Climate Change and the East Midlands Economy – Executive Summary

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Executive summary

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Executive Summary

Our climate is changing. Increasing temperatures, variations in rainfall patterns and more frequent severe weather events will have diverse impacts on the everyday activities of businesses, organisations and individuals here in the UK. Over the thirty year period 1961-1990, observations of the regional climate suggest that:

- The East Midlands has been a relatively mild region - milder than northern England and Scotland, but cooler than Greater London and coastal areas in the South West and South East;
- Mean annual temperatures have been between 8 and 10°C in the East Midlands. In summer, average temperatures have been between 14 and 16°C. In winter, temperatures have been between 6 and 8°C in the north and east of the region and between 8 and10°C in the south of the region; and
- The East Midlands is one of the driest regions in the UK, with most parts of the region receiving an average of 700mm of precipitation per year, compared to a UK average of 1,101mm.

This review by the Met Office examines the way weather has influenced the economy of the East Midlands region in recent years, and considers how climate change may influence these relationships throughout the 21st century.

Covering the themes of energy, water and flood risk, transport, agriculture, the built environment, tourism and health in the East Midlands, the Met Office has developed an understanding of how these key areas are currently affected by the weather.

Critical issues identified in this report include:

The East Midlands is a major producer of energy, with its coal-fired power stations accounting for 10-15% of the UK's total capacity. From increasing demand in the summer for air conditioning to more frequent flood events and heatwaves, energy production is sensitive to climate change in a number of ways.

Manufacturing is vitally important to the region, accounting for a higher share of employment and output than any other English region. However, it can be significantly affected by the weather, particularly extreme temperatures and flooding – both of which are likely to increase in frequency in future years. Additionally, drought can affect water-dependent sectors (such as printing or food processing) whilst changing temperatures can impact on demand for different products.

The East Midlands is a relatively dispersed region, with a number of nationally important transport routes (e.g. the A1, M1 and Midland Mainline). It also has one of the highest levels of commuting of all English regions, meaning that transport infrastructure is particularly critical to economic activity. Extreme precipitation can cause increases in road traffic incidents, whilst extreme temperatures may degrade road surfaces. The 2007 floods had serious impacts on road transport in the region, causing sections of the M1 to close.

Agriculture and tourism are of key importance to the East Midlands, especially to Lincolnshire and Derbyshire. Agriculture accounts for around three quarters of land use in the East Midlands, and the region accounts for a large share of national high-quality agricultural land, producing a fifth of England's total crop output. Different crops can be affected by different temperature changes. The 2003 heatwave caused an average 20% reduction in yield across Europe, whilst drought can include losses in both crop and livestock. As the East Midlands is already a relatively dry region, warmer, drier summers could have a significant impact on water demand. However, warm weather can increase revenue from tourism, with the summer of 2003 bringing in an estimated £14 to £30 million increase in UK tourism revenue.

Building on the overview of the critical issues for the East Midlands economy and sensitivities to climate change, this study interpreted the 2009 United Kingdom Climate Projections (UKPC09) to better understand the challenges and opportunities for the region. UKCP09 projections were analysed for three overlapping 20-year future time periods, referred to by their middle decade - the 2030s, 2050s and 2080s.

Key regional findings from UKCP09 for the 2050s using a medium emissions scenario[1] include:

- Annual average temperatures rising by between 1.5 to 3.5°C, with a central estimate of 2.4°C, compared to the 1961 to 1990 average;
- Similarly, mean daily maximum temperatures in the summer months could rise by 3.3°C (with a range of 1.3 to 5.9°C) while winter minimum temperatures are also likely to increase by between 0.9 and 4.1°C, with a central estimate of 2.4°C;
- By the middle of the 21st century, seasonal rainfall patterns across the region are likely to have changed. Annual average summer rainfall is likely to decrease by 16% (with a range of -36 to 6%) with increases of 14% in winter rainfall (with a range of 2 to 29%);
- Other climate variables examined include cloud cover and relative humidity, both of which are projected to see small decreases throughout the 21st century; and
- Relative sea level rise by 2100 is unlikely to be less than 25cm or greater than 90cm, with a central estimate of 58cm – although this could be an underestimate due to the complexity of projecting sea level rise.

