Urban microclimate in temperate cities: **Planning practice implications**

London Climate Change Partnership / Buildings & Cities joint event

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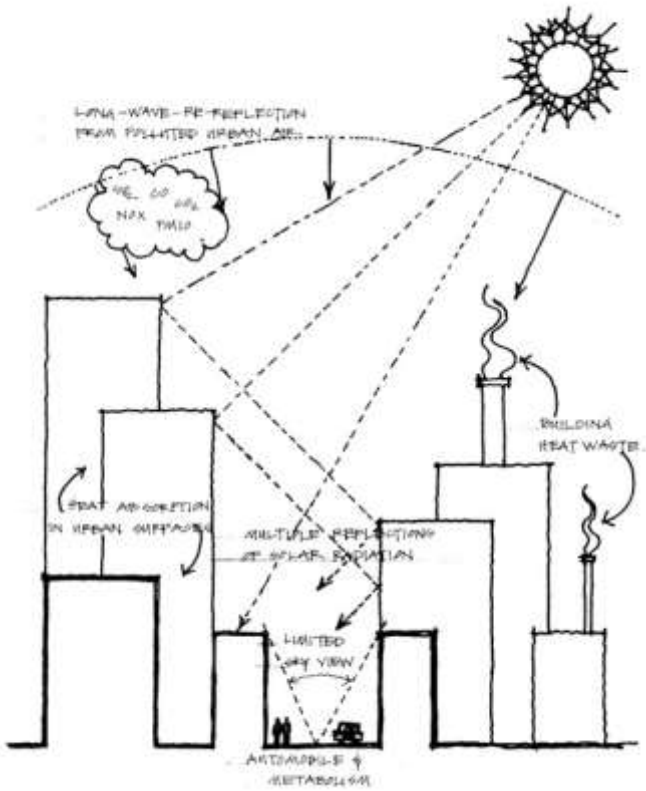
What de we know?

TYPE OF IMPACT	IMPACT PARAMETER	DESCRIPTION OF IMPACT
Climate	*Air temperature*	Up to **6°C increase** in air temperature in relation to the surrounding countryside —typically highest at night
	Relative humidity	**Drier** conditions in cities but depends on water use
	Precipitation	**Increased precipitation downwind of c**ities (in summer and the mornings), exacerbated by air pollution
	Regional/global climate	**Stronger fee**dback in highly urbanised regions (such as Western Europe); unclear elsewhere
Wellbeing and biodiversity	*Air quality*	Deterioration due to both **transportation** as well as **waste heat from buildings** (also act as a greenhouse gas)
	Vegetation and biodiversity	Reduced ability to provide **ecosystem services** by vegetation; enhancing the ability of **invasive species** to thrive as well as decreasing native species' ability to adapt
	Human health	Risk of **mortality** due to heat increases by between 1% and 3% per 1°C, but this is tempered by population density, economic health of city, fraction of elderly, and existing inequities
Carbon	*Energy consumption*	Decreased energy demand in winter and increased demand in summer, but this depends on building geometries; temporal differences in peak energy demand will have **different carbon consequences depending on the electricity generation mix**
	Water (quality and quantity)	**Increases in water use** (e.g. for irrigation) as well as runoff (due to paving and roads). Sealed surfaces also reduce water availability to absorb heat, leading to temperature changes and loss of water quality
	Economic impacts	Higher cooling loads (thus, **higher energy use**) and **productivity losses** have economic consequences. This is further exacerbated by air quality deterioration



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Approaches to mitigation

	GOAL	APPROACH	TOOLS		
What	*Climate Improvement*	**Temperature control** to manage heatwaves and mitigate overheating, reduce interference with humidity and precipitation	Urban form manipulation	Nature-based solutions (N*b*S)	Material properties
	Health and Wellbeing	**Thermal comfort** and **air quality** enhancement; Health, productivity and comfort; and improvements to biodiversity			
	Carbon management	Efficiency enhancement in **energy** and water use			
Where	*Macro-scale*	**City-wide** interventions to improve climate / carbon			
	Micro-scale	**Neighbourhood or street-scale** interventions for more immediate enhancement of well-being			

