SNACC

Suburban Neighbourhood Adaptation for a Changing Climate

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University of the West of England

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SNACC Project Overview

- Research question 'How can suburban neighbourhoods be best adapted for a changing climate?'
- Why is this important? 86% of the population live in suburbs. Largely privately owned, and slow rate of change around 1% per year
- Where did we undertake our research? 3 case study cities; Bristol, Stockport, Oxford
- What did we do? Socio- technical research including, review, modelling and qualitative data collection - to determine feasible, effective and acceptable adaptations and understand how to bring about change

Overall Rationale

There are climate change pressures affecting suburbs

Suburbs are facing climate change pressures of different types

Gradual and extreme events

Hotter and dryer summers

Warner, wetter winters, with more storms

There are a wide range of potential impacts on suburbs

From different pressures e.g. more heat waves, floods etc.

These will have an impact on:

People e.g. comfort, cost, health

Built and natural environment (e.g. damage to homes, degradation of greenspace)

Impacts may vary according to socio-economic and physical conditions

A number of adaptations could be carried out

Different adaptations are needed for different pressures

In different suburbs

Mitigation and adaptation measures need considered

Adaptations can take place at differing scales: homes, gardens, neithbourhood

Can be anticipatory or responsive

Adaptations need to perform well technically, be feasible and acceptable

Different stakeholders are involved in making the changes

Residents (single or collective)

State

NGOs

Private companies

But action depends on a number of factors

Best adaptation options for a suburb are ones that 'work', and are acceptable and practical to suburban stakeholders

Best adaptation options are different for different types of suburbs, facing different threats, and with different adaptive capacities

There is no 'one size fits all'

We have results that show:

Which adaptations are likely to work

Perceptions of different climate change threats in suburbs

Which adaptations stakeholders are more likely to do

Which they won't!

Who is responsible for making changes

What needs to change in order for successful adaptation

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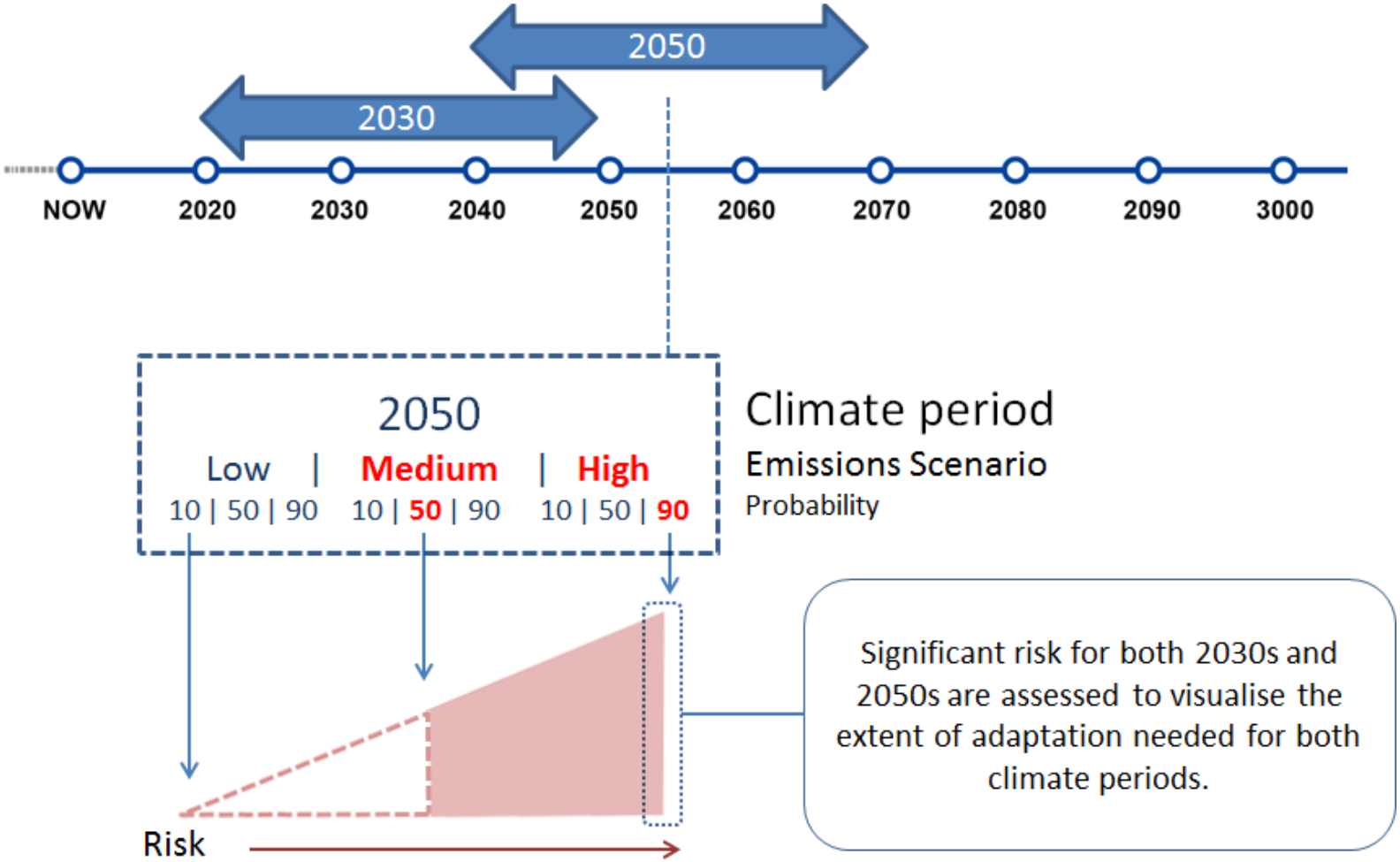
Defined the probabilistic range for climate change risk



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Identified the climate change hazards

	Bristol		Oxford		Stockport	
	2030 high emissions 90%	2050 high emissions 90%	2030 high emissions 90%	2050 high emissions 90%	2030 high emissions 90%	2050 high emissions 90%
Summer Temperature Increase	3.4	5.1	3.4	5.1	2.9	4.5
Winter Precipitation Increase	22%	37%	21%	36%	16%	27%
Summer Solar Radiation increase	19%	23%	16%	21%	15%	19%

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Climate change hazards across the case study areas

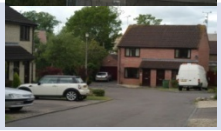
	Bristol		Oxford		Stockport	
	St. Werburghs	**Upper Horfield**	**Summertown**	**Botley**	**Bramhall**	**Cheadle**
Temperature change	**High**		**High**		Moderate	
Winter Precipitation change	Greatest increase		Moderate-high increase		Lesser increase	
Fluvial flood risk (EA, 2012)	**Historic flooding documented – flood risk possible from south and west edges of neighbourhood**	None	Minimal – some flood risk on the east edge	None	None	Moderate flood risk along north edge and possible along the eastern edge
Summer precipitation change	**Significant decrease**		**Significant decrease**		Moderate decrease	
Water stress	Low		**High**		Low	

