

Cities, Climate Adaptation & the RECLAIM Network Plus



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Chair in Air Quality and Health
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Adjunct Professor, Trinity College Dublin, Ireland & Guest Professor, Southeast University, China

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Outline

- Global Centre for Clean Air Research (GCARE)
- Climate Change & Nature-Based Solutions
- Guildford Living Lab: Case Studies
- Hedges, Green Living Gate, Sensor networks, Schools,....
- RECLAIM Network Plus
- Q &A

GCARE.. team & collaborators

Global Centre for Clean Air Research



'to realise a collaborative global vision of 'clean air for all'



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“Clean Air for All”

Building the interfaces of air pollution and climate change with the health of the people and the environment.

Key aims

- Understand the impact of air pollutants on the quality of life and the built environment
- Develop internationally-validated engineering-driven solutions
- Underpin regulatory strategies
- Set the agenda for future research.

What we are researching

- Pollution emissions and exposure
- Indoor and outdoor air pollution
- Interfacing air pollution with health
- Nature-based solutions
- Climate change mitigation
- Built environment (cities, megacities, smart cities)
- Low-cost sensing

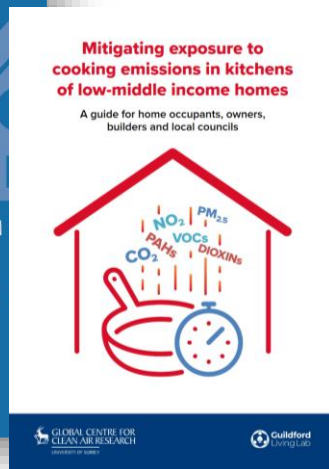
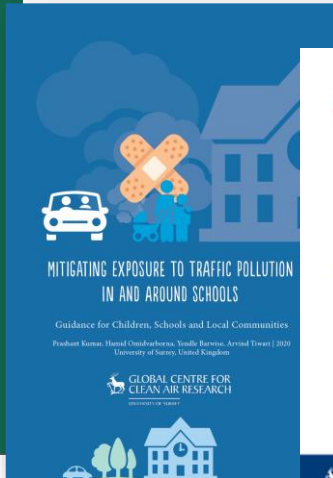
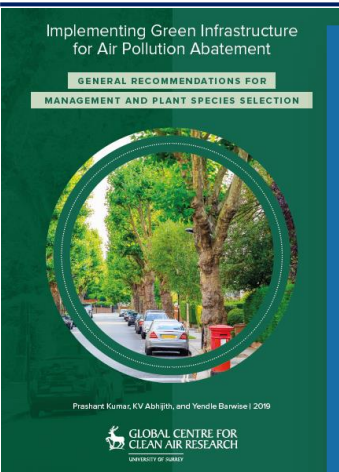


.. a platform for researchers, community & stakeholders for co-creating & co-designing air pollution and climate change mitigation solutions

>>> GCARE IN NUMBERS <<<

20+ GCARE core researchers	30+ Research sponsors
£11m+ Research funding	50+ International visitors
45+ Projects	5,000+ Media articles
100+ Global partners	350+ Journal publications



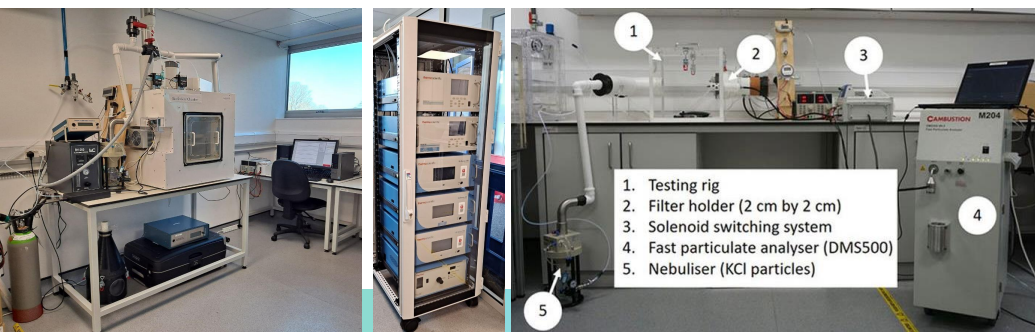


Projects

- UKRI (EPSRC, NERC, AHRC) RECLAIM Network Plus (sustainable cities)
- UKRI Centre for Doctoral Training in Aerosol Science
- Innovate UK MyGlobalHome (developing indoor sensing technology)
- EPSRC INHALE (exposure in indoor/outdoor microenvironments)
- EPSRC COTRACE (COVID19 infection & ventilation in schools)
- OveArup/RSA Heat-Cool (educational initiative for school children)
- H2020 OPERANDUM (nature-based solutions for climate)
- H2020 HealthySailing (air quality and infection in ships)

VC-Fellow, PGR Researcher of the Year 2020, Researcher of the Year 2017

More at www.surrey.ac.uk/GCARE



Numerous public resources: Guidance, HedgeDate tool, Sensor Toolbox, Policy briefs....

