# Urban nature, health & climate change – the perspective of urban heat

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European BfN/ENCA conference - Biodiversity and Health in the Face of Climate Change
Tuesday 27th June, 2017 (with additional slides)

*Acknowledgements*: Cynthia Skelhorn, Geoff Levermore, Henry Cheung, Gina Cavan, Matthew Dennis, Susannah Gill, Andy Speak, Claire Smith, James Rothwell, John Parkinson & others. Research 2003-2017+

Photograph: Sarah Lindley

# Hottest July day ever recorded in UK

1 July 2015 | England

*Original image removed for copyright reasons. New photograph Manchester City Centre in June 2017 (Source: Sarah Lindley)*

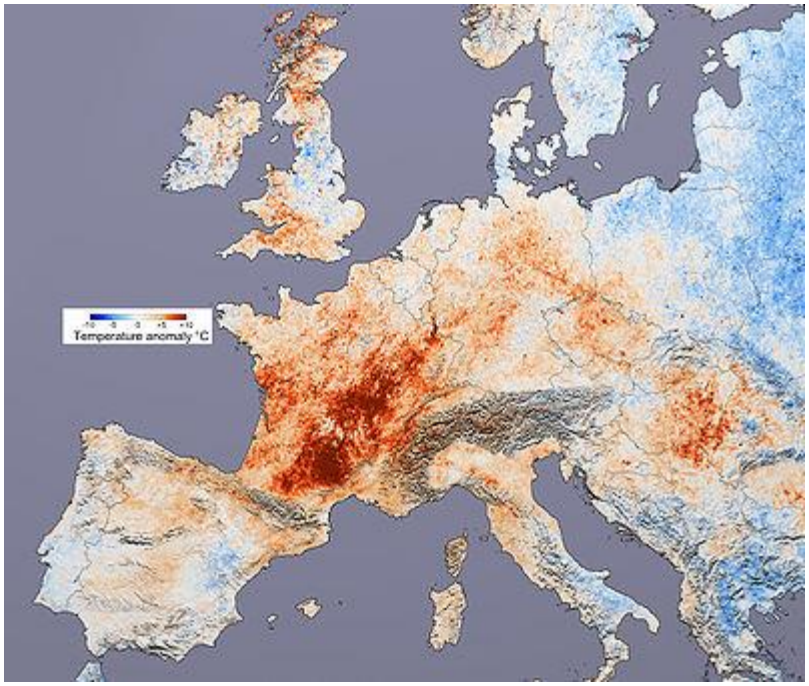

**The UK has seen the hottest July day on record, with temperatures hitting 36.7C (98F).**

The Met Office said the reading had been registered at Heathrow - breaking the previous record set in 2006.

A level 3 "heatwave action" heat-health alert has been declared for all parts of England.

But in Scotland, forecasters warned of **thunderstorms, torrential downpours and hail stones** up to 1cm in size.

## Other extreme events are also expected to become increasingly frequent



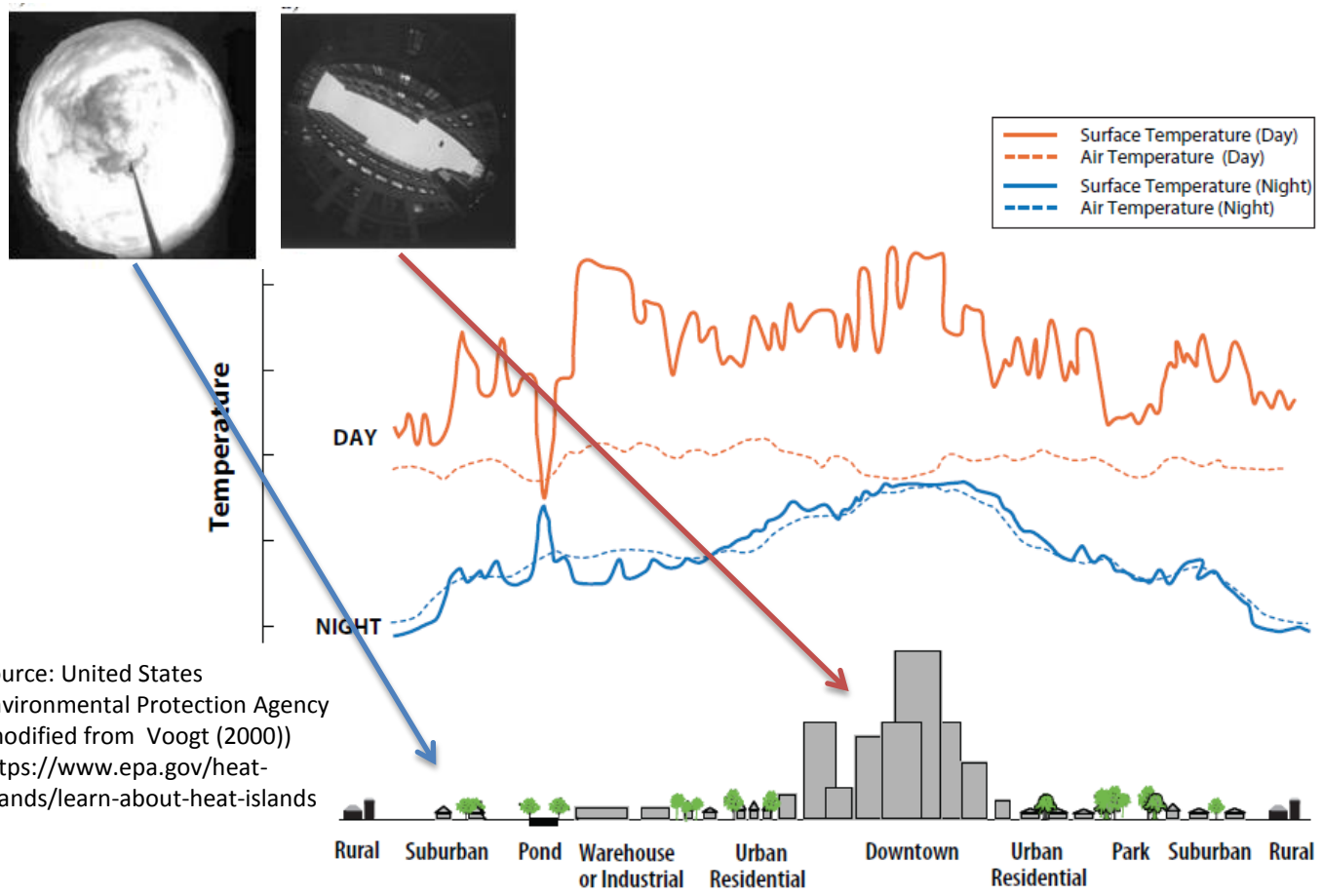

Difference in average temperature (2000, 2001, 2002 and 2004) from 2003, covering the date range of 20 July – 20 August. No copyright – Public Domain "Image courtesy Reto Stockli & Robert Simmon, based upon data provided by the MODIS Land Science Team." - http://earthobservatory.nasa.gov/IOTD/view.php?id=3714 (image)

The Met office reports >20,000 people lost their lives. Many of the 2,000 excess deaths in England and Wales during the August 2003 heat wave were > 75 years of age. **Urban areas were particularly affected.**

Sources: BBC, Met Office & Climatejust.org (all re-accessed 30th June 2017)

# Urban Heat Island

- Urban areas are associated with warmer temperatures compared to rural counterparts
- UHI intensity (urban T – rural reference T) exacerbates high temperatures & health impacts

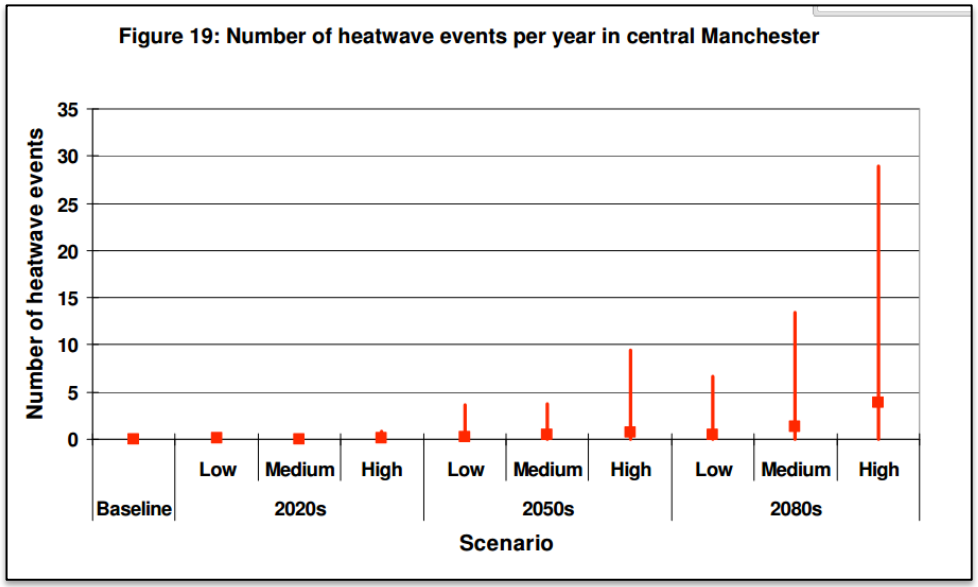


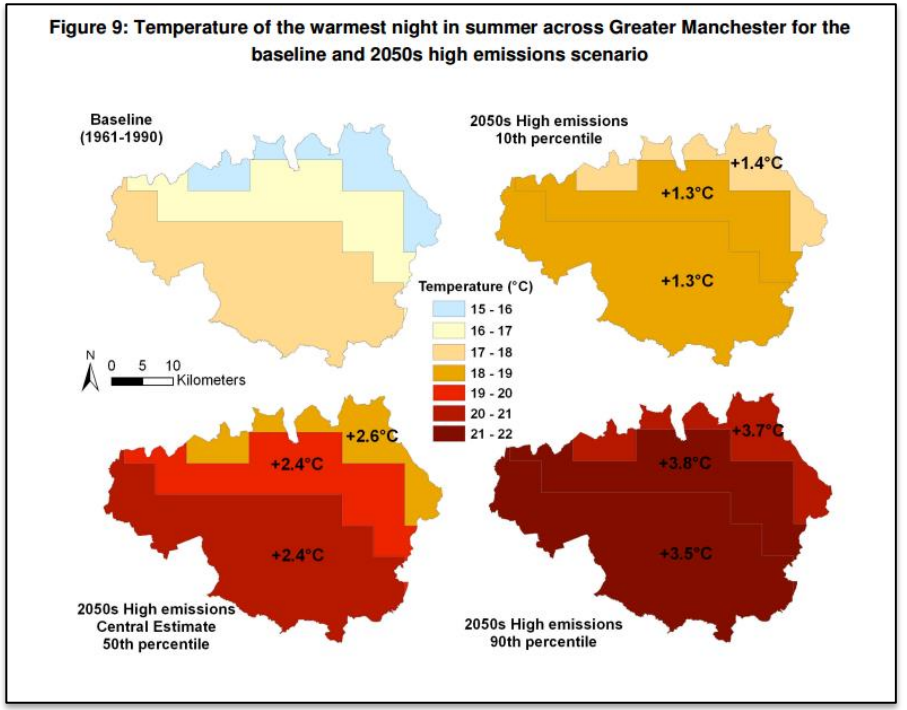

Source: United States Environmental Protection Agency (modified from Voogt (2000)) https://www.epa.gov/heat-islands/learn-about-heat-islands

