

# Heatwave Vulnerability in Hounslow

Nick Benoit, Jerry Brown, Benjamin Mattiuzzi, Connor Murphy



**London Borough  
of Hounslow**



**WPI**





# Roadmap

- Project Goals
- Previous Project Review
- Identification of Vulnerability Data
  - Indices of Multiple Deprivation
  - MOSAIC
  - Census Age Data
  - Indoor Temperature Model
  - GIS Maps from Earthlight
- Data Assessment
- Conclusions
- Recommendations

# Project Goals



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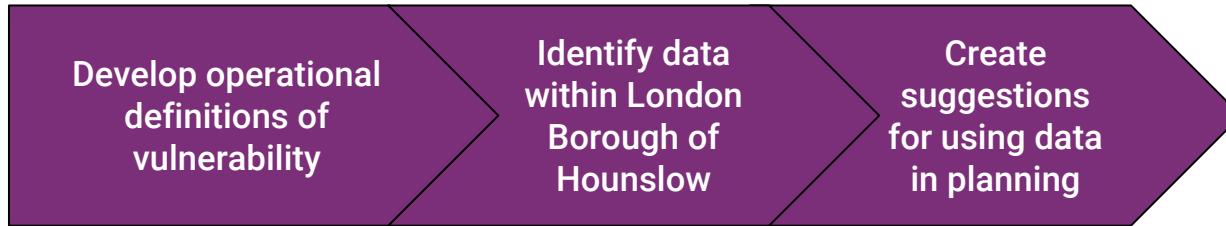


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# Project Goals

**Main Objective:** Identify data within the London Borough of Hounslow for use in heatwave emergency planning



**Project Partners:** Greater London Authority, Public Health England, University College London, London Climate Change Partnership



# Previous Project Review



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# LUCID

```
graph TD; LUCID[LUCID] --- M1[Module 1]; LUCID --- M2[Module 2]; LUCID --- M3[Module 3]; LUCID --- M4[Module 4]; LUCID --- M5[Module 5]; M1 --- MD[Model Development]; M2 --- VT[Validity Testing]; M3 --- EUL[Energy Use Urban form Local Temp.]; M4 --- AH[Application on Health]; M5 --- FR[Final Report];
```

Module 1

Model  
Development

Module 2

Validity  
Testing

Module 3

Energy Use  
Urban form  
Local Temp.

Module 4

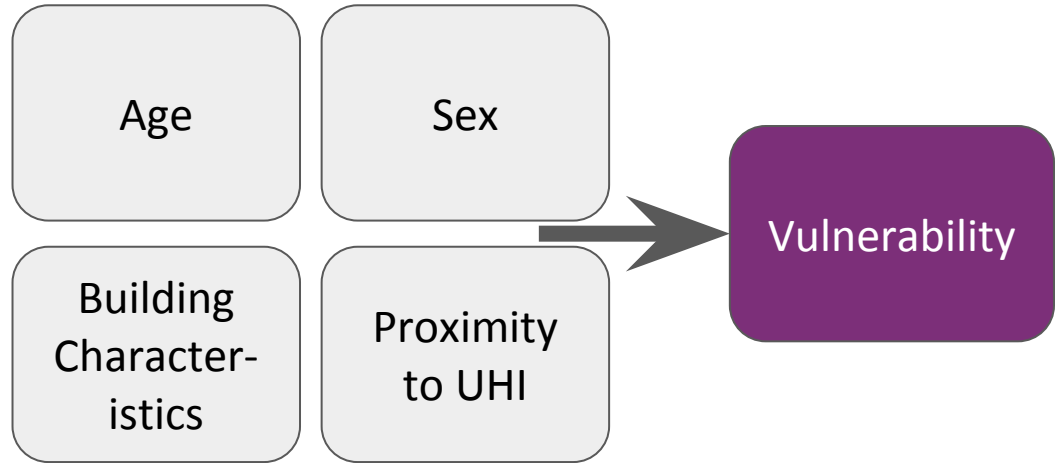
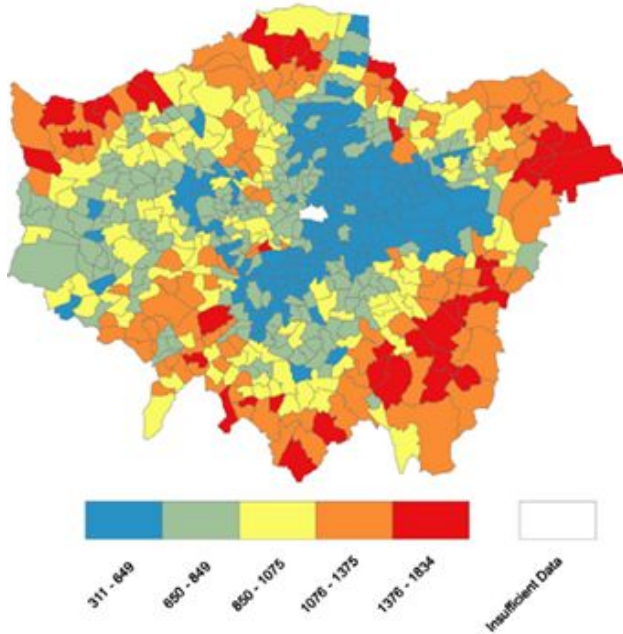
Application  
on Health

Module 5

Final Report



# Triple Heat Jeopardy



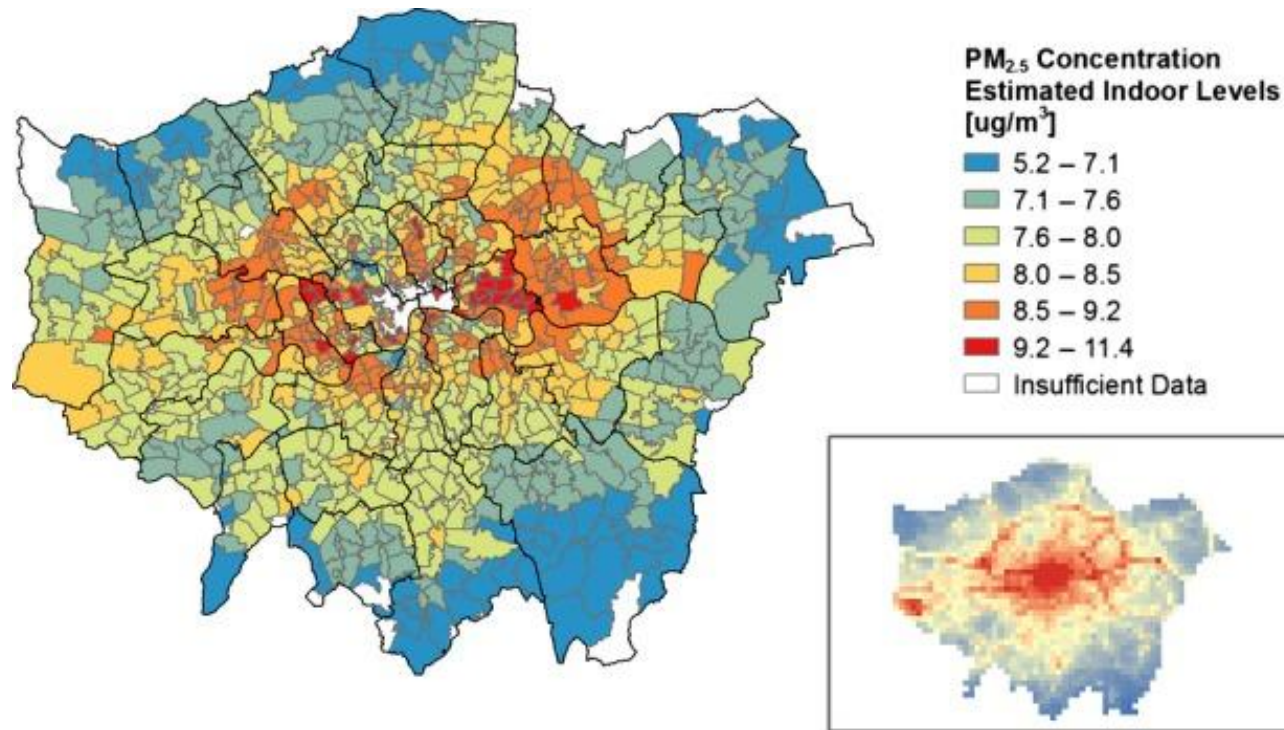


AWESOME

Air pollution and WEather-related health impacts: methodological study based on Spatio-temporally disaggregated multi-pollutant models for present-day and future.



# AWESOME



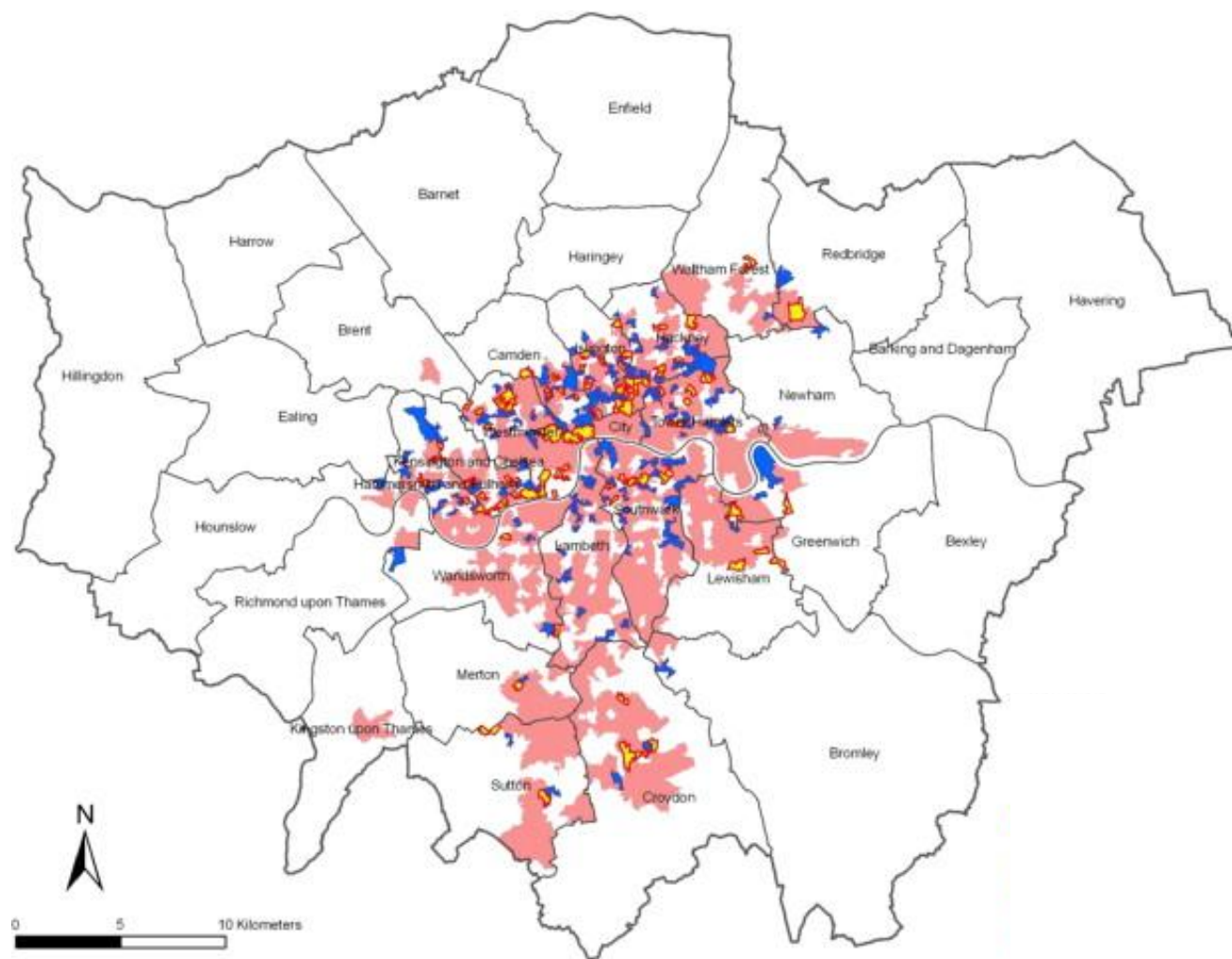
Average simulated  
PM<sub>2.5</sub> Concentration  
in London.

