Health Effects of Climate Change in the West Midlands

Draft Preliminary Report

December 2009

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Introduction:

This study aims to assess the effects of climate change on health in the West Midlands. Following the publication of a report by the Department of Health in 2001 (updated in 2008), entitled "Health Effects of Climate Change in the UK", it was recommended that the project was downscaled to a Regional level, and the UK Climate Impacts Programme 2009 (UKCP09) interface was made use of to get the most up-to-date climate projections. In this document both of these recommendations are covered by using pre-existing literature, surveillance data and climate projections. It covers a wide variety of diseases and health effects that could be affected by climate change, and provides numerical projections for specific health effects (where data is available) for the West Midlands up until the end of the century.

For this draft, Part 3.1 has been completed to demonstrate the type of results that will be displayed in the final report. Where the draft is incomplete grey writing is used to describe what needs to be done to complete the section. Currently the literature reviews are short and just give a brief overview of the particular health effect, however these can be extended for the final report.

Chapter 1 Climate Change Projections for the West Midlands

1.1. Observed trends:

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1.1.1. Temperature:

The Central England Temperature Series (CET) gives a complete record of temperature readings since 1772, with daily maximum and minimum temperature available since 1878. In recent years, CET has been shown to rise, with an increase of approximately 1^{o}C since 1980 (Figure 1) (Jenkins et al, 2009). The recent UKCIP Trends report (Jenkins et al, 2009) details changes for the West Midlands specifically. It specifies that annual daily mean temperature has increased by 1.56^{o}C since 1961-2006, with temperature increases across all seasons (spring = 1.57^{o}C, summer = 1.70^{o}C, autumn = 1.21^{o}C, winter = 1.95^{o}C). The change in annual daily maximum temperature (^{o}C) over the same period is 1.77^{o}C, with changes being most prominent in summer and winter (2.01^{o}C and 2.16^{o}C respectively). The annual daily minimum temperature has also risen, by 1.36^{o}C from 1961-2006, with the greatest change again experienced in summer and winter (1.38^{o}C and 1.74^{o}C respectively).

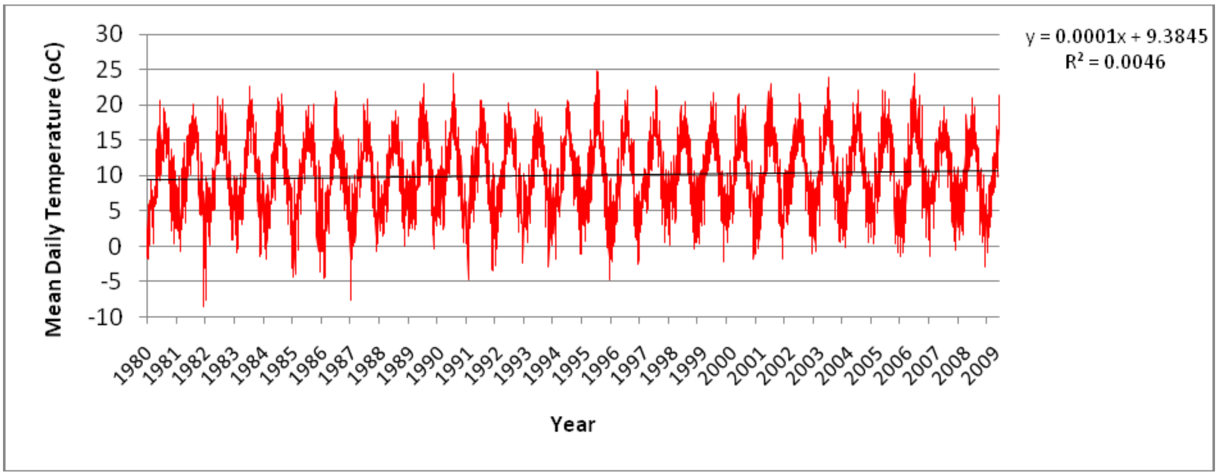

Figure 1: The CET series mean daily temperature with linear trend line (1980-2009)

Generally in the UK, temperature changes have been greater in the south than in the north, therefore we can expect that the south of the Region has warmed slightly more than the north in recent years.

Between 1961-2006 the percentage change in number of Heating Degree Days (HDD; which are days with a mean temperature below 15.5°C and thus will require heating to be used) is -17.9. The absolute number of Cooling Degree Days (CDD; the number of days with a mean temperature over 22°C and thus will require air conditioning to be used) between 1961 and 2006 is +21.6, as reported by the UKCP09 trends document (Jenkins et al, 2009).

1.1.2. Precipitation:

The UK Precipitation Series (HadUKP) central England sub-region (CEP) gives a complete record of precipitation of daily data since 1931 (Alexander & Jones, 2001). In recent years, no significant trend can be observed annually (Figure 2), however evaluation of seasonal rainfall suggest a decrease in summer rainfall and an increase in winter rainfall. The UKCIP Trends report (Jenkins et al, 2009) reports an annual change in precipitation amount of +7.6%. The smallest change was seen in spring (-1.4%) and the largest in autumn (+29.8%), with summer and winter change of -5.2% and +10.9% respectively.

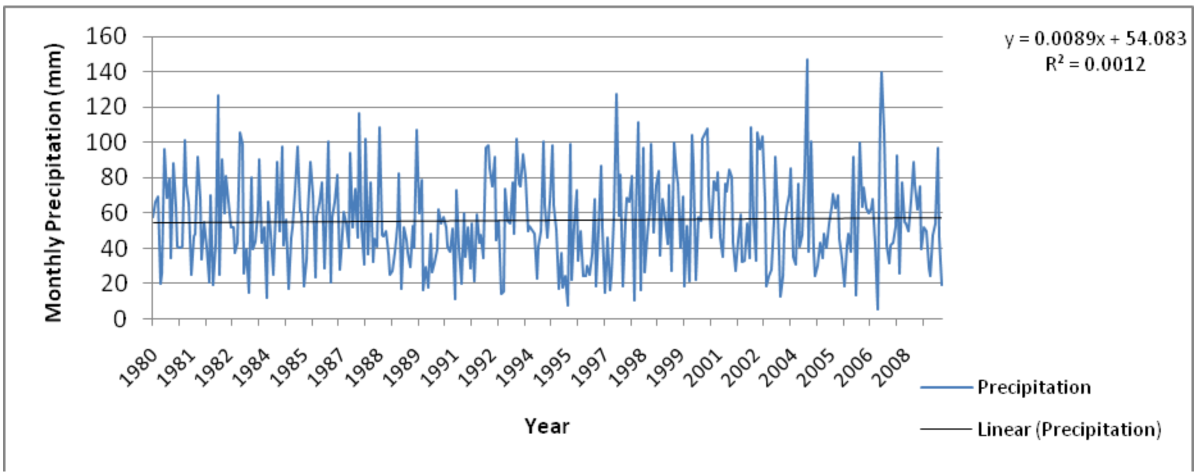

Figure 2: The CEP series total monthly rainfall with linear trendline (1980-2009)

Between 1961-2006 the number of days of rainfall in spring decreased by 2.7, while in autumn there was an increase of just 3.6. The large increase in rainfall compared to the small increase in rainfall days during autumn, suggests an increase in rainfall intensity during that season (Jenkins et al, 2009).

1.1.3. Relative Humidity:

The UKCIP Trends report (Jenkins et al, 2009) reports an annual change in relative humidity of -3.1% between 1961 and 2006 for the West Midlands. The highest change in relative humidity for the Region can be viewed in summer, with a decrease of 3.3%. The lowest decrease is in spring with a 2.6% decrease. There are no datasets available that represent the whole of the West Midlands.

1.2. UKCP09 Future Projections:

All of the projections used in this report will be based on the UKCP09 projection model (http://ukcp09.defra.gov.uk/). Currently the medium emissions scenario (A1B, defined by the international Panel of Climate Change, IPCC) is being used by politicians as the most likely to occur; however if a deal is not reached in Copenhagen in December 2009 the high emissions scenario (A1FI, IPCC) will also have to be considered. For the purposes of this draft report only the medium emissions will be considered, however we plan to broaden our projections to include the high scenario. All projections made will be for three times slices – the 2020's, 2050's and 2080's.

1.2.1. Temperature projections

Table 1: Temperature Change for the West Midlands Administrative Region under the medium emissions scenario for mean winter temperature, mean summer temperature and summer mean daily maximum temperature. Projections are for the 2020s, 2050s and 2080s and the 10%, 50% and 90% probability levels.

