A Summary of Climate Change Impacts in the West Midlands Combined Authority Area

West Midlands Combined Authority

WEST MIDLANDS Greener Together

About this document

In June 2019, the West Midlands Combined Authority (WMCA) declared a climate emergency and the WMCA Board agreed a target for the region to reach net zero carbon emissions by 2041.

Efforts to reduce carbon emissions look to address the cause of climate change.

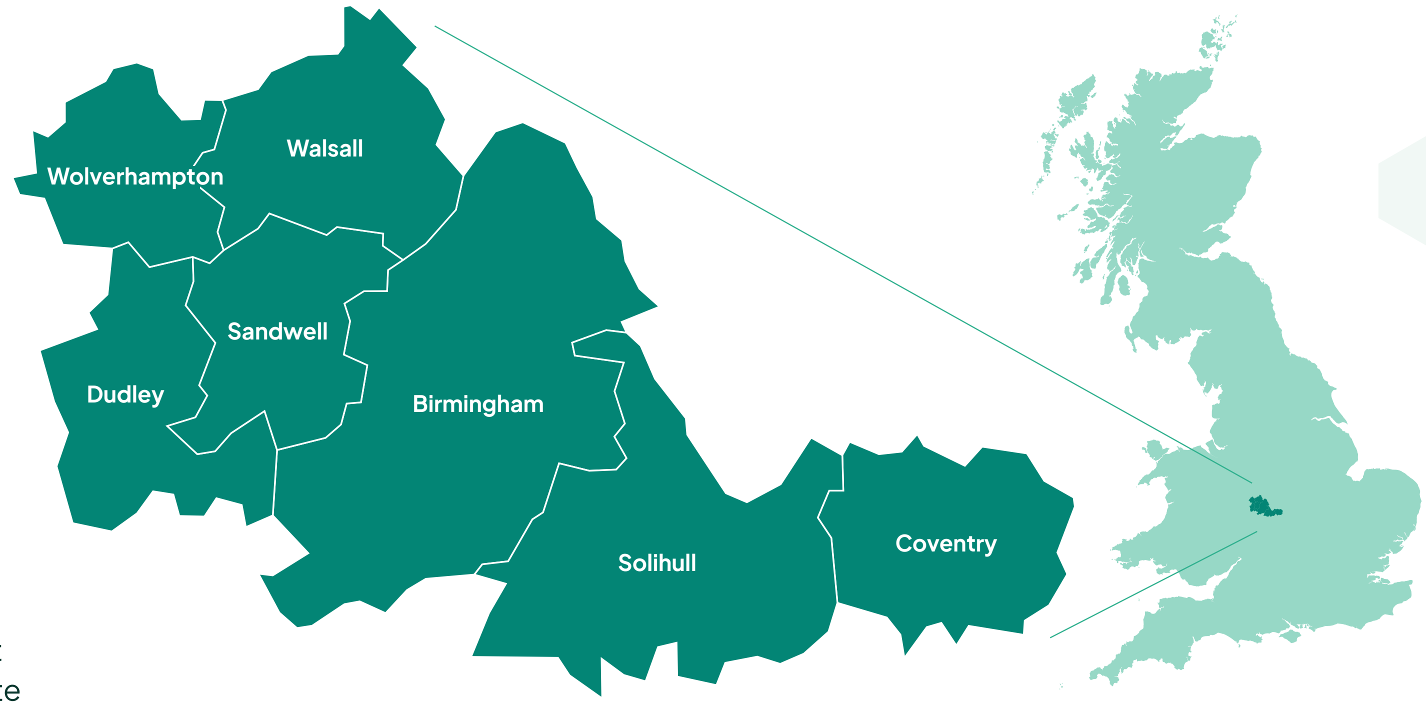
But we also need to be prepared for the impacts of climate change. This is one of the five principles of WM2041: 'we will boost our resilience to climate change'.

This document provides a high-level summary of the climate change scenarios, likely impacts to people, infrastructure and the natural environment and risks across the WMCA area.

The 2022 UK Climate Change Risk Assessment concluded that progress with adaptation policy and implementation is not keeping up with the rate of increase in climate risk, and that the risks to all aspects of life in the UK have increased over the last 5 years.

More adaptation action is required nationally, regionally and locally, and this summary document provides an introduction to climate impacts aimed at encouraging action from across society to make changes that will protect ourselves and simultaneously take advantage of adaptation opportunities.

The majority of the evidence and information provided in this document comes from the UK Climate Change Risk Assessment independent review, the UK Climate Change Projections 2018 and the West Midlands Climate Change Adaptation Plan.



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Introduction

Global view

Our climate is already changing as the planet has warmed by 1.1°C since the Industrial Revolution about 200 years ago.

The global commitment to limit human induced climate change to well below 2°C came in 2015 as part of the Paris Agreement and was adopted by 196 parties. It is agreed that the ideal target is to limit a global temperature rise to a maximum of 1.5°C, compared to pre-industrial levels.

The World Meteorological Organisation (WMO) and the UK's Met Office announced that there is a 40% chance of the average annual global temperature reaching 1.5°C of warming by 2026.

However, despite global policies and efforts, the planet is currently on track for up to 2.9°C of warming by 2100, and only an urgent system-wide transformation can avoid an accelerating climate disaster.

We have already observed more frequent and intense extreme weather events as a result of climate change, causing widespread adverse impacts and related losses and damage to nature and people.

This leads to an array of impacts across water scarcity, food production, health & wellbeing, cities, settlements and infrastructure.

By 2070, around 2 billion people living in some of the most politically fragile areas of the world will be enduring annual average temperature of 29°C.

UK view

In summer 2022 seven Met Office weather stations recorded maximum temperatures in excess of 40°C across England for the first time.

Not every summer will be hotter than the last, but temperature records are expected to be regularly broken, while heatwaves are likely to be longer and happen more often.

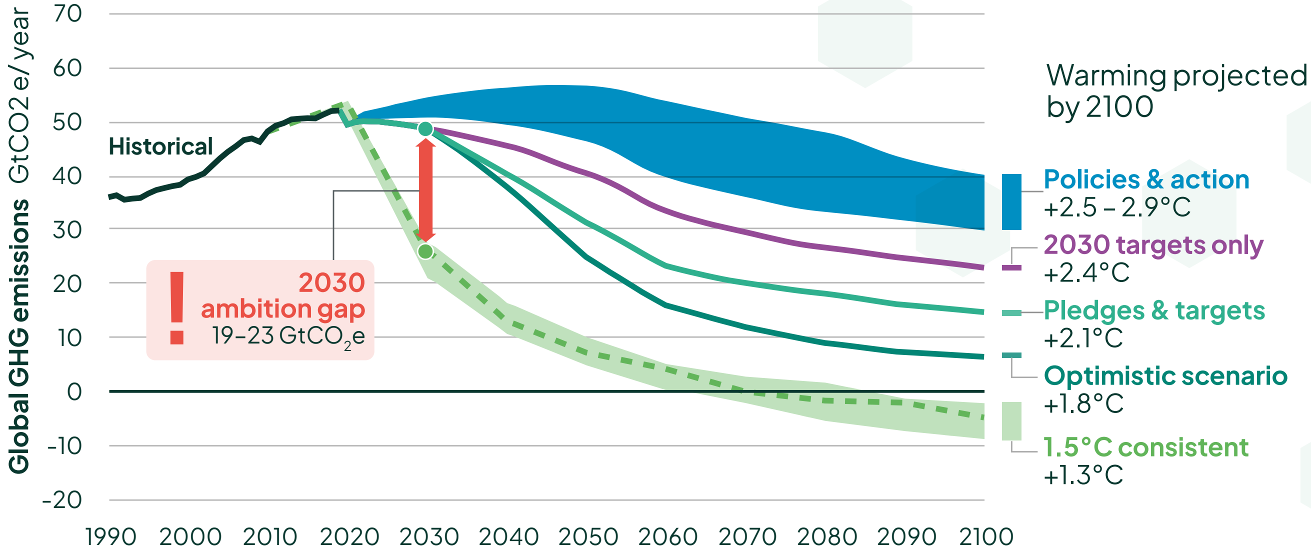
Human-caused climate change has made the chance of 40°C in the UK 10 times more likely when compared with the pre-industrial climate.

As the climate continues to change, the UK is likely to see wetter winters and drier summers, with extreme events happening more frequently. Wildfires are set to increase by 50% by 2099, and severe flooding events will become the new normal without sufficient adaptation.

Climate change is affecting us now and we need to prepare for it, to prevent significant consequences across society, infrastructure and the natural environment.

2100 WARMING PROJECTIONS

Emissions and expected warming based on pledges and current policies



Adaptation will be more successful if action is taken within the next decade, especially if this is underpinned by supporting action taken on decarbonisation measures. Adaptation investment also has the opportunity to not only protect us from climate impacts, but to provide multiple benefits across society, for our health, economy and environment. This is especially true where we use nature-based solutions to minimise risks from overheating, flooding and droughts. Section 3 covers adaptation in more detail.

It is therefore important that organisations and people across the WMCA understand what climate impacts mean for them, to begin to implement the plans and action required to adapt.

1. Climate Projections

The UK Climate Projections (UKCP18) are scientific projections made by the Met Office using a range of tools designed to help decision-makers assess their risk exposure to climate.

The UKCP18 data provides updated observations and climate change projections up to 2100 in the UK and globally.

Appendix A provides further information on the science behind the Climate Projections and detail on the climate parameters (temperature/ precipitation/ wind/ humidity/ cloud cover). It also highlights the range of possibilities provided by the latest UKCP18 from the Met Office.

This page presents some headline figures taken from the Met Office for the year 2021.

This year has been chosen as at the time of writing it was the most recent 'State of the UK Climate' report that had been published.

- 2021 was warmer than all but one year between 1884 and 1990.
- UKs ninth warmest summer
- Winter and spring colder than the 1991 – 2020 average
- 3rd warmest autumn
- All the top 10 warmest years for the UK since 1884 have occurred this century
- Air frosts and ground frosts highest on record
- Sunniest April on record
- 2021 was the 5th driest April and 2nd wettest May
- The 21st century so far has been warmer than any period of equivalent length from the last three centuries

1.1 Projected Climate

Overall, the West Midlands is experiencing changes to the climate and these are projected to become more significant over time. As our climate warms, it is anticipated that weather events will become more extreme.

For **temperature**, minimum, maximum and monthly average are all set to increase across both summer and winter. Maximum temperatures could be between 2.9°C and 7.5°C warmer than the baseline period (1981–2000) by 2099. Average maximum temperatures are taken both spatially and over a specified time period. It is important to note that average maximum temperature does not reflect extreme values (e.g. highest daily temperature). This change gives a potential average maximum temperature of 23.1°C-27.7°C over summer.

However, extreme temperatures are likely to exceed this as experienced when the 2022 heatwave reached 40.3°C in England.

The predicted increase in **rainfall** ranges from 7% to 24% (winter) by 2099 depending on emissions. Across the average winter months, the projected rainfall is 244mm. A typical 'wet day' is a day that has 1mm of rainfall or more. This is countered by much drier summers, 31% less rainfall than the baseline over the summer period. Projections suggest significant increases in hourly rainfall extremes, particularly in the autumn.

Changes to **cloud cover and humidity** are likely to have less obvious but still key impacts across the UK. Ecosystems are likely to drastically change with increased humidity, and it will also have an influence on the levels of precipitation. Cloud cover also provides a key barrier for sun exposure, and a fall in cloud cover can contribute to lower precipitation levels and in some instances higher temperatures.

Baseline 2050 2099	Best-Case Scenario (RCP 2.6)		Worst-Case Scenario (RCP 8.5)	
	Summer	Winter	Summer	Winter
(Avg. temp.)	15.4°C 1.7°C warmer 2.3°C warmer	4°C 0.9°C warmer 1.2°C warmer	15.4°C 2.1°C warmer 6.5°C warmer	4°C 1.6°C warmer 4°C warmer
(Avg. precipitation)	171mm 17% drier 25% drier	195mm 4% wetter 7% wetter	171mm 23% drier 42% drier	195mm 7% wetter 24% wetter
	4% less cloud cover 10% less cloud cover	Little change	4% less cloud cover 21% less cloud cover	Little change
	7% more humid 9% more humid	8% more humid 8% more humid	9% more humid 26% more humid	11% more humid 31% more humid

Table 1.1: Climate Projections Summary for the West Midlands against baseline period 1981–2000 (see Appendix A for more detail).