The inset is an  
image of the  
estimated PM<sub>2.5</sub>  
Concentration used  
in the model.



# Heatwave Vulnerability Index





# Individual exposure and adaptive capacity



# Identification of Vulnerability Data



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## London Borough of Hounslow

### Housing Investment Team

Rory Prendergast  
Martin Tompkins

### GIS Team

Vinesh Govind

### Health and Wellbeing

Laura Maclehose

### Adult Social Care

John Morgan  
Andrew Heap

### Information Governance

Matthew Kay

### Head of Contingency Planning and Resilience

Twam Palmer

## Hounslow Heatwave Steering Group

### University College London

Anna Mavrogianni  
Jonathon Taylor  
Clive Shrubsole

### Public Health England

Angie Bone  
Ross Thompson

### Greater London Authority

Emer O'Connell  
Annette Figueiredo

### World Health Organization

Tanja Wolf

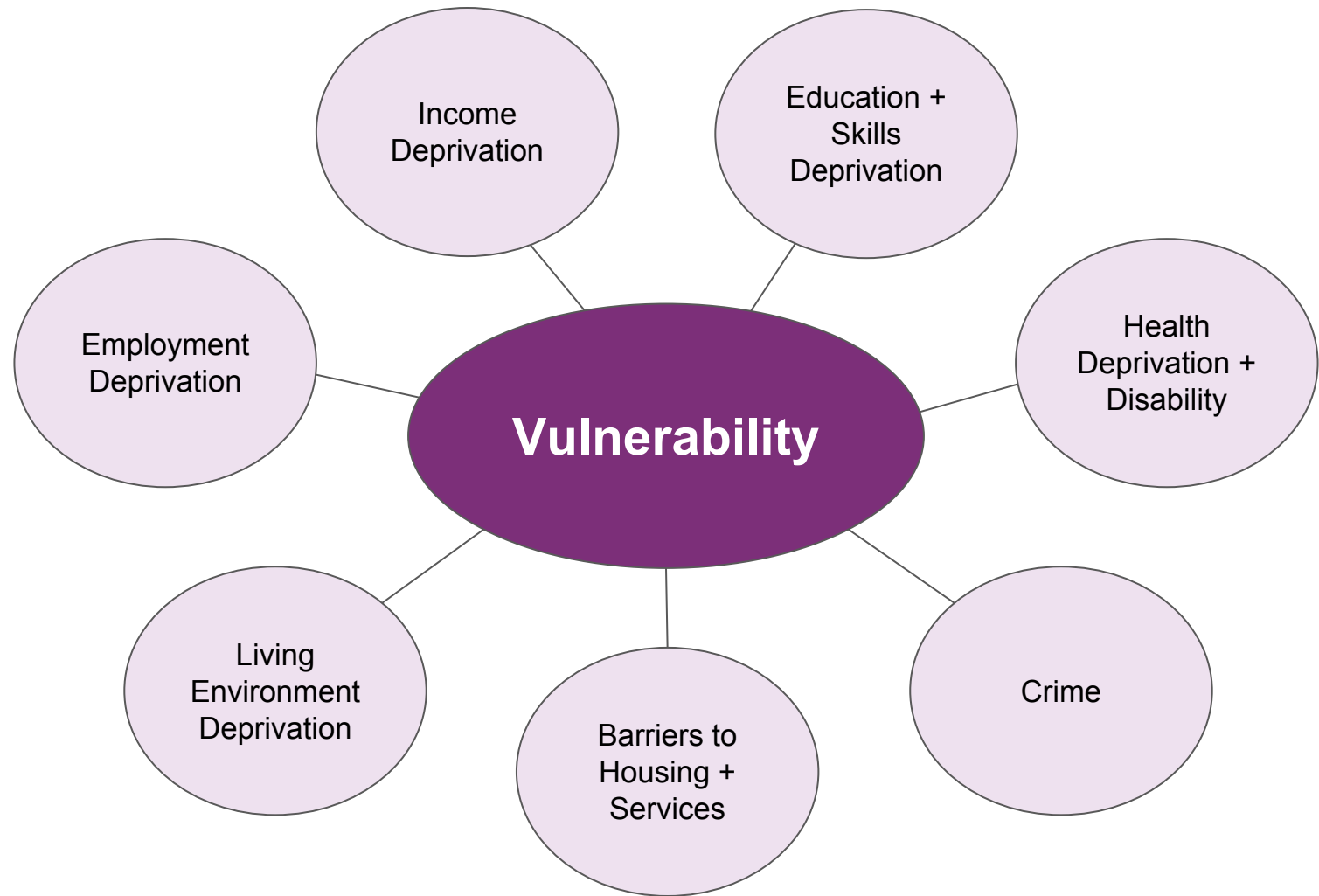
# Indices of Multiple Deprivation



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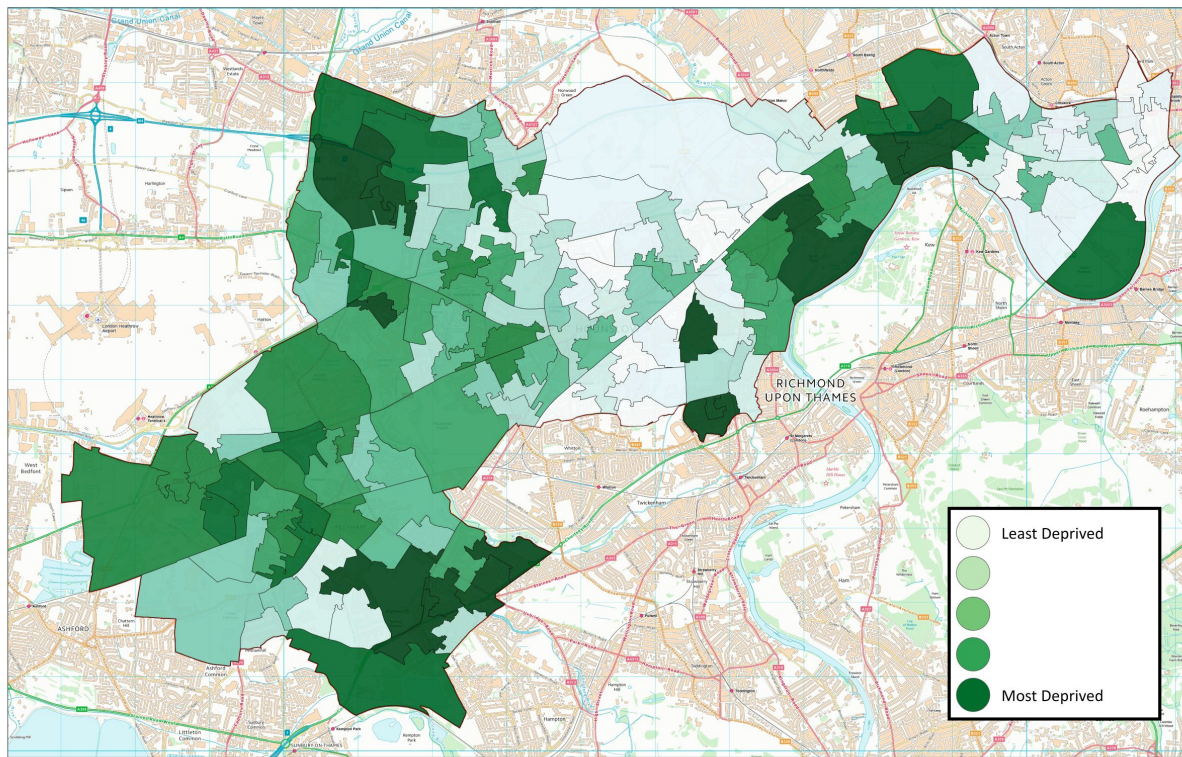


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| Domain  | Weight        |
|---|---------------|
| <b>Income deprivation</b>                         | <b>22.50%</b> |
| Employment deprivation                            | 22.50%        |
| <b>Education, skills and training deprivation</b> | <b>13.50%</b> |
| > <i>Skills subdomain</i>                         | 6.75%         |
| > <i>Children and Young People subdomain</i>      | 6.75%         |
| <b>Health deprivation and disability</b>          | <b>13.50%</b> |
| <b>Crime</b>                                      | <b>9.33%</b>  |
| <b>Barriers to housing and services</b>           | <b>9.33%</b>  |
| > <i>Wider Barriers subdomain</i>                 | 4.67%         |
| > <i>Geographical Barriers subdomain</i>          | 4.67%         |
| <b>Living Environment deprivation</b>             | <b>9.33%</b>  |
| > <i>Indoor subdomain</i>                         | 6.22%         |
| > <i>Outdoors subdomain</i>                       | 3.11%         |

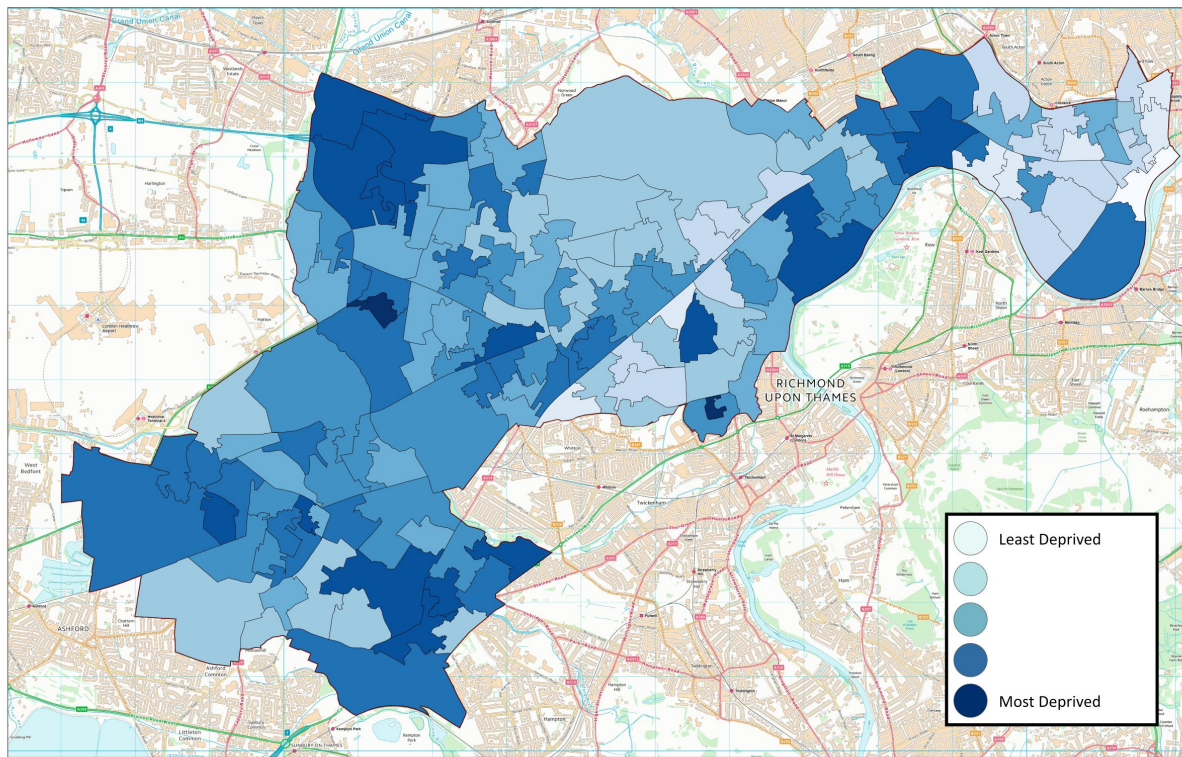
# Hounslow IMD Deciles 2010



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0 0.25 0.5 0.75 1 kilometres 1:20000

