

Climate Risk and Vulnerability Assessment (CRVA) tools for local and regional authorities

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16th October 2024

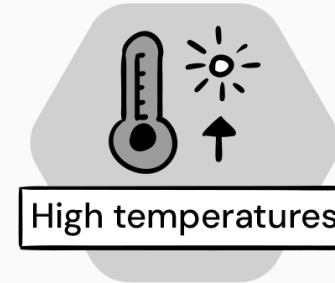
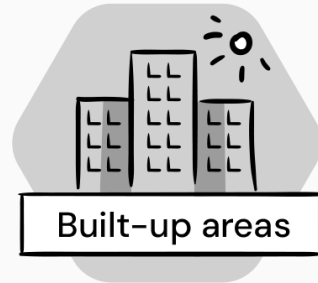


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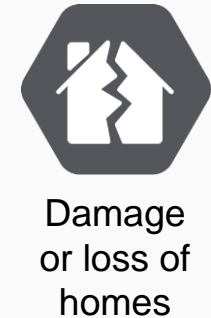
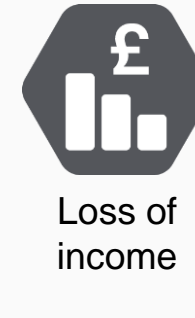
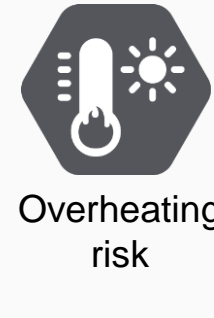
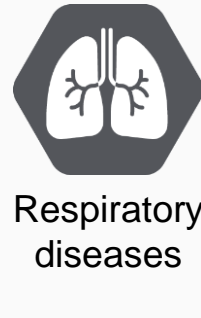
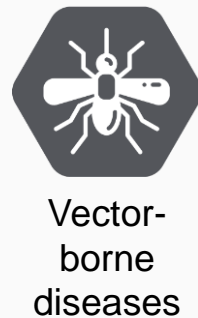
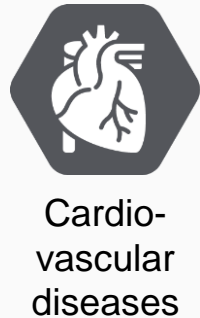


Planners and decision-makers must respond

Without addressing these hazards...

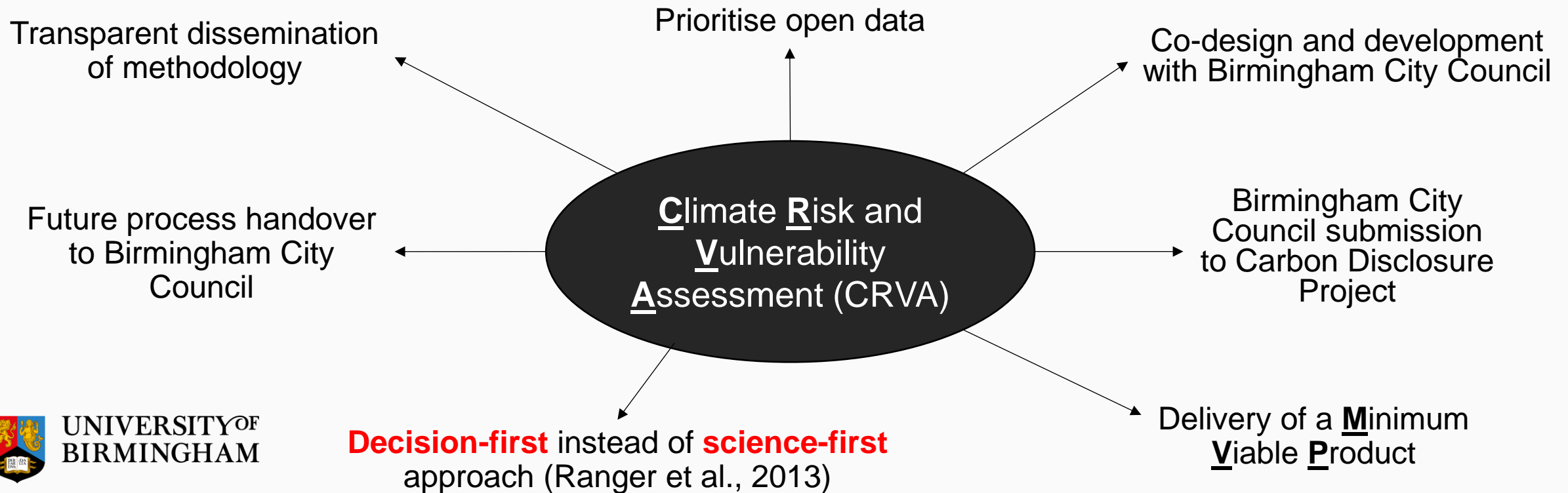


... citizens are vulnerable to...



CRVA: Aim and objectives

To develop a prototype toolkit that enables practitioners to evaluate the effects of climate change on new or existing developments

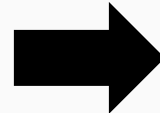
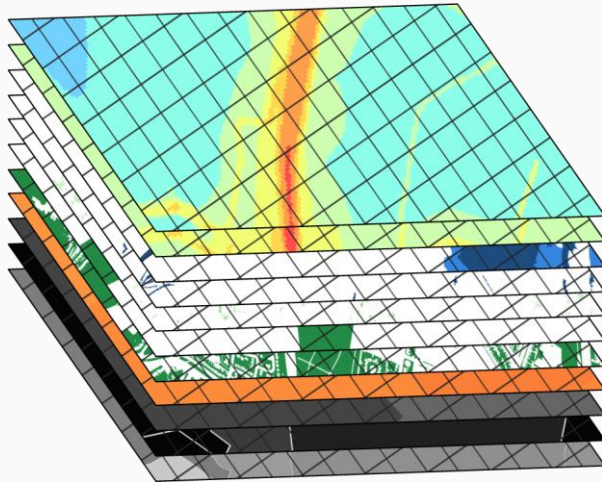