University of the West of England, Bristol

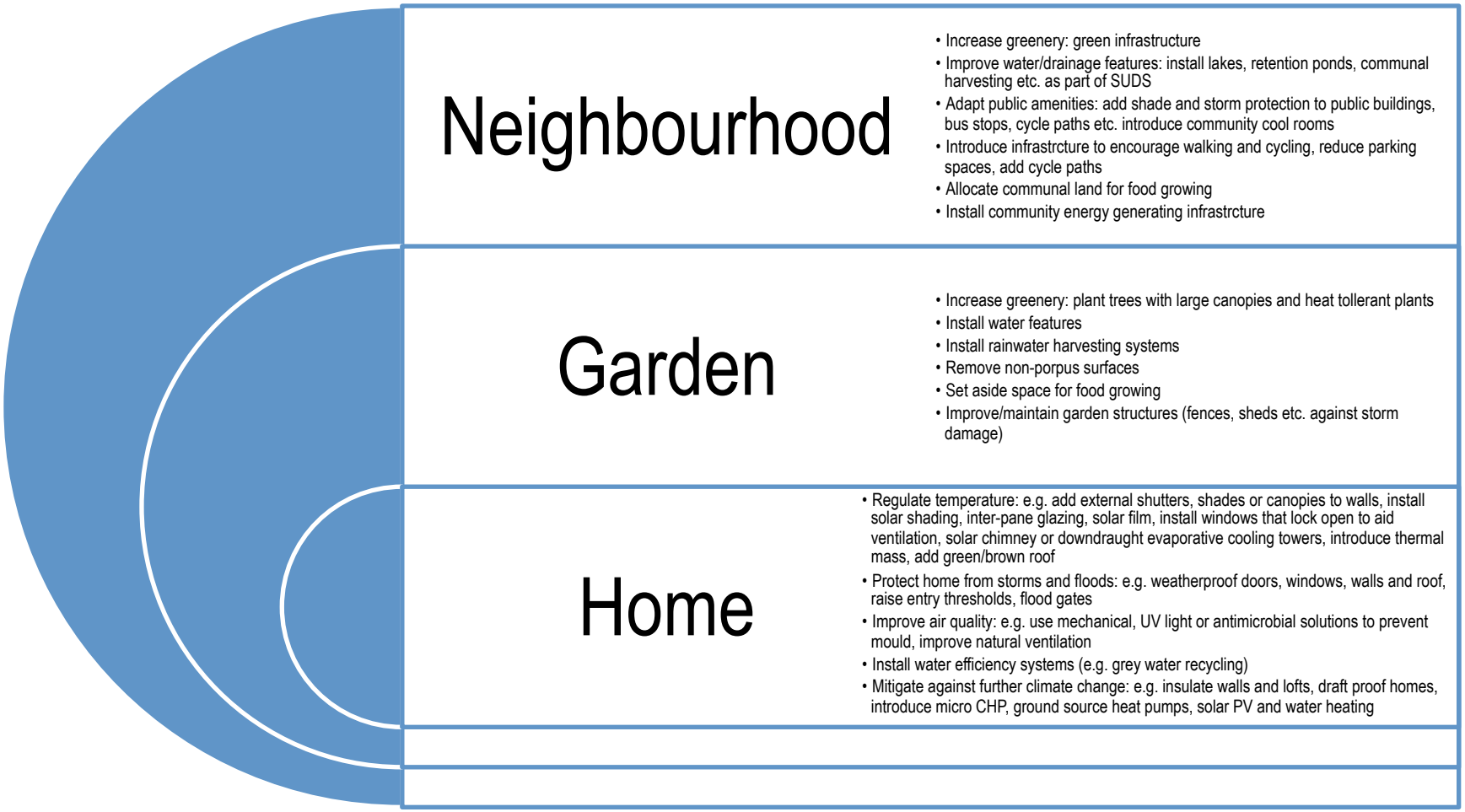
Oxford Brookes University

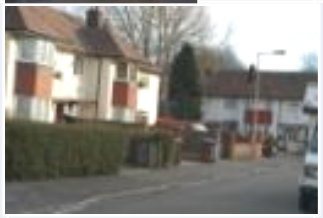
Heriot Watt University

Developed a typology of 6 suburban types

Type of suburb	
Inner Historic Suburb, Early 1900s	
Pre-War 'Garden city' suburb'	
Interwar period 1920s-late 30s	
Social Housing Suburb, 1950s – 1970s	
Car Suburb Late 1970s – mid 1990s	
Medium - High Density Suburbs, mid 1990s – present day	

Developed a master-list of adaptation options



Suburb type	Image	Case study	Income	Community activity	Flooding
Inner historic		St Werburghs, Bristol	Lower income	Active	Localised fluvial
Pre-war garden city		Summertown, Oxford	Medium-higher income	Weak – emerging	Fluvial (gardens only)
Interwar		Botley, Oxford	Medium-higher income	Active	Fluvial (on low ground)
Social housing		Cheadle, Stockport	Lower income	Active	Localised exposure (blocked culvert)
Car		Bramhall, Stockport	Medium-higher income	Active	None
Medium-high density		Upper Horfield, Bristol	Lower income	Weak - emerging	None

Modelled a selection of the adaptation options




Tested the adaptation options with residents and other stakeholders

7X residents workshops in 6 suburbs

Views on climate change

Used modelling results and visualisations for each neighbourhood

Voting and discussion on adaptation measures (home, garden, neighbourhood)

Discussion of why/why not likely to implement

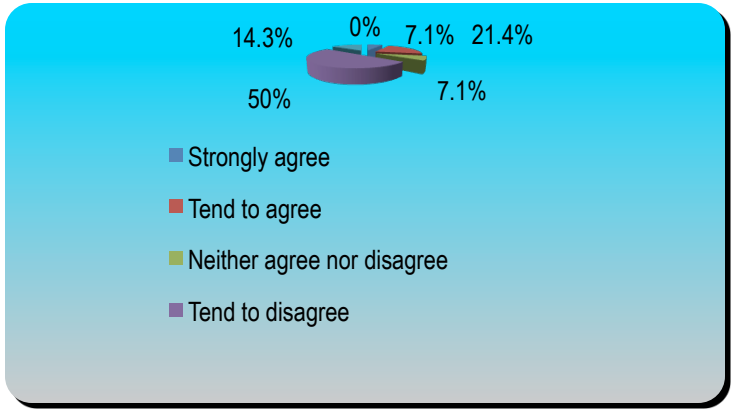
3X stakeholder workshops in 3 cities

Views on climate change

Presents residents views from workshops in their cities, and modelling and visualisation results

Discussion on facilitating adaptation

Discussion of why/why not likely to implement



SNACC Findings

1. Modelling
2. Resident workshops
3. Stakeholder workshops
4. Overall findings

DECoRuM-Adapt

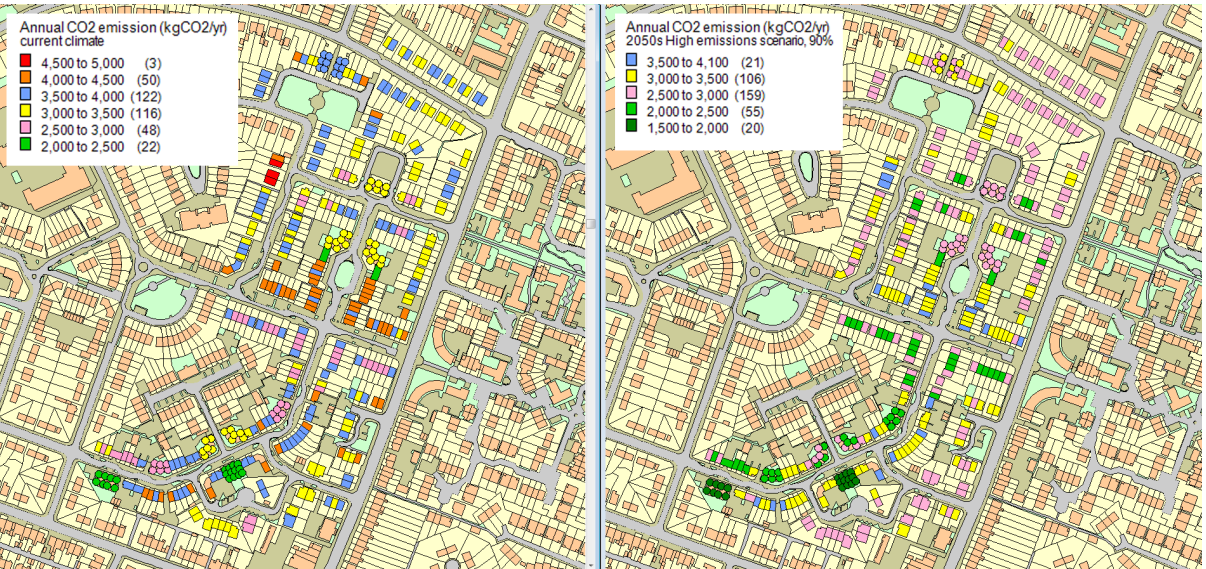
Neighbourhood scale

Climate change impact: future CO_2 emissions

Bristol: St. Werburghs

13% CO_2 emissions reduction

Age band	Built form	Total (269)	
1900-1929	End-Terrace / Semi	31	
1900-1929	Mid-terrace	217	81%
1950-1965	End-Terrace	3	
1950-1965	Mid-terrace	4	
1966-1976	Mid-terrace	2	
1977-1981	End-Terrace	2	
1977-1981	Mid-terrace	8	
1982-1990	Mid-terrace	2	