2. Climate Impact Assessment

In July 2022, a Red Extreme heat warning was in place for much of England (including the West Midlands) and Wales. The Met Office noted 'likely adverse health effects for the public, not just limited to those most vulnerable to extreme heat.'

The result was three new highest daily maximum temperatures in England (40.3°C), Scotland (35.1°C) and Wales (37.1°C). This led to fires, travel disruption, health warnings, water shortages, damage to property and infrastructure and even excess deaths. The increase in severity of the extreme heat events is already clear in the observed record. The increase in frequency, duration and intensity of these events over recent decades is linked to the observed warming of the planet. As part of the Red Extreme heat warning, key impacts were shared to spread awareness.

These impacts included:

- **Adverse health effects for those vulnerable to heat (incl. heat exhaustion and other heat related illnesses)**
- **Failure of heat-sensitive equipment**
- **Possible loss of electricity, water supplies and gas**
- **Disruption to travel**
- **Increased congestion**
- **Risk of water safety incidents.**

These impacts only relate to extreme heat, but there are a large range of impacts across multiple climate parameters, such as those described in Section 1. The global change in melting ice and sea level rise is going to have a knock-on impact across food security, health, the environment and sustainable development.

The 2022 UK Climate Change Risk Assessment noted that reducing climate impacts requires both emissions reduction (mitigation) and adaptation. It concluded that progress with adaptation policy and implementation is not keeping up with the rate of increase in climate risk, and that the risks to all aspects of life in the UK have increased over the last 5 years. This section explores those impacts across a range of climate parameters detailed in Section 1. This assessment has been produced for three key focus areas:

- **People**
- **Infrastructure**
- **Natural environment**

Three focus areas

The impacts from climate change will affect all parts of the world, which is likely to have knock on impacts for the global economy. This section tailors those impacts for the WMCA across the three focus areas:

People

The impacts on people will review how different aspects of society may be affected, including the identification of vulnerable groups and inequalities.

Infrastructure

The infrastructure section will look at damage to physical assets from climate change, explicitly across transport, housing, health, education and water and the potential knock-on effects on businesses and the economy.

Natural Environment

The natural environment section reviews how climate change will impact biodiversity, habitats, soil health and the potential knock-on effects to natural capital that society is dependent upon (e.g. agriculture).

There are risks to productivity, supply chains and distribution networks. Financial systems are starting to recognise the importance of climate change and disclosure of risks, but there is still limited action being taken to help address these risks.

By understanding the risks, improving the evidence base and investment into climate adaptation, these impacts can be reduced.

2.1 Impact Assessment Process

The climate impact assessment uses a range of sources to help understand how the projected climate parameters in Section 1 will affect the seven constituent local authorities that make up the WMCA. To contribute to the WMCA's climate risk assessment, a total of **58** datasets have been identified from multiple sources. These datasets cover the categories outlined in Table 2.1 and help inform the impact assessment by allowing measurement of each impact identified.

Social	Infrastructure	Natural Capital
• Indices of Deprivation • Employment • Population for Vulnerable Age Groups • Utility Usage • Housing Stock	• Public Buildings • Transport Infrastructure Assets • Energy Infrastructure Assets • Education Assets	• Flooding Zones/ Flood Defences • Land Designations • National Forest Inventory • Climate Change Vulnerability • Agricultural Land Classification • Biodiversity and Climate Regulation Classification

Table 2.1: Categories used for differentiating datasets

Some impacts will have knock-on effects across multiple parts of the region's infrastructure, some of which are interconnected and could therefore result in cascade failure. Further, how places beyond the West Midlands respond to climate change will also have an impact on how successful the region is in tackling its own challenges; collaboration with others will therefore be essential for delivery of measures.

Datasets

A high level assessment has been completed to highlight how different locations in the WMCA area are vulnerable to different risks. A more granular assessment would be required to understand precisely where these impacts are at street level. The mapping has relied on being able to access datasets from multiple organisations. These are listed in subsequent tables as **'quantified data'** and used in the mapping. A low-risk rating does not indicate an absence of risk – it just highlights that the risk is less significant/ prevalent than risks elsewhere in the area. There are also impacts that will be felt from climate change where the data does not exist, or was not available for mapping for this project. These impacts are still important to highlight and have been included as **'qualitative data'** in this report. For more detail on methodology please see Appendix A'

2.2 Impacts on People

The impacts of climate change on people are far reaching. With the WMCA region being home to just under 3 million people, it is imperative that the places where the most vulnerable people live are considered for adaptation measures. These communities are typically more vulnerable and less able to prepare, respond and recover from shocks to their daily lives, such as extreme weather events. Birmingham was recently ranked 1st, with Coventry ranked 14th, in a study examining the greatest number of priority neighbourhoods for heat adaptation. There is an urgent need to identify at risk areas so that actions can be appropriately identified. To focus efforts and understand these impacts in more detail, the impacts on people have been split into two areas:

- **Demographics; and**
- **Health & Social Care.**

The qualitative data for the climate change impacts on people in the West Midlands is shown in Table 2.2. This includes impacts around water resources, energy demand and disruption to communication and information technology and these should be considered alongside the quantitative assessment. The impacts that could be quantified, and therefore mapped, are broken down in Table 2.3.

Climate Parameter	Impact
Decreased precipitation	• Increased water scarcity, disproportionally impacting more deprived areas with greater pressure on health and care services.
Increased temperature	• Disruption to accessing and using infrastructure services, affecting public connectivity and resulting in isolated communities • Milder minimum temperatures can increase the intensity and impacts of nocturnal urban heat island within the WMCA. • High rise buildings and mobile homes are susceptible to overheating as a result of increased air temperature.
Increased temperature/ humidity	• Disruption in delivery of public services, such as education. • Reduced quality of life and wellbeing, due to overheating and strain on health and social services.
Increased humidity	• Reduced indoor air quality, having greater implications for the elderly.
Increased humidity/ precipitation	• Increased moisture inside homes can cause damage to health (e.g. damp).
Decrease in cloud cover	• Increase in sun exposure.

Table 2.2: Non-measured (qualitative) impacts to people from the changing climate

Measured impacts

Climate Parameter	Impacts
Decreased precipitation	• Increased water scarcity causing higher demand and raising water prices, affecting access for lower income households.
Increased average air temperature & humidity	• Health impact of heatwaves on people with pre-existing vulnerabilities. (E.g. heat deaths) • Increased health inequality due to extreme climate factors e.g., worsened air quality. • Excess heat mortality associated with temperatures above an average of 24.5°C or more for five or more days over the summer period.
Increased average air temperature	• Changes to the pattern of peak electricity demand increasing energy prices, putting lower income households at financial risk.
Increased precipitation	• Displacement of people and communities due to extreme weather events e.g. flooding.
	• Increased financial damages associated with costs from flood damage repair, particularly affecting lower income households. • Increased health inequality due to increasingly extreme climate factors e.g., vulnerability to flooding.
	• Extreme events and changing climatic conditions such as flooding affecting health assets, reducing access to the public for receiving adequate health & social care service delivery.
Increased average air temperature, humidity & precipitation	• Widening health inequalities (e.g. on more vulnerable people) as a result of greater climate disadvantage due to more extreme weather.
Increased temperature & reduced air quality	• Overheating of domestic properties causing health hazards (e.g. heat exhaustion). • Widening inequalities (e.g. those that rely on public spaces for outdoor areas) relating to a lack of access to urban green space. • Increased urban heat island effect, greater reduction in air quality and decreased quality of life for vulnerable communities.

Table 2.3: Measured impacts from Climate Change on demographics, health & social care

Economic risks and impacts

The impacts of climate change on the population are also likely to impact the local economy, affecting businesses and industry. These could include:

- Increases in climate-related **health problems** affecting productivity.
- As our population grows more people will be deemed vulnerable to climate impacts, resulting in a strain on **health and social care resources**.
- **Income inequality** may grow as access to utilities such as water and energy become more expensive (to cope with damaged infrastructure) which will particularly affect those already on a low-income.

Benefits or adaptation opportunities

There may also be some benefits or opportunities for people associated with climate change impacts and adaptation. These could include:

- Higher average temperatures in winter could reduce general population vulnerability to **cold-related health implications**.
- As well as reducing the risks from cold, there could be **health benefits** from warmer temperatures that would in turn also reduce disease burdens on the health and social care system.
- Warmer winters may also cause some **financial relief** as a result of reduced energy bills.
- Adapting buildings and places to support people's resilience during extreme weather can provide **all year round benefits**, including better access to green space, improved air quality and physical and mental health.

People: Climate Vulnerability Hotspots

The quantifiable data in Table 2.3 above have been combined with data on where some of the region's most vulnerable communities live (using the Indices of Multiple Deprivation - IMD). This has produced a map showing climate vulnerability hotspots (Figure 1).

Figure 1 shows how people's risk exposure to climate change is different across the region:

- The five very high-risk areas (C2, D2, D3, F5 and G3) are in urban areas (the confluence between Sandwell, Wolverhampton and Walsall, and Central Birmingham) with high levels of deprivation, a high level of flood risk and contain a high relative proportion of the vulnerable population to the impacts of climate change. However, despite their urban location in Coventry grids K1, K2, K3, L1, L2 and L3 performed well in the assessment, with a relatively lower risk to people from climate change. This is mostly due to a relatively high IMD value, lower average energy usage and a lower number of health assets at risk from flooding.
- The 14 grids in the very low risk category (A1, C6, F3, G1, H1, H5, H6, I5, J1, J2, J3, K1, L3 and N2) are all located outside of urban centres with an absence of characteristics such as flood risk and high proportion of vulnerable people.
- Suburban grids are mostly at medium risk, with a diverse range of impacts revealed through the assessment (e.g. contrasting flood risk vulnerabilities and differences due to the effects of heatwaves on different areas places and people).

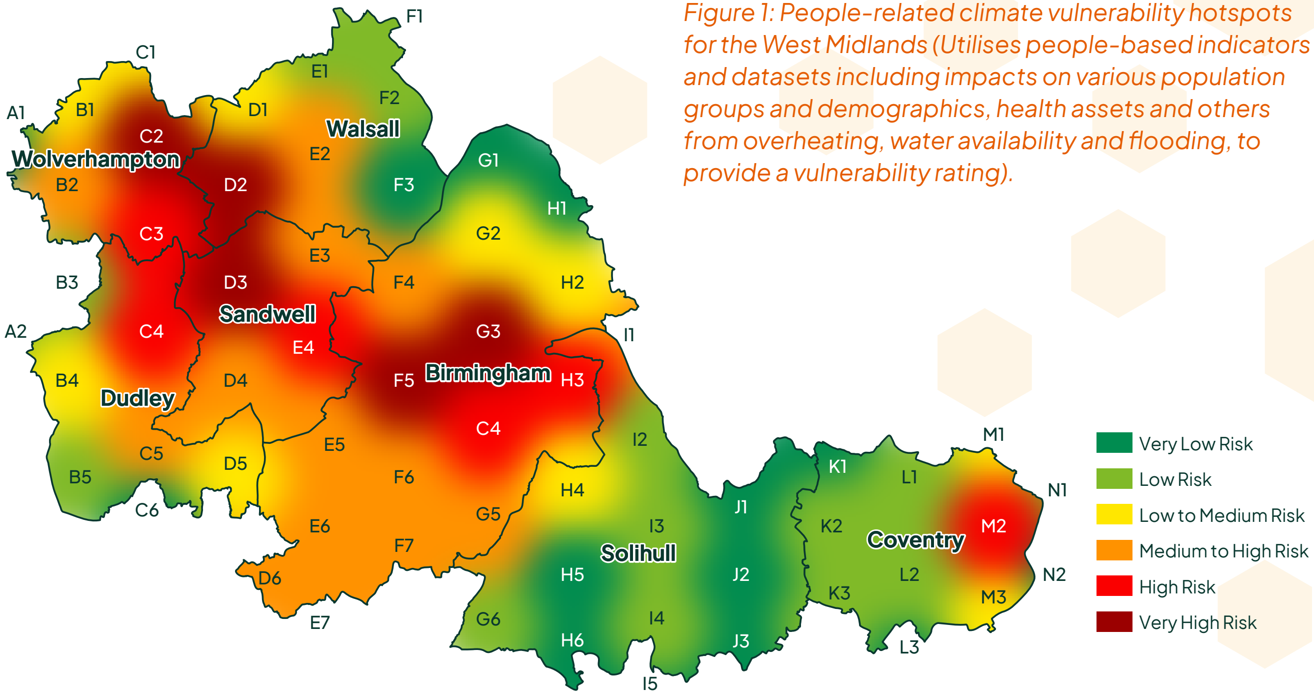


Figure 1: People-related climate vulnerability hotspots for the West Midlands (Utilises people-based indicators and datasets including impacts on various population groups and demographics, health assets and others from overheating, water availability and flooding, to provide a vulnerability rating).