Temperature Change	**2020**			**2050**			**2080**		
Probability Level	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Mean Winter T (oC)	0.6	1.3	2.1	1.2	2.1	3.3	1.7	3.4	4.5
Mean Summer T (^{o}C)	0.5	1.5	2.6	1.3	2.6	4.4	2.1	4.8	6.2
Summer mean daily max T (^{o}C)	0.6	2.1	4	1.5	2.7	6.7	2.5	6.6	9.4

Table 2: Actual Temperature for the West Midlands Administrative Region under the medium emissions scenario for mean winter temperature, mean summer temperature and summer mean daily maximum temperature and winter mean daily minimum temperature. Projections are for the 2020s, 2050s and 2080s and the 10%, 50% and 90% probability levels.

Actual Temperature	**2020**			**2050**			**2080**		
Probability Level	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Mean Winter T (oC)	4.1	4.6	5.1	4.8	5.6	6.3	5.5	6.7	7.8
Mean Summer T (^{o}C)	15.1	15.8	16.6	16.1	17.2	18.3	17.2	19	20.7
Summer mean daily max T (^{o}C)	19.6	20.5	21.3	21.2	22.8	24.4	23	25.7	28.4
Winter mean daily min T (oC)	1.3	1.7	2.2	2.3	3.2	4.2	3.4	5	6.8

1.2.2. Precipitation projections

Table 3: Percentage change in rainfall for the West Midlands Administrative Region under the medium emissions scenario for mean winter precipitation and mean summer precipitation for the 2020's, 2050's, 2080's and the 10%, 50% and 90% probability levels.

Precipitation Change	**2020**			**2050**			**2080**		
Probability Level	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Winter Mean (%)	-3.0	5.1	14.5	2.2	12.8	27.2	3.2	17.2	38.0
Summer Mean (%)	-22.9	-6.6	11.8	-36.6	-16.7	6.0	-43.5	-20.4	5.7

1.2.3. Humidity projections

Table 4: Percentage change in humidity for the West Midlands Administrative Region under the medium emissions scenario for mean winter and summer humidity for the 2020's, 2050's and 2080's.

Relative Humidity Change	**2020**			**2050**			**2080**		
Probability Level	**10**	**50**	**90**	**10**	**50**	**90**	**10**	**50**	**90**
Winter Mean (%)	-0.7	-0.1	0.5	-1.0	-0.1	0.7	-1.2	0.1	1.1
Summer Mean (%)	-7.4	-2.8	1.8	-11.2	-4.9	0.9	-14.3	-6.6	0.4

1.2.4. Future projections for extreme weather events

Weather Generator – to be investigated

Chapter 2 General description of methods

2.1. Data Sources

Meteorological and Climatological Data

- Climate projections were carried out using the UKCP09 interface (UK Climate Projections interface: http://ukcp09.defra.gov.uk/).
- 1961-1990 Baseline data was provided by the UK Met Office (http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcp09/)
- 1999-2006 Temperature data (mean and maximum) for grid squares covering the West Midlands Area was provided by the UK Met Office (http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcp09/)
- The Central England Temperature series (CET, 1950-2008) was provided by the UK Met Office by the BADC (http://badc.nerc.ac.uk/home/index.html)
- The HadUKP series (CEP, 1980-2008) was provided by the UK Met Office (http://www.metoffice.gov.uk/climate/uk/about/archives.html) however this was not used for analysis as the geographical area covered is not comparable to the health data for the West Midlands

Registration was required for all of these datasets however no charges were made.

Health Data

- 2001-2008 All Cause mortality, Cardiovascular Mortality, Cerebrovascular Mortality, Ischaemic Heart Attack Mortality, Respiratory Disease Mortality, Asthma Mortality and COPD Mortality were all provided by the West Midlands Public Health Observatory (HES data). (WMPHO: http://www.wmpho.org.uk/requests/)
- 2001-2008 Hospital Admissions Data for Cardiovascular diseases, Cerebrovascular diseases, Ischaemic Heart Attack, Respiratory diseases, Asthma, and COPD were all provided by the West Midlands Public Health Observatory (HES data). (WMPHO: http://www.wmpho.org.uk/requests/)
- 2000-2008 data for laboratory confirmed cases of Campylobacter, Cryptosporidiosis and Salmonella were provided by the Regional Epidemiology Unit – West Midlands (HPA, http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733761705)
- 1999-2008 data for laboratory confirmed cases of E. coli, Legionnaires' disease, Lyme Disease and Norovirus were provided by the Regional Epidemiology Unit – West Midlands (http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733761705)
- 1998-2008 data for laboratory confirmed cases of Meningitis was provided by the Regional Epidemiology Unit – West Midlands (HPA, http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733761705)
- 1993-2006 data for the incidence of Malignant Melanoma in the West Midlands was provided by The Office of National Statistics, Clinical and Health Outcomes Knowledge Base (http://www.nchod.nhs.uk/)

All of the data listed above is for the West Midlands Region only, the data requires registration and confidentiality rules apply.

2.2. Climate projections

The UKCP09 interface was used for the climate projections. The climate variable change values (mean, maximum and minimum temperature, precipitation, humidity and cloud cover) were calculated for the Medium Emissions Scenario (high emissions scenario projections in progress) for the 2020s, 2050s and 2080s using the 10%, 50% and 90% probability levels.

To allow for these projections to be used for mortality/morbidity projections, the actual variable values had to be calculated. This was done for temperature by using the 1961-1990 baseline data provided by the Met Office. As the projected climate change values work from the average weather conditions between 1961-1990, the change values projected for the 2020's, 2050's and 2080's could simply be added to the baseline to get the actual projected values. These values are detailed in section 1.2..

2.3. Health projections

Important diseases in terms of climate change were investigated using the literature. Surveillance data for the West Midlands was then acquired for diseases that demonstrate seasonal dependence and was compared to daily or monthly temperature (min, max, mean) over the same time period (daily = Central England Temperature between 2001-2008, monthly = West Midlands Administrative Region Temperature between 1999/2001-2006). Cardiovascular diseases and respiratory diseases were analysed using daily data; therefore CET had to be used. All other diseases were analysed using monthly data, so the gridded data from the Met Office was used. STATA 11 was used for regression analysis and to find the best fit line between temperature (either min, mean or max) depending on which showed the strongest correlation; STATA outputted the number of cases of the diseases expected at a given temperature.

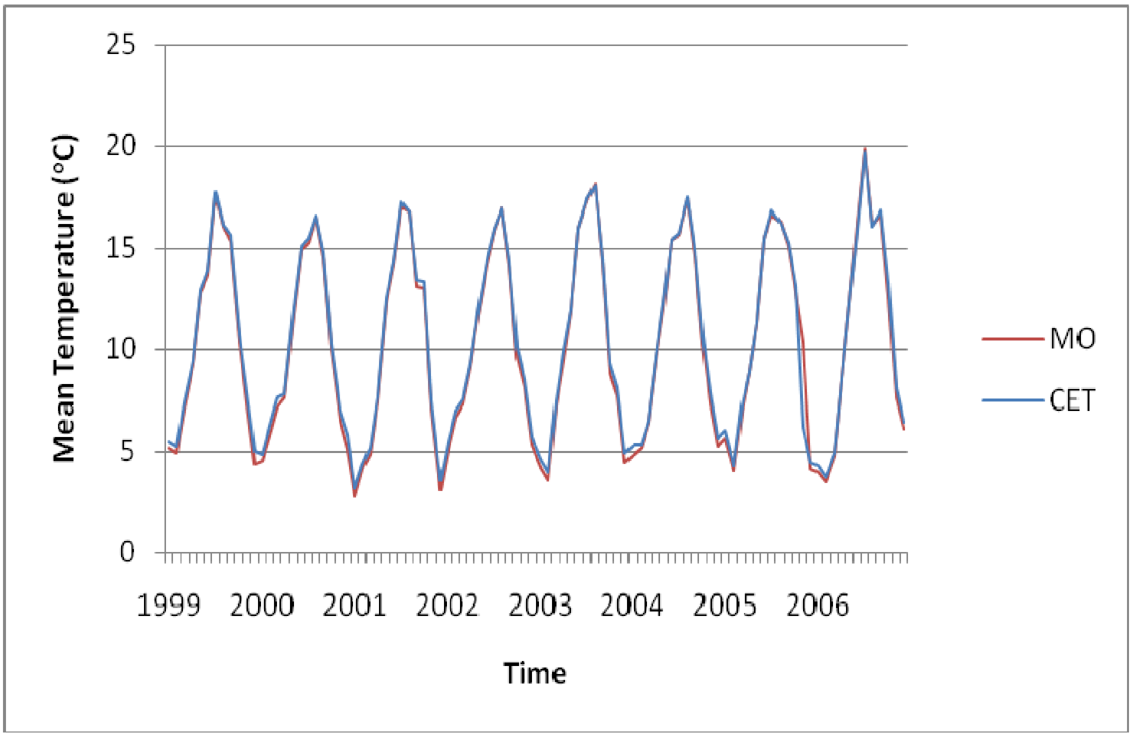

Figure 3: A comparison of CET series and the Met Office data series for mean temperature between 1999-2006

