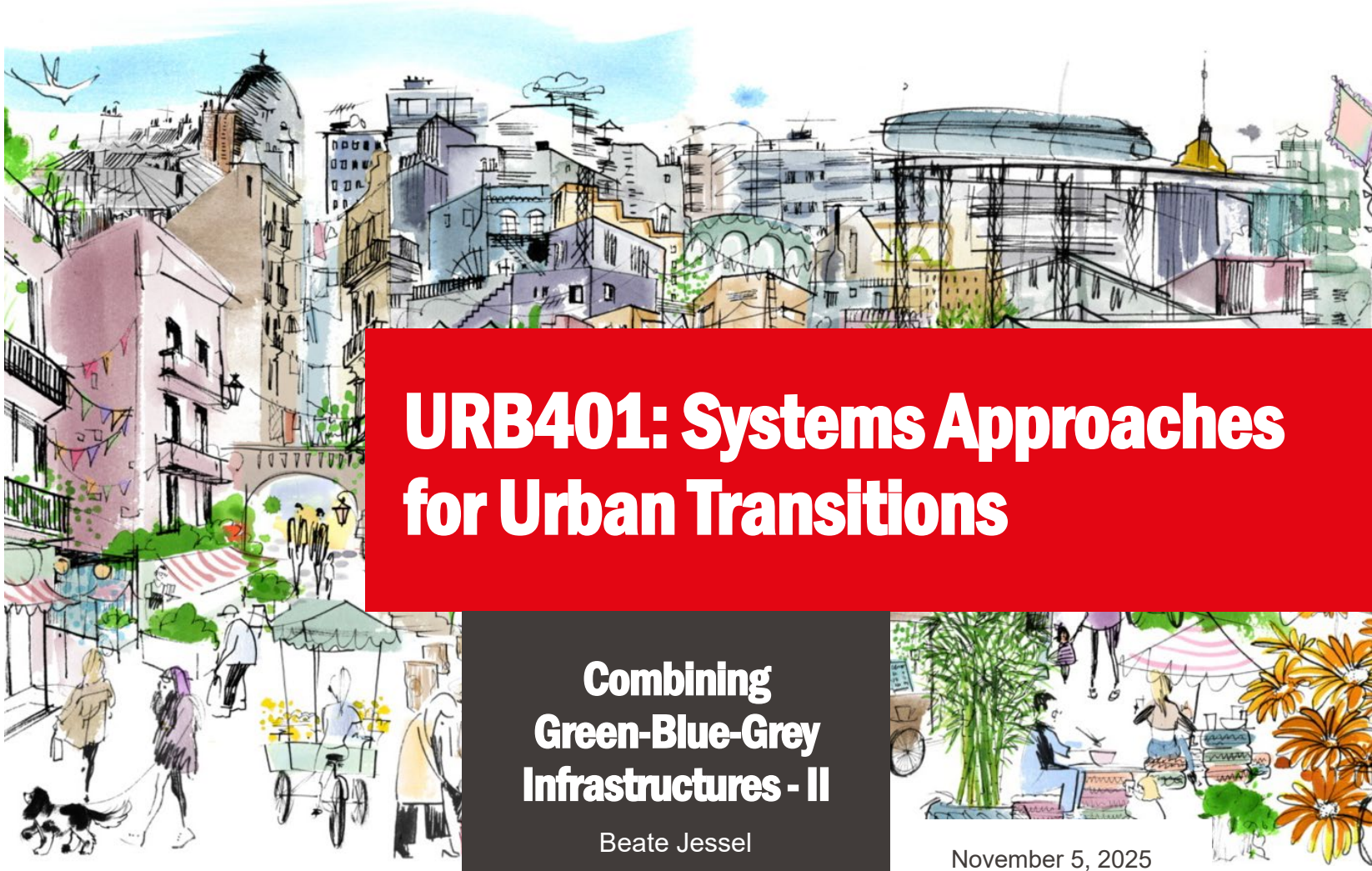

URB401: Systems Approaches for Urban Transitions

Combining Green-Blue-Grey Infrastructures - II

Beate Jessel

November 5, 2025

Courtesy of UN-Habitat and Global Utmaning

Course syllabus

Lectures 9:00-11:00
GC D0 386

Part	Week	Date	Teacher	Lecture
Part I: Urban transitions from a systems perspective	**1**	Sep 10	Hecher	Introduction to the course **Special guest:** Poetic transitions in the case of a historical architectural and urban design (Darius Karácsony)
	2	Sep 17	Hecher	Systems thinking for sustainable urban transitions
	3	Sep 24	Hecher	**Special guest:** Leverage points in the housing system (Anna Pagani)
	4	Oct 1	Binder	Transition research in urban systems
	5	Oct 8	Binder	Urban metaphors and urban metabolism
Part II: Social perspectives of urban transitions	**6**	Oct 15	Hecher	Social innovation and urban niches
	7	Oct 29	Hecher	Social acceptance in cities
Part III: Urban infrastructure and ecology in cities	**8**	Nov 5	Jessel	Multifunctional approaches through ecosystem services
	9	Nov 12	Jessel	Combining green-blue-grey infrastructures: Large-scale approaches (city level)
	10	Nov 19	Jessel	Combining green-blue-grey infrastructures: Small-scale approaches (building and neighborhood level)
Part IV: Policy and governance for urban transitions	**11**	Nov 26	Montfort	Multi-level embedding of cities: From global governance to scope for action in cities
	12	Dec 3	Montfort	Climate solutions in different types of cities
	13	Dec 10	All	**Special guest:** Urban transition processes in practice (Anton Sentic)