- ❑ Less vegetation (shading & evapotranspiration)
- ❑ Properties of urban surfaces (thermal storage)
- ❑ Complex urban geometry (wind, reflections, reduced *Sky View Factor* moderating long wave radiation losses)
- ❑ Effect of heat emissions (direct heat sources)

More information: Voogt, J.A., and T.R. Oke. 2003. Thermal remote sensing of urban areas. Remote Sensing of Environment 86: 370–384
Images (#4138900634041) Svensson, MK (2004) Sky view factor analysis – implications for urban air temperature differences Meteorol. Appl. 11, 201–11

# Additional context on local future climate projections- *reference slide not presented*




- Based on - UK Met Office Heat-Health threshold of a maximum temperature exceeding 30°C for two days and a minimum temperature exceeding 15°C on the intervening night.

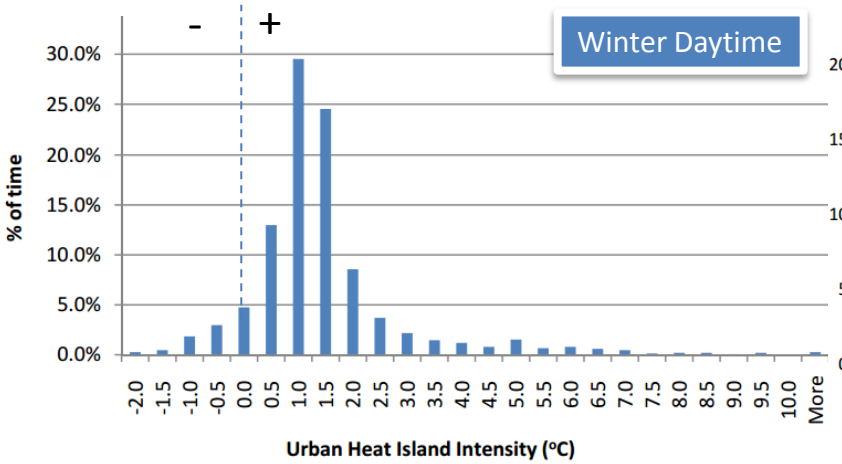
- Note: analysis takes <u>high</u> emission scenario.
- 10th percentile Summer night Tair change likely to be > this value
- 50th percentile central estimate
- 90th percentile summer night Tair change likely to be < this value

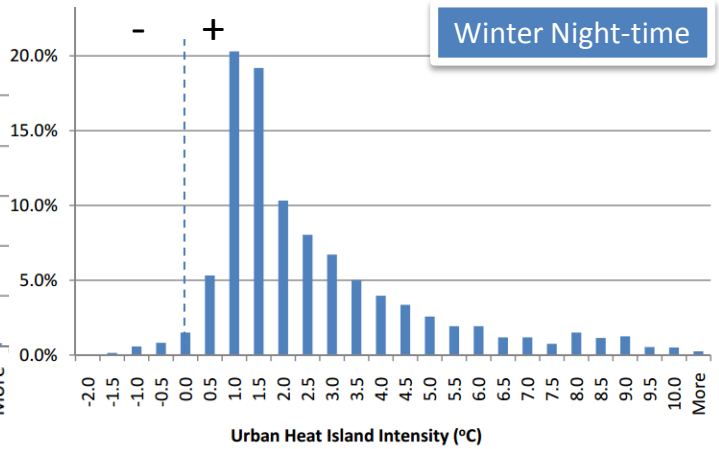
Data: Cavan, G. (2010). Climate change projections for Greater Manchester. EcoCities project, University of Manchester, Manchester, UK. http://media.adaptingmanchester.co.uk.ccc.cdn.faelix.net/sites/default/files/Climate_change_projections_GM_final.pdf

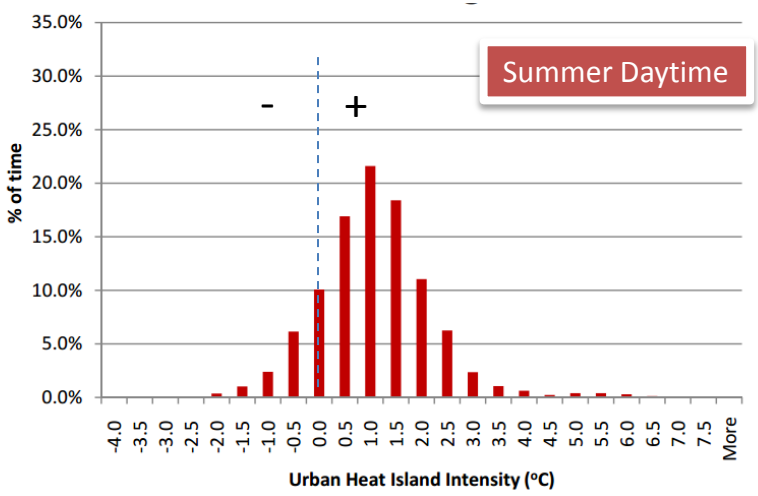
# Manchester UHI intensity

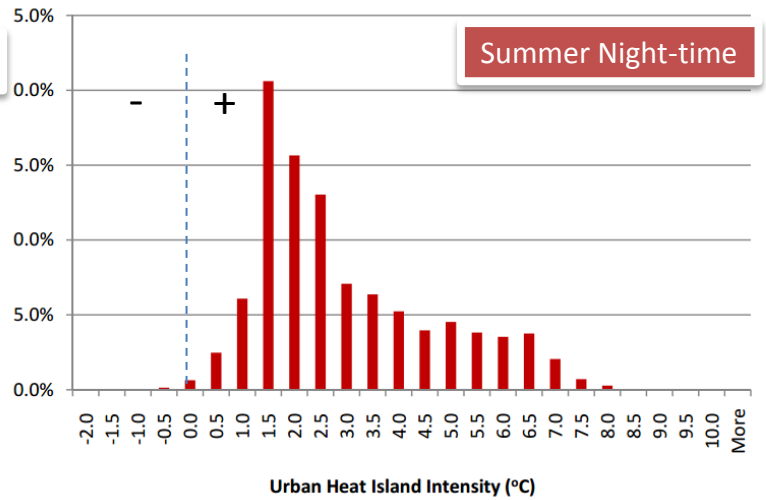
11 city centre sites summer 2010 (ibuttons) urban – rural reference


- Pop. 2.5 m,
- 1300 km$^2$
- Temperate maritime climate
- Mean annual T 9 ◦C
- Annual precip = 806 mm.



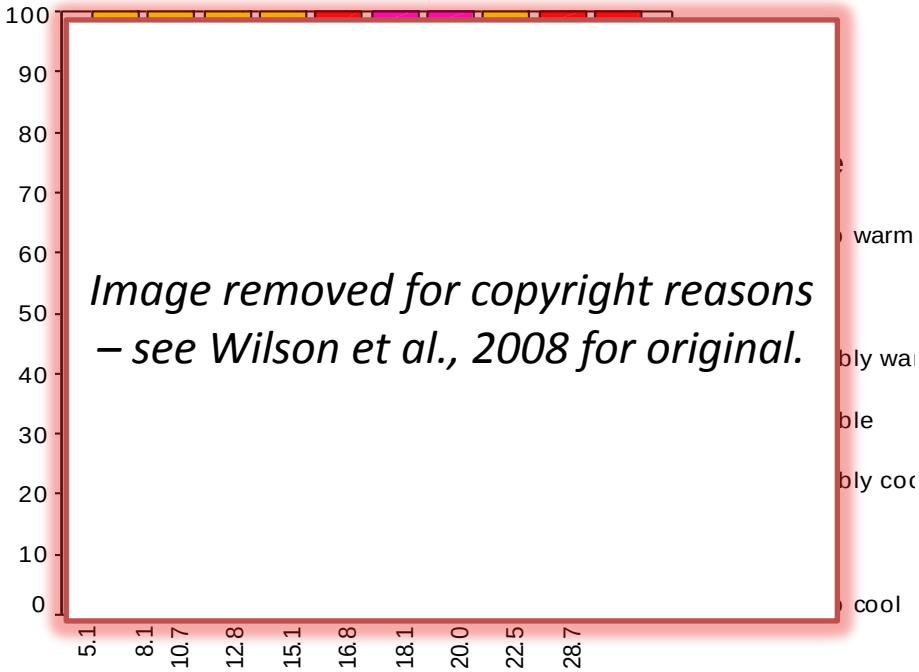



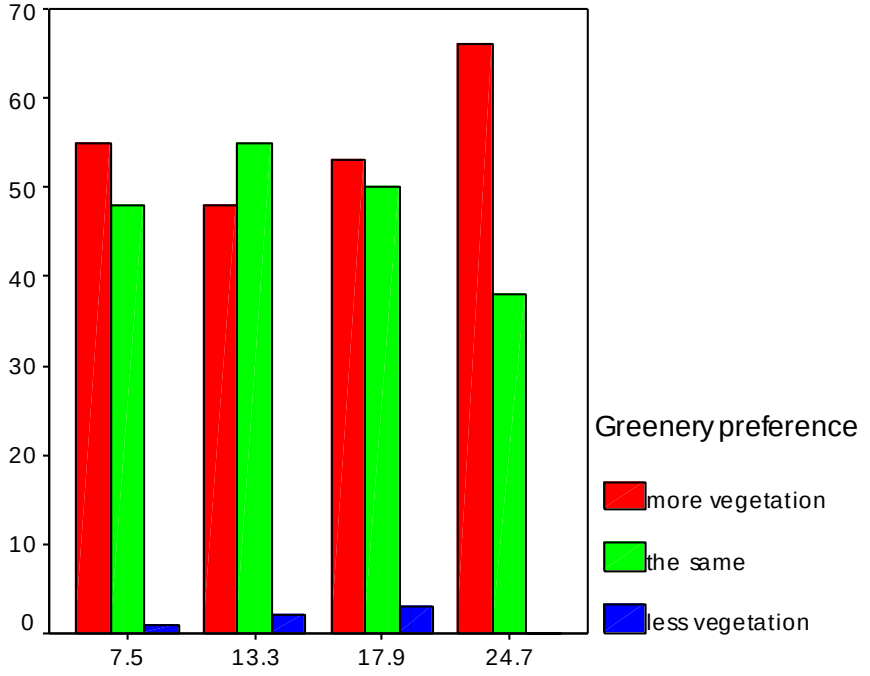

Cheung (2011) An urban heat island study for building & urban design Derived from open access document [Thesis]. Manchester, UK: The University of Manchester; 2011. (https://tinyurl.com/n2mpy29) & Armson et al, 2012