The projected changes in disease occurrence were then assessed. As the number of disease cases at a given temperature are known (due to STATA analysis), the projected temperature for the 2020s, 2050s and 2080s could be used to find how many cases of each disease can be expected at that temperature, as shown below:

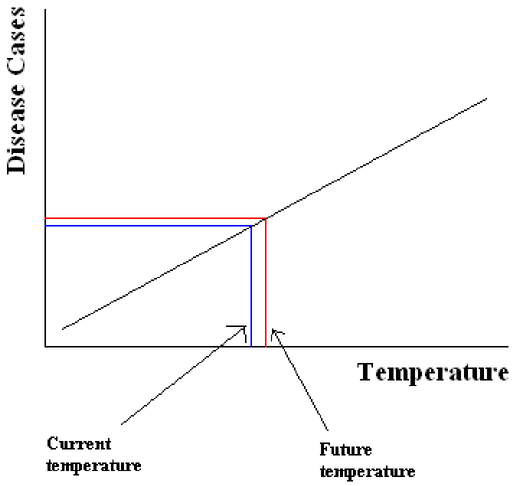

Figure 4: Demonstration of method for identifying future disease risk at future temperatures

Projections for diseases were seasonal to help eliminate further error; however the months that have the highest/lowest incidence are stated in the report.

Nothing will be factored into the calculations to cover population change as population projections only go as far as 2031; however incidence rate will be used to report projections instead of raw number of cases. A chapter on uncertainty will be included in the final report which will cover this. Using incidence rate assumes the age structure of the population will remain the same, but it is widely known that the UK population is aging, therefore it should be noted that projections for diseases affecting the elderly (CVD and Respiratory Disease) will probably underestimate the actual figure – hence they can be given as a minimum number of people affected.

As suggested by members of the WMCCAP the 10% and 90% probabilities will be looked at as well as the 50% probability so that a range can be included. This will encompass some uncertainty however these values cannot be taken as definitive minimum and maximum values due to the other uncertainty involved.

2.4 Uncertainty

Uncertainty includes:

- Population change and age structure change
- Unpredictability of diseases (may not follow current temperature trends – e.g. Meningitis in UK occurs in winter when it is colder, however in Africa it occurs more in summer)
- Emission scenario uncertainty
- Changes in behaviour/life style
- Advances in medicine/health care

Chapter 3 Direct effects of temperature on mortality and morbidity in the West Midlands

3.1. Cardiovascular Diseases and Temperature

Cardiovascular disease describes diseases which affect the heart and/or the circulatory system, while Cerebrovascular diseases are diseases which affects an artery supplying the brain. These diseases are known to be exacerbated by increased temperature, including heat waves (Luber and Prudent, 2009, Haines et al 2006, Kalkstein and Valimont 1987, Martens 1998, Rooney et al 1998, Schuman 1972). Deaths from Cardiovascular diseases are generally higher in winter than in summer. Cold environments can cause an increase in blood pressure, which increases cardiac stress (Wilmhurst, 1994). Similarly, mortality rates due to stroke show a seasonal trend, which peaks in the winter months (Rothwell et al 1996). Heart and circulatory diseases are the UK's most common cause of mortality; therefore the relationship with temperature is very important when considering future public health.

3.1.1. Past Mortality Data for the West Midlands

The data for all cardiovascular disease mortality in the West Midlands shows higher mortality at lower and higher temperatures, with a minimum mortality between approximately 15-18°C. The highest mortality occurs during colder periods, with the coldest day (mean T -1.8°C, minimum T -6.6°C) in the 2001-2008 CET series (01/01/2002) seeing 77 deaths, 24 above the daily average (53) for the region. On the hottest day (19/07/2006, mean T 24.5°C, maximum T 32.9°C) 57 deaths from cardiovascular diseases were recorded.

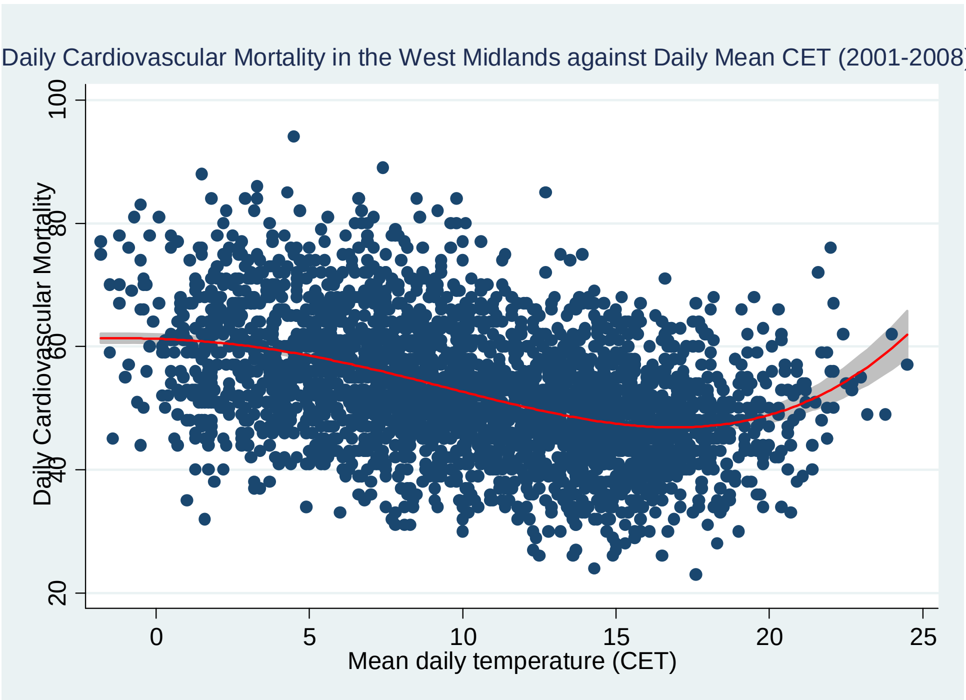

Figure 5: Daily Cardiovascular Mortality in the West Midlands against Daily Mean Central England Temperature (2001-2008)

Similar patterns can be observed when the cardiovascular data is divided into categories (Ischaemic Heart Attack and Cerebrovascular disease (Figure 4)), however heart attack shows a slightly higher temperature sensitivity. The minimum mortality is again between 15-18°C. On days when temperatures were >24°C or <3°C, an average of 3 extra deaths per day were recorded for Cerebrovascular Disease and 4 extra deaths per day were recorded to be caused by Ischaemic Heart Attack.

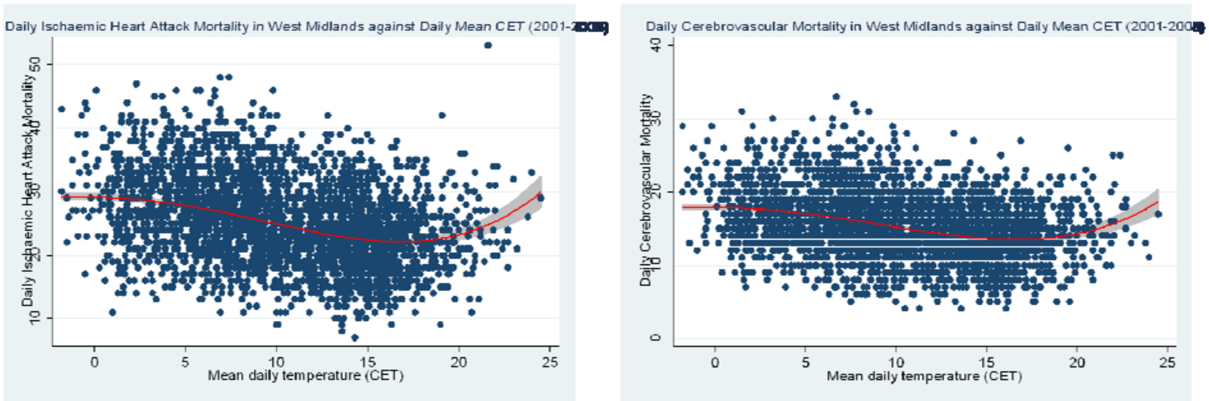

Figure 6: Daily Ischaemic Heart Attack Mortality (left) and Cerebrovascular Mortality (right) in the West Midlands against Daily Mean Central England Temperature (2001-2008)

3.1.2. Projected Cardiovascular Mortality for the West Midlands (2020s – 2080s)

	Total Number of Cardiovascular Deaths per Season									
	2001-2008	2020			2050			2080		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)	5211	5310	5310	5220	5310	5220	5130	5220	5130	4950
Spring (MAM)	4777	5060	4968	4876	4968	4876	4784	4874	4784	4600
Summer (JJA)	4416	4324	4324	4324	4324	4324	4416	4324	4324	4600
Autumn (SON)	4706	4732	4641	4550	4641	4550	4459	4550	4459	4368

	Number of Excess Cardiovascular Deaths per Season (baseline = 4745 deaths per season)								
	2020			2050			2080		
	10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)	+565	+565	+475	+565	+475	+385	+475	+385	+205
Spring (MAM)	+315	+223	+130	+223	+131	+39	+131	+39	-145
Summer (JJA)	-421	-421	-421	-421	-421	-329	-421	-421	-145
Autumn (SON)	-13	-104	-195	-104	-195	-286	-195	-286	-377

On average 47% of the deaths from Cardiovascular diseases are from Ischeamic Heart Attacks, with a slightly higher percentage in winter and warm summers. In the current dataset the figures only vary by ±1%. Twenty Nine percent of cardiovascular deaths are a result of Cerebrovascular Diseases, with a slightly higher percentage in winter and summer. In the current dataset the figures only vary by ±1%.

