The Assessment Report for Climate Change in Cities (ARC3-2)

Urban Planning and Design - *First Look at ARC3-2 Findings*

Jeffrey Raven, Brian Stone, Gerald Mills, Lutz Katzschner, Pascaline Gaborit, Mattia Leone, Matei Georgescu, Maryam Hariri, Joel Towers
James Lee, Jeffrey LeJava, Ayyoob Sharifi, Cristina Visconti, Andrew Rudd
Gina Cavan, Irene Gallou, Aleksandra Kazmierczak, Edward Ng, Chao Ren

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“Adaptive Mitigation”: *Mesures d'atténuation adaptatives*
An Urban Climate Management Priority

Urban Climate Factors: Design and Planning Tools

Design Process for Configuring Climate-Responsive Districts

Case Studies

- **Vegetative Coverage Scenarios for UHI Mitigation**
- **High-Density Adaptive Re-Use through Ventilation Corridors**
- **Adaptive Mitigation Projects: Tropics and Desert**

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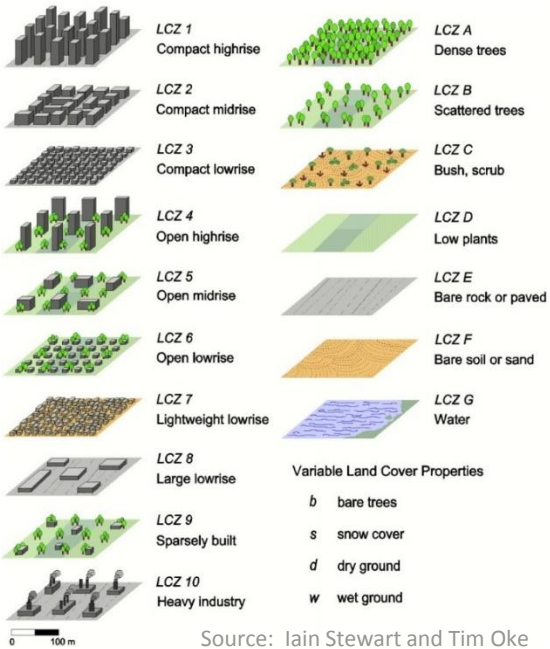
Land Cover, Form, and Spatial Scales

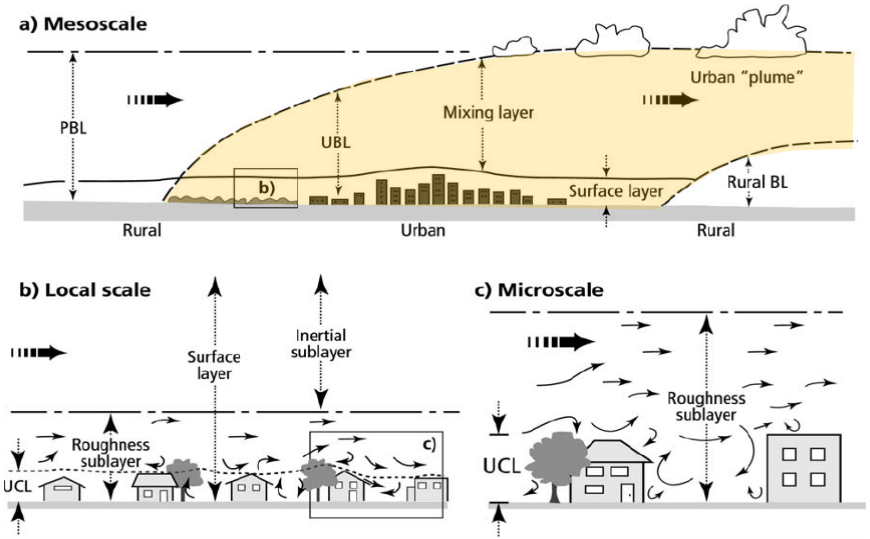
Local Climate Zones and Atmospheric Layers

Local Climate Zones



Source: Iain Stewart and Tim Oke

Atmospheric Layers



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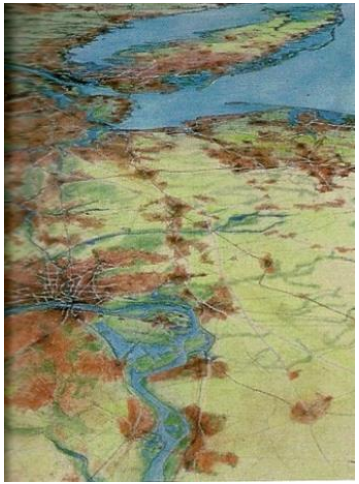
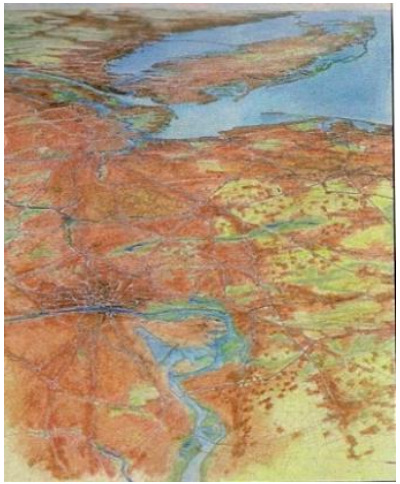
Adaptive Mitigation

Urban Climate Management Goal

“Adaptive Mitigation” = Climate Change Adaptation + Climate Change Mitigation





Reduce the global greenhouse gas effect, while increasing climate resilience to urban heat and flooding

Urban Strategy cards: Interdependent Strategies: STAR Communities (Sustainable Tools for Assessing and Rating Communities) (J.Raven)

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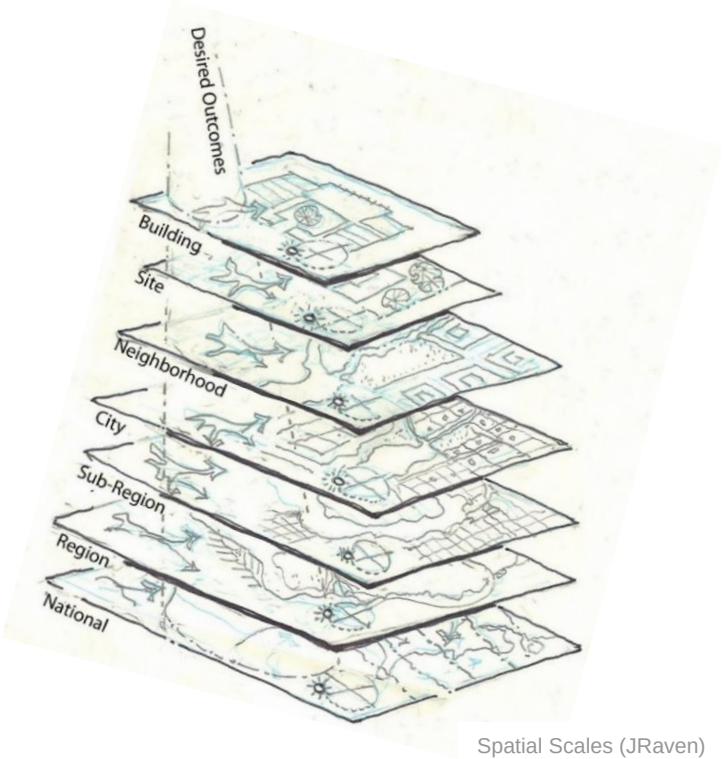
Adaptive Mitigation for Sustainable & Resilient Cities