# Hounslow IMD Deciles 2015



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0 0.25 0.5 0.75 1 kilometres 1:20000

# MOSAIC

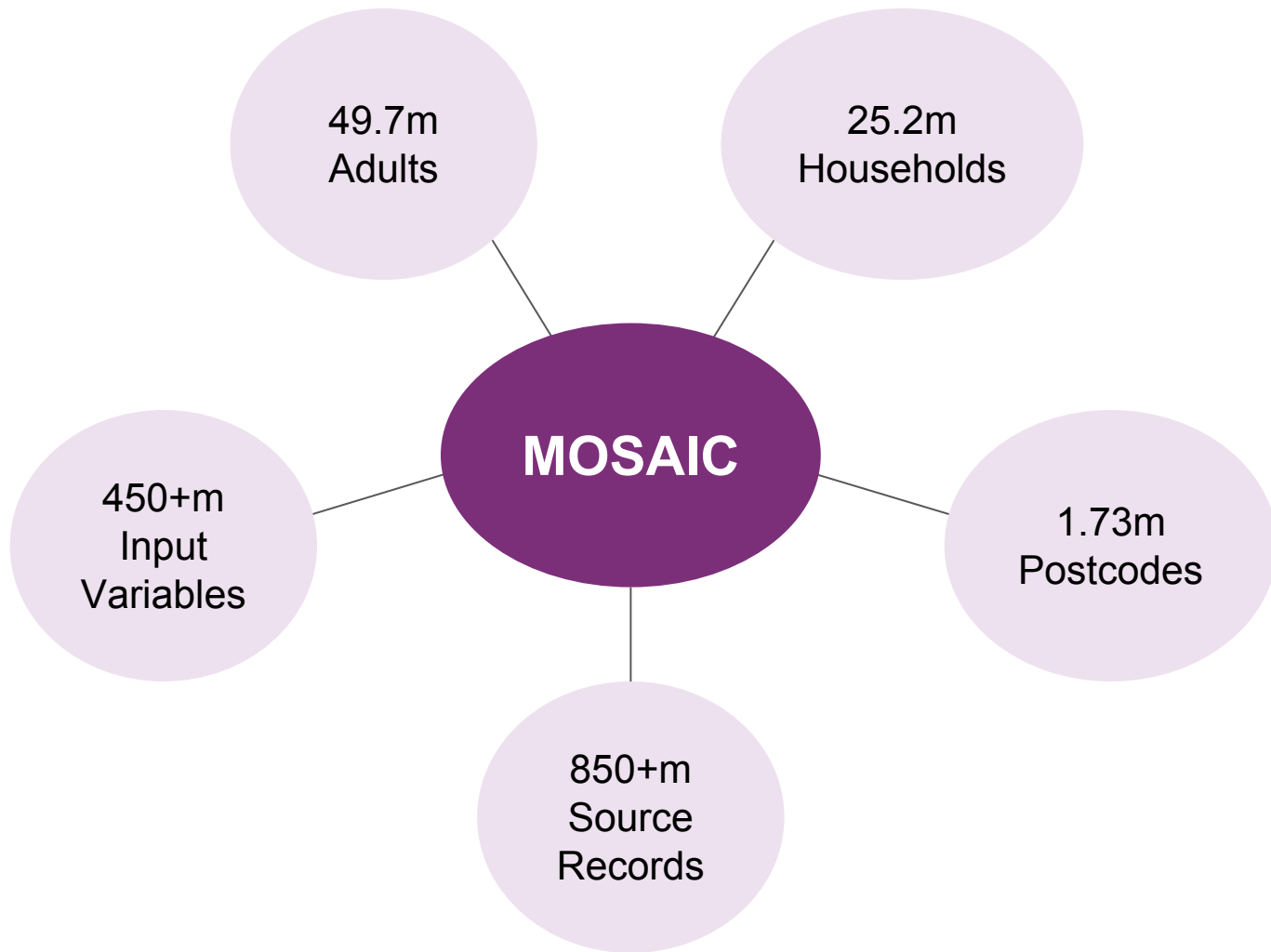


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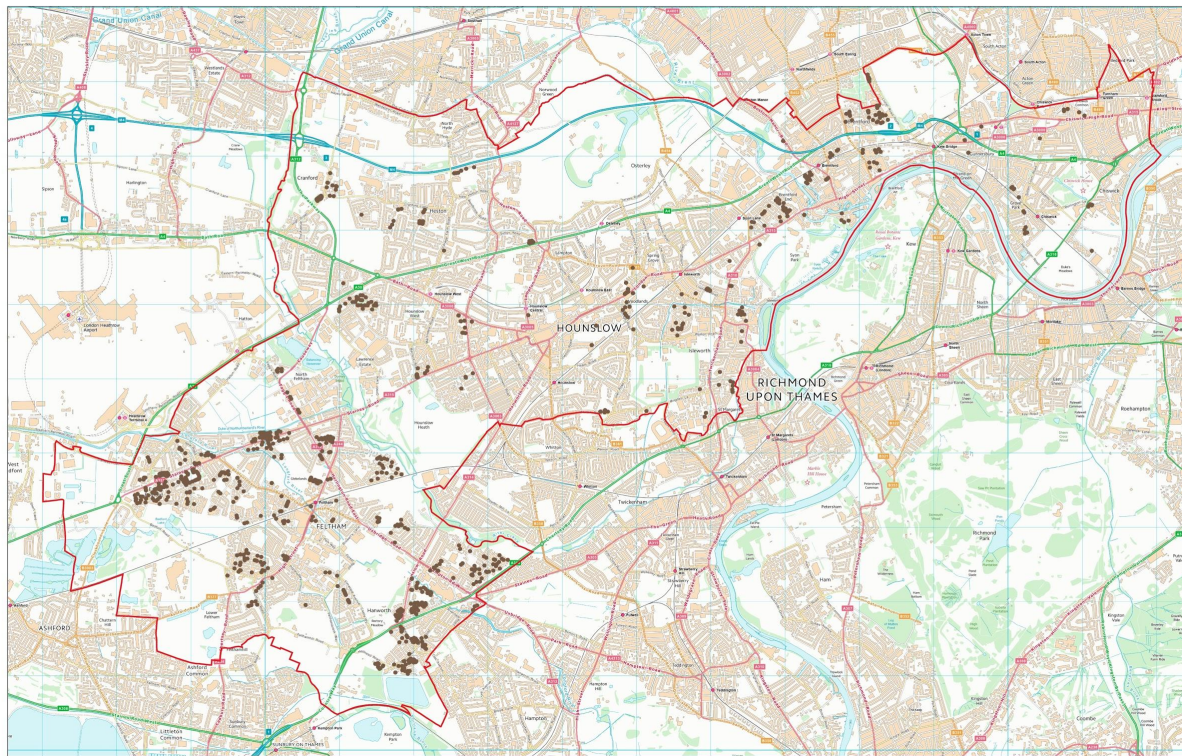


WPI





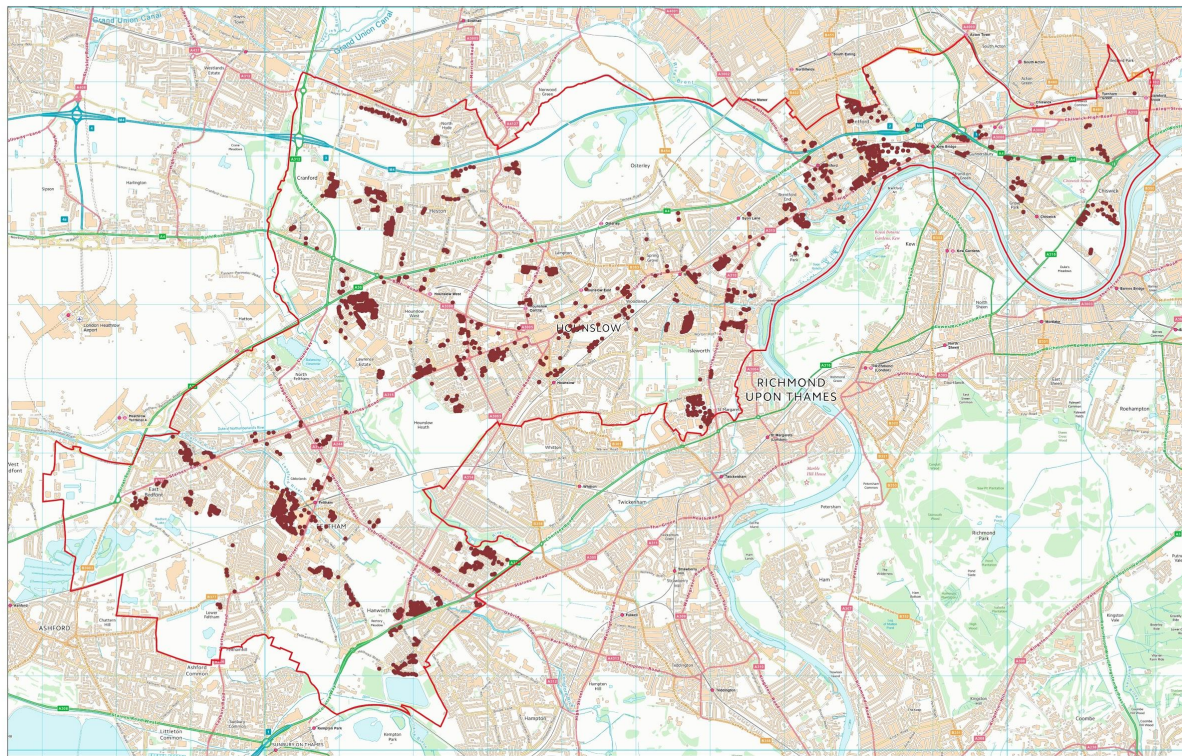
# MOSAIC Group N



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0 0.25 0.5 0.75 1 kilometres 1:20000

# MOSAIC Group O



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0 0.25 0.5 0.75 1 kilometres  
1:20000

