

# Sustainable Cooling in Cities: Strategies for Urban Resilience



Km Verde - West 8



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# Acknowledgment



*No Challenge  
No Change*



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Chongqing University

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## IEA EBC - Annex 97 - Sustainable Cooling in Cities



International  
Energy Agency

Special attention is given to the objectives of the newly launched IEA EBC Annex on Sustainable Cooling in Cities and its role in supporting evidence-based UHI mitigation.



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## Urban and Building Science (UBS)

Climate change impact assessment

Environmental performance monitoring and assessment

Smart and resilient cities and communities

Low-carbon communities and buildings

Nature-based solutions

Positive climate mitigation and adaptation

Comfort, health, well-being, and work productivity

Carbon emission mapping and trading

Circular economy and innovation management



## Editorial Board

### Editor-in-Chief

**Prof. Bao-Jie He**

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**Research Interests:** climate-adaptive urban design; urban/building ventilation; urban heat mitigation and adaptation; human comfort and health; net zero carbon buildings; urban morphology; CFD simulation; Decision support system.



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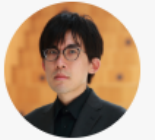
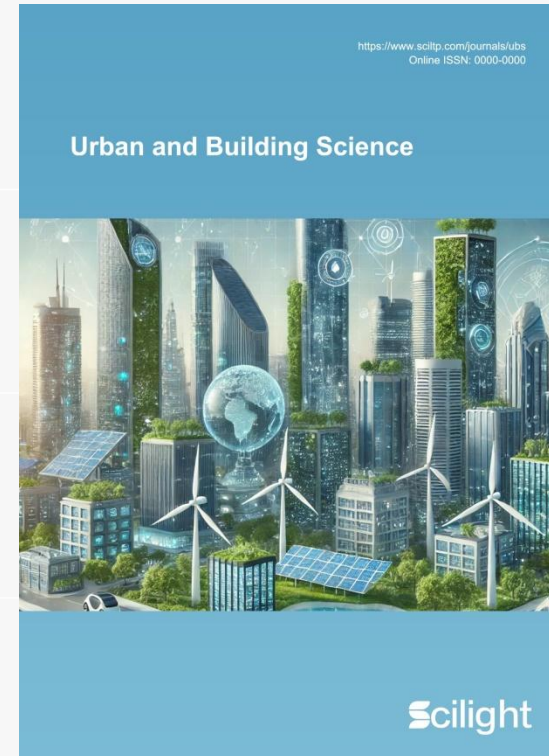
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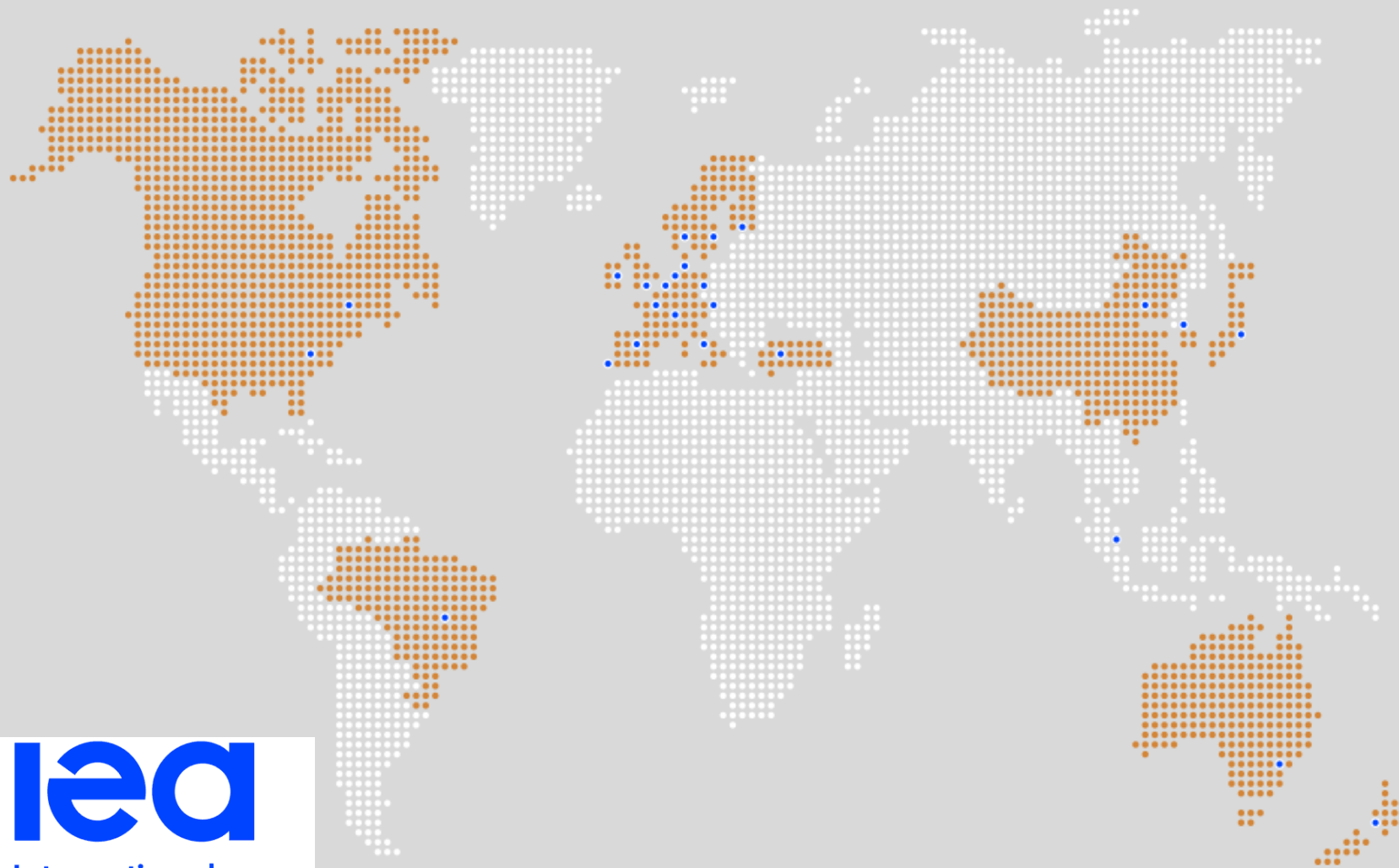
# IEA EBC - Annex 97

