



Cities, Climate Adaptation & the RECLAIM Network Plus



Professor Prashant Kumar

Chair in Air Quality and Health

Founding Director, Global Centre for Clean Air Research (GCARE)

Department of Civil & Environmental Engineering, University of Surrey, United Kingdom

Co-Director, Institute for Sustainability, University of Surrey, UK

Adjunct Professor, Trinity College Dublin, Ireland & Guest Professor, Southeast University, China

X @AirPollSurrey @pk_shishodia @GuildfordLL @SurreySustain

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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@GuildfordLL



surrey.ac.uk/gcare



“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

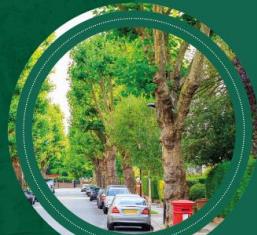
>>> GCARE IN NUMBERS <<<	
20+ GCARE core researchers	30+ Research sponsors
£11m+ Research funding	50+ International visitors
45+ Projects	5,000+ Media articles
100+ Global partners	350+ Journal publications





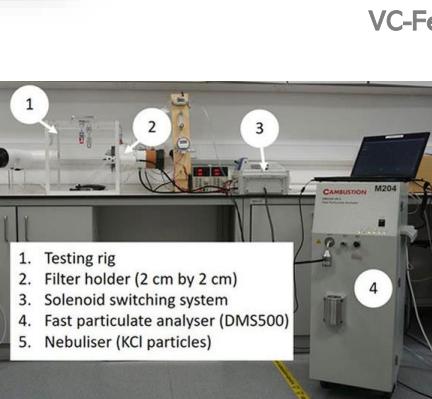
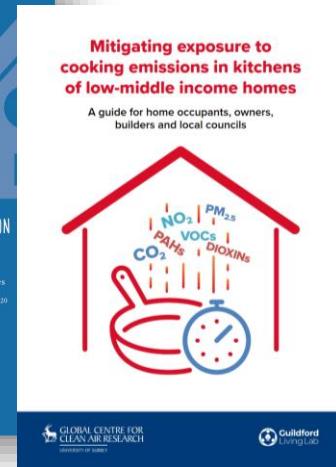
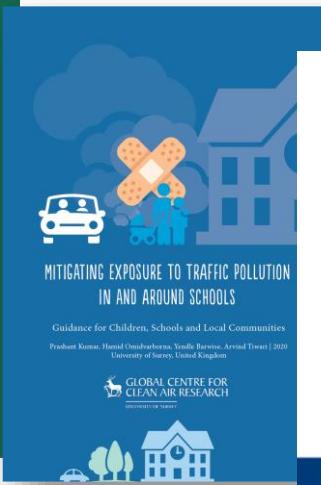
Implementing Green Infrastructure
for Air Pollution Abatement

GENERAL RECOMMENDATIONS FOR
MANAGEMENT AND PLANT SPECIES SELECTION



Prashant Kumar KV Abhijith, and Yenelle Barwise | 2019

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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....

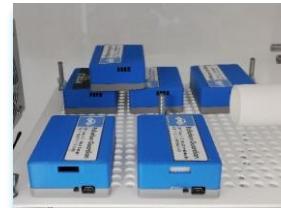
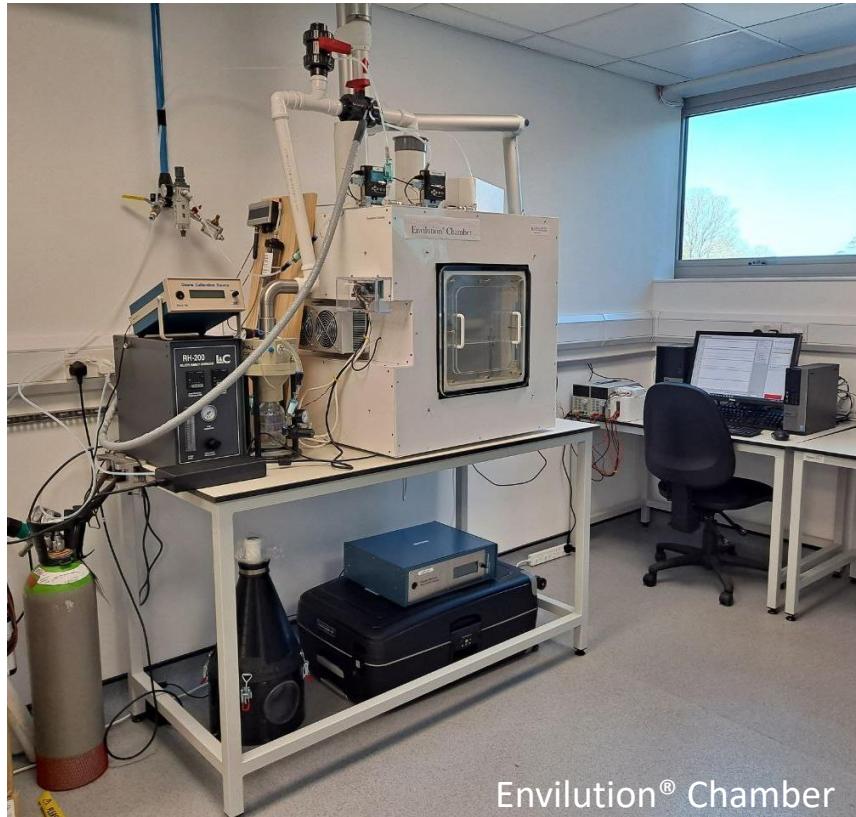
GCARE's Air Quality Lab