2.3 Infrastructure Impacts

Infrastructure delivers services that can help drive economic growth, support jobs, increase people's safety and improve quality of life. It is an integral part of society, and encapsulates transport, housing, education and health assets, energy systems, access to water, telecoms and information technology.

All infrastructure sectors are connected, meaning that vulnerabilities on one network can cause problems for others, and impact beyond the infrastructure system itself, affecting the economy, health and wellbeing.

The infrastructure sector needs to adapt to deal with the changing climate, both for existing and new assets. Due to the physical nature of assets, it's the most measurable across the three topics in this study.

To help identify the impacts across key areas of infrastructure, they have been split into 5 areas (housing, public buildings, energy, transport and water).

These impacts are mostly related to physical damage to assets, but the available data was unable to ascertain or identify the vulnerable assets. That can be from overheating, reduced water availability or from issues with the interdependency of assets.

The impacts that could be quantified, and have therefore been mapped, are shown in Table 2.5.

Non-measured (qualitative) infrastructure impacts

Climate Parameter	Impact
Decreased precipitation	Buried infrastructure such as underground cabling damaged by subsidence.
	Disruption to supply of energy (e.g. Hydroelectric power output disruption in the UK leading to greater pressure on the energy network, due to changing river flows)
	More frequent power shut offs of energy infrastructure as a required safety response to drier weather and higher temperatures causing sparking or wildfire risk.
	Reduced water availability for generation plants as a result of climatic changes.
	Reduced water availability reducing output of thermal power generators.
Decreased precipitation & increased temperature	Greater incidence of extreme weather affecting service delivery and building function.
Decreased & increased temperature	Summer and winter temperature changes potentially reducing heating need but increasing cooling need.
Increased temperature	Cascading failure of the infrastructure network; failure of one system leading to multiple failures in others as a result of more extreme weather, including heatwaves.
	Data/broadband and other telecom centre failures due to overheating.
	Failures of infrastructure assets such as energy systems, transport, and ICT.
	Heatwaves impacting IT and communications services causing freight and travel delays.
	Increase in costs for maintenance and reconstruction of urban infrastructure associated with extreme weather events weather, including heatwaves.
Increased precipitation & increased temperature	Slope and embankment failure affecting transport networks.
Increased precipitation	Disruption to infrastructure services associated with fluvial flooding and erosion.
	Bridge collapse causing significant disruption to transport, particularly in rural areas.
	Failures of water infrastructure assets.
	Flooding of water treatment facilities leading to reductions in water quality.
	Risks to buried infrastructure, such as water pipelines, with damage potentially becoming more frequent in future due to flooding and subsidence.

Table 2.4: Non-measured (qualitative) infrastructure impacts from the changing climate

Measured (quantitative) impacts on Infrastructure

Climate Parameter	Impacts
Increased precipitation	• Damage to domestic properties due to flooding, compounded by increased development on greenfield sites, increasing floodwater runoff. As a result, there will be an increase in costs for maintenance and reconstruction of urban infrastructure associated with extreme weather events. • Potential damage caused by moisture, wind and driving rain.
	• Greater frequency and extent of flooding as a result of climatic changes. • More frequent and extensive river, surface water and groundwater flooding. • Damage to assets from flooding, including areas of shelter/ refuge and education facilities.
	• Extreme events and changing climatic conditions such as flooding affecting health assets, reducing ability to serve public needs through health and social care service delivery.
	• Disruption to power stations due to flooding. • Failures of infrastructure assets such as energy systems and ICT. • Flooding of electricity substations disrupting air travel.
	• Flooding of transport infrastructure and hubs, resulting in travel and freight delays, accidents and impacts on emergency services. • Greater incidence of extreme weather affecting service delivery, building function, business supply chains and distribution networks. • More frequent flooding and severe erosion of infrastructure. • Potential damage to infrastructure caused by moisture, wind and driving rain.

Table 2.5: Measured (quantitative) impacts from Climate Change on Infrastructure

Risks, Impacts and Adaptation

Understanding the potential threat of the impacts to infrastructure is important to provide sufficient adaptation. The trends, risks and impacts extracted from this assessment echo the findings of the Climate Change Committee, indicating that disruption to infrastructure networks from extreme weather can have significant implications not just for economic activity, but societal equity, health and wellbeing more generally. Networks are also vulnerable to increased degradation and reduced performance over time as a result of long-term changes in climate.

Economic risks and impacts

The impacts of climate change on infrastructure are likely to affect the local economy, its businesses and industry. These could include:

- Local **energy** providers may suffer from infrastructure failure. It has been estimated that the total economic loss resulting from the failure of five electricity substations to be around £27 million per day.
- Damage to local **transport** such as railway lines, bridges, and roads, will cause economic losses to infrastructure providers and may place increased stress on alternative public transport services.
- The **aviation** industry may be affected by weather-related infrastructure failure.
- Failure of infrastructure may cause disruption to **supply chains**, affecting business costs directly as well as indirectly such as through lost production time.
- Infrastructure belonging to **local businesses** may be vulnerable to increased flood risk, as well as other extreme weather events. Present day expected annual damages to non-residential properties across the UK average around £670 million.
- Businesses may be affected by water scarcity. It is estimated that 1 billion litres of water are used by businesses in England each day for cooling and heating, washing products, dissolving chemicals, suppressing dust, and as a direct input to products.
- Risks to **finance, investment and insurance** either from physical risks (e.g. weather-related insurance claims) or from transition risks (as the economy shifts towards a greener economy).

Adaptation opportunities

There may be some infrastructure opportunities associated with adaptation to climate change impacts. These could include:

- A demand for innovation to develop more climate resilient infrastructure, creating a **local economic opportunity** for infrastructure providers.
- Retrofitted homes and buildings will create a cost benefit over time as improved insulation may **reduce energy demand**, causing lower utility bills for consumers and lower carbon emissions.
- Creating climate resilient infrastructure could help to reduce the local technology gap by upgrading IT to a unified standard. For example using common formalised standards of resilience across different infrastructure sectors including the energy sector will help to build systemic resilience across the whole infrastructure system.
- **Nature based solutions**, or green infrastructure, provides benefits for people, the environment and the economy.

Infrastructure: Climate Vulnerability Hotspots

Figure 2 shows the outputs of the infrastructure impact assessment and disparities in the distribution of impacts, based on the quantifiable measures identified in Table 2.5. These impacts can be summarised as follows :

- There are 7 very high-risk areas (D2, E2, E3, F4, F6, G3 and M2) and 9 high risk areas (C2, C4, C5, D3, F5, G2, H2, I3 and I4) which are areas with high densities of infrastructure vulnerable to flooding, ranging from transport assets to energy infrastructure.
- In contrast, the 12 grids in the very low-risk category (A1, C6, E5, F1, H1, H6, I5, J1, J3, K1, L3 and N2) contain similar characteristics of low overall flood risk in areas that may be combined with either a lack of transport, energy, health and public infrastructure. The locations of these very low risk areas are all on the outskirts of the WMCA, in primarily rural areas.

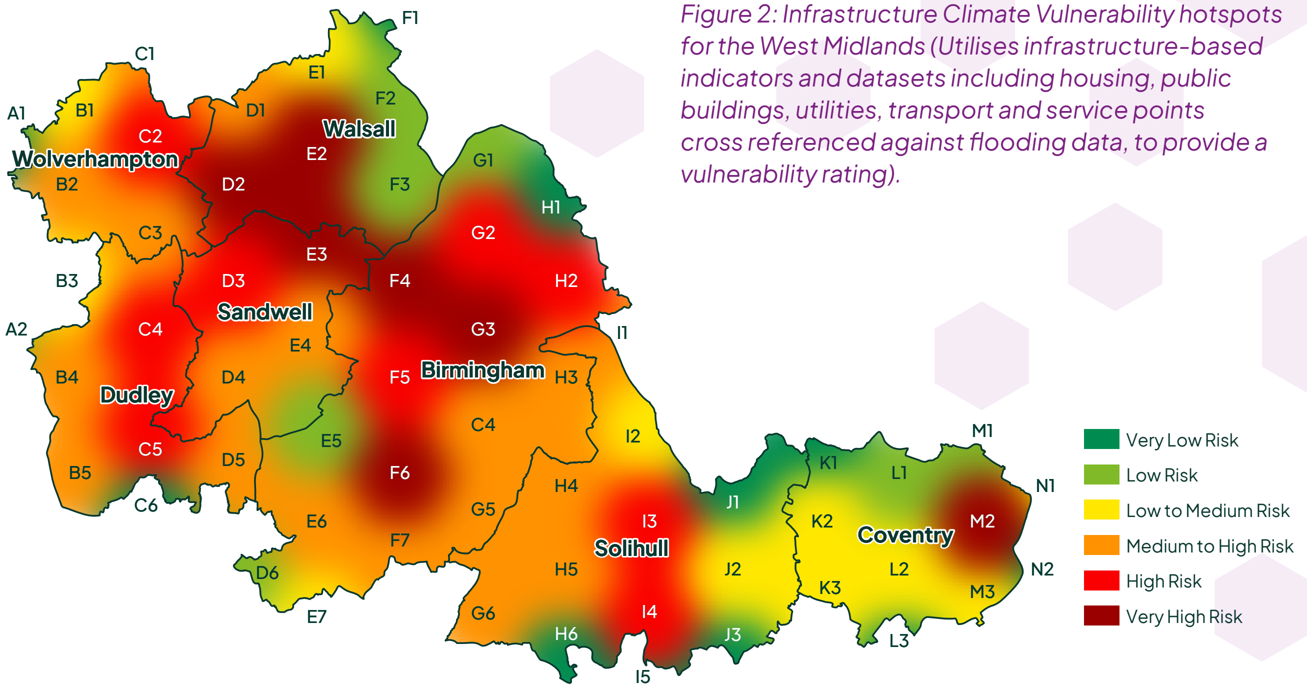


Figure 2: Infrastructure Climate Vulnerability hotspots for the West Midlands (Utilises infrastructure-based indicators and datasets including housing, public buildings, utilities, transport and service points cross referenced against flooding data, to provide a vulnerability rating).

2.4 Natural Environment Impacts

Climate change has the potential to have significant impacts on our natural environment. England is one of the most nature-depleted countries in the world due to its long history of industrialisation and land use changes over millennia. Green infrastructure is integral to help combat the impacts of climate change, whether it's reducing the urban heat island effect, improving air quality, improving soil and water quality, providing carbon storage, acting as flood management or for improved well-being. The WMCA contains a number of statutorily protected ecological sites such as Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs) and Local/National nature reserves (LNRs). These are considered to be of at least national, and in some instances international, importance. Further to this (and not always recognised by statutory designations) are sites and habitats of regional and local importance, as well as areas that may be important or critical for populations of fauna and flora. Protecting these natural assets from the impacts of climate change is vital to avoid the decline and/or alteration of these sites, and where possible, support the recovery of nature.

To understand the impacts to the natural environment in more detail, the impacts from climate change have been split into two areas. The qualitative assessment of impacts, that was not available for mapping, is included in Table 2.6. These impacts are around water resources, agricultural land, and destruction to habitats from wildfires. The impacts on the natural environment from climate change are likely to be wide-ranging, so this section does not cover some of the key interdependencies between ecosystems, for example soil moisture and disruption to ecosystems from seasonal changes. The quantitative data, which was of sufficient quality for mapping, is included in Table 2.7.