CRVA: v1 for Birmingham

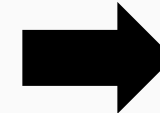
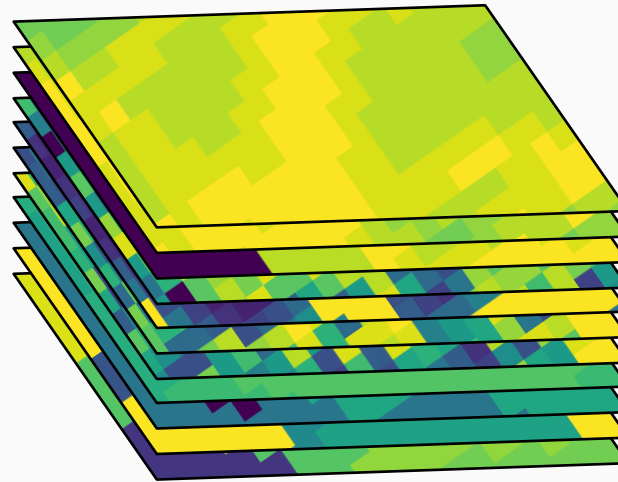


Choosing the fillings, making the burger: with raster algebra 🍔

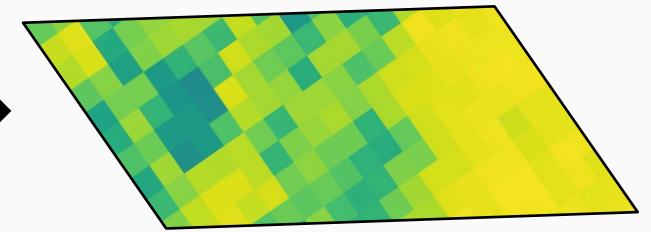
11 geospatial datasets



Transform into standardised, **relative** scores



Combine to create a single CRVA score



Air quality, green space, tree canopy cover, flood risk, surface temperature, building height and density, IMD, excess years life lost...