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



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Pollution Guardian,
Phase I – UK Innovative



Woking Green Party –
Guildford Living Lab



Pollution Guardian,
Phase II – UK Innovative



MyGlobalHome – UK
Innovative

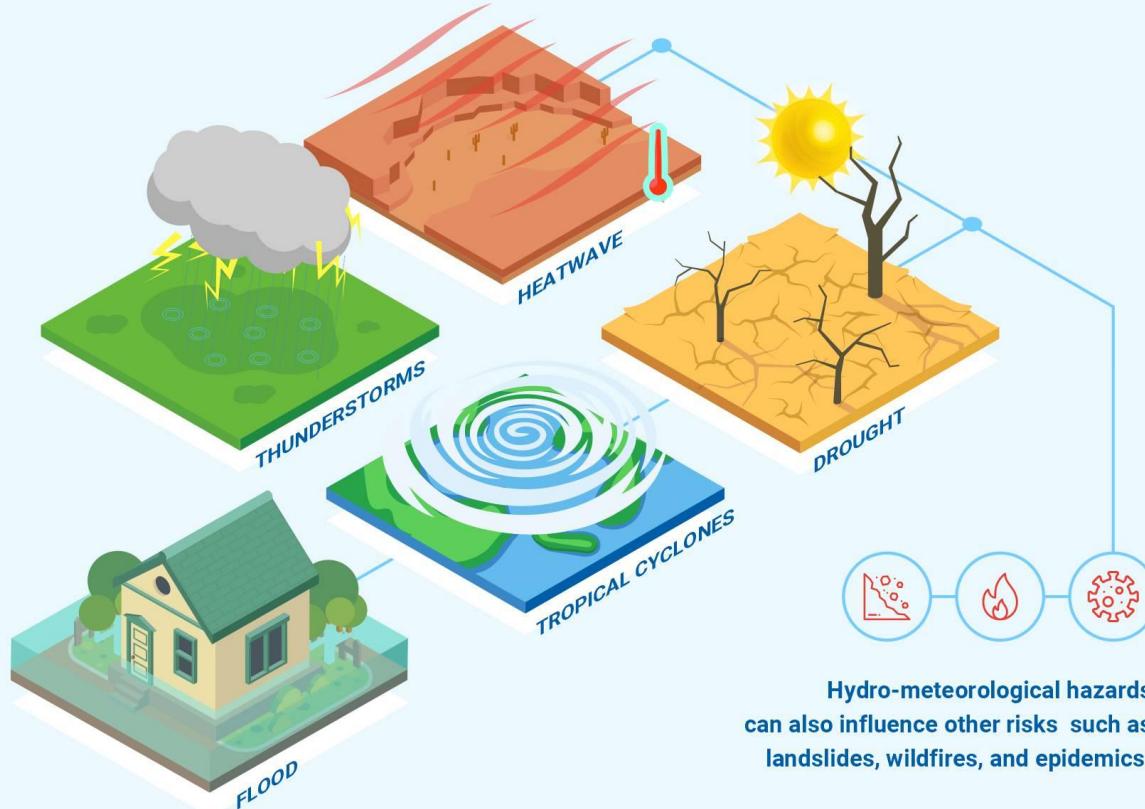


OPERANDUM – H2020



MyGlobalHome – UK
Innovative

Climate hazards



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

Source: [The Column](#)

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

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

Nature-based Solutions



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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 suns 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



