same report notes that alternative valuations of the cost of mental health treatment are available, which may give a better indication of the true cost/benefit of effective, rapid treatment. 'The Mental Health Foundation identifies the costs of treatment through improved access to psychological therapies as £840 per patient, and the benefits in the first 2 years of £1,300 from extra GDP, £340 in NHS savings and £3,700 in reduced suffering' (Environment Agency, 2016: 183).

3. Risks to health, well-being and productivity from high temperatures

The effects of temperature - both heat and cold - present a significant 'threat to human health in Europe' (Wolf et al, 2015: 904).

The effects of climate change are often portrayed as negative in media coverage. While this is often the case, particularly for the increases in temperature year-round, there may also be some positive impacts. As temperatures warm, milder winters are likely to reduce the costs of heating homes and buildings, helping to alleviate fuel poverty and reduce the number of excess winter deaths from cold (CCC, 2016).

The 2017 CCRA identified heat as a priority risk due to the effects of cold weather in the UK, it is important to discuss the risks of both heat and cold here.

3.1. Mortality & cold

Although 'cold-related mortality is projected to remain substantially higher than heat-related mortality in the first half of the 21st century', the Health Protection Agency estimated in 2012 that 'it is estimated to decline by 2% in the 2050s and by 12% in the 2080s, compared with the 2000s baseline.' (HPA, 2012; 36).

'Low temperatures and extreme cold weather pose a significant risk to human health [and] have an effect on respiratory tract infections, myocardial infarction, stroke hospitalisation and general hospital admissions, and mortality' (Wolf et al, 2015: 906). 'Extreme cold spells cause increases in morbidity and mortality due to respiratory, cardio-, and cerebrovascular diseases [; the effect of which] increases with age' (ibid). It is suggested that 'as the climate warms, cold-related deaths in the European Union are expected to fall by 50,000 to 1,000,000 deaths per year by the 2020s and by 100,000 to 250,000 deaths per year by the 2080s, with Ireland, the United Kingdom, and southern Europe likely to experience the greatest reductions' (ibid: 907).

To help combat cold related mortality, in June 2017, the UK's then Secretary of State for Health, Jeremy Hunt, 'announced a second wave of funding to ease pressure on hospital emergency departments ahead of [2017] winter. A further £20.74 million has been awarded to 27 hospitals in England, which follows an initial £55.98 million given to 70 hospitals in April [2017]. This money was part of the dedicated funding announced in the Spring Budget to ensure local A&Es are prepared for the additional demands that winter brings' (Department of Health & Social Care, 2017).

3.2. Mortality & heat

It is estimated that 'annual UK heat-related mortality is projected to increase by two-thirds by the 2020s, by around 250% by the 2050s, and by more than 500% by the 2080s from a current baseline of 2,000 heat-related deaths per year' (CCC, 2016). The South East could see an increase of up to 700 and 1,000 heat-related deaths per year, and up to 3 times as many per year by the 2050s based on the year 2000 baseline, even with warming limited to 2°C (CCC, 2016).

‘A number of well-controlled studies showed that ambient temperature was significantly associated with […] morbidities, in which most reported heat effects with only a few reporting cold effects [sic]’ (Ye et al, 2012: 26). ‘Mortality and morbidity rates are often highest during the winter period, [and] in countries with milder climates and low income, aspects of housing conditions and composite measures of fuel poverty were most consistently associated with mortality, morbidities or wider social outcomes in cold weather[.] Vulnerability factors including extremes of age, gender, and comorbidities moderated the adverse health and social impacts’ (Tanner et al, 2013: 1061, 1065).

Schwartz et al (2004), highlighted the relationship between hospital admissions, and temperature increase in the United States. Results demonstrated that ‘controlling for season, hotter temperatures were associated with increased admissions for cardiovascular disease [and were] consistent with mortality studies that consistently show a rise in cardiovascular deaths during heat waves’ (758). Additionally, they found ‘a linear relation of temperature with hospitalisation’ (ibid; Dengel, A., 2016: 6).