20 quantile bins
0.05 score intervals
Highest score per layer = 1

Highest possible score = 11

CRVA: v1 for Birmingham

Legend



Lowest



Low



Medium

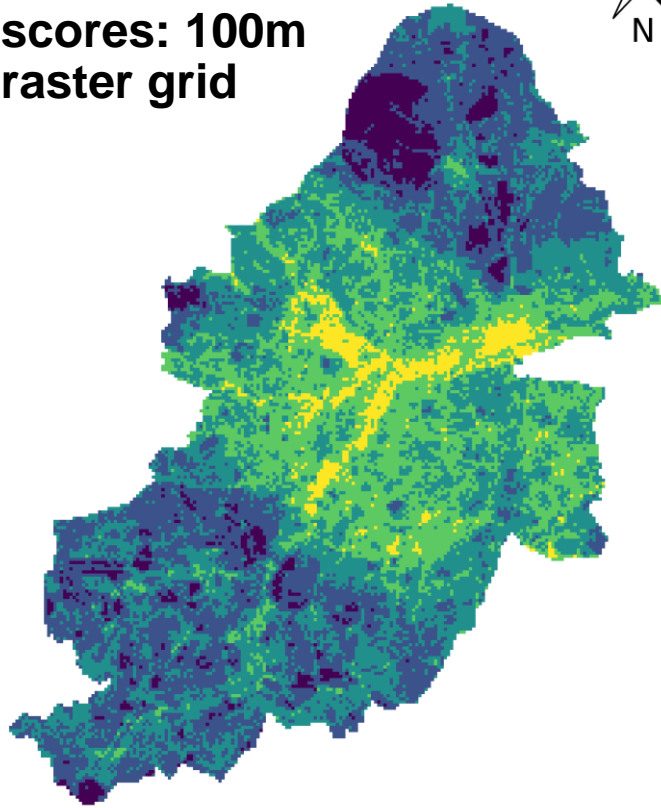


High

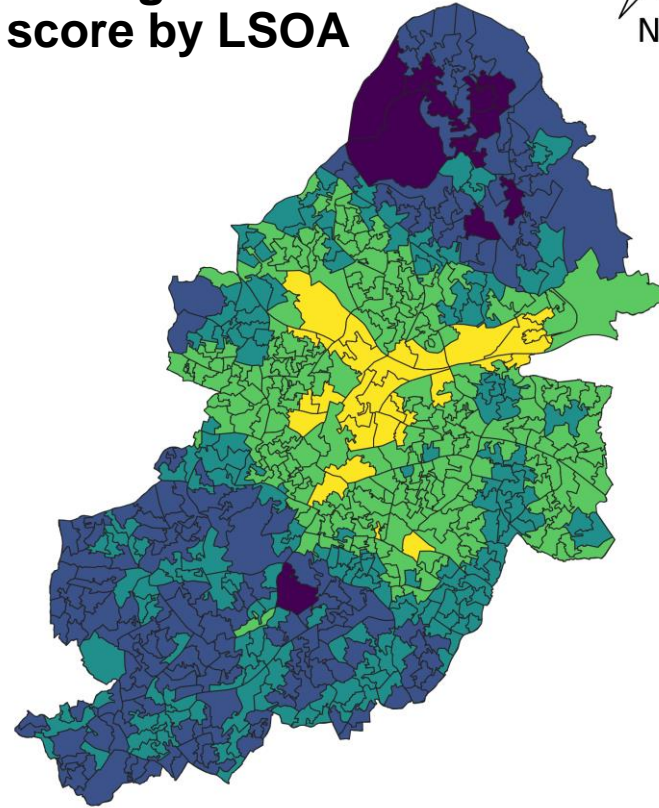


Highest

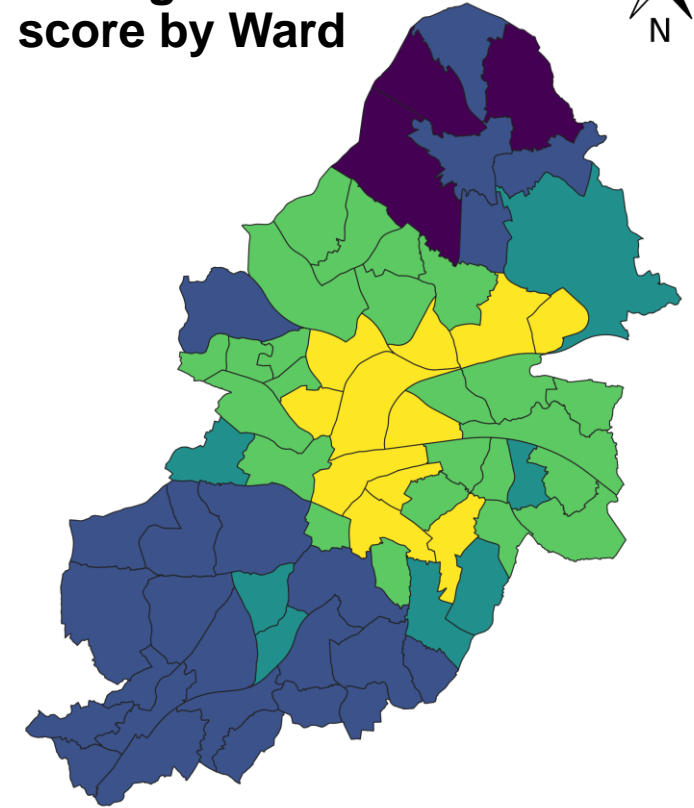
Actual CRVA
scores: 100m
raster grid



Average CRVA
score by LSOA



Average CRVA
score by Ward



Publication of the CRVA for Birmingham

Background:

On 11 June 2019 the [council declared a climate emergency](#). In this declaration, the council recognised that the impacts of climate change, such as increased extreme weather events such as flooding, droughts and heatwaves will affect Birmingham residents. With this, the council is also committed to [preparing Birmingham for the effects of climate change](#) to make sure our city and residents are resilient to future climate risks. This resulted in Birmingham's [Environmental Justice Map](#), which is helping with the planning and delivery of the [City of Nature Plan](#), reducing the risks of climate change for the most vulnerable and working towards building a more resilient and greener city.

To help the council develop the city while also adapting to climate change, a climate risk and vulnerability assessment (CRVA) is needed to help identify where the needs of Birmingham are greatest. The council has developed a CRVA map, which builds on the success of the Environmental Justice Map.

Methodology:

The CRVA map scores areas of Birmingham based on compiling the presence and extent of 11 different factors that may influence the effect of climate change. These factors are:

- Concentration of nitrogen dioxide (an air pollutant)
- Concentration of fine particulate matter (an air pollutant)
- Fluvial (river) flood risk
- Pluvial (surface) flood risk
- Surface temperature
- Local climate zone classification
- Deficit in open green space
- Deficit in other green space
- Deficit in tree canopy cover
- Excess years life lost
- Indices of Multiple Deprivation

Most of these datasets are open source and can be viewed using geographic information system (GIS) mapping software, such as ArcMap or QGIS.

To create the CRVA map, the map of Birmingham was divided into a 100m² grid and a score from 0 to 1 was generated per grid square for each factor. The higher the score in a layer, the more at risk or vulnerable that area is to the factor. The scores for all the layers were then summed to create the final CRVA score for the grid across Birmingham, where the higher the score, the more at risk and vulnerable that area is to the compound effects of climate change, now and in future.

For the list of data sources and a more in-depth description of the methodology see [here](#)

How is the risk defined?

CRVA By Ward

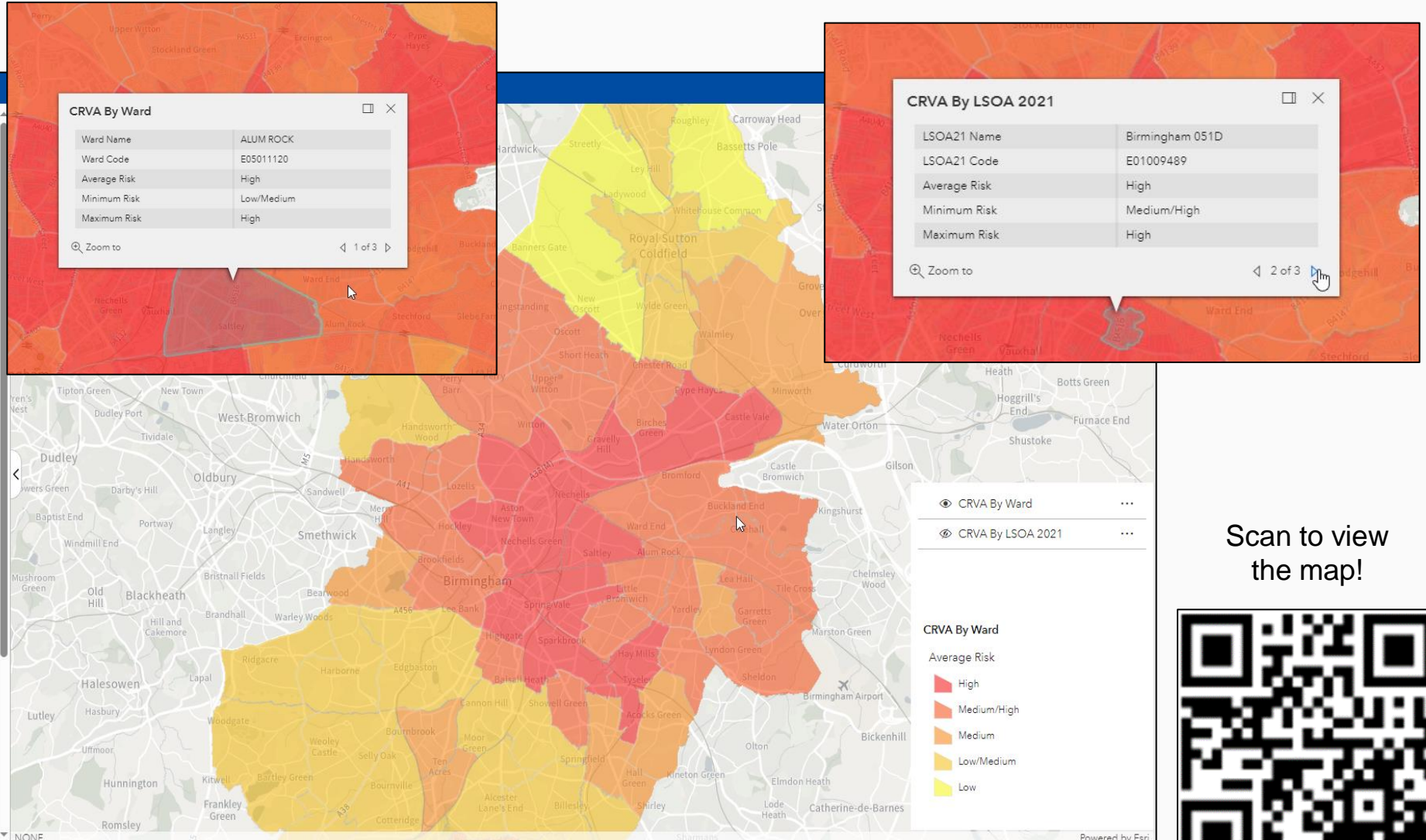
Ward Name	ALUM ROCK
Ward Code	E05011120
Average Risk	High
Minimum Risk	Low/Medium
Maximum Risk	High

