



NorthWest  
Public Health  
Observatory



The impact of  
Climate Change  
upon Health and  
Health Inequalities  
in the North West  
of England

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January 2012

# Acknowledgements

The authors would like to acknowledge the North West PCTs for their role in commissioning this project through the Liverpool John Moores University Environmental Support Team Steering Group.

In particular we would like to thank Matthew Ashton, Assistant Director of Public Health, Strategy & Intelligence at NHS Knowsley and David Seddon, Business and Projects Manager at the Centre for Public Health for leading the working group for this project.

We would also like to thank the following people for their helpful comments and contributions to the work:

Andrew M Bennett -  
Independent Practitioner

Mark Brown -  
Greater Manchester  
Health Protection Unit

Jenny Brizell -  
Centre for Public Health

Stacie Cohen -  
Energy Savings Trust

Matt Ellis -  
Environment Agency

Ellie McCoy -  
Centre for Public Health

Amy Luxton -  
Centre for Public Health

Ruth Passman - Department  
of Health North West

John Reid - Visiting Professor,  
Liverpool John Moores  
University

Everyone who participated  
in the workshop event at the  
CLASP and North West Public  
Health Sustainable Development  
Network event in April 2011

# Foreword

Climate change impacts on the health of our region. This timely report highlights these issues in a clear and user friendly format for everyone with a role in the development of strategy, planning and service delivery in health and social care.

Climate change has become an important factor, affecting current and future environmental sustainability and contributing to increasing inequalities in health. The 2010 Marmot report states that tackling social inequalities in health and tackling climate change must go hand in hand.

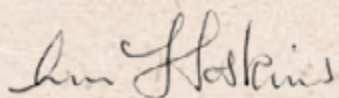
*The impact of climate change upon health and health inequalities in the North West of England* provides a rationale and stimulus for local action across the North West. Climate change is expected to result in regional changes in temperature, rainfall, sea levels and extreme weather events.

Such events will have direct and indirect impacts on health, disproportionately affecting vulnerable populations including children and the elderly.

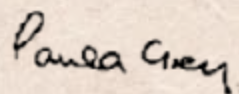
This report should be used to support local health partnerships to understand the impact of climate change on health and well-being, and to take effective action to reduce or mitigate these impacts. Such actions can be taken immediately and some are possible with no associated costs.

Tackling the threats to health associated with climate change also provides an opportunity to address sustainability issues, maximising the benefits to health and well-being of reducing the region's carbon footprint through the promotion of sustainable activities and practices such as cycling and walking.

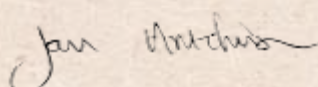
We very much hope that this report will inform, enable and empower health and local government professionals to take action in response to climate change.



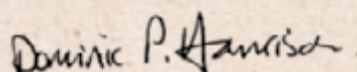
Ann Hoskins, Interim Regional Director of Public Health



Paula Grey, Chair of Cheshire & Merseyside DPH Group



Jan Hutchinson, Chair of Greater Manchester DPH Group



Dominic Harrison, Chair of Lancashire DsPH

# Executive Summary

The consensus of expert opinion and evidence from climate science supports the theory that human activity is contributing to a changing climate, which could have far-reaching environmental, social and economic consequences.

Climate change affects the fundamental requirements for health – clean air, safe drinking water, sufficient food and safe shelter.

Climate change can be addressed in two ways. Firstly by mitigating the affects of the changing climate by reducing the carbon footprint. Secondly by adapting policy to tackle present problems or to anticipate future changes due to increased rainfall, higher temperatures, scarce water, and more frequent storms.

This review aims to inform, enable and empower health and local government professionals to take action in response to climate change.

## Important facts about climate change in the North West

The current projections related to climate change in the North West of England include:

- Temperatures are expected to increase by 2.6°C in winter and 3.7°C in summer by the 2080s. The mean daily maximum temperatures in summer are predicted to increase 4.8°C during the same time period.
- The frequency of heat waves is expected to increase in the next twenty years and more dramatically in the second half of the 21st century.

- Winter rainfall is predicted to increase 16% by the 2080s and summer rainfall is predicted to fall 22%. Incidences of greater disruption events through heavy rainfall and storms are predicted to increase.
- Sea levels are predicted to rise 30-32cm from current levels in parts of the North West by the 2080s.
- Reduced emissions of pollutants to mitigate climate change are expected to have a positive impact on air quality and lower levels of air pollution are predicted this century.

## What is the impact of climate change on health and health inequalities?

Although climate change may bring some localised benefits, such as fewer winter deaths in temperate climates, the overall health effects of a changing climate are likely to be overwhelmingly negative.

The risks to health of climate change appear likely to impact particularly upon individuals in areas of higher deprivation, and this is reflected throughout this report. Factors such as poor quality housing, residing in inner-city areas and lower income are likely to increase the health risks related to climate change.



### Respiratory diseases including asthma

- High levels of air pollution and periods of hotter than average temperatures are associated with increased risk of respiratory illnesses.
- Incidence of asthma and other respiratory allergies increase with exposure to air pollutants.
- Populations experiencing flooding are at higher risk of respiratory illnesses.

### Cardiovascular diseases

- Exposure to warmer spells of temperature may increase the risk of cardiovascular disease.
- Reduced exposure to air pollutants is likely to decrease the risk of cardiovascular disease.
- Vulnerable groups in the UK generally considered more susceptible to cardiovascular disease, such as the elderly and South Asian individuals, may be particularly at risk due to climate change.

### Skin cancer

- Increased exposure to UV radiation due to ozone layer depletion is associated with increased risk of skin cancers.
- Increasing temperatures in the North West in the 21st century may increase time spent outdoors and consequently UV radiation exposure.
- The risk of skin cancer increases for individuals residing in areas of lower deprivation. Higher risk of skin cancer in more affluent areas is attributed to wealthier individuals taking overseas holidays.

### Thermal illnesses

- In very hot conditions the body is unable to cool itself through sweating and heat-related illnesses can occur.
- Young children and individuals with impaired thermoregulation, including the elderly and those on medications, are believed to be particularly at risk during heat waves as their bodies are less able to regulate temperature and are therefore at risk of overheating, dehydration and heatstroke.

### Gastro-intestinal illness including food poisoning and water-borne diseases

- Rising temperatures, increased rainfall and flood events are predicted to increase the risk of gastrological illnesses during the 21st century.
- Contamination of food and water supplies due to higher temperatures and increased frequencies of heavy rainfall and flooding are predicted to increase the risk of food poisoning and intestinal illnesses.

### Mental health and well-being

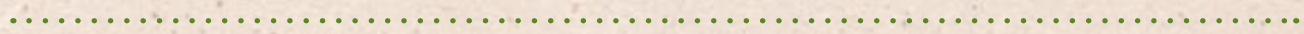
- Experiencing flooding and natural disasters that cause damage to property, relocation and loss of possessions can have a detrimental effect upon mental health, including post-traumatic stress disorder.
- High levels of air pollution and high temperatures may also impact negatively upon mood.
- Heat waves may increase risk of mortality and psychological problems among people with mental health problems.

### Insect-borne diseases

- The risk of diseases borne by mosquitoes and other insects is likely to be increased by changing temperatures and precipitation levels in some parts of the world and reduced in others.
- Warmer winters and higher summer temperatures in the next century may make the UK more conducive to insect-borne disease and exposure may be greater due to increased outdoor activities in warmer weather.
- Medical facilities and public health in the UK and other developed countries may protect against the risk of insect-borne disease.

### Access to healthcare

- Increased incidence of flooding and storms increases the risk of injury, death and damage to infrastructure, which may reduce access to healthcare.
- Disabled, elderly and isolated individuals may be at increased risk in the event of flooding.





## A framework for action

It is important to assess, strengthen and build capacity to manage the impact of climate change on health in the North West. Below we have outlined a framework for action that can be used as the basis for tackling the threats to health associated with climate change:

- **Improving knowledge about the impact of climate change on health**

Local partners must have a good understanding of how health will be affected by climate change. This knowledge enables problem areas to be identified, appropriate interventions to be implemented and their impacts measured.

- **Committing to manage the impact of climate change on health**

Implementing sustainable action to enable mitigation and adaptation to climate change requires the commitment of a wide range of partners. Climate change and health related issues should be recognised and integrated into local strategic planning.

- **Developing strong partnerships**

A wide range of partners need to be involved in managing the impact of climate change on health. By working together, local partners can make better use of local resources, provide a consistent approach to climate change and focus their activity towards achieving shared goals.

- **Ensuring leadership**

Leadership from the top will be important. Although there is uncertainty in the public sector about which organisations have responsibility for particular issues, it is especially for those 'at the top' to take proactive ownership of the climate change and health agenda.

- **Advocating for action**

High-profile champions need to provide leadership within organisations and partnerships and a focus for action to manage the impact of climate change on health. Champions can help build the case for local strategy development and planning, partnership work including engagement with local people and the economic case for action and investment.

- **Engaging with people and communities**

Using the strengths and resources of people and communities will be important. An asset-based approach should identify the skills and resources of local people, associations and institutions; the infrastructure and physical assets; the economic assets such as the local business assets; and cultural assets including the traditions and ways of knowing and doing of the groups living in the community.

- **Communicating the importance of the impact of climate change on health**

It is important to raise awareness that climate change is a fundamental threat to human health among professionals and the public. It is important to provide information in an accessible and credible way. Promoting those actions that have additional value may help the case for change. Cycling rather than driving improves cardiovascular fitness as well as reducing transport emissions.

- **Adhering to an evidence-based approach**

Understanding the impacts of interventions to manage the impact of climate change on health is critical to ensure local activity achieves its aims and that scarce resources are used efficiently. This includes ensuring that proposed actions are in line with evidence of effectiveness, and that their impacts are monitored and evaluated.





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# Introduction

Climate change is one of those contemporary issues that people often think is ‘someone else’s problem’. The aim behind this review is to put the health impact issues into a user friendly context that is relevant and useable by local government and health professionals. We have written the review in sections relating to significant health conditions and vulnerable population groups rather than climatic events, with the aim that specialists can see the relevance and impacts to their area of interest.

The report takes into account current projections related to climate change in the North West of England including those for temperature, precipitation, incidence of flooding, air quality and ultraviolet (UV) radiation, and examines how these changes may impact upon the following aspects of health: respiratory disease, cardiovascular disease, skin cancer, thermal injuries, gastro-intestinal disease, mental health and well-being, insect-borne disease and access to healthcare.