‘Excess deaths during heatwaves may be caused by dementia, renal disease, respiratory disease, and cerebrovascular disease. Hot periods can lead to dehydration, hyperthermia, renal colic and renal failure. Heatwaves have a significant effect on morbidity and mortality due to respiratory diseases[.] For each 1C increase above a threshold in maximum apparent temperature, hospital admission for respiratory disorders increased by up to 4.5% in 12 European cities’ (Wolf et al, 2015: 905). The elderly, it is noted, ‘are more vulnerable to the effects of heatwaves, due in part to poorer physical health and the effects of cognitive impairment on the perception of heat-related health risk’ (ibid; Dengel, A., 2016: 6). Across Europe, heat-related mortality rates by the 2080s ‘are likely to increase [...] totalling approximately 50,000 to 160,000 additional deaths annually’ (ibid).

3.3. Heat & the elderly

However, as Kovats (2006) asserts, ‘the impact of heat waves also reveals important lessons about the care of the elderly and dispossessed in our society - in both the community and social care. The impact of heat waves in the United States is mostly confined to poor elderly people living in urban areas - who cannot afford air conditioning - and to the homeless. Elderly people in nursing and residential homes are typically frailer than those living independently or with family. Although such people have a higher risk of death than the general population, they should not have a higher risk of heat related death. Heat illness can be prevented by keeping the patient cool, hydrated, and with adequate salt balance. In the UK, air conditioning is rare in clinical settings, and hospital inpatients may also be exposed to high indoor temperatures and a high risk of heatstroke’ (Kovats, 2006: 314-315). Indeed, there are many preventative measures that can be taken with regards to existing dwellings (Dengel et al, 2016: 9-10), such as:

- Insulation
- Shading
- Reflection and protection
- Means of ventilation
- Occupier behaviour
- Natural ventilation
- Air movement
- Comfort cooling

It is therefore possible that if measures suggested by Dengel et al. (2016) were implemented within residential homes it may be possible to prevent several heat related deaths.

Gupta et al (2016), highlight several key points regarding heat in care homes. Firstly, 'care and extra-care housing schemes are generally hybrid building types, simultaneously functioning as long-term residences, sometimes nursing environments and workplaces. This hybridity can impact on the building's risk of summertime overheating, including safety issues, diverging needs and preferences [...] and questions about who is responsible for thermal conditions. Recent research also indicates that the regulatory context and business considerations of a care scheme focus on the provision of good care, which is associated with ensuring no resident is too cold and that they are secure and safe. These considerations reinforce the idea that care settings should be 'warm' places' (Gupta et al, 2016: 84; Lancaster University, 2016).

Furthermore, 'there is some evidence that new-build care and extra-care housing schemes are already too warm for occupants and are overheating'; and it is suggested that 'understanding the relation between indoor temperatures and health is probably more critical due to the range of factors mediating the relation between indoor and outdoor temperature, including building design and occupants' thermal comfort practices' (Gupta et al, 2017). Case study analysis of indoor temperatures in four care homes during heatwave periods, drew several pertinent results. 'Across the monitored spaces the average mean indoor temperatures were relatively high. CIBSE guidance on thermal comfort indicates that in bedrooms, thermal comfort and quality of sleep decreases in temperatures above 24°C. Overall, nine out of the eleven bedrooms monitored had an average mean temperature of 24°C or above, and the average mean temperature across all the bedrooms was 24.5°C' (ibid: 11). Significantly, 'PHE guidance indicates that at 24.5°C excess heat-related deaths become apparent, suggesting that the temperatures within all the case-study buildings could be resulting in both thermal discomfort and increased health risks' (ibid).

'Informal discussions with both staff and residents during the building survey indicated that three case studies were generally considered to be very warm during summer' (Gupta et al, 2017: 12). Potential causes of overheating in care homes include the significant impact had by ‘building design [...] in terms of exacerbating or mitigating high temperatures (ibid: 13). ‘Across all the case studies residential areas were found to be mostly single-aspect spaces lacking through ventilation due to practical, spatial and care requirements. Internal shading (blinds, curtains) were common but keeping blinds closed during the day as a remedial measure was found to be feasible only where rooms were unoccupied, as residents needed to see out and have access to daylight’ (ibid: 13-14). Furthermore, ‘the design of heating and ventilation controls also appeared to impact upon the occupants’ ability to manage their thermal environment effectively’, and ‘building surveys also uncovered a lack of effective heat management practices’ (ibid: 14).

In attempting to overcome such issues, ‘the reactionary and immediate response [...] is to install air-conditioners in vulnerable households, [but] air-conditioning is neither a technically feasible option in the short term nor an environmentally [...] sustainable option in the longer term’ (Maller and Strengers, 2011: 493).