3.2. Respiratory

A relationship between temperature, air pollution and respiratory disease incidence exists in which the effects of temperature and air pollution are very difficult to separate. As projections of ozone (O_3) levels cannot be made, this section will focus entirely on the effects of temperature, while chapter 4 will investigate O_3 more closely using current trends.

Respiratory diseases include diseases such as pneumonia, emphysema, bronchitis, chronic obstructive pulmonary disease (COPD) and respiratory tract infections. These diseases are known to be affected by temperature, involving a relationship with pollution and humidity (Luber, 2009, Haines 2006, Kalkstein and Valimont, 1987, Martens, 1998, Rooney et al 1998, Schuman 1972)). As temperature increases and the period of warm weather and sunshine continue, ozone is produced. Ozone, which is produced most during warm and cold weather (low humidity) can exacerbate respiratory problems. It impairs pulmonary function, causes lung inflammation and lung permeability and can lead to respiratory problems, increased medication usage, illness and death (EEA, 2008).

3.2.1. Past Hospital Admissions Data for the West Midlands

Hospital admissions for respiratory diseases increase during cold and warm weather, with minimum admissions during temperatures of 18-20°C (162 hospital admissions on days where the temperature was ~19°C). Colder weather effects patients more, with the coldest day (mean T -1.8°C, minimum T -6.6°C) in the 2001-2008 CET series (01/01/2002) seeing 247 hospital admissions, while the warmest day (19/07/2006, mean T 24.5°C, maximum T 32.9°C) saw 188 admissions.

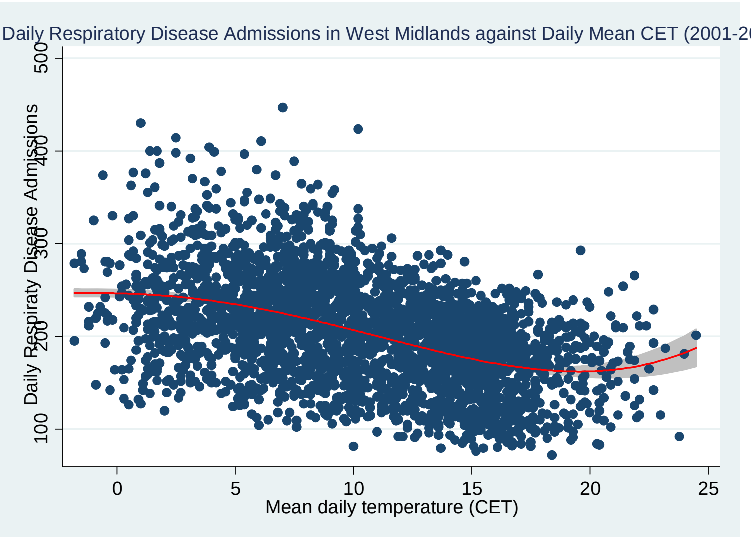

Figure 7: Daily Respiratory Disease Admissions in the West Midlands against Daily Mean Central England Temperature (2001-2008)

Although overall respiratory diseases show sensitivity during hot and cold weather, this pattern is not followed when 2 of the categories of respiratory diseases are observed separately. Asthma shows the opposite pattern, with more admissions during milder conditions. Maximum admissions for asthma occur at ~7°C (22 admissions per day), while the minimum number of admissions occurs in warmer weather (above 22°C, 16 admissions per day). In weather <2°C the number of admissions is similar to the average, of 21 daily admissions). COPD displays a similar pattern to the All Cause Respiratory admissions; however there is a higher rise during warmer weather. Maximum admissions occur in cold weather (37 admissions per day when temperature is <1.5°C). In temperatures above 24°C there are 31 admissions daily, and the minimum number of admissions occurs at ~18°C.

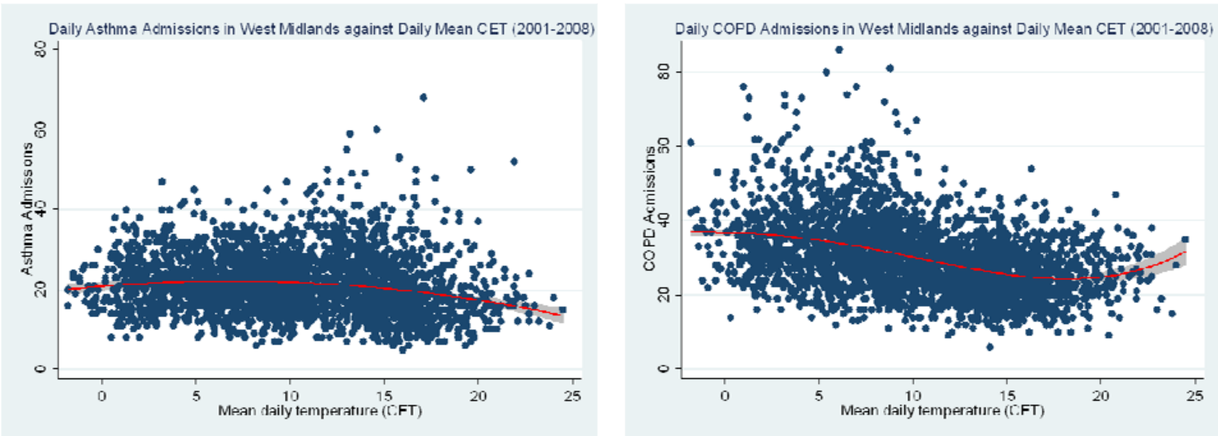

Figure 8: Daily Asthma Admissions (left) and COPD Admissions (right) in the West Midlands against Daily Mean Central England Temperature (2001-2008)

3.2.2. Projected Respiratory Disease Admissions for the West Midlands (2020s – 2080s)

	Total Number of Respiratory Hospital Admissions per Season									
	2001-2008	2020			2050			2080		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)										
Spring (MAM)										
Summer (JJA)										
Autumn (SON)										

	Number of Excess Respiratory Admissions per Season (baseline = ...admissions per season)								
	2020			2050			2080		
	10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)									
Spring (MAM)									

Summer (JJA)									
Autumn (SON)									

Chapter 4 Air Pollution, Asthma, Allergies and Climate Change

4.4. Air Pollution

Most pollutants will be reduced by air pollution policy in the UK; however decreases in VOC and NO_x concentrations will cause an increase in ozone levels in the West Midlands. Ozone levels are related closely to weather conditions, and episodes frequently occur during the summer as a result of successive hot, sunny days. These are likely to increase in the future, however episodes in the winter, caused by cold static air masses could decrease.

