Urban heat mitigation by green and blue infrastructure: a review of drivers, effectiveness and future needs

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Urban heat mitigation by green and blue infrastructure: a review of drivers, effectiveness and future needs

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(30 co-authors, 26 organisations; Under review)

Research questions

- Which GBGI types are the most utilised measures for heat mitigation?
- How do GBGI vary in their effectiveness against heatwaves & their spatial distributions?
- Which GBGI category(ies) produced the highest average performance against heatwaves?
- What are the knowledge gaps that hinder the performance of GBGI?

Scope

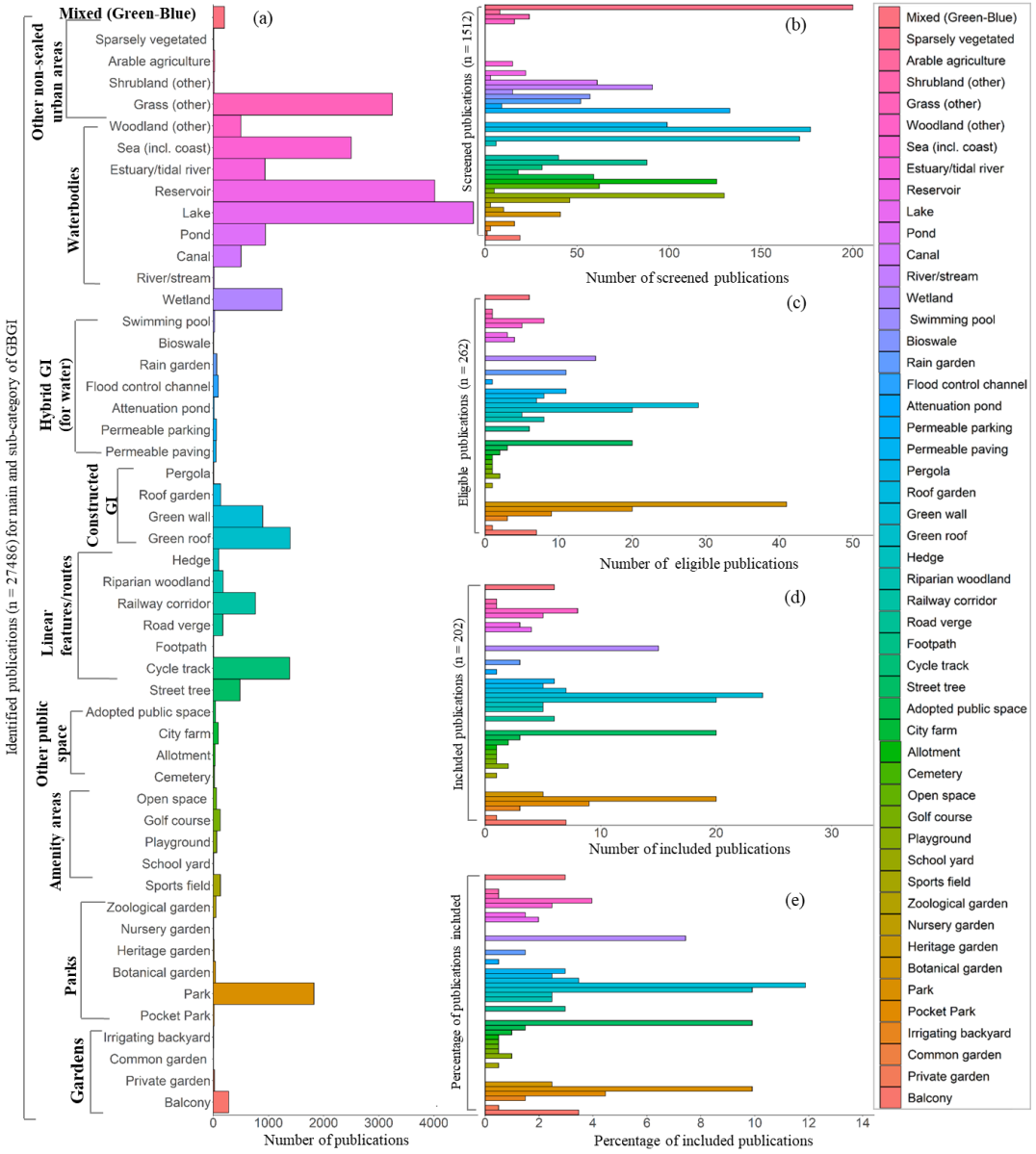
Included

- Functionality and benefits of GBGI measures to mitigate heat,
- Co-benefits & disbenefits of GBGI measures,
- Focus on air/land surface temperature
- Identified relevant knowledge gaps, and
- Practical recommendations of GBGI implementation.

Beyond the Scope

- No literature found on 18 GBGI sub-categories (out of 51);
- Detailed design and implementation principles of GBGI;
- Functionality of GBGI related stream (water) temperature cooling;
- Review of cost & benefits of GBGI; and
- Limits of GBGI to climate change and other global challenges.

Search analysis



51 sub-categories divided under

10 main GBGI category

- Identified papers (27486)
- Screened papers (1512)
- Eligible papers (262)
- Included papers (202)