Zoom to 1 of 3

CRVA By LSOA 2021

LSOA21 Name	Birmingham 051D
LSOA21 Code	E01009489
Average Risk	High
Minimum Risk	Medium/High
Maximum Risk	High

Zoom to 2 of 3



Scan to view the map!



CRVA: v2 for the West Midlands



**West Midlands
Combined Authority**

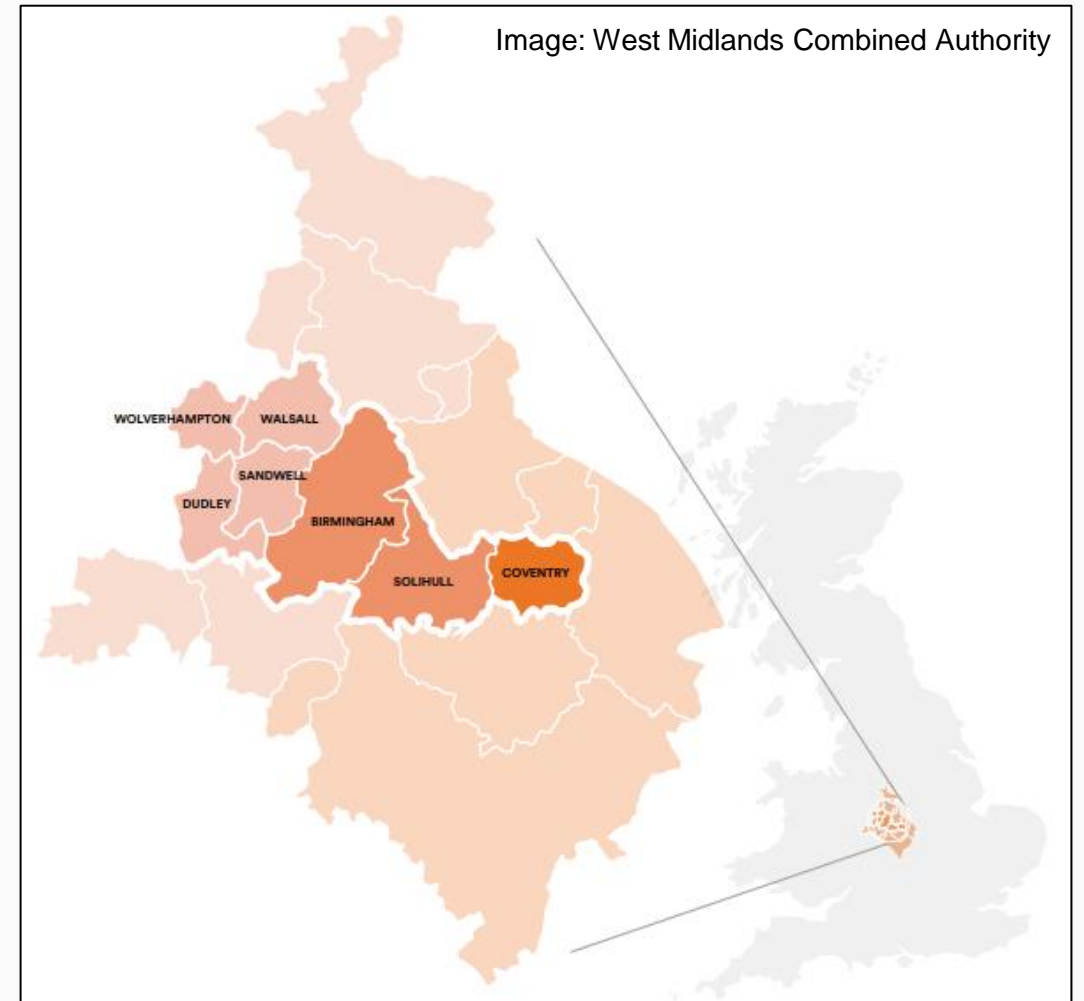
WMCA as strategic authority has the money and power to make decisions for its region (including Birmingham)

Mapping work was extended to the region as climate change adaptation planning has increased since 2022

Also tested for the transport sector



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CRVA: v2 for the West Midlands

Key revisions in expanding the map

1

Improve the
community
vulnerability
dimension of
data

2

Engage with
citizens to
inform but
also gain
feedback

3

Review the
methodology:
can we
improve it?