Across Spatial Scales, Jurisdictions and Electoral Cycles



Spatial Scales (JRaven)

Ensure long-range strategies across scales, jurisdictions and electoral time-frames

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Adaptive Mitigation for Sustainable & Resilient Cities

Embed Climate-Responsive Design into Planning and Design Process

Recent “best practice” policy / knowledge-transfer initiatives

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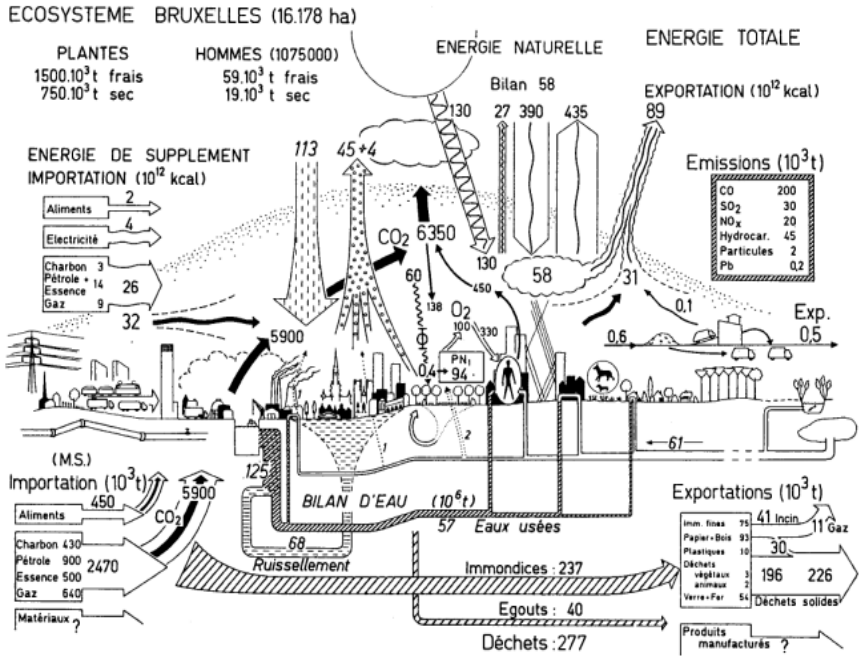
Role of Designers and Planners: An Expanded Agency

Embed Climate-Responsive Design into Planning and Design process



Placemaking Principles

Permeability – connectivity
Vitality – Interactions
Variety – Options
Legibility – Intuitive

An Expanded Agency

Resilience – Adaptation
Comfort - Environment Permeability
Demand reduction
Resource Efficiency and Re-Use
Biotic Support
Environmental Diversity
Health - Pathological Prevention

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Adaptive Mitigation for Sustainable & Resilient Cities

Local Conditions Drive Climate-Responsive Strategies

Consider local conditions to generate climate-responsive strategies

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Adaptive Mitigation for Sustainable & Resilient Cities

Urban Quality of Life and People-Centered Spaces for Social Resilience

Deliver quality of life for urban citizens as the key performance outcome across all sectors.

Invest in social cohesion as key to resilience, whose success hinges on people centered urban spaces.

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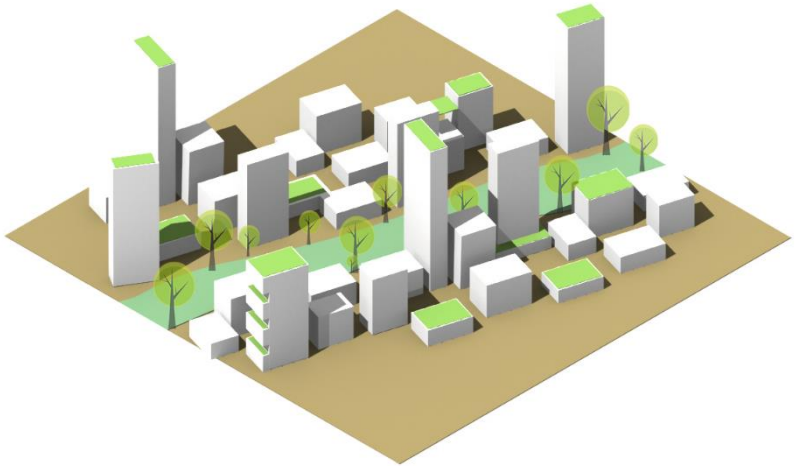
Urban Climate Factor #1 - Urban Form

Surface Cover: Enhancing the Built Environment's Vegetative Coverage



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Urban Climate Factor #1 – Urban Form

Surface Cover: Enhancing the Built Environment's Vegetative Coverage

Co-Benefits Across Systems & Spatial Scales

Mid-town East Retrofit & TOD Linked to Greenways

Green Infrastructure Co-Benefits: STAR Communities

Urban Strategy cards: Interdependent Strategies: STAR Communities (Sustainable Tools for Assessing and Rating Communities) (J.Raven)

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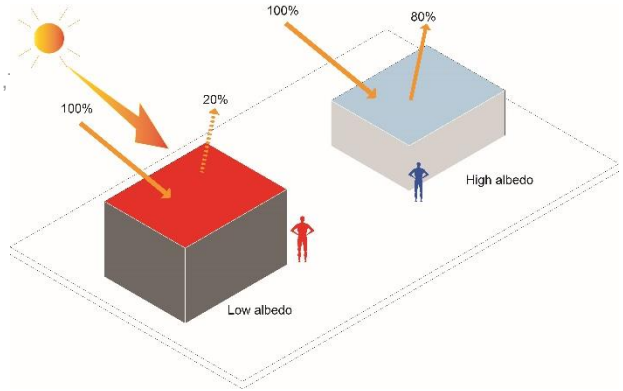
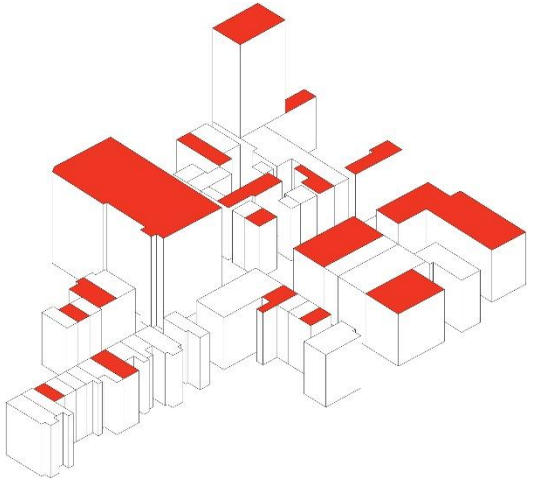
Urban Climate Factor #2 – Urban Form