# Person Aged 65+ (Census)



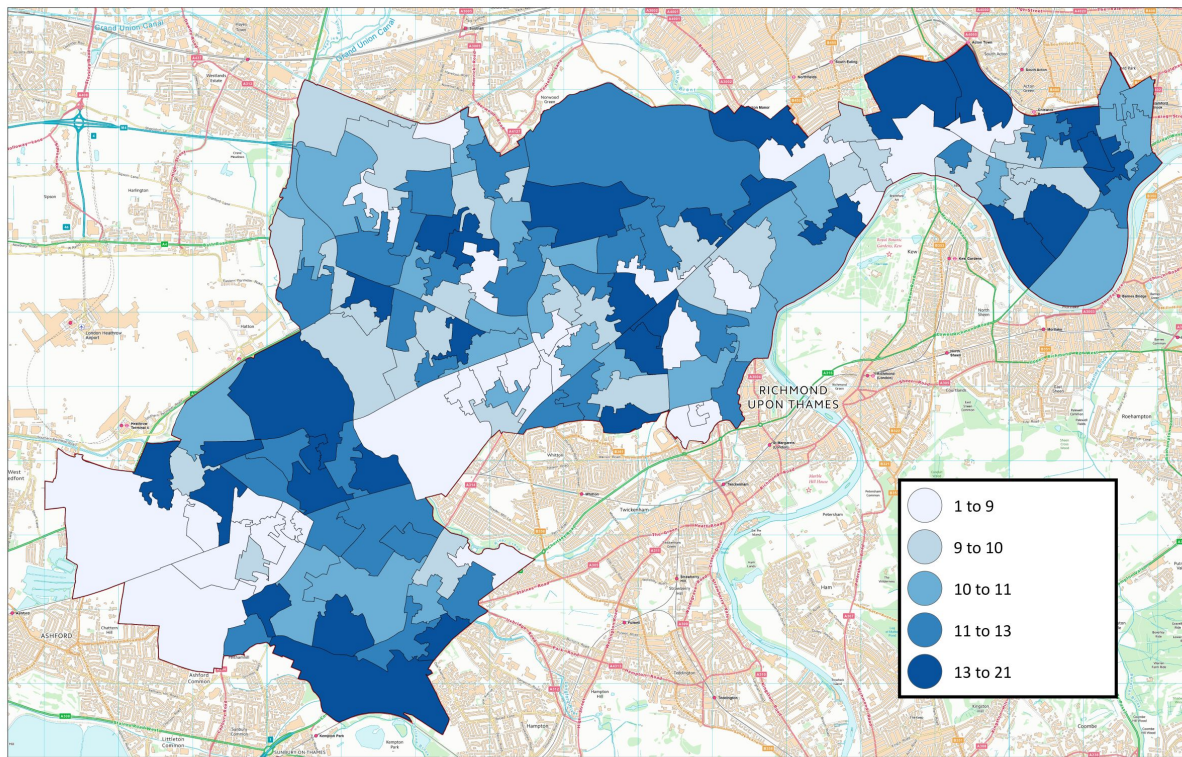
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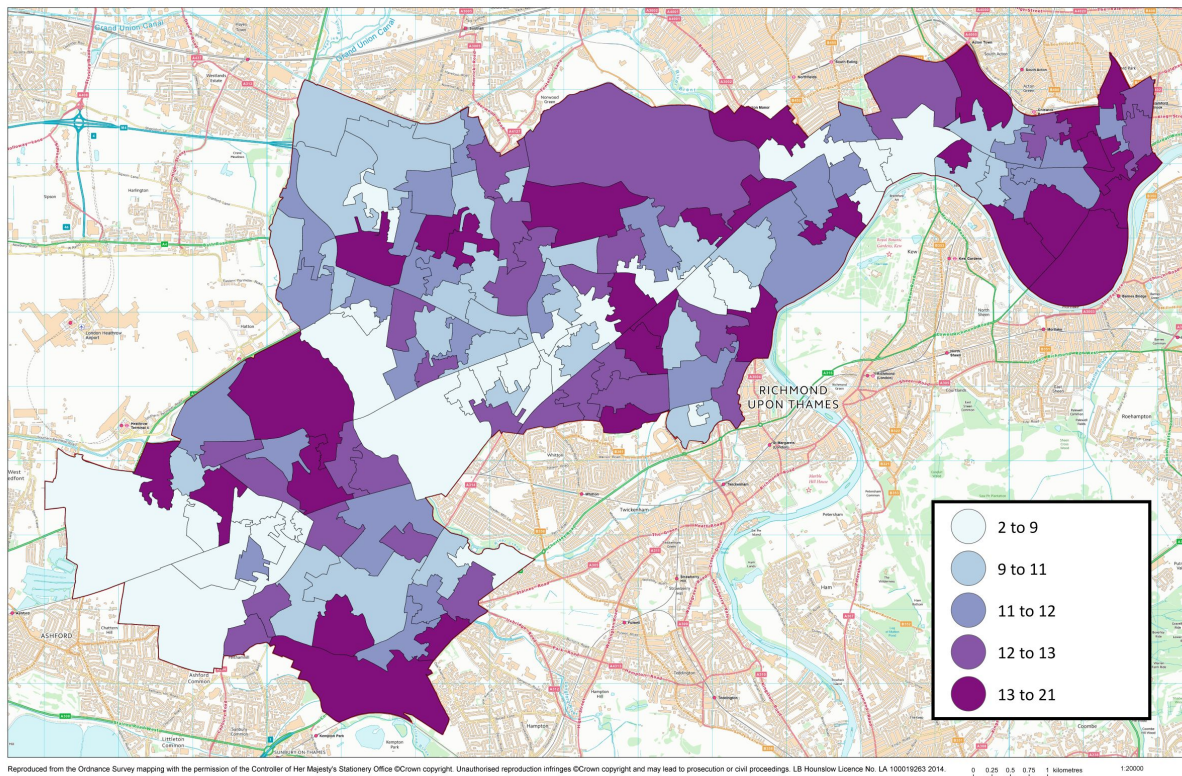
## 2011 Census Hounslow Residents Aged 65+



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0 0.25 0.5 0.75 1 kilometres 1:20000

## 2015 Midyear Estimates Citizens Aged 65+



# Indoor Temperature Model

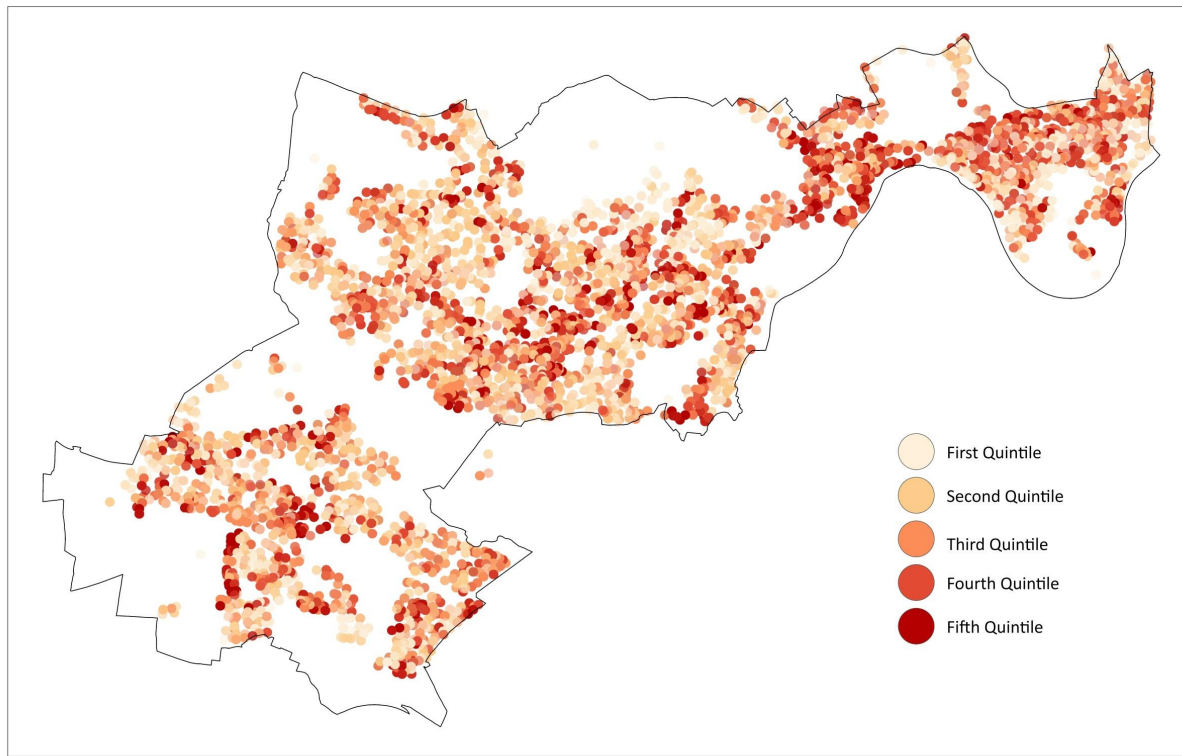


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## Indoor Overheating 18 C Outdoor Temperature



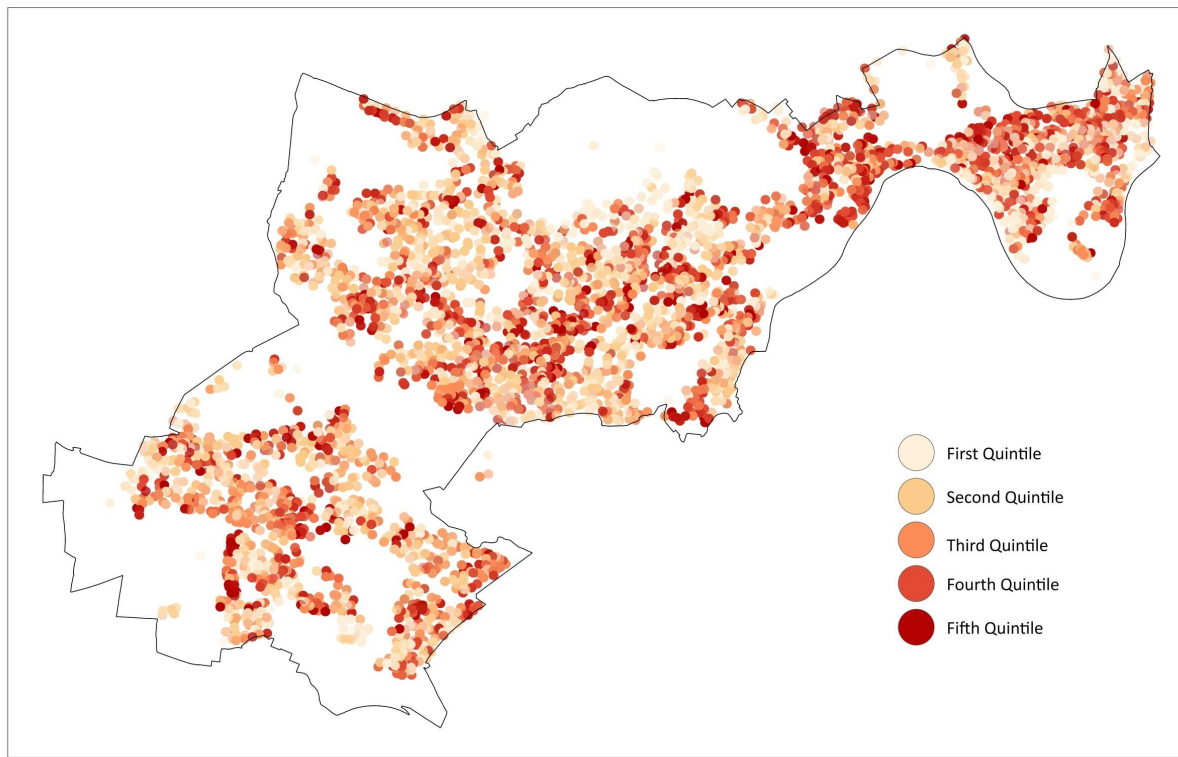
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0 0.25 0.5 0.75 1 kilometres

1:20000



## Indoor Overheating 20 C Outdoor Temperature

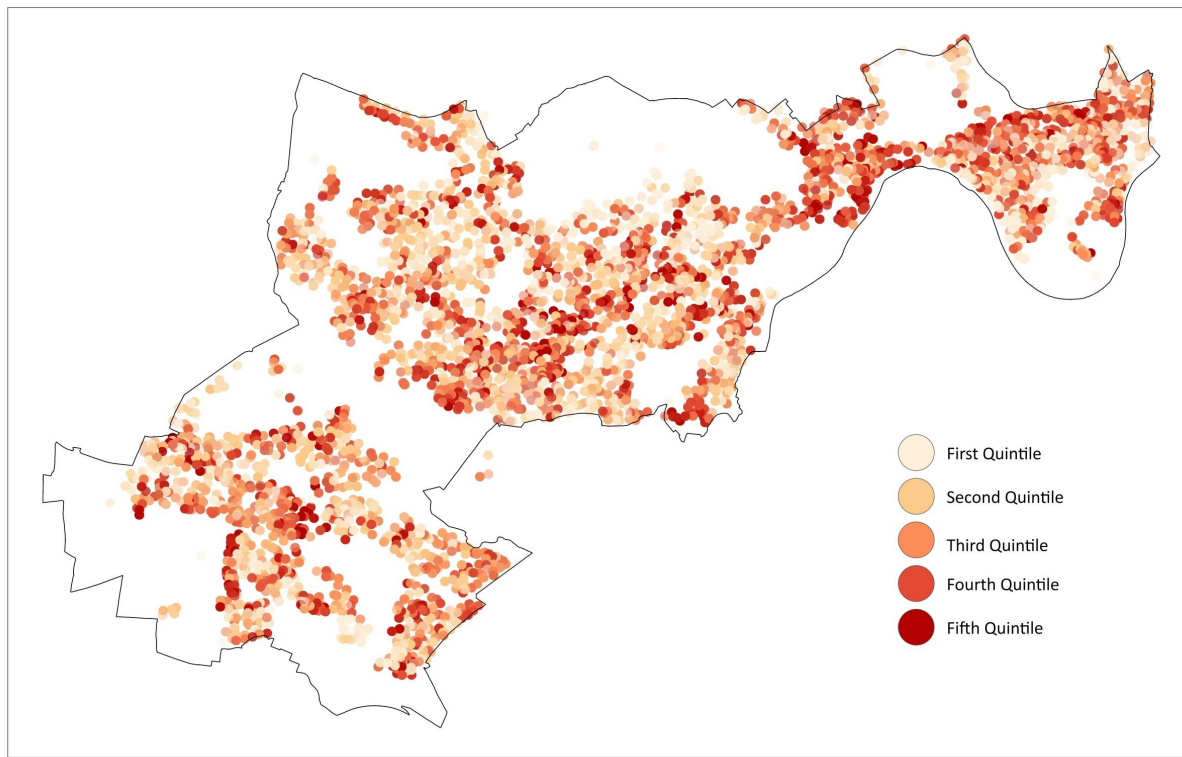


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0 0.25 0.5 0.75 1 kilometres