Combined with an understanding of the sensitivities of the East Midlands' economy to the weather, these projections help *emda* recognise the consequences that climate change could have on the region. The impacts are diverse, but may include heatwaves becoming more frequent, particularly in urban locations. Similarly,

[1] An emission scenario is a plausible representation of the future development of emissions of substances (e.g. greenhouse gases and aerosols) that can influence the global climate. The emissions scenarios used in UKCP09 do not include the effects of planned mitigation policies, but do assume different pathways of technological and economic growth which include a switch from fossil fuels to renewable sources of energy. There are three emissions scenarios used in UKCP09 – high, medium and low emissions (From UKCIP, 2009).

increased winter precipitation and possible enhancement of the intensity of summer rainfall events (despite overall decreases in summer rainfall totals) could, without adaptation, increase flood risk in future years.

Furthermore, by using the Weather Generator, a tool produced by the UK Climate Impacts Programme for use alongside UKCP09, the Met Office were able to explore a number of specific case studies for key locations in the East Midlands. These case studies built upon the findings from the analysis of UKCP09, providing an in-depth look at four possible impacts of climate change on the economy of the East Midlands.

Case study 1

The first case study examined the impact of increased temperatures on health in key urban locations. The Weather Generator was used to investigate the risk of daytime maximum temperatures exceeding 30°C and night time minimums exceeding 15°C for two consecutive days in the future. Nottingham and Leicester were chosen as locations with large urban populations, with possible urban heat island effects, and a rural location in central Lincolnshire was chosen as a comparator.

The results summarise the number of times the threshold is exceeded in a single year during a 30 year time period. This is compared to the number of historic heatwaves between 1961 and 1995[2]. In this period the threshold was exceeded on 4 separate occasions (or 0.1 times a year when averaged over the whole baseline period). In the 2030s the Weather Generator suggested that, irrespective of the emissions scenario used[3], heatwave incidences were unlikely to differ greatly from the baseline. In the 2050s, the number of heatwave incidences may increase, but there is less evidence for an increase in the rural location compared to the two city locations. For the 2080s the distinction between the emissions scenarios becomes much more apparent – with mean heatwave incidences increasing to 1, 3 and 6 times a year for the low, medium and high emissions respectively (but only to 0, 3 and 3 respectively for the rural

[2] To validate the Weather Generator results, runs for 1961-1995 were compared with observed temperatures for the same period. Although observed temperatures demonstrated 4 heatwave incidences over the period, the Weather Generator was unable to reproduce this incidence over the same period (generating no heatwaves). This is because the Weather Generator is likely to underestimate extreme conditions. The results of Weather Generator runs for future periods are compared to the baseline run, and must be interpreted with care.

location). Overall, there is evidence than an increase in heatwaves would be more likely in urban compared to rural environments.

Case study 2

The second case study looked at how changes in temperature may affect tourism, by producing Weather Generator runs for Skegness on the Lincolnshire Coast. The 2003 heatwave provides the precedent in this case, which is estimated to have brought between £14m and £30m in revenue to the UK. One could therefore reasonably expect similar heatwaves in the future to be beneficial for Skegness, as one of the East Midlands' main seaside resorts.

The Weather Generator threshold detector was set to count the number of days that exceeded maximums of 27°C and minimums of 17°C (the hottest day recorded in Skegness in 2003). With the same caveat in mind as the first case study, Weather Generator runs for the 2030s suggested that the number of heatwave occurrences would differ little from the baseline. In the 2050s, the mean of heatwave incidences becomes much larger, on average between 2 and 4 incidences a year (although the uncertainty associated with these estimates is very large). Finally, for the 2080s, the mean estimates are for 3, 7 and 13 heatwaves per year in Skegness for the low, medium and high emissions scenarios. The uncertainty associated with the thresholds is large, since they represent an extreme event that occurs rarely. However, when run again with thresholds set to the average temperature for summer 2003 (rather than the hottest day), the increase in incidences is much higher for all time periods, with frequencies reaching 30, 44 and 54 incidences a year in the 2080s for the three emissions respectively.