Construction Materials, Heat Capacity and Surface Reflectivity

Southwood Valley School-College Station ,

High albedo roofs cool roof surfaces, reduce cooling loads.
This strategy alone does not impact comfort at street level





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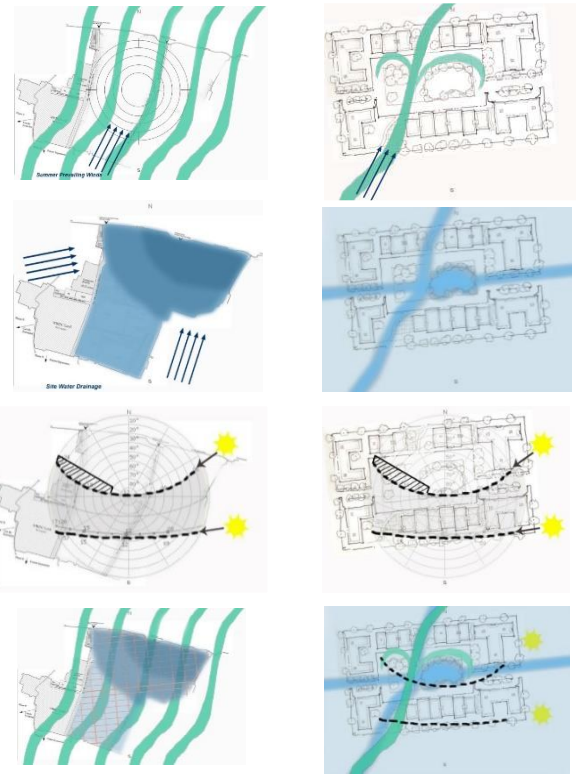
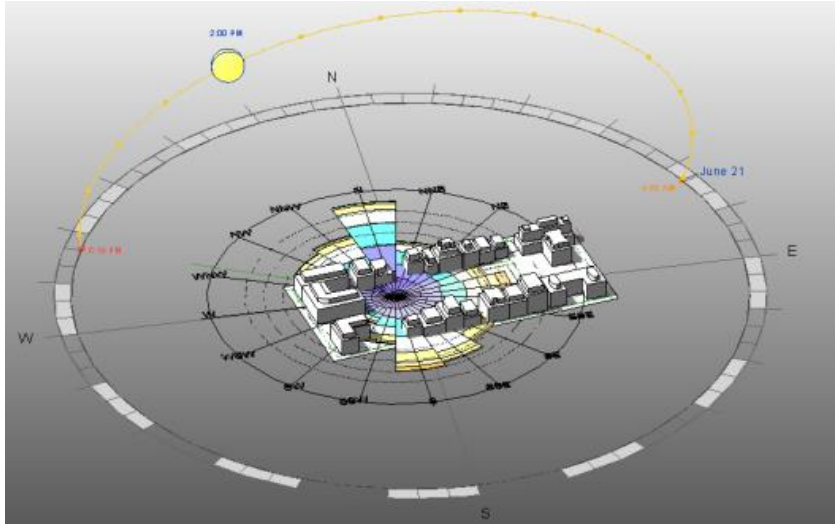
Urban Climate Factor #3 – Urban Form

Built Geometry: 3D Urban Form, Orientation, Ventilation and Solar Impacts





Kolkata Green Satellite Cities Project, India (Raven A+U)

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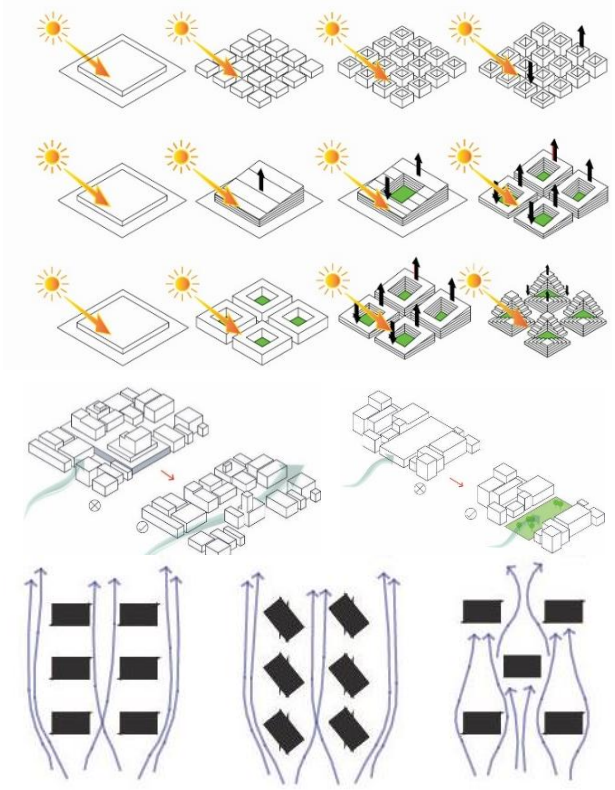
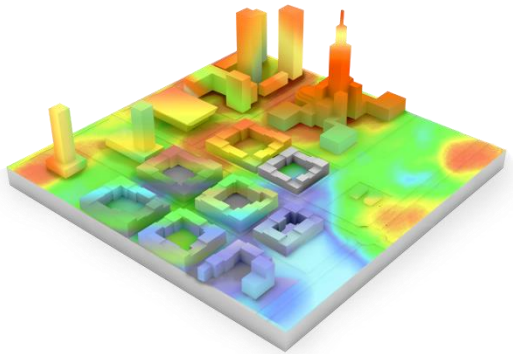
Urban Climate Factor #3 – Urban Form

Built Geometry : 3D Urban Form, Orientation, Ventilation and Solar Impacts





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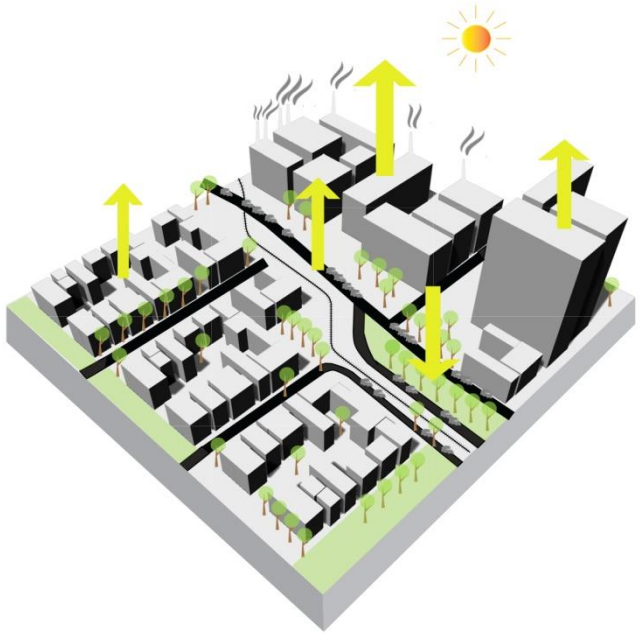
Urban Climate Factor #4 – Urban Function