For each aspect of health we have identified some of the vulnerable groups in the North West who may be most at-risk from climatic events.

We should be clear about our assumptions from the start. We believe that the consensus of expert opinion and evidence from climate science supports the theory that human activity, or carbon emissions, is contributing to a changing climate. Everyone in the North West can play a useful part to mitigate climate change and to reduce their own carbon footprint.

People whose work relates to health or public health may be able to use mitigation for added benefit, as a variety of activities which reduce carbon footprint also improve health and well-being; these are referred to as health co-benefits.

As part of longer-term planning, individuals whose work contributes to health may consider changes to policy and strategy to enable mitigation or adaptation to climate change. This work can be done locally and immediately and may be possible with little investment that may result in long-term savings.

The target audience that this report strives to engage with is diverse, encompassing all those with a role in the development of strategy, planning and service delivery in health and social care. We hope this report will be applicable within their daily practice and can be used to inform planning and strategy within health and local government. Our aim is to highlight the issues relating to each specialty to engage professionals and stimulate them to consider appropriate changes to practice or policy.

*This report was informed by a review of the literature and through a workshop on climate change and health attended by representatives of the North West local authorities and health sector held in Manchester in April 2011.*



# Chapter One

## Projected climate change in the North West

In this chapter we refer to projections made by the Department for Environment, Food and Rural Affairs (Defra) for temperature and precipitation change during the 21st century.

Projections are based on three scenarios according on the level of emissions: low, medium or high. In the text we refer to the central estimate for the medium emissions scenario and it is reasonable to plan for these figures.

The figures in this scenario only represent an average: variations and extreme events will still occur and still need to be planned for.

More information on the Defra model is available at the UK Climate Projections website<sup>1</sup>.

**Figure 1: Summary of projected climate change and related events affecting the North West of England.**

Winter temperature	↑	2.6°C increase by 2080s <sup>a</sup>
Summer temperature	↑	3.7°C increase by 2080s <sup>a</sup>
Summer mean daily maximum temperature	↑	4.8°C increase by 2080s <sup>a</sup>
Frequency and duration of heat waves	↑	
Winter rainfall	↑	16% increase by 2080s <sup>a</sup>
Summer rainfall	↓	22% reduction by 2080s <sup>a</sup>
Heavy rainfall and storm events	↑	
Sea levels	↑	Increase 30-32cm by 2080s
UV radiation	↑	Increased exposure with more time spent outside due to warmer temperatures and higher number of sunny days.
	↓	Long-term exposure risk reduced as ozone layer recovers in the second half of this century
Flooding events	↑	Increased risk of flooding due to higher winter rainfall, frequency of heavy rainfall events and rising sea levels
Air pollution	↓	Lower air pollution due to reduced emissions
Ozone levels	↑	Gradually increasing

<sup>a</sup> Projections according to projected temperature and precipitation changes. Projections vary according to level of projected emissions.

<sup>1</sup> [www.ukclimateprojections.Defra.gov.uk/content/view/12/689/](http://www.ukclimateprojections.Defra.gov.uk/content/view/12/689/)

## Temperature changes

Defra has made available projections for temperature change during the 21st century for the North West compared to 1961-1990 data, dependent on the level of emissions of greenhouse gases and other substances that affect climate change.

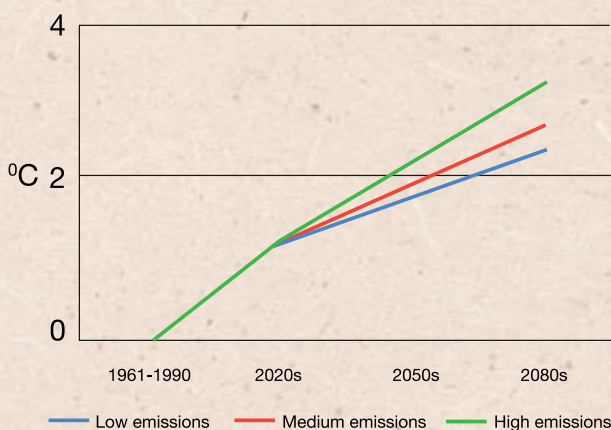
There is a clear pattern with temperatures in the North West predicted to rise throughout the 21st century in both winter and summer. Taking the medium emissions scenario, mean (average) temperatures are expected to increase by 2.6°C in winter and 3.7°C in summer and mean daily maximum temperatures in summer are predicted to increase 4.8°C by the 2080s. In the next two decades, increases of 1.2°C and 1.5°C are predicted for winter and summer mean temperature respectively.

The frequency of heat waves in the UK is expected to increase in the next twenty years and more dramatically in the second half of the 21st century with periods of hot weather lasting longer and occurring more frequently than at present (Department of Health, 2008). The issues caused by increases in temperature may be intensified in cities by the Urban Heat Island effect.

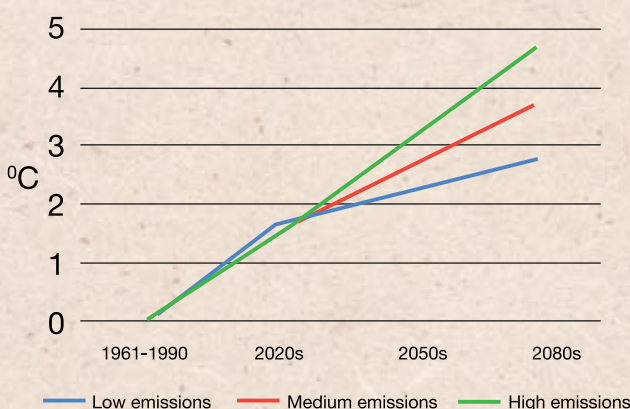
Features of large urban areas including tall concrete buildings, roads and vehicles combine to raise temperatures. Additionally heat in urban areas is absorbed during the daytime and raises the night time temperature (Luber and McGeehin, 2008). Rising temperatures due to climate change are likely to increase the impact of Urban Heat Islands (Forest Research UK, 2010).

**Figure 2: Defra projected temperature increases in the 21st century in the North West**

**Projected increase in winter temperatures under different emission scenarios.**

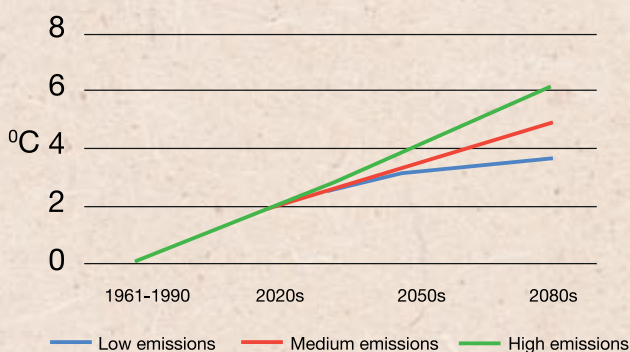


**Projected increase in summer temperatures under different emission scenarios**



**Figure 3: Defra projected summer maximum mean daily temperature increase in the North West in the 21st century**

**Projected increase in maximum mean daily summer temperature under different emission scenarios**



## Precipitation changes

Defra have made predictions on changing precipitation levels this century compared to 1961-1990 data. Overall annual precipitation is not expected to change dramatically in the North West under any emissions scenario.

However, there are significant changes in seasonal rainfall, with an increase in winter and drop in summer precipitation expected in all emission scenarios during the next two decades and becoming more exaggerated throughout the 21st century.

With medium levels of emissions, winter rainfall in the region is predicted to increase 16% by the 2080s and summer rainfall is predicted to fall 22%. Additionally, incidences of greater disruption events through heavy rainfall and storms in the UK are predicted to increase (Department of Health, 2008).

## Rising sea levels

Rising sea levels around the UK since the mid-20th century are attributed to ocean warming, leading to sea water expansion, and increased amounts of water from melting land ice and land reservoirs (Nicholls and Cazenave, 2010).

Sea levels are predicted to rise further in the 21st century and in the North West are predicted to rise 30-32cm from current levels (dependent on location) by the 2080s (Northwest Regional Development Agency, 2010).

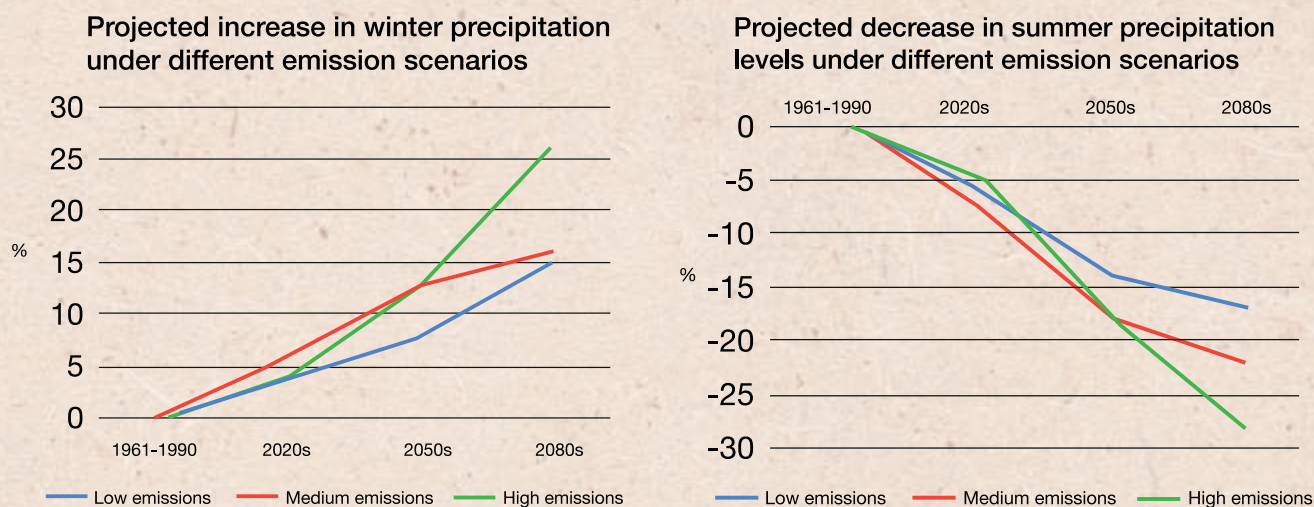
The North West has 430km of coastline with a population of 95,000 residing in the coastal flood plain (UK Climate Impacts Programme, 2011) so rising sea levels potentially pose a great risk to the region.