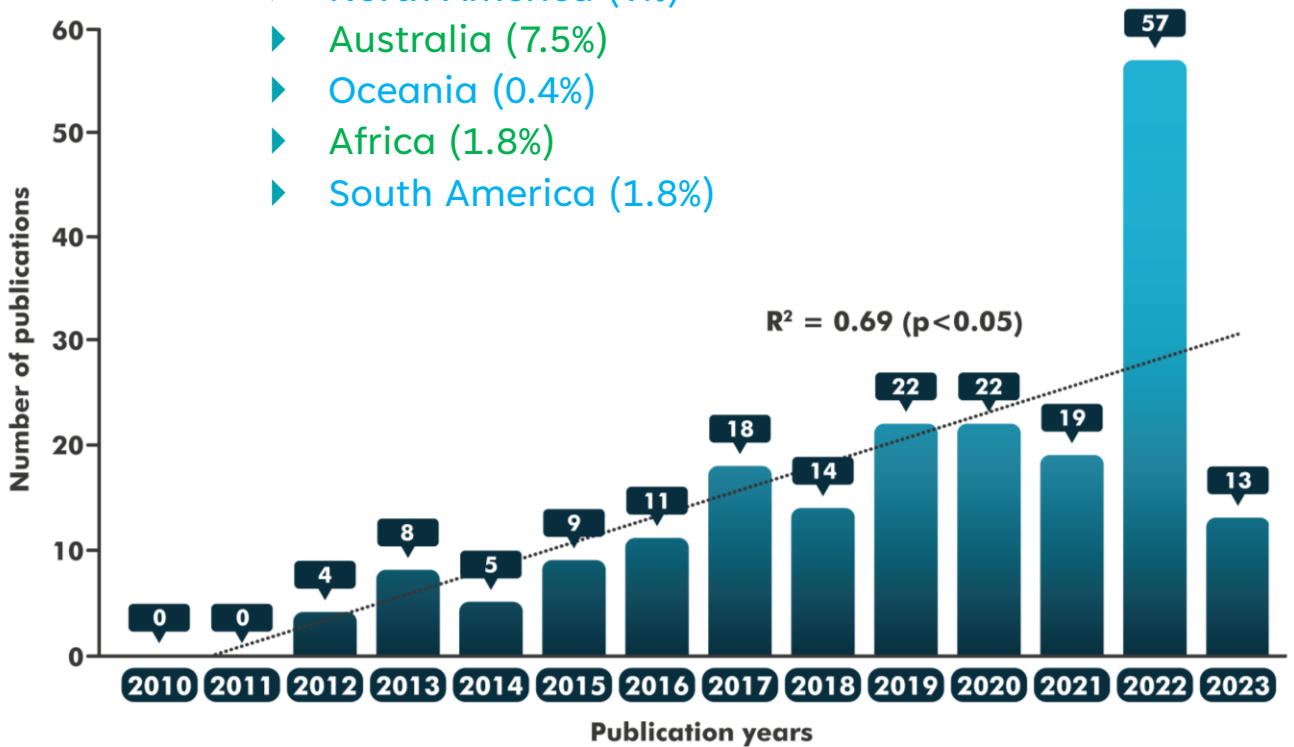
Temporal & spatial trends

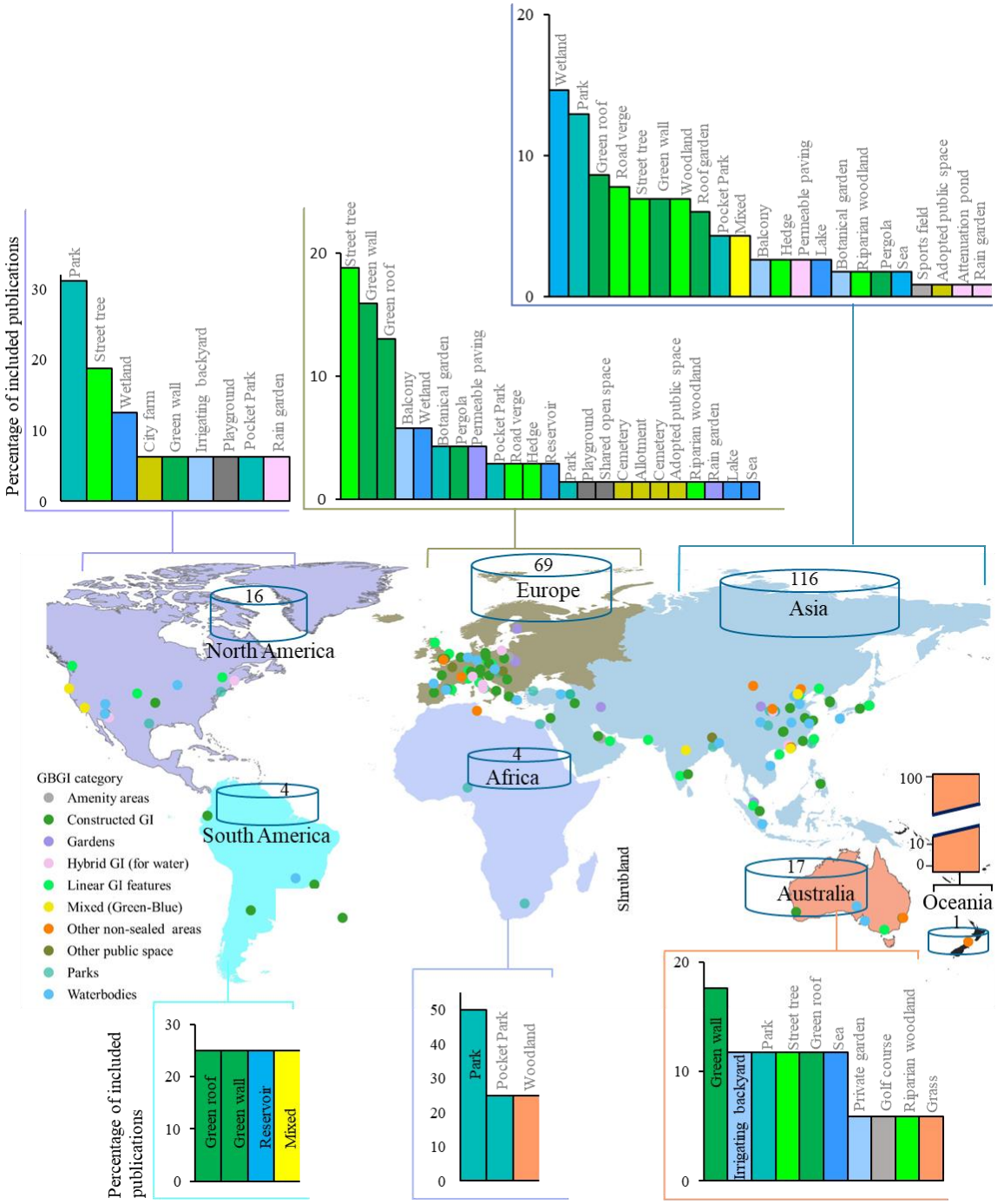
Temporal trend

- Relatively low studies in the earlier years 2010-2016 (1.9%; *n* = 4; 2012) to 5.5% in 2016