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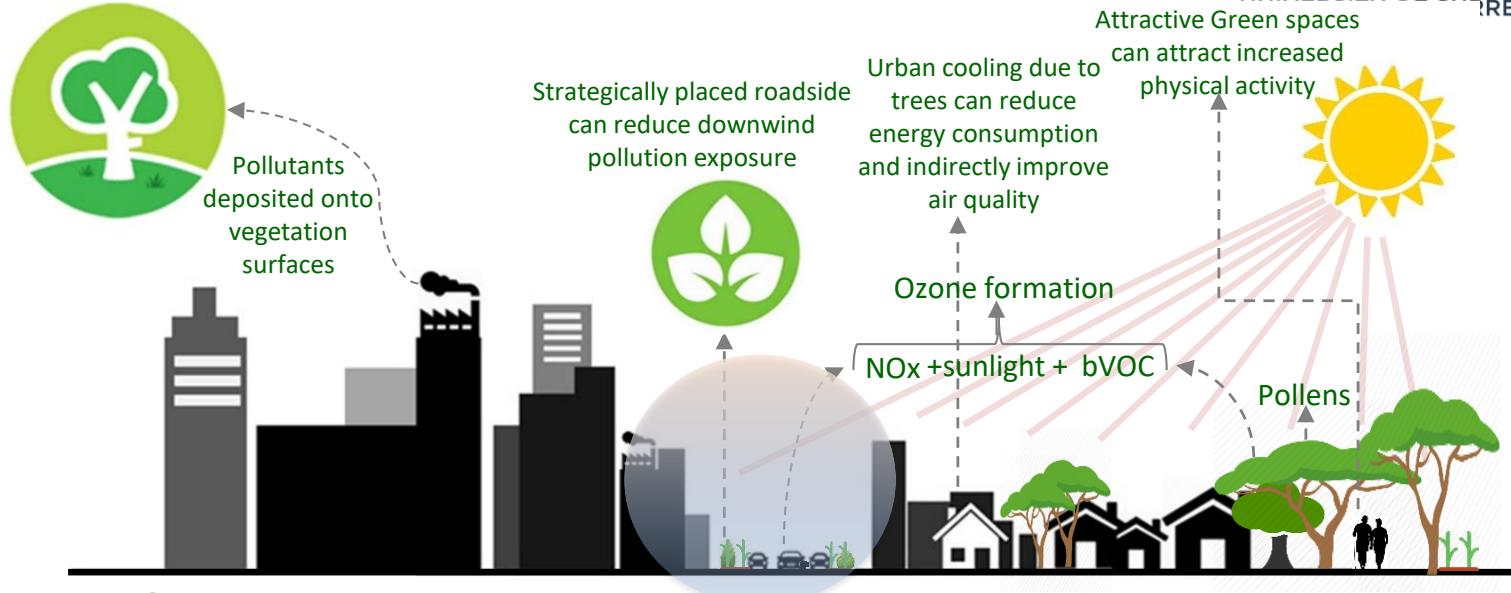
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Green Infrastructure (GI)
can be in different forms
&
they provide multiple co-
benefits that are usually
looked in isolation.

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

Contents lists available at ScienceDirect

Contents lists available at ScienceDirect

Atmospheric Environment

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

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

A

Haagen-Smit Prize 2023 Winner

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Science & Environment

Cities need 'hedges as well as trees' for environment

Angie Harrabin
environment analyst

May 2017 | [Read more](#)

f | [Share](#)



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



What our future could look like?

Courtesy: Sebastian Pfautsch, WSU



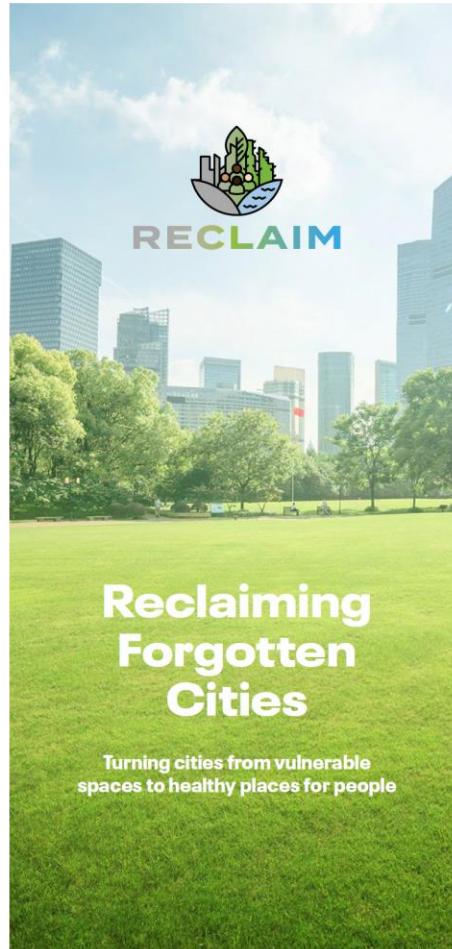
RECLAIM

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 [@reclaim_network](https://twitter.com/reclaim_network)

[in Reclaim Network Plus](#) [RECLAIM Network+](#)



Engineering and
Physical Sciences
Research Council



Natural
Environment
Research Council



Arts and
Humanities
Research Council

RECLAIM network is for towns and cities to find and support you need to invest in infrastructure in your community with others who are in touch with others with similar challenges.