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Planning and Design

APPROACH	DESCRIPTION	INTENDED USERS	POINT OF APPLICATION
Urban climate mapping	Urban climate mappings (UCMaps) consist of a UC-AnMap, which analyses climatic, geographical and planning information in map form, and a UC-ReMap, which develops planning instructions from an urban climatic point of view. Useful technical standards exist for UCMap (VDI 1997)	Urban planners and urban designers	Masterplan, zoning plan and local development plan
Shading analysis	Optimising street canyon geometry to enhance the thermal comfort in public places offers several approaches to enhance shading, especially in the public realm	Urban designers, building designers and building services engineers	Street design and preliminary planning approval for buildings
Ventilation analysis	Similar to Air Ventilation Assessment (AVA) in place in Hong Kong since the SARS epidemic in 2003 to monitor the air flow effects of buildings	Urban planners and public health officials	Masterplan, urban regeneration and neighbourhood development plan
Planning codes as toolkits to manage urban heat	The 'cool roofs' programme (enhancing roof albedo); 'green roof' (intensive and extensive roof green cover); 'cool pavements' (similar to cool roofs, but for pavements) and urban forestry regulations (especially in the U.S.)	Urban planners, building designers, public health, health and social care sectors	Streetscape design and building design

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Where are interventions needed?

POLICY AREAS	ACTIONS
Public health	Hotspot mapping; heat-related workload scheduling; and heat-related health and safety management
Building regulations	Heat stress-resistant building design guidelines; building morphology and form controls; control of building surfaces/material properties; financial incentives; include heat stress resistance in building energy certification; demonstration buildings
Planning actions	Cool refuges/public places for adaptation; heat mapping as part of an urban planning framework; urban climate mapping; ventilation and shadow assessment; open space/nature-based solutions (NbS) as part of the planning framework, inclusion of future climate scenarios for current regulations and practices
Infrastructure and services	Enhance infrastructure demand monitoring and modelling to account for heat stress; adopt public transport infrastructure to heat stress; review water and electricity infrastructure to manage heat-related demand