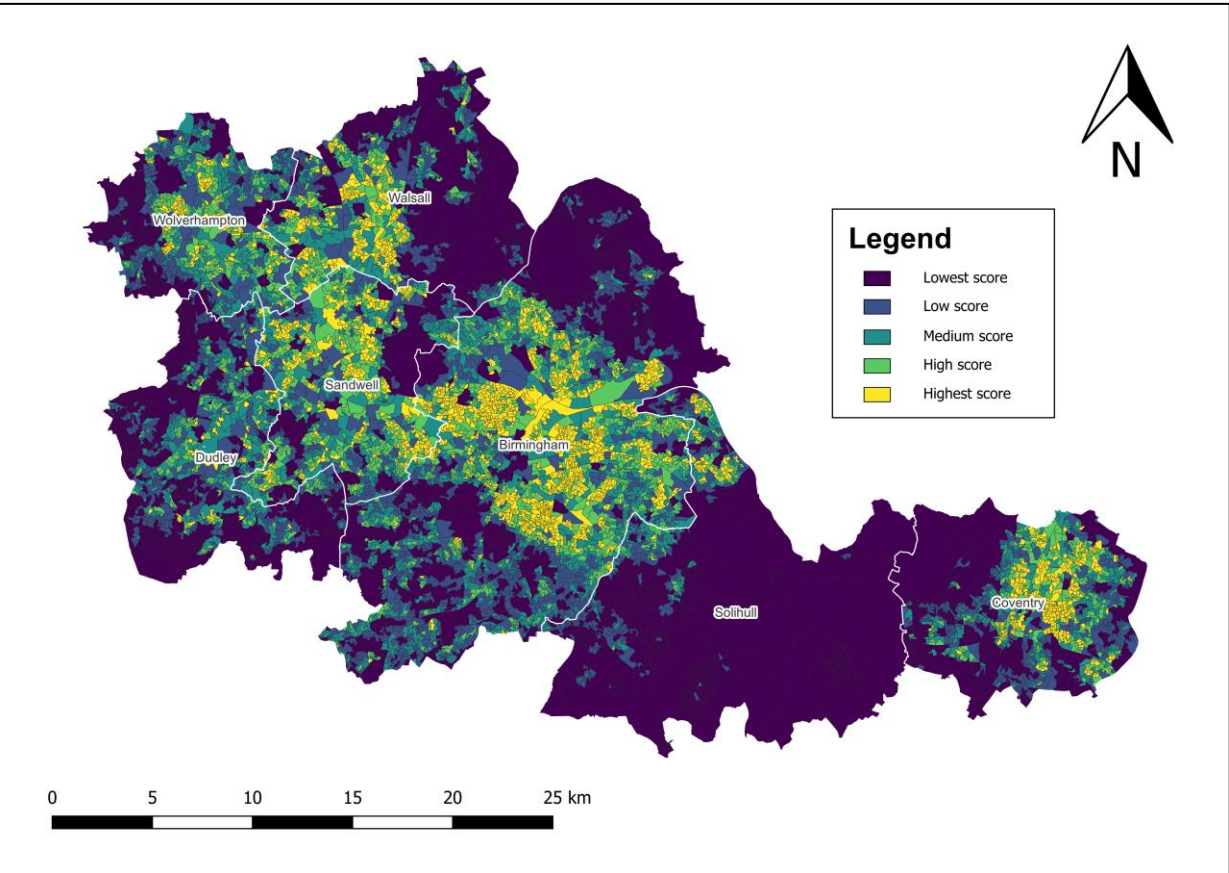


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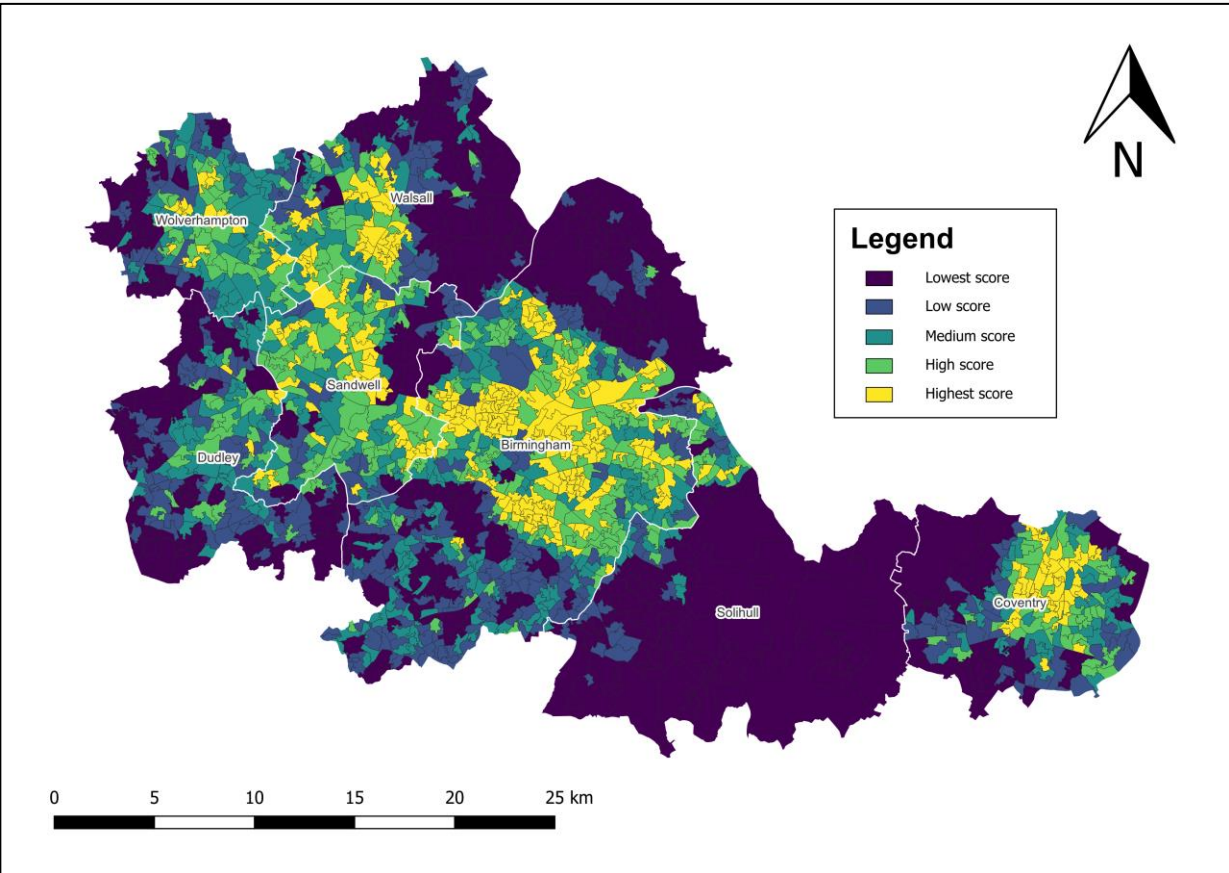
... we also tested the approach for transport with further support from Transport for West Midlands!