# Greenery preference



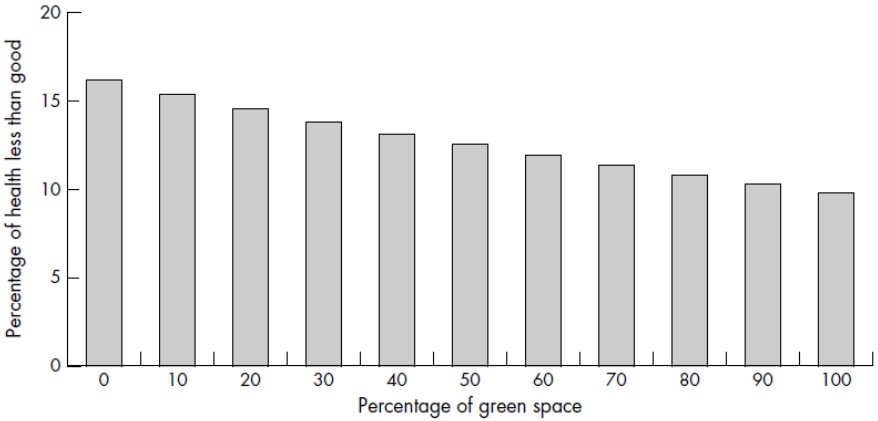

Mean temperature in decile




Quartiles of air temperature

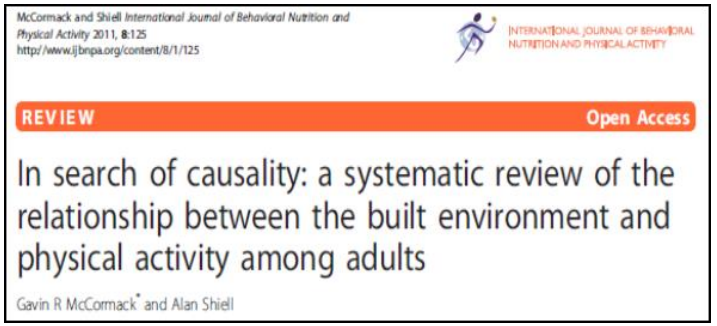
Nicol et al., 2006 (https://tinyurl.com/ya7osuk8) Open access (image on right and above) Source for image on left Elizabeth Wilson, Fergus Nicol , Leyon Nanayakkara & Anja Ueberjahn-Tritta (2008) Public Urban Open Space and Human Thermal Comfort: The Implications of Alternative Climate Change and Socio-economic Scenarios, Journal of Environmental Policy & Planning, 10:1, 31-45. Copyright fee for reproduction prohibitive for re-use.

# Evidence of health benefits




Large study (Netherlands) % of green space (urban green space, agricultural space, natural green space) < 1km and <3km around postcode centroids (Maas et al., 2006)

**Positive associations→ especially lower socioeconomic, old & young groups**


McCormack and Shiell International Journal of Behavioral Nutrition and Physical Activity 2011, 8:125
http://www.ijbnpa.org/content/8/1/125

INTERNATIONAL JOURNAL OF BEHAVIORAL NUTRITION AND PHYSICAL ACTIVITY

REVIEW Open Access

In search of causality: a systematic review of the relationship between the built environment and physical activity among adults

Gavin R McCormack* and Alan Shiell

**Mechanisms?**

- **Physical Activity**
- **Social Contact (Maas et al, 2009)**
- **As well as reduction of hazards….**

**…and restorative effects**

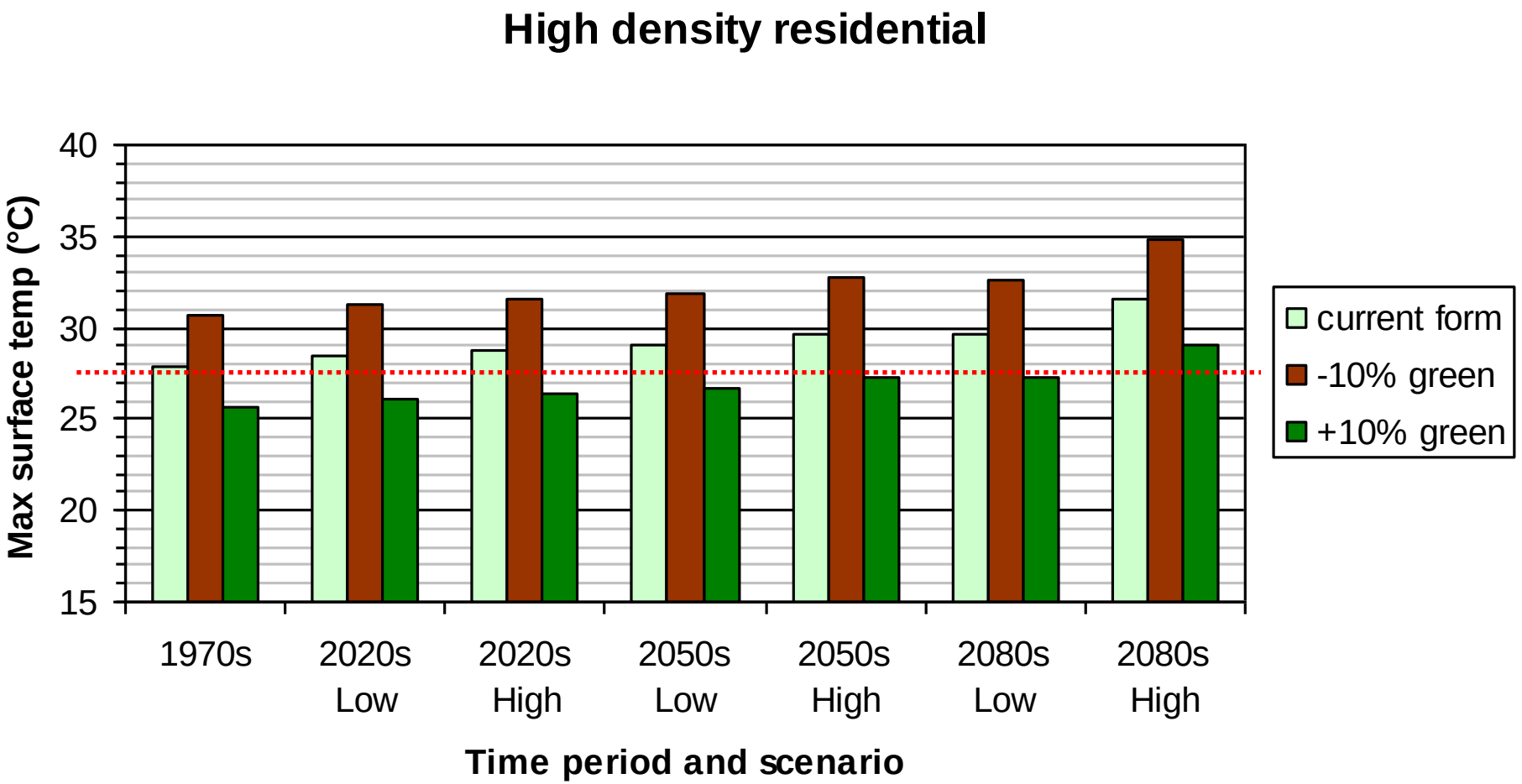
**…sense of place & heritage**

Maas et al (2006) Green space, urbanity, and health: how strong is the relation? J Epidemiol Community Health 2006;60:587–592. Open access, including image above.

Maas et al (2009) Social contacts as a possible mechanism behind the relation between green space & health. Health & Place,15(2), 586–95.