We are:

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



RECLAIM
is a UKRI-funded
Network Plus scheme
 (£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

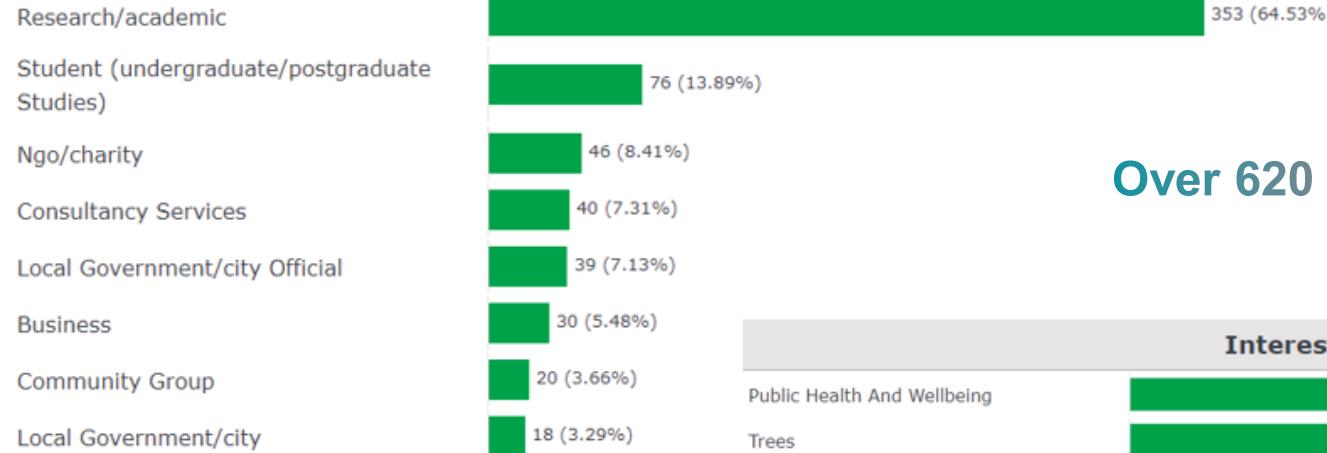


Network Members



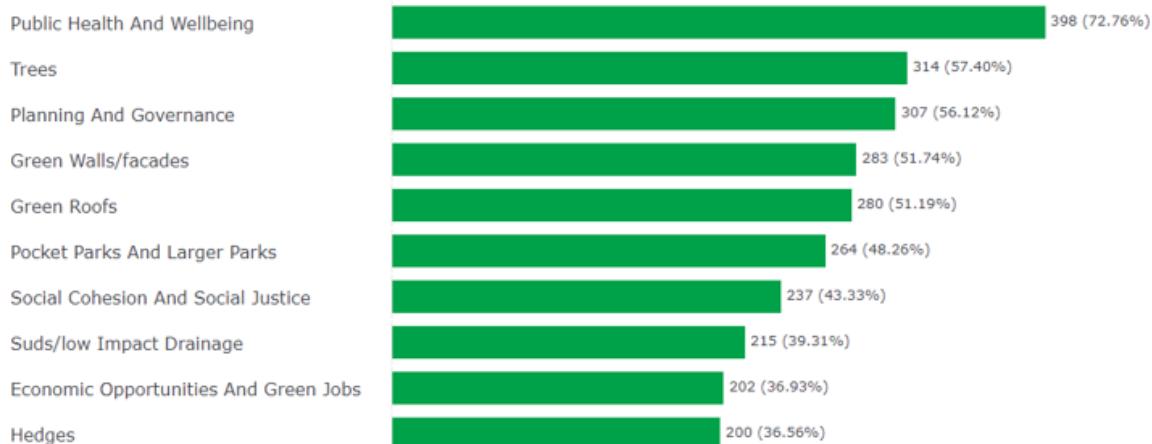
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Type of work



Over 620 from over 45 Countries

Interest areas



**RECLAIM**

REVIEW

N

www.the-innovation.org

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

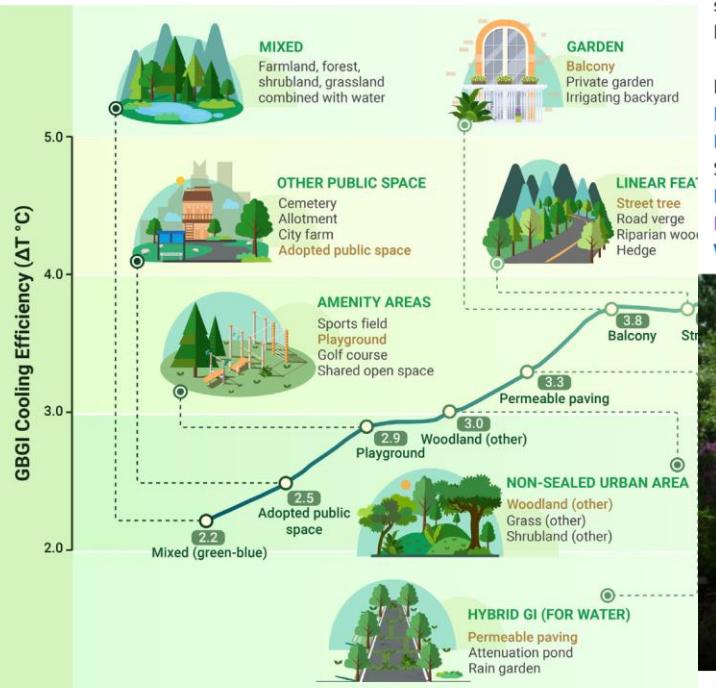
Prashant Kumar,^{1,2,10,*} Sisay E. Debele,¹ Soheila Khalili,¹ Christos H. Halios,³ Jeetendra Sahani,¹ Nasrin Aghamohammadi,⁴ Maria Athanassiadou,⁷ Kamaldeep Bhui,⁸ Nerea Calvillo,⁹ Shi-Jie Cao,^{1,10} Frederic Coulon,¹¹ Jill L. I Edmilson Dias de Freitas,⁵ Hai Guo,¹⁴ Matthew C. Hort,⁷ Madhusudan Katti,¹⁵ Thomas Rodding Kjeldsen,¹⁶ Giuliano Maselli Locosselli,¹⁸ Shelagh K. Malham,¹⁹ Lidia Morawska,^{1,20} Rajan Parajuli,²¹ Christoph Jannis Wenk,¹⁶ and Laurence Jones^{13,26}