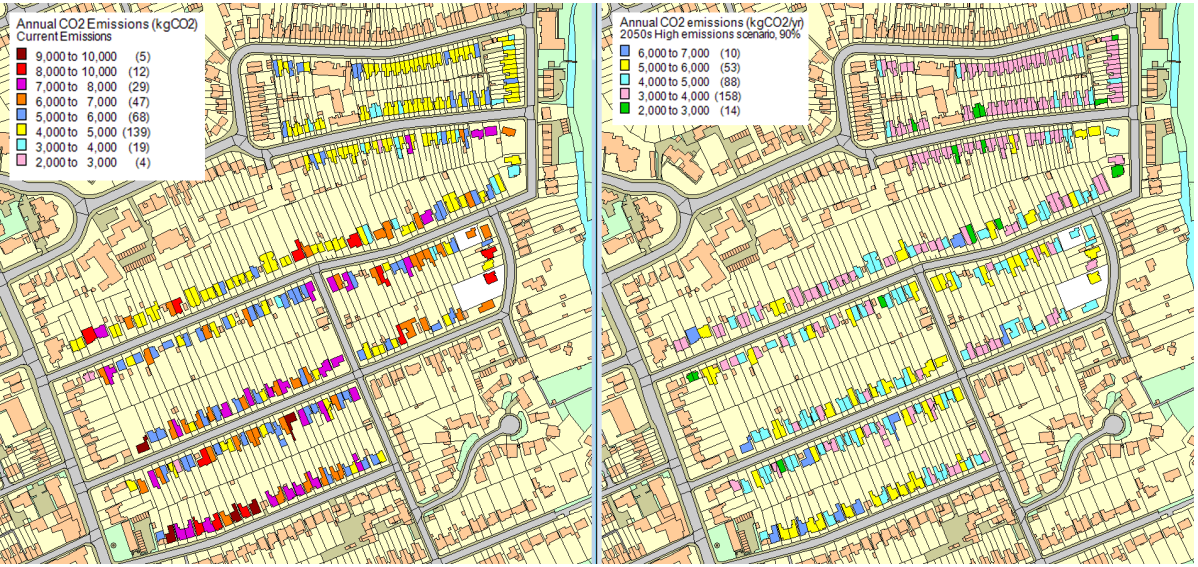


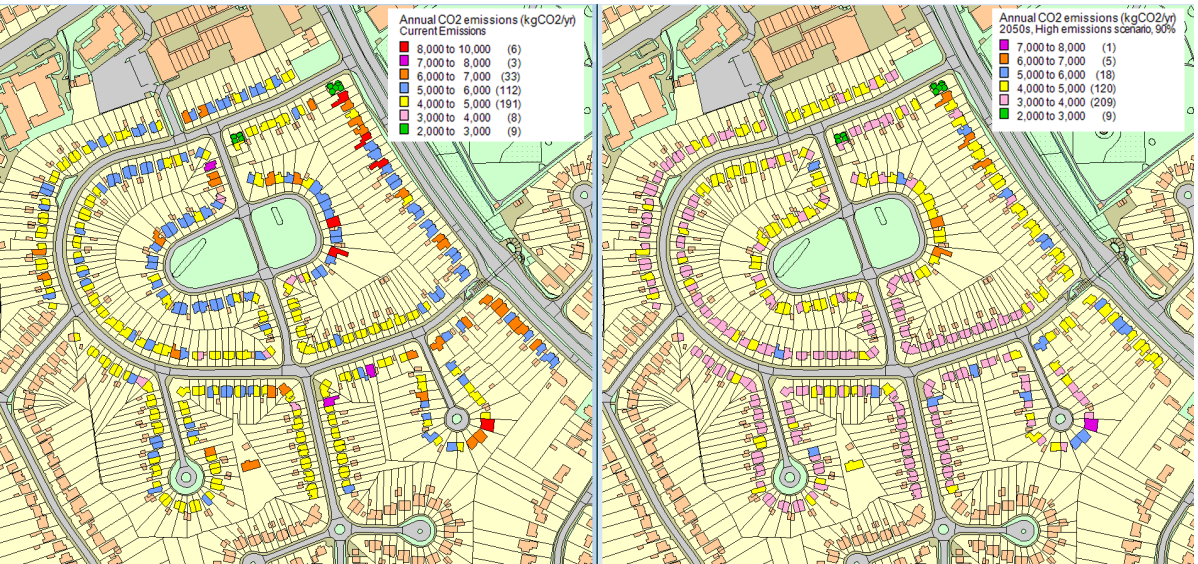
Bristol: Upper Horfield

18% CO_2 emissions reduction

Age band	Built form	Total (361)	Percentage of total
1991-1995	End-Terrace / Semi	8	
1991-1995	Mid-terrace	7	
1991-1995	Flat	12	
1996-2002	Detached	1	
1996-2002	End-Terrace / Semi	28	
1996-2002	Mid-terrace	6	
Post 2002	Detached	6	
Post 2002	End-Terrace / Semi	135	37%
Post 2002	Mid-terrace	92	
Post 2002	Flat	66	

Climate change impact: future CO_2 emissions





Oxford: Summertown

23% CO_2 emissions reduction

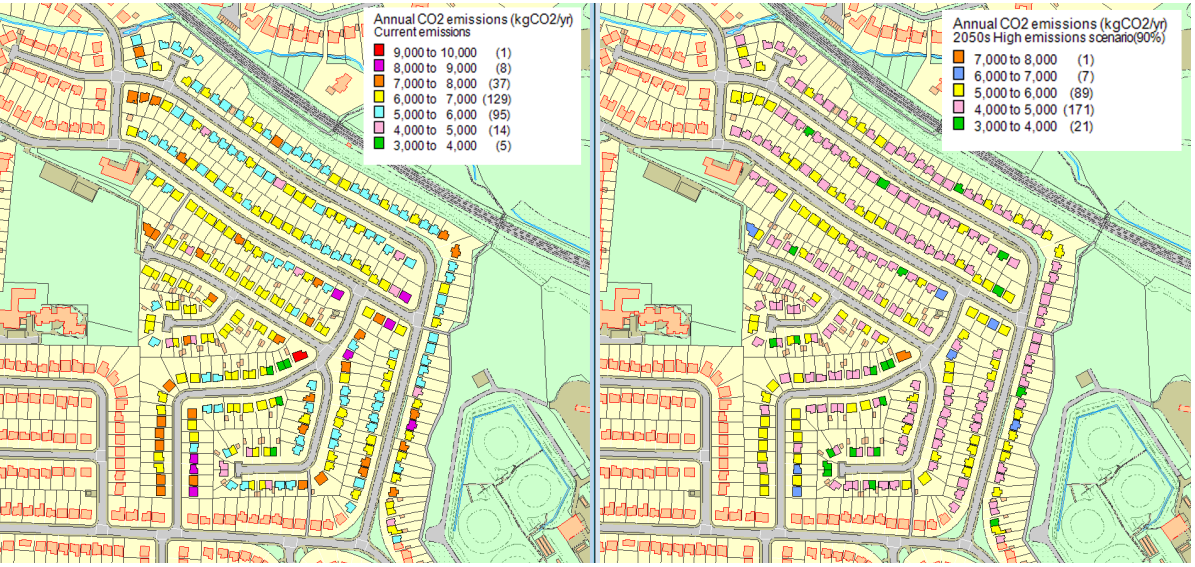
Age band	Built form	Total (321)	Percentage of total
Pre-1900	Detached	1	
Pre-1900	End-Terrace / Semi	29	
Pre-1900	Mid-terrace	17	
1900-1929	Detached	21	
1900-1929	End-Terrace / Semi	81	25%
1900-1929	Mid-terrace	45	
1930-1949	Detached	25	
1930-1949	Semi-detached	67	
1950-1965	Detached	5	
1950-1965	Semi-detached	4	
1966-1976	Detached	2	
1966-1976	Semi-detached	3	
1977-1981	Detached	4	
1977-1981	Semi-detached	1	
1982-1990	Detached	1	
1996-2002	Detached	2	
1996-2002	Semi-detached	13	