Human & Infrastructure-Generated Waste Heat: Transport, Buildings and Industry

Image credit: Inhabit, BedZed



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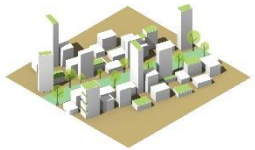
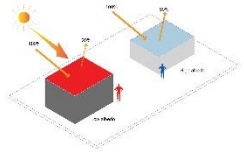
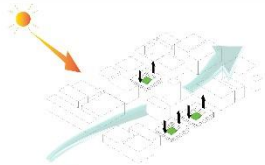
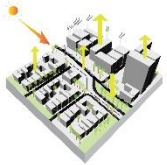
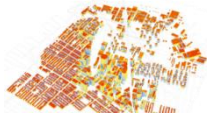
Climate-Resilient Urban Design

Urban Climate Factors

	Urban Climate Factors	Tools	Units
	**Vegetation** Green-blue infrastructure Building-integrated	Surveys Satellite images GIS mapping	% Coverage Vegetation type Evapotranspiration
	**Surface Reflectivity** **Thermal Mass**	Radiation Analysis Building envelope energy analysis	kWh/m2 R-value
	**Geometry** Ventilation Solar Impacts	Massing diagrams Wind / sun impacts Sky view factor Outdoor comfort	FAR / bldg. height Solar radiation Wind Speed UTCI / PET
	**Energy** **Waste heat** Transport Buildings Industry	Transport data Indoor comfort On-site energy Radiant heat map	VMT UTCI / PET Kwh Temperature

Design Intervention Process

1. Climate Analysis Mapping

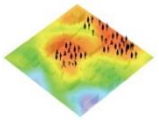


Urban Scale

Local Scale

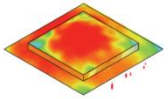
2. Public Space Evaluation

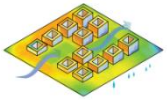
Level of comfort



User Groups / Climate Intensity

3. Planning and Design Intervention





4. Post-Intervention Evaluation

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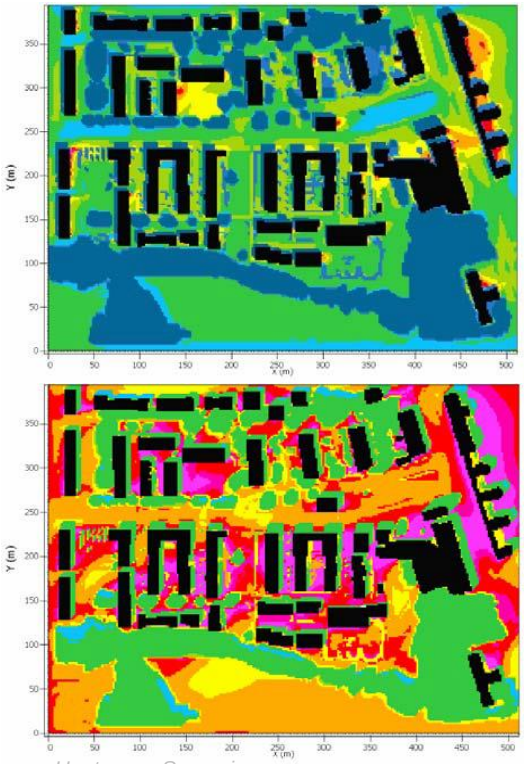
Planning Process: Climate Analysis Mapping

Kassel, Germany



Heat wave Scenario

Human thermal comfort within urban spaces, combining:

- Micro-climate modeling
- Population surveys

Urban Climate Map (UCM), Kassel- Germany 2009

Human Thermal Comfort

Typical day (above)

Heat wave (below)

- Climate Analysis Map (1/10,000)
- Recommendation Map
- Urban (1/25,000); District (1/2,500)

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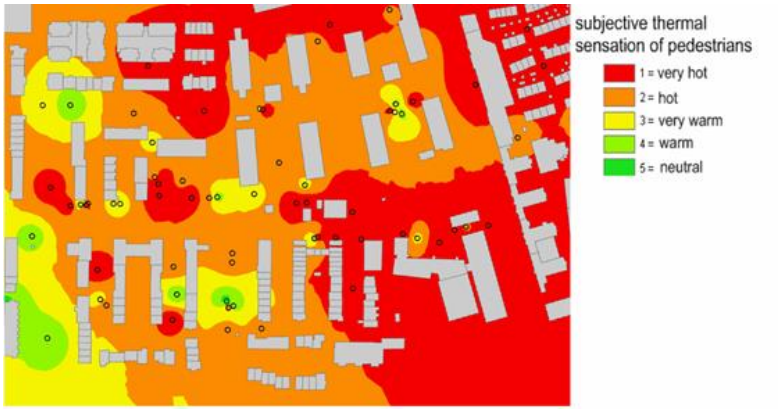
Planning Process: Public Space Survey

Kassel, Germany

Population Survey Crosschecked Against Simulation



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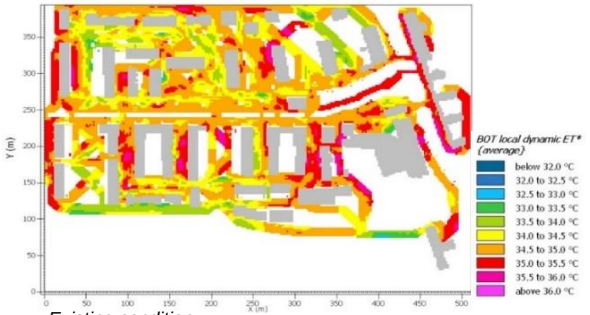
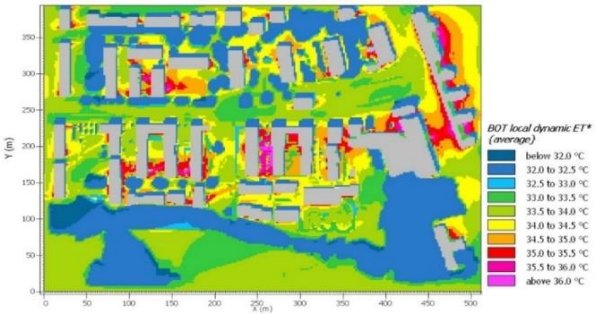
Planning Process: Design Intervention