## Sustainable Cooling in Cities



# 26 Member Countries of Energy in Buildings and Communities (EBC) Programme

Annex 97 - Sustainable Cooling in Cities



- Australia
- Austria
- Belgium
- Brazil
- Canada
- China
- Denmark
- Finland
- France
- Germany
- Ireland
- Italy
- Japan
- Korea
- Netherlands
- New Zealand
- Norway
- Portugal
- Singapore
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
- United States of America

# Structure and Subtasks

- 1. Fundamentals.** Definition of comfort and health and productivity and safety and sustainability KPIs, measurement standards, and else.
- 2. Methods.** Modelling. Measurement. Survey. Observation. „Science to Science“
- 3. Solutions.** With further differentiations, e.g. with a firm structure, Urban morphology, wind, air movement, plants, water, materials, district cooling, including policy, proofs of concepts, such as case studies and monitoring of effects, including their community
- 4. Policy.** Standardisation, Dissemination, Executive reports, guidance for decisionmakers. „Science to Decision Makers“

# Resilience against short term events



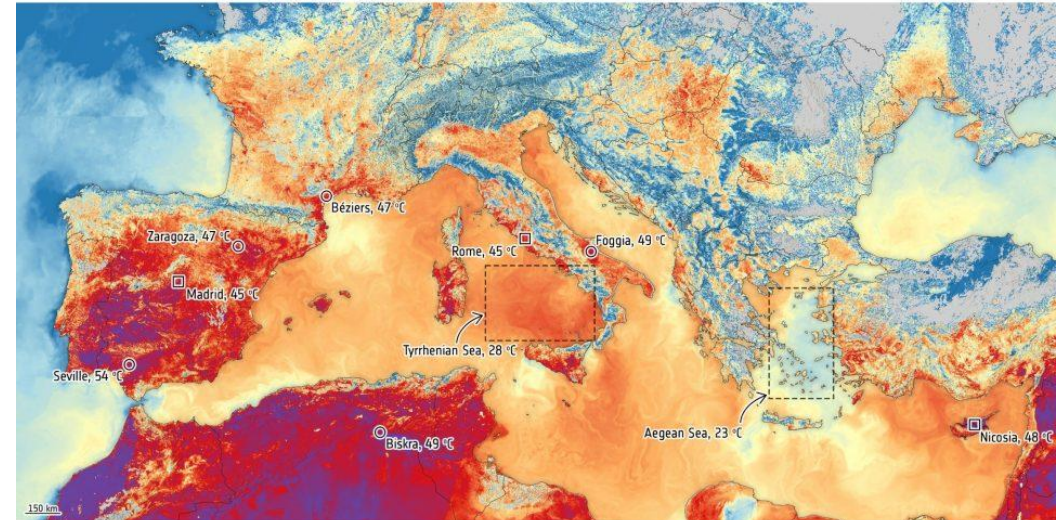
# Disruptions



**Drought**

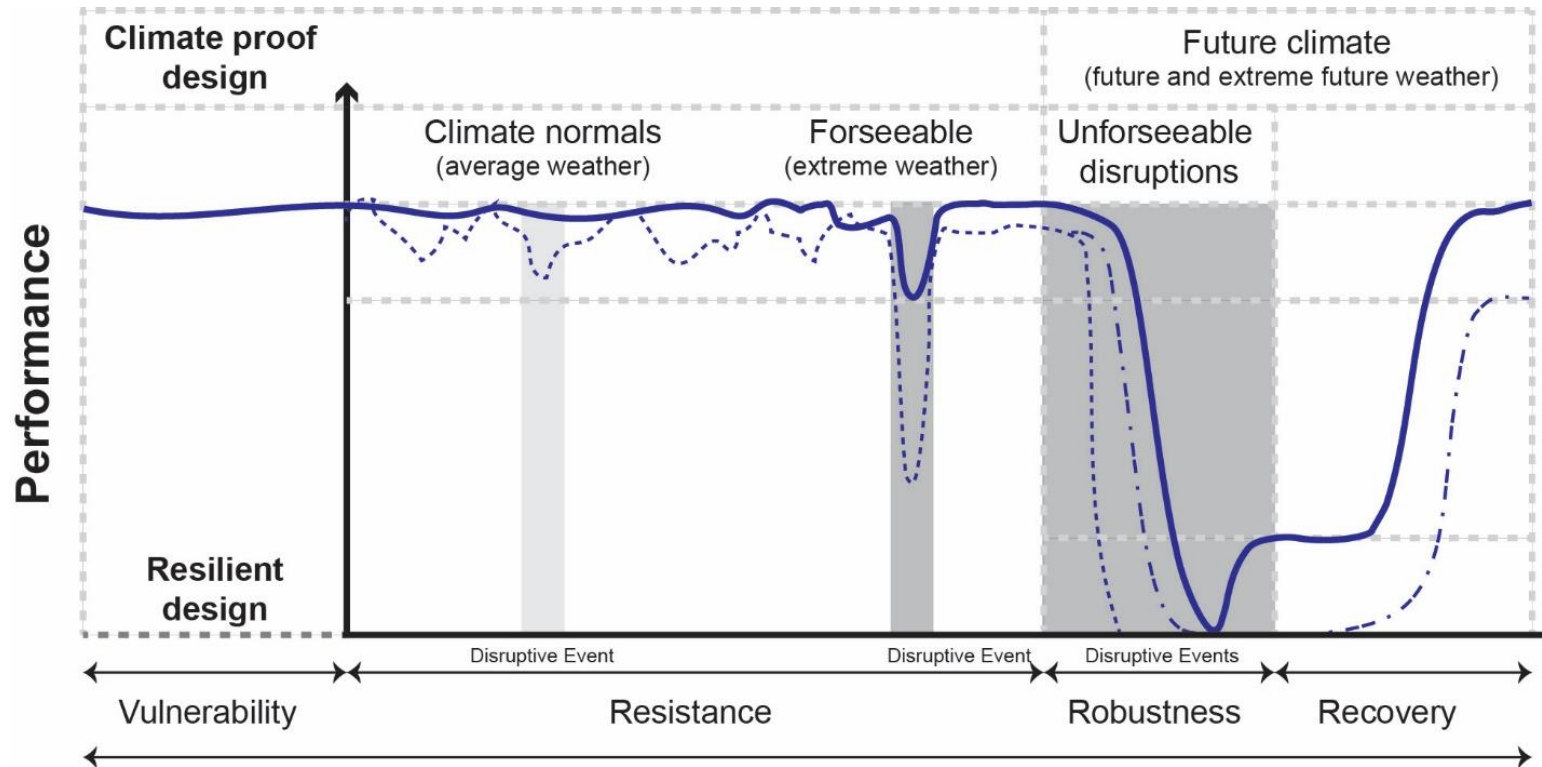


**Heat waves**



**Heat Domes**

# Definition: Resilience vs. Shock = FAILURE



## Resilience

1. designed thermal conditions
2. minimum thermal conditions
3. critical thermal conditions

1. weather files: extreme weather
2. weather files: average weather
3. weather files: future weather
4. weather files: worst future weather

- Event 1: short extensive heatwave
- Event 2: short intensive heatwave
- Event 3: long extensive heatwave
- Event 4: long intensive heatwave
- Event 5: power outage