Oxford: Botley

21% CO_2 emissions reduction

Age band	Built form	Total (362)	Percentage of total
1930-1949	Detached	7	
1930-1949	End-Terrace / Semi	345	95%
1930-1949	Mid-terrace	1	
1977-1981	Flat	9	

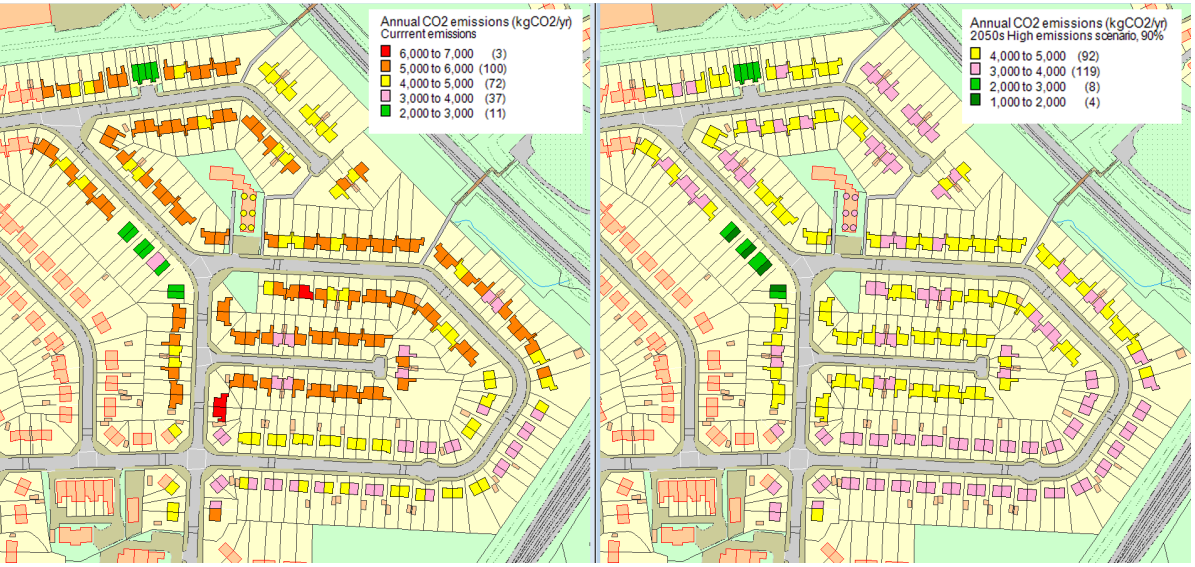
Climate change impact: future CO_2 emissions



Stockport: Bramhall

24% CO_2 emissions reduction

Age band	Built form	Total (289)	Percentage of total
1950-1965	Detached	24	
1966-1976	Detached	183	63%
1966-1976	Semi-detached	82	



Stockport: Cheadle

20% CO_2 emissions reduction

Age band	Built form	Total (223)	Percentage of total
1950-1965	Semi-detached	205	92%
1977-1981	End-Terrace / Semi	2	
1977-1981	Mid-terrace	4	
1982-1990	Semi-detached	4	
1982-1990	Flat	8	

Climate change impact: Potential future overheating risk at neighbourhood level: **Bristol: St. Werburghs** (Inner historic suburb)

Climate change impact: Potential future overheating risk at neighbourhood level: **Bristol: Upper Horfield** (Higher density urban extension
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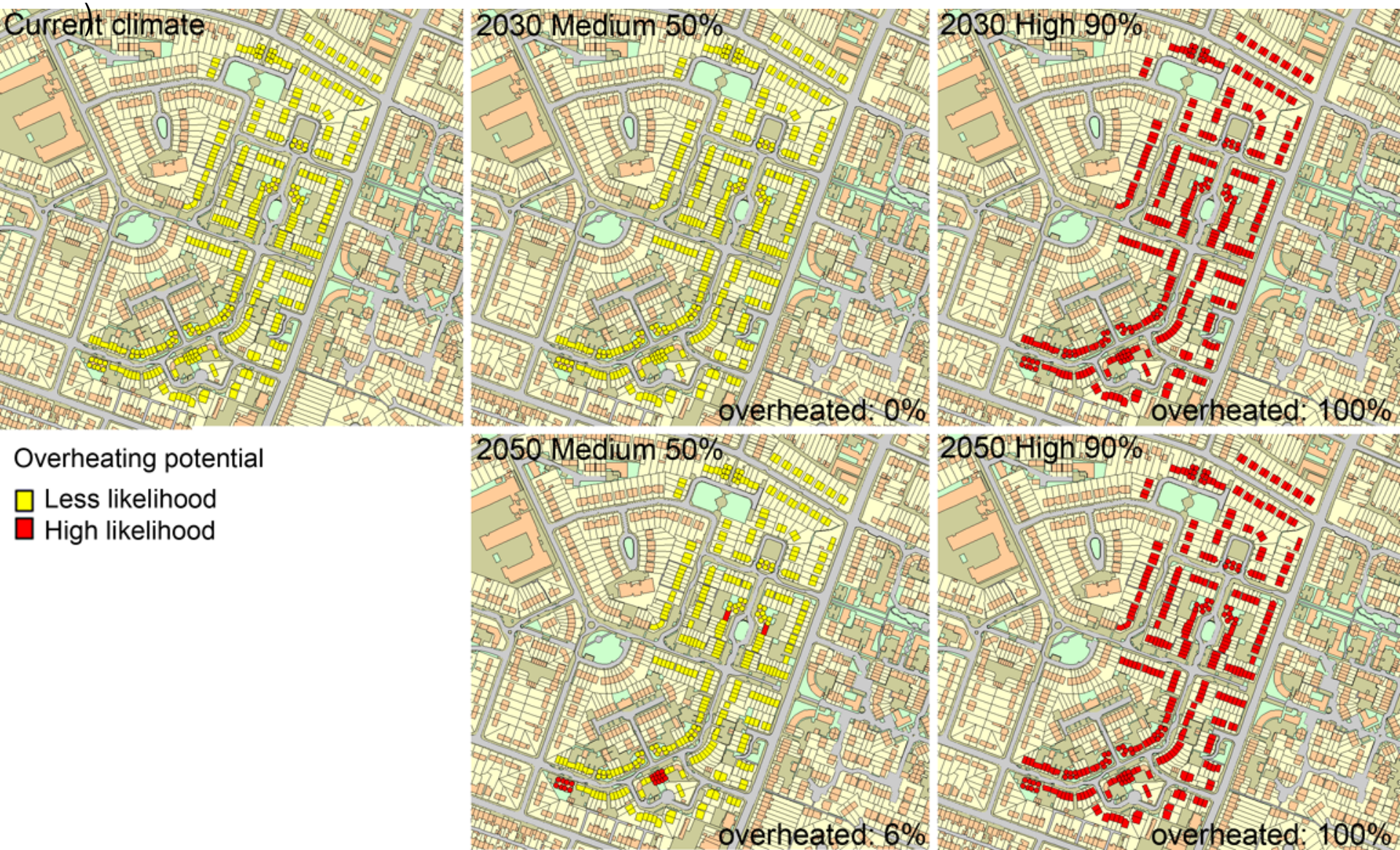
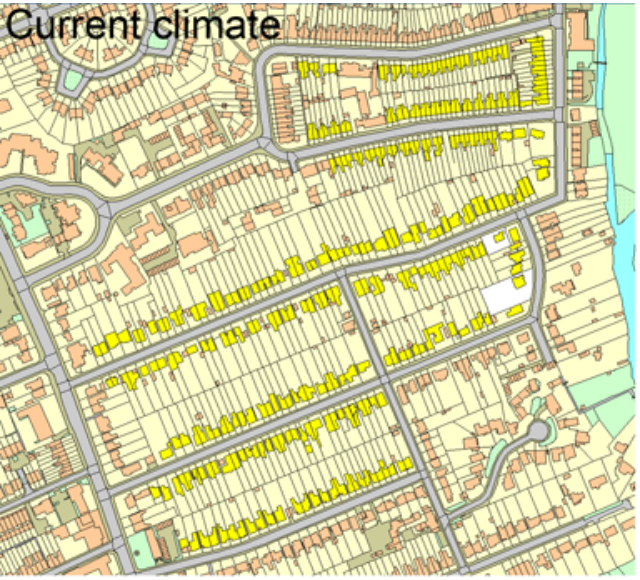
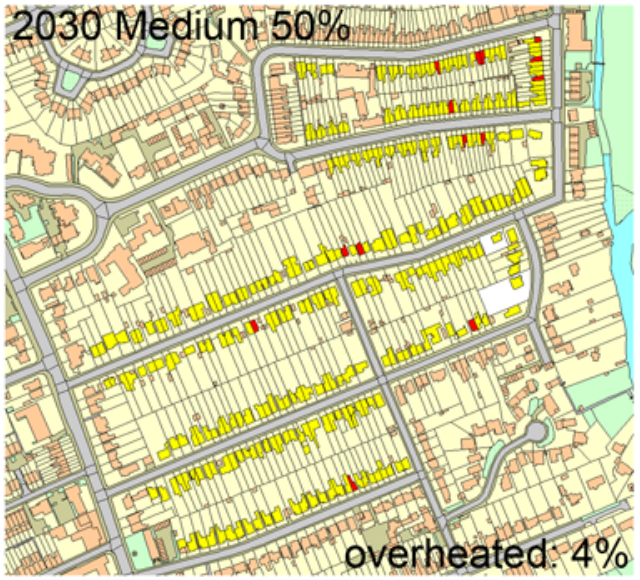
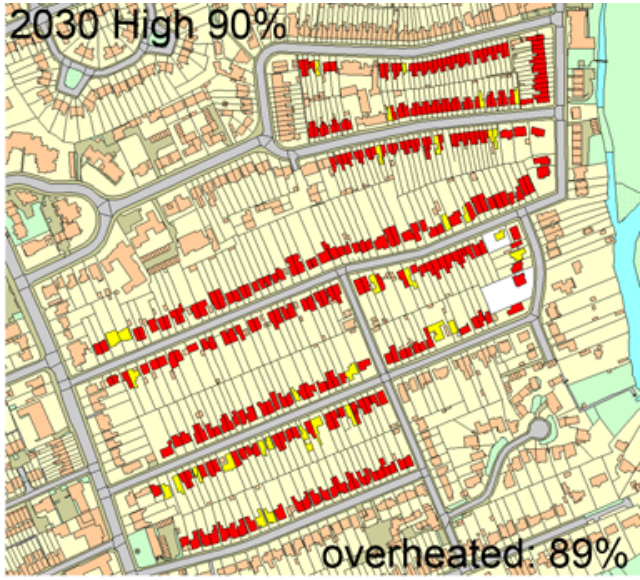