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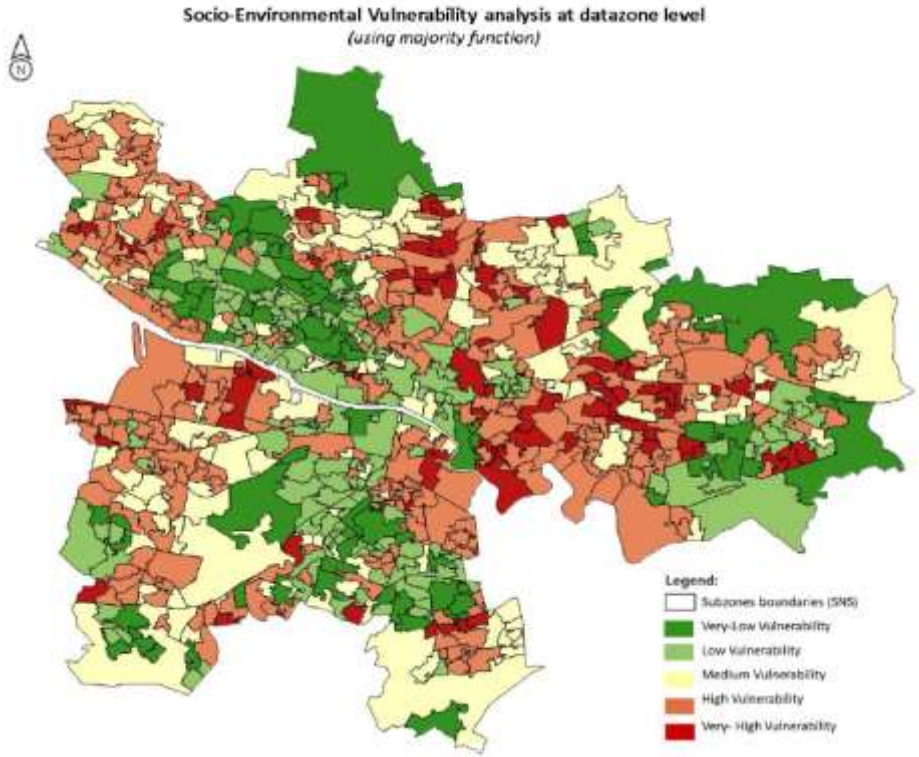
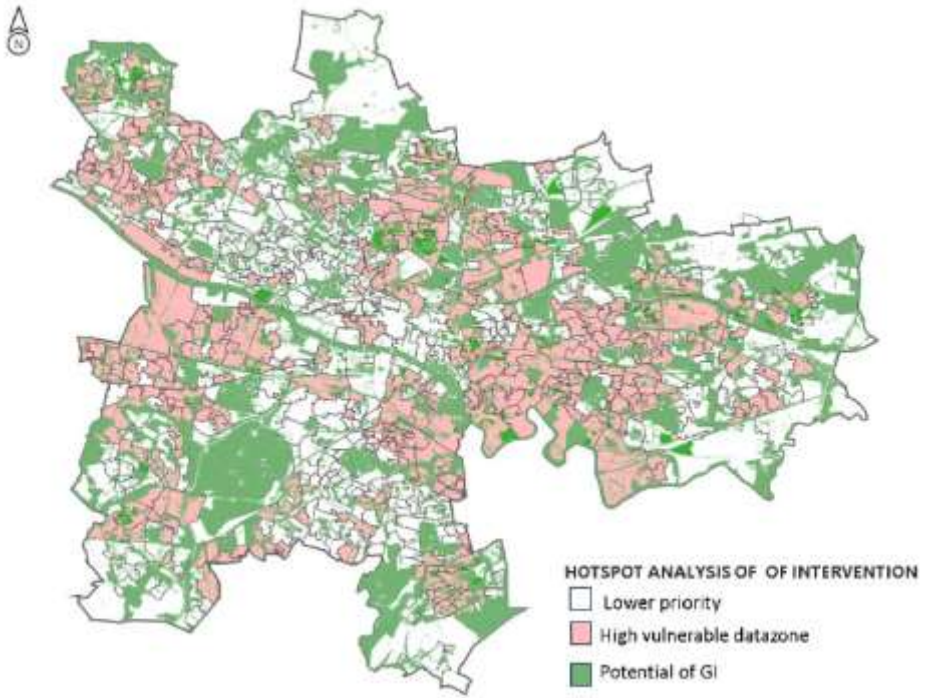
Hotspot mapping





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Building regulations - density