CRVA: v2 for the West Midlands

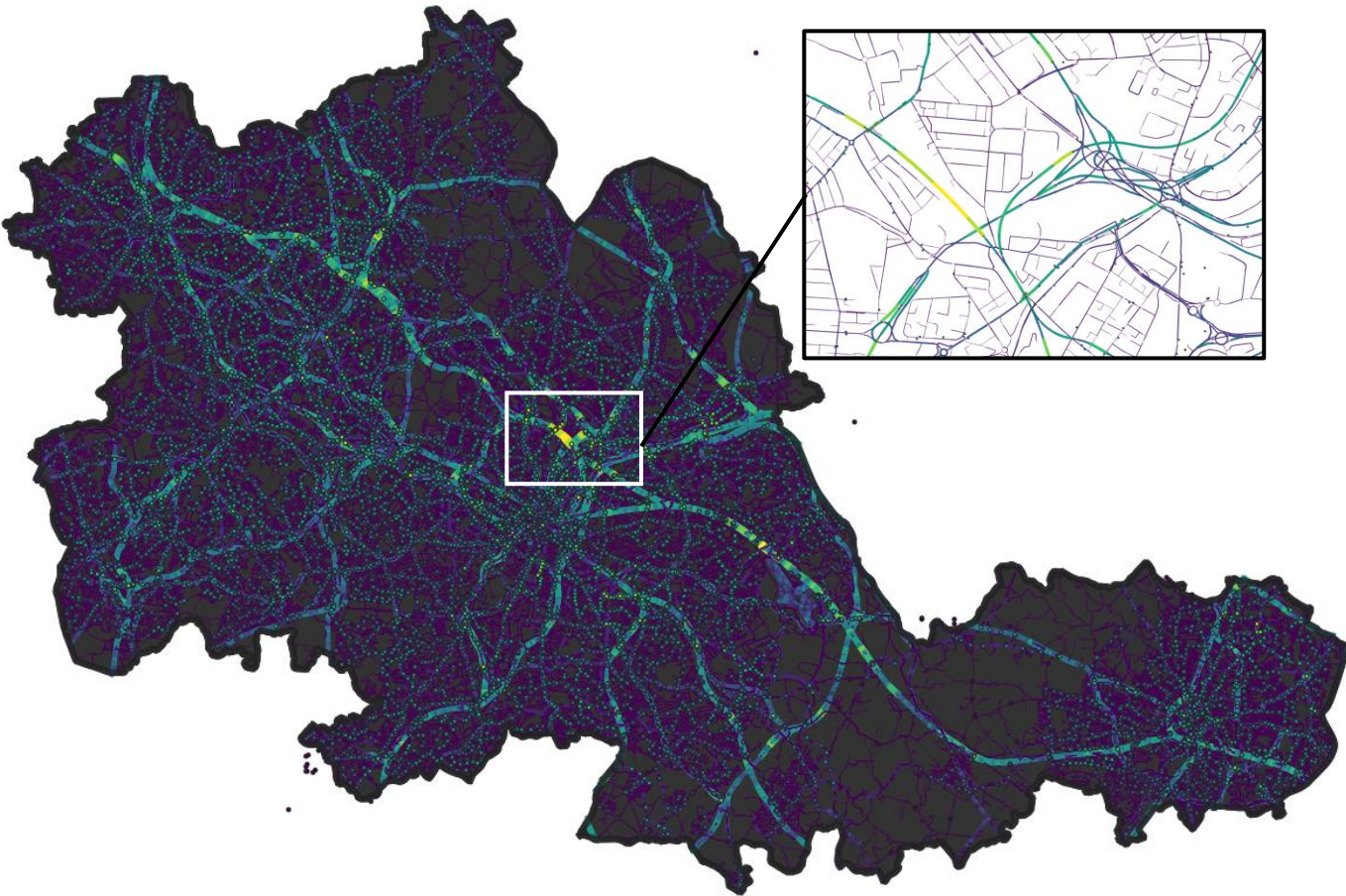
Average CRVA score by Output Area



Average CRVA score by Lower Super Output Area



CRVA: v2 for the West Midlands transport sector



1. Data collection

Combining many different datasets representing climate risk. These include:

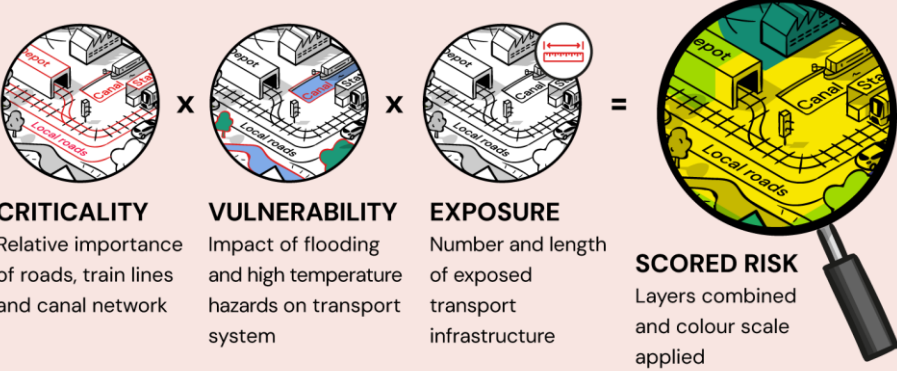
- Datasets that represent climate HAZARDS, or could worsen a climate hazard, e.g.
- Flood Zones
 - Landsat Surface Temperature
 - LiDAR derived tree cover
 - Topographical data
 - Geological information
 - Location of water courses.