Maller and Strengers’ 2011 paper emphasises individual agency as a facet of ‘social practice theory’; that which ‘concerns the dynamic interactions between individuals and wider systems of power, infrastructure, technologies and society’ (Maller & Strenger, 2011: 496). This focus on practice extends to actions that ‘people engage in to moderate their vulnerability to heat’; and focuses attention on how and why the effects of heat are moderated as opposed to just how people feel and perceive heat (ibid: 496).

The notion of agency and moderation has important ramifications when considered within a context of care homes and the health and social care sector. It alludes to the capacity that those who own/manage care homes, for example, have to make significant changes, not least in the building design.

3.4. Heat & domestic housing

Heatwaves also have an indirect social impact on domestic housing. In Australia, cities are experiencing significant ‘demand problems caused primarily by increasing residential air-conditioner use, leading to regular blackouts on hot summer days [which] is also responsible for current and predicted residential electricity price rises. These price increases will add to the heat-related vulnerability of low income households, who may be unable to pay for cooling services [and] vulnerable households relying on air-conditioning during heat-related events will be left even more vulnerable if blackouts occur on the hottest days when peak demand is at its worst’ (Maller & Strengers, 2011: 494).It is noted that ‘older people comprise the majority of victims [and] other groups identified as vulnerable include low-income households [and those] residing in urban areas due to the urban heat island effect’ (ibid: 495). Crucially, it is noted that ‘a range of social and contextual factors need to be accounted for in interpreting and understanding mortality and morbidity patterns and assessing how vulnerability is created' (ibid). Specifically, 'little research has explored how housing [...] may moderate vulnerability in certain population groups and hence contribute to or reduce vulnerability to heat stress[.] The key concept underlying the research should be the interaction between housing and health' (ibid: 495-496).

In an individual's own home, Maller & Strengers (2011) ideas of agency and moderation refer to a practice-based approach that encompasses an individual's ability to change, and to an extent, "control" their situation, via the use of 'passive cooling measures [or adapting] daily practices [...] by moving around the house during the seasons to the coolest or warmest parts' (ibid: 494). This capacity to adapt, 'is largely ignored in heat stress policy and research, as is the role of the built environment in moderating heat stress, to which changes are considered a long-term goal' (ibid).

3.5. Heat & food

The HPA notes that climate change is likely to impact on human behaviour, including 'food consumption and preparation practices, which can increase the risk of food-borne diseases. In addition, warmer weather and milder winters will allow pathogens such as Salmonella to grow more readily in food and will favour flies and other pests that affect food safety' (HPA, 2012; 204). The HPA recommends that, to help combat these risks, there should be increased promotion of the risks of food contamination, particularly regarding raw meat, and the effects of temperature on bacteria. However, it is also noted that 'Our understanding of how food- and water-borne diseases are affected by current climate variability is limited, making it difficult to ascertain the likely impacts of climate change' (HPA, 2012; 205) and highlights the need for further research on this area.

4. Risks of shortages in the public water supply

> ***'From 2003-2012, 15 major droughts affected nearly 36.5 million people worldwide; with nearly 8 million people affected in 2013 alone' (Ebi and Bowen, 2015: 98).***

Ebi & Bowen (2015) noted that 'evidence of the magnitude and pattern of impacts of a drought are difficult to document because the onset and ending of a drought are ill defined, and because droughts can last for years without accumulating effects. Socioeconomic choices, population growth and movement, infrastructure, land use change, the underlying population vulnerability, and other factors affect the severity of droughts. Poor health, poverty, and conflict contribute to the impacts of a drought' (ibid). 'Recent comprehensive reviews [...] highlight the potentially significant consequences of long-term drought. Most of the health impacts of droughts are indirect: food and water insecurity; loss of livelihoods; population displacement; [...] with the impacts largest on low-income countries' (ibid).

The impact of floods, droughts and heatwaves in London was summarised in a briefing document by the London Sustainability Exchange (2012) and can be extrapolated to the South East. Natural causes of drought include: 'lack of rainfall, increased evaporation of surface water, [and] declining water tables [which] can be exacerbated by human use of the water supply' (ibid: 4). The primary concern of drought in the South East resides around 'water supply shortage. In Kent, 73% of the public water supply is from groundwater sources, predominantly from chalk aquifers, with the rest collected from rivers. Across the county, it is estimated that only 34% of rainfall reaches the water table, of which 11% is abstracted and 23% recharging groundwater supplies and rivers (EA, 2012). 'With the population density of London and the South East of England being so high this leaves a relatively small amount of water per person' (LSE, 2012). Consequently, 'water supply companies [...] must find a balance between providing the resource for their customers and ensuring that natural habitats are not harmed' (ibid).