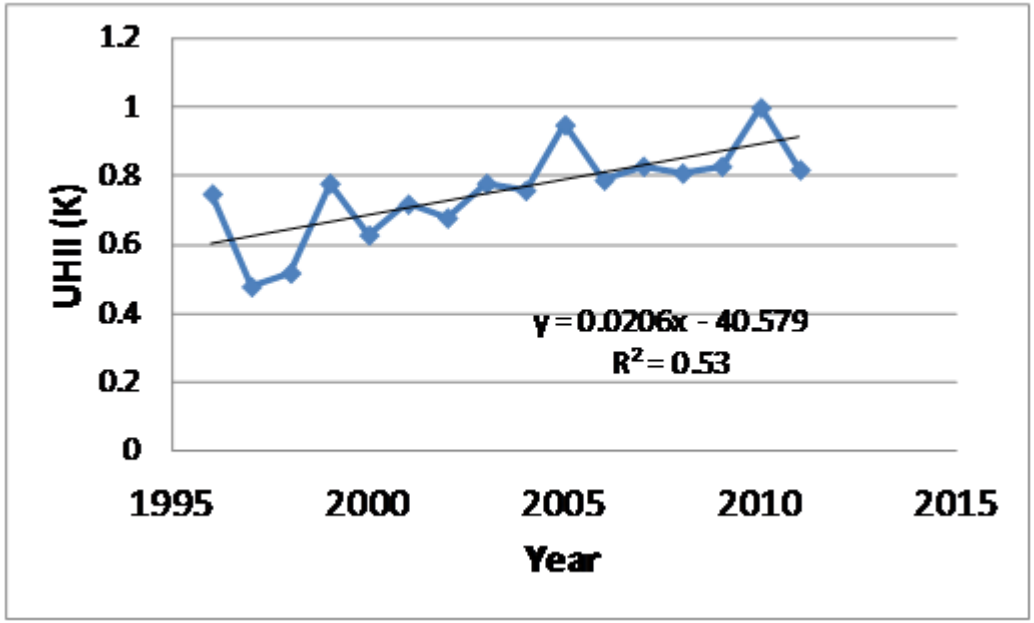
Other evidence - Mitchell & Popham (2008) Effect of exposure to natural environment on health inequalities: an observational population study The Lancet
Volume 372, Issue 9650, Pages 1655-1660

# Residential ± 10% green cover
# How are we doing?

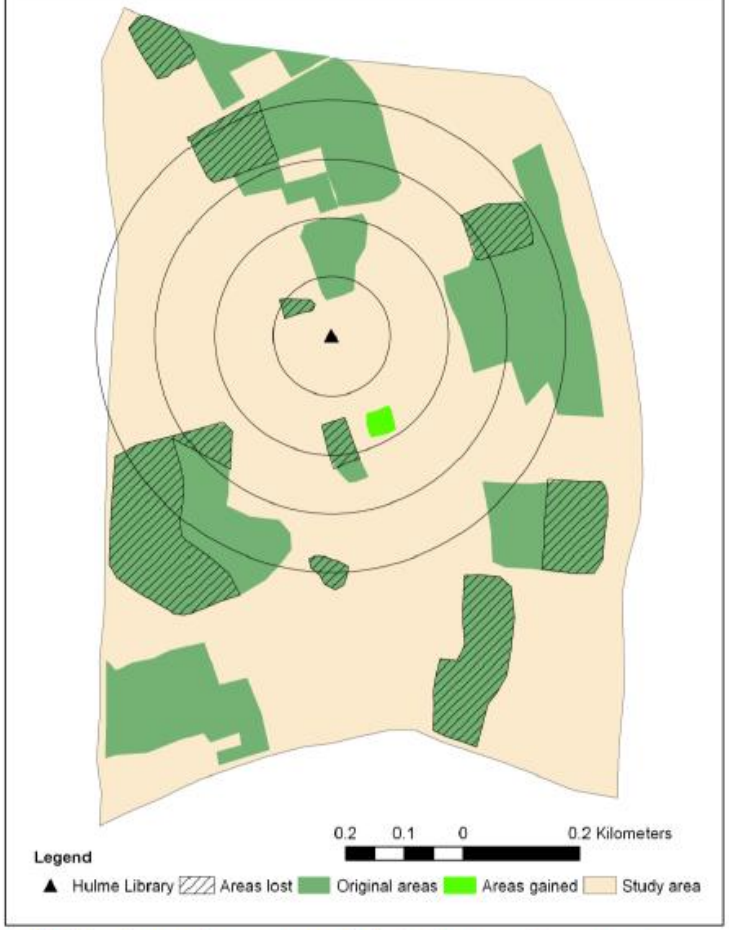



Gill, S.E., Handley, J.F., Ennos, A. R., & Pauleit, S. (2007) 'Adapting cities for climate change: the role of the green infrastructure', *Built environment*, *33*(1), pp. 115-133. Open access versions of image are available.

# ….but UHI intensity seems to be increasing & green space lost



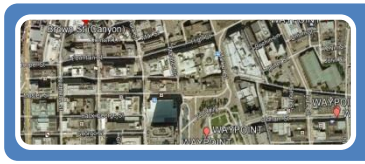

Some change in cloud cover but also 11% green space loss around urban site 2000-9




- Difference between **urban weather station** (2km S of city centre) & **rural reference**
- Statistically significant trend (p< 0.1%) 0.021 °C per annum
- →2.42 °C by end of this century.
- Equivalent to some climate change scenario predictions (medium emissions scenario)

Levermore, G, Parkinson, J Lee, K, Laycock, P & Lindley, S (in press, 2017) The increasing trend of the urban heat island intensity *Urban Climate*

# ENVI-Met modelling



**Base case representing current field conditions**

+5% New Trees

**+5% Mature Trees**

+5% Hedges

Addition of Green Roof on Largest Building

**Replacing all current greenspace with asphalt**

C. Skelhorn et al. / Landscape and Urban Planning 121 (2014) 129–140/ Skelhorn , Levermore & Lindley Modelling Greenspace Effects on Urban Microclimate and Building Energy ICUC8 (content available open access online)

# Study sites

## URBAN CENTRE

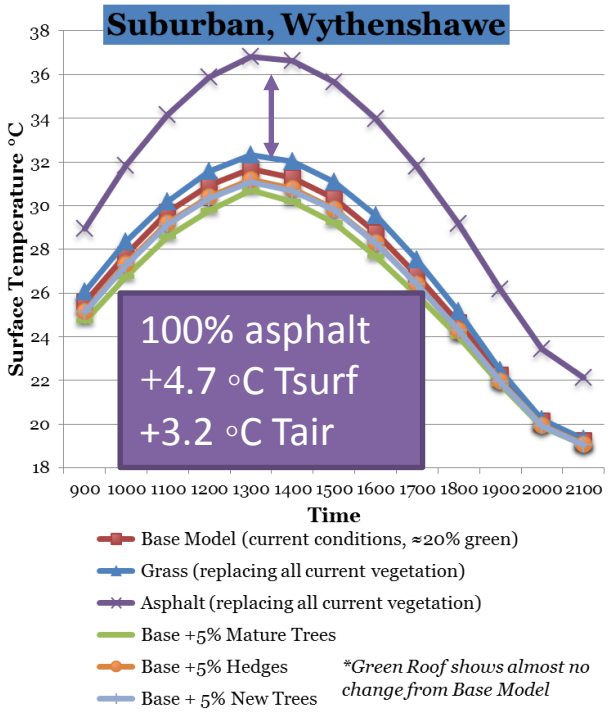

- 668m x 544m, **about 3% greenspace**
- Office and Retail, av building height 20 m (max 118 m)
- Av SVF for study area (buildings only) 0.66

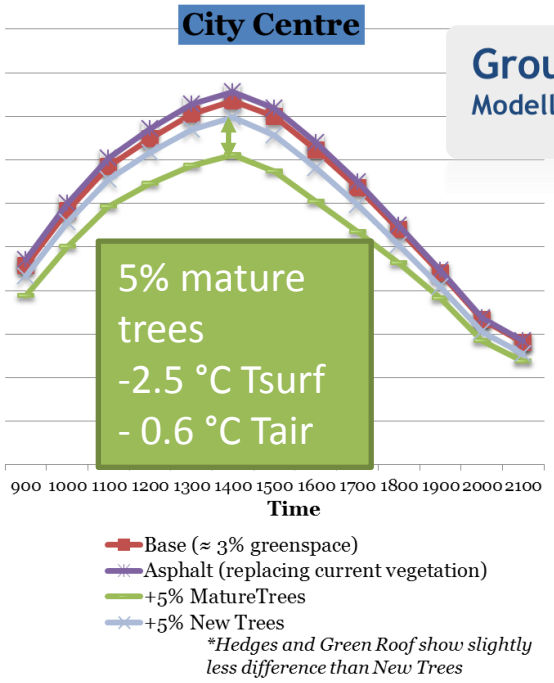
## SUBURBAN


- 692 m x 560 m, **about 20% greenspace**
- Retail & Residential, Av Building Height 10 m (max 30 m)
- Av SVF for study area (buildings only) 0.76

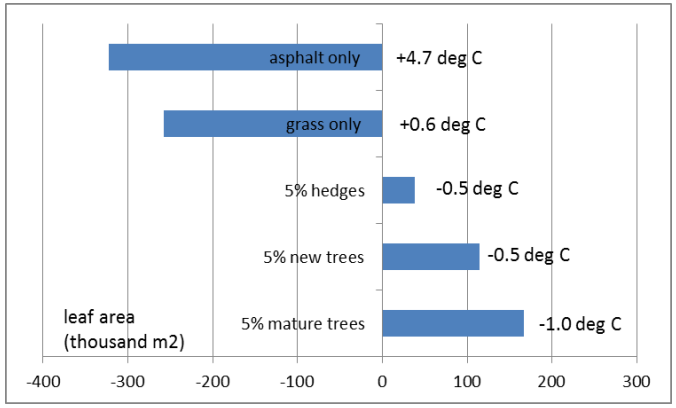
**Tree surveys** → model input e.g. *Acer pseudoplatanus* (Sycamore) & *Quercus robur* (English Oak).
Empirical evidence of local species effects in Armson, D., Rahman, M. A. &Ennos, A. R (2013) Arboriculture & Urban Forestry 39(4): 157–64

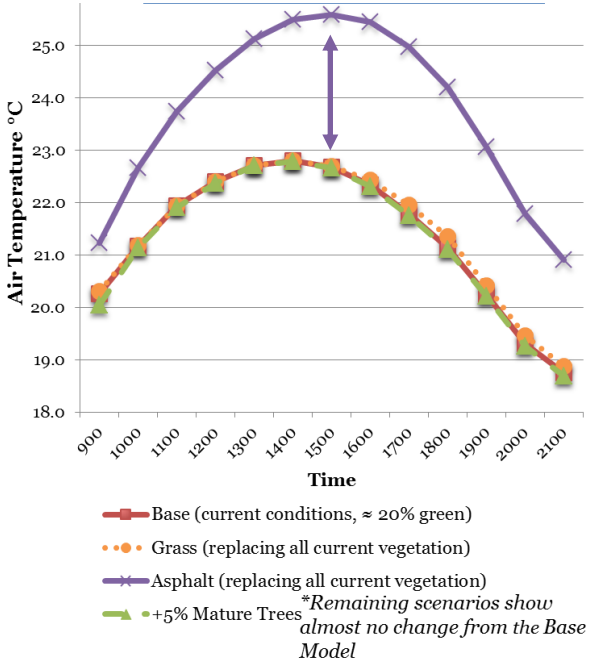
Model set up explained in C. Skelhorn et al. / Landscape and Urban Planning 121 (2014) 129–140/ Skelhorn , Levermore & Lindley Modelling Greenspace Effects on Urban Microclimate and Building Energy ICUC8