1:20000

## Indoor Overheating 22 C Outdoor Temperature

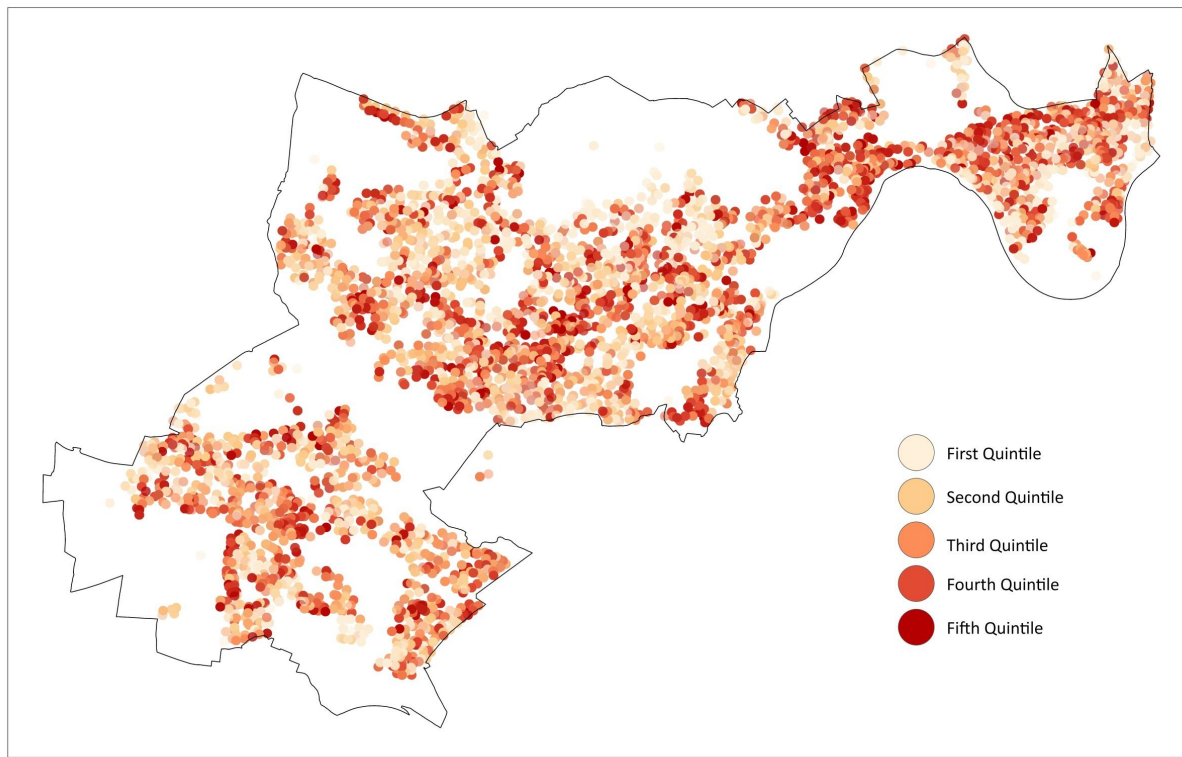


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0 0.25 0.5 0.75 1 kilometres

1:20000

## Indoor Overheating 24 C Outdoor Temperature

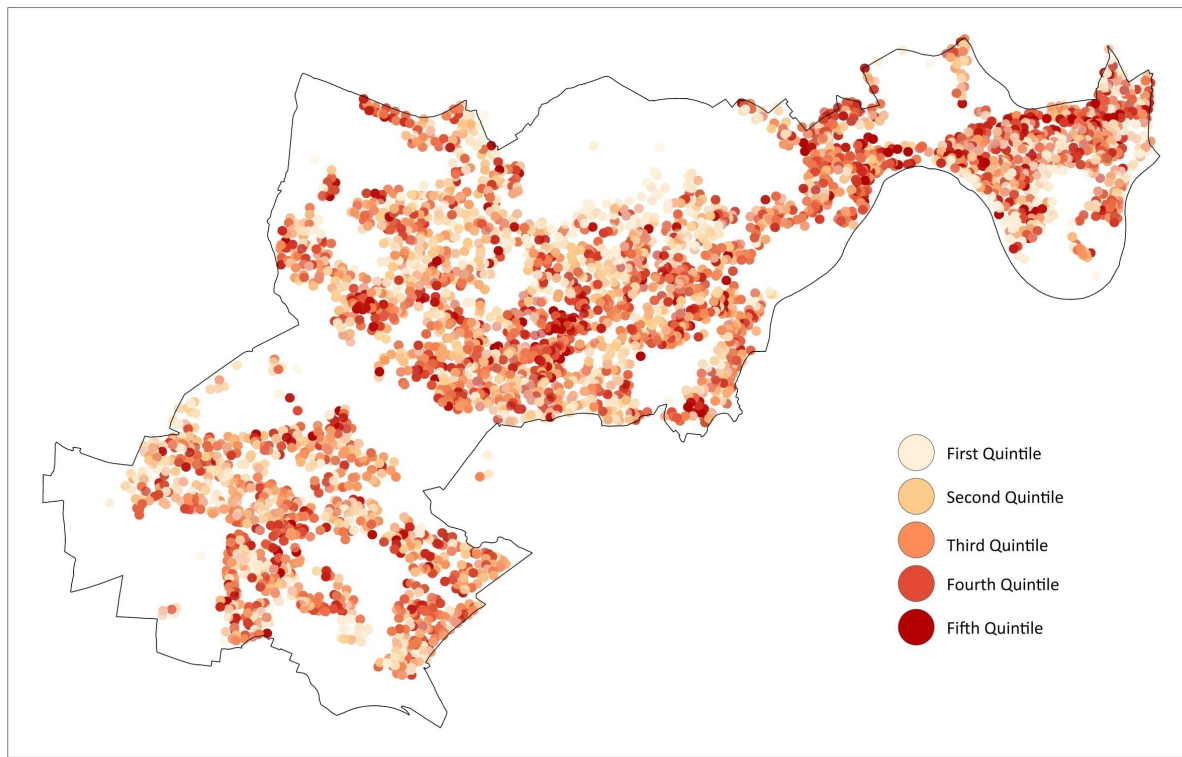


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0 0.25 0.5 0.75 1 kilometres

1:20000

## Indoor Overheating 26 C Outdoor Temperature

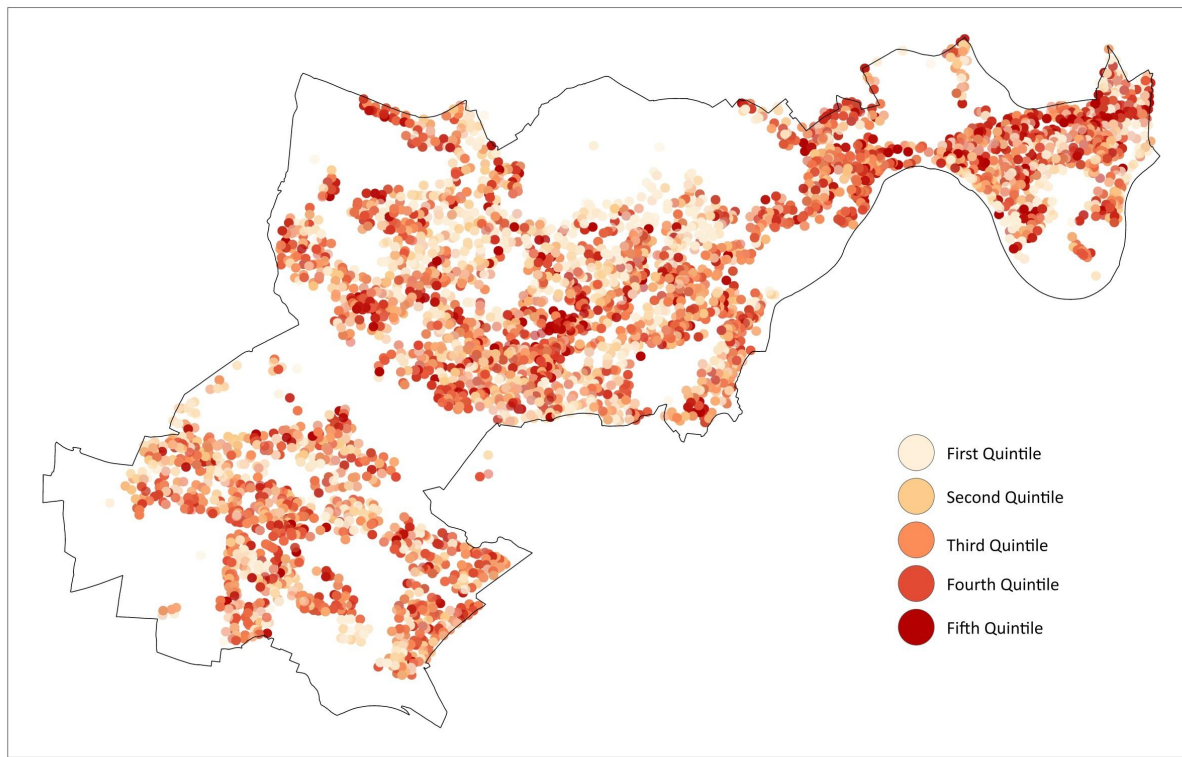


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0 0.25 0.5 0.75 1 kilometres

1:20000

## Indoor Overheating 28 C Outdoor Temperature



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0 0.25 0.5 0.75 1 kilometres