- Datasets that represent the CRITICALITY AND VULNERABILITY of different transport types, e.g.
- Key route network
 - Strategic road network
 - Agree diversion routes
 - Traffic census information
 - Bus routes / frequency
 - Station patronage
 - Car park spaces
 - Accessibility indicators
 - Cycle routes.
- Datasets to map the transport EXPOSURE to climate change, e.g.
- Networks: road, rail, tram, cycle and bus
 - Airports, depots, bridges, park & ride, stops.

2. Scoring the data

We have taken a section of the map to explain how we score the data. We combine a number of factors to arrive at a scored risk at each location.



CRVA: v2 for the West Midlands



Greenham, SV., Ferranti, EJS., Cork, NA., Jones, SA., Zhong, J., Haskins, B., Higgins, W., Grayson, N., Needle, S., Acton, WJF., MacKenzie, AR., Bloss, JW. 2024. Mapping climate risk and vulnerability in the West Midlands. A guidance document produced by the WM-Air project, University of Birmingham. Funding provided by NERC innovation grant NE/S003487/1. Ferranti acknowledges EPSRC Fellowship EP/R007365/1. <https://doi.org/10.25500/epapers.bham.xxxxxxx>

MAPPING CLIMATE RISK AND VULNERABILITY IN THE WEST MIDLANDS

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Utilising the map	5
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GIS techniques	10

A guidance document from the WM-Air project Version 1.0 October 2024

The climate is changing. As mean global surface temperatures rise, it brings changes to the climate and weather patterns. In the West Midlands, the likely changes are warmer, wetter winters; hotter, drier summers; and more extreme weather events.

We need to adapt to a changing climate. Some of the weather events we are currently experiencing is unprecedented. Without adaptation, people, infrastructure and the natural environment are more at risk to the impacts of climate change.

The impacts of climate change are felt differently across the West Midlands, as climate hazards and socio-economic factors affecting people's ability to cope are unevenly spread across the region. It is therefore important to understand the spatial patterns.

Modern society faces several challenges. These include more people living in cities¹, income and wealth inequality², increases in the cost of living³, as well as the changing climate⁴. Below are examples of five hazards connected to these challenges, which are all interlinked.



New guidance documents coming soon!

PRODUCING THE CRVA MAP

The step-by-step processes in QGIS to produce each underlying layer at the standardised 100m resolution in raster format are outlined in Table 2. Once the layers for each variable are created, those comprising hazard features and vulnerability features are each summed and rescaled to a score range of 0-1, resulting in two new layers that summarise the combination of hazard and vulnerability data respectively. Only one layer reflects exposure (population density) so no further steps are undertaken.

As shown in box 2 of Figure 1, the combined hazard, combined vulnerability and the exposure layers are combined further to produce the final risk map. This is done via raster algebra in QGIS, using the raster calculator to multiply the three layers together. It produces a final 100m raster layer that can then be rescaled again to create a total

risk score range of 0-1 across the West Midlands region. The step-by-step process to create the combined hazard and vulnerability layers, and using these with the exposure data layer to create the final CRVA map for the West Midlands is outlined in Table 3.

Using zonal statistics in QGIS, the 100m raster layer can be aggregated to different area scales. It produces risk scores based on the average of all 100m raster cell scores within each area. Figure 2 shows the average total risk score map for the West Midlands region at Output Area (OA) level. These are areas of between 40 and 250 households and a resident population typically between 100 and 625 persons²⁷. It shows that climate risk and vulnerability are unevenly distributed across the West Midlands. Many areas must at risk are within Birmingham.

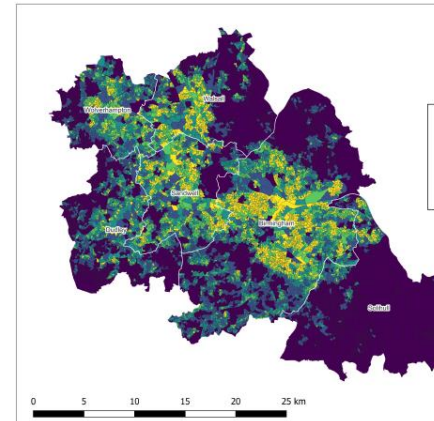


Figure 2. Total CRVA risk map for the West Midlands at OA level. White boundaries and labels denote the 7 council areas.