Case study 3

The third case study looked at the frequency of extreme precipitation around Derby City, selected as an important location for transport infrastructure and for manufacturing. Two thresholds were investigated in this study – the number of days where precipitation exceeded 20mm and the number of days it exceeded 40mm. Results are provided for both summer (where rainfall is expected to decrease) and winter (where it is expected to increase). In the baseline period (1961 to 1995) the local weather station recorded precipitation exceeding 20mm 24 times in the winter and 48 times in the summer (or 0.7 times a year in winter and 1.4 times a year in the summer), whilst there were no occurrences in excess of 40mm in the winter and only 3 in the summer (or 0.1 per year in the summer). The Weather Generator was able to replicate these incidences fairly closely for the baseline period.

In the 2030s, the Weather Generator runs suggest that the frequency of daily precipitation in excess of 20mm around Derby may increase to an annual average of 0.7-0.8 times in the winter, with no signal that such events will become less likely in the summer. In the 2050s, there is further evidence of an increase in winter precipitation, but still no clear change for the summer. By the 2080s, however, a clear difference becomes evident between the emissions scenarios. Around Derby, winter precipitation events exceeding 20mm per day occur on average 0.9 times per year under low emissions and 1.2 times under high emissions, whereas summer rainfall events exceeding 20mm occur on average 1 and 0.9 times per year for low and high emissions respectively for summer events. For precipitation events in excess of 40mm, there is very little difference between time periods and emissions scenarios, which may suggest that the Weather Generator is less able to predict events of this extreme.

Case study 4

The final case study again looked at precipitation events, but this time in the context of a major transport interchange. The Catthorpe Interchange in Northamptonshire is a key location for the region’s infrastructure, with M1 junctions to the M6 and A14 – the main North-South and East West routes in this part of the UK. Compared to the baseline period (an annual average of 0.3 precipitation events exceeding 20mm in the winter and 0.8 events in the summer), there is little difference in the 2030s. Runs for the 2050s suggest a slight increase in winter events, to 0.5 under medium emissions. Winter events are likely to increase more significantly by the 2080s, to means of 0.5, 0.6 and 0.7 a year for the three emissions scenarios respectively. For all three time periods there is no clear signal for summer events.

This case study also looked at incidences of high temperature, due to impacts on road degradation. The threshold was set for a maximum summer temperature of more than 30°C for two consecutive days. The baseline run showed 0 events for 1961-1995, which is likely to be an underestimate. However, by the 2030s, the Weather Generator suggested that the threshold was likely to be exceeded at least once a year. By the 2050s, this had increased to between 1 and 3 incidences per year. In the case of the 2080s, there is a greater distinction between the three emissions scenarios, with means of 3, 5 and 6 incidences a year for the low, medium and high emissions respectively.

In conclusion

Despite the levels of uncertainty attached to the projections over the long-term, the impacts of a changing climate are likely to be significant and wide-ranging. In summary, differences between the emissions scenarios are generally more limited in the 2030s and 2050s, but become much larger by the 2080s. Under the medium emissions scenario, significant increases in average temperature are likely by the 2050s (a rise of between 1.5 and 3.5°C on current temperatures). The projections also point to drier summers and wetter winters in the 2030s and 2050s, with more significant changes in total annual rainfall by the 2080s. More frequent heatwaves could pose increasing risks to our health. Conversely, higher summer temperatures may attract greater numbers of visitors to our coastal resorts. Declining summer rainfall could result in decreased crop yield, while rising winter rainfall could lead to more flooding and disruption to the East Midlands' economy. This study presents an overview of these and many of the other impacts of climate change in the East Midlands.

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