	14	Dec 17	All	Presentation City Lab projects

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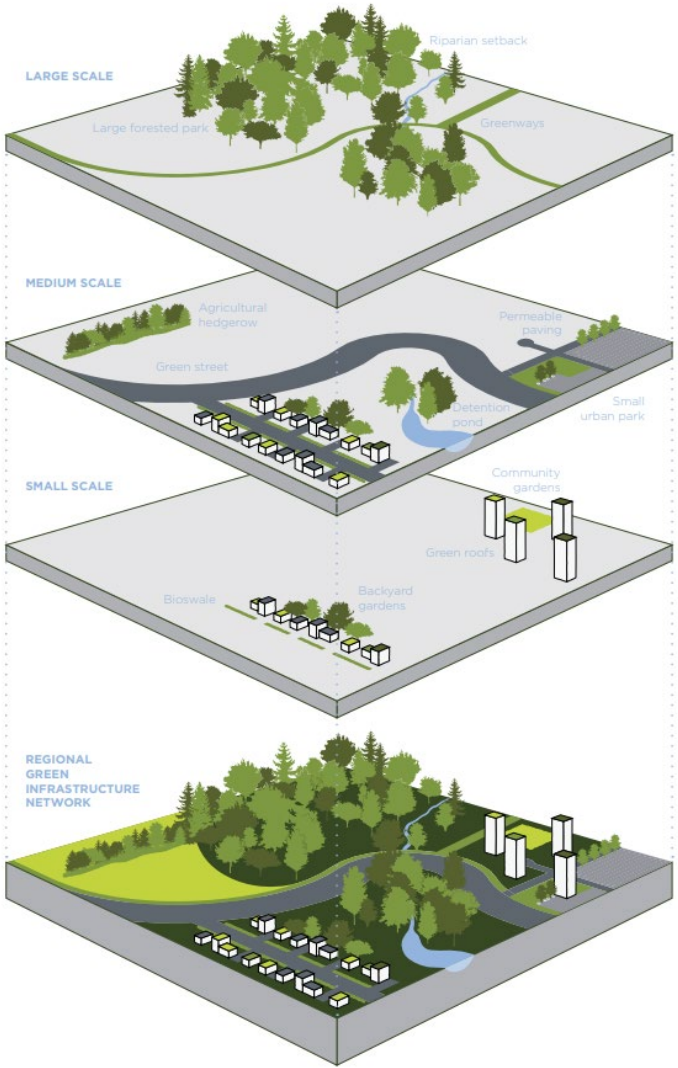
Key Questions

- How can the ecological perspective be integrated into systems approaches for urban transitions?
- Understanding the importance of green infrastructure for urban systems
- Explore the benefits of interconnected blue-green, grey and social infrastructure systems on different scales

Recap: Some Examples of Infrastructure Components

Gray (technical) infrastructure – Built and/or technical Systems
Blue – Natural or nature-based systems, that provide ecological
Green – or climate-based functions
Social – Institutions and spaces supporting community life and social services

Recap: Green infrastructure on different scales – forming networks together



Metro Vancouver
https://metrovancouver.org/services/regional-planning/Documents/connecting-the-dots.pdf

Recap: Linking blue-green, grey and social and infrastructures through integrated approaches

Green and social infrastructure, e.g.

- **Multifunctionality:** city parks, community gardens or urban squares that also serve as social infrastructure (places of learning, encounter and health)
- **Participation and governance:** citizen participation in planning and implementation strengthens social cohesion
- **Environmental justice:** planning green infrastructure can compensate for social inequalities or – in the case of unequal access – also exacerbate them ('Green Gentrification')