## Risk of flooding

The predicted increase in rising sea levels along with winter precipitation and frequencies of storms and heavy rainfall events during the 21st century are all likely to contribute to an increase in the risk of flooding in the North West.

Estimated annual average economic damages due to flooding are predicted to increase from £43 million to £138 million due to climate change (North West Development Agency, 2009). This economic impact could have indirect effects on health and well-being, for example house repairs and availability of home insurance may cause long-term anxiety.

**Figure 4: Defra projected percentage changes in summer and winter precipitation during the 21st century in the North West.**





## Exposure to ultraviolet radiation

Ultraviolet (UV) radiation is part of the energy emitted by the sun and small amounts are necessary for human health to enable production of vitamin D (World Health Organisation, 2011). In the latter part of the 20th century increased emission of chlorofluorocarbons (CFCs) and other pollutants resulted in depletion of levels of stratospheric ozone (the 'ozone layer') in the Earth's atmosphere. Consequently, exposure to UV radiation has increased, which has been linked to increased risk of developing melanoma and non-melanoma skin cancers. In the UK, exposure to UV radiation has increased further as a result of wider use of sun beds (Cancer Research UK, 2011). Climate change projections of rising temperatures in the UK are likely to result in individuals spending more time outdoors and in the sun, exacerbating the risks.

The Montreal Protocol was established to reduce emissions of gases that damage the ozone layer. If the aims are met, it is hoped that ozone levels will recover to pre-1980 levels by approximately 2050 (Air Pollution Information System, 2011; Herman and Newman, 2011), which will result in reduced exposure to UV radiation in the second half of the century.

The Montreal Protocol is a clear example of a successful global agreement to regulate human activities in order to protect the natural environment. Protection of public health was a major consideration underlying this agreement. This precedent suggests that health could be an important agenda to expedite global climate change agreements.

## Air quality

In the UK, the primary air pollutants are from power plants, agriculture and transport and include particulate matter, ground level ozone (distinct from the stratospheric ozone layer), carbon monoxide, nitrogen dioxide and sulphur dioxide (Defra, 2011; Environmental Protection UK, 2011). Reduced emissions of pollutants to mitigate climate change are expected to have a positive impact on air quality this century and lower levels of air pollution are predicted.

Levels of secondary pollutants are affected by many factors and are thus difficult to predict, the main example being ground level ozone.

Formation of ozone is greatest on hot sunny days and as the frequency of these days is predicted to increase with climate change, the impact of ozone on health will be exacerbated. As an example, during the summer of 2006, high summer temperatures resulted in high levels of ozone in the UK and across Europe (Defra, 2006).

Local emissions of pollutants responsible for ozone formation are likely to decrease in the UK (mainly due to legislation). However, to a large extent, ozone formation is dependent on movement of air masses and therefore the threat from ozone should be addressed across the continent of Europe rather than in any particular locality (Environmental Protection UK, 2011). Over several decades the recovery of the stratospheric ozone layer may reduce ground level ozone risks since the ozone layer absorbs UV radiation, required for ozone formation, thus reducing the amount reaching ground level (Herman and Newman, 2011).

Climate change and air quality are likely to remain linked, as there is a clear relationship between temperature and emissions. For example, increased frequency and duration of heat waves may result in higher emissions due to increased use of air conditioning, while warmer winters may result in lower emissions from heating (Kinney, 2008).

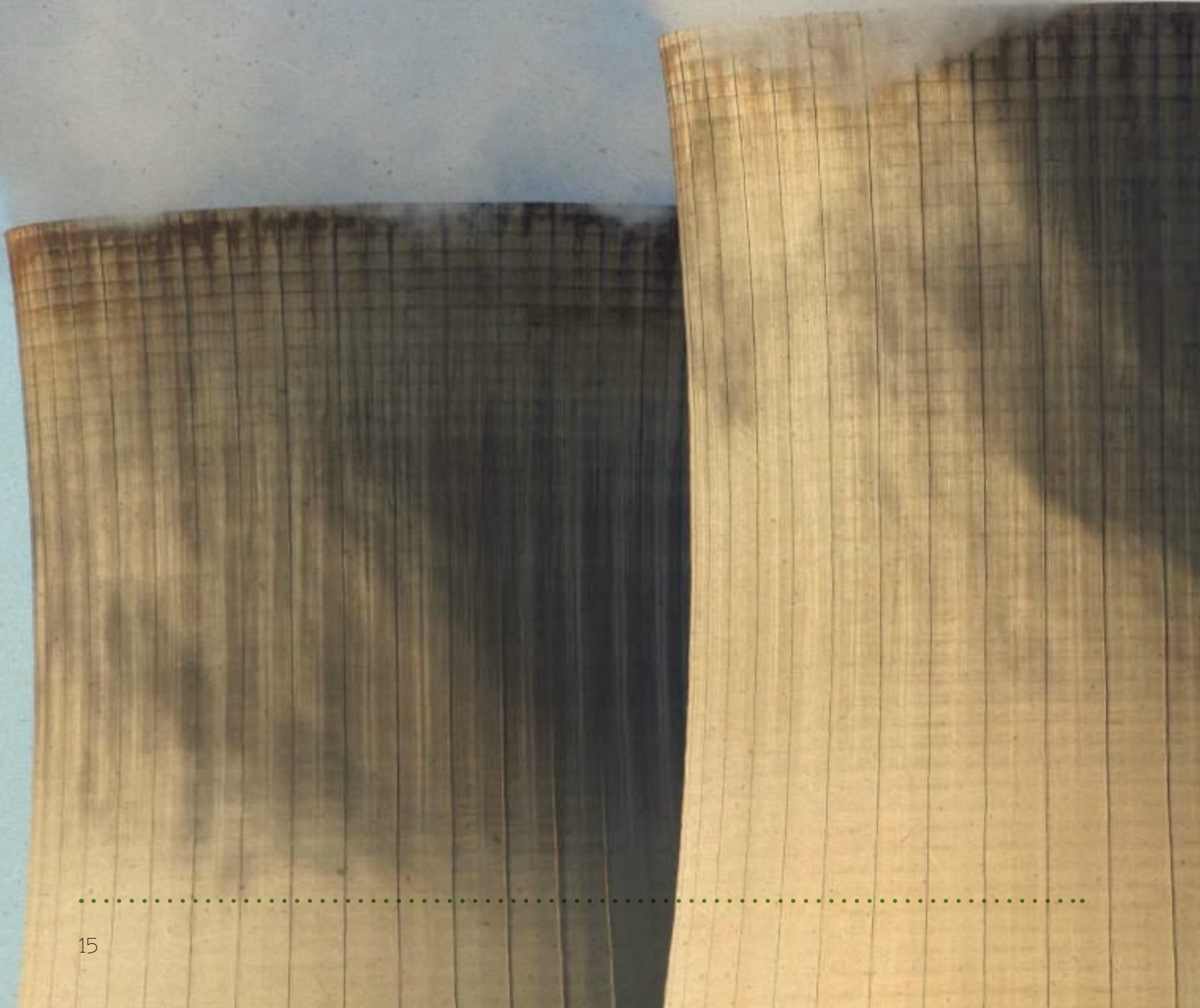
## The Montreal Protocol



The Montreal Protocol (1987) and subsequent amendments were established to phase out the use of CFCs and other pollutants associated with ozone depletion after they were recognised as the primary cause of ozone layer depletion.

Nearly 25 years later it is believed that these regulations have successfully reduced worldwide production and emission of CFCs and other ozone-depleting substances and as a consequence the ozone layer is recovering. It is believed that ozone levels may recover during the 21st century (Herman and Newman, 2011).







**Figure 5: Summary of the projected impacts of climate change on health and vulnerable groups**

	<b>Vulnerable groups</b>	<b>Air quality &amp; air pollution</b>
Respiratory disease	Asthma sufferers, COPD sufferers, hayfever sufferers, inner-city residents	Less exposure to air pollution through reduced emissions decreasing the risk of respiratory diseases
		Higher levels of ground level ozone resulting in higher risk of respiratory disease in summer
		Changing pollen season increasing risk of allergies and asthma
Cardiovascular disease	Older people, people experiencing fuel poverty, inner-city residents	Less exposure to air pollution decreasing the risk of cardiovascular disease
Skin cancer	Pale skin, children, people susceptible to skin cancer, outdoor workers	Depletion of ozone layer has increased exposure to UV radiation resulting in increased risk of skin cancer. However ozone layer is now recovering so risk will gradually decrease
Thermal illnesses	People whose bodies are unable to regulate temperature: young children, the elderly, disabled people, people using medication	Not related
Gastro-intestinal disease	Immune deficient	Not related
Mental health and well-being	Low socioeconomic status, homeless, individuals with pre-existing conditions (including depression, anxiety), those living in low lying areas and river valleys, inner-city residents	High levels of air pollution may impact negatively upon mood
Insect-borne disease	Animal and outdoor or rural workers, countryside recreation and tourists	Not related
Access to health care	Residents of low-lying areas, disabled people	Not related
Key:	Positive impact	Low negative impact







Temperature	Precipitation & flooding
Periods of hotter than average temperatures associated with increased risk of respiratory illness	Populations experiencing flooding are at higher risk of respiratory illnesses
Warmer average winter temperatures may reduce cases of seasonal flu and other respiratory illness	
Exposure to warmer and cooler spells of temperature increase the risk of cardiovascular disease	Not related
Rising temperatures may increase time spent outdoors and consequently exposure to UV radiation and risk of sunburn	Not related
<p>More frequent hot days and heatwaves may increase risk of heat stroke.</p> <p>Rising temperatures may increase time spent outdoors and increase risk of sunburn</p>	Not related
Rising temperatures increase the risk of food poisoning and gastrointestinal illness	Increasing heavy rainfall and flood events increase the risk of food poisoning and contamination of water supply
Extreme temperatures may increase risk of mortality and exacerbate mental health problems	Experiencing flooding can have a detrimental effect upon mental health
Warmer winters and higher summer temperatures may make conditions more conducive to insect-borne disease	Risk of insect-borne disease likely to increase in regions experiencing a rise in precipitation
Storms resulting in structural damage, loss of power, driving hazards	Floods resulting in structural damage, loss of power, driving hazards
Medium negative impact	High negative impact







# Chapter Two

## The North West: demographics and characteristics



This chapter highlights characteristics which may increase the impact of climate change on health in the region.