1:20000

# Other GIS Maps

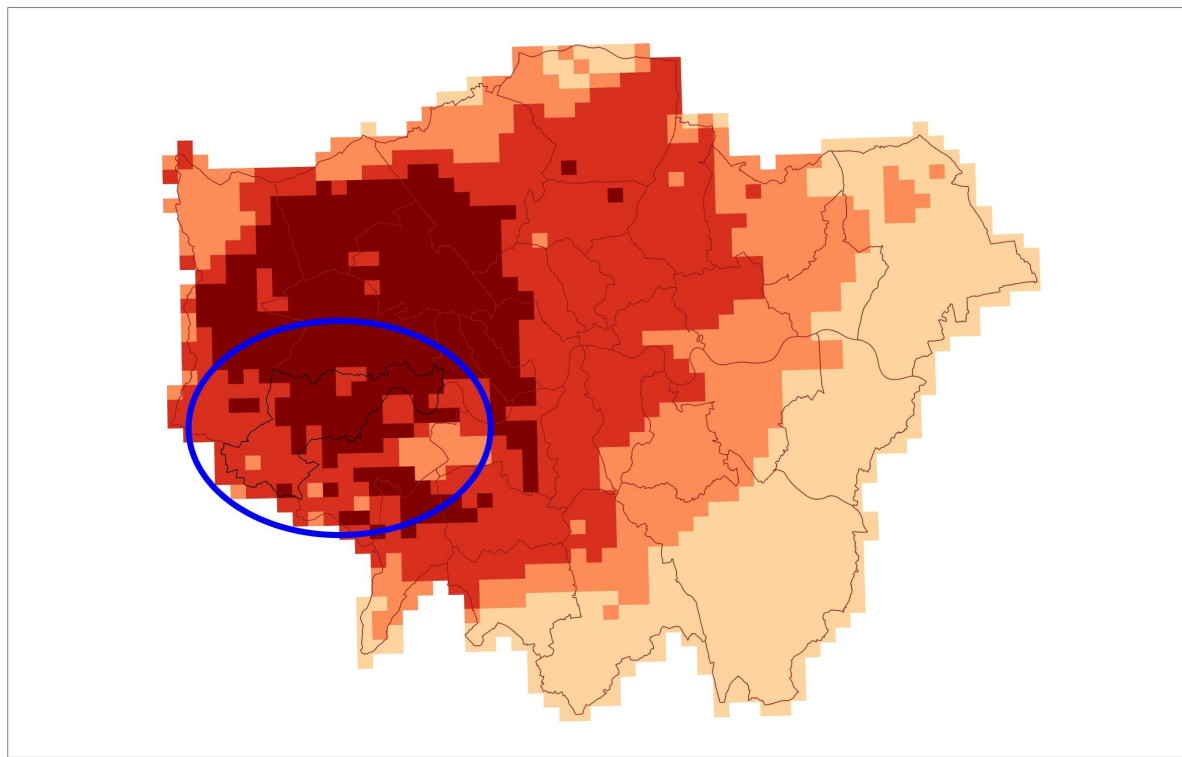


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# London Urban Heat Island



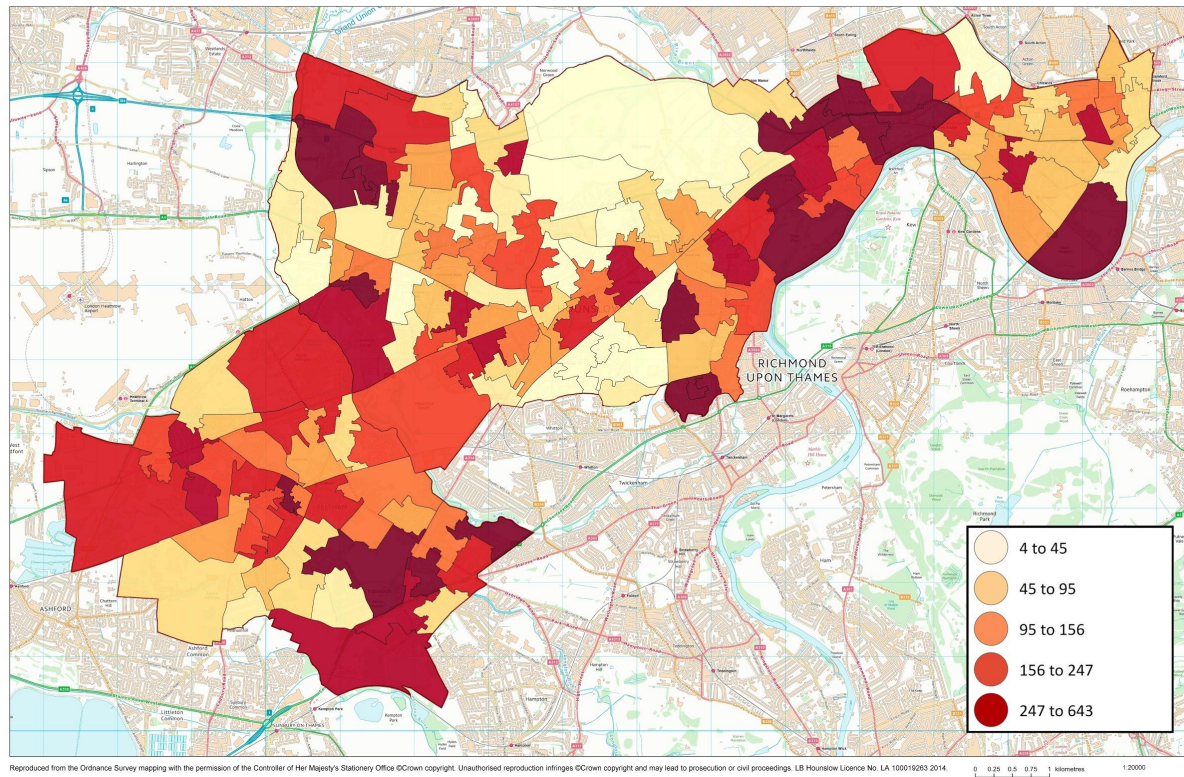
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0 1 2 3 4 kilometres

1:100000

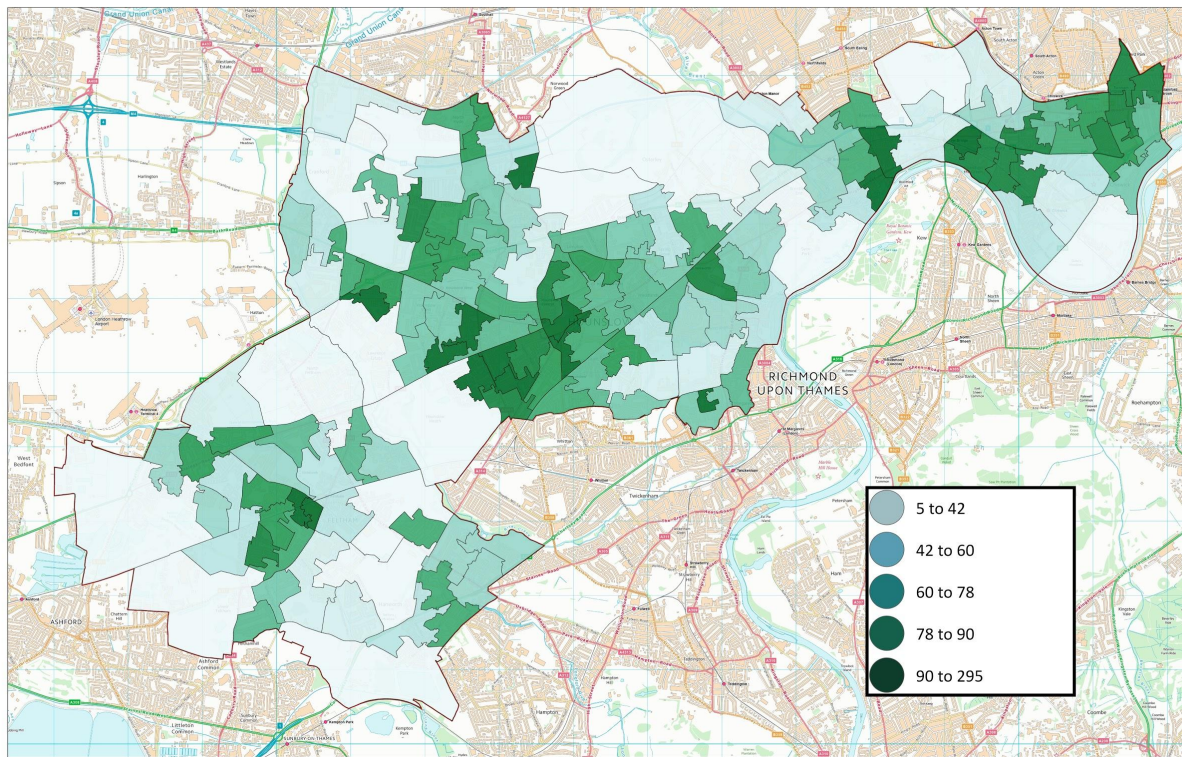


## Rented Tenure





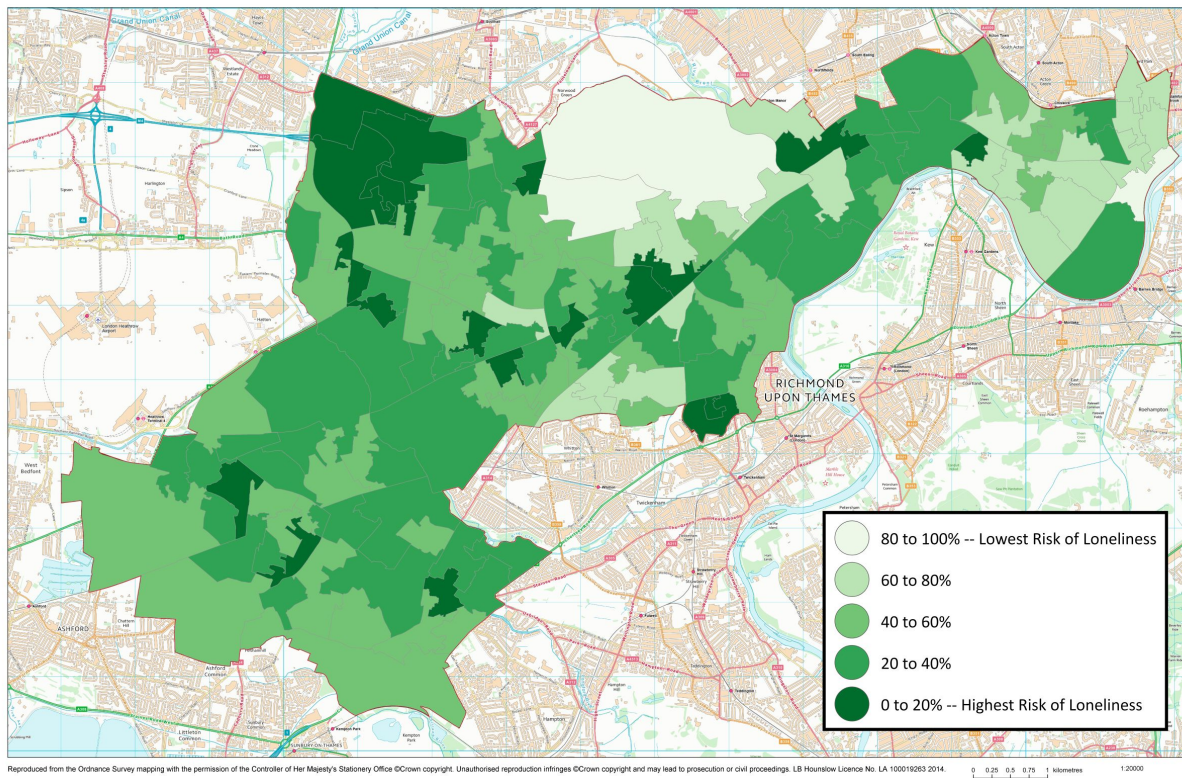
# Population Density



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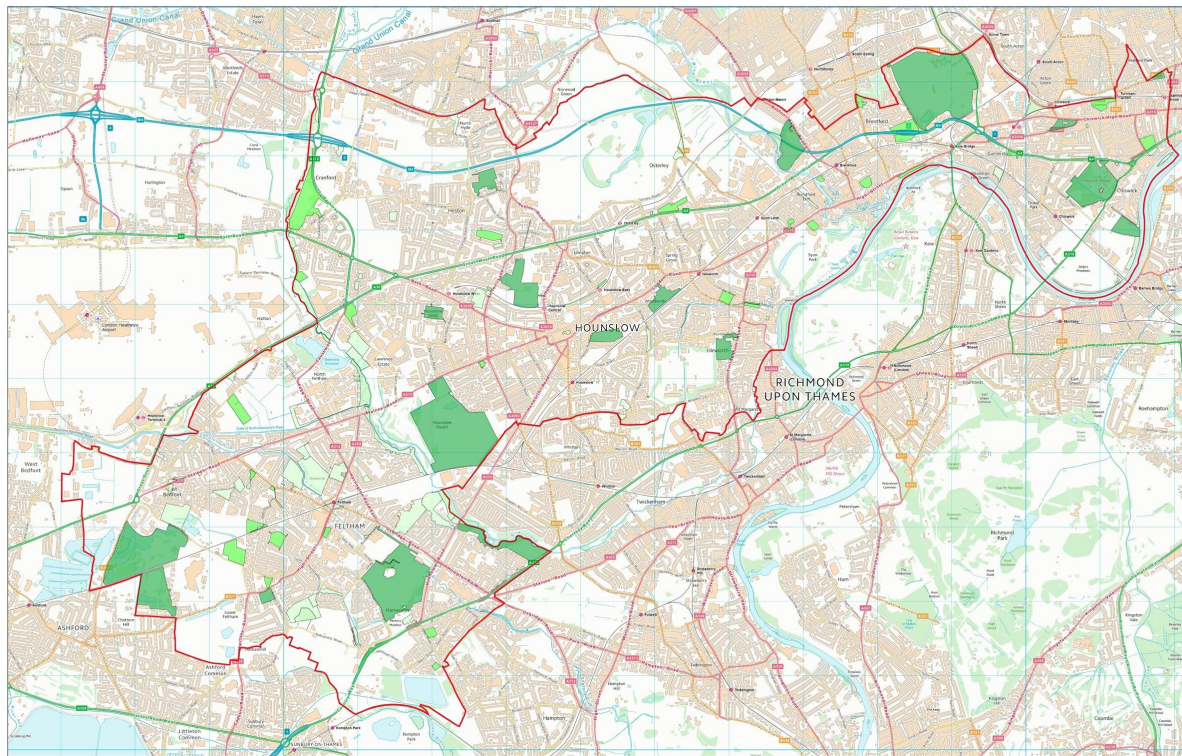
0 0.25 0.5 0.75 1 kilometres 1:20000