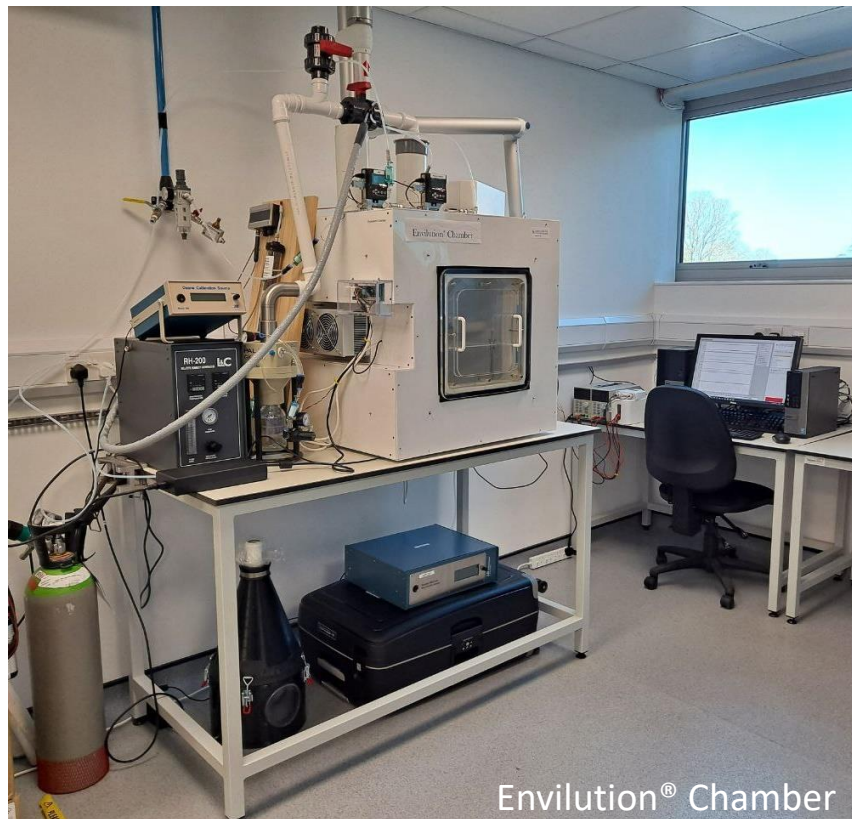
GCARE's Air Quality Lab

State-of-the-art air pollution monitoring and low-cost environmental sensing facility..

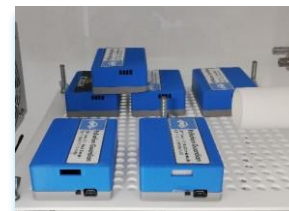


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Envilution® Chamber



Pollution Guardian,
Phase I – UK Innovative



Woking Green Party –
Guildford Living Lab



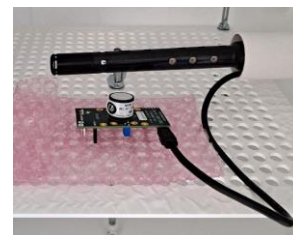
Pollution Guardian,
Phase II – UK Innovative



MyGlobalHome – UK
Innovative

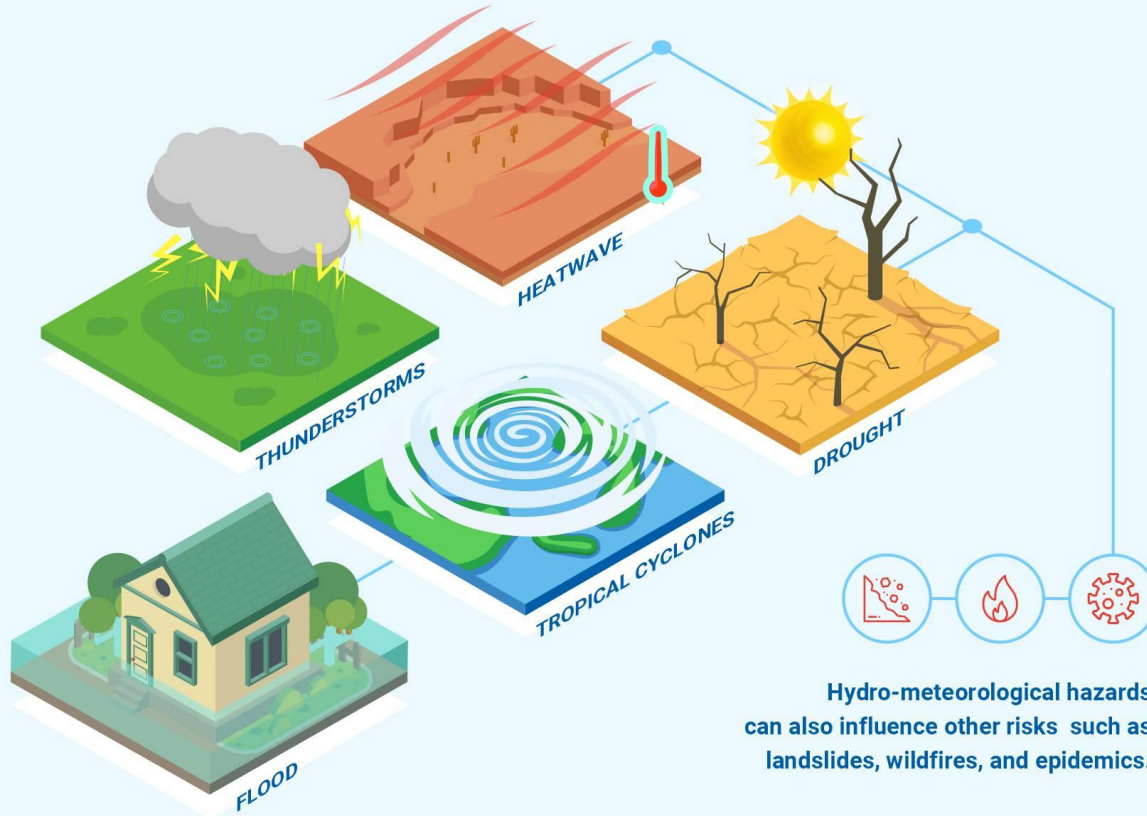


OPERANDUM – H2020



MyGlobalHome – UK
Innovative

Climate hazards



In 2021, the estimated economic loss of natural disasters worldwide was 343 billion U.S. dollars.