Climate change impact: Potential future overheating risk at neighbourhood level: **Oxford: Summertown** (Pre-war 'garden city' type suburb)

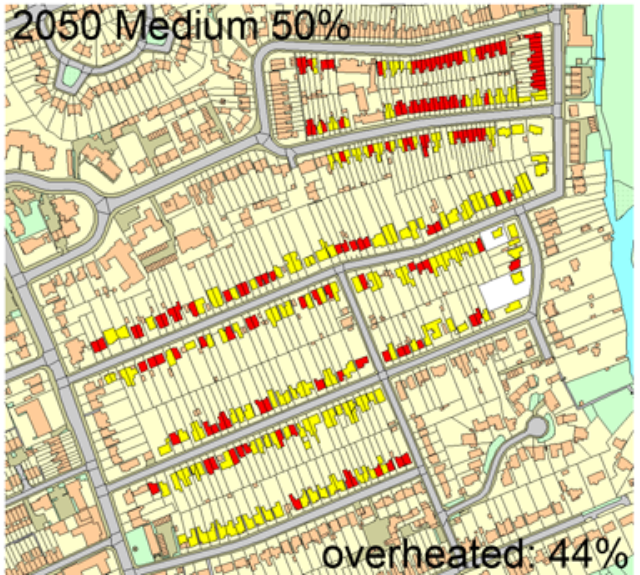


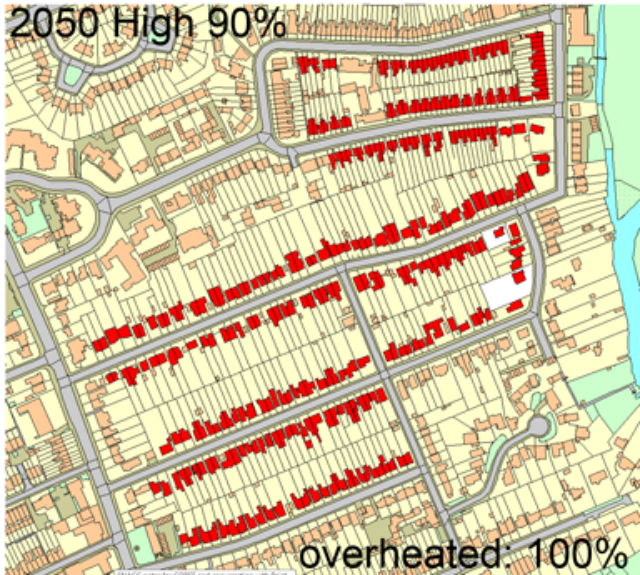




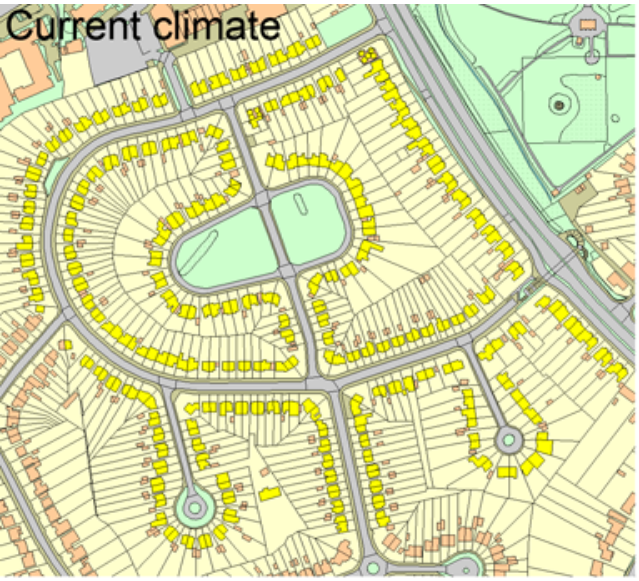
Overheating potential

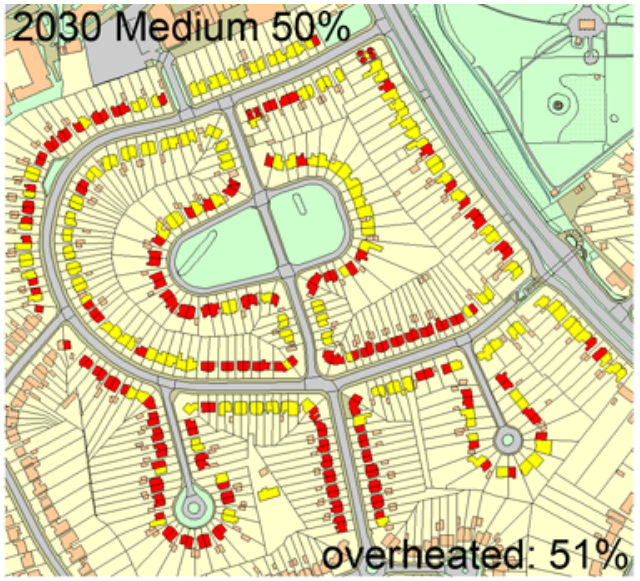
- Less likelihood
- High likelihood

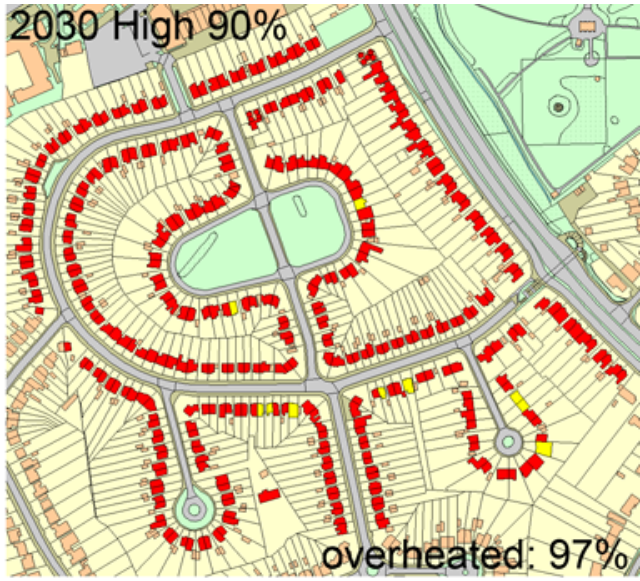




Climate change impact: Potential future overheating risk at neighbourhood level: **Oxford: Botley** (Public transport suburb)