Climate Parameter	Impact
Decreased precipitation	Productivity losses from reduced soil health and water degradation. Natural habitats will be impacted on wetlands where seasonal drying will become much more frequent and extensive, impacting surface water and groundwater fed ecosystems.
Decreased precipitation & increased temperature	Wildfires causing destruction to habitats and drying out of water dependent habitats and species.
Increased temperature	Decrease in snowmelt water availability for irrigation.
	Increase in pests, pathogens and invasive species.
Increased precipitation	Riverbank erosion from rising sea/river levels.
	Disruption of agricultural practices and business due to increased groundwater salinity from saltwater intrusion and eutrophication.

Table 2.6: Non-measured (qualitative) Natural Environment impacts from the changing climate

Measured (quantitative) impacts on Natural Assets

Climate Parameter	Impacts
Increased temperature	• Risks to natural carbon stores, freshwater species, habitats and sequestration, causing destruction and release of locked-in carbon. • Extreme events and changing climatic conditions damaging biodiversity and resulting in further water scarcity, wildfire and flooding. • Biodiversity loss in terrestrial and freshwater ecosystems.
	• In areas which are predominantly urban, green infrastructure (e.g. parks) is vital for both providing habitat corridors for nature and barriers to land-use change - the damage to these through the impacts of climate change can result in habitat fragmentation (resulting in knock on impacts to flora and fauna), and increase the urban heat island effect.
	• Changing climatic conditions, including seasonal aridity and wetness causing an impact on soil health. • More frequent downstream estuarine flooding, leading to changes in salinity and impacts on species migration within the West Midlands. • Negative impacts on cultural heritage due to changes in temperature, groundwater and landscape change (e.g. parks, gardens and designed landscapes).
Increased precipitation	• Biodiversity loss in terrestrial and freshwater ecosystems.
	• Risks to soil health from increased flooding.
	• More frequent downstream estuarine flooding, leading to changes in salinity and impacts on species migration within the West Midlands. • More frequent and extensive river, surface water and groundwater flooding leading to a greater water pollution risk.
	• Changing climatic conditions, including seasonal aridity and wetness. • More frequent downstream estuarine flooding, leading to changes in salinity and impacts on species migration within the West Midlands. • Negative impacts on cultural heritage due to changes in precipitation, groundwater and landscape change (e.g. parks, gardens and designed landscapes).
Decreased precipitation	• Extreme events and changing climatic conditions damaging biodiversity and resulting in further water scarcity, wildfire and flooding. • Biodiversity loss in terrestrial and freshwater ecosystems.
	• Higher water temperatures and scarcity of water due to lower precipitation
	• Increased food insecurity due to agricultural failure associated with high temperatures and drought.
Increased humidity	• Biodiversity loss in terrestrial and freshwater ecosystems.

Table 2.7: Measured (quantitative) impacts from Climate Change on Natural Assets

Risks, Impacts and Adaptation

The trends extracted from this assessment align with the conclusions of the Climate Change Committee, suggesting there is a clear rationale for ensuring action is taken now to build the resilience of the natural environment, so it is more able to accommodate change in the future.

Economic risks and impacts

The impacts of climate change on the natural environment are likely to knock on to the local economy, affecting businesses and industry. These could include:

- The **agricultural** sector will likely see changes in water availability for crops but also increased flooding and possible loss of crop or reduced productivity due to shorter seasons. This, alongside changing average temperatures, could affect the success of certain crops, and adaptation to new farming methods may be costly. Farmers may also see economic losses as a result of higher temperatures causing crop failure.
- Changes to **soil conditions** are likely due to heavier rainfall events. The current rate of erosion is estimated at 2.9Mt per year in England and Wales with losses in productivity estimated at £40m per year.
- The growth of **invasive non-native species** (INNS) as a result of changing weather patterns has been estimated to cost the UK economy £1.7 billion a year.

Adaptation opportunities

There may also be some natural environment opportunities associated with climate change impacts and adaptation. These could include:

- Changes to the local climate may provide opportunities for **opportunistic species** (species that are not necessarily compatible with certain habitat types) to become established and thrive.
- Whilst there is likely to be impact on traditional crops, warmer average temperatures will create **ideal growing conditions** for certain crop species that are currently primarily imported, increasing local species biodiversity. This may also have secondary economic benefits for the local agriculture and farming sector.
- **Nature based solutions** provide many opportunities to both tackle climate change, but also support nature recovery and provide people with physical and mental health.

Natural Environment: Climate Vulnerability Hotspots

Figure 3 highlights the disparity in the distribution of climate change impacts on the natural environment across the WMCA area and highlights disparity in the distribution of impacts across the WMCA. These impacts can be summarised as follows:

- There are 4 very high-risk areas (B4, C2, D2 and M2). These habitats are highly vulnerable to climate change, affecting urban green infrastructure, susceptibility to the impacts of climate change on food security, with a high risk to soil health.

- The 13 grids in the low-risk category (A1, C6, E5, F1, F3, F6, G1, H1, J3, K1, L2, L3 and N2) highlight two main groups. From a people perspective the group of grids which are primarily in urban areas are affected by the potential impacts of food insecurity and the equivalent rising prices. Those in suburban areas contain habitats that may be vulnerable to climate change, as outlined in Table 2.7.

- Although there are few grids at very high risk , there are 14 grids which show there is a high-risk to the natural environment from climate change. These are in four identifiable locations: the interface between Dudley, Sandwell, Wolverhampton and Walsall, the M6 corridor in East Birmingham, the River Blythe catchment in Solihull and Northeast Coventry.

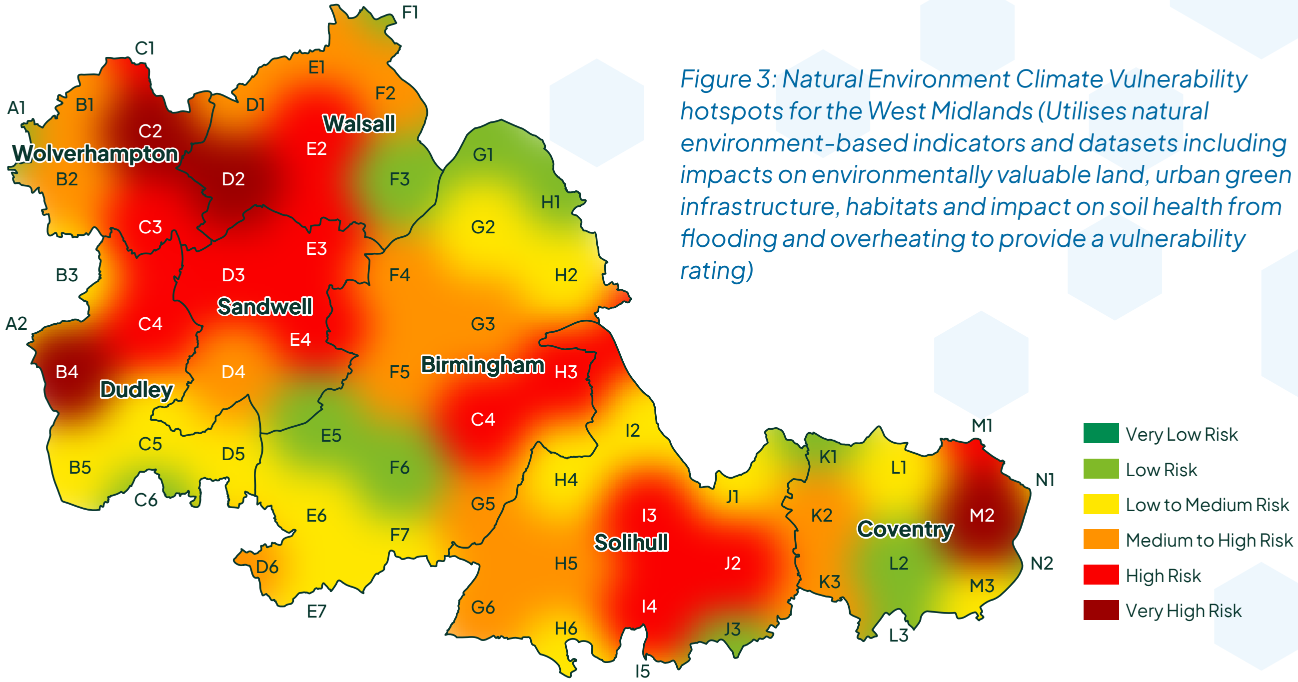


Figure 3: Natural Environment Climate Vulnerability hotspots for the West Midlands (Utilises natural environment-based indicators and datasets including impacts on environmentally valuable land, urban green infrastructure, habitats and impact on soil health from flooding and overheating to provide a vulnerability rating)

3. What does adaptation look like?

The previous sections demonstrate that climate change is likely to result in significant impacts across the West Midlands. However, we have a chance to respond and adapt.

Climate change adaptation refers to action across society for everyone to play a role in, including those outlined in the diagram opposite. Adaptation will be more successful if action is taken within the next decade, and, if investment is put into the right responses, interventions could not only protect us from climate impacts, but also provide multiple benefits across society, the economy and support our broader efforts to tackle climate change through carbon reduction goals.

There are many potential adaptation interventions, including hard engineering works, behaviour change and nature-based solutions. Regarding the latter, an example is on-going tree planting schemes. Planting trees results in them absorbing carbon and can improve wildlife habitat quality. However, trees can also help to alleviate flood risk or provide shading to help reduce the effects of heatwaves, especially in urban areas .

Considering how existing or planned activities can improve our resilience to climate change is key to ensuring that adaptation actions can be rolled out quicker and more effectively across the region, without having to implement an unmanageable range of new interventions.

Adaptation interventions

Figure 4: Adaptation interventions

West Midlands Climate Change Adaptation Plan

The West Midlands Climate Change Adaptation Plan gives an idea of the sorts of measures policymakers and organisations can take to help adapt the region to the sorts of impacts listed in this summary.

For example:

- Integrating responses to flood and overheating risk into urban greening programmes, such as Sunrise in Stoke-on-Trent.
- Rolling out nature-based solutions where one of the main objectives is flood alleviation, such as the River Severn Partnership.
- Assessing the susceptibility of care homes to overheating to minimise health risks to vulnerable people, such as the ClimaCare project.
- Ensuring the resilience and security of our water supplies, such as through the Severn Trent Birmingham Resilience project.
- Protecting our infrastructure assets, such as through Network Rail's resilience programme.

The visual to the right demonstrates the kind of adaptation features you could expect to see in an urban landscape and Adaptation Scotland have produced a Climate Ready Places interactive platform to highlight the differences between adapted and unadapted places.

Examples of urban components

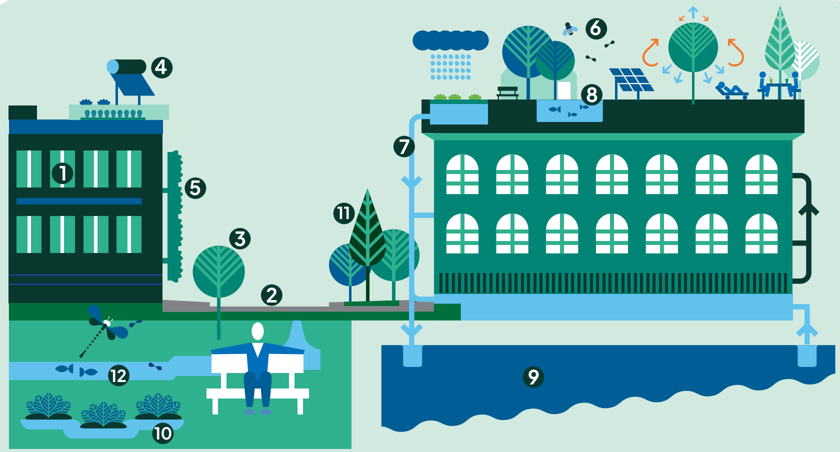


Figure 5: What a climate resilient city could look like (© Climate-KIC)

4. Summary

The West Midlands is expected to experience hotter, drier summers and warmer, wetter winters as a result of climate change.

How extreme the effects of the resulting impacts will be, including extreme heatwaves, flooding and storms, depends on our success with meeting or exceeding global carbon reduction targets and the rapidity and effectiveness of our adaptations. Both approaches to tackling climate change are increasingly important and could work effectively in tandem.