Hydro-meteorological hazards can also influence other risks such as landslides, wildfires, and epidemics.

Londoners should be charged for paving gardens, says climate resilience report

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Fiona Harvey *Environment editor*

Wed 17 Jul 2024 06.00 BST

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Review says capital needs new reservoir, better flood defences and 'heat plan' for vulnerable people



Londoners should be given incentives to remove paving, says the report. Photograph: John Graham/Alamy





Milan: Bosco verticale (vertical garden)

Multi-hazards: Urban floods, heatwaves, air pollution

NBS types:

- Hybrid: Green walls/green roofs

Targets:

- Enhancing sustainable urbanization (SDG11)
- Increasing carbon sequestration through NBS (SDG 13)
- Developing climate change mitigation (SDG 13)
- Water management (SDG 6)

NBS KPI:

- Regulate micro-climate (humidity, temperature) & remove PM
- Absorb CO₂ and dust, produces oxygen
- Protects people and houses from the sun's rays
- Protects people from acoustic and air pollutions
- Regulate water and reduce the risk of urban flooding

More: <http://crowd-geoikp.kajoservices.com/views/map> (OPERANDUM Geo-catalogue)

Green Infrastructure – urban forms



Trees



Parks



Gardens



Urban Greenspaces



Roadside Hedges



Green walls

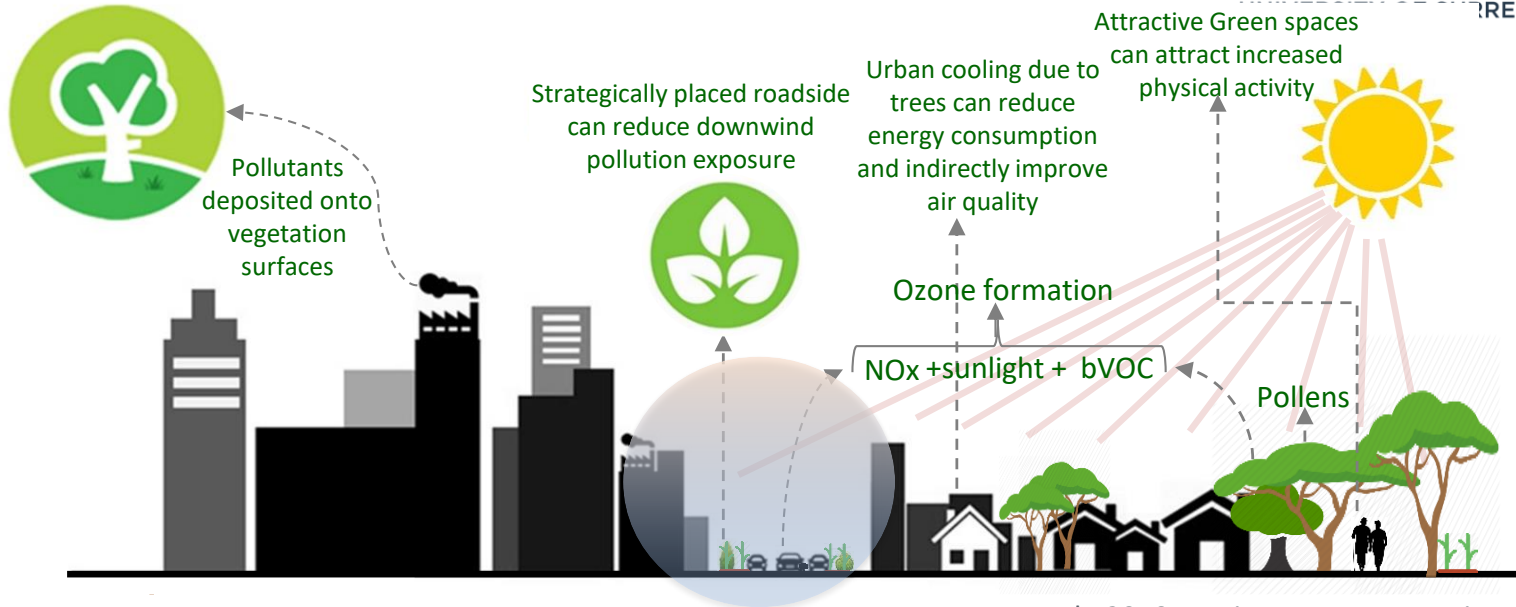


Living Pillars

Green Infrastructure (GI)
can be in different forms
&
they provide multiple co-
benefits that are usually
looked in isolation.

Source: online images

Greening – how it works?



Kumar et al., 2019. *Environment International* 133, 105181.

- **Green infrastructure is good and we all love it, but there are also downsides**
- **Important to choose what and where to place?**
- **Local scale can act as a passive barrier between source and receptor (appreciable decrease 😊)**
- **City scale air quality (much less compared with local scale) but have other diverse benefits e.g. biodiversity..**

Greening – how it works?



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Environment International 133 (2019) 10518

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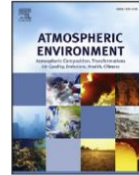
Contents lists available at ScienceDirect



Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv



Cities need 'hedges as well as trees' for environment

Ger Harrabin
environment analyst

May 2017

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Review article

Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review



K.V. Abhijith ^a, Prashant Kumar ^{a, b, *}, John Gallagher ^{c, d}, Aonghus McNabola ^c,
Richard Baldauf ^{e, f}, Francesco Pilla ^g, Brian Broderick ^c, Silvana Di Sabatino ^h,
Beatrice Pulvirenti ⁱ

Haagen-Smit Prize 2023 Winner



Cooling, pollution, active travel, biodiversity, aesthetics, wellbeing....

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What our future could look like?