Kassel, Germany



Existing condition



Optimized scenario

Planning usage of ENVIMET Simulation

Urban Planning Scenario

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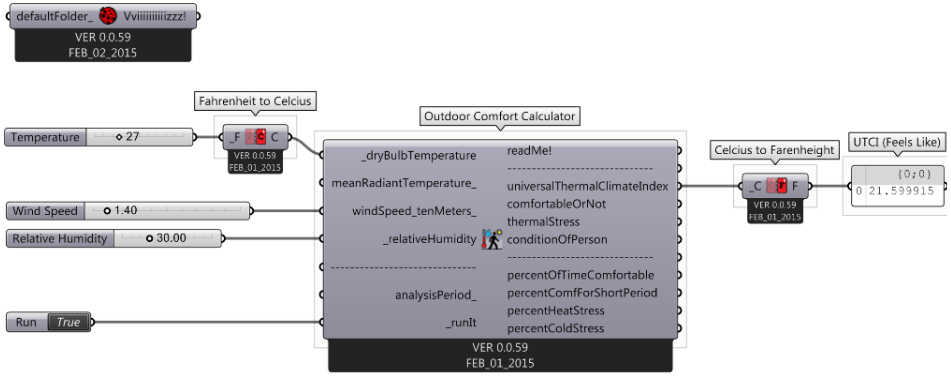
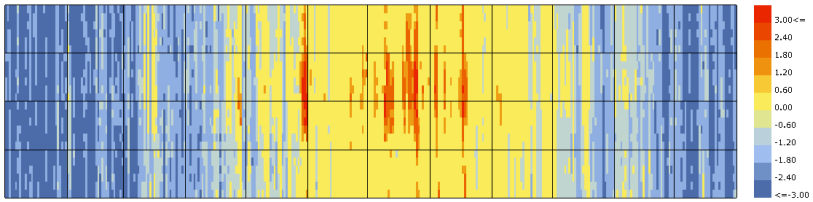
Performance-Based Urban Design Process

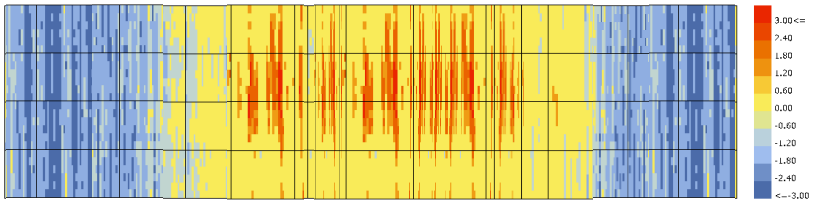
Calculating Outdoor Comfort



Mode Lab 2015



Year 2015: Outdoor Comfort NYC – January-December



Year 2050 (illustrative): Outdoor Comfort NYC – January-December

Rhino+ Grasshopper + Ladybug
Universal Thermal Climate Index (UTCI)

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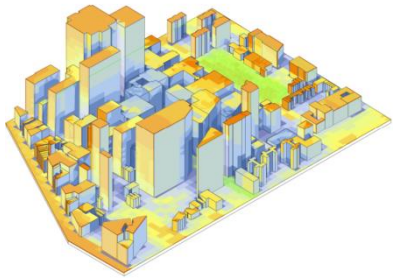
Performance-Based Urban Design Process

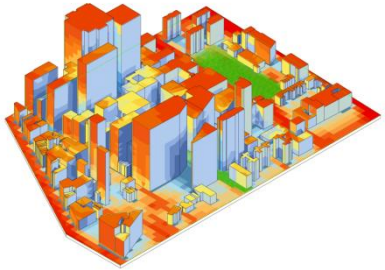
Calculating Outdoor Comfort

Existing Urban Configuration:

2015

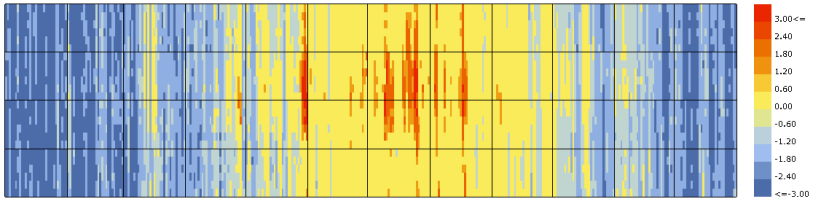


2050



Mode Lab 2015

Rhino+ Grasshopper + Ladybug
Universal Thermal Climate Index (UTCI)



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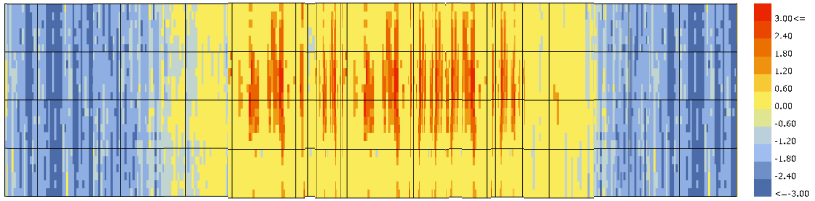

Year 2050 (illustrative): Outdoor Comfort NYC – January-December

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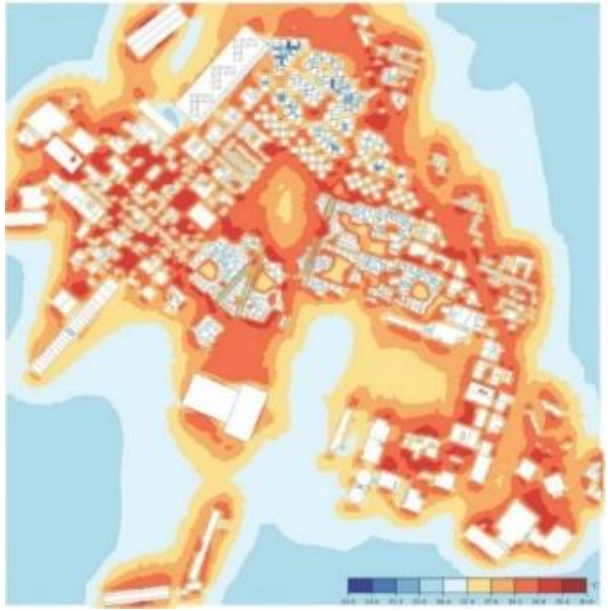

Thermal Comfort

Climate-resilient, high-density mixed use design intervention

Vegetative Coverage

Mitigating remaining hot spots with landscaping

Brooklyn
Urban Climate Lab
Graduate Program in Urban + Regional Design, NYIT
Collaboration with Klimaat Consulting

NOTE: Average or mean seasonal universal thermal climate index (UTCI) values in ˚C (due to the local combination of wind, solar, ambient temperature and humidity exposure).