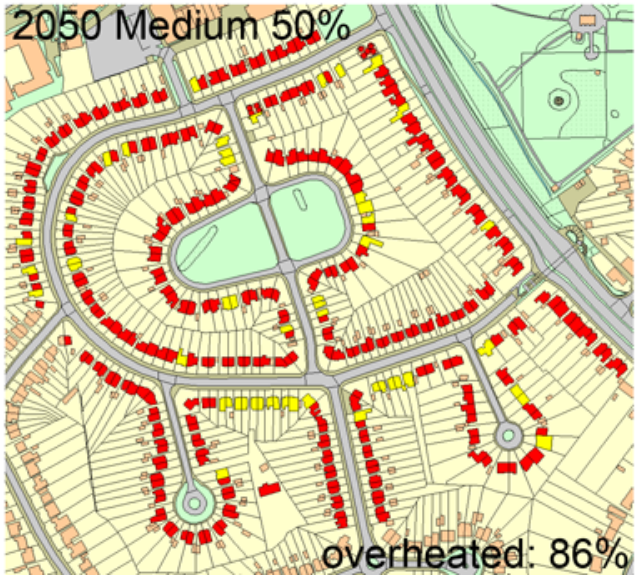


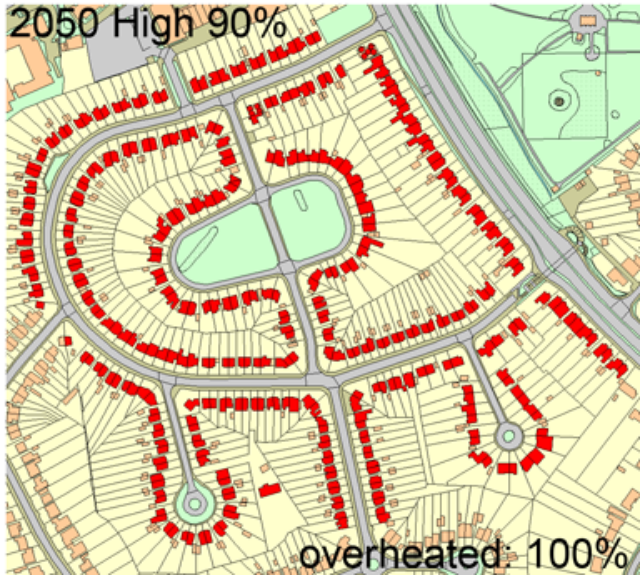




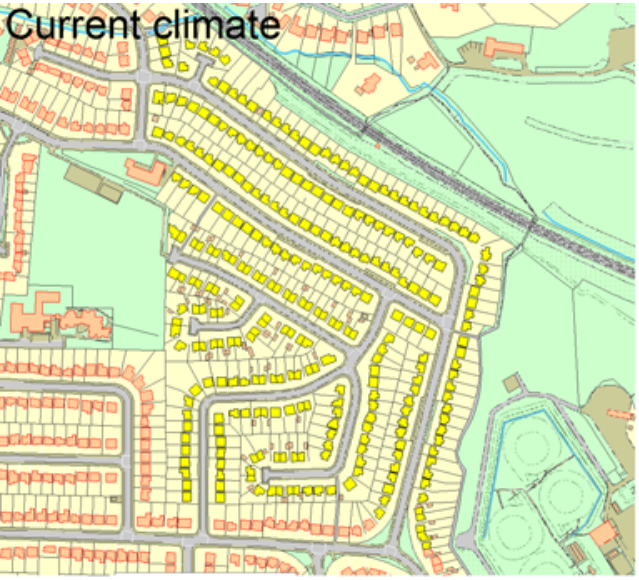
Overheating potential

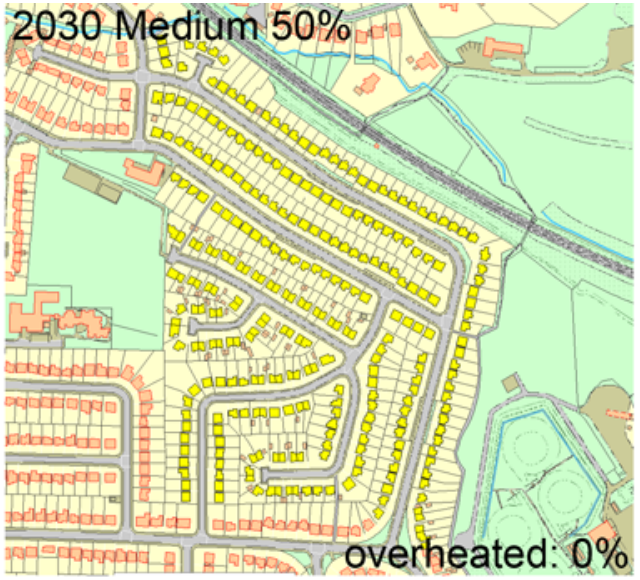
- Less likelihood
- High likelihood

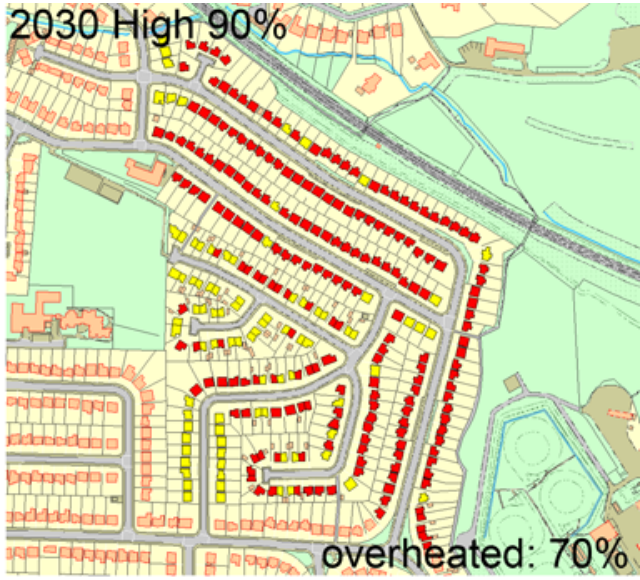




Climate change impact: Potential future overheating risk at neighbourhood level: **Stockport: Bramhall** (Car suburb)