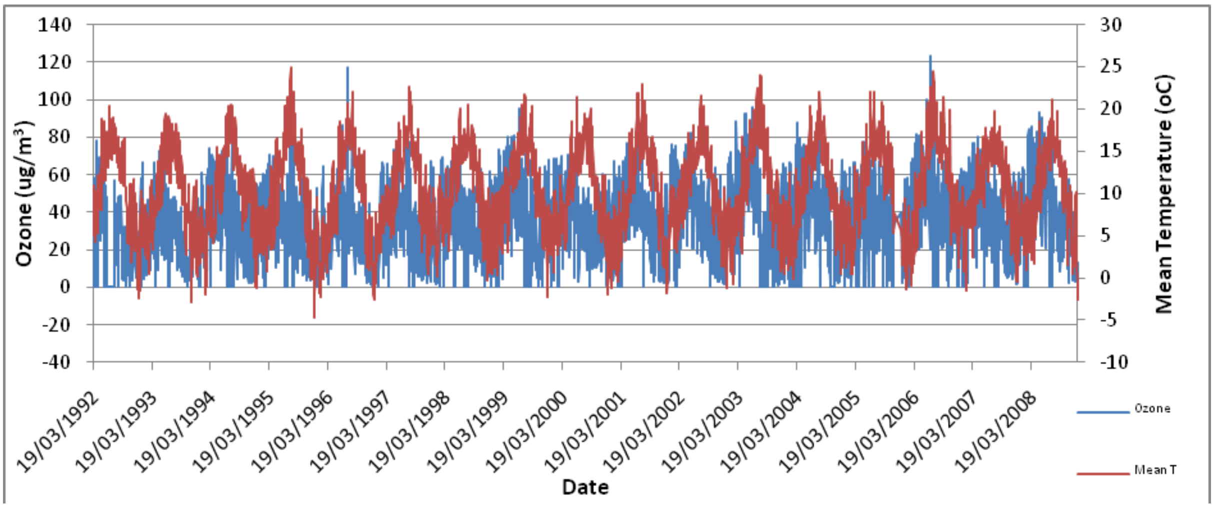

Figure 9: Mean daily ozone against mean daily temperature

A plot of maximum (midday) ozone values will be made shortly as these could be more important for respiratory problems.

4.4.1. Asthma and Air Pollution

Asthma data and ozone values will be compared, other pollutants may be looked at in terms of respiratory diseases as well, however further investigation of available data has not yet been carried out. PM_{10} and $PM_{2.5}$ have been suggested as an area to look at. Predicted trends will be investigated.

4.2. Allergies

Information on allergies will be qualitative as data for predictions is unavailable and symptoms/triggers are so variable. This section will include information on mould/spores, mites and pollen (below).

4.2.1. Hay fever

Hay Fever is extremely common in the UK; affecting 1 in 5 people (NHS, 2009). Its incidence has increased from 1% in Europe at the beginning of the century to 15-20% presently. People in Western European countries are particularly badly affected (WHO Europe, 2003). Children and adolescents are currently the most affected age group and generally spring and summer are the seasons when hay fever is most troublesome. The amount of pollen released from the flowers depends upon the amount of sunshine, moisture and air in the atmosphere. Rains cause the pollen levels to fall. Sunny windy days are the days when flowers open up and release pollen.

Climate change is likely to cause an increase in the pollen season as growing seasons become longer and the onset of spring occurs earlier. With warmer temperatures, decreased humidity and less summer rainfall hay fever incidence is likely to continue to increase. Climate change may also result in the introduction of new flora in the UK which could result in new allergies. An example of this is Ragweed, which has become more common in Europe and the USA. Its pollen is particularly allergenic so it could cause increased hay fever prevalence if it establishes itself in the West Midlands.

Chapter 5 Water borne Diseases and Climate Change

Cryptosporidiosis is the most common cause of gastroenteritis in the UK. The true incidence is probably greater than 9.3 per 100000 annually. It is an infectious disease and can be caught by drinking contaminated water, using swimming pools which are not properly maintained or by taking part in other water based recreation, and from sewage, as well as contaminated food and contact with animals. The majority of cases occur in autumn in the UK, with a small peak in spring. This could be due to the increased temperature combined with a change in behaviour – such as more people taking part in water sports.

5.1. Cryptosporidiosis

5.1.1. Past trends in Cryptosporidiosis Cases in the West Midlands

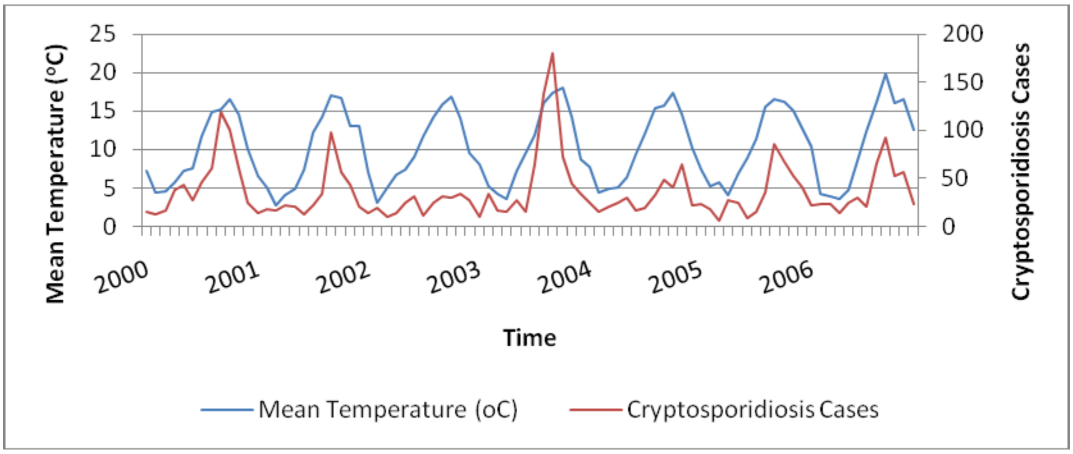

Figure 10: Time series of monthly laboratory confirmed cases of Cryptosporidiosis and mean West Midlands Temperature (2000-2006) with a lag of 2 months

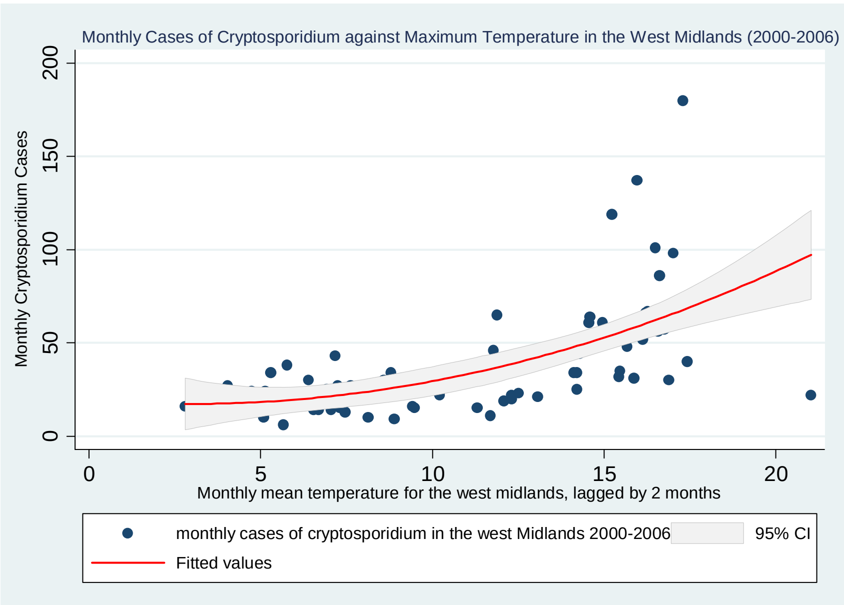

Figure 11: Monthly laboratory confirmed cases of Cryptosporidiosis against mean West Midlands Temperature (2000-2006) with a lag of 2 months; showing best fit line and 95% confidence intervals.

It can be seen clearly that fewer cases of Cryptosporidiosis occur when the weather two months earlier was colder. During the coldest month on the 2000-2006 dataset (01/2001, 2.8°C), there were just 17 cases in March, however during the hottest month (07/2006) there were 73 cases in the following September. The average number of cases per month in the West Midlands is 37.

5.1.2. Projections for Cryptosporidiosis Cases in the West Midlands (2020s – 2080s)

	Total Number of Cryptosporidiosis Cases per Season									
	2001-2008	2020			2050			2080		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)										
Spring (MAM)										
Summer (JJA)										
Autumn (SON)										

	Number of Excess Cryptosporidiosis Cases per Season (baseline = ...cases per season)								
	2020			2050			2080		
	10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)									
Spring (MAM)									
Summer (JJA)									
Autumn (SON)									

Chapter 6 Vector borne Diseases and Climate Change

6.1. Tick borne

Ticks are likely to increase in woodlands due to milder winter temperatures. This combined with a change in behaviour (more hiking/outdoor activity in the warmer weather) could mean that tick bites increase, therefore leading to an increase in Lyme Disease and Tick borne Encephalitis. The current incidence of Lyme disease is 0.3 per 100000.

Too few cases of Lyme disease to allow us to analyse data properly, however literature review is complete so qualitative info can be covered. A meeting at REU WM revealed that work has been carried out on deer (host) populations in the West Midlands so this could be looked into.

6.2. Mosquito borne

6.2.1. Malaria

Malaria in the UK is caused by travellers returning from countries where Malaria is endemic. Currently the mosquito vector cannot survive in the UK climate; however this could change with climate change. Outbreaks of endemic malaria are likely to be small and concentrated in the SE of England near the coast. Projections from another study are as below.