## Risk of Loneliness in Older People





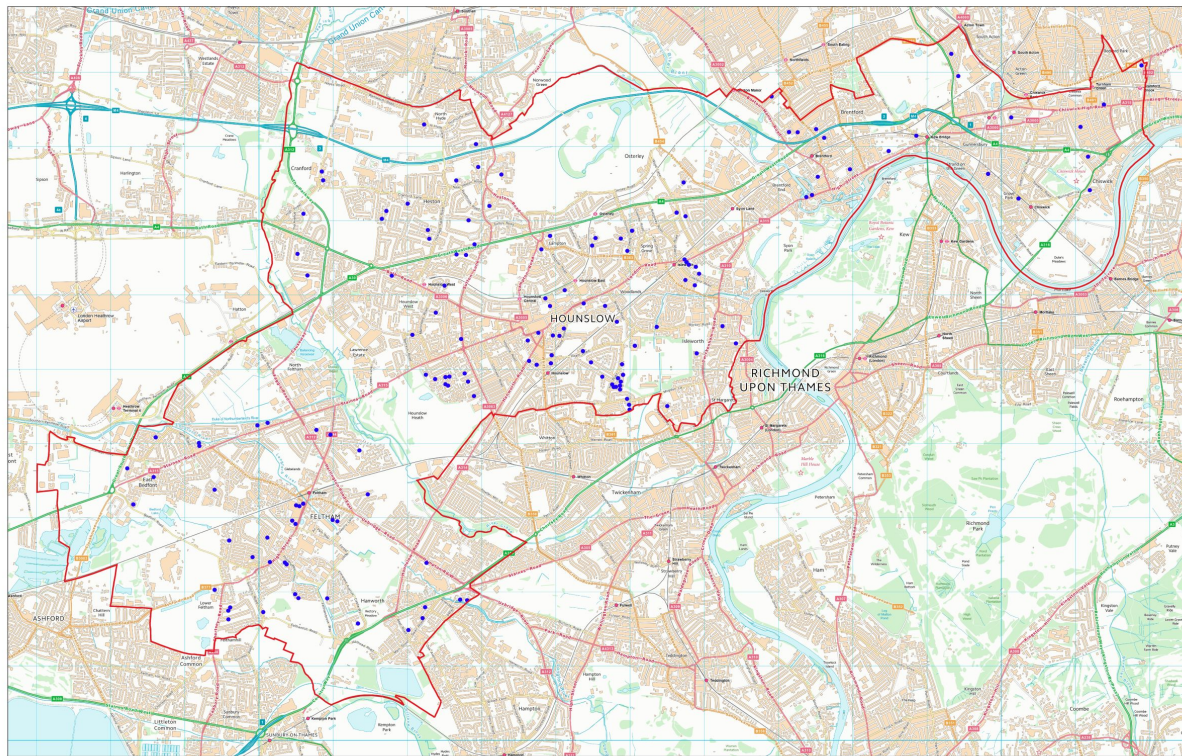
## Key, Secondary, and Tertiary Parks



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0 0.25 0.5 0.75 1 kilometres 1:20000

# Households with no Central Heating



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0 0.25 0.5 0.75 1 kilometres 1:20000

# Data Assessment



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# Census Data

- Easily Accessible
- Not up to date
- Reliable
- Aggregated at Lower Super Output Area level
- Very relevant
- Complete



# EPC Data

- Easily Accessible
- Semi-recent
- Semi-reliable
- Address-level
- Relevant
- Incomplete



# Social Housing Data

- Semi-accessible
- Up-to-date
- Reliable
- Individually addressed
- Relevant
- Incomplete





# GIS Database

- Semi-accessible
- Semi-current
- Semi-reliable
- Variable resolution
- Relevant
- Variable completeness



# Indoor Temperature Model

- Semi-accessible
- Can be up to date (model needs to be run with current data)
- Semi-reliable
- Individually addressed
- Relevant
- Semi-complete

# Conclusions



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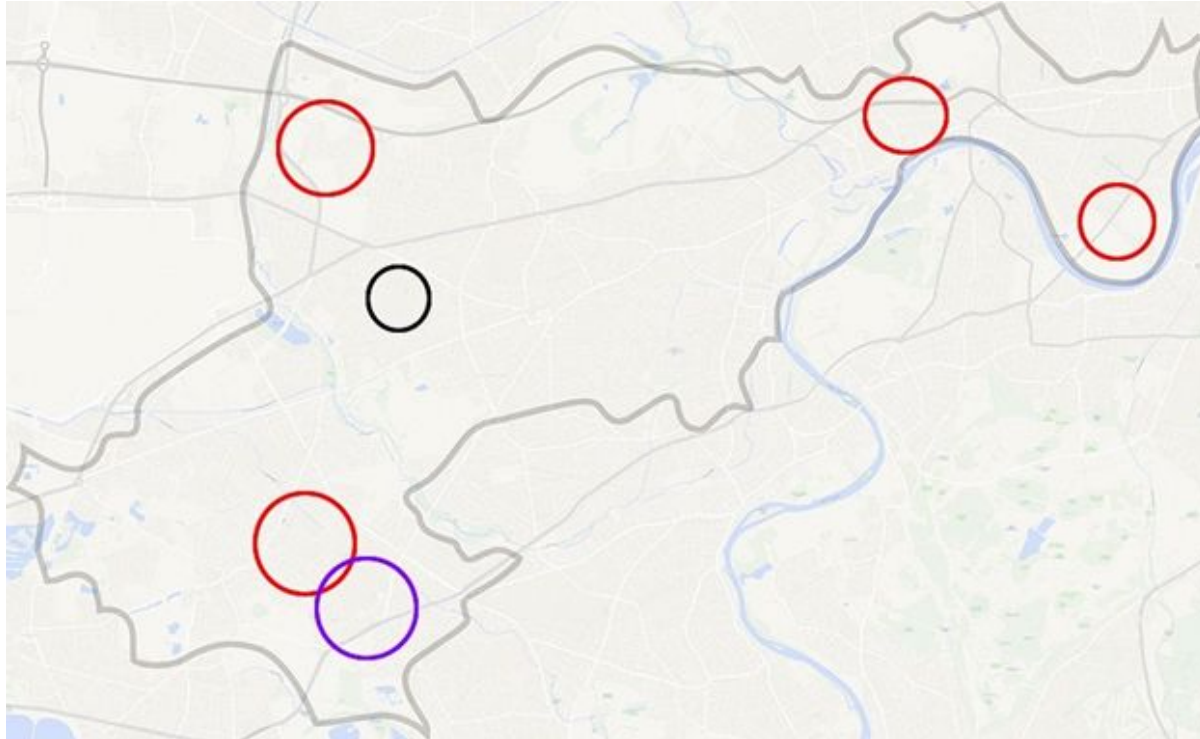
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| Area                 | Count | Vulnerabilities  |
|----------------------|-------|--|
| <b>Hounslow West</b> | 8     | Indices of Multiple Deprivation<br>MOSAIC Group N<br>MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Dense<br>Houses of Multiple Occupation<br>Age - Census 2011<br>Risk of Loneliness |
| <b>Cranford</b>      | 7     | Indices of Multiple Deprivation<br>MOSAIC Group N<br>MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Not dense with Green Space<br>Houses of Multiple Occupation<br>Risk of Loneliness |
| <b>Brentford</b>     | 7     | Indices of Multiple Deprivation<br>MOSAIC Group N<br>MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Dense<br>Age - Census 2011<br>Risk of Loneliness                                  |

| Area            | Count | Vulnerabilities   |
|-----------------|-------|---|
| <b>Chiswick</b> | 7     | Indices of Multiple Deprivation<br>MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Less Dense with Green Space<br>Houses of Multiple Occupation<br>Age - Mid-year 2015 estimate<br>Risk of Loneliness |
| <b>Feltham</b>  | 7     | MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Dense<br>Houses of Multiple Occupation<br>Age - Census 2011<br>Risk of Loneliness<br>Central Heating  |
| <b>Hanworth</b> | 6     | MOSAIC Group N<br>MOSAIC Group O<br>Rented Tenure<br>Population Density/Parks – Not dense with Green Space<br>Age - Census 2011<br>Risk of Loneliness   |



# Vulnerable Areas





# Indoor Temperature Model





# Privacy Impact Assessment

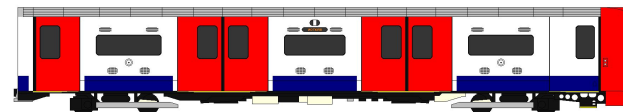


Piccadilly line

Week 3:  
Began PIA

Week 7:  
No Response

Week 4:  
Submitted PIA







# Identified Data Table

| Dataset                         | Source  | Contact          | Origin of Data                                  | Format   | Resolution    | Protected Anonymity | Refresh Rate | Specified Vulnerability (ies)                                     | Completeness/ Coverage   | Data Access                           |
|---------------------------------|---|------------------|---|--|---------------|---------------------|--------------|---|--|---------------------------------------|
| Census Data                     | N/A   | N/A              | Office of National Statistics                   | CSV / Excel  | LSOA          | ✓                   | 10 years     | Age, Population, Ethnicity, Population Density, Housing Occupancy | Fully complete/Country   | Public                                |
| London Datastore                | Greater London Authority                        | N/A              | N/A   | Varies: Excel, CSV, PDF, Website, ZIP, XML, Shapefile, Misc. | Borough level | ✓                   | Rolling      | Urban Heat Island   | Complete but cannot see past borough level                       | Public                                |
| EPC Housing Data                | Department for Communities and Local Government | Rory Prendergast | Individual Contractors                          | Excel  | Address       |                     | Rolling      | Indoor Heat Exposure  | Only covers private homes being newly rented, sold, or revovated | Public                                |
| Indices of Multiple Deprivation | GIS / Earthlight                                | Vinesh Govind    | Department for Communities and Local Government | GIS layer / Excel  | Varied        | ✓                   | Rolling      | Sensitivity (Deprivation )  | Fully complete/Country   | Public / Borough staff for Earthlight |

[illegible]