Heat wave & Power Outage: Existing Buildings

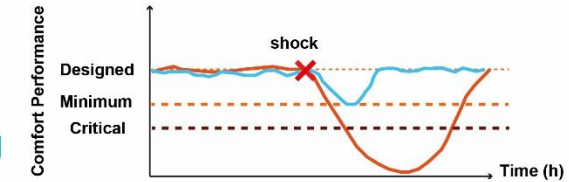


Resilient Performance Scheme

- Non-Resilient Building
- Resilient Building

Building Resilience Indicator

- NOT ACCEPTABLE
- MARGINAL
- ACCEPTABLE



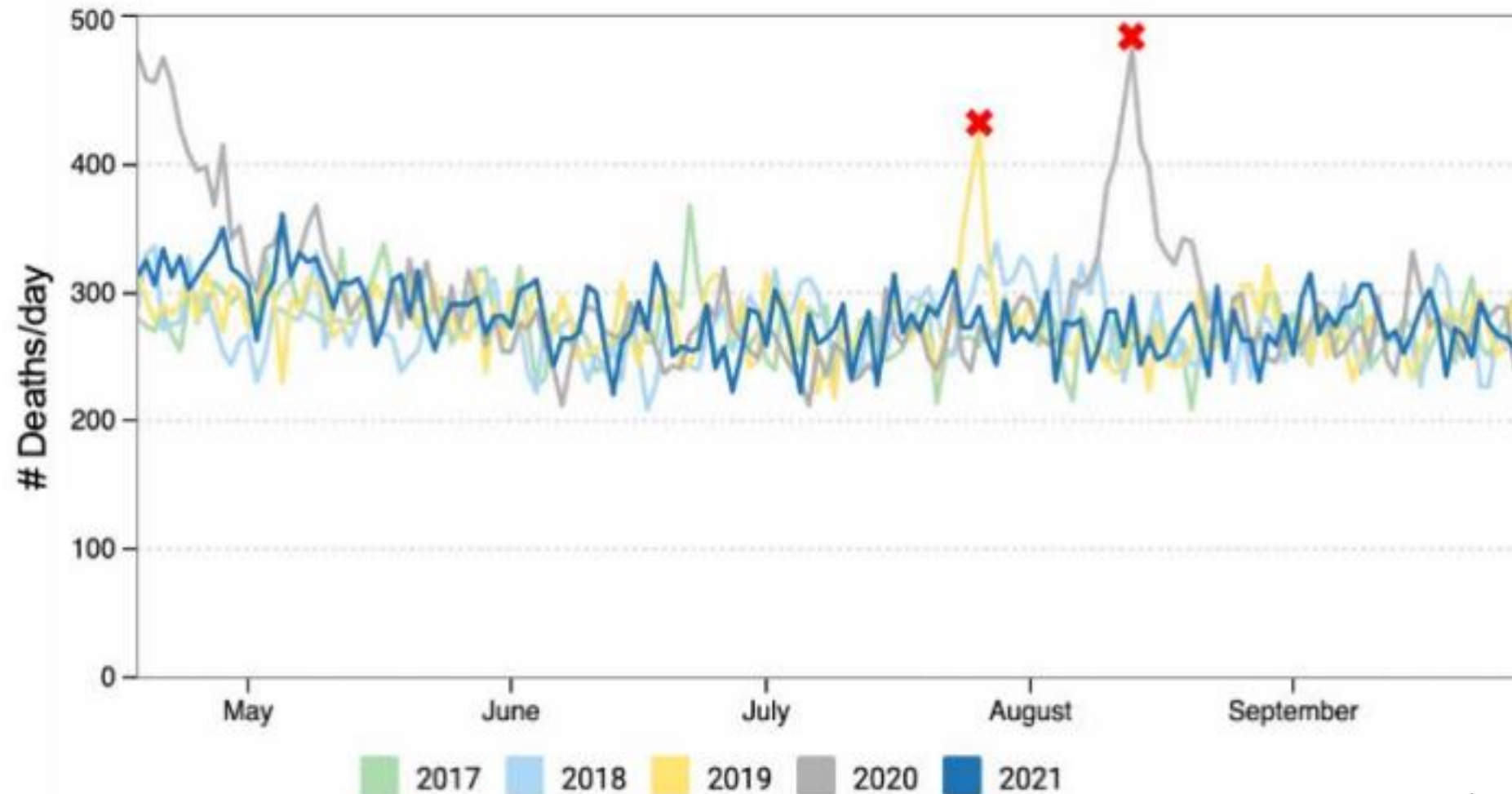
Disruption Events: Resilient Building Solution



Non-Resilient and Resilient Performance Curve during heat waves and power outage events.

# Mortality rates in Belgium 2017-2021

At least 15,000 people have died across Europe because of hot weather in 2022 (Germany 4500 - Belgium 1100)



# **Greenery KPIs in Cities: Cooling Strategies for Urban Resilience**



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