*Correspondence: p.kumar@surrey.ac.uk

Received: August 7, 2023; Accepted: February 5, 2024; Published Online: February 7, 2024; https://doi.org/10.1016/j.eyNAWnnu
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51 GBGI Types

GRAPHICAL ABSTRACT



Landscape Architecture Foundation

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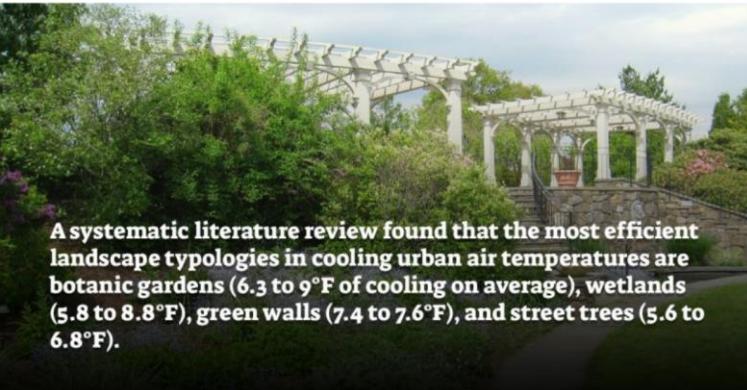
What are the most efficient landscapes for reducing urban temperatures?

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>

This is just one of 200 entries in our Landscape Performance Fact Library, a searchable collection of landscape benefits derived from published research. Browse the whole Fast Fact Library collection at <https://lnkd.in/e4WDkUpB>

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).

You and 37 others

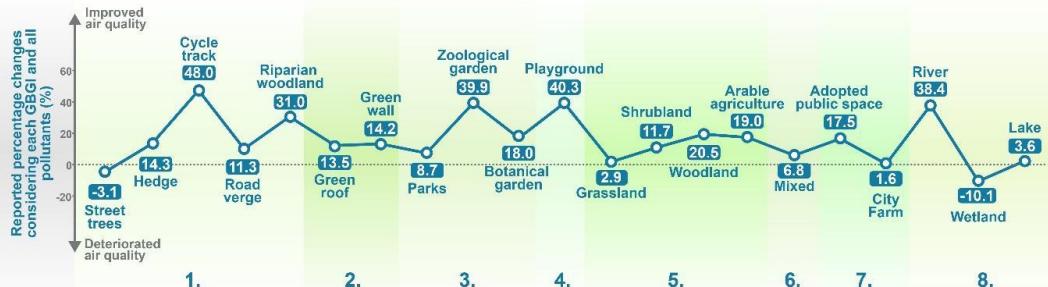


NBS & Urban A

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Air Pollution Abatement from Green-Blue-Grey Infrastructure