Street-level air temperature variations in July in Glasgow

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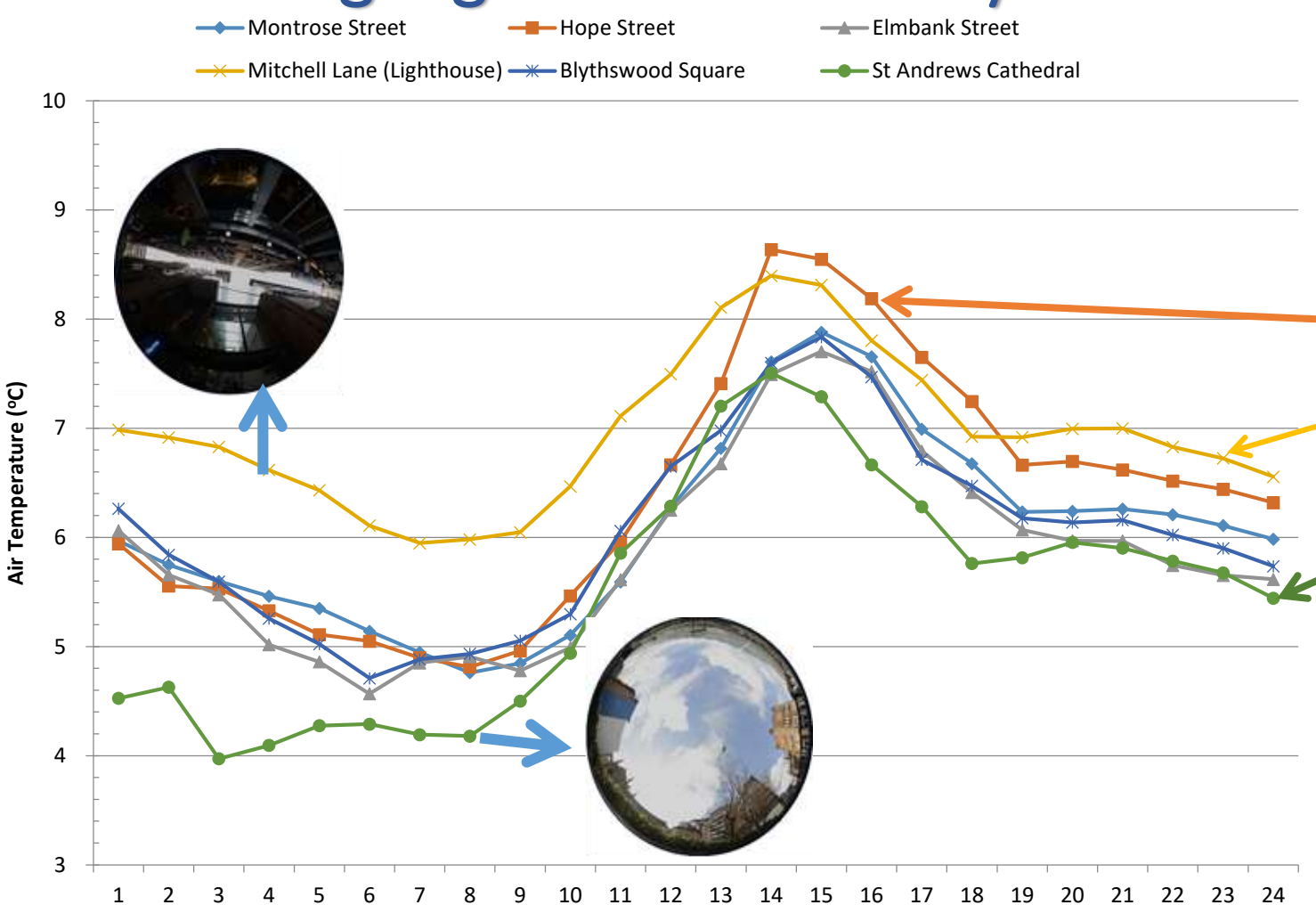
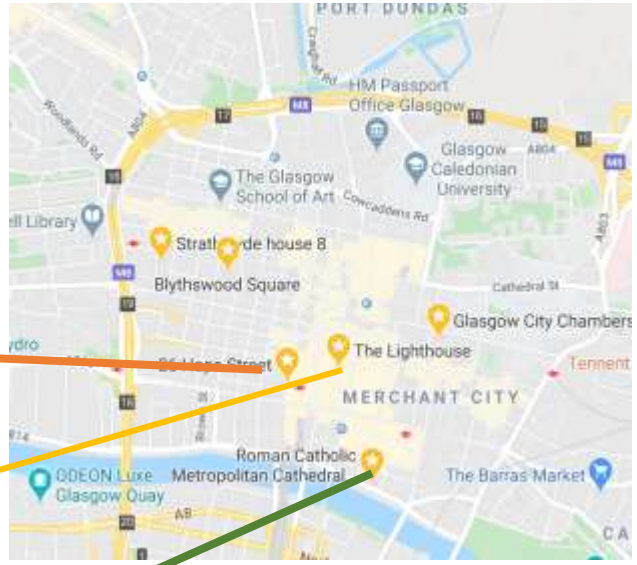
Building regulations – density . . .