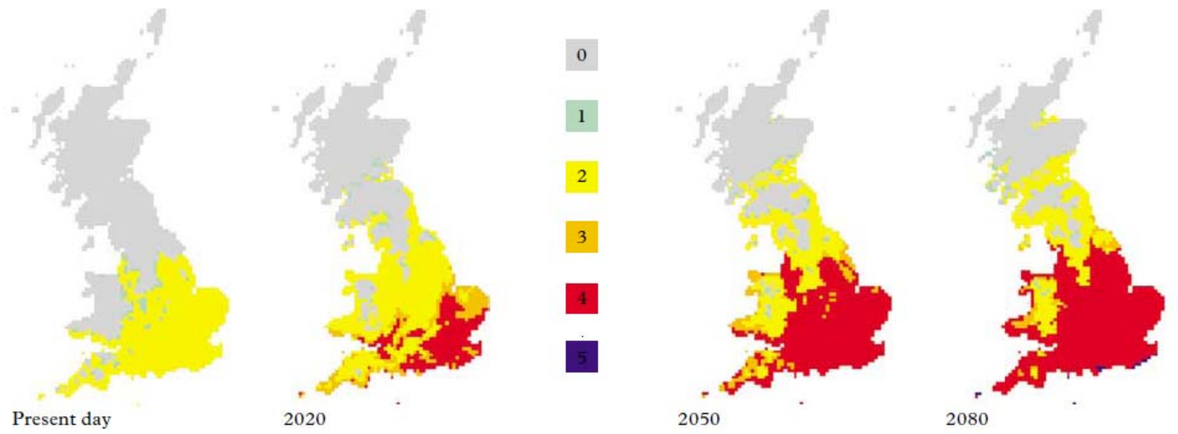

Figure 2 *Present and projected future risk of malaria in Great Britain. Legend shows number of months that vivax transmission could be maintained under a medium-high climate change scenario.*

Figure 12: Taken from: Hulme M, Jenkins G, 1998.
(Yellow = persent for 2 month of the year, Orange = present for 3 months of the year, Red = present for 4 months of the year).

Extensive literature review carried out however there are many different scenarios and lots of uncertainty. No data can be used because it consists mostly of Malaria contracted whilst travelling.

6.2.2. Other (Dengue, Chikungunya, West Nile?)

Effects probably much too small to be a significant public health issue but outbreaks in mainland Europe have occurred.

Chapter 7 Food borne Diseases and Climate Change

7.1. Salmonella

Salmonella is the second most common cause of gastrointestinal infection in the UK, caused generally by ingestion of contaminated food. The bacteria can cause huge outbreaks and elderly, pregnant women and immunocompromised people are particularly at a higher risk of severe disease. Salmonella presents a regular seasonal pattern with higher incidence in late summer. This may be due to two main reasons, the bacterial faster multiplication in higher temperatures and more frequent raw food consumption.

There was a much stronger association with temperatures 2-5 weeks earlier, pointing to the importance of factors operating earlier in the food production or distribution system. The results of this study suggest that the food poisoning problem requires action by food producers and distributors as well as by consumers. It is likely that some of the first detectable changes of global climate change on food safety will be seen as longer summertime peaks of food borne disease and/or increased geographic range.

7.1.1. Past Data for Salmonella Cases in the West Midlands

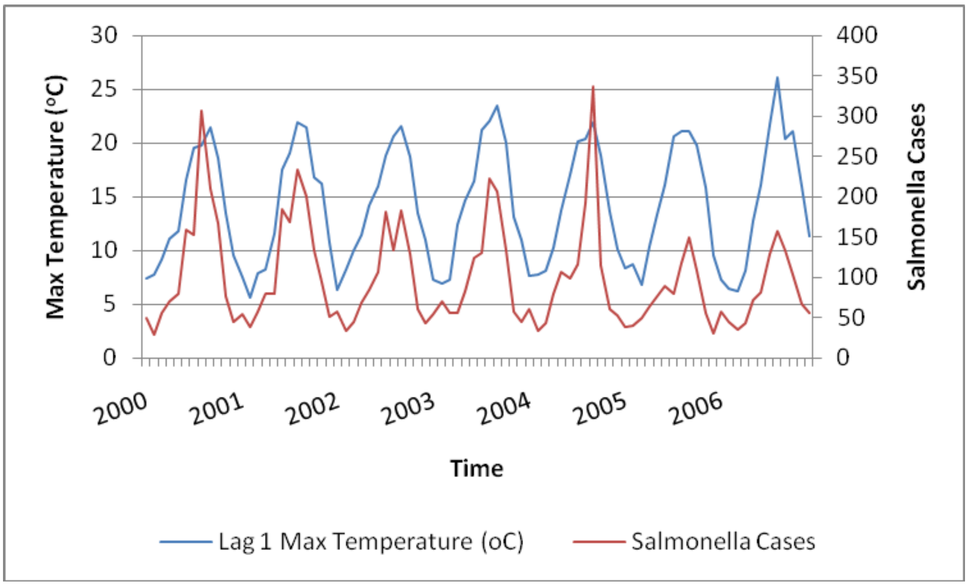

Figure 13: Time series of the number of cases of Salmonella and the mean daily maximum temperature lagged by 1 month (2000-2006) in the west Midlands

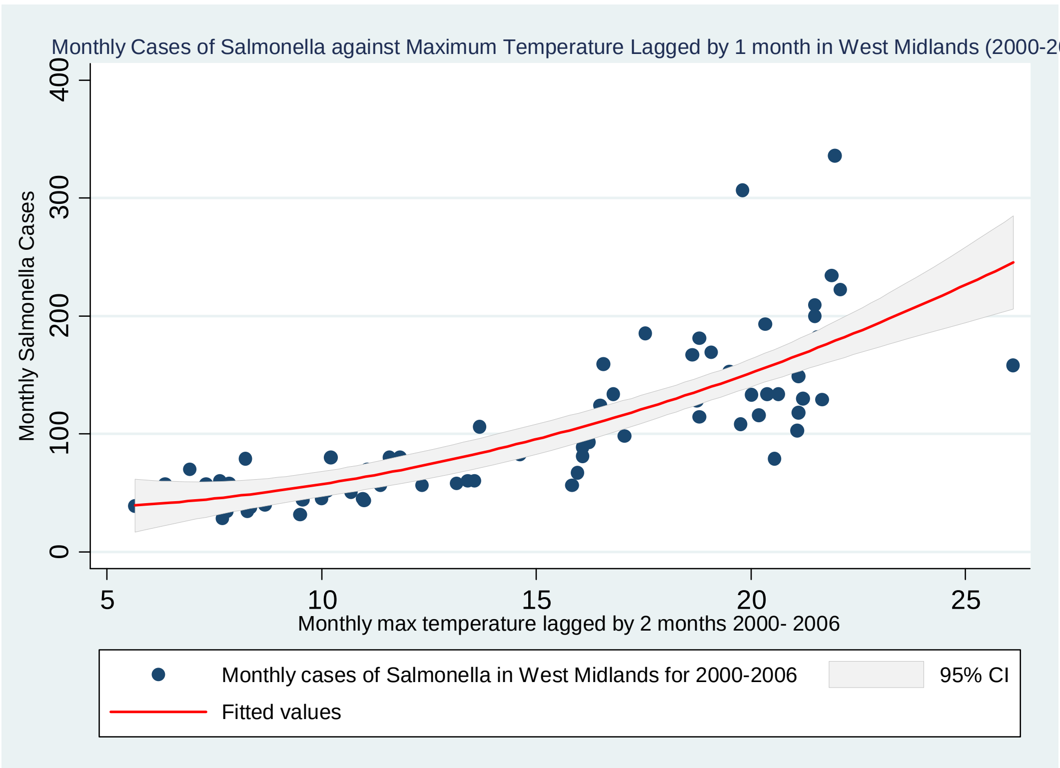

Figure 14: Cases of Salmonella against the mean daily maximum temperature lagged by 1 month (2000-2006) in the West Midlands

In the West Midlands Salmonella occurs most when the previous month was warm. The average number of cases per month is 99, however during the hottest month this increased to 168 (07/2006, mean daily max temperature = 26oC). During the coldest month (01/2001, mean daily maximum temperature = 6°C) there were 39 cases.