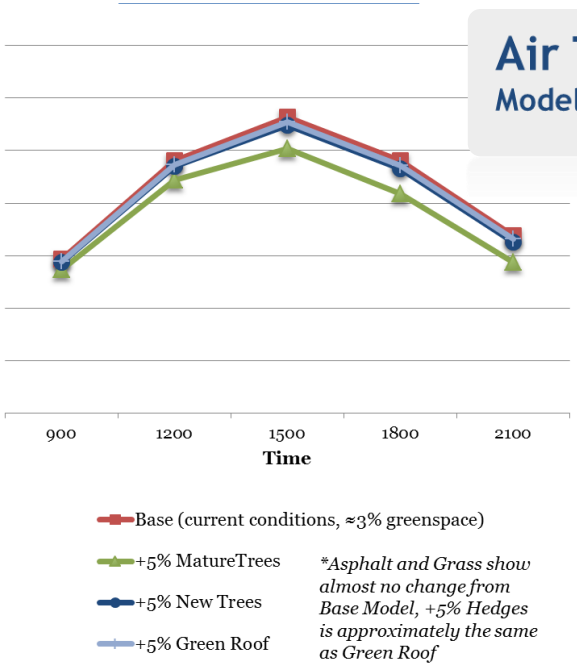



## Ground Surface Temperatures
Modelled with ENVI-met, 19 July 2010



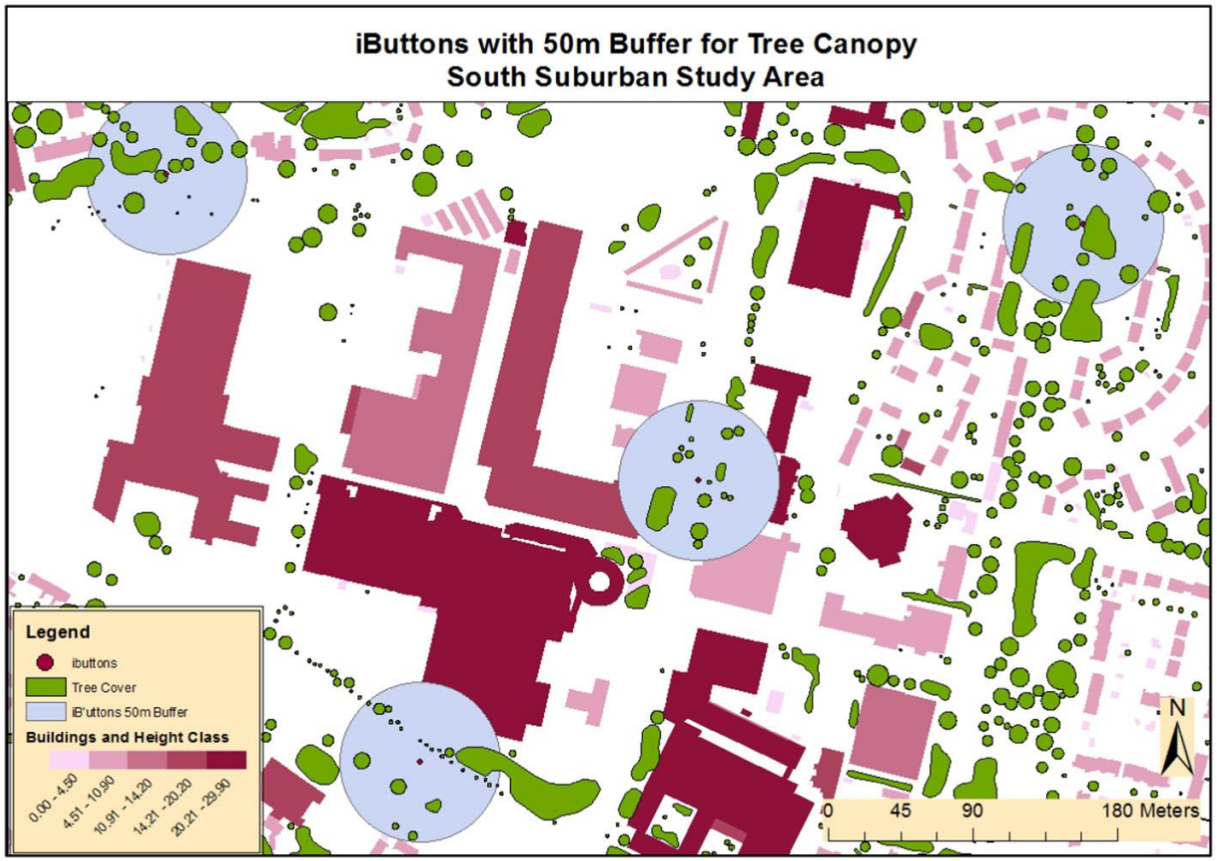



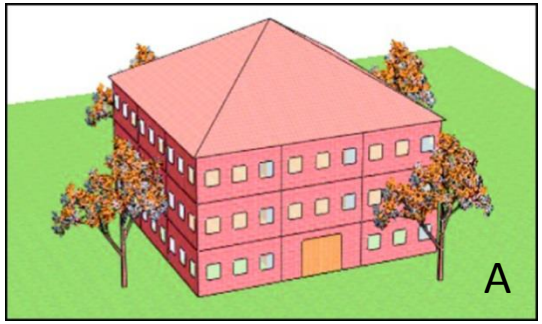

## Air Temperatures
Modelled with ENVI-met, 19 July 2010

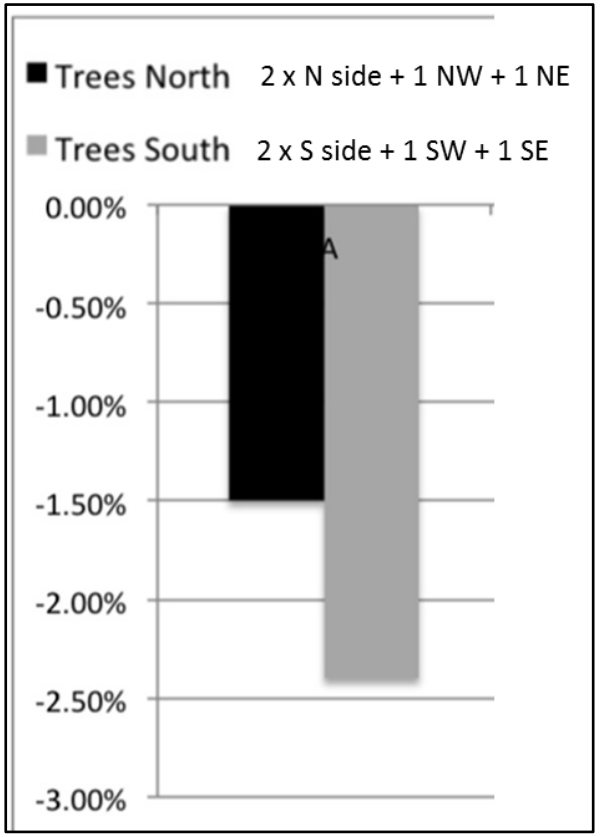
- Modelling for an **'UHI day'**
- Data = max on that day
- Change to all asphalt extreme impact on air temps in the suburbs
- Even +5% mature trees effective in the city centre