Key characteristics of the North West

### Population characteristics

Information in this section is drawn from a recent report on demographic and physical characteristics of the North West:

*Young and Sly (2011): Portrait of the North West.*

- **Population of approximately 7 million that is increasing at a slower rate compared with the UK.**
- **The North West population is predicted to increase to 7.5 million in 2033, a 9% increase from 2008 compared to 18% nationally. The elderly population however is predicted to increase 47% in the same time period.**
- **Population density in the North West (489 people per square km) is higher than the average for England (398 people per square km) and the second highest regional population after London.**

### Areas of high deprivation

Information in this section is drawn from three sources: *Young and Sly (2011): Portrait of the North West.*

*Northwest Research and Intelligence Unit (2011): The English Indices of Deprivation 2010.*

Office of National Statistics (2010a): Annual Survey of Hours and Earnings – 2010 results.

- **The rate of unemployment in the region (8.0%) is higher than the national rate (7.7%).**
- **The median (the middle value) gross weekly wage for adults residing in the North West in 2011 is £471.2 (mean £554.8); lower than the national median of £506 (mean £609.5).**
- **The North West has the greatest number of Lower Super Output Areas (LSOAs; small areas of England) in the 10% most deprived LSOAs in England. Deprivation is greatest in urban areas particularly Liverpool, Manchester and Knowsley.**

The risks to health of climate change appear likely to impact particularly upon individuals in areas of higher deprivation, and this is reflected throughout this report. Factors such as poor quality housing, residing in inner-city areas and lower income are likely to increase the health risks related to climate change.

The most deprived indices in the North West are in and around Liverpool and Manchester. Smaller urban areas in Lancashire including Burnley, Blackburn, Preston and Blackpool also contain areas with the most deprived indices. The Northwest Regional Intelligence Unit has made available maps showing levels of deprivation throughout the region<sup>2</sup>.

Average median and mean weekly wage for full time employees residing in areas within the North West are presented overleaf. The figures demonstrate that throughout the region, the median wage (£471.2) is lower in comparison to the median wage throughout England (£506).



<sup>2</sup> *Indices of Deprivation 2010 – England's Northwest* [www.nwriu.co.uk/PDF/IMD%202010%20-%20Northwest.pdf](http://www.nwriu.co.uk/PDF/IMD%202010%20-%20Northwest.pdf)



When the region is broken down into local authorities (Figure 6), all areas have a lower weekly median wage than the average throughout England with the exception of Cheshire West and Chester Unitary Authority (£530.4). The area with the lowest median weekly wage in the North West was Blackpool Unitary Authority (£374.3).

**Figure 6: Median and mean gross weekly wage for full-time employees in 2010 by place of residence<sup>3</sup>**

	Median (£)	Mean (£)
England	506.0	609.5
Blackpool UA	374.3	423.2
Blackburn with Darwen UA	439.9	491.5
Halton UA	443.6	510.8
Merseyside	472.6	542.4
Lancashire	466.9	546.5
Greater Manchester MC	462.7	551.3
Cumbria	485.0	555.6
Cheshire West & Chester UA	530.4	605.8
Cheshire East UA	503.5	620.4
Warrington UA	503.3	628.9

### Urban Heat Islands and Urban Green Space

Projections of rising temperatures are likely to impact highly on urban areas, creating or intensifying Urban Heat Islands (as discussed in Chapter One).

Therefore the health risks associated with rising temperatures will differ in different locations within towns and cities. Mapping of Manchester's Urban Heat Island (Knight et al., 2010) reported differences in temperature in the city and a maximum heat island effect of 10°C with the highest temperatures in central Manchester.

a cooling effect within urban areas both at their location and in the surrounding area. Increased vegetation and shading leads to reduced temperatures and lower levels of heat being absorbed by buildings and manmade surfaces during the day time (Forest Research, 2010). Urban areas with shortages of green space in the North West are therefore likely to be at increased risk. The School of Environment and Development at the University of Manchester (Kingston, 2011) has developed a tool<sup>4</sup> that allows population density, or degree of urbanisation, and areas of urban green space to be assessed simultaneously.

Using this tool it is possible to identify towns and cities within the North West, or areas within towns and cities, where green space is plentiful or lacking. For example, the tool demonstrates that in densely populated Bolton there are large green spaces to the east of the town only, whereas other parts of the town may be at increased risk from projected temperature rises.

### Risk of flooding from rivers or the sea

The information in this section is drawn from the Environment Agency<sup>5</sup> and a 2009 report on flooding risk in England: *Environment Agency (2009): Flooding in England: A National Assessment of Flood Risk*.

- The number of properties in the North West at significant risk of flooding is estimated to be approximately 29,000: the third lowest regional total in England.
- Warrington is the area in the North West most at serious risk of flooding, containing over a quarter of all at-risk properties in the region.

The risk of river and reservoir flooding is predicted to increase this century due to high precipitation and frequency of heavy rainfall events. Houses and businesses in the flood plains for rivers in the North West are therefore likely to be at increased risk due to climate change.

Green space and green infrastructure can have

In the North West the number of properties at risk

<sup>3</sup> Office of National Statistics (2010a). *Annual Survey of Hours and Earnings, 2010 Provisional Results* [www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-200444](http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-200444)

<sup>4</sup> GRaBS Adaption Action Planning Toolkit [www.ppgis.manchester.ac.uk/grabs/tool.html](http://www.ppgis.manchester.ac.uk/grabs/tool.html)

<sup>5</sup> The Environment Agency [www.environment-agency.gov.uk/](http://www.environment-agency.gov.uk/)



is estimated to be relatively low compared to the rest of the country with the third lowest total for any region in England, but approximately 29,000 properties are still estimated to be at risk.

It is possible to assess the flood risk for areas throughout the North West through a tool developed by the Environment Agency<sup>6</sup>.

Figure 7 displays the risk of flooding in and around Warrington, the most at-risk local authority in the North West containing over a quarter of the region's properties at serious risk of flooding. Warrington is the tenth most at-risk local authority in England for number of properties at serious risk of flooding.

Figure 7: Map of flood risk around Warrington - *The Environment Agency (2011)*



<sup>6</sup>Environment Agency (2011). Flood Maps. [www.environment-agency.gov.uk/homeandleisure/37837.aspx](http://www.environment-agency.gov.uk/homeandleisure/37837.aspx)





# Chapter Three

## Impact of climate change on health issues

For each section in this chapter, one or more groups that may be vulnerable to different health issues or diseases as a result of climate change are highlighted.

It is not within the scope of this report to accurately predict the numbers of people in the North West who are likely to be affected by each health issue discussed in this chapter. Where possible, changes in the occurrence of diseases due to climate change identified in previous research are reported.

However, variation in population characteristics and physical attributes within the region suggests

that climate change will have different impacts in different parts of the North West.

It is not suggested that only groups that are identified here may be vulnerable and it is advisable to refer to Figure 5 in Chapter One for an overview of vulnerable groups that may be at risk of each health issue discussed.

## Respiratory diseases including asthma

- **High levels of air pollution and periods of hotter than average temperatures are associated with increased risk of respiratory illnesses.**
- **Incidence of asthma and other respiratory allergies increase with exposure to air pollutants.**
- **Populations experiencing flooding are at higher risk of respiratory illnesses.**

Aspects of climate change predicted to affect respiratory illnesses and asthma include air pollution, rising temperatures, and flooding.

### Air quality

Literature examining the association between health and increased exposure to air pollutants including particulate matter, ozone, sulphur dioxide, nitrogen dioxide and carbon monoxide report several impacts including decreased lung function; inflammation of the lungs; increased respiratory symptoms and airway reactivity; exacerbation and development of asthma and development of and mortality from other respiratory disease in adults and children (Dennekamp et al., 2010; GyParis et al., 2004; Neidell, 2004; Trasande and Thurston, 2005; Wilhelm et al., 2009). In the UK, exposure to ozone and particulate matter has been positively associated with mortality caused by respiratory conditions including bronchitis and emphysema (Janke et al., 2009; Wordley et al., 1997).

**15%** The predicted increase between 2003 and 2020 in annual hospital admissions (in the UK) and deaths attributable to respiratory diseases as a result of increasing levels of ozone.

*Department of Health, 2008*

Respiratory diseases are diseases of the lungs and airways including lung diseases, pulmonary disease and hypertension and asthma (World Health Organisation, 2011).



## High deprivation is common in the North West and is a risk factor for asthma

The North West contains the highest proportion of areas falling within England's 1%, 5%, 10% and 20% most deprived local areas. Liverpool has the highest proportion of LSOAs (51%) falling in the most deprived LSOAs nationally. Manchester and Knowsley are in the top four. Detail on deprivation in North West is presented in Chapter Two of this report.

*Department for Communities and Local Government, 2011*

High levels of air pollution contribute to the risk of respiratory illnesses including asthma.

It is believed that children who reside in areas of low socioeconomic status may be at an increased risk of developing asthma. Diagnosis of asthma, cases of severe asthma and hospitalisation for asthma are all associated with individual and area-based indicators of social disadvantage.

Factors associated with low socioeconomic status and exacerbated by climate change, including poor indoor and outdoor quality of air and presence of allergens and damp housing conditions, may contribute to asthma prevalence.

*Cesaroni et al., 2003. Individual and area-based indicators of socioeconomic status and childhood.*

One model predicts that there is likely to be an overall gradual increase in ground level ozone which could lead to an increase of 15% in attributable deaths and hospital admissions related to respiratory disease by 2020 compared to 2003 (in the UK) with impact considered more severe in summer months (Department of Health, 2008).

Reviews of the effects of climate change on allergic asthma (Beggs et al., 2005; Cecchi et al., 2010) suggest that increases in carbon dioxide levels along with higher temperatures may result in increases of pollen production and the allergenicity of pollen.

Climate change may therefore result in longer pollen seasons and increases in pollen intensity and consequently increased incidence of and susceptibility to asthma. Exposure to increased levels of pollutants has been associated with increased symptoms of other respiratory allergies including rhinitis, sinusitis and hayfever (Bhattacharyya et al., 2009; Hajat et al., 2001; Parker et al., 2009).