- An exponential increase in 2017 (8.9%)
- Peaked in 2022 (28.2%)

Spatial trend

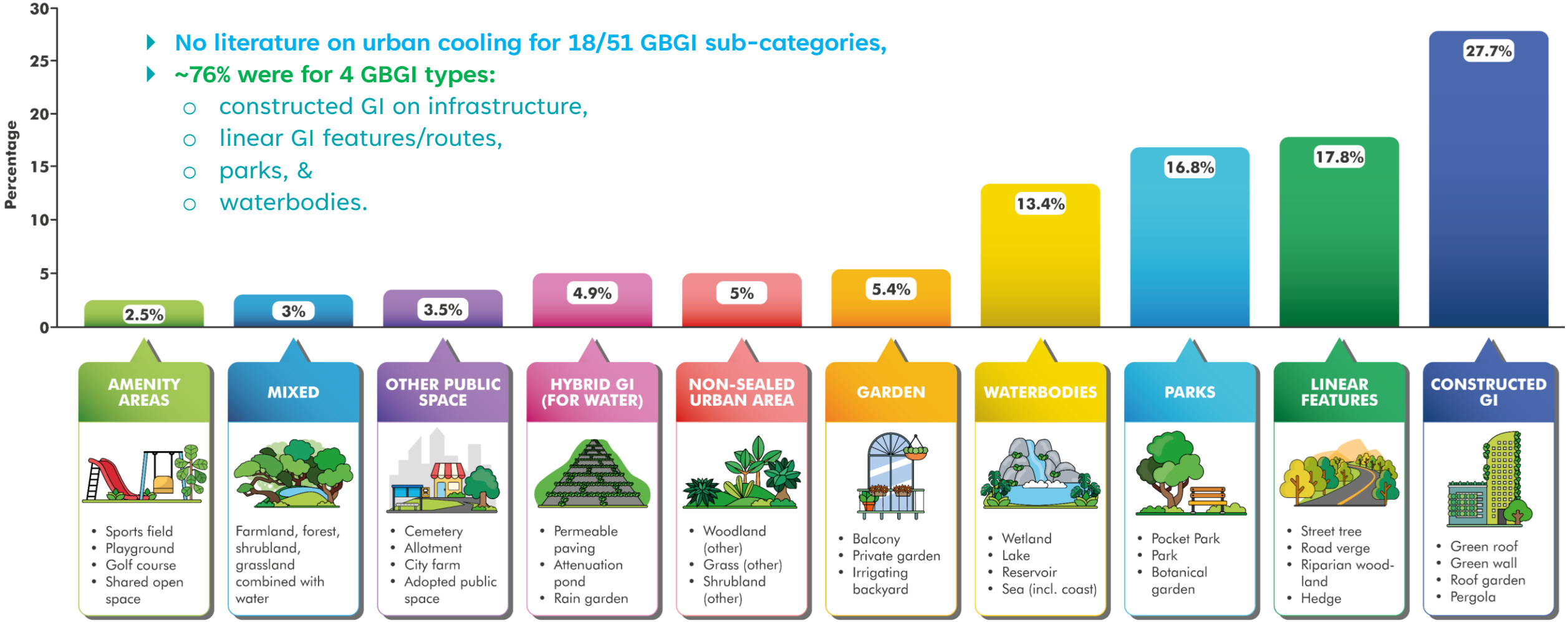
- Asia (51.1%)
- Europe (30.4%)
- North America (7%)
- Australia (7.5%)
- Oceania (0.4%)
- Africa (1.8%)
- South America (1.8%)





Most studied Interventions

- No literature on urban cooling for 18/51 GBGI sub-categories,
- ~76% were for 4 GBGI types:
  - constructed GI on infrastructure,
  - linear GI features/routes,
  - parks, &
  - waterbodies.