4.1. Health impacts of drought

'Drought can affect health effects associated with inadequate nutrition, food- and water-borne diseases, airborne and dust-related diseases, vector-borne infectious diseases, illnesses related to exposure to toxins, mental health effects [...] and other health effects. Droughts could also exacerbate chronic diseases that leave individuals less able to cope with and recover from another event' (ibid).

Supportive of this latter assertion is Berman et al's 2017 research investigating the relation between drought and the risk of hospital admissions and mortality. Their research estimated 'risks of cardiovascular-related and respiratory-related hospital admission and mortality associated with drought conditions for the elderly population in western USA' (Berman et al, 2017: 17). 'Compared with non-drought periods, respiratory admissions significantly decreased by –1·99% [...] during the full drought period, but not during worsening drought conditions. Mortality risk significantly increased by 1·55% (0·17 to 2·95) during the high-severity worsening drought period, but not the full drought or low-severity worsening drought periods. Cardiovascular admissions did not differ significantly during either full drought or worsening drought periods. In countries where drought occurred less frequently, [they] found risks for cardiovascular disease and mortality to increase during worsening drought conditions' (ibid). Drought conditions increased the risk of mortality during high-severity worsening drought but decreased the risk of respiratory admissions during full drought periods among adults aged 65 years and older' (ibid).

4.2. Social impacts of drought

A report entitled 'Vulnerability to heatwaves and drought: case studies of adaptation to climate change in south-west England' published by the Joseph Rowntree Foundation highlights that 'vulnerability to drought is largely understood in terms of a household's ability to afford sufficient water' (Benzie, M., et al, 2011: 71). Interestingly, it is noted that 'those particularly vulnerable to the impact of heatwaves are not necessarily those who are most vulnerable in drought conditions.

There is potentially an overlap in that the only option for some people to reduce their heat stress would be to use water to cool down. [Reasons include that] their home is poorly insulated; they live within an urban heat island with no access to cool space, or they are housebound or restricted from accessing public space for cultural or domestic reasons[.] As heatwaves become more common, however, the use of water may become a more dynamic issue [if] water use for recreational or domestic cooling purposes is restricted because of ability to pay'. The JRF report refers to the fact that, by introducing water meters to those are already vulnerable, those groups may face further vulnerabilities, particularly if they are already financially vulnerable (London Sustainability Exchange, 2012).

People that 'rely on water use for medical needs cannot necessarily reduce their consumption [and] with some medical conditions greatly affecting income; water metering can place extra stress amongst such segments of the population' (ibid). In response to this, water companies are now offering discounts, however 'it is anticipated that more needs to be done to assist those most vulnerable as many may struggle to meet a direct debit payment each month or in extreme cases may not [have] a bank account' (ibid: 5).

5. Risks to natural capital, ecosystems, soils and biodiversity

The natural environment and what it offers has a crucial role to play in improving peoples' 'economic prosperity, health and wellbeing' (DEFRA, 2010)'.

Many of the assets of natural capital draw strong parallels with the risks identified by the CCRA - specifically, with domestic and international food production; flooding and coastal change; and risks of shortages in the public water supply. Therefore, any analysis of the impact of climate change on natural capital, and the way in which it affects the health and social care sector, cannot be separated from these risks.

Used to 'describe those elements of the natural environment that provide benefits for humans' (Parliamentary Office of Science and Technology, 2016: 1), the benefits gained by societies from natural capital 'include food, recreation, and clean air and water' (ibid). Much of the value of natural capital lies in its propensity towards directly influencing sectors such as conservation, agriculture, commercial business and infrastructure (DEFRA, 2014; Joint Nature Conservation Committee, 2015), and having little direct impact on the health and social care sector. Where it does, is arguably via the aforementioned parallels with the

CCRA risks, and thus for the purposes of this review, the influence of natural capital on the health and social care sector will be summarised indirectly, through analysis of the other risks.