Courtesy: Sebastian Pfautsch, WSU



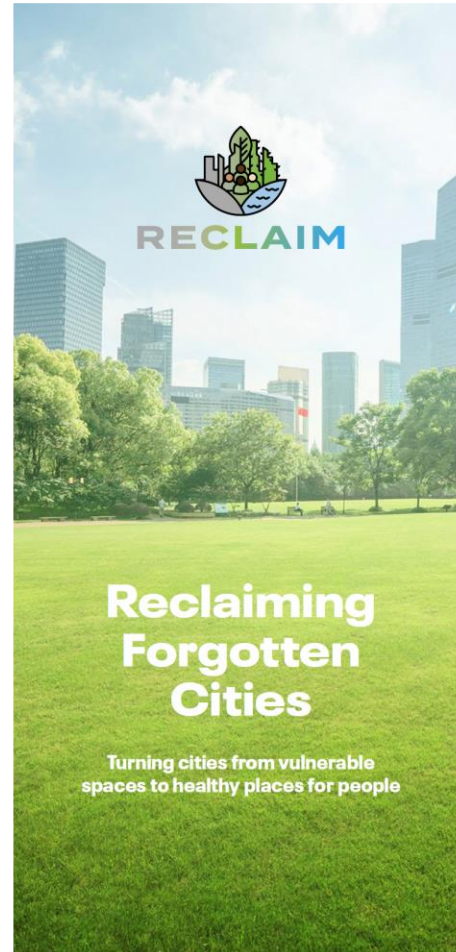
RECLAIM

Get Involved



RECLAIM Network Plus [EP/W034034/1]

'Reclaiming Forgotten Cities - Turning cities from vulnerable spaces to healthy places for people' is funded by the UKRI under the "Improve the sustainability of urban systems and infrastructure (SUSI)" call.



Meet the RECLAIM Team



Prof Prashant Kumar
University of Surrey



Prof Laurence Jones
UKCEH



Dr Thomas Kjeldsen
University of Bath



Dr Nerea Calvillo
University of Warwick



Dr Shelagh Malham
Bangor University



Dr Sisay Debele
University of Surrey



Mark Simmons
University of Surrey

If you would like to get in touch with the RECLAIM TEAM email: info@reclaim-network.org

[reclaim-network.org](https://www.reclaim-network.org) [@reclaim_network](https://twitter.com/reclaim_network)

[Reclaim Network Plus](https://www.linkedin.com/company/reclaim-network-plus) [RECLAIM Network+](https://www.youtube.com/channel/UC...)



Engineering and
Physical Sciences
Research Council



Natural
Environment
Research Council



Arts and
Humanities
Research Council

RECLAIM network is for towns and cities to find the support you need to install infrastructure in your community in touch with others with similar goals.

We are:

- building a community of practice, sharing knowledge and urban green-blue-grey infrastructure
- identifying and addressing knowledge gaps and implementation challenges,
- helping to fast-track solutions which address the sustainability of cities and their residents and societal challenges.



RECLAIM
is a UKRI-funded
Network Plus
(£1.2M)



RECLAIM Network Plus will provide the following network activities:

- **Secondments**
- **Workshops**
- **Horizon Scanning & Synthesis Studies**
- **Webinar Series**
- **Engagement Event**

Plus much more



RECLAIM network activities are specifically designed to:

- identify opportunities
- address complex challenges
- accelerate solutions-based interventions
- develop a skills pipeline for early-career researchers (ECRs) and non-academic and academic partners through a secondment programme

If you would like to learn more about our various activities, visit reclaim-network.org