Street-level air temperature variations in winter in Glasgow

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Building regulations – inter-dependency

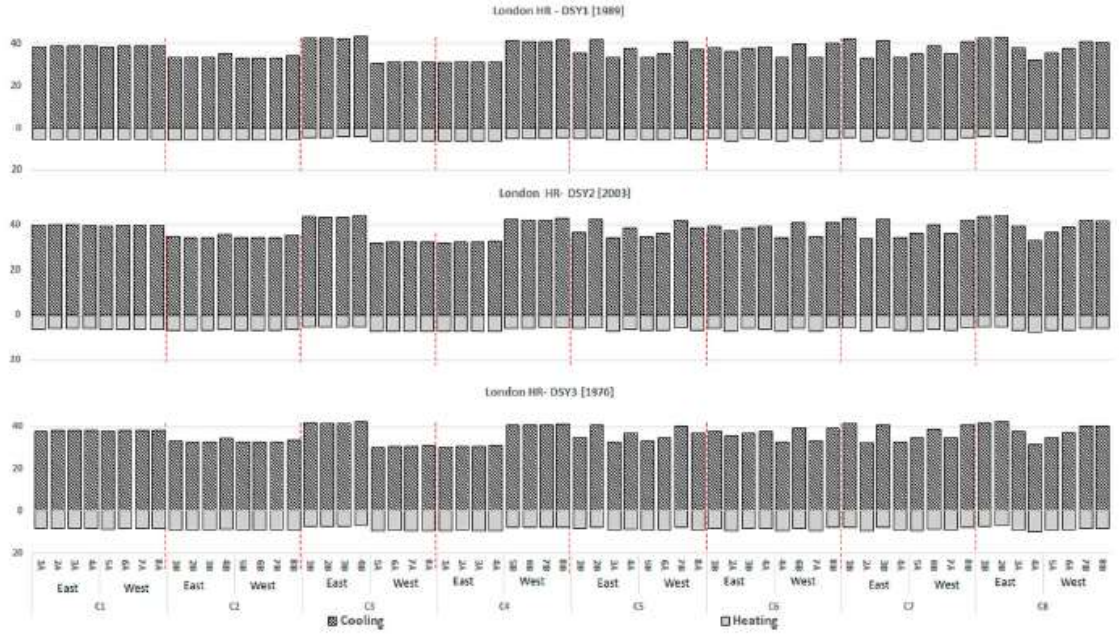


Figure 8. Output performance for all buildings in their eight-street canyon configurations (C1–C8) for the three London Heathrow (HR) design summer year (DSY) weather files (east- and west-facing buildings only) (kWh/m^2/yr).

Streets with similar FARs but in different geometries have significantly different energy consumption at a local scale

Source: *Futcher, Mills & Emmanuel, 2018*

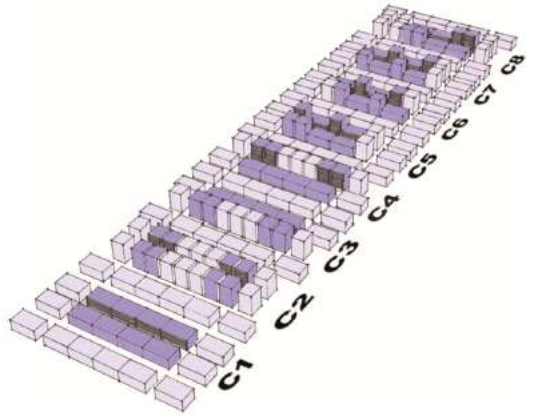


Figure 4. Geometric arrangement for the two office building forms along the eight urban canyons. Each building can be identified by its canyon number (C1–C8), building reference number (1–4) east facing, (5–8) west facing and building form (A–B). The non-shaded or pale buildings represent the boundary conditions, *i.e.* the surrounding system and infill buildings.