5.1. Natural capital and health

The UK Government have committed Public Health England to provide clear, practical evidence about how to improve health; making explicit reference to the value of access to the natural environment (DEFRA, 2014: 20). Likewise, in partnership with the NHS, Change4Life campaigns inspire children and families to increase their activity, focusing particularly on outdoor activity (ibid: 21). While not related to climate change directly, campaigns such as these have the potential to have a positive impact on the NHS by delivering multiple outcomes across different sectors, taking into consideration that 'the cost of obesity-related illness to the NHS and society has been predicted to reach £50 billion by 2050' (HM Government, 2009: 13).

There is a marked positive impact on mental health that can be obtained via engaging with the natural environment, and this is being positively utilised by several social care service providers (Social Care Institute for Excellence, 2010a). This has been encouraged by the Sustainable Social Care programme, funded by the Department for Health; a programme which demonstrates a 'balanced approach to social, economic and environmental factors in the commissioning and delivery of adult social care' (Social Care Institute for Excellence, 2010b).

6. Risks to domestic and international food production and trade

> ***'Unmitigated climate change has the potential to lead to immense economic losses, which may translate to greatly weakened consumer purchasing power to obtain food in the developing world' (Myers et al, 2017: 269).***

Climate change, by virtue of the fact that it alters global temperature and precipitation, is 'expected to reduce global crop productivity and, through market responses, lead to changes in management intensity, cropping area, consumption, and international trade' (ibid: 1938; Schmidhuber and Tubiello, 2007: 19703). Such changes 'affect dietary and weight-related risk factors associated with an increased incidence of non-communicable diseases and mortality, such as low fruit and vegetable consumption, high red meat consumption, and increased bodyweight [sic]' (ibid).

As an industry, agriculture ‘is a main user of natural resources, and it has a strong link with rural societies and the environment’ (Stoddart, 2013: 30). Agriculture is a key area of interest, particularly when considering the nature of global food consumption and production, in conjunction with climate change and its impacts.

The Organisation for Economic Co-operation and Development argue that agricultural production areas that are less resilient will suffer the most from climate change, in terms of production variability and uncertainty of supplies. Consequently, this may ‘enhance food safety risks [as a result of] increases in the frequency of extreme events such as droughts and water borne diseases, with temperatures rising and flooding, or even extreme shifts in the production zones’ (Stoddart, 2013: 33).

Additionally, ‘the socio-economic environment in which climate change is likely to evolve is more important than the impacts that can be expected from the biophysical changes of climate change [and these will] be the crucial determinant for food utilisation [and] will be decisive for the ability to cope with problems of food instability, be they climate related or caused by other factors’ (Myers et al, 2017).

6.1. Availability of food

Given that there is a global challenge to feed populations, agricultural production will need to double by 2050, but this will necessarily have to be achieved whilst taking into consideration the existence of ‘scarce resources and climatological changes [sic]’ (Stoddart, 2013: 30-31).

A modelling study conducted by Springmann et al ‘projects that by 2050, climate change will lead to per-person reductions of 3.2% [in] global food availability [which can be] associated with 529,000 climate-related deaths worldwide’ (2016: 1937). The cause of such a reduction, they state, is due to the impact of ‘agricultural production and regional food availability', which, as shall be discussed, have marked consequences on health (ibid).

Springmanns’ model demonstrated that ‘the effects of climate change on food availability and consumption were subject to large regional variation’, due to reductions in the consumption of both fruits and vegetables, and red meat. Despite the health benefits associated with reducing red meat consumption, it was noted that the ‘negative health effects [...] far outweighed’ these (ibid: 1942).

In contrast to predictions that ‘by 2050, foresight modelling indicates that 60% of adult men, 50% of adult women and about 25% of all children under 16 could be obese’ (Government Office for Science, 2007: 2), Springmann et al (2016) also found that a ‘lower caloric availability because of climate change increased the total number of underweight people, which led to 266,000 additional deaths [but] it also reduced the number of overweight people, which led to 35,000 avoided deaths’ (Springmann et al, 2016: 1942).

6.2. Effects of climate change on food production

Despite the yield benefits, warmer temperatures ‘increase winter survival of insect pests and rates of herbivory, [and] drive shifts in the latitudinal range of crop pests and pathogens’ (Myers et al, 2017: 264).