This analysis begins to paint a picture of what we can expect in the WMCA area, and what this means for society, infrastructure and environment. A summary of the vulnerability hotspots, the areas at high or very high risk of climate change impacts, are as follows:

People	The confluence between Sandwell, Wolverhampton and Walsall and Central Birmingham.
Infrastructure	Central Walsall to South Dudley, North to South Birmingham and North to South Solihull.
Natural environment	The interface between Dudley, Sandwell, Wolverhampton and Walsall, the M6 corridor in East Birmingham, the River Blythe catchment in Solihull and Northeast Coventry.

Table 4.1: Locations of vulnerability for each category

However, the response to climate change must be consistent across the region to ensure adaptation measures not only prevent the impacts from causing significant disruption, but also to ensure responses factor in the diverse needs of the people across the West Midlands.

The WMCA and organisations across the region are now working together to develop a programme of adaptation activity to ensure we are more resilient to the expected climate impacts, as well as contributing to the wider levelling up agenda of the region through the multiple benefits adaptation can bring.

The West Midlands Climate Change Adaptation Plan, published in November 2021 provides more information on this activity.

Appendix A: Further detail & projections

As with most of the UK, the climate in the WMCA is projected to experience seasonal changes in weather, and this can be broken down by each climate parameter (e.g. precipitation, temperature).

This summary note has examined what a changing climate might look like for the area during the 21st century, with a particular focus on shifting weather patterns of precipitation levels and air temperature, and reference to levels of humidity, cloud cover, and wind speed.

In 2018, the Met Office published headline figures for the UK, noting the expected changes in rainfall and winter precipitation. This summary provides an idea of the potential changes, and a foundation for more detailed analysis of impacts.

For this summary note, the climate projections have been developed for the wider West Midlands region, not just the Combined Authority geography (due to available dataset spatial scale). Analysis of impacts is confined to the WMCA boundary. The climate projections are based on a series of datasets provided by the Met Office and there are a number of detailed data processes that have been used to develop the projections.

The summary is derived from the following information:

- Datasets have been manipulated for the region, for those climate parameters where there is the most robust climate science available.
- 25km projection datasets have been used across the region.
- Where available a 1981–2000 baseline has been used, for example by 2065 the average air temperature will see a 4.5°C increase compared to the baseline (this is known as an anomaly value).
- Each climate parameter uses data extracted for each season, and for each RCP scenario if possible. This is done on an annual basis to plot a time series to highlight change over time.

Introduction to Climate Projections

The UK Climate Projections (UKCP) are a series of datasets that act as a tool to demonstrate how the UK climate may change in the future, based on scientific modelling.

These datasets provide a future view of changing weather patterns, so that we can better understand how climate change may impact the UK. In 2018 the projections were updated, and this study uses this information (referred to as UKCP18) as the basis for the assessment. UKCP18 shows climate change projections up until the year 2100.

The UKCP18 data is split up into four different scenarios, ranging from 'best' to 'worst'.

- In the **best scenario** immediate and impactful action is taken to reduce impacts to the climate.
- The **worst scenario** is where changes to the climate are severe, as the least action is taken to limit this change.

Scientifically these scenarios are called **Representative Concentration Pathways (RCP)**, and the four scenarios are set at RCP 2.6 (the best case), 4.5, 6.0, and 8.5 (the worst case). Each scenario refers to different assumptions, based on economic, social and physical changes to the environment that will influence climate change and the expected global temperature change.

- **RCP 2.6** (best case scenario) assumes immediate action is taken and results in a global temperature change of 1.6°C by 2081–2100.
- **RCP4.5**, less action is taken compared to RCP2.6, which results in a global temperature change of 2.4°C by 2081–2100.
- **RCP6.0**, less action is taken compared to RCP4.5, which results in a global temperature change of 2.8°C by 2081–2100.
- **RCP8.5** (worst case scenario), least action is taken and results in a global temperature change of 4.3°C by 2081–2100.

In this summary the best and worst scenarios have been used to give a range of future climate changes within the West Midlands Combined Authority (WMCA) area.
To increase the accuracy of the projections, the UKCP18 information uses percentiles which presents a range of estimates and the probability of that estimate occurring.

Figure 6 shows how percentiles are used to predict the probability of different maximum temperatures across the WMCA by the year 2099. For the purposes of the projections in this summary note, the 'most likely' outcome, the 50th percentile (the centre line), has been used.

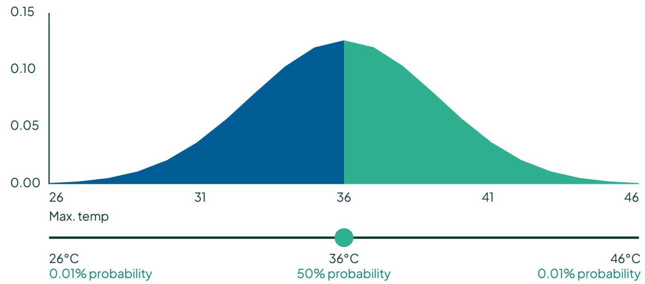


Figure 6: Example distribution probabilities of projected max temperature

The Baseline Period

The WMCA is predicted to experience changes in air temperature during this century.

Using historic data from the UKCP dataset, actual temperature values are available from the late 19th century (Figure 7). The historical data shows that the average temperature across all seasons in 1900 was 12.8°C.

By 2020, that figure was at 14.9°C, demonstrating a clear increase in temperature. For the baseline period in 1981, the average temperature for the whole year was 13.1°C, and by 2000 it was 13.9°C. This baseline period is used to compare against the future projections.

Where the baseline figure is referenced, this refers to the average across the WMCA, and does not reflect absolute values. For example, the average maximum temperature across the baseline period was 20.2°C, but the highest recorded temperature across the West Midlands in this period was 37.1°C.

This is because the average is taken across all days within a month and across the average of different stations within the WMCA. With the Midlands region at some distance from the sea, with its moderating effects on temperature, the annual range is more pronounced than in most parts of the UK.

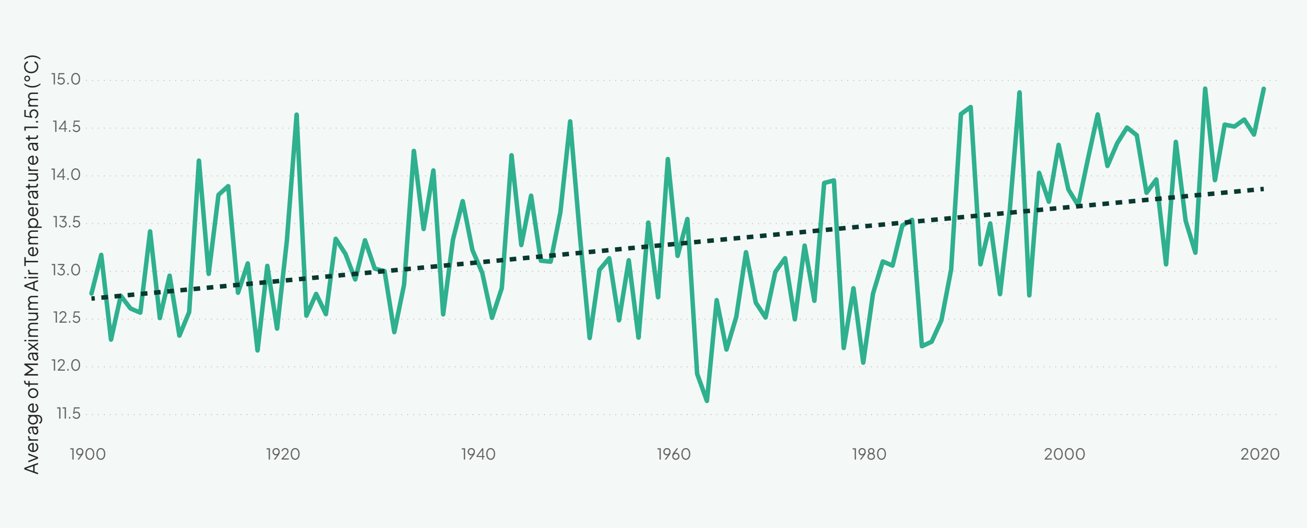


Figure 7. Average Maximum Air Temperature, by season compared to baseline period

Maximum Temperatures

Figure 8 shows the changes in maximum air temperature from 2020 up until 2099 using the projected average or 50th percentile.

The lines fluctuate on a yearly basis due to the variance in the projections. Whilst the overall trend is an increase, some years will experience higher temperatures, but that is not necessarily cumulative. As an example, 2022 was an extreme year for high temperatures, and while 2023 is likely to have higher temperatures than the baseline period on average, it may still not meet the peak heights of 2022.

On average for the baseline period, the maximum air temperature was 13.3°C, with a summer maximum air temperature of 20.2°C.

In the best-case scenario projection (RCP 2.6), summer is expected to have a maximum temperature 2.9°C warmer than the baseline period.

In the worst-case scenario (RCP 8.5) summer is expected to have a maximum temperature 7.5°C warmer than the baseline period.

In the best-case scenario projection (RCP 2.6), winter is expected to have a maximum temperature 2.9°C warmer than the baseline period.

In the worst-case scenario (RCP 8.5) winter is expected to have a maximum temperature 3.8°C warmer than the baseline period.

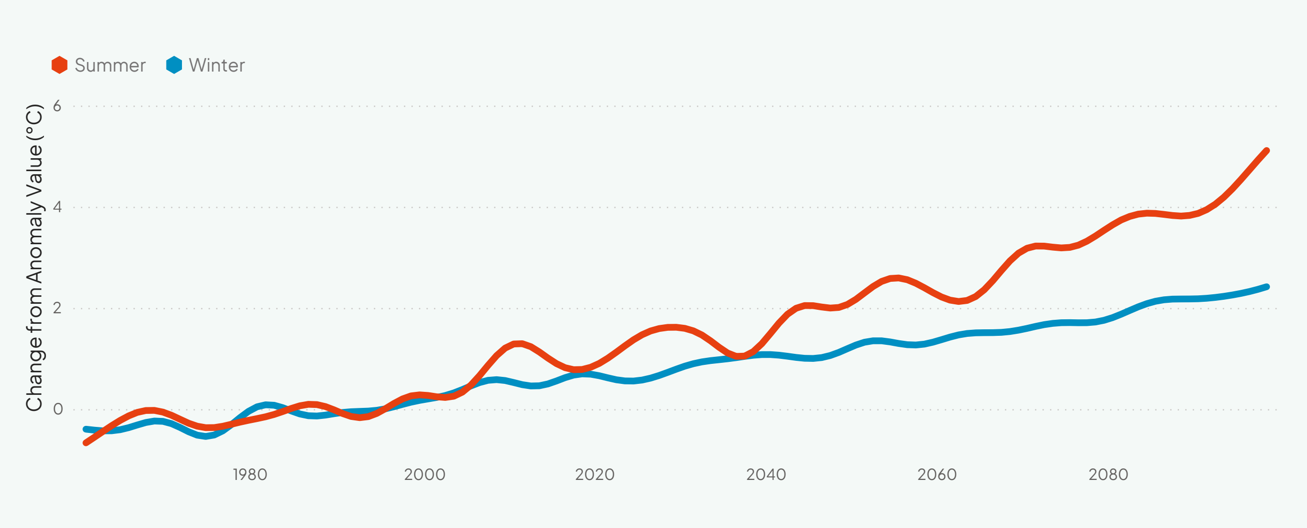


Figure 8: Average Maximum Air Temperature, by season, compared to baseline period

Minimum Temperatures

Figure 9 shows the changes in minimum air temperature from 2020 up until 2099 using the projected average or 50th percentile.

On average for the baseline period, the minimum air temperature was 5.5°C.

- Across all scenarios, the average minimum air temperature is expected to increase by 2099.
- In the best-case scenario, it is projected to increase by 1.4°C by 2099 on average across all seasons.

- In the worst-case scenario, summer is projected to see the greatest change. Minimum air temperature is set to increase by 5.8°C in 2099 from the baseline average: 10.6°C to 14.5°C.