7.1.2. Projections for Salmonella Cases in the West Midlands (2020s – 2080s)

	Total Number of Salmonella Cases per Season									
	2001-2008	2020			2050			2080		
		10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)										
Spring (MAM)										
Summer (JJA)										
Autumn (SON)										

	Number of Excess Salmonella Cases per Season (baseline = ...cases per season)								
	2020			2050			2080		
	10%	50%	90%	10%	50%	90%	10%	50%	90%
Winter (DJF)									
Spring (MAM)									
Summer (JJA)									
Autumn (SON)									

7.2. E. coli

E. coli is caused by eating poorly prepared or under cooked foods, such as meats and raw eggs. Higher incidence in the summer could be due to warmer temperatures causing decrease food hygiene or increased number of barbeques on which meat is improperly cooked. The stress response of E. coli may mean that as climate changes the bacteria become more resistant, leading to an increase in cases. Increases in temperature cause an increase in E. coli cases. The current incidence in the UK is ~6.1 per 100000 population per year.

7.2.1. Past Data for E coli Cases in the West Midlands

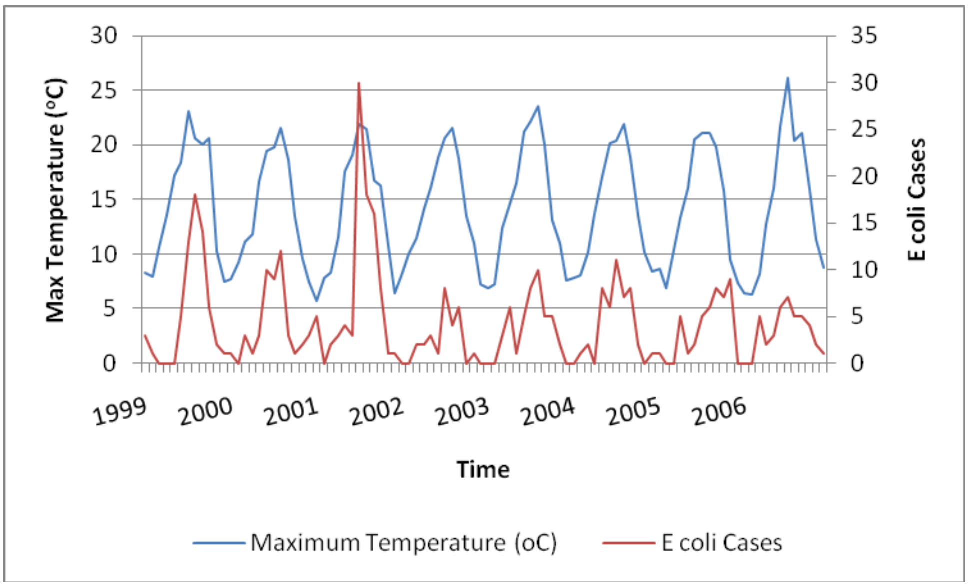

Figure 15: Time series of the number of cases of E coli and the mean daily maximum temperature (1999-2006) in the west Midlands

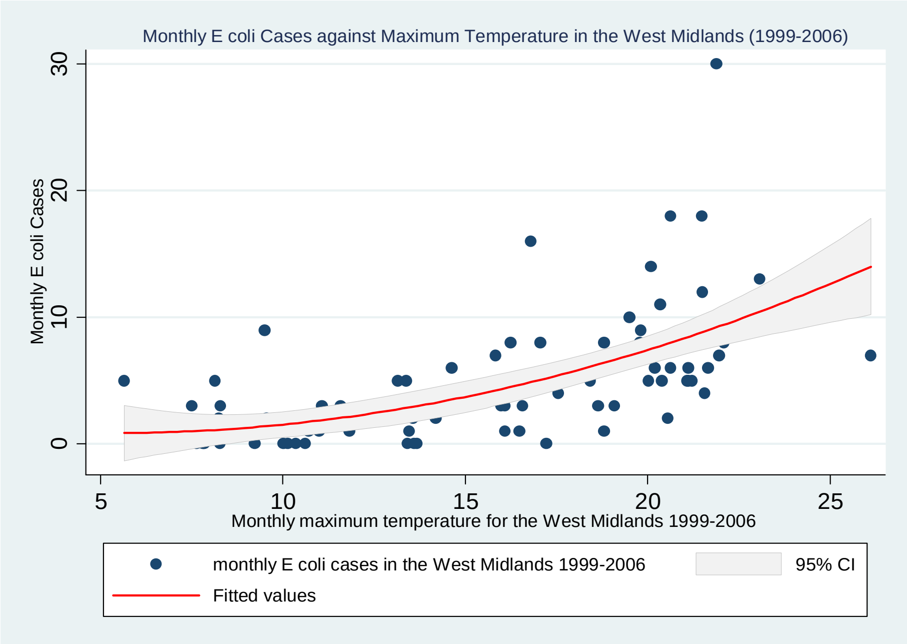

Figure16: Cases of E coli against the mean daily maximum temperature (1999-2006) in the West Midlands

E coli poisoning is not as common as the other food borne diseases however it is very serious so has been considered in this report. The average number of cases per month is 4, however during the warmer months 8 cases occur. During outbreaks (all in summer) there has been as many as 30 cases.

7.2.2. Projections for E coli Cases in the West Midlands (2020s – 2080s)

	Total Number of E coli Cases per Season									
	2001-2008	**2020**			**2050**			**2080**		
		10%	**50%**	**90%**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
Winter (DJF)										
Spring (MAM)										
Summer (JJA)										
Autumn (SON)										

	Number of Excess E coli Cases per Season (baseline = ...cases per season)								
	2020			**2050**			**2080**		
	10%	**50%**	**90%**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
Winter (DJF)									
Spring (MAM)									

Summer (JJA)									
Autumn (SON)									

7.3. Campylobacter

Campylobacter is the most common cause of intestinal bacterial infection in developed countries and affects all ages. In the UK around 50 000 laboratory confirmed cases are reported every year. However, the true community incidence is thought to be much higher with estimates around 8.8 per 1 000 population. Mortality is rare, around 25 per year. Children under 5 years of age present the highest incidence followed by young adults. There is a sharp peak in late spring and early summer. Groups at increased risk are people who work with farm animals, travellers abroad, gay men and family contact of cases.

The recent IPCC report emphasises that increases in daily temperatures will increase the frequency of food poisoning, particularly in temperate regions. In New Zealand a study showed that seasonal variation in Campylobacter levels was evident, with higher median levels detected in summer, when human exposure through recreational water use is maximal. Climate variability on laboratory-confirmed cases of Campylobacter were investigated by study which used 15 populations (Europe, Canada, Australia and New Zealand)All countries showed a distinct seasonality in campylobacter transmission, with many, but not all, populations showing a peak in spring. Countries with milder winters have peaks of infection earlier in the year. The timing of the peak of infection is weakly associated with high temperatures 3 months previously. Weekly variation in campylobacter infection in one region of the UK appeared to be little affected by short-term changes in weather patterns. The geographical variation in the timing of the seasonal peak suggests that climate may be a contributing factor to campylobacter transmission. The main driver of seasonality of campylobacter remains elusive and underscores the need to identify the major serotypes and routes of transmission for this disease.

7.3.1. Past Data for Campylobacter Cases in the West Midlands

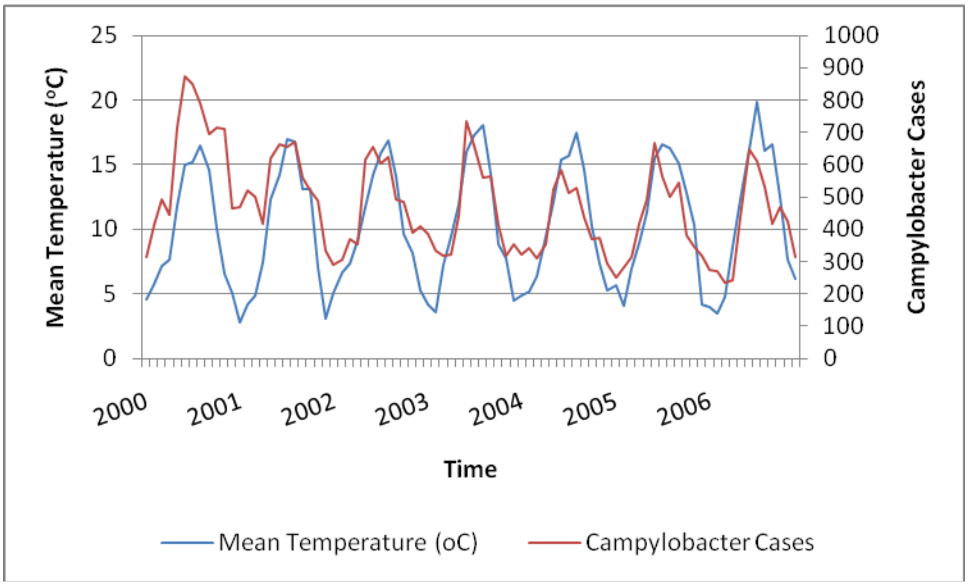

Figure 17: Time series of the number of monthly cases of Campylobacter and the mean daily maximum temperature (1999-2006) in the west Midlands