Skelhorn et al. as before

# Reduction in cooling energy demand



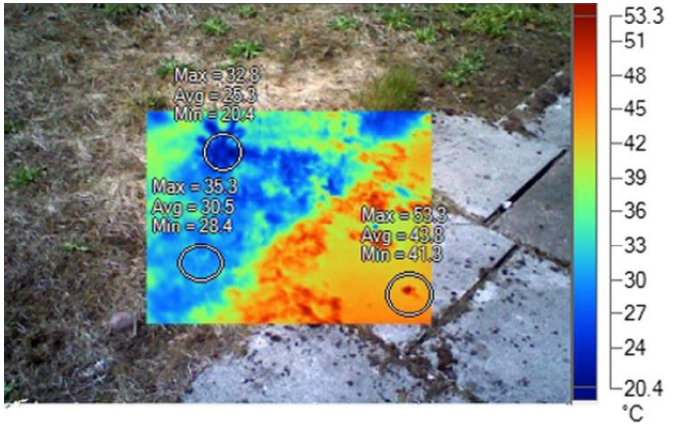



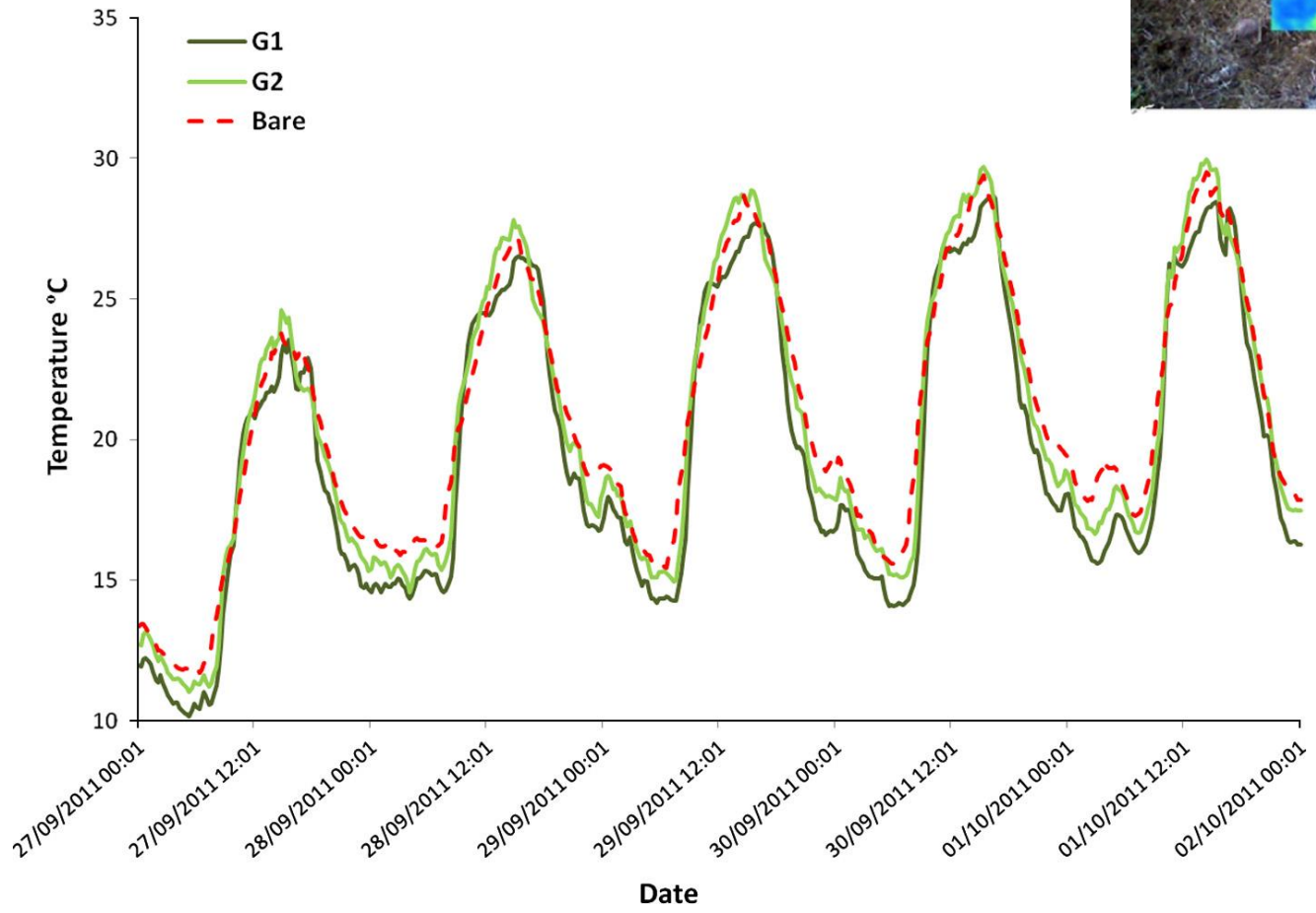




- Even in relatively cool Manchester, modelling studies suggest that the summer **UHI increases air conditioning loads by ~7–8%** (Skelhorn, et al., 2017).
- % **reduction in chiller energy from the base scenario to the shade scenario, due to trees placed on North and South sides of buildings,** (shading simulated with SunCast in IES-VE). July modelling. Note: interesting seasonal trade-offs.

#4138940279023 licence order reference Skelhorn, C.P., et al., Urban greening and the UHI: Seasonal trade-offs in heating & cooling energy consumption in Manchester, UK Urban Climate (2017) & http://www.meteo.fr/icuc9/LongAbstracts/udc7-6-8471671_a.pdf

# Effect of poor management

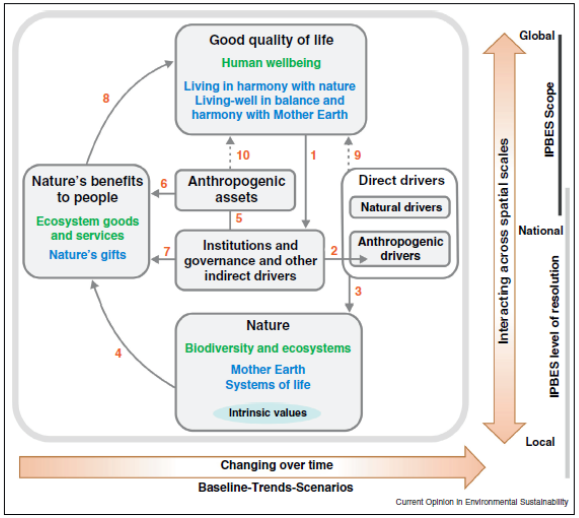



- Damaged green roof performs poorly for surface temperature (Tsurf) and long recovery time
- G2 = damaged roof G1 = undamaged roof
- On campus! (mowed during drought)

AF Speak, JJ Rothwell, SJ Lindley, CL Smith (2013) Reduction of the urban cooling effects of an intensive green roof due to vegetation damage Urban Climate 3, 40-55 # 4138940745768 licence order number.

Based on ipbes framework (Díaz et al., 2015) Open access




HEALTHY LIVING – but for whom?

# What sorts of connections emerge?

Promote virtuous circle, i.e. fewer burdens more participation

**NATURE's ROLE**

+ UHI & adaptation
+ mitigation (energy use)
+ physical activity
+ mental health
+community cohesion
+physical health associations
+ less exposure to some hazards, e.g. noise
- More exposure to other hazards sometimes, e.g. Pollen, ticks etc.

Trade-offs (e.g. seasonal)

Valuation? What value restorative / heritage roles?

Trade-offs

Roles inter-related

**INSTITUTIONS**

- Governance – trade-offs
- ***Maintenance & practices***
- ***Inequalities***
- Harness public engagement?

**DIRECT DRIVERS**

- Climate Change
- Develop-ment pressures

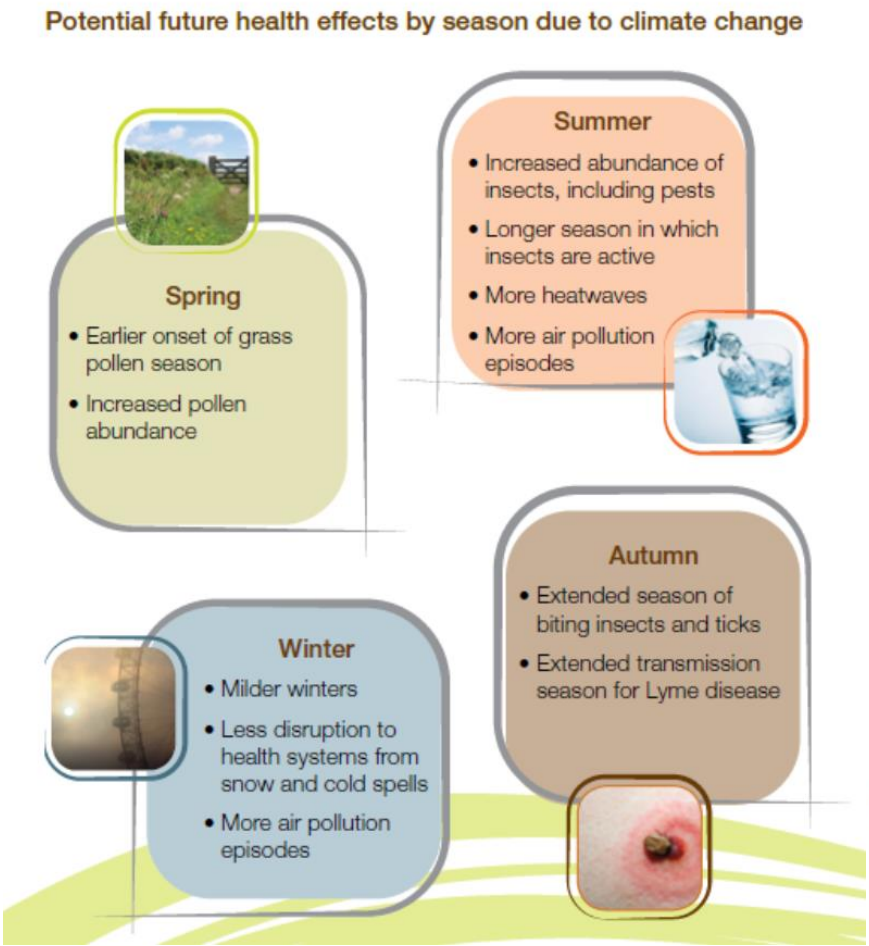
**NATURE**

Urban blue & green space vegetation (Mature trees! Trees over grass ) Quality/structure

What links to bio-diversity?

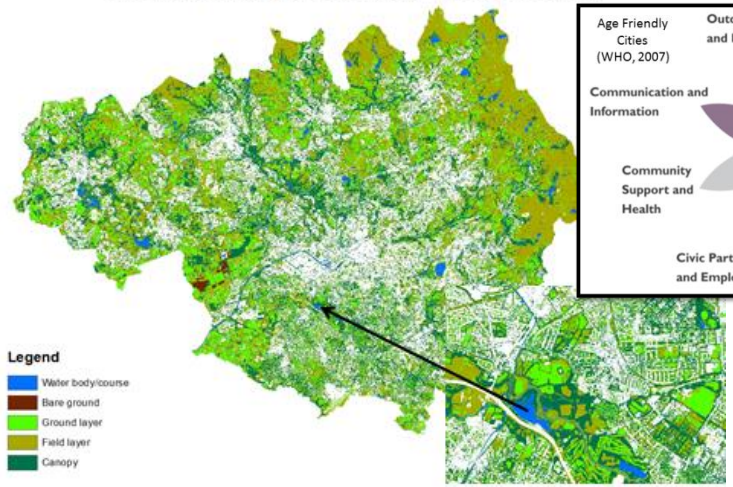
# Future challenges

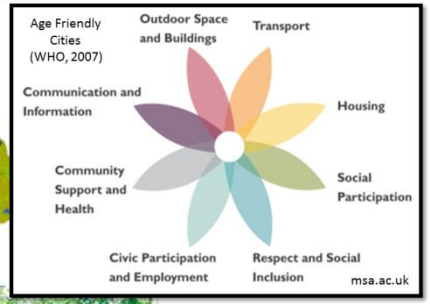
- Changing & ageing populations
- Reducing urban green space
- Climate drivers & trade-offs
- Economic pressures and ‘problems’ of valuation





Quality of green spaces and health – systematic natural experiments– pathways (isolation, physical activity) - exposure trade-offs




- Living with Environmental Change (LWEC) Health Climate Change Impacts Report Card 2015 (Open access)

Additional slides at the end of this presentation give more information

# Green infrastructure additions help to offset losses

Right – Urban nature can be brought into unpromising spaces

Below – Losses come from a range of drivers - tree death in West Yorkshire after Boxing Day floods (26/12/15)

Photographs: Sarah Lindley

# Urban nature, health & climate change – new projects for reference

*Sarah Lindley*
*Geography, School of Environment, Education & Development, University of Manchester*