Use of water will become more restricted, as agriculture currently ‘consumes about 70% of the world’s freshwater withdrawals’ (Stoddard, 2013). Climate change itself ‘is expected to alter the seasonal timing of rainfall and snowpack [sic] melt, and result in a higher incidence and severity of floods and droughts’ (Stoddard, 2013).

Additional impacts caused by increasing temperatures and extreme rainfall are outlined by Myers et al (2017), emphasising that climate change ‘alters relationships among crops, pests, pathogens, and weeds; and it exacerbates several trends including declines in pollinating insects, increasing water scarcity, increasing ground-level ozone concentrations, and fishery declines. [Yet] there are yield benefits to higher concentrations of atmospheric carbon dioxide and potential productivity gains at higher latitudes’ (2017: 260).

Furthermore, extreme weather ‘can destabilise agricultural systems, compromising crop defences and creating niches that allow pests and weeds to establish themselves’ (ibid). Along a similar trajectory, climate change is also perceived as negatively affecting the abundance of pollinating insects, which has the potential to have a marked impact on human health (ibid). Specifically, this would decrease yields of ‘pollinator-dependent food crops that play important roles in providing food and micronutrients to humans [which] would increase child mortality and birth defects from increased vitamin A and folate deficiency [...] and also increase the risk of heart disease, stroke, diabetes and certain cancers in adults as a result of a reduced dietary intake of fruits, vegetables, nuts, and seeds’ (ibid). Similarly, increasing levels of carbon dioxide also change the nutritional composition of crops, placing people at risk of ‘zinc, iron, and/or protein deficiencies’ (ibid: 266).

Schmidhuber and Tubiello note that ‘in temperate latitudes, higher temperatures are expected to bring predominantly benefits to agriculture: the areas potentially suitable for cropping will expand, the length of the growing period will increase, and crop yields may rise. A moderate incremental warming in some humid and temperate grasslands may increase pasture productivity and reduce the need for housing and for compound feed’ (2007: 19704). Yet the reverse is predicted to occur in drier regions; with cultivated areas becoming ‘unsuitable for cropping’, alongside an expansion of ‘the range of many agricultural pests and an increase in the ability of pest populations to survive the winter and attack spring crops’ (ibid; Myers et al, 2017: 260-264).

While highlighting the potential impact of droughts and flooding on agriculture, Schmidhuber and Tubiello make the salient point that the strength by which ‘these impacts will be felt will crucially depend on whether such fluctuations can be countered by investments in irrigation, better storage facilities, or higher food imports' (2007: 19704).

6.3. Food and vulnerability

Climate change and its impacts on agriculture will 'worsen the living conditions for many who are already vulnerable' (Stoddard, 2013). Referring to '[the] troubling prospect of disrupting our capacity to maintain an adequate supply of nutritious foods', Myers et al make the grave proposition that if this is not rectified, 'the purchasing power of wealthier populations will ensure that food flows towards the wealthy, leaving the poor with an insufficient supply' (ibid: 268). Arguably, this is compounded by people's ability 'to access, afford, and use food' (ibid).

Crucially, conflict here has a key role to play, as 'political and economic forces dictate food access', which ostensibly can 'exacerbate social exclusion by increasing competition for scarce natural resources and forcing mass migration, factors that played important roles over the past few decades in severely restricting food access during civil conflicts in sub-Saharan Africa and the Middle East' (ibid). Indeed, population displacement and its subsequent migration, has, in recent years, been the source of much tension within the UK. Further, 'high intensity conflict and associated population displacement would likely lead to more acute undernutrition, in addition to other health burdens' (ibid).

Economic impacts of climate change are examined further by Schmidhuber and Tubiello, who emphasise that models 'have gauged the impact of climate change on agricultural gross domestic product and prices. At the global level, the impacts of climate change are likely to be very small [and] at the regional level, the importance of agriculture as a source of income can be much more important. In these regions, the economic output from agriculture itself [...] will be an important contributor to food security' (2007: 19705). They highlight that 'prices for food are expected to rise moderately in line with moderate increases of temperature' (ibid: 19706). It is noted that 'climate change will [...] intensify economic pressures on food access' (ibid), the result of which - higher food prices - will 'increase poverty and food insecurity not only for the urban poor [...] but also for rural people, the majority of whom are net food consumers' (ibid). Within the UK, this is arguably observable in contemporary times: with food prices on the increase, the prevalence and utilisation of food banks within the UK, is marked (Trussell Trust, 2017).