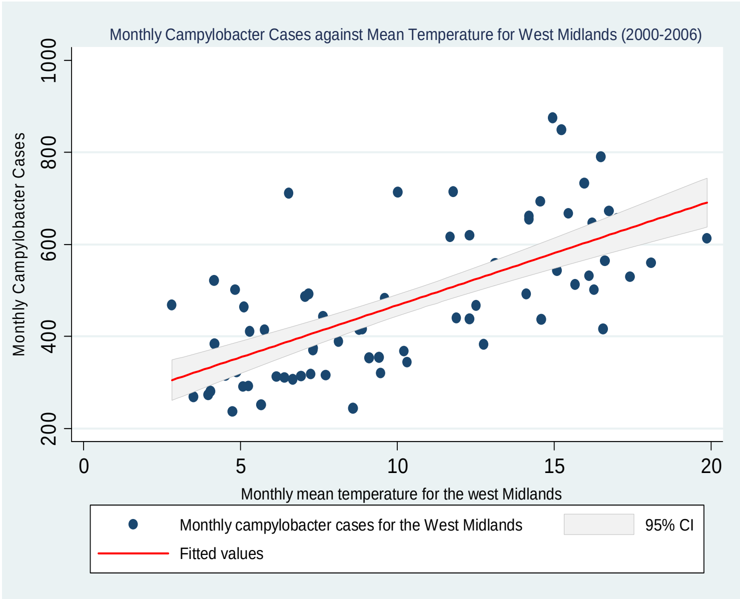

Figure 18: Monthly cases of E coli against the mean daily maximum temperature (1999-2006) in the West Midlands

The average number of campylobacter cases per month is 474, however during the hottest month (07/2006) this rose to 613. The coldest month (01/2001) had 314 confirmed cases.

7.3.2. Projections for Campylobacter Cases in the West Midlands (2020s – 2080s)

	Total Number of Campylobacter Cases per Season									
	2001-2008	**2020**			**2050**			**2080**		
		10%	**50%**	**90%**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
Winter (DJF)										
Spring (MAM)										
Summer (JJA)										
Autumn (SON)										

	Number of Excess E Campylobacter Cases per Season (baseline = ...cases per season)								
	2020			**2050**			**2080**		
	10%	**50%**	**90%**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
Winter (DJF)									
Spring (MAM)									
Summer (JJA)									
Autumn (SON)									

Chapter 8 Other Diseases and Climate Change

8.1. Legionnaires' Disease

We are not sure whether the relationship is strong enough to use in the final report in much detail so we may just mention it. It shows no significant relationship with temperature however it could increase as a result of increased use of air conditioning systems/public showers.

8.1. Meningitis

It looks like the effects will be unpredictable because here Meningitis is more common in winter, where as in places like Africa it is much more common in summer, so a linear trend can't be assumed.

8.3. Norovirus

Not much in literature regarding Norovirus and climate change, however as there is an inverse relationship with temperature; there could be a decrease in cases if winter temperatures increase...?

Chapter 9 UV and Climate Change

9.1. Skin Cancer

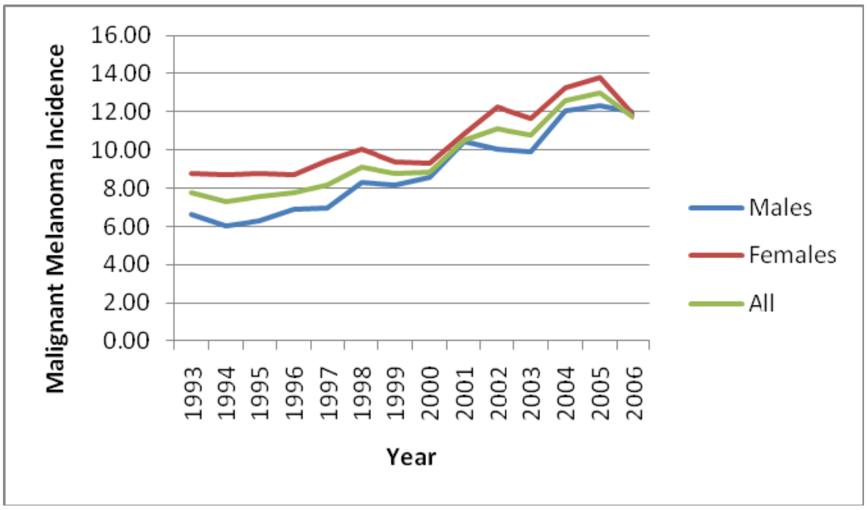

Figure 19: Annual Skin Cancer (Malignant Melanoma) Incidence in the West Midlands Region (1993-2006)

9.2. Cataracts

Very difficult to quantify because of the way the data is recorded (mostly = outpatient procedure). Increases have been suggested from other areas due to increased UV as result of more sunny days.

Chapter 10 Extreme Weather Events and Climate Change

- Windstorms/tornados (?)
- Heat Waves

Weather Generator being investigated for some of these

10.3. Flooding

According to a report by the EEA, the centre of the UK has seen more floods in the last 10 years (5 or >6 events) than the rest of the UK (EEA report), showing that the West Midlands Region is susceptible to such events. During the winter months there is a projected increase in discharge of 10-40% in the West Midlands, while during the summer discharge is set to decrease (EEA report). The Midlands is number 10 in the top 44 priority areas for flooding in the UK, with 22000 properties at risk from surface water flooding, and further risk from fluvial floods (UKCP09). Overall in the West Midlands up to 20% of the land is in a flood plain (reality = much less), however houses at risk from flooding is increased in the south west of the region (Flooding in England).

Flooding is a big issue already in the West Midlands, demonstrated by the fact that 3 of the UK top 10 natural disasters between 1900 and 2009 were flood and affected the Region. All of the floods occurred in last 20 years (EM-DAT, 2008). According the an Environment Agency report, there are currently 1000s of properties at risk, with the highest risk of flooding being in the South West of the region.

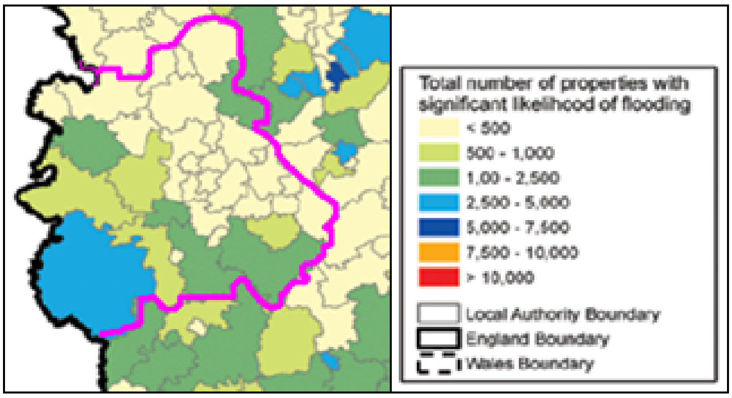

Figure 20: The total number of properties with significant likelihood of flooding (area within pink line = West Midlands). Adapted from Environment Agency 2006, Flooding in England Report (EA 2006). Projected heavier rainfall in the Region in the winter months could increase risk of flooding significantly.

Literature review could be extensive; however information/quantification of specific flood events in the West Midlands area is sparse.

10.3.1. Case Study of Selly Park Floods 6.09.2008

On 6th September 2008 flash floods occurred in the West Midlands region due to unusually heavy rainfall. Over one year later, on 16.12.09, a group of flooded residents from the Selly Park area were interviewed to find out about the effects the flood had on their lives.

The flood waters entered the houses of the residents and ruined many of the ground floor rooms, leading to the majority having to find alternative accommodation for up to 6 months following the event.

Both physical and psychological effects were talked about. Generally it was elderly residents who suffered physically. One suffered from a Stroke 11 months after the flood, suspected to be due to the trauma, while another resident died 3 months after the event. A third resident is still suffering from heart problems – possibly related to stress – and has been unwell since the flood.

Psychologically, the overwhelming symptom was stress. The trauma caused by the loss of property was apparent however the stress related to insurance claims, renovation work and displacement was what seemed to be the biggest issue. On return to their residence many residents felt uncomfortable in their houses and were overly cautious of household appliances and rainfall. Time was taken off work for stress and still, 15 months later, the effects are acute.

Chapter 11 Effects of Climate Change Indoors

Literature review has just been completed by Lorenza.

Will include:

- Indoor conditions in schools
- Indoor air quality
- Indoor temperature (heating and air conditioning)
- Fungal spores
- Dust mites

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To be improved

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