£1.45 Million



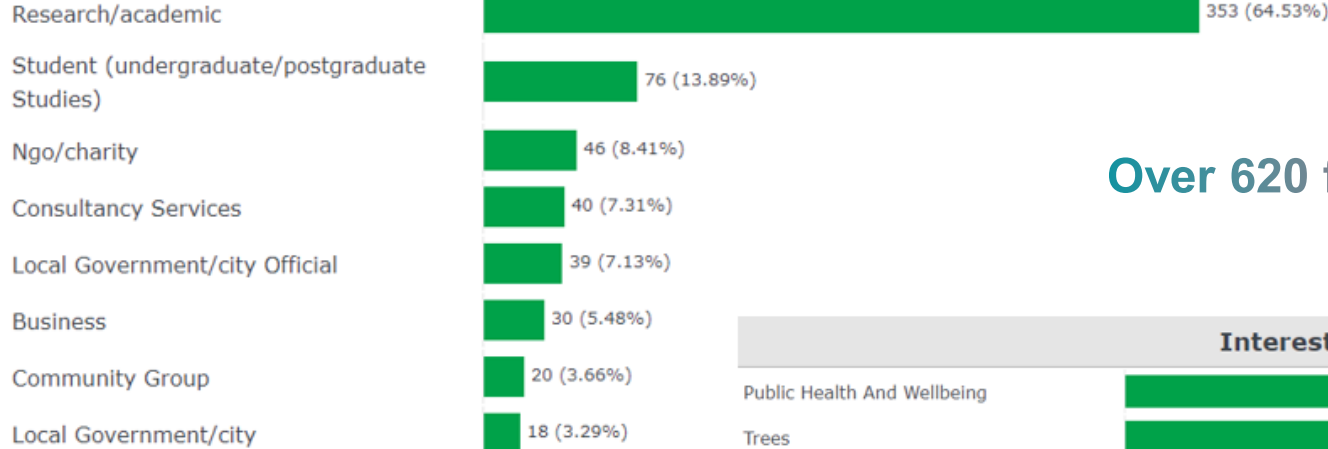
Network Members



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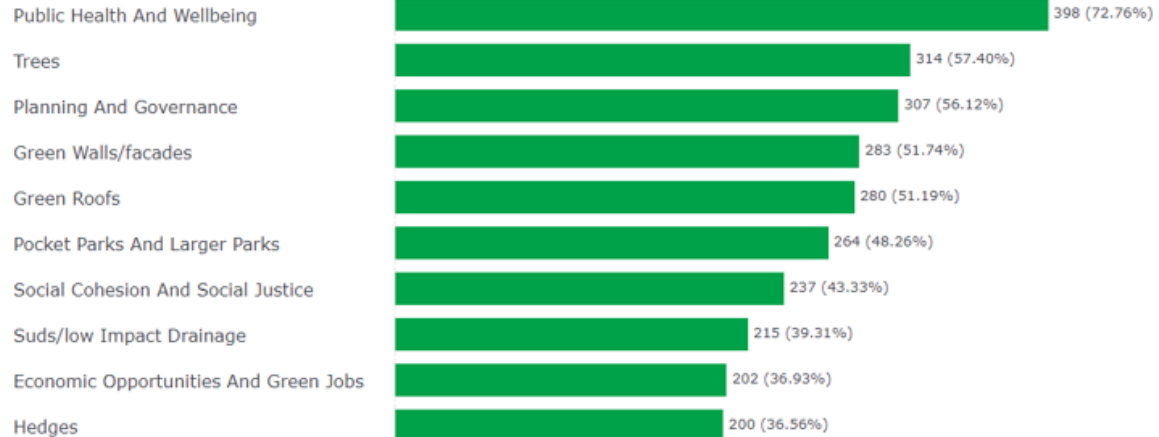
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Type of work



Over 620 from over 45 Countries

Interest areas





RECLAIM

N

www.the-innovation.org

REVIEW

Urban heat mitigation by green and blue infrastructures: effectiveness, and future needs

Prashant Kumar,^{1,2,10,*} Sisay E. Debele,¹ Soheila Khalili,¹ Christos H. Halios,³ Jeetendra Sahani,¹ Maria Athanassiadou,⁷ Kamaldeep Bhui,⁸ Nerea Calvillo,⁹ Shi-Jie Cao,^{1,10} Frederic Coulon,¹¹ Jill L. Edmilson Dias de Freitas,⁶ Hai Guo,¹⁴ Matthew C. Hort,⁷ Madhusudan Katti,¹⁵ Thomas Rodding Kjøl Giuliano Maselli Locosselli,¹⁸ Shelagh K. Malham,¹⁹ Lidia Morawska,^{1,20} Rajan Parajuli,²¹ Christoph Jannis Wenk,^{1,6} and Laurence Jones^{13,26}

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Received: August 7, 2023; Accepted: February 5, 2024; Published Online: February 7, 2024; <https://doi.org/10.1016/j.inov.2024.100161>
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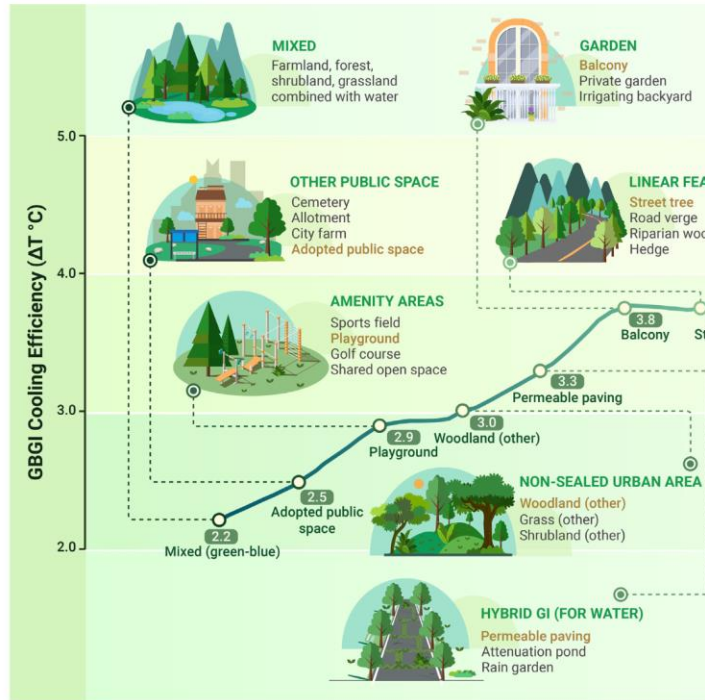
Follow ...

What are the most efficient landscapes for reducing urban temperatures?

According to a 2024 systematic literature review in "The Innovation," the top landscapes are botanic gardens, wetlands, green walls, and street trees (in that order).

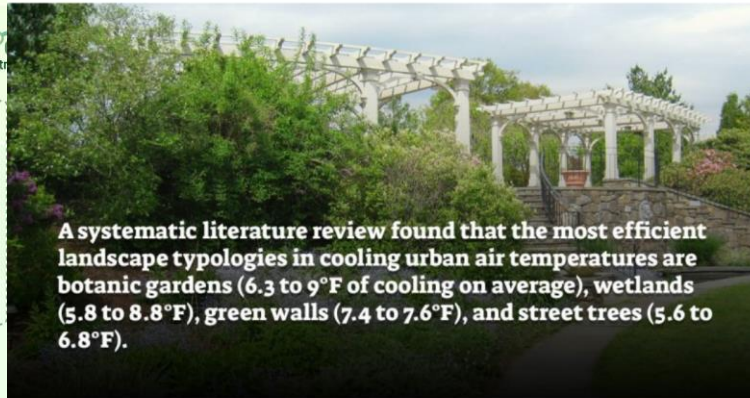
Find a full citation and a link to this open-access research here: <https://lnkd.in/eyNAWnnu>

GRAPHICAL ABSTRACT



This is just one of 200 entries in our Landscape Performance Fact Fact Library, a searchable collection of landscape benefits derived from published research. Browse the whole Fast Fact Library collection at <https://lnkd.in/e4WdUpB>