Consequently, there is a general negative correlation between the price of food, and the consumption of all food groups, leading to the assumption that 'higher prices are likely to reduce nutrient intake [although this] will vary depending on wealth across and within countries' (Schmidhuber and Tubiello, 2007: 19706; Stoddart, 2012: 1942). On the macro level, 'unmitigated climate change has the potential to lead to immense economic losses, which may translate to greatly weakened consumer purchasing power to obtain food in the developing world' (Myers et al, 2017: 269).

However, while there is likely to be a positive correlation between increasing climate change and 'the number of people at risk of hunger, the exact impacts will [...]strongly depend on the projected socio-economic development' (ibid: 19706). Indeed, 'climate change will increase the dependency of developing countries on imports [and] within the developing world, the adverse impacts of climate change will fall disproportionately on the poor' (ibid: 1708).

Schmidhuber & Tubiello (2007) highlight the connection between food security and infectious disease, in which disease 'causes or compounds hunger, which, in turn, makes the affected populations more susceptible to infectious disease [resulting in] an increase in poverty and even mortality' (Schmidhuber & Tubiello, 2007: 19705).

7. New and emerging pests, diseases and invasive non-native species

> ***'The range, activity and vector potential of many ticks and mosquitoes will increase across the UK' (HPA, 2012).***

Prior to the discovery of the role of infectious agents, it was known that climatic conditions have a significant impact on epidemic diseases. Roman aristocrats 'retreated to hill resorts each summer to avoid malaria [and] South Asians learn[t] early that, in high summer, strongly curried foods were less likely to cause diarrhoea' (Patz et al, 2003: 103, McMichael, 2015: 545).

It is purported that most models 'estimate the effects of changing mean values of a climate condition, usually temperature, whereas there is increasing evidence that less predictable changes in extreme values, particularly of precipitation, may be more important for many diseases' (Grantham Institute, 2015). Indeed, any attempt 'to carry out a full accounting of the health impacts of climate change' highlights 'significant knowledge gaps' (Campbell-Lendrum & Woodruff, 2006: 1939).

Randolph (2009) notes that there is 'clear evidence that intuitive assertions based on the undeniable sensitivity of vector borne diseases to climate, and therefore climate change, are not a reliable basis for either explaining the past or predicting the future' (2009: 928).

Paul Parham, Honorary Lecturer in Infectious Disease Epidemiology at Imperial College London, supports the notion that 'climate change remains a substantial threat to future human health', further stating that 'it seems unquestionable that climate change will affect many, if not all, of these diseases' (Grantham Institute, 2015). Parham asserts that 'the extent to which climate increases the risk of becoming infected in certain regions [when] compared to other factors such as poverty or fragile health systems', is not as clear (ibid).

A key point which may be drawn from this is that climate change does not have the sole role in influencing the transmission of diseases to humans. Socioeconomic factors have an equally important role, and it is here that the impact on the health and social care sector can be most felt.

Patrozou supports this, noting that 'the number of environmental migrants in the next decades will project in the tens to hundreds of millions leading to an increased risk for infectious disease outbreaks due to poor access to sanitation, poor water, and food quality' (2015: 533). Given that the role of sanitation and housing are crucial when it comes to the transmission of infectious disease, the impacts this could have on the health and social care sector can potentially incite a more preventative role.

Beyond the scope of this review to cover in extensive detail, the potential of health and social care departments to be a reactive force, and mitigate the potential of diseases to spread, rather than just respond to them when they occur, would benefit from further research.

7.1. Vector borne diseases

Vector-borne diseases have a potential to be influenced by climate change. However, this influence is difficult to quantify as there are a large number of influencing factors including climate, land use changes and human activity (HPA, 2012). It is asserted that 'the range, activity and vector potential of many ticks and mosquitoes will increase across the UK up to the 2080s. The introduction of exotic species and pathogens is a possibility' (HPA, 2012; 163).

There are a variety of diseases which are transmitted by rodents, including salmonella, listeria, and tick-borne encephalitis: arguably, the presence of these diseases represents the 'exceptional trend [that] some infectious diseases are emerging for the first time in developed nations, [and] large outbreaks of food-borne illness tend to increase' (Epstein: 118).