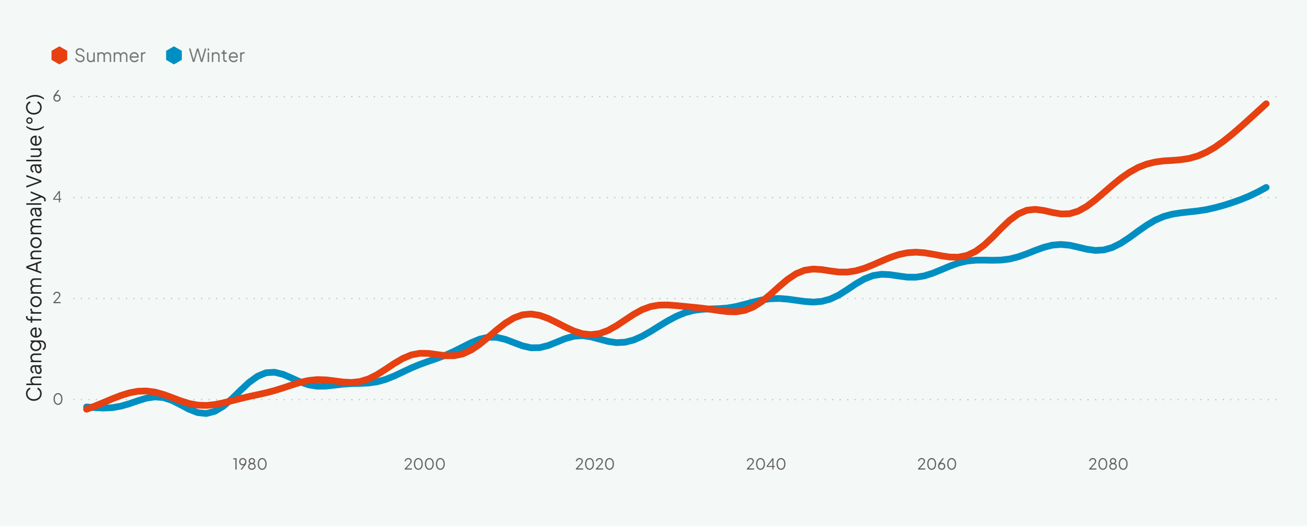


Figure 9 Average Minimum Air Temperature anomaly by season compared to baseline period

Average Temperatures

The average air temperature across all scenarios and seasons will increase (figure 10).

In the best-case scenario, the average temperature by 2099 will have increased by 1.4°C. In the worst-case scenario, this increases to 4.6°C.

In the summer season, the worst-case scenario would see the average temperature increase by 6.5°C. The average mean air temperature in summer for the baseline period was 15.4°C, therefore we could see average air temperatures of about 22°C by 2099[1].

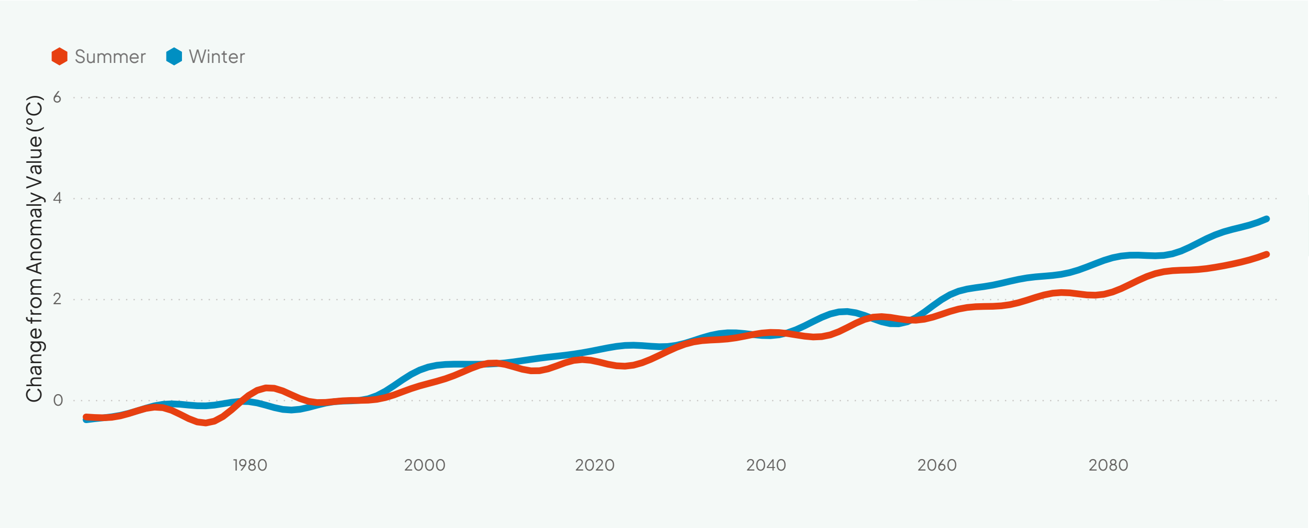


Figure 10: Average Air Temperature by season compared to baseline period

1 Average temperatures consider temperature across a 24-hour period, so with temperature often dropping overnight, these changes to 'average' don't highlight extremes.

Precipitation

One of the main changes to predicted precipitation patterns will be drier summers.

The UKCP forecast sets out that there will be on average 31% less rainfall compared to the baseline period in the summer seasons. This means that whilst previously the WMCA received on average 171mm of rainfall in summer, this could decrease to 118mm. Autumn is likely to see a 10% increase in rainfall, and winter is expected to see rainfall increase by 15%. The average rainfall in winter during the baseline period was 195mm, so this could increase up to 224mm. A typical 'wet day' would be one with rainfall totals of 1mm or more. So 224mm across winter months (90 days in a common year) is a significant increase.

Changes to precipitation patterns during this century will not only be seen in the form of drier summers and wetter winters, but also in the form of extreme weather events such as flash floods that, alongside other parameters such as increased wind speed, can lead to more intense and frequent storms.

Figure 11 shows the change in rainfall levels across each season for the West Midlands in the best-case scenario, against the historic baseline.

In the best-case scenario, summers will be 25% drier than the baseline period. Winters are likely to be 7% wetter, as is autumn, whilst spring remains mostly consistent with the baseline period.

Figure 12 shows the change in rainfall levels for the West Midlands in the worst-case scenario, broken down by season. Summers are anticipated to have 42% less rainfall by 2099, a decrease of 72mm down to just 99mm of rainfall in summer. During winter, rainfall could increase by 24% by 2099, amounting to 242mm. Given increased temperatures, this is not likely to lead to an increased amount of snowfall.

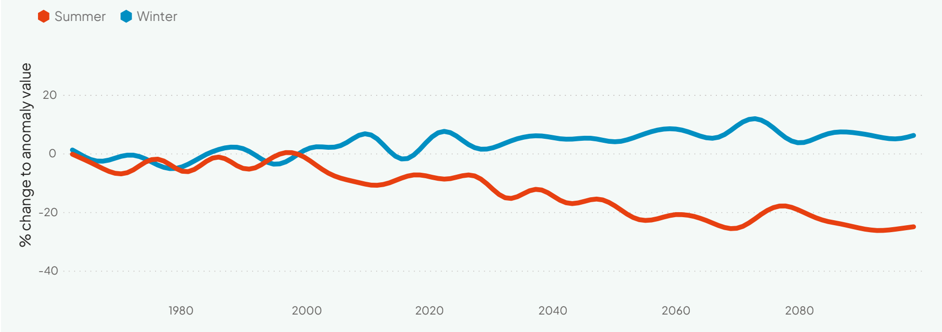


Figure 11: Best Case Scenario: Average Rainfall (precipitation) Levels across each season compared to baseline period

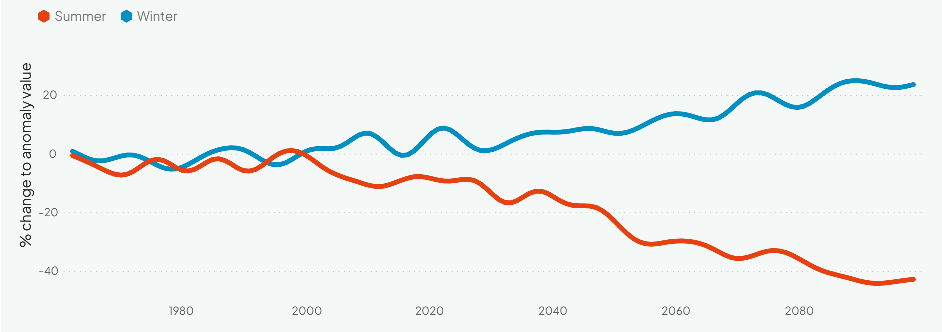
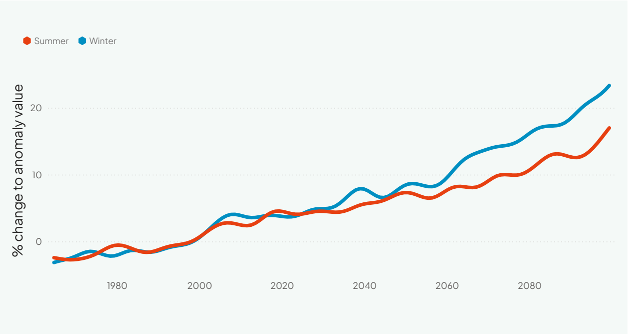


Figure 12: Worst Case Scenario: Average Rainfall (precipitation) Levels across each season compared to baseline period

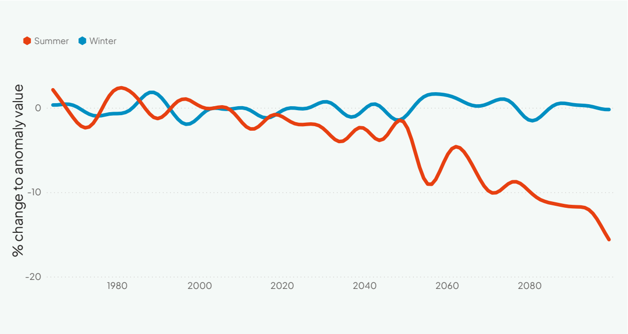
Humidity



Across all scenarios, the projections show a more humid environment by 2099. Compared to the baseline, humidity levels in autumn are expected to increase by 24%, the highest % change across all the seasons on average, and, looking at the worst-case scenario, this could increase to 36%.

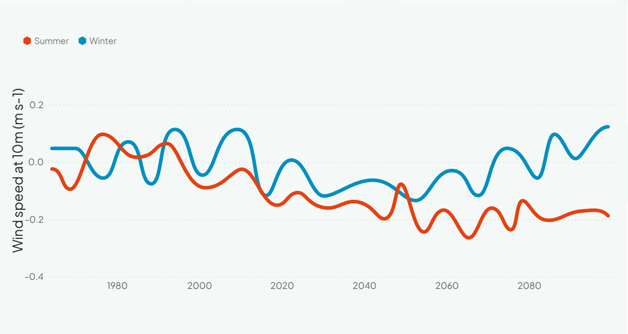
The higher the humidity the greater the water vapour and the more rain we are likely to experience. This will affect health and comfort levels, but increased humidity levels can cause several issues in an urban environment, as noted in the main summary.

Cloud Cover



Cloud cover is also likely to change, although the projections are similar to that of rainfall, in that they show significant seasonal variations. The most significant projection shows that 15.4% less cloud is expected across summer on average. For the other seasons, there is no significant deviation to the norm. A decrease in cloud cover means an increase in sun exposure, which contributes to lower precipitation levels and in some instances higher temperatures.