## Temperature

Studies suggest that incidence of respiratory illness may increase during or immediately following periods of high temperature, with estimated increases of mortality varying from 12%-80% during and following heat waves in the UK, Europe and USA (D'Ippoliti et al., 2010; Huynen et al., 2001; Revich and Shaposhnikov, 2008; Rooney et al., 1998). Increased respiratory illness has been identified as the greatest contributor to increased mortality during extreme heat events (Revich et al., 2008; Huynen et al., 2001).

Additionally, the risk of respiratory illness may increase in the days and weeks following a period of colder temperature (Hajat et al., 2002). It is suggested that cold weather is likely to increase rates of mortality from flu and flu-like conditions (Kunst et al., 1993), and therefore the predicted warmer average temperatures in the coming century may have a positive impact by reducing cases of flu and other respiratory illnesses during the winter months.

Researchers suggest that mortality during a heat wave may increase on days with high levels of pollution due to particulate matter, and that individuals are more likely to suffer respiratory problems when temperature and ozone increases (Luber and McGeehin, 2008). For example, concurrent air pollution during the 1995 summer heat wave in the UK was believed to have attributed to excess mortality; including a 12% increase in deaths caused by respiratory disease. (Rooney et al., 1998).





## Respiratory illness and temperature in a growing elderly population

In the North West, the total population is predicted to rise to 7.5 million by 2033, an increase of 9% on the 2008 population, but at a lower rate than is expected nationally (Young and Sly, 2011). However, the elderly population in the North West is expected to rise by 47% over the same time period with many implications for the burden on health services in the region.

Respiratory illness has a strong effect on increasing mortality risk during periods of high temperatures, particularly for elderly people over the age of 85.

Respiratory-related deaths also increase during times of cold weather in both the over 85 years and the 0-64 years populations.

Individuals living in nursing and residential homes are identified as being particularly at risk from respiratory illnesses during both hot and cold weather and their needs must be considered. For example, residential homes should consider air conditioning as a way of controlling temperature.

*Hajat et al., 2007. Heat-related and cold-related deaths in England and Wales: Who is at risk?*

## Flooding

Studies from the UK suggest that individuals who have experienced flooding may be at risk of respiratory diseases. In the days following flooding residents in flooded areas are susceptible to cold-like symptoms including sore throats and coughs and in the following weeks and months may experience respiratory and chest illnesses (Reacher et al., 2004; Tapsell and Tunstall, 2008; Tunstall et al., 2006). These effects are attributed to the cold flood waters and the stress of cleaning up and having to live in cold and damp conditions. Exposure to fungal spores in damp housing is believed to relate to respiratory conditions including asthma (Cecchi et al., 2010). The risk of flooding for different parts of the North West can be assessed via the Environment Agency tool<sup>7</sup> discussed in Chapter Two.

## Precipitation

An association between thunderstorms and hospital admissions related to asthma is well established and therefore increasing incidence of storms this century may result in higher numbers of cases of asthma attacks (Cecchi et al., 2010).

## Case study

### Healthy Outlook COPD forecast alert service - Met Office

Individuals with chronic obstructive pulmonary disease (COPD) can sign up to this Met Office service, which monitors environmental conditions.

They receive a telephone call when poor conditions are forecast that may impact upon their condition.

The call warns them that their health may be at risk, refers them to additional information in patient packs and feeds back information to their doctor.

Primary Care Trusts and GP practices can sign up to the service. Currently in the North West the service is used by NHS Cumbria and NHS Blackpool. For further information, see:

[www.metoffice.gov.uk/health/public/copd](http://www.metoffice.gov.uk/health/public/copd)

<sup>7</sup>Environment Agency (2011). Flood Maps. [www.environment-agency.gov.uk/homeandleisure/37837.aspx](http://www.environment-agency.gov.uk/homeandleisure/37837.aspx)



# Cardiovascular diseases

- **Exposure to warmer spells of temperature may increase the risk of cardiovascular disease.**
- **Reduced exposure to air pollutants is likely to decrease the risk of cardiovascular disease.**
- **Vulnerable groups in the UK generally considered more susceptible to cardiovascular disease, such as the elderly and South Asian individuals, may be particularly at risk due to climate change.**

Cardiovascular disease, particularly coronary heart disease (CHD) and stroke, is the leading cause of death in the UK and accounts for approximately 200,000 deaths per year (Scarborough et al., 2010). Hot and cold temperatures and air pollution are associated with increased risk of cardiovascular diseases.

## Temperature

Experiencing hot and cold temperatures can increase risk of cardiovascular problems by impacting upon a number of physiological factors including blood pressure, blood viscosity, blood cholesterol, thrombosis and hyperthermia. Studies of mortality rates during heat waves demonstrate that the risk of mortality and hospitalisations due to cardiovascular disease, ischaemic heart disease and pulmonary disease may increase during periods of higher temperatures (Braga et al., 2002; D'Ippoliti et al., 2010; Huynen et al., 2001; Revich et al., 2008).

A similar effect has been demonstrated during cold spells with higher incidence of cardiovascular-related illness and mortality during cold weather with the elderly particularly susceptible (Revich et al., 2008; Huynen et al., 2001). Warmer average temperatures may therefore reduce the risk of cardiovascular disease during future winters.

## Air quality

Short-and long-term exposure to pollutants including particulate matter, sulphur dioxide and carbon monoxide is associated with increased risk

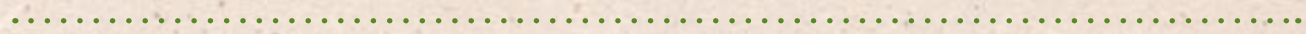
of cardiovascular-related mortality (Department of Health, 2006; Pope et al., 2004; Pope and Dockery, 2006). Cardiovascular disease may be particularly affected by exposure to high levels of particulate matter (Dennekamp et al., 2010; Dockery, 2001; Pope et al., 2004).

Days of higher levels of air pollution have been associated with increased deaths as a result of circulatory diseases, CHD, myocardial infarction and stroke in Birmingham, London and throughout the UK (Janke et al., 2009; Poloniecki et al., 1997; Wordley et al., 1997). Reduced emission of air pollutants due to legislation in the UK is likely therefore to reduce the risk of cardiovascular diseases in the North West.

## Increasing temperatures as a risk factor for cardiovascular disease affecting inner-city areas of high deprivation

The Health Survey for England 2006 reports that men and women in the lowest two quintiles for household income, along with women in the highest quintile, are at greater risk of cardiovascular disease (The NHS Information Centre, 2008). Changes to climate increasing the risk of cardiovascular disease may therefore particularly impact upon residents in the most deprived areas in the North West, typically found in urban areas.

As a consequence of the urban heat island effect populations in inner-city areas are more vulnerable to higher temperatures and heat waves (Luber and McGeehin, 2008), which are projected to increase in frequency and duration during this century. Vulnerability of residents in areas of high deprivation during heat waves also increases due to economic and social factors that may prevent measures being taken to cope with higher temperatures.





## Case study

### Preventing obesity and cardiovascular disease: Low Carbon Healthy Lifestyles

This research has addressed whether messages about sustainability and health resonate with young people and whether there is an added benefit of combining these messages. It also asked whether children of diverse ethnic and socioeconomic backgrounds were engaged in the discourse.

The title 'Low Carbon Healthy Lifestyles' was used to introduce two examples of co-benefits to health; cycling or walking to school and growing their own vegetables.

The draw and write method was applied to the whole-class setting. Groups of children were given photograph prompts, and asked to write and draw responses. Participants were enthusiastic about the activities.

For some aspects children showed awareness of being environment-friendly, for other aspects they were aware of benefits to health

and well-being. The latter benefits would be consistent with behaviours which reduce risk of developing cardiovascular risk later in life.

When the facilitator discussed the advantage of addressing health and climate change together, this did seem to resonate with many children.

Community leaders were interviewed to explore the opportunities available to the children, both at school and the wider community. Many initiatives and programmes have enabled children to take part in healthy or environmental activities.

However, while community leaders could understand the benefit of making the co-benefits explicit, they lacked resources to do this.

Developing a network of organisations and schools could be mutually beneficial, and if evaluation could be built-in, this would be an efficient way of tracking progress on many different objectives (Chadborn et al., 2011).

### Cardiovascular mortality is higher amongst the South Asian population in the UK

The North West has the third lowest proportion of non-White ethnic groups in populations in England at 8%. Asians and British Asians make up the highest non-White ethnic group in the region at 4% of the total population of the North West (Young and Sly, 2011).

South Asians are at higher risk of cardiovascular illnesses, with mortality rates for coronary heart disease and stroke considerably higher in Indian, Pakistani and Bangladeshi individuals compared to the general population in the UK (Fischbacker

et al., 2007; Wild et al., 2007). Consequently the impact of climate change on cardiovascular diseases may be particularly pronounced among South Asian communities and intervention within these communities is needed to reduce the risk of circulatory and heart diseases.

There may be a further association between deprivation and cardiovascular risk within the South Asian population in the UK. Mortality may be higher amongst less advantaged individuals (Tillin et al., 2008) and this is significant for the South Asian population for whom socioeconomic status may be lower compared to the White populations in the UK (Williams et al., 2009).



# Skin cancer

- **Increased exposure to UV radiation due to ozone layer depletion is associated with increased risk of skin cancers.**
- **Increasing temperatures in the North West in the 21st century may increase time spent outdoors and consequently UV radiation exposure.**
- **Populations in the least deprived areas of the North West may be most at risk.**

**150%** The predicted increase in cases of melanoma skin cancer by 2020 compared to 2005 in the North West of England  
*Shack et al., 2007*

Skin cancers are caused mainly by exposure to UV radiation, which has increased in the UK due to the depletion of ozone in the stratosphere (ozone layer). The most common skin cancers are non-melanoma skin cancers, which include basal cell carcinomas and squamous cell carcinomas. There are around 98,800 cases of these types of cancer in the UK per year (Cancer Research UK, 2011). Less common, but more serious, are melanoma skin cancers, which are predicted to effect 1 in 61 men, and 1 in 60 women (Cancer Research UK, 2011). Incidence of melanoma skin cancer in the North West has increased dramatically since the 1980s and is predicted to increase from approximately 1,000 new cases per year in 2003-2005 to over 2,500 new cases per year by 2018-2020 (Shack et al., 2007).