- Remaining ~24% were for 6 other GBGI types.
- Nearly half (~42%) were for green walls (12%), Green roofs (10%), street trees (10%) & Parks (10%)

Performance

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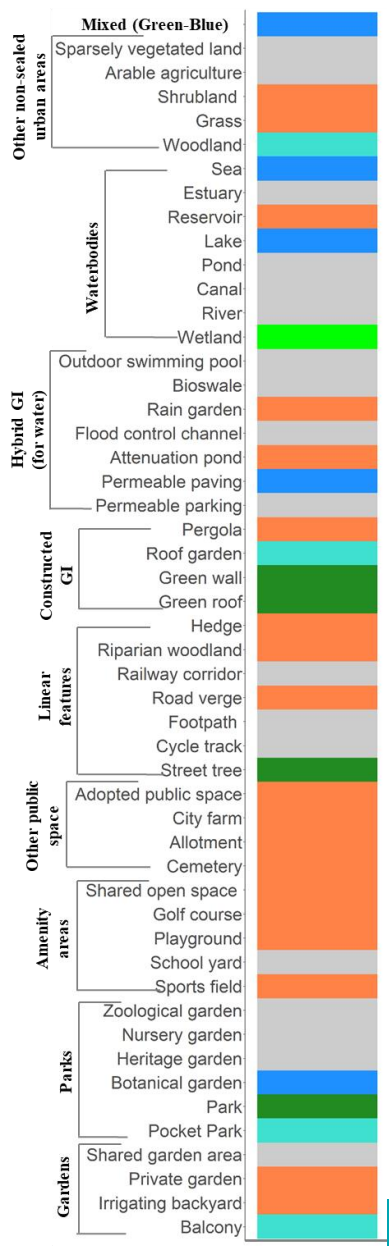


≥80% (V. High)
≥60 ≤80% (High)
≥40 ≤60% (Medium)
≥20 ≤40% (Low)
≥0 ≤20% (V. Low)
0% (Negligible)

GBGI Cooling Efficiency (ΔT °C)

5.0
4.0
3.0
2.0

MIXED
Farmland, forest, shrubland, grassland combined with water

OTHER PUBLIC SPACE
Cemetery
Allotment
City farm
Adopted public space

AMENITY AREAS
Sports field
Playground
Golf course
Shared open space

GARDEN
Balcony
Private garden
Irrigating backyard

LINEAR FEATURES
Street tree
Road verge
Riparian woodland
Hedge

NON-SEALED URBAN AREA
Woodland (other)
Grass (other)
Shrubland (other)