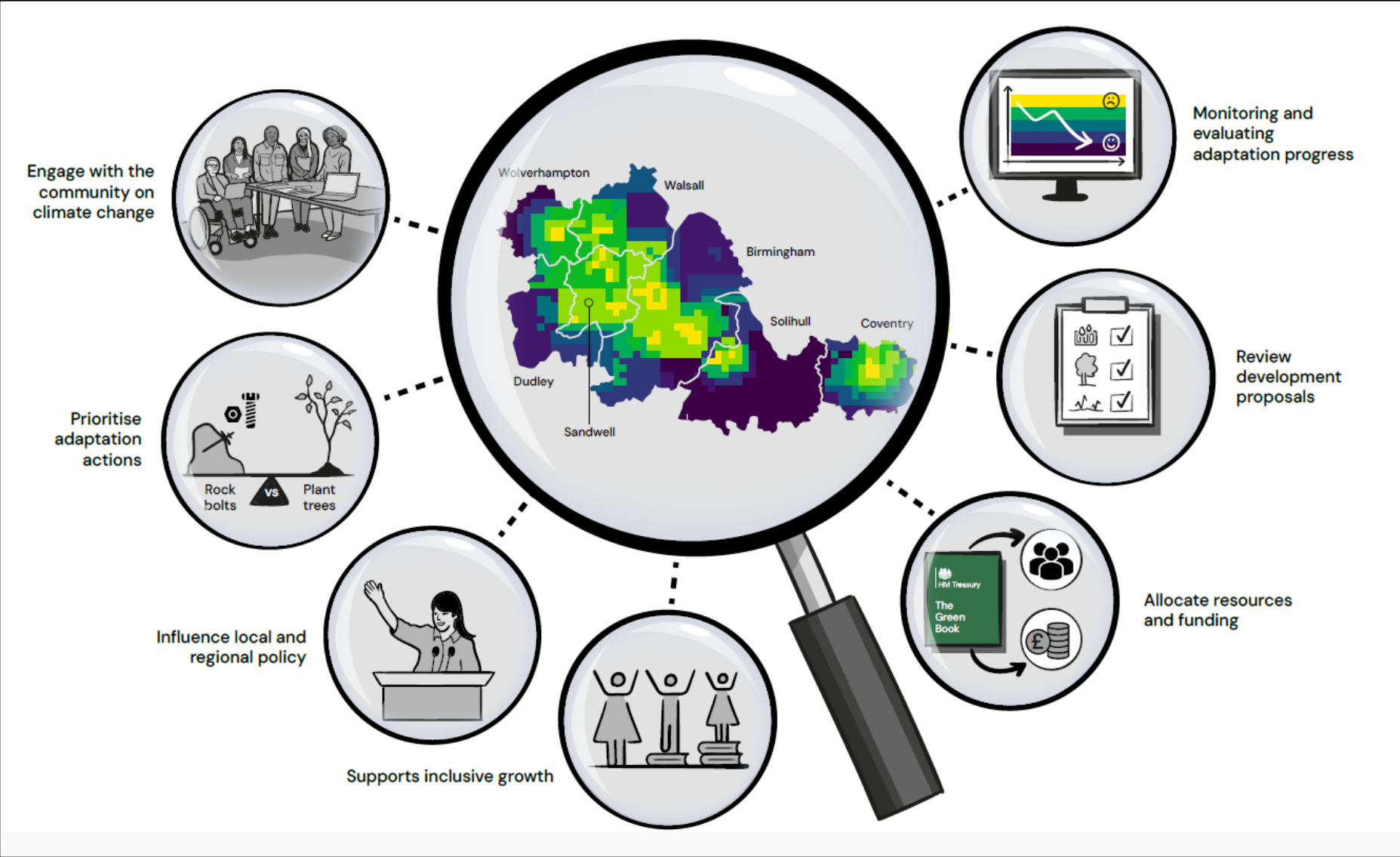
References
 27. ONS (n.d.) Census 2021 Statistical geographies. An overview of the statistical geographies in the four countries <https://www.ons.gov.uk/methods/geography/geographies/geographies-statistical-geographies>. Last accessed 17/09/2024.
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 30. Islam & Winkel (2017) Climate Change and Social Inequality. United Nation Department of Economic & Social Affairs. Available at <https://www.ons.gov.uk/methods/geography/geographies/geographies-statistical-geographies>. Last accessed 23/09/2024.
 31. Sheng et al. (2023) Climate shocks and wealth inequality in the UK: Evidence from monthly data. *Environment*, pp.7771-7773.

Table 2. Conversion processes of each layer underlying the CRVA process

	Data layer	Converted layer	GIS processing
Households deprived regarding housing			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)
Households with dependants under 15 years			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)
Households of single occupancy over 65 years			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)
Population of ethnic minority			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)
Population whose main language is not english			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)
Households with no access to a car or van			<ul style="list-style-type: none"> In the .csv file, calculate the % of each OA that falls into the criteria Join .csv file to OA boundary vector file by OA name Join to grid - 100m fishnet grid by majority score according to OA area intersecting the fishnet grid Rasterise using 100m fishnet grid resolution and extent Use quantile function to determine 20 quantile bins (5%iles) Reclassify by table according to bin values (0-1, 0.05 intervals)

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How might this map help the West Midlands?



How might this map help the West Midlands?

West Midlands Environment & Net Zero Dashboard

In June 2019, the West Midlands Combined Authority (WMCA) declared a climate emergency.

The WMCA Board agreed a target for the region to reach net zero carbon emissions by 2041.

A subsequent 'green paper' was written to indicate how the region could take action in order to reach net zero carbon emissions by 2041 and was consulted upon in early 2020.

The purpose of this tool is to pull together relevant published, publicly accessible data regarding net zero carbon and environmental priorities into a single resource.

Click on the buttons below to view the data

- Greenhouse Gas Emissions
- Energy
- Natural Environment (coming soon)
- Climate Adaptation (coming soon)**
- Circular Economy (coming soon)
- Air Quality (coming soon)
- Transport (coming soon)
- Business as usual (coming soon)

CRVA legacy and future development

CARMINE

CLIMATE RESILIENT DEVELOPMENT PATHWAYS
IN METROPOLITAN REGIONS OF EUROPE



Goal: To help metropolitan communities become more climate resilient by co-producing knowledge-based tools, strategies and plans for enhanced adaptation and mitigation actions.

Budget: EU Contribution: approx. €10,17M

of Partners: 32 from 11 countries

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them. UK participants in this project are co-funded by UK Research and Innovation (UKRI). The work of the Meteomatics partner (Switzerland) has received funding from the Swiss State Secretariat for Education (SERI).



8 CASE STUDY AREAS

- 

Prague (CZ)
- 

Leipzig (DE)
- 

Funen-Odense (DK)
- 

Athens (EL)
- 


Barcelona (ES)
- 


Bologna (IT)
- 


Braşov (RO)
- 


Birmingham (UK)



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