## Air quality

The relationship between ozone layer depletion and exposure to UV radiation is well established and increased exposure to UV radiation is associated with higher risk of skin cancer (van der Leun et al., 2008; Diffey, 2004; Norval et al., 2007; Rigel, 2008). The Montreal Protocol is an international treaty which aims to reduce the emissions of substances that are believed to contribute to the depletion of the ozone layer. It is hoped that if the terms and amendments to the Montreal Protocol are followed, then UV radiation in the UK should return to pre-1980 levels in the second half of this century (Diffey, 2004).

## Temperature

Risk of non-melanoma skin cancer in the USA has been associated with higher than average exposure to UV radiation and maximum average daily temperature (van der Leun et al., 2008). During periods of higher temperatures, individuals may be more likely to spend time outside and in the sun, increasing exposure to UV radiation. In the UK, risk of skin cancer may therefore be expected to increase as temperatures rise during the next century. It is predicted that in the first half of this century, before ozone levels are expected to recover, there will be an additional 5,000 cases of skin cancer per year in the UK (Diffey, 2004).

## Precipitation

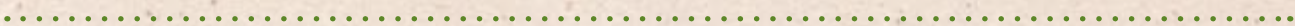
Less precipitation during the summer months suggests more hours of sunlight per day in the future. This is likely to encourage people to spend more time outdoors and increase risk of exposure to UV radiation.

**Exposure to the sun in childhood causes skin cancer later in life**

Although skin cancer is rare in childhood, exposure to the sun and frequency of sunburn are associated with moles and melanoma and non-melanoma skin cancers as an adult. Risk may be greatest among fairer children with lighter coloured hair and eyes and those who are susceptible to sunburn rather than tanning.

Prevention of skin cancer therefore should begin in childhood. Recommendations to reduce exposure to UV radiation and subsequently sunburn include ensuring children are wearing adequate clothing and headwear, avoiding exposure to the sun at times of high intensity and using appropriate sunscreens.

*Wigle, 2003. Child Health and the environment.*



## Case study

### **Skin cancer prevention: Merseyside and Cheshire Cancer Network – iVan (Merseyside and Cheshire Cancer Network, 2010)**

The iVan is a mobile cancer awareness vehicle that targets diverse groups within Merseyside and Cheshire by travelling to various community locations including schools, GP practices, work places, town centres and places of worship.

The service aims to raise awareness of cancer, particularly skin cancer.

In one year between July 2009 and July 2010 over 35,000 people had contact with the iVan with 300 of them being referred to their GP. 50 of these people had cancer or pre cancerous conditions subsequently diagnosed.

For further information, see:

[www.mccn.nhs.uk/userfiles/documents/Microsoft%20Word%20-%20ivanannualreportv12010.pdf](http://www.mccn.nhs.uk/userfiles/documents/Microsoft%20Word%20-%20ivanannualreportv12010.pdf)

## Thermal illnesses

### Temperature

In very hot conditions the body is unable to cool itself through sweating and heat-related illnesses can occur (Health Protection Agency, 2011a).

Young children and individuals with impaired thermoregulation, including the elderly and those on medications, are believed to be particularly at risk during heat waves as their bodies are less able to regulate temperature and are therefore at risk of overheating, dehydration and heatstroke (Department of Health, 2011).

Severe heatstroke can cause multiple organ damage and can quickly cause death within hours of onset (Kovats and Hajat, 2008).

Further examples of thermal illnesses include heat cramps, heat rash, heat syncope and heat exhaustion (Department of Health, 2011) and sunburn, which may be painful and is predicted to relate to the onset of skin cancer (Health Protection Agency, 2011b). The projected increase in summer temperatures and the frequency and intensity of heat waves in the UK during the 21st century is likely to increase the risk of heatstroke. Additionally, increased time spent outdoors in the sun due to higher temperatures and reduced cloud cover is likely to increase risk of sunburn in the UK.

### Younger children are at increased risk of thermal illness during heat waves.

A study in Spain (Basagana et al., 2011) found that risk of mortality in children aged less than one year increased by 25% on hot days, with the highest risk for girls in the period shortly before or after birth for whom mortality risk doubled on the hottest days. Cause of death varied but included disorders of the digestive, cardiovascular and respiratory systems, infections and blood disorders.

Children under four years of age, and those who are overweight or on medication are particularly at risk during heat waves (Health Protection Agency, 2011a). Thermal injury in children can

be prevented through following straight forward measures. The Health Protection Agency (2011c) recommends that on hot days children:

- Should drink plenty of cold water and eat normally
- Do not take part in vigorous exercise
- Seek the shade when outside and not sit in direct sunlight when inside
- Wear loose light-coloured clothing; hats; use sunscreen



# Gastro-intestinal illness including food poisoning and water-borne diseases

- **Rising temperatures, increased rainfall and flood events are predicted to increase the risk of gastrological illnesses during the 21st century.**
- **Contamination of food and water supplies due to higher temperatures and increased frequencies of heavy rainfall and flooding are predicted to increase the risk of food poisoning and intestinal illnesses.**

**10,000** The predicted number of extra cases of food poisoning per year in England and Wales as a result of rising temperatures in the 21st century  
*Department of Health, 2008*

Gastro-intestinal conditions believed to be affected by climate change include diarrhoeal diseases, intestinal illness and food poisoning following consumption of contaminated food. Changes in temperature and precipitation and increased risk of floods are all predicted to impact upon gastro-intestinal illnesses.

## Temperature

Rising temperatures may result in increased risk of food poisoning. Evidence indicates that cases of food poisoning, salmonellosis and other food-borne illness increases during periods of higher temperatures (Bentham and Langford, 1995; 2001; Kovats et al., 2004; Lake et al., 2009; D'Souza et al., 2004; Zhang et al., 2010). It is predicted that with a 1°C rise in temperature, an extra 4.5% cases of food poisoning may occur and middling estimates predict an extra 10,000 reported cases in England and Wales per year (Department of Health, 2008). Generally, the effects on incidence of food poisoning have been shown to emerge between one and five weeks after a period of high temperature.

This implies that due warning can be given during hot weather that could moderate the incidence

of food poisoning (Department of Health, 2008). Additionally, improved food hygiene and reduced pathogens in food have seen the risk of food poisoning decrease during times of high temperature in the UK in recent years (Lake et al., 2009), which may reduce the impact of climate change.

In developing countries an association has been recorded between higher temperatures and incidence of diarrhoea (Checkley et al., 2000; Chou et al., 2010; Singh et al., 2001), with children especially at risk due to an expected wider exposure to bacterial pathogens (Chou et al., 2010). Food contamination, increased water consumption and poor hygiene in developing countries during periods of increased temperature may explain this increased risk of diarrhoea (Chou et al., 2010).

## Precipitation and flooding

Heavy rainfall is associated with intestinal illnesses due to increased contamination of water supplies. Links between increased rainfall and incidence of intestinal illness, diarrhoeal diseases and food poisoning have been established worldwide in developing countries (Chou et al., 2010; Kistin et al., 2010; Singh et al., 2001), but also in developed countries including the UK, Canada and Australia (Curriero et al., 2001; Nicholls et al., 2009; Zhang et al., 2010). Low levels of rainfall have also been associated with increased risk of outbreaks of intestinal disease in the UK (Nicholls et al., 2009).

There is evidence in the UK that flooding is associated with increased risk of gastro-intestinal illnesses. In the weeks and months following floods in England and Wales, gastro-intestinal illnesses were the highest reported physical health effect experienced with between 10% and 73% of individuals in different towns being affected (Reacher et al., 2004; Tapsell and Tunstall, 2008; Tunstall et al., 2006). The range may be explained by the depth of flooding in towns, for example, with





deeper flooding reported to have significantly increased the risk of gastroenteritis among residents in Lewes (Reacher et al., 2004). The risk of flooding for different parts of the North West can be assessed via the Environment Agency tool<sup>8</sup> discussed in Chapter Two.

Worldwide, the risk of outbreaks of potentially fatal gastroenteritis and diarrhoeal disease may increase following floods due to increased contamination of water supplies (Hunter, 2003). However, it is believed that the risk in developed countries is lower due to more advanced infrastructures and protected water sources (Hunter, 2003).

### Case study

#### Fresh food to tackle food poisoning: Liverpool Food Alliance

Liverpool Food Alliance aims to develop a co-operative network of local producers, traders and buyers. Their aim is to set up a business model whereby several large organisations commit to buying local produce, which can then provide a stable demand for many small producers.

There is increasing interest and opportunity within the city for small producers; including market

gardens, city farms, and the food alliance aims to re-connect the food supply chain to enable these initiatives to increasingly supply the city's needs. An advantage of local food is that supply chains are short and food can be very fresh.

This could be an important defence against increasing risks of food poisoning due to climate change, because long storage times and long distance transportation can be reduced.

## Mental health and well-being

- **Experiencing flooding and natural disasters that cause damage to property, relocation and loss of possessions can have a detrimental effect upon mental health, including post-traumatic stress disorder.**
- **High levels of air pollution and high temperatures may also impact negatively upon mood.**
- **Heat waves may increase risk of mortality and psychological problems among people with mental health problems.**

### Flooding and natural disasters

Studies from the UK have shown that having experienced flooding can impact up the mental health and well-being of the population. Floods have been associated with psychological distress including post-traumatic stress disorder

(PTSD), anxiety and depression and studies indicate that effects can be long lasting (Mason et al., 2010; Reacher et al., 2004; Tunstall et al., 2006). Over a quarter (28%) of individuals who experienced flooding in Tewkesbury met the criteria for PTSD and over a third (35%) met criteria for depression (Mason et al., 2010). Following flooding in Lewes, nearly three quarters of persons taking part in a study reported experiencing negative psychological effects.

The most common symptoms experienced included anxiety when it rains (55%), increased stress (36%) and problems sleeping (25%) since flooding (Tunstall et al., 2006). Similar findings were reported by individuals residing in Oxfordshire after flooding in 1998 (Tapsell and Tunstall, 2008). Populations in flooded areas may be likely to experience psychological distress due to loss of property, physical threat, having to vacate homes and relocate,

<sup>8</sup> Environment Agency (2011). Flood Maps. [www.environment-agency.gov.uk/homeandleisure/37837.aspx](http://www.environment-agency.gov.uk/homeandleisure/37837.aspx)



and financial difficulties as a consequence of loss or damage to property and possessions.