HYBRID GI (FOR WATER)
Permeable paving
Attenuation pond
Rain garden

CONSTRUCTED GI
Green roof
Green wall
Roof garden
Pergola

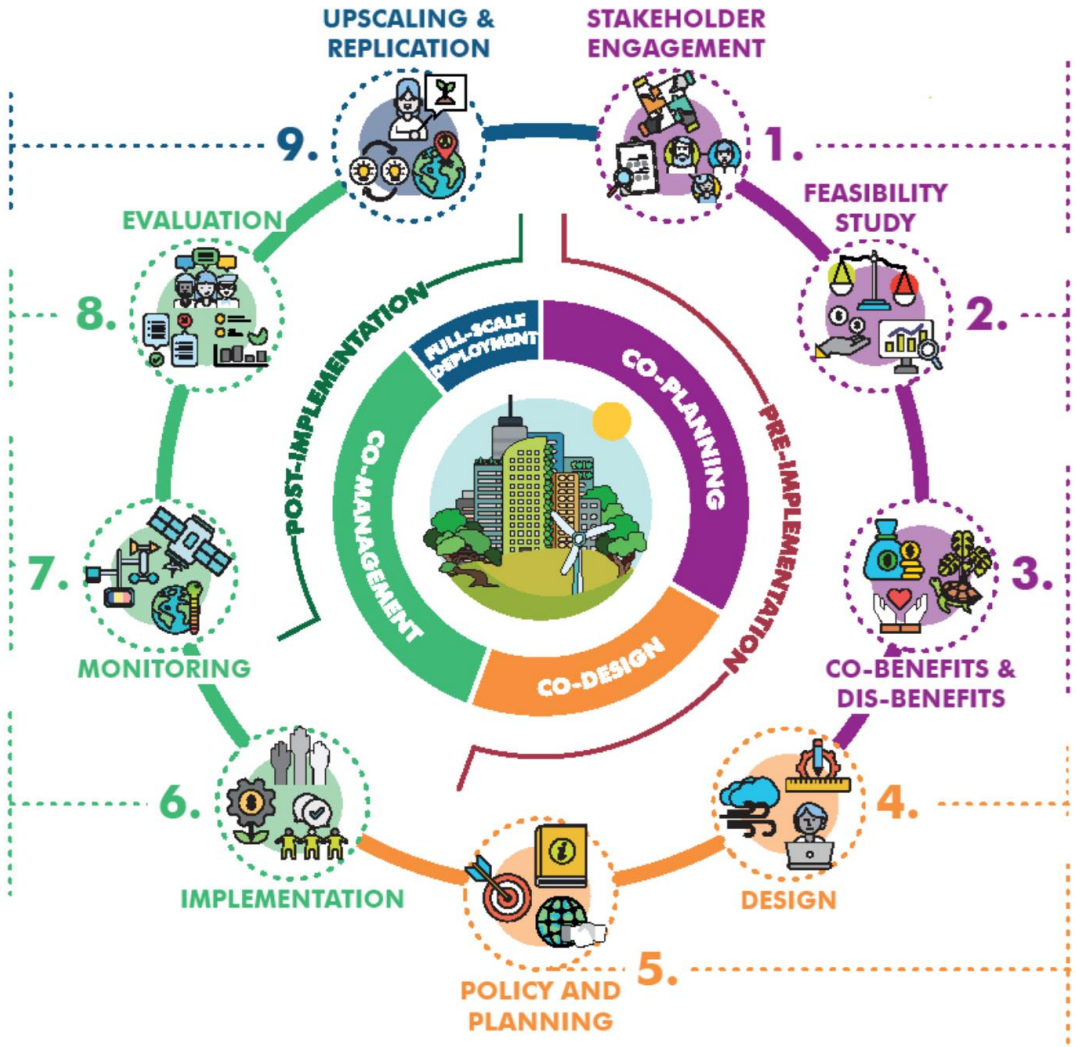
WATERBODIES
Wetland
Lake
Reservoir
Sea (incl. coast)