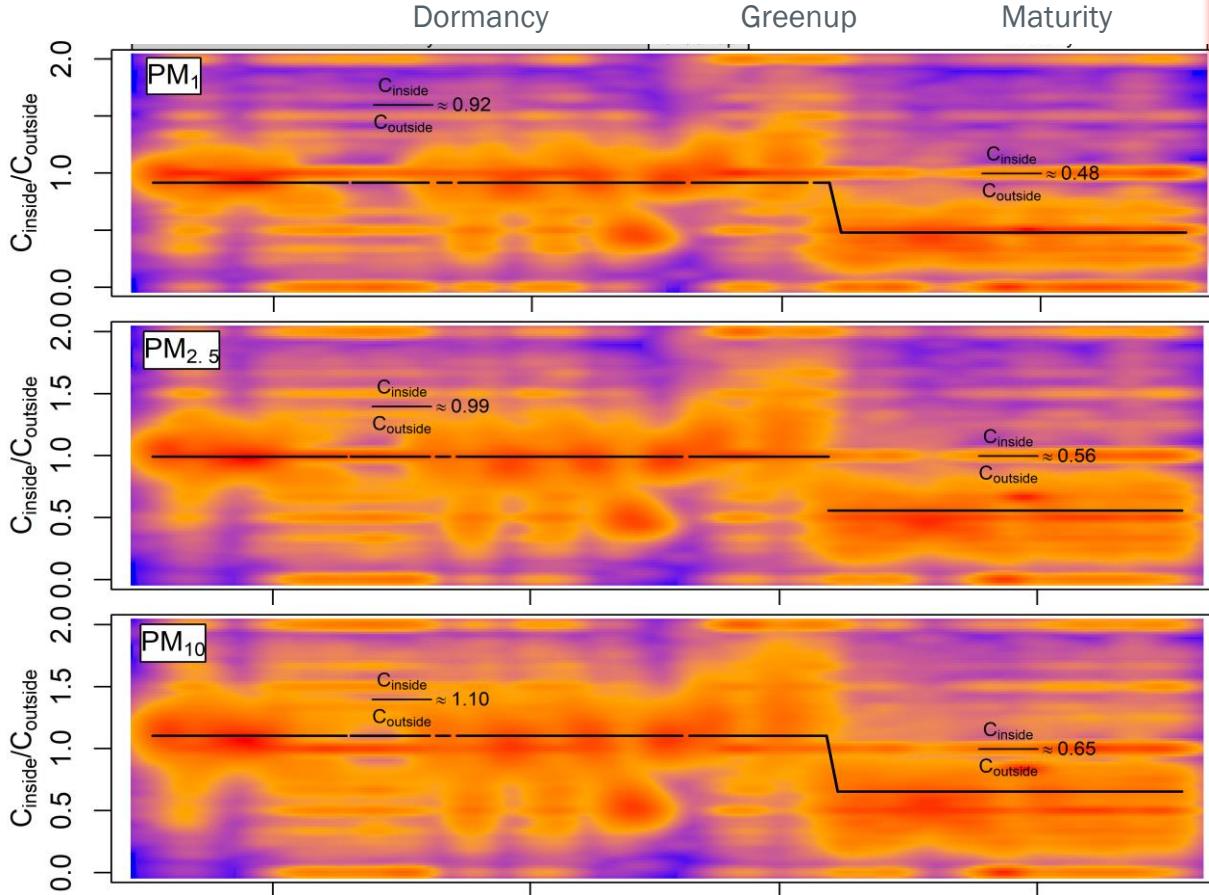
Prashant Kumar^{1,2,3,4,*1}, Karina Corada⁵, Sisay E. Debele¹, Ana Paula Mendes Emerydo¹, KV Abhijith¹, Hala Hassan⁶, Parya Broomandi^{7,8}, Richard Baldauf^{9,10}, Nerea Calvillo¹¹, Shi-Jie Cao^{1,4}, Sylvane Desrivières¹², Zhuangbo Feng⁴, John Gallagher^{3,13}, Thomas Rodding Kjeldsen¹⁴, Anwar Ali Khan¹⁵, Mukesh Khare¹⁶, Sri Harsha Kota¹⁶, Baizhan Li¹⁷, Shelagh K Malham¹⁸, Aonghus McNabola¹³, 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	2. CONSTRUCTED GI	3. PARKS	4. AMENITY AREAS	5. OTHER NON-SEALED URBAN AREAS
Street Trees	Green roof	Parks	School yard	Grassland
Hedge	Green wall	Heritage garden	Playground	Shrubland
Cycle track	Roof garden	Nursery garden	Sports field	Woodland
Footpath	Pergola	Zoological garden	Golf course	Arable agriculture
Road verge		Pocket park	Shared open space	Sparsely vegetated land
Railway corridor		Botanical garden		
Riparian woodland				
6. MIXED	7. OTHER PUBLIC SPACE	8. WATERBODIES	9. HYBRID GI	10. GARDENS
Trees and hedges	Cemetery	River	Permeable paving	Balcony
Trees and shrubs	Allotment	Wetland	Permeable parking	Private garden
Grass and trees	Adopted public space	Canal	Attenuation pond	Shared common garden area
	City Farm	Pond	Flood control channel	
		Reservoir	Rain garden	
		Estuary	Bioswale	
		Sea	Outdoor swimming pool	
		Lake		



Hedges, playground (passive intervention)



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

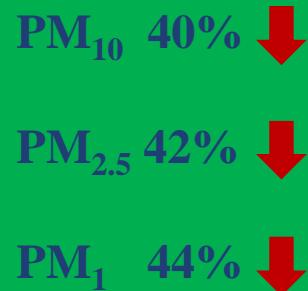
Interventions: School boundaries



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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