Studies from across the USA suggest that PTSD and psychological disturbance is frequent in survivors of natural disasters such as Hurricane Katrina (McLaughlin et al., 2009; Osofsky et al., 2009; Sastry and VanLandingham, 2009; Weems et al., 2007). It would therefore be expected that following natural disasters, high numbers of deaths and destruction of property, mental illness such as depression and PTSD would increase.

The risk of flooding for different parts of the North West can be assessed via the Environment Agency tool<sup>9</sup> discussed in Chapter Two.

### Air quality

Research has suggested an association between well-being and air pollution, with higher levels of air pollution believed to increase risk of psychological illness (Briere et al., 1983; Chattopadhyay et al., 1995; Szyszkowicz et al., 2007). In a study of hospital admission rates, Szyszkowicz and colleagues (2007) reported significantly higher admissions for depression during periods of high levels of particulate matter, carbon monoxide and nitrogen dioxide; with females particularly susceptible.

However, research on this association is limited and largely restricted to older studies.

### People with pre-existing mental health problems are at increased risk during heat waves

People with pre-existing mental health problems may be more vulnerable than the general population to general health problems and mortality during heat waves. During heat waves in Adelaide between 1993 and 2006, hospital admissions for people with mental and behavioural disorders increased compared to rates during periods of normal temperatures.

Admissions increased for people with organic mental disorders (21% increase), dementia (17%), neurotic disorders (10%) and mood disorders (9%). Numbers of hospital admissions for disorders of psychological development and senility were low, but increased dramatically during heat waves compared to other periods (61% and 100% increase respectively). Mortality amongst individuals with schizophrenia, schizotypal personality disorders, dementia and delusional disorders increased significantly during heat waves. The heat waves had particular impact upon hospital admissions and mortality amongst older persons.

*Hansen et al., 2008. The effect of heat waves on mental health in a temperate Australian city.*

People with mental health problems may be more physically vulnerable to increases in temperature because medication used to treat many conditions can impact upon the body's ability to increase or reduce temperature through sweating and heat production (Hansen et al., 2008).

Persons with mental health problems may lack understanding about the need to alter behaviour during a heat wave (Bark, 1998), may be less likely to be able to afford air conditioning and are likely to be less physically fit (Kaiser et al., 2001; Naughton et al., 2002).

Patients receiving residential care for mental health problems may be dependent largely upon nurses and other staff and their understanding of the need to change behaviour during a heat wave. They may be at increased risk if the quality of care is inadequate and due to environmental factors such as not having access to air conditioning (Bark, 1998).

<sup>9</sup>Environment Agency (2011). Flood Maps. [www.environment-agency.gov.uk/homeandleisure/37837.aspx](http://www.environment-agency.gov.uk/homeandleisure/37837.aspx)



## Temperature

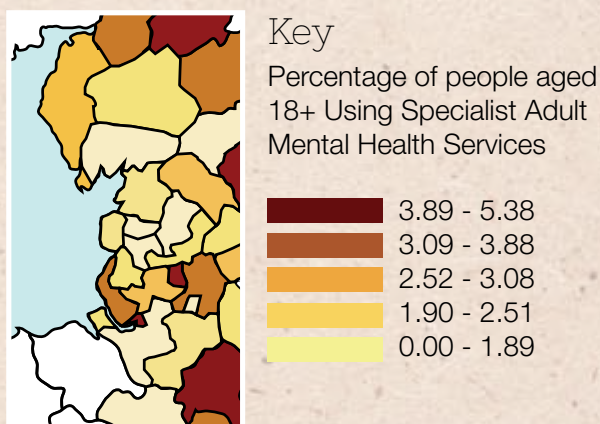
An association between increasing ambient temperature and the risk of suicide in England and Wales has been reported (Page et al., 2007), including excess of suicide during the 1995 heat wave.

The relationship does not appear to be straightforward, however, and there is mixed evidence concerning the impact of heat waves and periods of increased temperature on rates of suicide (Dixon and Kalkstein, 2009).

Incidence of mental illness is thought to increase during periods of high temperatures and individuals with mental illness are particularly vulnerable (Hansen et al., 2008).

## Mental Health and well-being in the North West

**Figure 8: Use of Adult Mental Health Services by local Authority in the North West**



Source: Office of National Statistics (2010b): Patterns of Mental Health Service Usage in England.

On average, the North West has lower use of Mental Health Services compared to the rest of England. In the North West, use of services is highest in Merseyside and Greater Manchester and the north of Cumbria and these areas may be at higher risk from aspects of climate change predicted to impact upon mental health.

The North West Mental Wellbeing Survey (Deacon et al., 2009) provided a breakdown of mental well-being by Primary Care Trust (PCT) area throughout the region. Locations with lower mental well-being may be particularly at increased risk due to climate change. PCT areas with the highest mental well-being recorded in the survey were Warrington, Halton and St Helens, and Stockport. The lowest mental well-being was recorded in North Lancashire, Knowsley, Blackpool and Liverpool PCTs. A full breakdown by PCT area is available in the report<sup>10</sup>.

Throughout the region lower levels of well-being were more likely amongst the following groups: 40-54 year olds, those living in the most deprived areas, White adults, individuals who are unemployed and individuals with few qualifications.

It therefore appears likely that more deprived areas could be at higher risk from climate change impacting upon mental well-being.

### Case study

#### The Cockermouth Flood Action Group

A case study about the flooding in Cockermouth is given in the Access to Healthcare section in this chapter of this report.

The general disruption caused by having to live in temporary accommodation, as well as longer term issues such as repairs and insurance caused much distress, which could trigger or exacerbate mental health conditions.

A flood forum was set up to support people whose homes or businesses have been damaged by flooding. It gives advice on damaged property and financial issues, which is likely to have a positive impact on mental health.

For further information, see:  
[www.ckermouthfloodactiongroup.org.uk/welcome](http://www.ckermouthfloodactiongroup.org.uk/welcome)

<sup>10</sup> North West Mental Wellbeing Survey 2009 [www.nwph.net/nwpho/publications/NorthWestMentalWellbeing%20SurveySummary.pdf](http://www.nwph.net/nwpho/publications/NorthWestMentalWellbeing%20SurveySummary.pdf)



## Insect-borne diseases

- **The risk of diseases borne by mosquitoes and other insects is likely to be increased by changing temperatures and precipitation levels in some parts of the world and reduced in others.**
- **Warmer winters and higher summer temperatures in the next century may make the UK more conducive to insect-borne disease and exposure may be greater due to increased outdoor activities in warmer weather.**
- **Medical facilities and public health in the UK and other developed countries may protect against the risk of insect-borne disease.**

Mosquitoes, flies, fleas, ticks and other biting insects cause great harm worldwide through the spread of diseases such as Plague, West Nile virus, Lyme disease (borreliosis) and malaria, which causes around one million deaths a year worldwide (World Health Organisation, 2010). It is believed that due to climate change, conditions may become more conducive in the UK for the spread of insect-borne diseases.

### Temperature and precipitation

Rising temperatures and changing precipitation and humidity levels due to climate change are predicted to impact upon the risk of insect-borne diseases worldwide. Diseases transmitted by insects are common in parts of the world, particularly developing countries in South America, South Asia and Africa. However, the risk of malaria in currently temperate countries may increase if temperatures rise and conditions become more favourable to malaria parasite and mosquito development (Gage et al., 2008).

Warmer European temperatures in winters that are currently too cold for tick activity could result in extended seasons of activity, although if summer temperatures rise past optimal temperatures for tick activity then summer activity could be limited (Gage et al., 2008; Gray, 2008). Similarly, the impact of climate change on precipitation levels is expected to contribute to both possible increases and decreases in insect-borne disease. For example, periods of

drought would reduce the risk of disease spread by mosquitoes, fleas and ticks (Gage et al., 2008; Lafferty, 2009; van Lieshout et al., 2004), but in regions where precipitation increases the risk of insect-borne disease is likely to increase (Gage et al., 2008).

Worldwide, increased global temperatures associated with climate change may therefore result in a shift in the geographical areas at risk of insect-borne disease (Lafferty, 2009). Risk due to climate change is not predicted to increase in the least developed countries that typically already have climates conducive to these diseases; however risk in developing countries is expected to increase as climate change continues (van Lieshout et al., 2004). The UK climate may become more conducive to insect-borne disease, with rising summer temperatures and warmer winters more favourable for the spread of malaria and prolonged seasons of tick activity (Gray, 2008; Hunter, 2003). It is believed that climate change is unlikely to impact on the incidence of malaria and similar diseases in the UK (Department of Health, 2008) due to the advanced medical facilities and public health strategies common to developed countries. However the epidemic of West Nile virus in the USA causing deaths and serious illness since 1999 (O'Leary et al., 2004) serves as an example that developed countries with advanced health care systems may be at risk of insect-borne disease.

Research into the impact of climate change on insect-borne diseases in the UK including the North West of England appears limited at present. Therefore it is not possible in this report to state the extent to which areas in the North West will be affected in the future by climate change. However, places associated with the habitats of mosquitoes, flies and ticks are likely to be most affected. For example, ticks are particularly associated with livestock (Borreliosis and Associated Diseases Awareness UK, 2010) so increases in tick activity might particularly impact upon regions with large areas of farmland and rural activity while areas with permanent groundwater such as marshland and lakes may be susceptible to mosquitoes (Health Protection Agency, 2007). The Health Protection Agency (2010a) has identified the Lake District as an example of a location in the UK where people may acquire Lyme borreliosis.



## Case studies

### Research to assess how climate change may increase transmission of infectious disease - ENHanCE - ERA Net Health and Climate in Europe (McIntyre et al., 2011)

This project will assess the impact of climate change on the spread of infectious disease throughout Europe. The project is taking a very broad approach in investigating all diseases which affect humans and domestic animals; the latter impacting on human nutrition and livelihoods. This international project is coordinated by University of Liverpool. A database is being created which describes the spatial distribution of pathogens of humans and animals.

A set of stages within the database then ascertains, first, those pathogens occurring in the European region, second, those with the greatest impact, and lastly, the relevant literature potentially identifying pathogens which have epidemiological linkages to temperature, moisture, etc and hence which may be influenced by climate change.

This systematic approach could lead to modelling of changing risk of disease. For new outbreaks or changes in the spread of disease (medical or veterinary), this group may offer very useful expertise within the North West.