In addition to the range expansion of terrestrial vector borne diseases, Lake (2015) notes that 'there has been an expansion of the biogeographical ranges of some harmful warmer water phytoplankton species into higher latitudes, and marine vibrio pathogens, which can cause gastro-enteritis and septicaemia, have led to disease outbreaks in Northern Europe and are now being routinely isolated from UK shellfish and bathing waters in the summer' (Lake, 2015: 2).

7.2. Impacts of temperature on vectors borne diseases

The correlation ‘between malaria and extreme climatic events has [historically been] studied in India [where it was observed that] excessive monsoon rainfall and high humidity was identified as a major influence, enhancing mosquito breeding and survival. Contemporary analyses have demonstrated that the malaria epidemic risk increases around five-fold in the year after an El Nino event’ (Patz et al, 2003: 112; Grantham Institute, 2015).

‘Milder winters allow sheep/deer ticks to actively feed, and as competent vectors of Lyme disease, this too presents a significant threat’ (Lake, 2015: 14). ‘Between 2004 and 2012, the total number of reported cases of Lyme disease in England and Wales rose from 500 to 1040, and the incidence is only set to increase with climate change’ (ibid: 15-16; HPA, 2012).

Similarly, ‘increases in international travel allows for the potential importation of mosquitos as vectors for diseases such as dengue fever, yellow fever, and malaria’, to name but a few (ibid: 17-18; Epstein: 120). Weather, again, plays an important role, as ‘predicted warmer summers and milder winters will favour mosquito development and extend the biting season of some species whilst also providing more temporary and underground aquatic sites’ (Lake, 2015: 20-21).

With climate change, some exotic species of mosquitos and ticks may establish themselves in the UK. For example, ‘establishment in the UK of exotic ticks such as Hyalomma marginatum and mosquitoes such as Aedes albopictus will become more likely. In other parts of Europe these species transmit Crimean-Congo Haemorrhagic Fever virus and chikungunya virus, respectively’ (HPA, 2012; 163). The HPA does note, however, that ‘The risk from autochthonous transmission of malaria remains low’ (ibid).

7.3. Pests

The Chartered Institute of Environmental Health (CIEH) (2008) note that warmer temperatures, changing rainfall patterns, higher sea levels and more extreme weather events such as flooding, will become more frequent due to climate change and will therefore impact on pest populations. The current trend of a warmer and wetter climate will impact on rodents and by virtue of this their interaction with humans; as temperature and increased rainfall are major factors that influence breeding (CIEH, 2008).

Floods may cause common pest species to be displaced from their usual habitats in drainage and sewer systems, and farms, bringing them into closer contact with humans increasing the likelihood of disease transmission. The CIEH state that flooding has been associated with increased incidents of Weil’s disease (CIEH, 2008).

8. Conclusions

This review has provided a broad overview of the risks to the health and social care sector from climate change. As the health and social care sector is vast, it is difficult to assess the sector in its entirety. There is a certain duality towards the potential impacts to the sector: the nutritional aspect/health impacts (as focused on in this review), and indirect impacts on the social care sector due to the after-effects of severe weather events. Additional research into this second point would be an area that could use further exploration. Nevertheless, this review has highlighted points of key significance, and provides avenues for further research and exploration.

One of the key points that can be drawn from this review is that the five risks and one research priority identified in the CCRA (2017) are interconnected, and cannot be fully separated from one another, nor analysed as distinct categories when looking across a sector. This interconnection requires a holistic approach to understand and manage the risks to the health and social care sector from climate change, and that a more collaborative approach between sector agencies would be beneficial.

One example of such collaboration was highlighted in this review: the relation between national government schemes and the social care sector. Change4Life, run by Public Health England in partnership with the NHS, has great potential to have a positive impact on NHS services, in terms of reduced obesity, and therefore cost savings to the NHS for bariatric services. Additional future collaborations are identified in terms of the role of healthcare providers/care agencies in mitigating temperature risks for residents in care homes; and likewise, in terms of the role of building contractors and architects to factor in residents, when designing buildings. Further connections have been identified in the interaction between the agricultural industry and global food systems, and the impacts of flooding and drought on these sectors.

It is worth noting that a significant proportion of the literature uncovered for this review tended towards an emphasis on managing future risks from such events, rather than exploring its specific impacts on the health and social care sector or measures to adapt. As a separate research area, specific impacts on the health and social care sector would be important to consider, especially when considering the role the sector plays in mitigating the impacts.

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