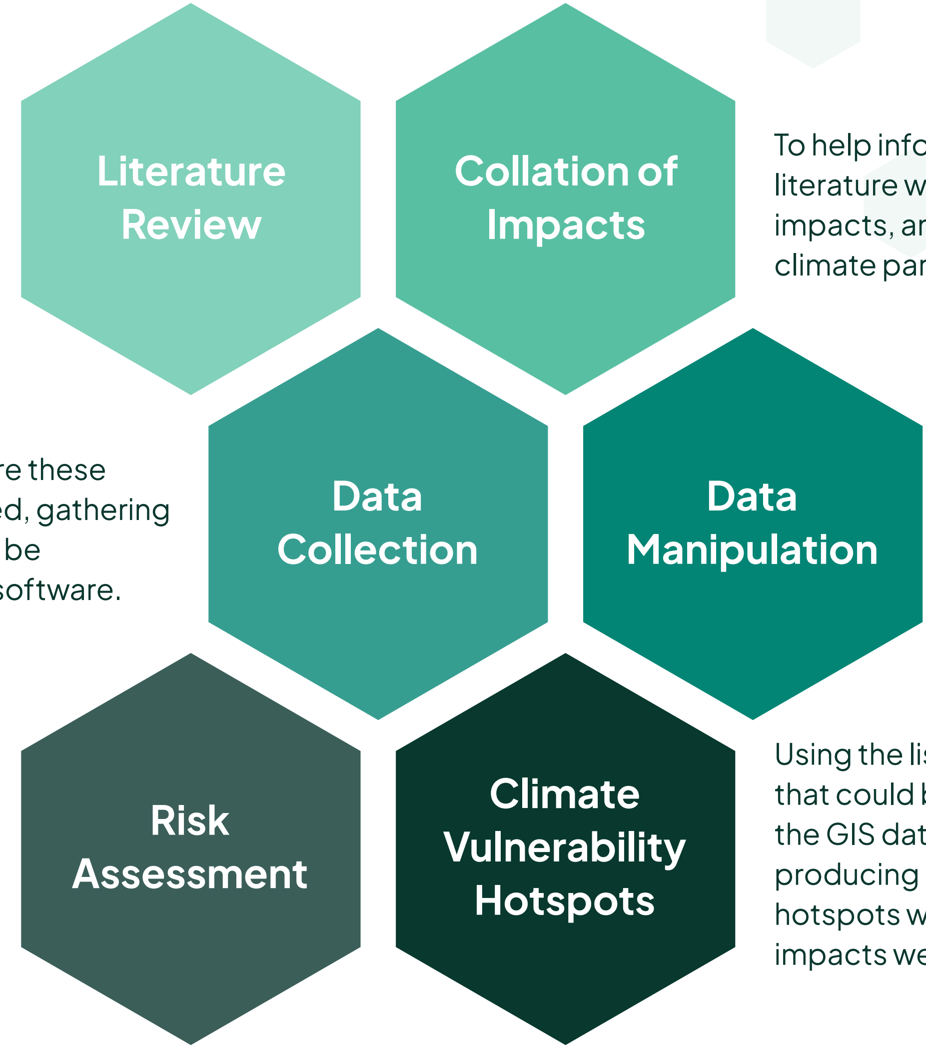
Wind Speed



Finally, wind speed patterns may see some changes, however the projections are quite sporadic and therefore not relied on in this summary report. Understanding there are potential changes to wind speed patterns is important in identifying potential impacts that may be experienced.

Technical Aspects of the Impact Assessment Process

The climate impact assessment process is shown in Figure 13 and helps to highlight some of the most measurable and expected impacts from Climate Change.



To help inform the assessment, literature was reviewed to identify impacts, and then collated per climate parameter and focus area.

Data to help measure these impacts was collated, gathering datasets that could be mapped using GIS software.

Using the list of impacts, those that could be measured using the GIS datasets were assessed, producing climate vulnerability hotspots where clusters of impacts were greatest.

Figure 13: The impact assessment process

Datasets

The datasets were mapped using a Geographical Information System (GIS) to help highlight areas of impact. Different datasets were layered over each other to identify potential impacts. For example, showing hospitals within Flood Zone 3 when combined with the projected increases in precipitation can help identify vulnerable areas. The quantifiable impacts identified from the literature review were grouped to help undertake the assessment. It is important to note that these impacts and mapped groups are not exhaustive and are limited by data available.

Figure 14 shows these grids across the WMCA. This approach was taken to provide a way to rank where risks are across the area. Each grid has been assigned a reference value, which has been used both as a unique identifier and to help with the visual assessment. If there are different risk levels between two grid hexagons it doesn't mean there is a drastic drop off in vulnerability, instead it shows that it is relatively less vulnerable than the adjacent hexagon.

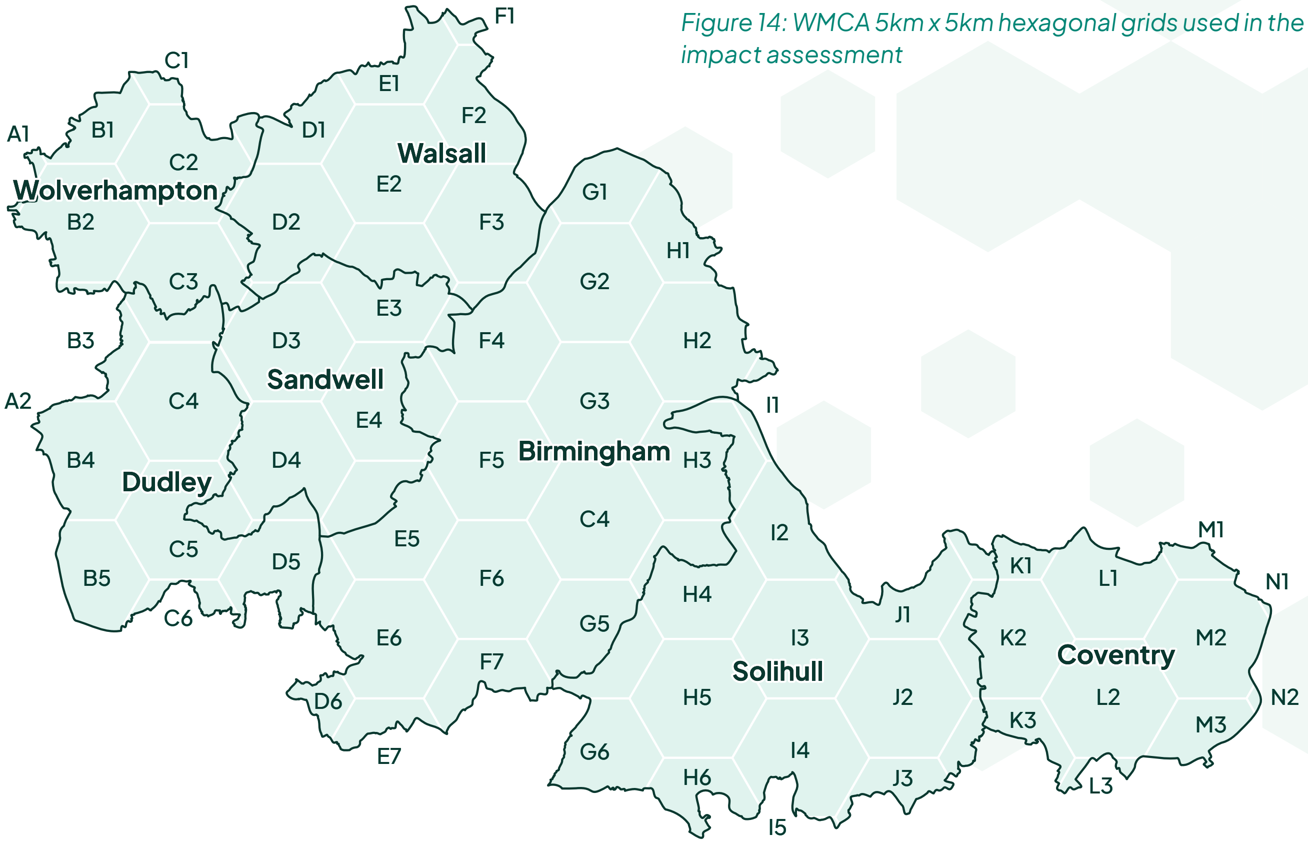


Figure 14: WMCA 5km x 5km hexagonal grids used in the impact assessment

Datasets used to develop the ‘People’ assessment

Dataset	Associated Metric Group(s) For Impact Assessment
Projected population aged 0–4 (2043), Projected population 65 and over (2043)	2 - Heatwaves
VectorMap district, Built-up areas, Open greenspace layer, National Forest Inventory, Priority habitat inventory	3 - Access to green space
Mean Domestic Electricity kWh Usage Per Household (2020), Mean Domestic kWh Per Meter Gas Consumption (2020)	4 - Increased utility demand
Health Assets (included in Public Buildings)	5 - Accessibility to healthcare
Aged 65 & over who are single, widowed, divorced or separated (%) (2011), Rate of referrals to children’s social care (2020/21)	6 - Displacement from flooding
Risk of flooding from surface water (1 in 30 year/ 1 in 100 year)	5 - Accessibility to healthcare 6 - Displacement from flooding 7 - Financial damages from flooding
Rivers and Sea Flood Zones 2/ 3	5 - Accessibility to healthcare 6 - Displacement from flooding 7 - Financial damages from flooding
IMD Decile	1 - Water scarcity 2 - Heatwaves 3 - Access to green space 4 - Increased utility demand 7 - Financial damages from flooding

Table A.1: Datasets used to inform the people assessment (Figure 5)

Datasets used to develop the 'Infrastructure' assessment

Dataset	Associated Metric Group(s) For Impact Assessment
New Housing developments 2018–19	8 - Flood risk to housing
Public Buildings (excluding Health Assets), Schools/ universities and colleges, Health Assets	9a, 9b, 9c - Flood risk to public buildings
WPD Substations	10 - Flood risk to energy infrastructure assets
National Grid Transmission Assets	10 - Flood risk to energy infrastructure assets
Risk of flooding from surface water (1 in 30 year/ 1 in 100 year), Rivers and Sea Flood Zones 2/ 3	8 - Flood risk to housing 9a - Flood risk to public buildings - Education assets 9b - Flood risk to public buildings - Civil structures 9c - Flood risk to public buildings - Health assets 10 - Flood risk to energy infrastructure assets 11a - Flood risk to transport infrastructure assets (Road Network) 11b - Flood risk to transport infrastructure assets (Rail Network) 11c - Flood risk to transport infrastructure assets (Service Points)
HS2 – Phase 1, Railway Network, OS MasterMap Highways, TfWM Key Route Network, Bus Lanes, Cycle Routes,	11a/b - Flood risk to transport infrastructure assets (Rail/ Road Network)
Petrol Stations, Electric Charging Points, Airports, Transport Stations	11c - Flood risk to transport infrastructure assets (Service Points)

Table A.2: Datasets used to inform the infrastructure assessment (Figure 7)

Datasets used to develop the ‘Natural Environment’ assessment

Dataset	Associated Metric Group(s) For Impact Assessment
Local Nature Reserves, National Nature Reserves, Sites of Specific Scientific Interest (SSSIs), Special Areas of Conservation	12 - Biodiversity vulnerability
Climate Change Vulnerability	12 - Biodiversity vulnerability 13 - Loss of urban green space habitats
VectorMap district, Built-up areas, Open greenspace layer, National Forest Inventory, Priority habitat inventory	13 - Loss of urban green space habitats
IMD Decile	14 - Effect of reductions in agricultural productivity
Agricultural Land Classification	15 - Risk to soil health
Habitat Networks Combined	16 - Flood risk to natural assets
Risk of flooding from surface water (1 in 30 year/ 1 in 100 year)	15 - Risk to soil health 16 - Flood risk to natural assets
Rivers and Sea Flood Zones 2/ 3	15 - Risk to soil health 16 - Flood risk to natural assets

Table A.3: Datasets used to inform the Natural Environment assessment (Figure 9)

Appendix B: Example Datasets

This section shows three example climate change vulnerability datasets, one for each of the themes considered in this summary (People, Infrastructure and Natural Environment). These show how data can be mapped and presented to visualise the impacts of climate change against certain metrics.