Research authors: [Professor Prashant Kumar](#), [Sisay Debele](#), [Soheila Khalili](#), [Christos Halios](#), [Jeetendra Sahani](#), [Nasrin Aghamohammadi](#), [Maria de Fatima Andrade](#), [Maria Athanassiadou](#), [Prof. Kamaldeep Bhui CBE](#), [Nerea Calvillo](#), [Shi-Jie Cao](#), [Frederic Coulon](#), [Jill Edmondson](#), [David Fletcher](#), [Edmilson Dias de Freitas](#), [Hai Guo](#), [Matthew Hort](#), [Madhusudan Katti](#), [Thomas Kjeldsen](#), [Steffen Lehmann](#), [Shelagh Malham](#), [Lidia Morawska](#), [Rajan Parajuli](#), [Runming Yao](#), [Jannis Wenk](#), et al.



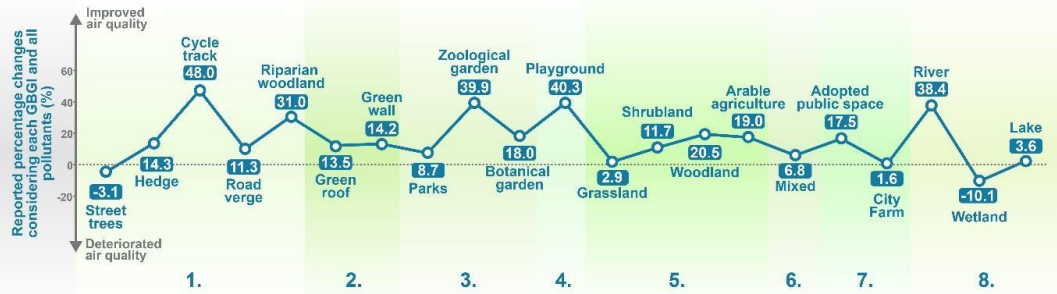
A systematic literature review found that the most efficient landscape typologies in cooling urban air temperatures are botanic gardens (6.3 to 9°F of cooling on average), wetlands (5.8 to 8.8°F), green walls (7.4 to 7.6°F), and street trees (5.6 to 6.8°F).

51 GBGI Types



RECLAIM

NBS & Urban



Air Pollution Abatement from Green-Blue-Grey Infrastructure

Prashant Kumar^{1,2,3,4,*1}, Karina Corada⁵, Sisay E. Debele¹, Ana Paula Mendes Emygdio¹, KV Abhijith¹, Hala Hassan⁶, Parya Broomandi^{7,8}, Richard Baldauf^{9,10}, Nerea Calvillo¹¹, Shi-Jie Cao¹⁴, Sylvane Desrivieres¹², Zhuangbo Feng⁴, John Gallagher^{3,13}, Thomas Rodding Kjeldsen¹⁴, Anwar Ali Khan¹⁵, Mukesh Khare¹⁶, Sri Harsha Kota¹⁶, Baizhan Li¹⁷, Shelagh K Malham¹⁸, Aonghus McNabola^{1,3}, Anil Namdeo¹⁹, Arvind Kumar Nema¹⁶, Stefan Reis²⁰, Shiva Nagendra SM²¹, Abhishek Tiwary²², Sotiris Vardoulakis²³, Jannis Wenk¹⁴, Fang Wang^{24,25}, Junqi Wang⁴, Darren Woolf²⁶, Runming Yao^{17,27}, Laurence Jones^{28,29}

1. LINEAR FEATURES

Street Trees
Hedge
Cycle track
Footpath
Road verge
Railway corridor
Riparian woodland

2. CONSTRUCTED GI

Green roof
Green wall
Roof garden
Pergola

3. PARKS

Parks
Heritage garden
Nursery garden
Zoological garden
Pocket park
Botanical garden

4. AMENITY AREAS

School yard
Playground
Sports field
Golf course
Shared open space

5. OTHER NON-SEALED URBAN AREAS

Grassland
Shrubland
Woodland
Arable agriculture
Sparsely vegetated land

6. MIXED

Trees and hedges
Trees and shrubs
Grass and trees

7. OTHER PUBLIC SPACE

Cemetery
Allotment
Adopted public space
City Farm

8. WATERBODIES

River
Wetland
Canal
Pond
Reservoir
Estuary
Sea
Lake

9. HYBRID GI

Permeable paving
Permeable parking
Attenuation pond
Flood control channel
Rain garden
Bioswale
Outdoor swimming pool