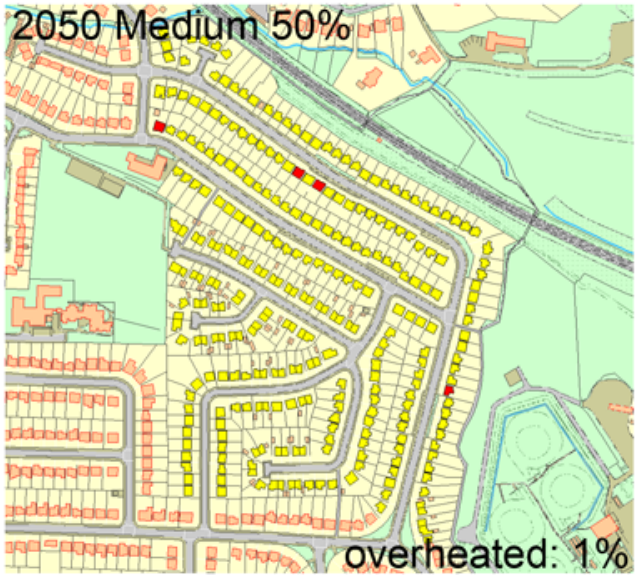


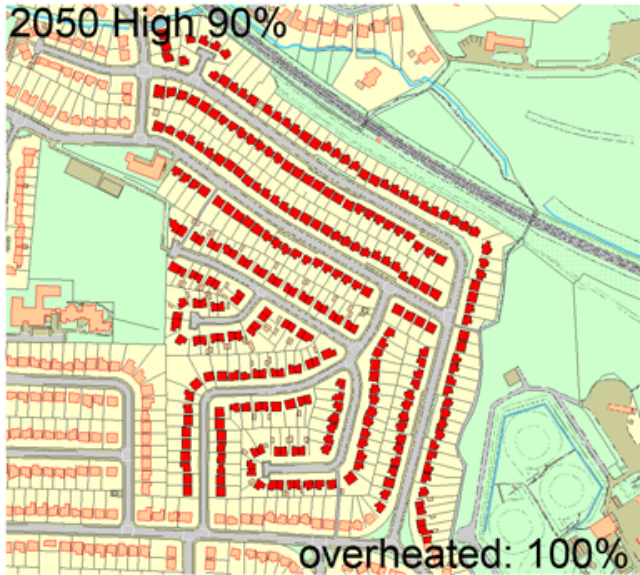




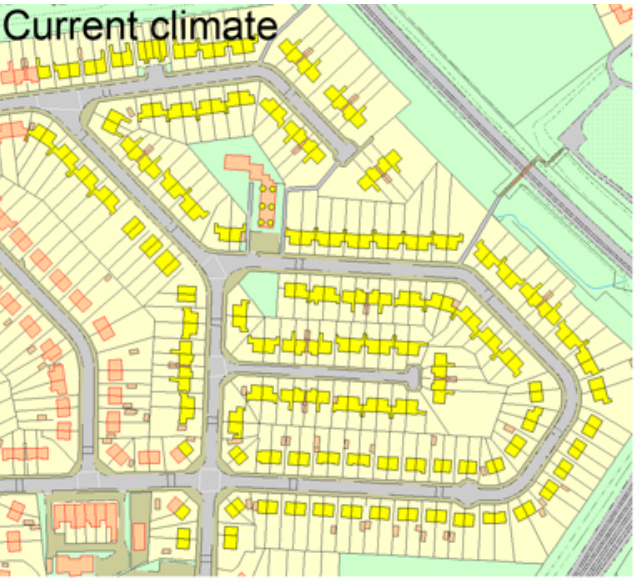
Overheating potential

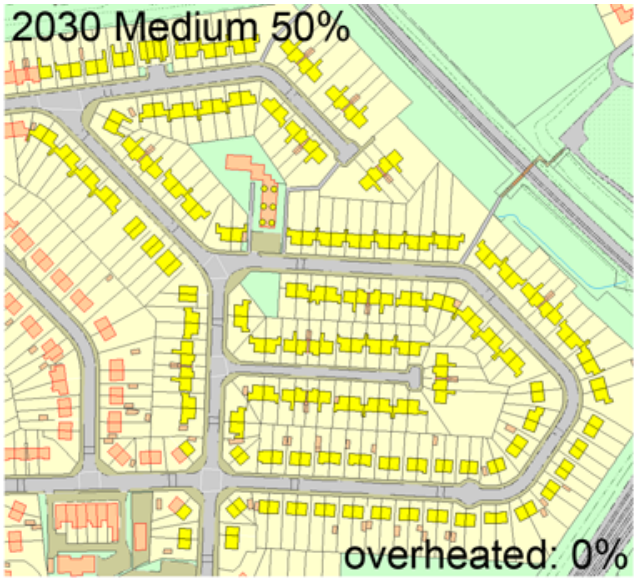
- Less likelihood
- High likelihood

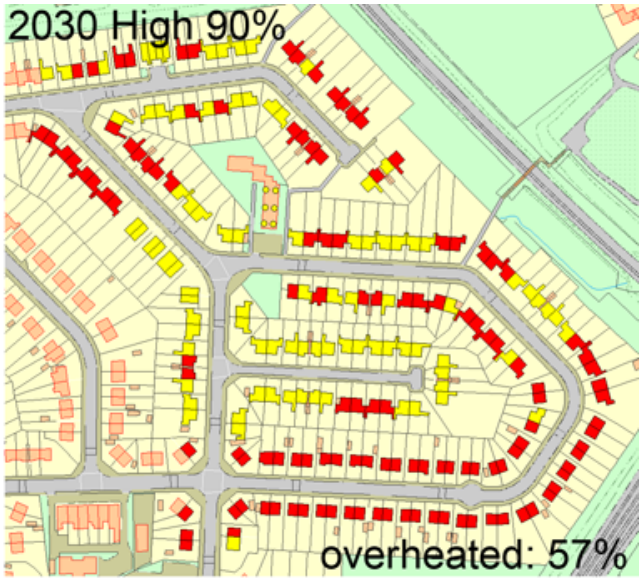




Climate change impact: Potential future overheating risk at neighbourhood level: **Stockport: Cheadle** (Social-housing suburb)

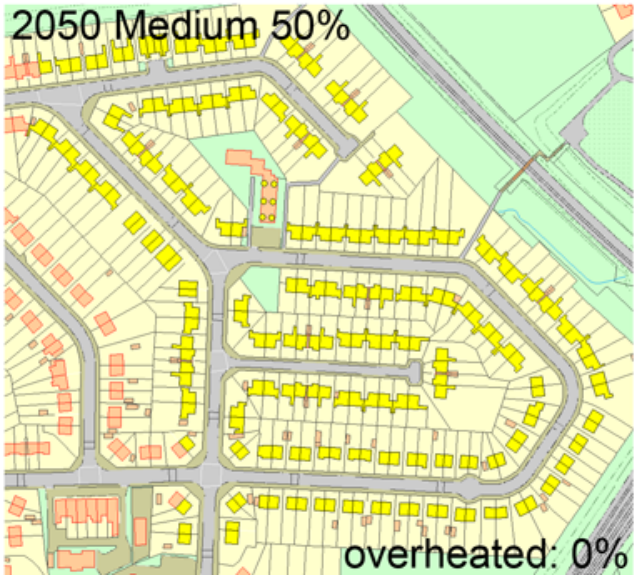


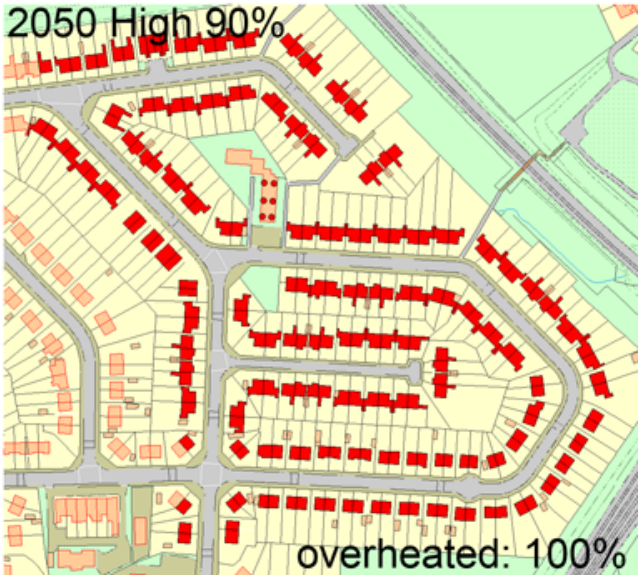




Overheating potential

- Less likelihood
- High likelihood





Summary: Whole neighborhood overheating potential

Suburb	Type	Current climate	2030 medium emissions 50%	2030 High emissions 90%	2050 medium emissions 50%	2050 High emissions 90%
Bristol – St. Werburghs	Inner historic suburb	0%	<1%	97%	71%	100%
Bristol – Upper Horfield	Higher density urban extension	0%	0%	100%	6%	100%
Oxford – Summertown	Pre-war 'garden city' type suburb	0%	4%	89%	44%	100%
Oxford – Botley	Public transport suburb	0%	51%	97%	86%	100%
Stockport – Bramhall	Car suburb	0%	0%	70%	1%	100%
Stockport – Cheadle	Social Housing Suburb	0%	0%	57%	0%	100%

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Climate change impact: key findings

- All neighbourhoods are projected to overheat 100% by 2050 high emissions 90% probability
- Older homes in compact proximity (e.g. St. Werburghs or Botley) tend to overheat before newer homes (Upper Horfield) or those in neighbourhoods with lower density (Summertown).