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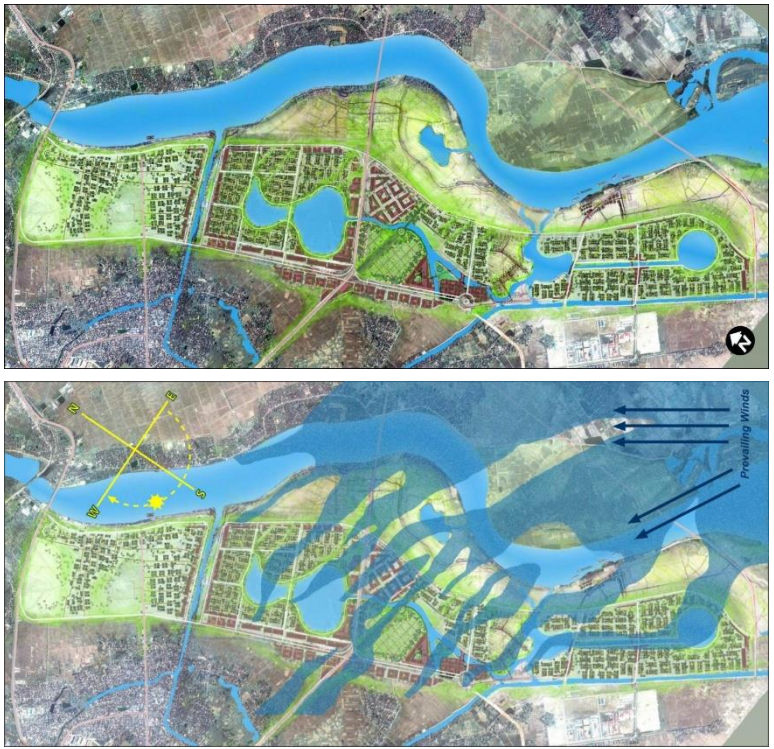
Case Study: Adaptive Mitigation in the Tropics

Thanh Hoa, Vietnam

Green and Blue "Fingers" through Compact City:

- Natural Cooling
- Stormwater Retention
- Canals and Connected Green Corridors aligned with prevailing summer breezes



Completed by Jeffrey Raven, as Director of Sustainability + Urban Design - Berger Group, 2008

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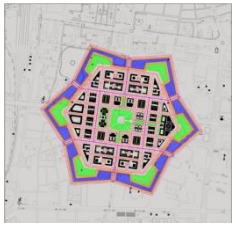
Case Study: Adaptive Mitigation in the Tropics

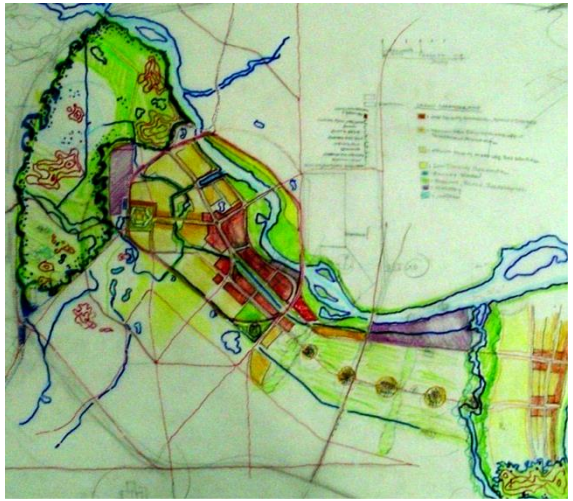
Thanh Hoa, Vietnam

Resilient Urban Design Green Infrastructure

Green and Blue "Fingers" through Compact City:

- Stormwater retention as urban design amenity
- Multi-modal transportation opportunities
- Enhanced pedestrian connectivity along canals
- Building envelopes: Passive cooling to lower energy loads





Canal Gateway, *Thanh Hoa Capital Plan*, *Raven-LBG (2008)*

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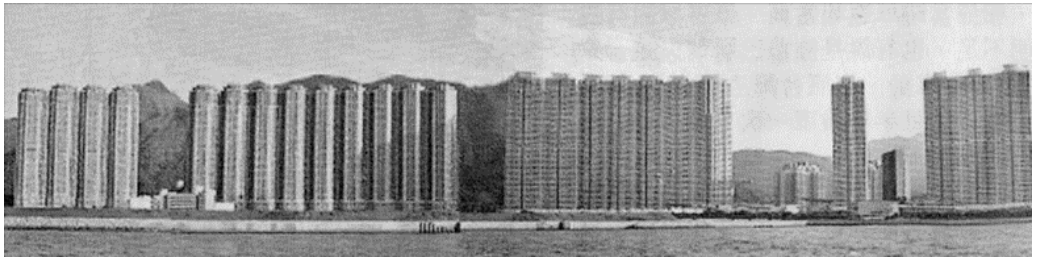
Case Study: Urban Ventilation Corridors for a High-Density City

Hong Kong, China



An example of wall building on the waterfront in Hong Kong

Hong Kong

A high density City with a population of 7.5 million living on 25 square kilometer of land.

Tall and wall-like buildings in the urban areas block the incoming wind and sea breezes.

This leads to the worsening of urban air ventilation and attenuates the city's urban heat island intensity.

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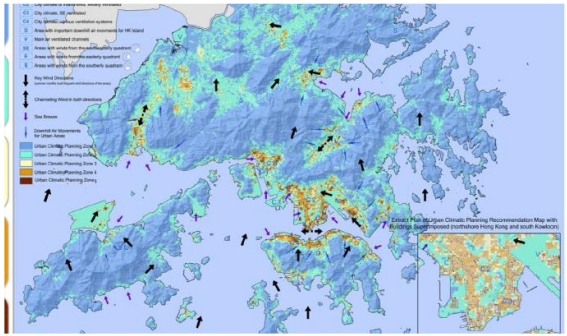
Case Study : Urban Ventilation Corridors for a High-Density City

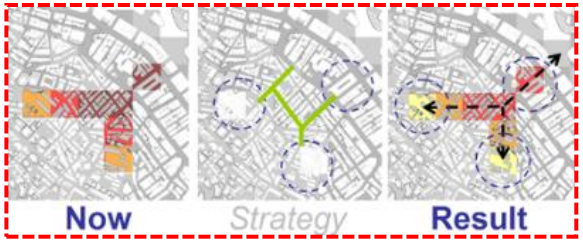
Hong Kong, China

Hot spots (red zones)

Open spaces (blue) and air paths (red lines) suggested for the area



The Urban Climatic Map classifies Hong Kong's urban and rural areas into five planning zones. The Hong Kong Government produces the Urban Climatic Map System to provide evidence-based tool for planning decision making.



A building volume density study of the area, Hong Kong- China

An example of wall building on the waterfront in Hong Kong

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Case Study: Vegetative Coverage Scenarios for UHI Mitigation

Manchester, UK

Vegetation drives urban microclimate

- **Direct shading**
- **Evapotranspiration**
- **Storing and reradiating less heat than built surfaces**

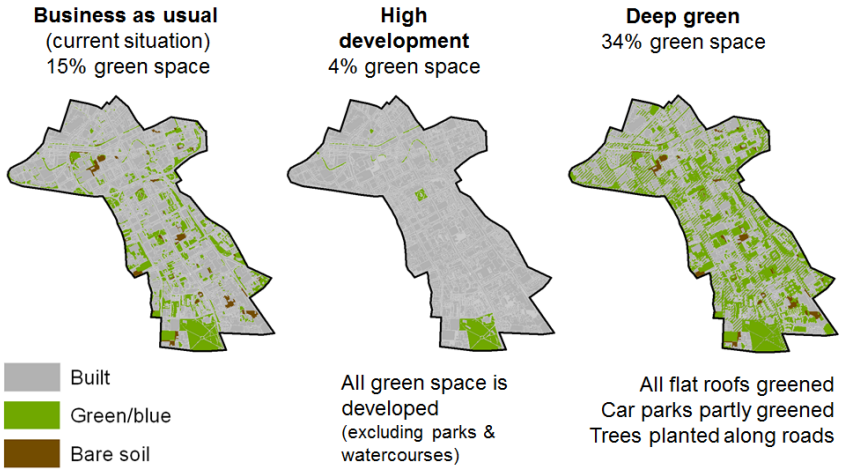
If land surface cover ratios remain the same (**Business As Usual**), climate change will increase maximum surface temperatures by 1.1-3.7° C

Under the **High Development** scenario, projected surface temperatures increase by at least 5° C.