10. GARDENS

Balcony
Private garden
Shared common garden area



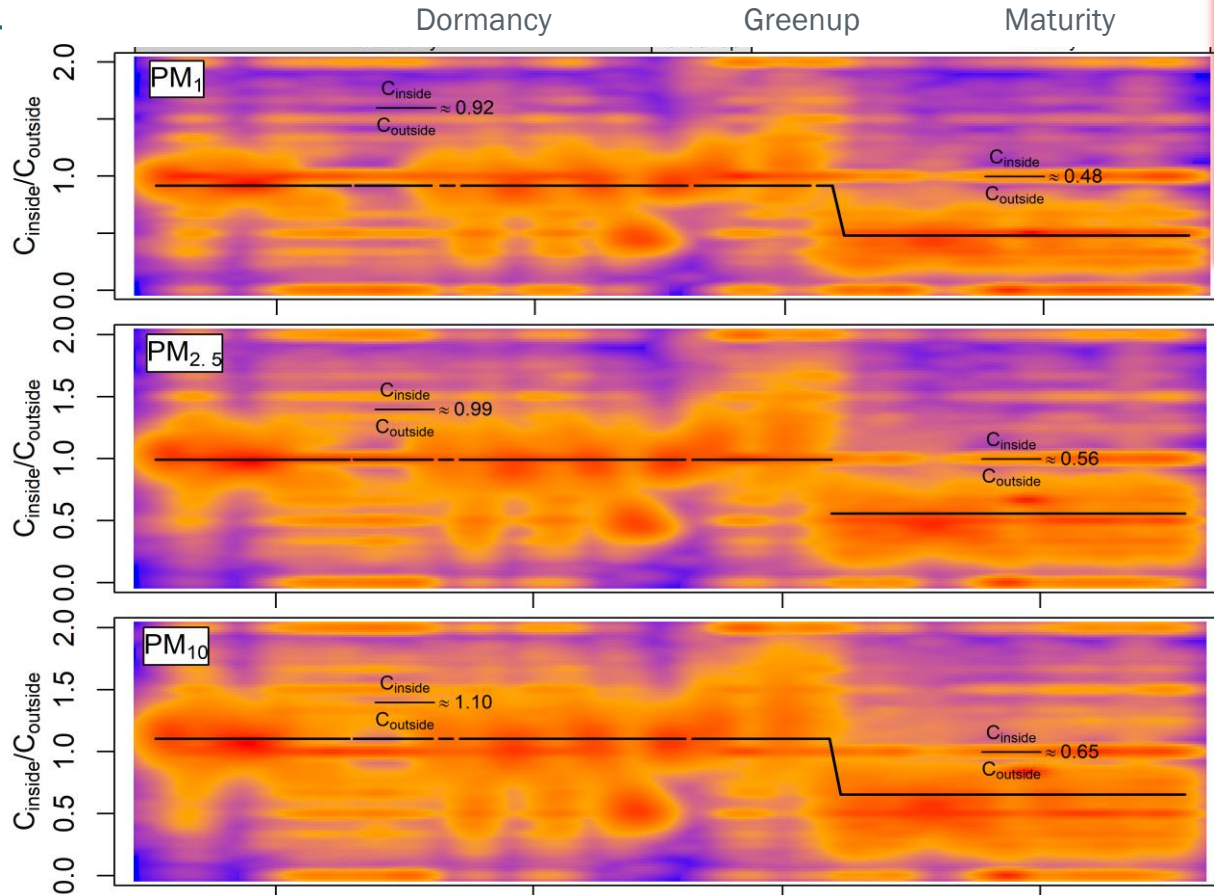
Kumar et al., 2024. The Innovation Geoscience, Under Review.

LAI < 2.9
Dormancy

LAI > 2.93
Greenup

LAI ~7.8
Greenup

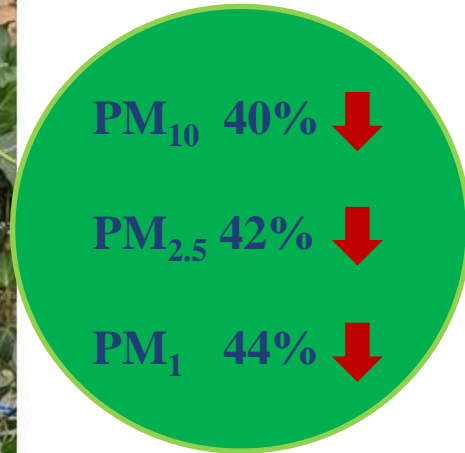
Hedges, playground (passive intervention)



Ottosen & Kumar, 2020. Sustainable Cities and Society 53, 101919. Thanks to GBC.



Green Screen



Lambeth Schools Project: GAP, Arup, Impact on Urban Health

Abhijith, Kukadia, Kumar, 2023. Investigation of air pollution mitigation measures, ventilation, and indoor air quality at three schools in London. *Atmospheric Environment* 289, 119303.

Possibly 'First School' Living Green Gate

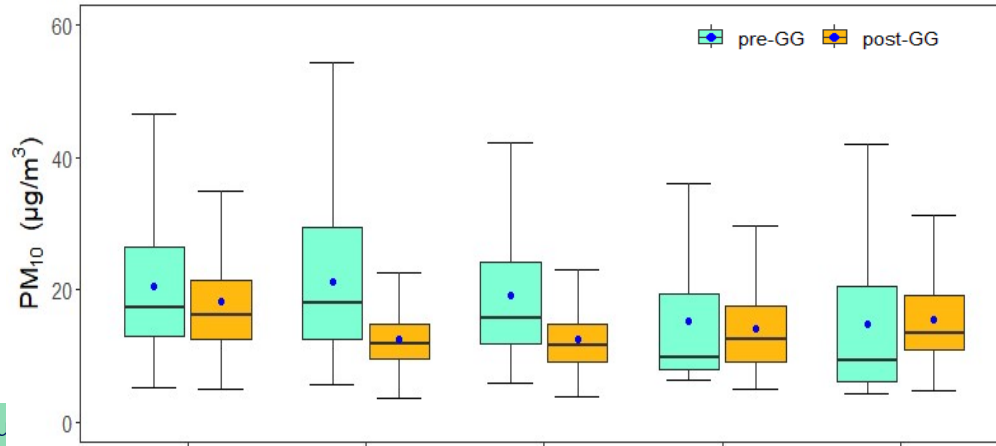


↓ Noise by 5dB(A)