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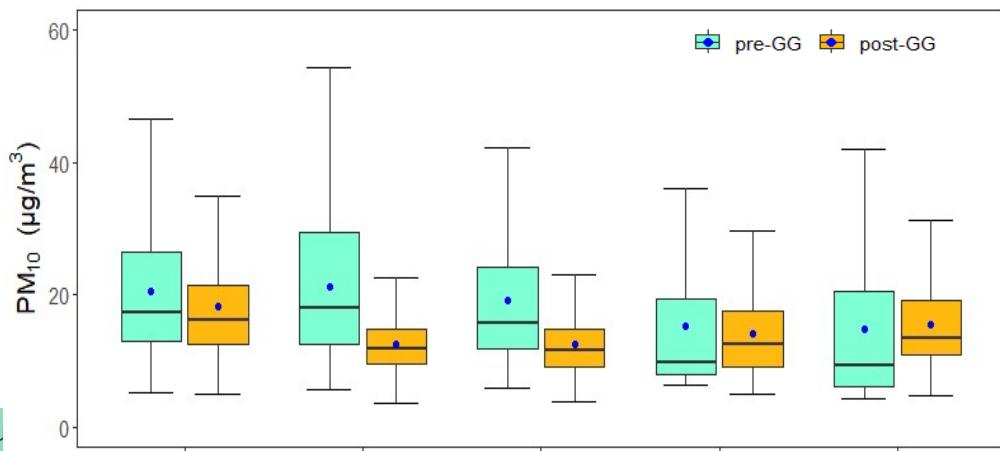
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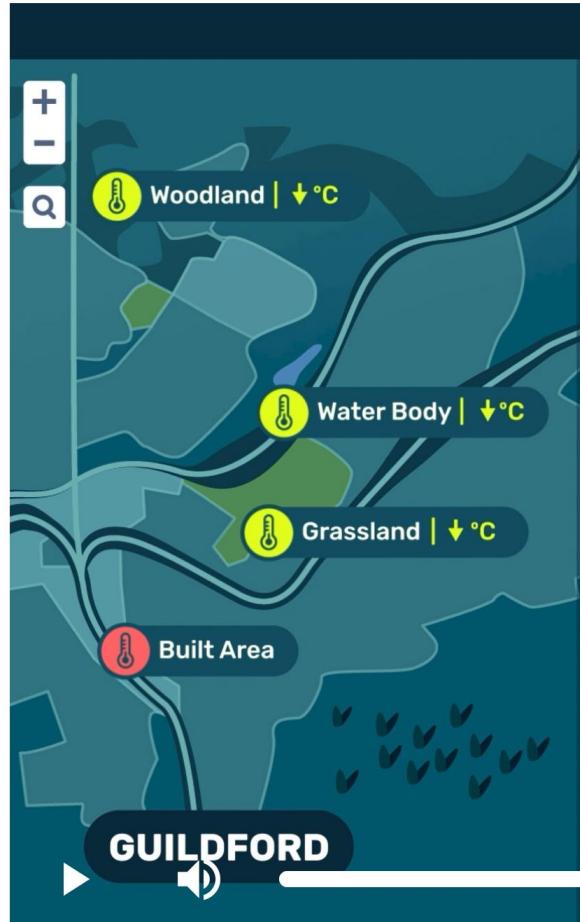
↓ Noise by 5dB(A)