Photograph: Sarah Lindley

# Green infrastructure and the Health and wellbeing Influences on an Ageing population (GHIA)

VALUING NATURE RESEARCH PROJECT

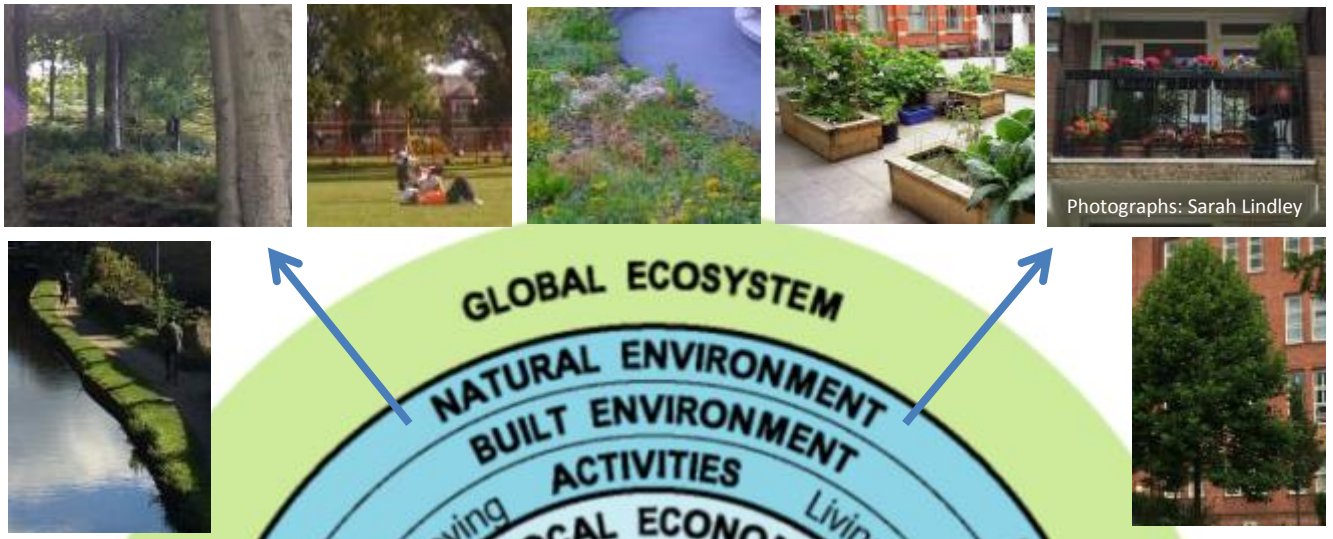
For other VNN projects, see http://valuing-nature.net/health-wellbeing-research-projects

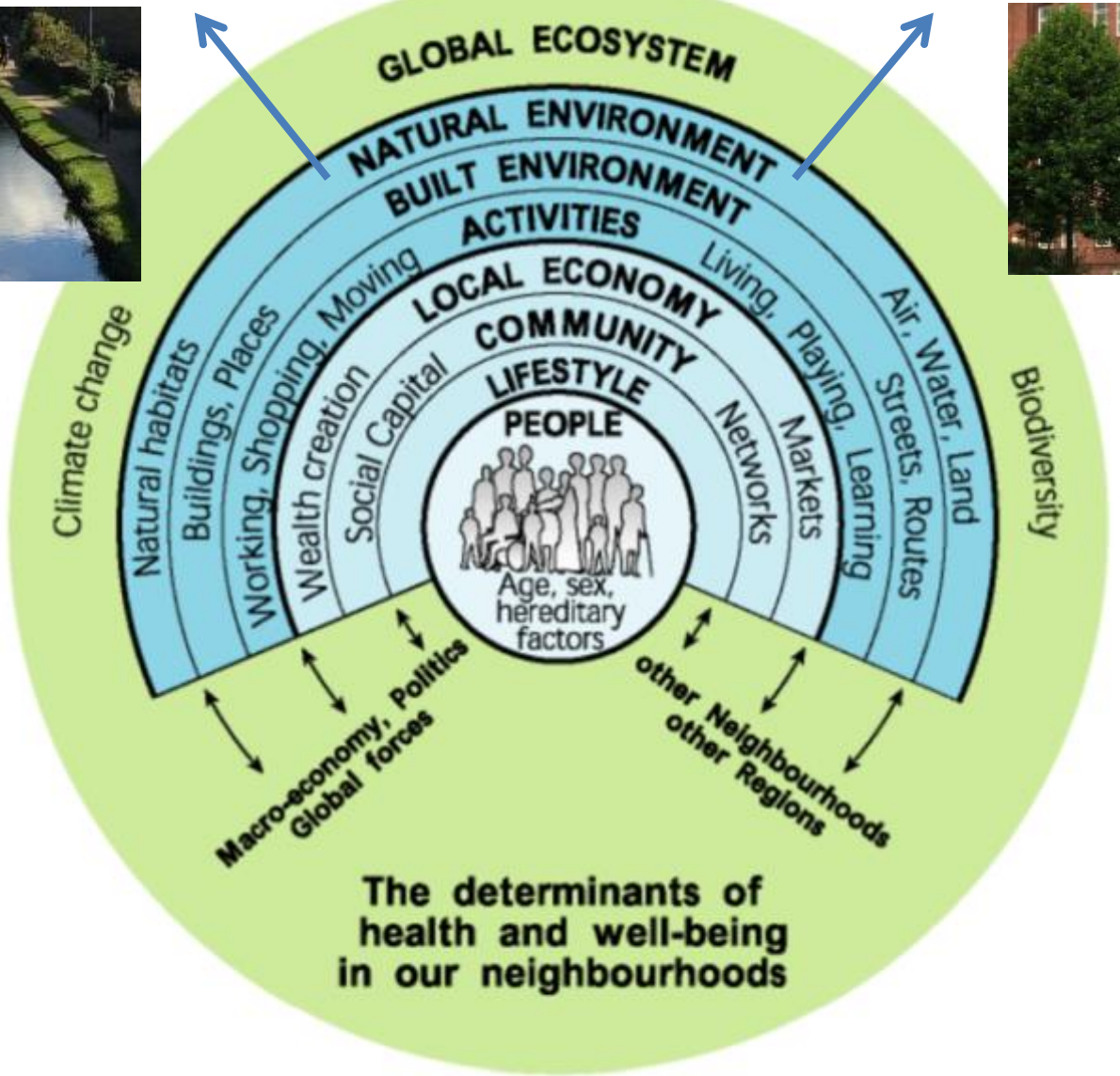
@GHIA_VNN

Sarah Lindley, University of Manchester

Photograph: Sarah Lindley

# A health map for the local human habitat




Barton, H. and Grant, M. (2006) A health map for the local human habitat. *The Journal for the Royal Society for the Promotion of Health*, 126 (6). Open access version available at http://eprints.uwe.ac.uk/7863/2/The_health_map_2006_JRSH_article_-_post_print.pdf

Based on Dahlgren and Whitehead's (1991) well known rainbow model https://core.ac.uk/download/pdf/6472456.pdf

HOUSES OF PARLIAMENT
PARLIAMENTARY OFFICE OF SCIENCE & TECHNOLOGY

October, 2016

POSTNOTE

# Creating Age Friendly Cities

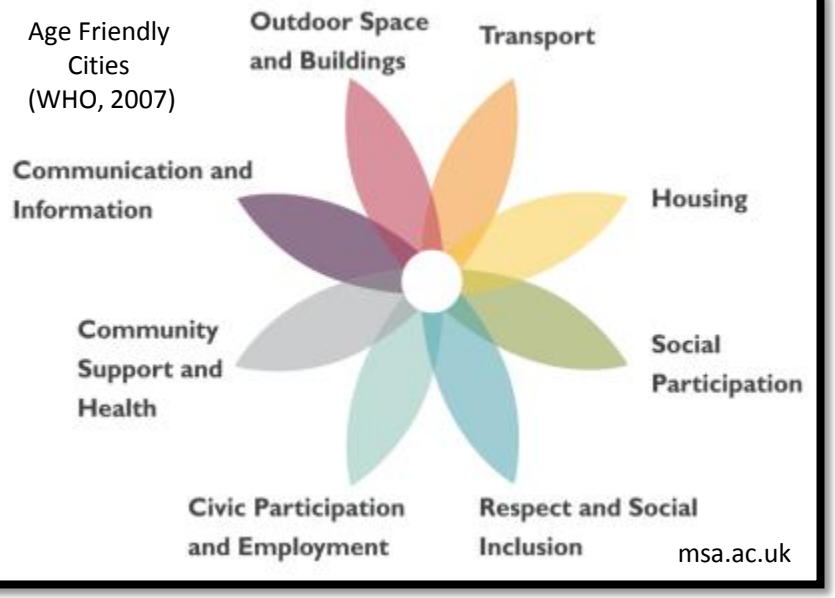
## Overview

- The UK population is ageing and many older people are living in major towns and cities.
- Age-friendly cities aim to support active and healthy living into older age. Twelve cities in the UK are members of a global network of age-friendly cities.
- The physical environment plays a key role in making cities better places for older people.

*Green space*

Access to green space is a Sustainable Development Goal and evidence suggests that access to green space (for example parks, woodlands and allotments) is associated with health benefits for the general population, including physical activity, mental health and wellbeing (PN 538).[89] A 2013 systematic review found that green spaces promote physical activity among older people and cross-sectional surveys have linked the quality of open spaces to older people's life satisfaction.[90,91,92] Several studies suggest that green spaces may help to address issues of loneliness and social isolation in older people by promoting social contact.[31,93,94]

Age Friendly Cities (WHO, 2007)




msa.ac.uk

Open access materials

Photographs: Sarah Lindley

# What do we aim to do?

- To better understand the benefits and values of urban GI to older people and how GI attributes and interventions can best support healthy ageing in urban areas.