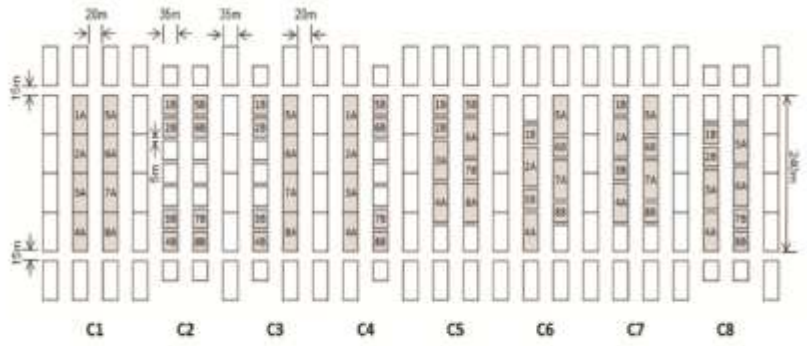
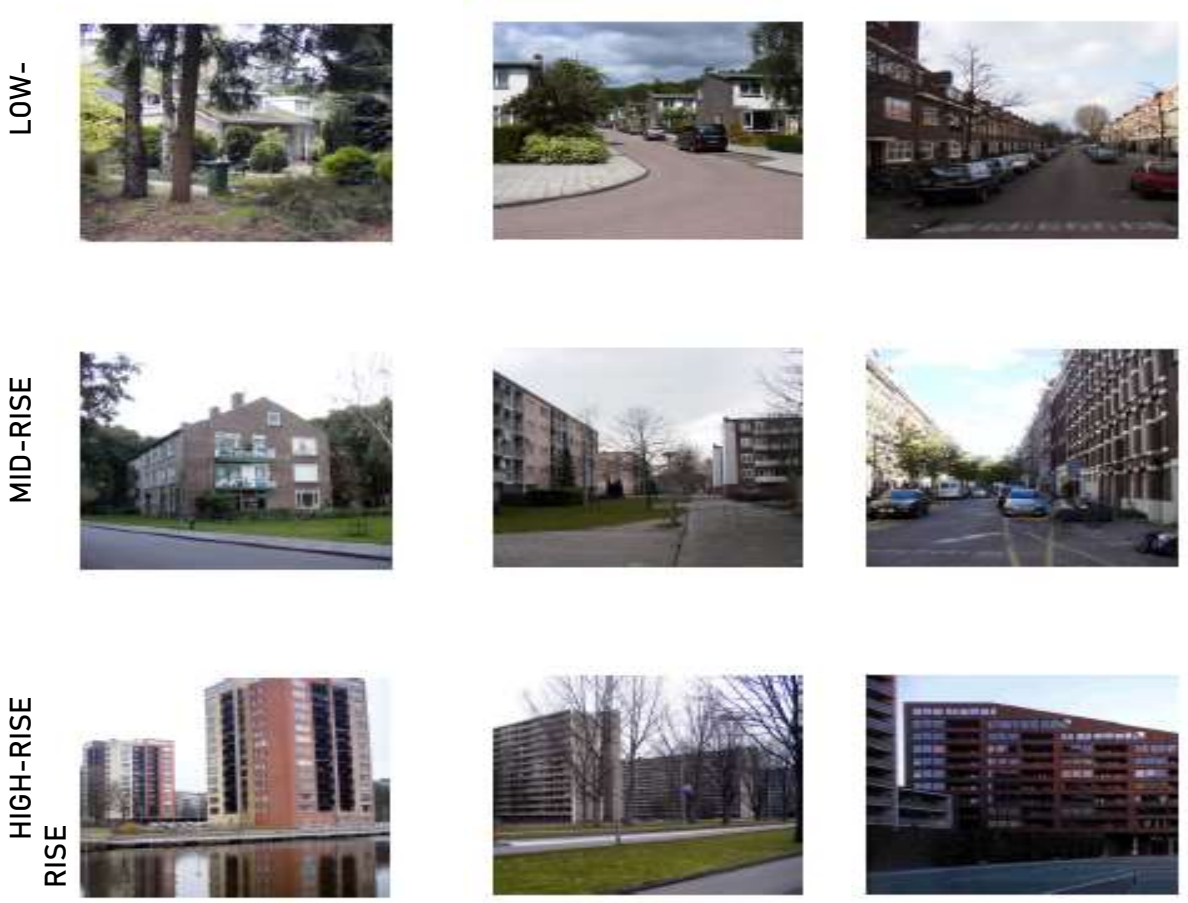