↓ PM₁₀ by 32%

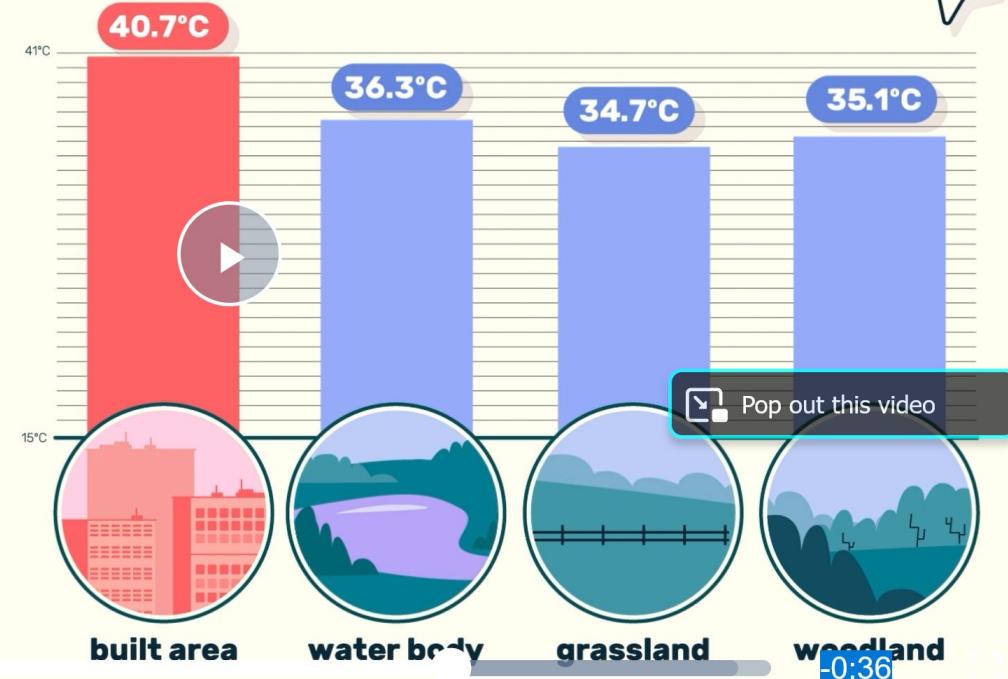
↓ PM_{2.5} by 19%

↓ Decay with distance





19th July 2022

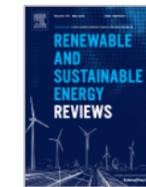


Link: <https://www.youtube.com/watch?v=f46ZA6v5aoA>

CI

Renewable and Sustainable Energy Reviews

Volume 178, May 2023, 113232



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IRREY



Henry Fawcett
@henryfawcett

Climate science learning how exciting
some exciting @pk_shishodia



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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<https://doi.org/10.1016/j.rser.2023.113232> ↗

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rchers have
dents to learn
and potential
imate change. ”
school. Rachel Harrison

Clear quantitative evidence that the Heat-Cool enhanced majority of pupils (79%, primary; 62%, secondary) understanding on climate change.



NBS & climate mitigation



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Nature-based solutions

- ① Afforestation and urban forestry
- ② Coastal ecosystem restoration
- ③ Wetland and peatland restoration
- ④ Grassland restoration and protection

Technology-based solutions

- ⑤ Carbon farming
 - No-till farming
 - Agroforestry
 - Cover cropping
 - Use of compost and other organic amendments
- ⑥ Wind turbines and solar panels
- 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
- ⑬ Integrated traffic management

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

Tools & guidance to empower public and support policy makers


HedgeDATE
Hedge Design for Abatement of Traffic Emissions

Thank you

Contact

Professor Prashant Kumar
P.Kumar@surrey.ac.uk
www.surrey.ac.uk/gcare



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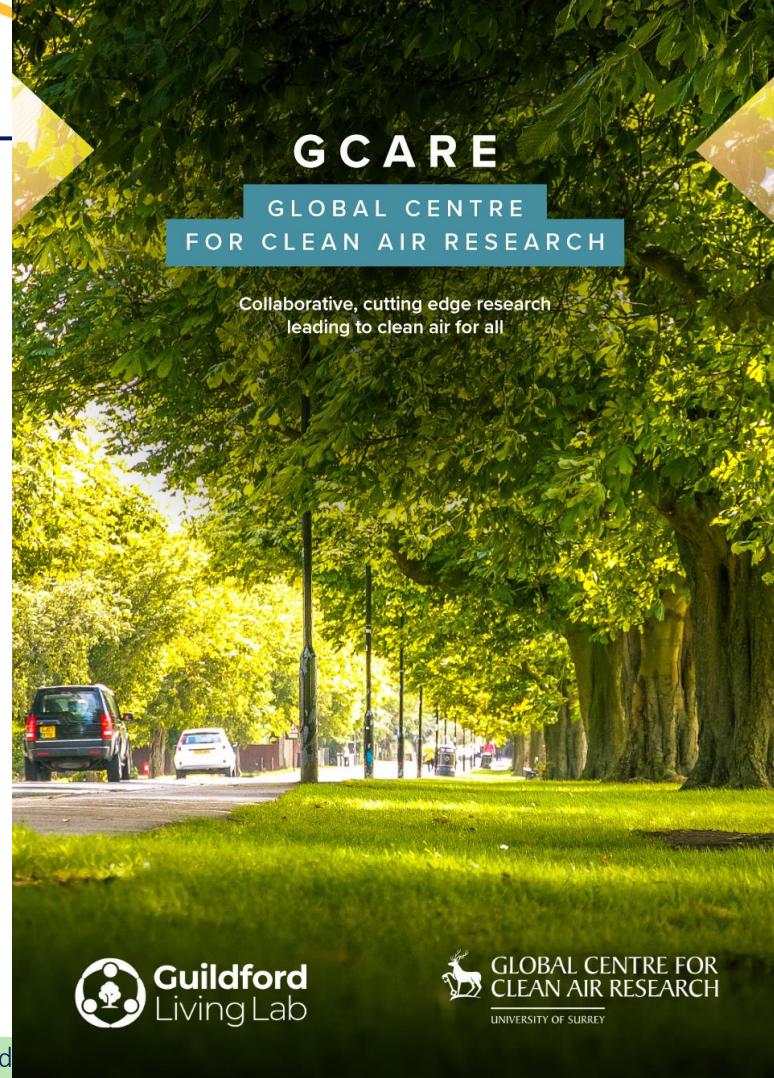
RECLAIM



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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Collaborative, cutting edge research
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