Greater Manchester as the case study

Older adults as co-researchers

Arts and heritage approach

Multiple perspectives on values

Natural experiments

biodiversity as a specific attribute of interest

**To agree GHIA's multi-disciplinary foundation**

1

2

**Understanding how <u>older people can realise physical, social & mental wellbeing</u> within GI spaces**

- *cultural participation & creative practice for tackling loneliness and isolation in old age*
- *role for GI & volunteering*
- *involvement of people with a variety of needs, while ensuring adequate protection, security & care*

3

**Understanding the ways in which GI can influence the <u>health and wellbeing</u> of older people**

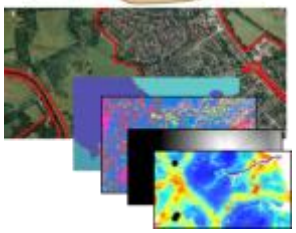
- *profiles of older people in GM and analysis of health & wellbeing indicators*
- *urban greening, physical activity & overall well-being*
- *environmental exposures & GI*

4

**Understanding how to <u>value GI</u> in the context of improving the health & wellbeing of older people**

- *participatory and equitable forms of valuation*
- *representation of non-monetary valuation in policy making & public deliberation*
- *limits of monetary valuation (**cf. BIOMOT project** - <u>www.biomotivation.eu</u> )*

5



**To develop & apply a new methodology for representing the needs, provision and value of GI for older people**

- *Maps of provision of and need for GI in GM*
- *Variations with scale*
- *Inequalities*

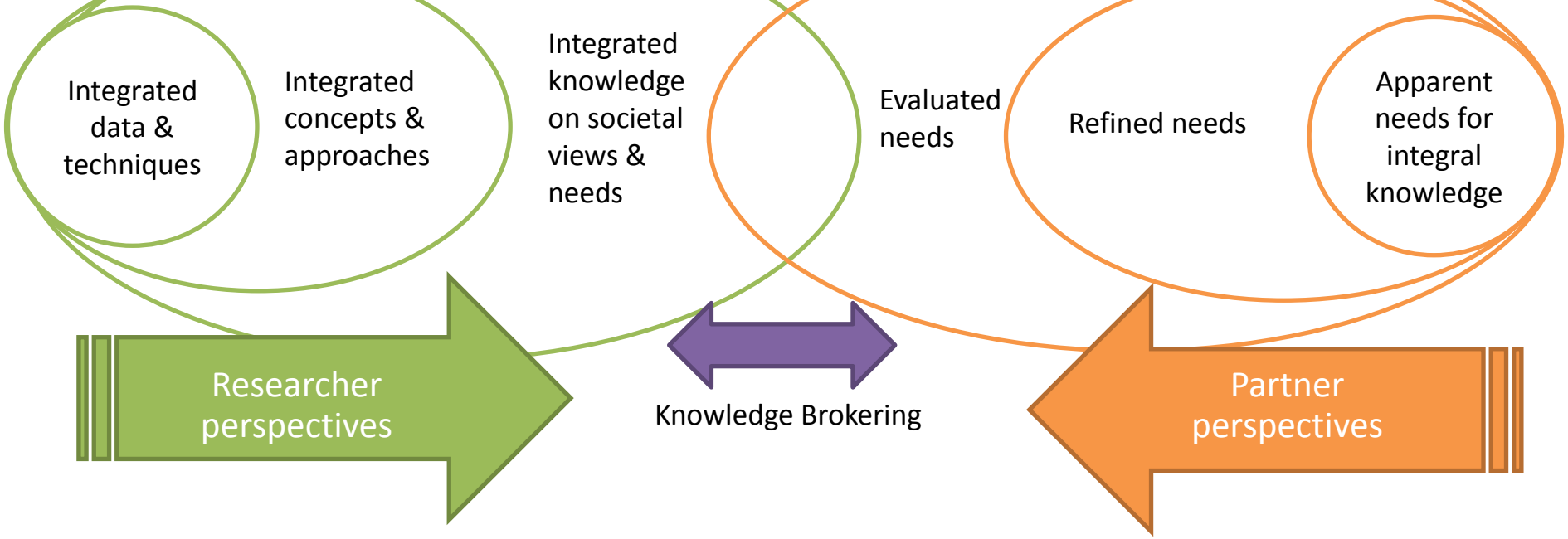
6

**To co-develop web-based materials, creative map, artist, heritage & evidence databases, reference materials, exhibitions & design guide**

# How will we do it ?

12 investigators & 4 researchers across geography, ecology, planning, sociology, arts, health, economics, philosophy….

5 project partners: Manchester City Council (now also **GM Ageing hub**), Canal & River Trust, Manchester Museums & Galleries Partnership, GMCVO, City of Trees, Climate Change Agency




Functional model of knowledge exchange with iterative, integrative stages (ellipses) (after Assmuth & Lyytimaki, 2015).

## Short Term

Ensure that user interests are built into all stages of the project & outputs

Organise regular 'open seminars'

Further enhance 'consultative' activity (though MICRA) and the Manchester Science Festival.

Status report

## Medium & Longer term

influence the delivery of the current GBIS (to 2020) and Age-Friendly Manchester activities

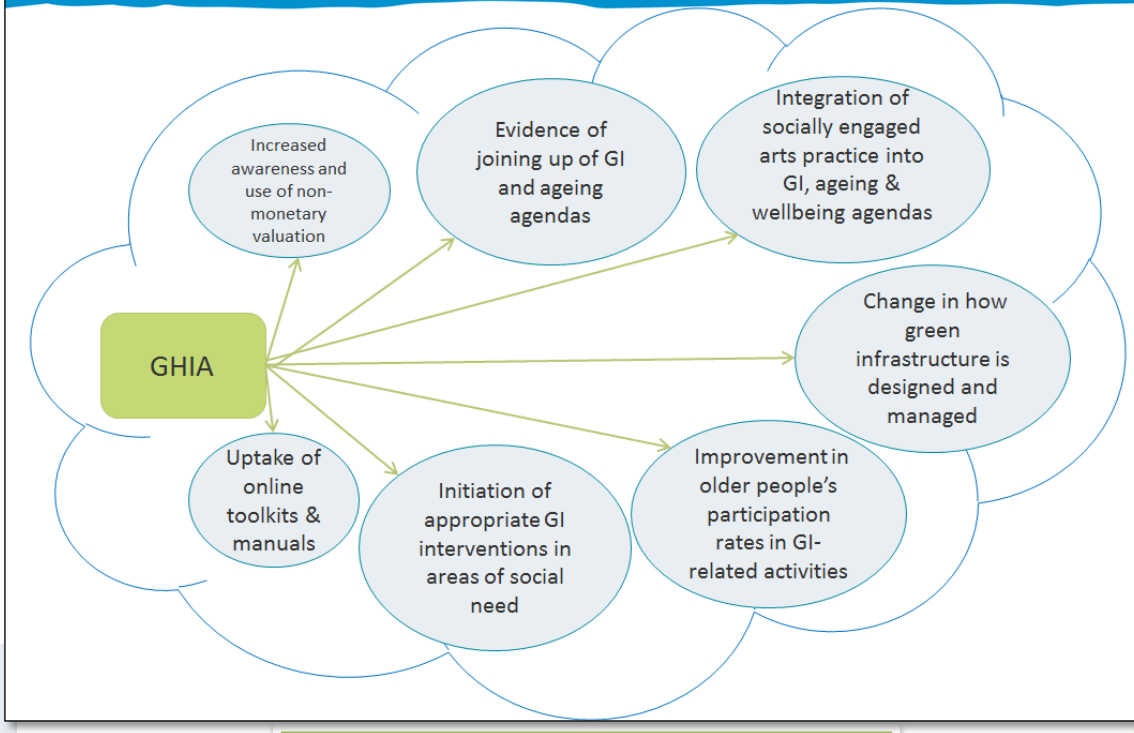
policy event

lasting impact on institutional capacities

Assess progress against status report

- **Project partners**
- **Local communities**
- **Stakeholders working in health, ageing & environment**
- **Health & environment professionals**
- **Wider network of research users and organisations, e.g. charities**
- **UK Government**
- **Academic community**

## Future Benefits




VALUING NATURE RESEARCH PROJECT

1st Aug 2016 – 31st July 2019

@GHIA_VNN

# GHIA Project team, partners & collaborators

Lead: **Sarah Lindley** Geography (School of Environment, Education & Development (SEED), UoM). Co-investigators:

- **Jenna Ashton** is a curator and arts practitioner (MMU)
- **Adam Barker** is Lecturer in Spatial Planning (SEED, UoM)
- **Gina Cavan** is Senior Lecturer in GIS and Climate (School of Science & the Environment (SoSE, MMU)
- **Penny Cook** is Professor in Public Health (School of Health Sciences, University of Salford (UoS)
- **David French** is Professor in Health Psychology (Faculty of Medical & Human Sciences, UoM).
- **Anna Gilchrist** is Lecturer in Environmental Management and Ecology (SEED, UoM)
- **Philip James** is Professor of Ecology (School of Environment and Life Sciences, UoS)
- **John O'Neill** is Hallsworth Professor of Political Economy (School of Social Sciences (SoSS), UoM)
- **Christopher Phillipson** is Professor in Sociology & Social Gerontology (SoSS, UoM)
- **Konstantinos Tzoulas** is Senior Lecturer in Environmental Management (SoSE, MMU).
- **Ada Wossink** is Professor of Environmental Economics (Department of Economics, SoSS, UoM).

The work is being conducted in close collaboration with:

- City of Trees
- Public Health Manchester & GM Ageing hub
- the Greater Manchester Centre for Voluntary Organisations (Ambition for Ageing project)
- the Canal and River Trust
- Manchester: A Certain Future Manchester City Council, MICRA (including older adult co-researchers)
- the Manchester Arts and Galleries Partnership
- Advisors and wider user representatives through the GHIA Advisory Group

Project Researchers

- Matthew Dennis
- Ruth Colton
- Richard Christian
- Jack Benton

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# Grow Green - Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments

- EU H2020 Project ID: 730283
- 1st June 2017 – 31st May 2022
- http://cordis.europa.eu/project/rcn/210514_en.html

University of Manchester contact
james.rothwell@manchester.ac.uk

**Cities and demonstration project partners**

- Manchester: Manchester City Council + Climate Change Agency + Guinness Partnership
- Valencia
- Wroclaw
- Lille
- Zadar
- Modena
- Wuhan

**Universities**

- University of Manchester
- Valencia Polytechnic University
- Wroclaw University of Environmental & Life Sciences
- University of Cambridge

**Technical Advisers and Designers**

- Trinomics
- International Union for Nature Conservation
- Leitat
- Bipolaire
- OuiShare

**Economic development and innovation agencies**

- New Economy Manchester
- InnDEA (Valencia)
- AWAW (Wroclaw)

**Project management and cross-cutting expertise**

- Tecnalia