PARKS
Pocket Park
Park
Botanical garden

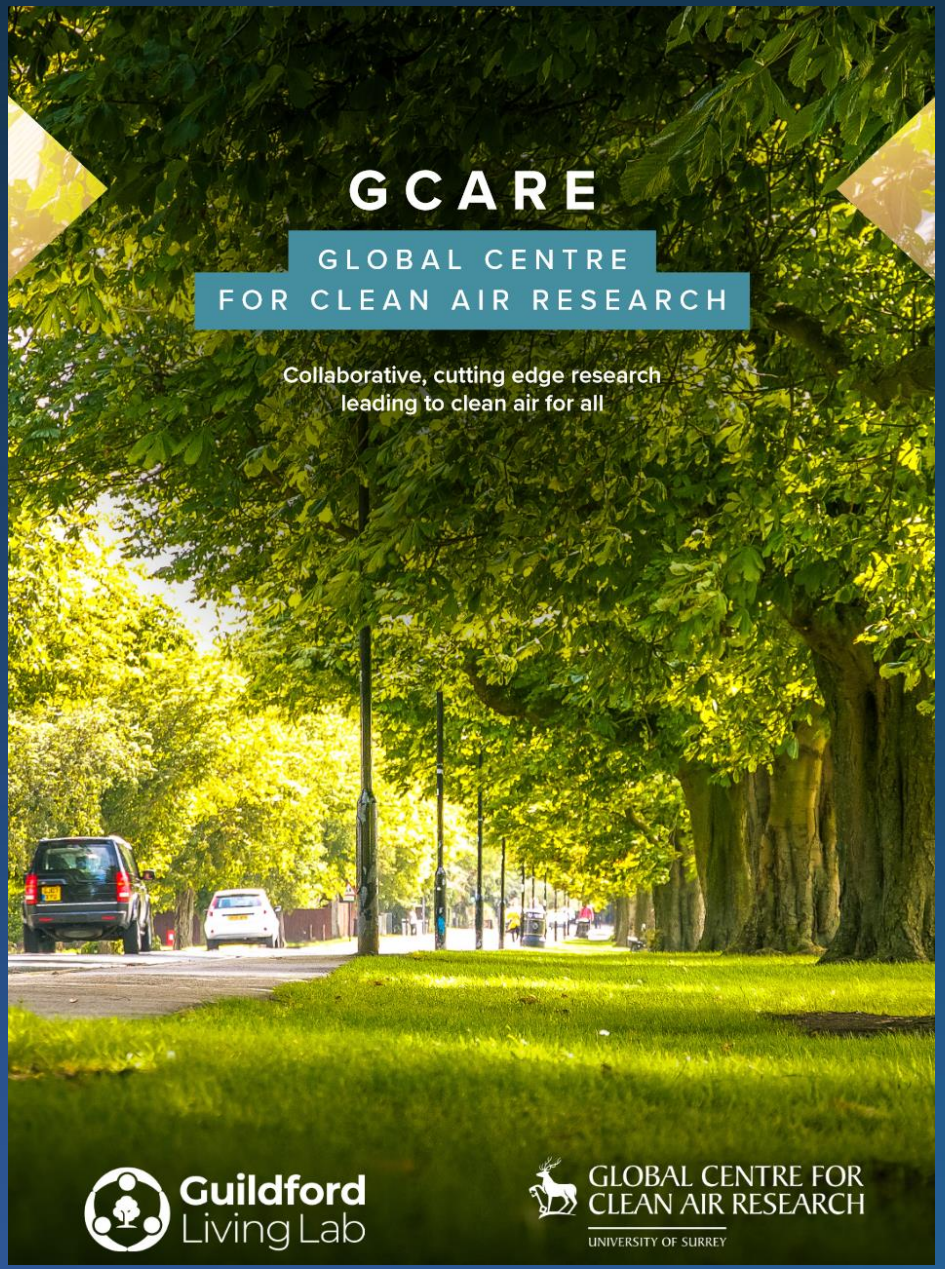
Mixed (Green-Blue), 2.2
Adopted public space, 2.5
Playground, 2.9
Woodland (other), 3.0
Permeable paving, 3.3
Balcony, 3.8
Street tree, 3.8
Green wall, 4.1
Wetland, 4.7
Botanical garden, 4.9

Recommendations (10)

- Monitoring and evaluation framework is crucial for assessing GBGI's performance in heat mitigation and identifying improvements.
- For effective climate-resilient urban heat mitigation, important to comprehend the characteristics, functionality and constraints of GBGI.
- Essential to carefully evaluate potential negative consequences to prevent any unintended side effects when implementing GBGI.
- Comprehensive heat mitigation strategies with straightforward-to-implement practical guidelines are required.
- Climate literacy programmes and public information campaigns are crucial in promoting positive action on urban heat and GBGI interventions.
- Stakeholder participation plays a pivotal role in promoting the adoption of GBGI solutions in regions susceptible to heat.



Thank you



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