Figure 6. Identification layout of all buildings within their urban configuration. Each building can be identified by its canyon number (C1–C8), building reference number (1–4) east facing, (5–8) west facing and building type (A–B). The non-shaded buildings represent the boundary conditions, *i.e.* the surrounding system and infill buildings.

Building regulations – Key questions

1. How compact?
2. How intense?
3. What's the layout



Source: *Berghauser Pont & Haupt, 2009*

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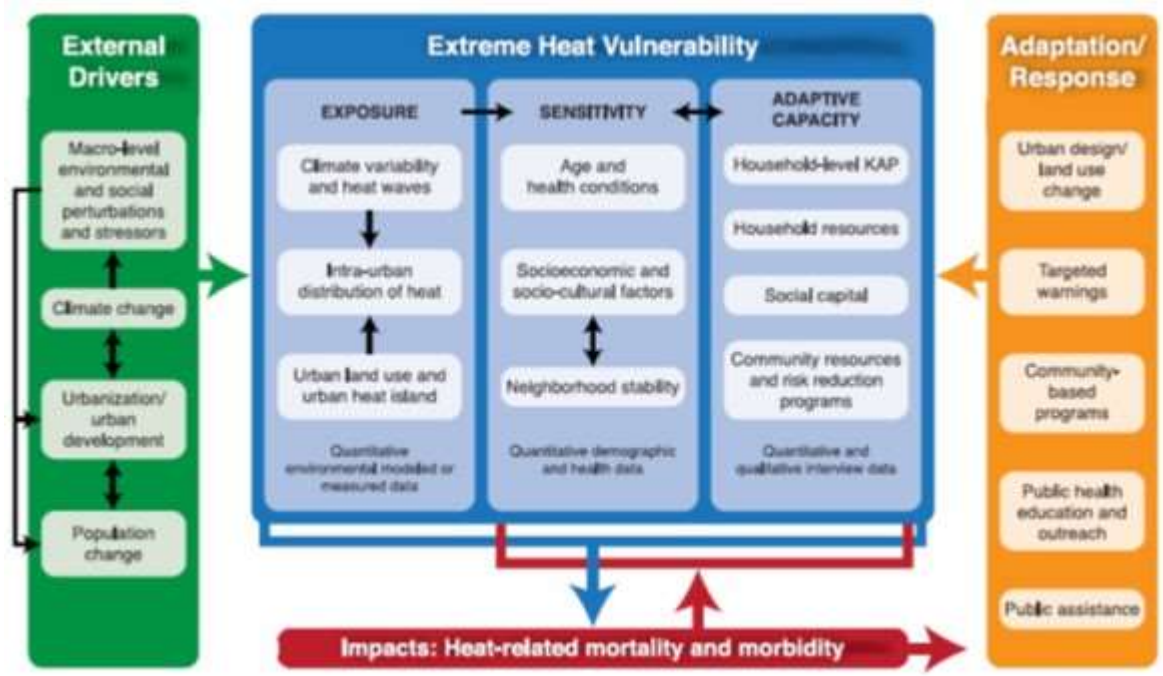
Bringing it all together



A Heat vulnerability framework
Source: *Wilhelmi & Hayden, 2010*

Key Lessons

- Clarity of focus needed:
  - Climate, comfort, carbon . . .
- Scale is important
  - Macro (city wide): wind corridors, climatic maps
  - Micro (neighborhood or single street): shading, GI
- Density is a key variable for urban climate control, but . . .
  - Which density? ↑ or →
- Urban climate management as part of the climate change risk management

References

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Thank you

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