### Annual event to raise awareness - Tick Bite Prevention Week 2011

Borreliosis and Associated Diseases Awareness UK (BADA-UK) aims to raise awareness and prevent further cases of tick-borne diseases through education and further research. This national organisation is run by volunteers who have been affected by Lyme disease or other tick-borne infections.

BADA-UK educates people about ticks and how to prevent tick bites at relevant events including agricultural and outdoor shows and country and game fairs. "Tick Bite Prevention Week" is an annual national awareness week involving widespread media coverage on how to prevent ticks biting people and their pets.

The event takes place in the spring to coincide with increased risk due to increased tick activity and time spent outdoors. The most recent was 11th-17th April 2011.

For further information, see:  
[www.tickpreventionweek.org](http://www.tickpreventionweek.org)  
[www.bada-uk.org](http://www.bada-uk.org)

## Access to healthcare

- **Increased incidence of flooding and storms increases the risk of injury, death and damage to infrastructure, which may reduce access to healthcare.**
- **Disabled, elderly and isolated individuals may be at increased risk in the event of flooding.**

### Flooding and extreme weather events

Extreme weather events and flooding can be expected to increase the risk to health in many different ways, including acute health issues for residents in flooded areas and emergency services. According to the Health Protection Agency, "the greatest health risks from flooding are drowning, accidents and injuries due to moving water (often involving vehicles) and concealed hazards, and carbon monoxide poisoning" (Health Protection

Agency, 2010b). Additionally, flooding has the potential to cause damage to infrastructure, as flooding events may pose a risk to buildings including healthcare facilities, water and electricity sources and roads and other transport facilities.

This could result in injury or illness and difficulty for the public in accessing healthcare or access for emergency services to those in need. A risk assessment of flooding in Greater Manchester concludes that types of infrastructure that could be at risk in the city include electricity substations and water storage and treatment plants and the city's transport systems (Kazmierzak and Kenny, 2011). The risk of flooding for different parts of the North West can be assessed via the Environment Agency tool described in Chapter Two<sup>11</sup>.

<sup>11</sup> Environment Agency (2011). *Flood Maps*. [www.environment-agency.gov.uk/homeandleisure/37837](http://www.environment-agency.gov.uk/homeandleisure/37837)



## Disabled individuals are at an increased risk of harm during and following floods.

It is recognised that people with disabilities may be at higher risk during emergencies caused by events such as storms and floods. Examples of how disabilities may increase risk include: not being able to get out of buildings quickly in an emergency or requiring help in order to do so; not being aware of or receiving warnings about

an emergency; not knowing how to react in an emergency; and reliance on care that may be disrupted by loss of power or food supplies. It is important to be able to quickly identify those at increased risk so that they can be helped in an emergency situation.

*Defra, 2008: Report on Disability Equality. Treating everyone the same.*

## Case Studies

### **The Cockermouth Flood Action Group**

This group was set up in 2005 after flooding and has been instrumental at coordinating adaptation since the devastating floods of 2009. The group have worked with a number of stakeholders including the Environment Agency and United Utilities. They have also developed a flood warden scheme and have issued homes with emergency action plans. As part of a national flood action group they highlight guidance from the Environment Agency, including advice to ensure that insurance repairs of flood damage include work to reduce future flood risk.

For further information see:  
[www.cockermouthfloodactiongroup.org.uk/welcome](http://www.cockermouthfloodactiongroup.org.uk/welcome)

A multi-agency recovery group was co-ordinated by Cumbria County Council.

A registration system was developed to follow-up people affected by the flooding, also local flood support centres offered help and advice.

The 2009 flood prompted the Cumbria Intelligence Observatory to perform an impact assessment. In terms of health impact, the report describes access to services and vulnerable groups affected. Due to damage to transport infrastructure residents were unable to access their local surgery; in Workington it was estimated that 7,000 residents could not access their GP. Emergency services were also constrained by the flood damage.

An analysis of the socioeconomic status of the communities across Allerdale which were affected by the flooding shows that older residents were disproportionately affected (analysed by ACORN dataset). Approximately 63% of residents were from older social groups, compared to only 17% in the wider population.

## Social determinants of health

Many social determinants of health will be affected by climate change. For example violence appears to increase in extremes of hot and cold weather. A recent retrospective study explored how frequency of sexual assaults in Manchester correlated with meteorological data (McLean, 2007). The study found that there was a positive correlation between maximum temperature and hours of sunshine and incidence of sexual assaults. However, the association was weak and was not apparent when weekdays were analysed separately.

At weekends the study found an increase in 0.5 cases for a 10°C rise in maximum temperature. The authors conclude that the association is likely to be dependent on other social factors, for example the number of people spending time outside and socialising (in line with Routine Activities theory), also alcohol and drugs are likely to play a role.

This study supports similar studies in US which have shown associations with violent crimes (Rotton, 1993).

Other theories have been proposed to explain the relationship, some of which propose temperature thresholds at which point there is a jump in frequency of murders or riots (Tennenbaum and Fink, 1994; Leishman, 2002).

Climate determines growing seasons and hence food availability and price. However, these and other factors are socially and economically mediated and will contribute to the complex array of social determinants of health. It would be impossible to predict how these factors will affect health, due to the complexity of the social factors, for example malnutrition could follow food shortages, the most likely cause may be panic buying; but attempting to predict when or where panic buying would occur would be impractical. Needless to say, these impacts are likely to be felt most by those in areas of social disadvantage.





# Chapter Four

## What next? Recommendations

It is important to assess, strengthen and build capacity to manage the impact of climate change on health in the North West. Below we have outlined a framework for action that can be used as the basis for tackling the threats to health associated with climate change:

### Interagency and interdisciplinary communication

The projected changes to the climate in the North West will have complex direct and indirect impacts on health. Many different disciplines contribute to public health, within different sectors and there will be increasing need for efficient communication between stakeholders.

This may develop along the lines of emergency preparedness. It may also look at vulnerable groups; sharing information about their needs and access to services. Integrated working should look closely at how different organisations organise and map information and how they link this to climate change events. Also different organisations may have different methods for care pathways and preventative approaches. Discussions should include:

- Review of current emergency preparedness in health and social care systems
  - particularly for extreme weather events
  - including systems for rapidly identifying and reaching vulnerable groups
- Continuous review of the need for and effectiveness of regional early warning systems for climate driven events

- e.g. for heat waves, flood alerts, food-poisoning

- Review infrastructure vulnerability and backup

- e.g. communications, transport, energy

### Maximise opportunities within communities

Individuals and community organisations are keen to address climate change and/or health issues. However, initiatives often struggle to negotiate with health or local government institutions. By working in partnership with community groups, professionals may:

- Tap into this capacity
- Engage the public
- Gather further information about needs within communities

### Public communication

As people may not have first-hand experience of the changing climate, much understanding of the issue is based on media messages. News media stories can be conflicting and changeable, which may result in apathy or disinterest towards the issue. Therefore it is not surprising that communication to the public is difficult. An example of this was the previous government's 'Act on CO2' campaign, complaints following TV and press adverts led to press adverts being banned by the Advertising Standards Agency<sup>12</sup>. More research is needed on appropriate ways to convey this information to the public.

More investment may be needed to engage the

<sup>12</sup> [www.asa.org.uk/ASA-action/Adjudications/2010/3/Department-of-Energy-and-Climate-Change/TF\\_ADJ\\_48225.aspx](http://www.asa.org.uk/ASA-action/Adjudications/2010/3/Department-of-Energy-and-Climate-Change/TF_ADJ_48225.aspx)



public with the current scientific understanding, rather than the simplistic climate believer/denier views which can still be found in the news media. It is also important to frame the issues in positive ways; expertise from health behaviour change can add to this.

The health agenda can add weight and a personal side to this argument in ways that perhaps the environmental or the economic approaches have not succeeded.

### Co-benefits

Involving health in the climate change discourse has additional value, due to the co-benefits to health. These are actions which mitigate climate change and improve health and well-being at the same time. For example cycling to the shop rather than driving improves cardiovascular fitness as well as reducing transport emissions. The public may be more willing to accept and act on these positive messages, rather than the changes which appear to constrain lifestyles. The broader issue is to find overlaps between health and environment, so that as much as possible, the natural environment is protected at the same time as our health. A further example is the NHS forest, where planting trees in hospital grounds can have a therapeutic benefit for patients, as well as being part of green infrastructure adaptation to climate change.

From the health economist point of view, the co-benefits discussed could be considered primary prevention strategies. Thus climate change messages could reduce the burden of ill-health on the NHS in the future, thus making an economic case for delivering these messages.

### Overlapping agendas

Overlapping agendas between health and climate change can be used both for public communication and for strategic discussions. To take skin cancer as an example; firstly for public communication, emphasising the increased risk of skin cancer due to climate change is a different approach to health awareness, with which some people may identify. Furthermore, making the risks to health explicit may give added urgency to mitigate climate change. Secondly, for strategic

discussions; if health professionals can emphasise how climate change will put more people at risk of skin cancer, this may give more motivation to mitigate emissions.

### Responsibility and ownership; leadership

**Reconfiguration of the health service means that currently there may be uncertainty in the public sector about which organisations have responsibility for tackling particular climate change issues.** At this time it is especially important for professionals to take proactive ownership of issues, and keep track of some long-term goals, as well as being able to show quick wins. Professionals need to be clear of the arguments and agendas to be able to put forward the 'business case' for action in strategic discussions. In different organisations and sectors different strategic goals may be pertinent, but it seems that the Joint Strategic Needs Assessment may be the most appropriate forum for these discussions, involving partners with the emergent Health and Wellbeing Boards.

### Need for action

**To advance the political debate on mitigating climate change, support needs to build from professional and other groups.** Previous political debates can be used as examples of how the public health discourse has eventually strengthened the argument for change. Recent examples include tobacco smoking, lead additives in petrol and emissions of chemicals which damage the ozone layer.









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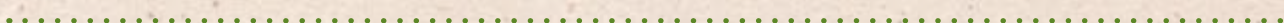


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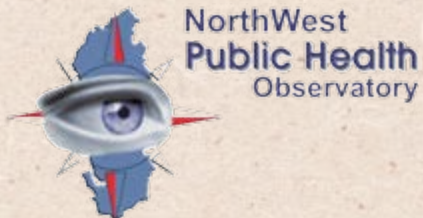
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January 2012

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ISBN: 978-1-908029-95-9