- Home age related overheating can vary in specific circumstances:
  - Older homes are assumed to have high heat loss from the hot water tank and uninsulated pipework, therefore higher internal gains
  - Newer homes have less internal gains but retain heat more with higher insulation and airtightness standards

Climate change impact: key findings

Home characteristics which contribute to higher likelihood of overheating:

- Built form:
  - Type: e.g. the home being mid-terrace (as opposed to end terrace)
  - Number of stories: a single storey flat will overheat before a 2-storey terrace
  - Compact form: having either or both a small floor area and limited exposed external wall area can lead to a higher probability of overheating
- Extent of glazing: Having a greater glazing area vs. less glazing area
- Location of glazing: Presence of roof lights lead to a higher likelihood of overheating
- Age dependent systems: e.g. older homes have less or no insulation on hot water cylinder; internal gains can be a significant factor
- Orientation: East and west facing homes overheat to a greater degree than south or north facing homes.
- In addition, homes on exposed streets (e.g. no shading from trees) have a higher likelihood of overheating.

Developing adaptation measures for tackling overheating

Three key principles:

- Reduce external temperatures by managing the microclimate (non-fabric changes)
- Design to exclude or minimise the effect of direct or indirect solar radiation into the home (fabric changes)
- Limit or control heat within the building (e.g. reduced internal gains or manage heat with mass) (can include ventilation)

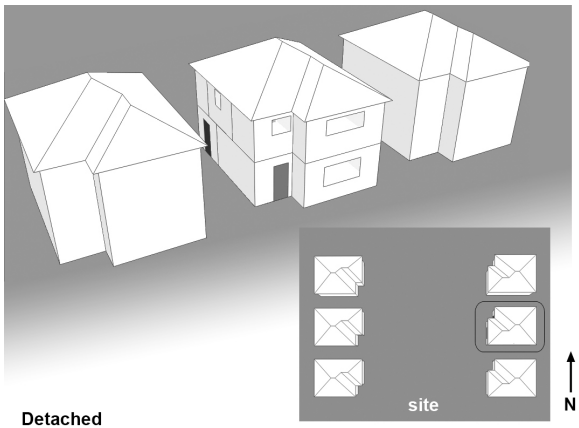
These principles are used to develop adaptation measures and packages that technically perform well to mitigate overheating.

IES modelling using hourly data (FWY)

Home scale

Methodology: modelling the home typologies

Further IES VE modelling allowed us to achieve a more refined level of detail and test adaptation measures which could not be tested in DECoRuM-Adapt.



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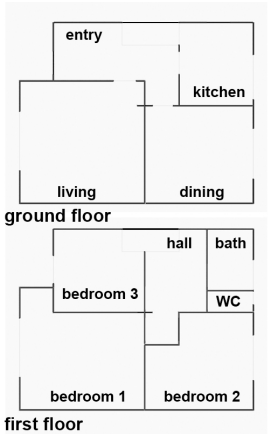
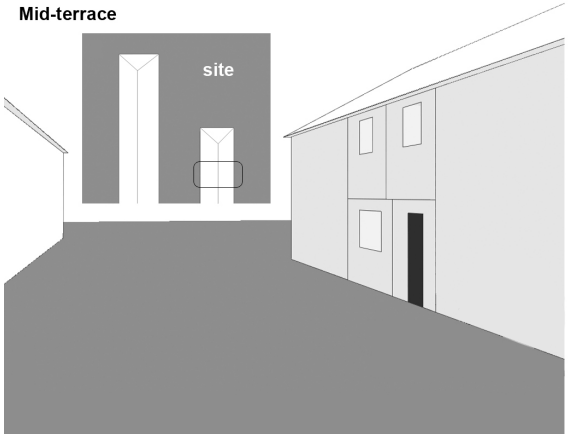
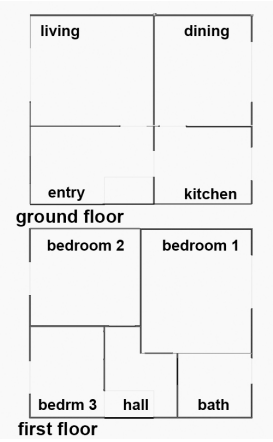
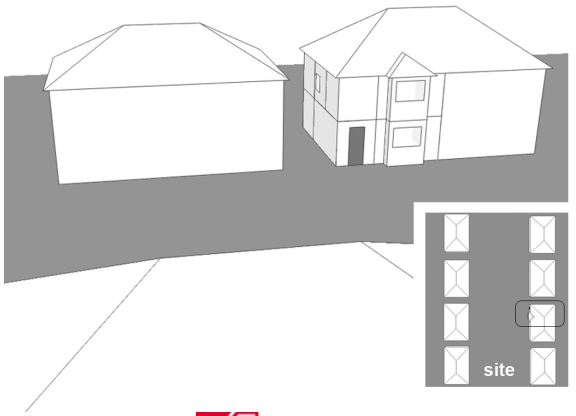


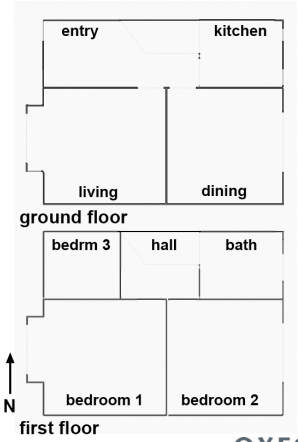
Mid-terrace



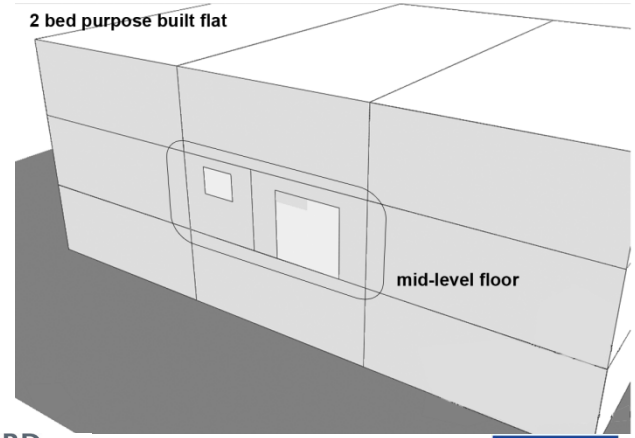


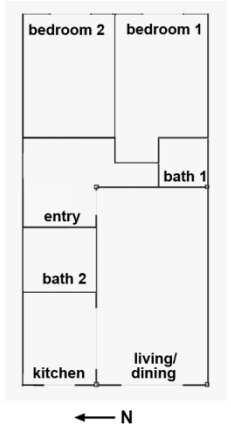
Semi-detached





2 bed purpose built flat





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Key assumptions

Home Typologies	% of households in England	Area	Occupant variable	Occupant variable details	Heating pattern[a]
Semi-detached home	29%	84 m^2	2 adults	Two working adults without dependants	0700-0900, 1600-2300
Mid-terraced home	21%	74 m^2	2 adults, 2 pre-school children	One working adult with two children at home with partner	0700-2300
Detached home	19%	98 m^2	2 adults, 2 teens	Two working adults with two children in school	0700-0900, 1600-2300
Purpose built flat (2 bed)	17%	72 m^2	Pensioners	Two pensioners at home most of the time	0700-2300

- Occupancy patterns are applied to explore vulnerabilities and impact on both future overheating and space heating variation