Under the **Deep Green** Scenario results in around 6° C reduction in projected surface temperatures. Around 21% additional green space will maintain baseline 1961-1990 temperatures

Methods

Three development scenarios were proposed:



Simulated development scenarios from aerial photograph Interpretation. Base map is © Crown Copyright /database right 2015. An ordnance Survey/ EDINA supplied service.

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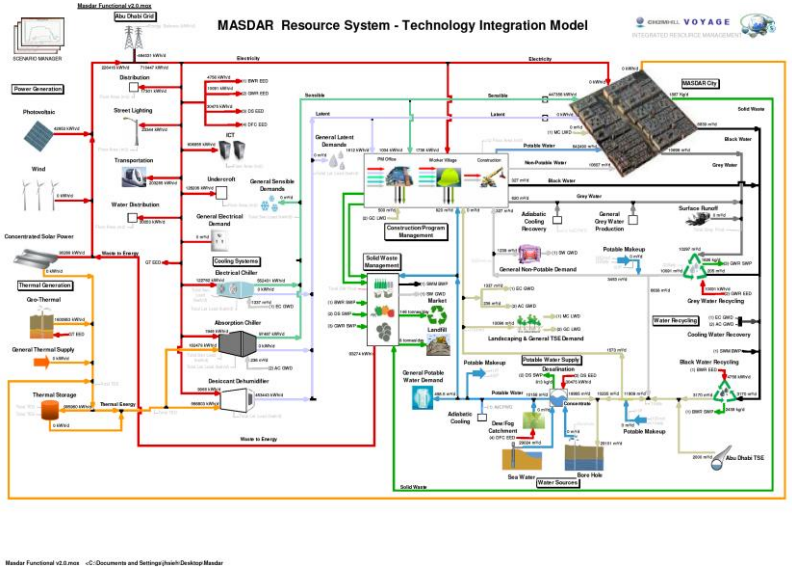
Case Study: Adaptive Mitigation in the Desert

Masdar, Abu Dhabi, UAE



Masdar, Carbon-Neutral Development Case Study: Abu Dhabi, UAE (Source: Foster + Partners)

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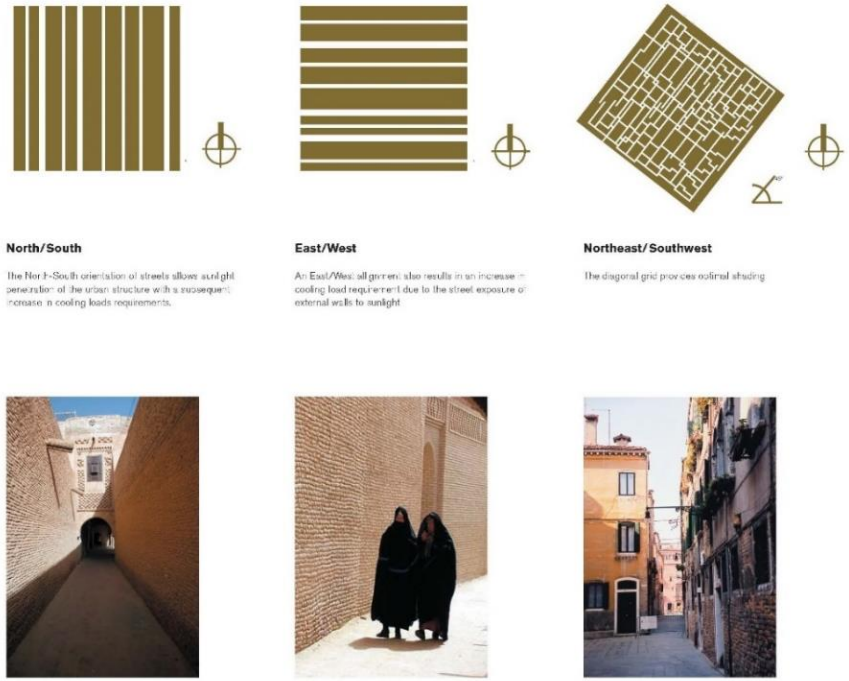

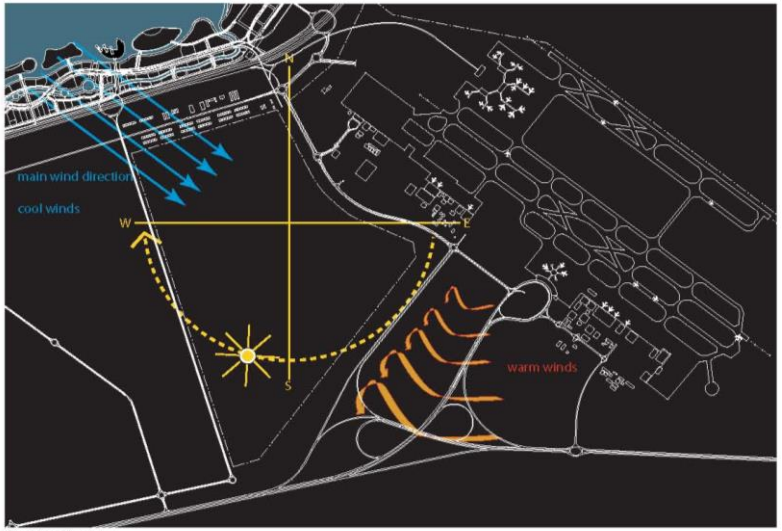

Wind Sun Direction

Source:Masdar / Fosters & Partners (2009).