Example Dataset: IMD Decile

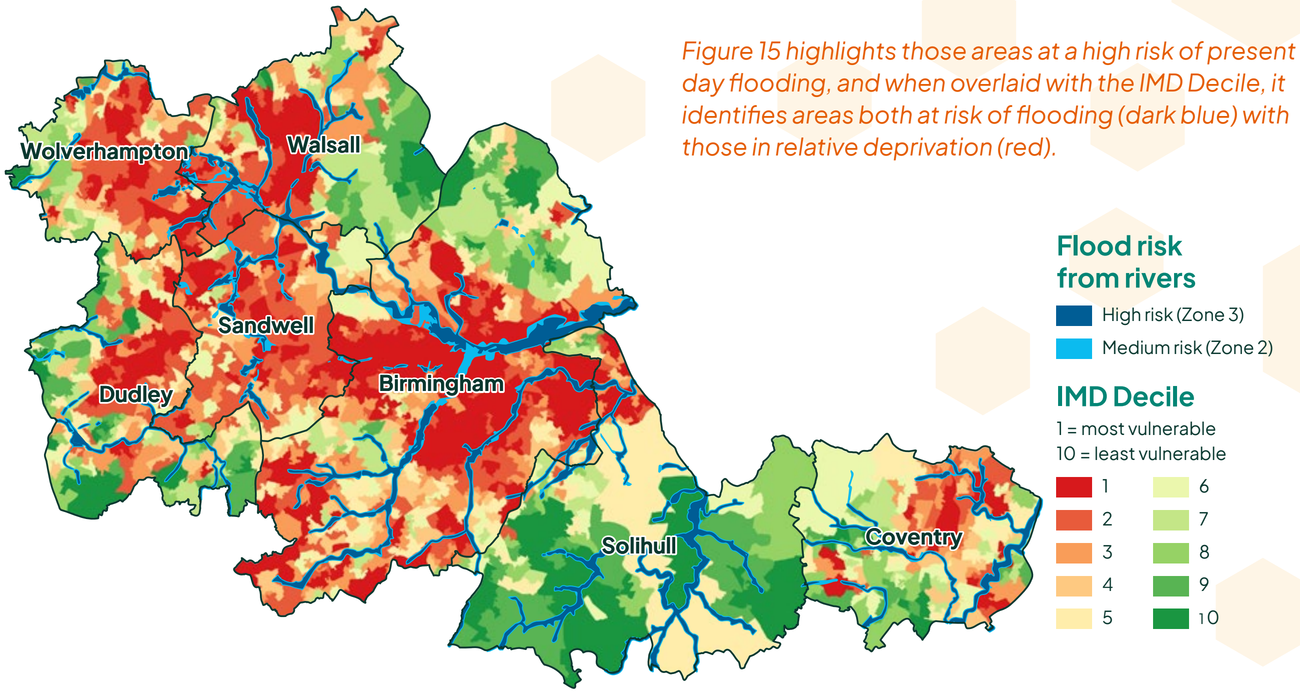
The IMD is the official measure of relative deprivation at a small local area (known as a lower super output area LSOA) level across England. The IMD Decile provides a rating for all LSOAs based on the 2019 IMD measure in England. '1' represents the most deprived 10% of LSOAs (red), whilst '10' represents the least deprived 10% of LSOAs (green). Across the WMCA, Birmingham, Sandwell, Walsall and Wolverhampton have greater levels of relative deprivation when compared with areas such as Solihull.

One of the key areas of exploration regarding the impacts to people relates to how climate change may disproportionally affect disadvantaged population subgroups. Because of the unequal distribution of environmental risks and related health outcomes, it's important to identify those areas that are relatively more deprived.

Fluvial flood risk refers to flooding resulting from increases in the water levels of rivers and the sea, causing banks to overflow, spreading water to the surrounding area. This type of flooding is not to be confused with pluvial flooding, which is flood risk associated with short periods of intense rainfall, overwhelming natural water infiltration rates, resulting in standing water unable to drain effectively. A combination of these flood risk categories has been analysed to show the overall flood risk in this impact assessment as both will likely be intensified by the impacts of climate change.

The outputs of this particular assessment alongside the range of other climate change impacts are shown within the climate vulnerability hotspots in the following section.

Figure 15 highlights those areas at a high risk of present day flooding, and when overlaid with the IMD Decile, it identifies areas both at risk of flooding (dark blue) with those in relative deprivation (red).



Example Dataset: Fluvial Flood Risk Areas and Major Roads

There are a range of datasets used to help inform the impact assessment. Figure 16 highlights two of these by using the medium and high fluvial flood risk zones to show the vulnerability of Motorways and A Roads at risk of fluvial flooding.

A key contributor to the climate impact assessment for infrastructure was the inclusion of the Environment Agency's national classification of fluvial flood risk zones 2 and 3. Flood zone 2 refers to areas at risk of river flooding following between a 1 in 1000 and 1 in 100 year-flood event and flood zone 3 shows areas which are at risk in a 1 in <100–year event.

For the impact assessment, areas were categorised as at risk of flooding if they were in an area affected by either pluvial or fluvial flooding in a 1 in 100 year (medium flood risk) or above. Given that climate change is likely to seasonally affect precipitation rates, it is deemed that areas at risk of flooding will increase and it is likely that many areas currently at medium risk of flooding will be at high risk of flooding in the future. This dataset was used in all eight metrics for the impact assessment.

In Figure 16 it is evident that there are key corridors of Motorways and A Roads which are at risk of fluvial flooding. These can be seen in Central to Eastern Birmingham and a corridor running from Eastern Wolverhampton to Central Birmingham. Impacts from these roads at flood risk can create further risks such as increases in the likelihood of road traffic accidents.

The outputs of these datasets, along with others which have contributed to the assessment of infrastructure risks associated with climate change are shown in the following section.

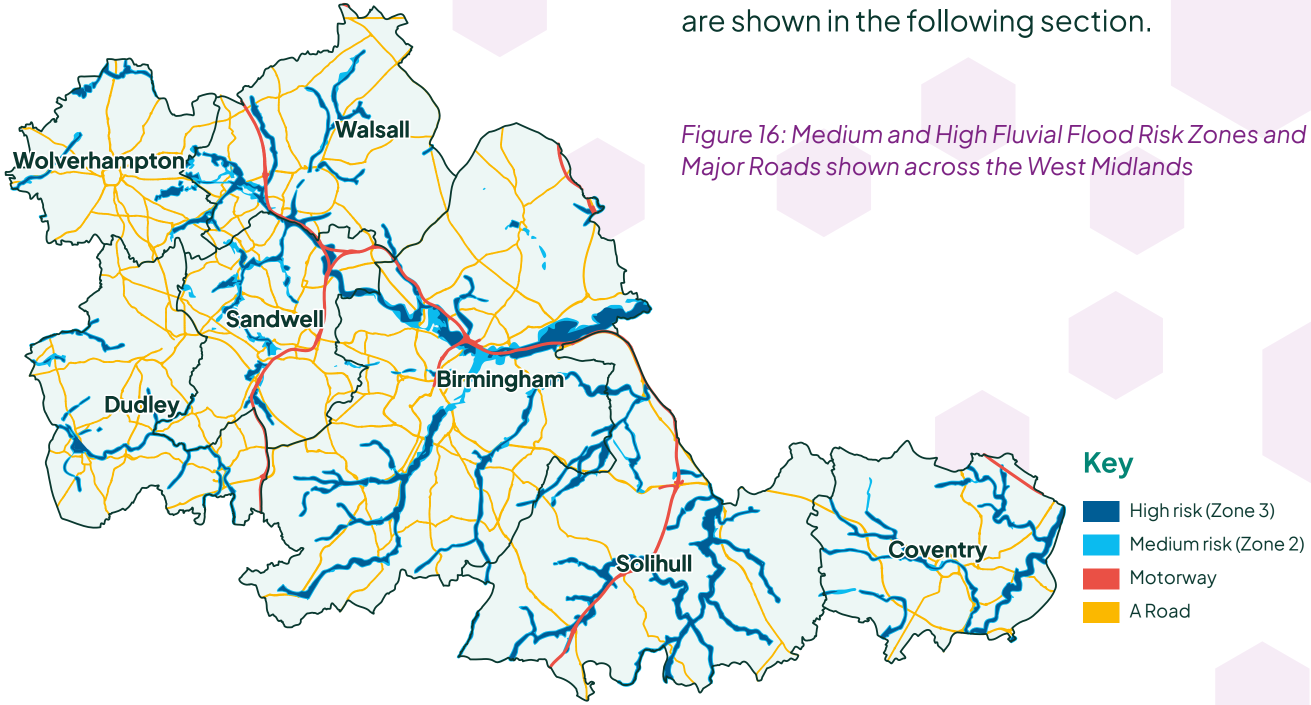


Figure 16: Medium and High Fluvial Flood Risk Zones and Major Roads shown across the West Midlands

Example Dataset: Climate Change Vulnerability

Within the natural environment impacts, one of the key areas of exploration relates to how climate change can induce habitat degradation/ loss. Due to the ranging interdependencies, conditions, strategic significance and biological composition of habitats within the WMCA, it is important to establish a metric which combines these factors into a tangible representation. To achieve this, as part of their National Biodiversity Climate Change Vulnerability Model, Natural England created the Climate Change Vulnerability GIS layer.

The layer creates 200m x 200m squares, identifying locations of biodiversity habitats as identified by Natural England. It then uses a series of variables to define the vulnerability to biodiversity from climate change for each square. Each of the four characteristics used to define this vulnerability (habitat sensitivity, fragmentation, topographic heterogeneity and management/ condition) are scored out of three. The scale goes from least vulnerable (one) to most vulnerable (three), with the overall vulnerability being the average of all the scores combined. As seen on Figure 17, four categories have been used in the analysis, ranging from <0.75 in dark green to >2.25 in dark red for the highest climate vulnerability. These have been categorised to provide a further level of granularity in the analysis, highlighting at risk areas in greater detail. When looking across the WMCA, it is evident that the areas with the most vulnerable habitats to climate change centre around Walsall, North Wolverhampton, Solihull and East Coventry when compared with areas with the least vulnerable habitats such as North and South Birmingham.

This dataset was used in two of the five metrics assessed during the development of this impact assessment combined with others, for example, flooding datasets, to identify areas of vulnerability. The outputs of how these datasets have contributed to the assessment of Natural Environment risks associated with climate change are shared in the following section.

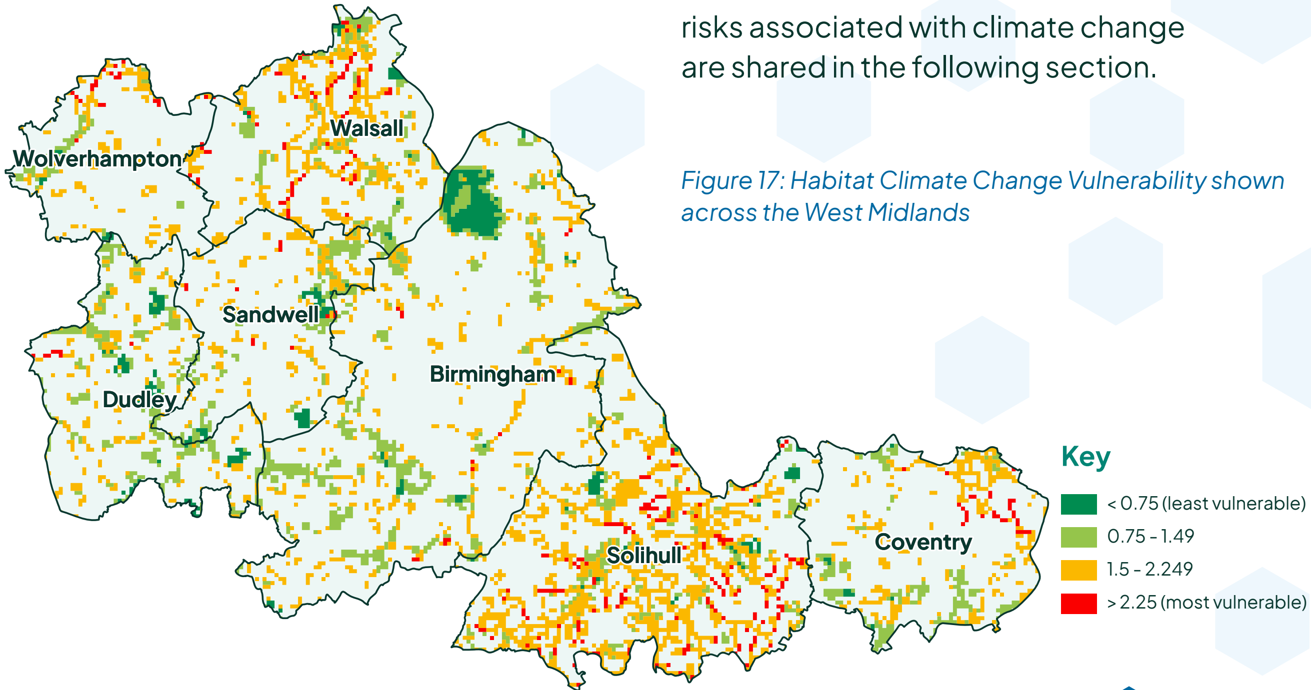


Figure 17: Habitat Climate Change Vulnerability shown across the West Midlands