↓ PM₁₀ by 32%

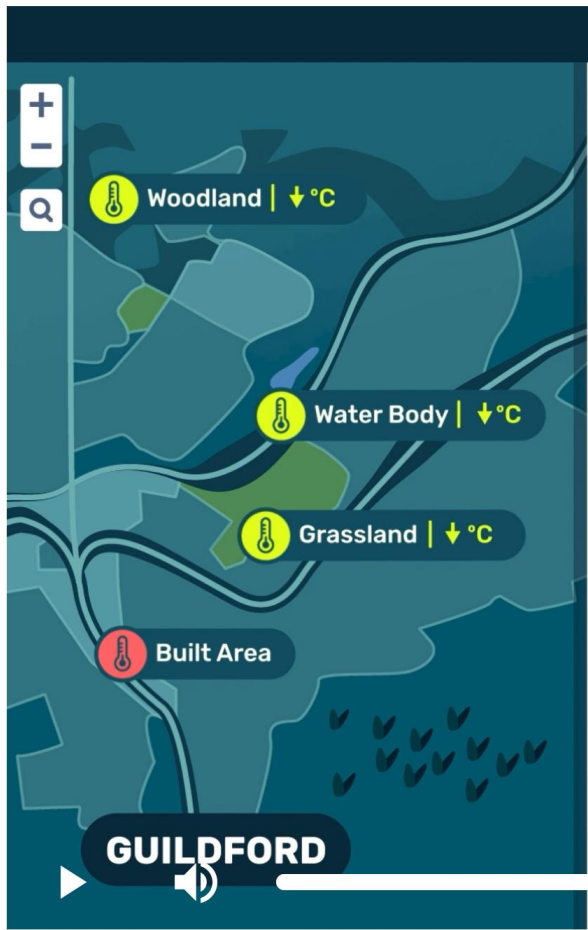
↓ PM_{2.5} by 19%

↓ Decay with distance

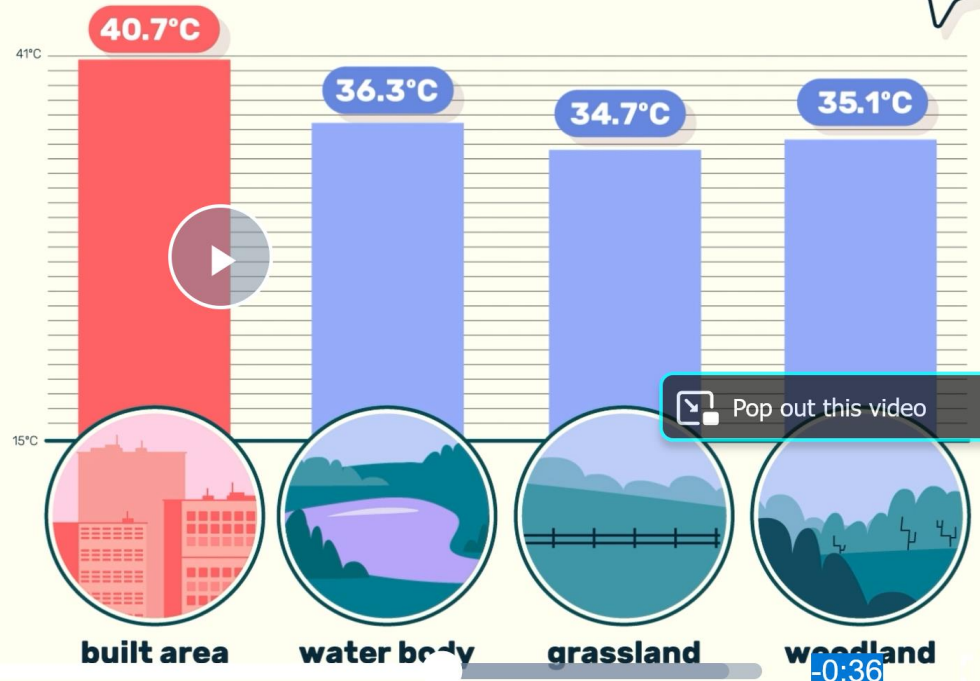




GreenCities F



19th July 2022



Link: <https://www.youtube.com/watch?v=f46ZA6v5aoA>

Sahani, Kumar, Debele, 2023. Efficacy assessment of green-blue nature-based solutions against environmental heat mitigation. *Environment International* 179, 108187.



Henry Fawcett
@henryfawcett

Climate science
learning how we
some exciting
@pk_shishodia



4:46 PM · Oct 14, 2022

Using empirical science education in schools to improve climate change literacy

Prashant Kumar^{a b c d}  , Jeetendra Sahani^a, Nidhi Rawat^a, Sisay Debele^a, Arvind Tiwari^a, Ana Paula Mendes Emygdio^a, K.V. Abhijith^a, Vina Kukadia^a, Kathryn Holmes^e, Sebastian Pfautsch^f

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cameras.



rchers have
dents to learn
and potential
climate change. ”

<https://www.surrey.ac.uk/school> Rachel Harrison

NBS & climate mitigation



Nature-based solutions

- 1 Afforestation and urban forestry
- 2 Coastal ecosystem restoration
- 3 Wetland and peatland restoration
- 4 Grassland restoration and protection
- 5 Carbon farming
 - No-till farming
 - Agroforestry
 - Cover cropping
 - Use of compost and other organic amendments

Technology-based solutions

- 6 Clean and renewable energy
- 7 Energy storage technologies
- 8 Sustainable agriculture
 - Conservation tillage
 - Crop rotation
 - Integrated pest management
- 9 Carbon capture, utilization and storage
- 10 Bioenergy with carbon capture and storage (BECCS)
- 11 Green building
- 12 Electrical vehicles

Wang, Kumar et al. (2023). The Innovation Geoscience 1, 100015.

Tools & guidance to empower public and support policy makers



Thank you

Contact

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www.surrey.ac.uk/gcare



Gopinath Kalaiarasan, Soma Kolluru, Juan Zavala-Reyes, Mamatha Tomson, Arvind Tiwari, Yendle Barwise, Elsa Aristodemou, Sarkawt Hama, KV Abhijith, RECLAIM, GreenCities, INHALE Projects & GCARE Team

July 2024

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