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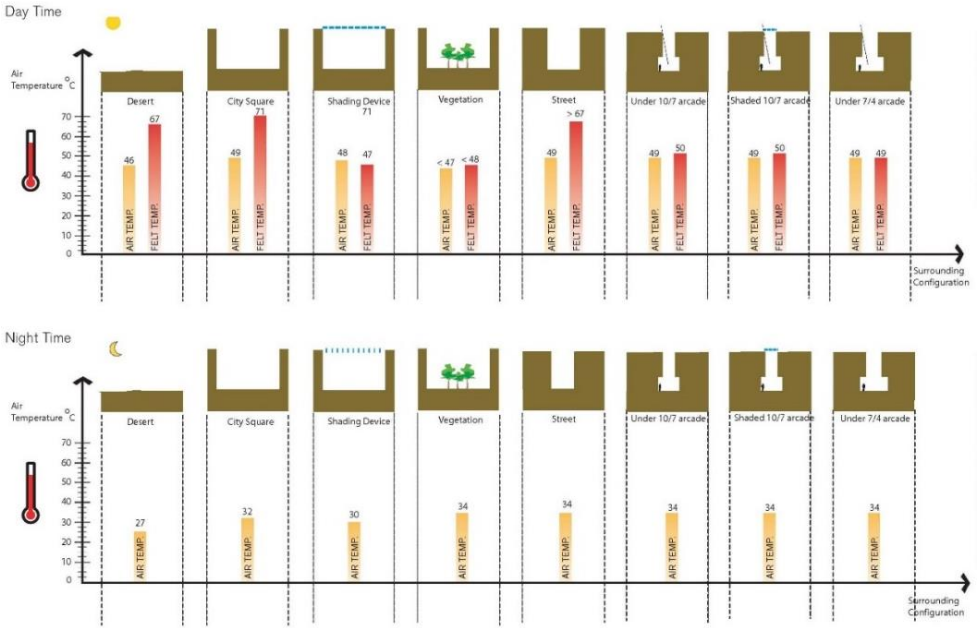

Source:Fosters & Partners

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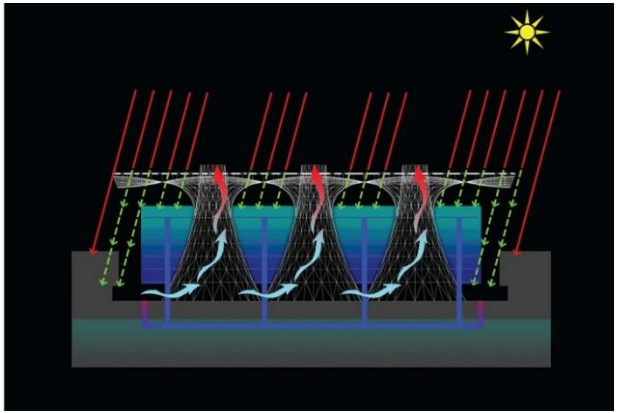
Wind Tower, Dubai



Wind Towers: Masdar Headquarters, Smith + Gill (2009).

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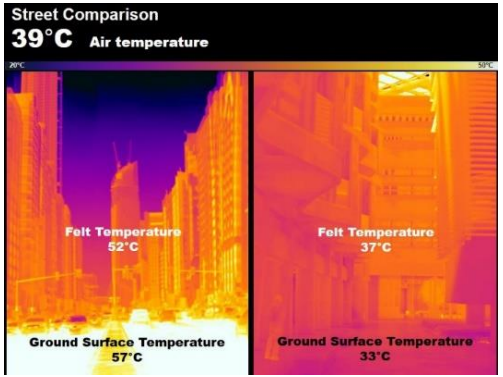
Masdar MIST: Post-Occupancy Analysis



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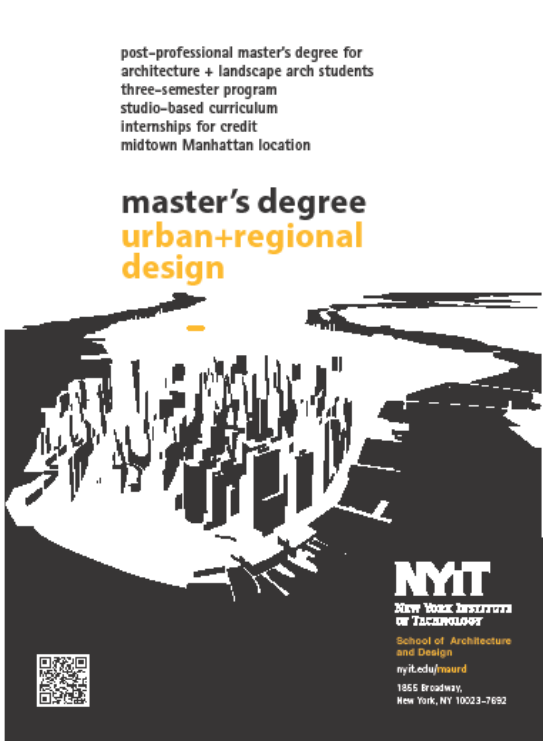
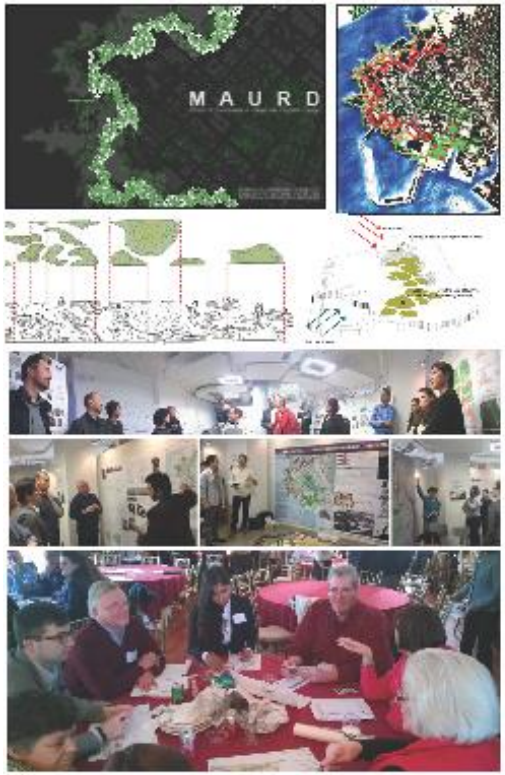
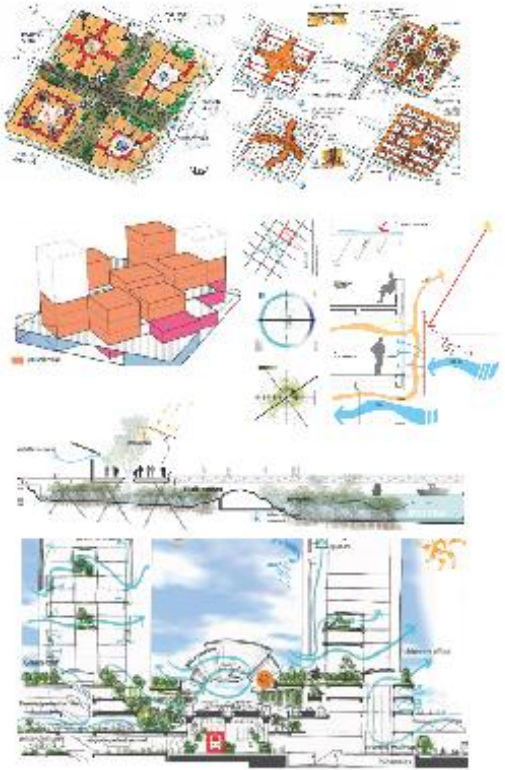
Urban Form, Low-Carbon Cities and Climate

Sustainable-Resilient Urban Design for the 21st Century







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