# Places to Look for More Data

Health and  
Wellbeing Team

General  
Practitioners

Clinical  
Commissioning  
Groups

# Recommendations



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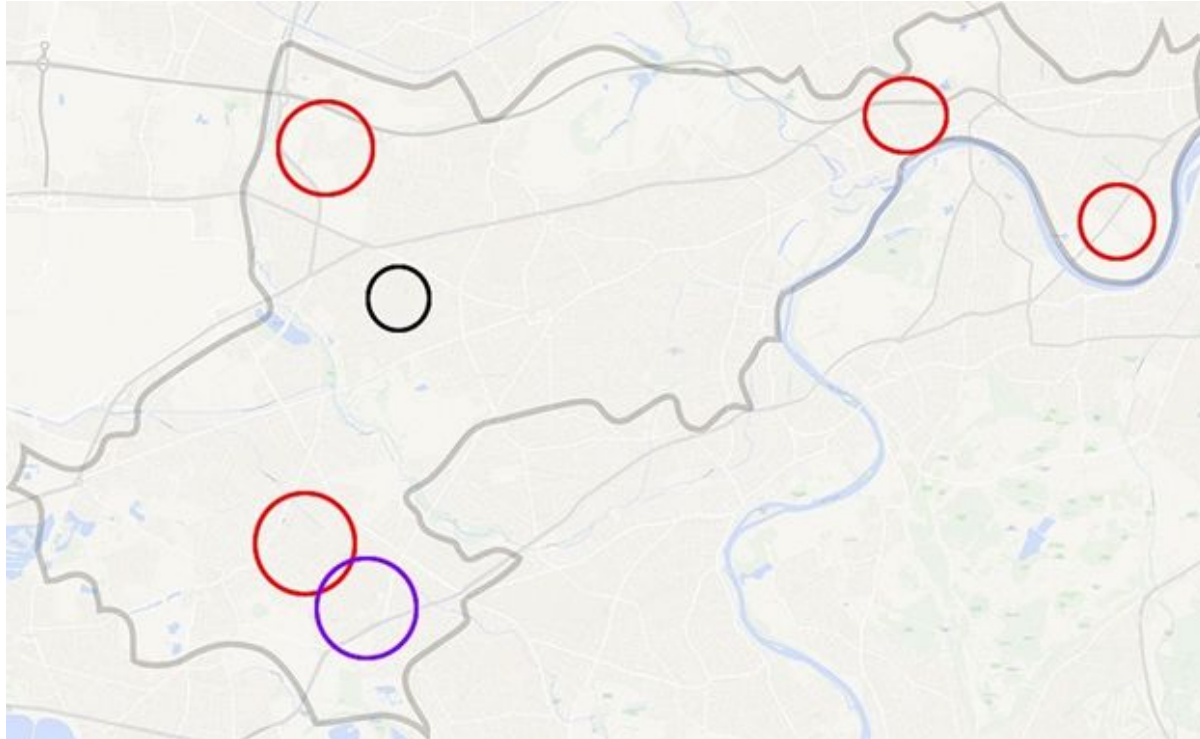


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Is it worthwhile?



# Targeted Warning & Informing

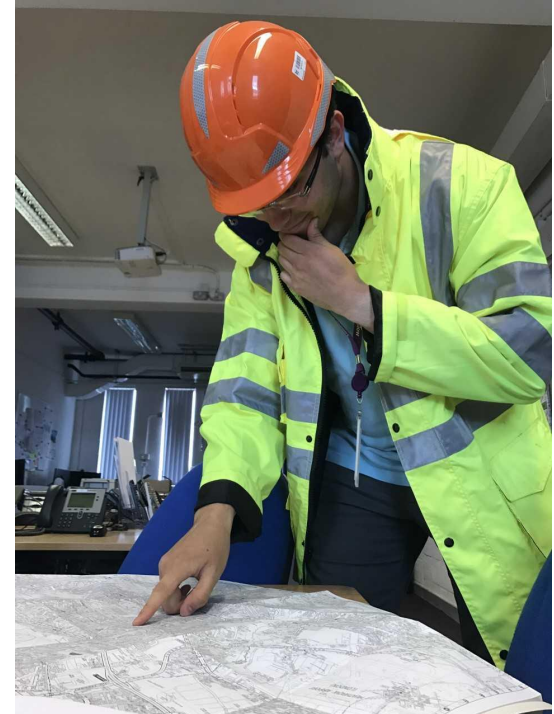






# Emergency Planning

- Targeted warning and informing - using the method most likely to get through
- Place cooling centers where they will be most effective
- Allocate response resources effectively





# Long Term Development

- Improvement projects for social housing
- Improved energy efficiency performance
- Urban planning
- Green space improvement



Munro, E. (2012, September 2). Lampton Park, London Borough of Hounslow, TW3 [Digital image]. Retrieved June 19, 2017.



# Acknowledgments

Thank you Dominic and Jennifer for being the greatest IQP advisors we could ever ask for, we couldn't have done it without you!

Twm, thank you for your guidance and advice. It was our pleasure to take the Piccadilly line to Hounslow every day.

Thank you to our colleagues in the London Borough of Hounslow and the Hounslow Heatwave Steering Group for donating your time, advice, and expertise.

# Questions?

Hounslow-17E2@wpi.edu



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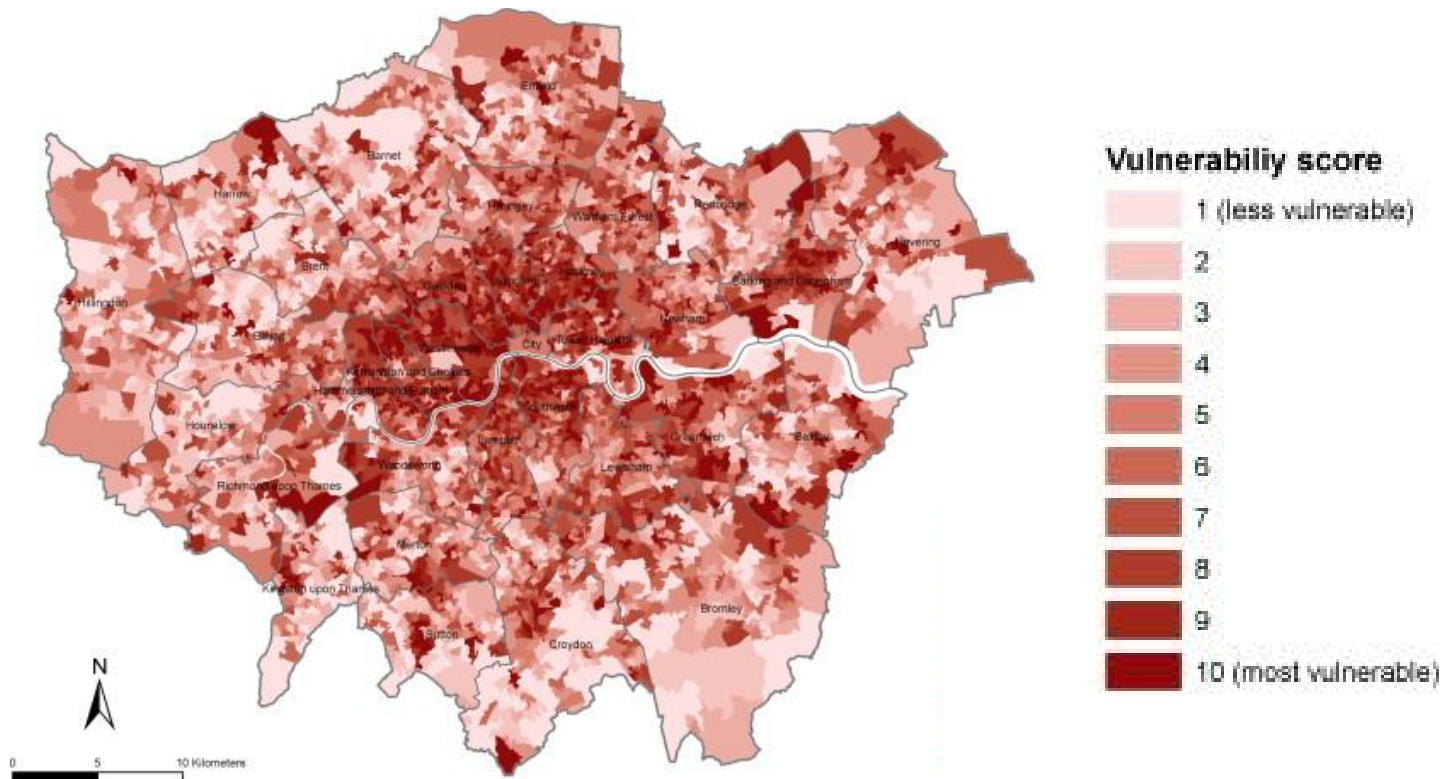
# Works Cited

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- Taylor, J., Wilkinson, P., Davies, M., Armstrong, B., Chalabi, Z., Mavrogianni, A., Symonds, P., Oikonomou, E. & Bohnenstengel, S. I. (2015). Mapping the effects of Urban Heat Island, housing, and age on excess heat-related mortality in London. *Urban Climate*, 14, 517-528.
- Wolf, T., & McGregor, G. (2013). The development of a heatwave vulnerability index for London, United Kingdom. *Weather and Climate Extremes*, 1, 59-68.





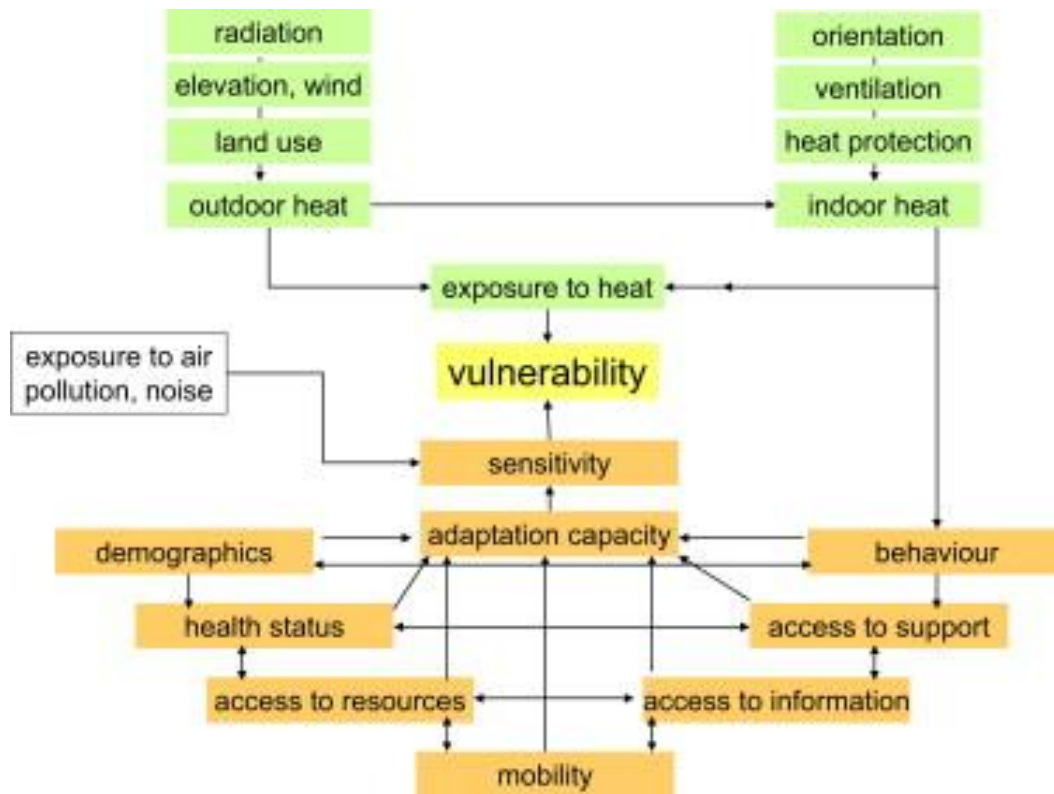
# Heatwave Vulnerability Index







# Heatwave Vulnerability Index



## ADMS-Urban Model

- Traffic
- Industrial
- Commercial
- Domestic
- Other

## Reading Urban Model (RUM)

- Thermodynamic energy
- Shadowing + Reflection
- Storage of heat in buildings
- Transport of heat into atmosphere

Calculate local temperature and air quality  
RUM will determine boundary conditions  
ADMS model will allow temp. variation calculations

Virtual London model

3D Representation of  
London's built form

Ground surfaces from  
aerial photos

Temperature Data

- Taxis with GPS technology
- Satellite data
- Fixed location temperature collection
- London Air Quality Network

Test new model against these temperature  
measurements