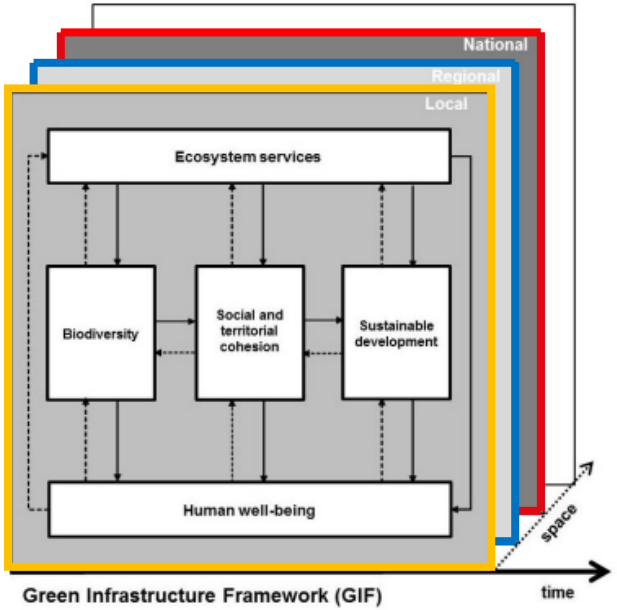
Green and technical infrastructure, e.g.

- **Blue-green systems:** Combination of green spaces with technical water management solutions (e.g. retention areas, infiltration basins)
- **Energy and transport systems:** Integration of trees to shade roads, photovoltaics in green roofs or greening of noise barriers
- **Smart City & Nature-Based Solutions:** Sensors and digital control (e.g. irrigation, heat monitoring) might combine green and technical infrastructure to create hybrid systems.

Green infrastructure is not an isolated ecological element, but an integral part of urban systems that

- ❖ provides ecological and social services,
- ❖ complements and relieves technical infrastructures
- ❖ and contributes significantly to the resilience, sustainability and quality of life of the city.

Integrated approaches to combining infrastructures – three large-scale case studies

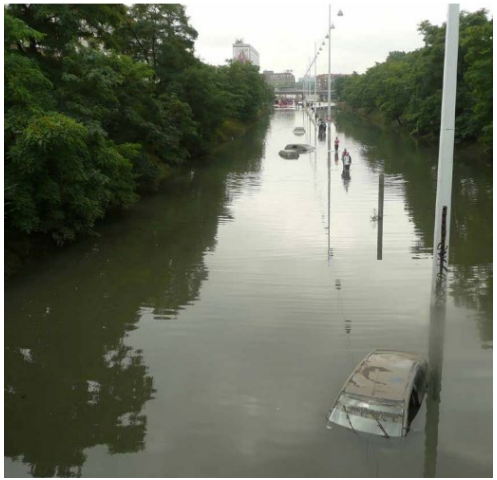


Lafortezza et al. 2013

Copenhagen, Denmark

Copenhagen Cloudburst Management Plan

THE CITY OF COPENHAGEN
CLOUDBURST MANAGEMENT PLAN 2012



On 2 July 2011, severe flooding of Copenhagen's city centre.

Heavy rainfall of more than 150 millimetres per square metre within two hours,

caused damage amounting to between €1 billion and €1.5 billion.

https://stadtundgruen.de/artikel/wolkenbruch-in-kopenhagen-17724
Photo: Lisa Risager

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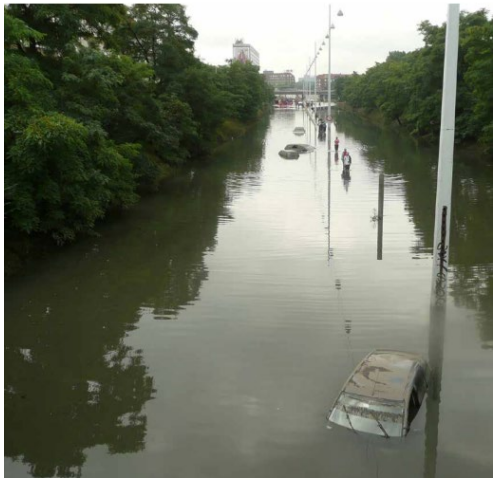
Copenhagen Cloudburst Management Plan Vision and Timeline with Key Moments

THE CITY OF COPENHAGEN
CLOUDBURST MANAGEMENT PLAN 2012



A common vision
that aligned engineers, hydraulic experts, GIS and information technologists, architects, planners, biologists, economists, communication specialists and landscape architects
with local citizens, investors and politicians

Date	Key moment
2011	The City Council approves the Copenhagen Climate Adaptation Plan.
2011	Copenhagen is hit by a cloudburst, a 1000-year storm. The city is flooded in less than two hours, causing $1 billion (US Dollars) of damage.
2012	The City Council approves the Copenhagen Cloudburst Management Plan.
2013-2014	A plan is made for each water catchment area of Copenhagen.
2015	Political decision to start the implementation of the CMP after a final list of more than 300 projects was decided and endorsed by the City Council.
2027	End of implementation under the current service level requirements. National changes require lower service level requirements, making it difficult to implement the CMP that has measures designed for higher service levels.
2035	Planned end date for implementation of the CMP.

https://climatefit-heu.eu/wp-content/uploads/2024/07/03_Cloudburst-Management-Plan.pdf

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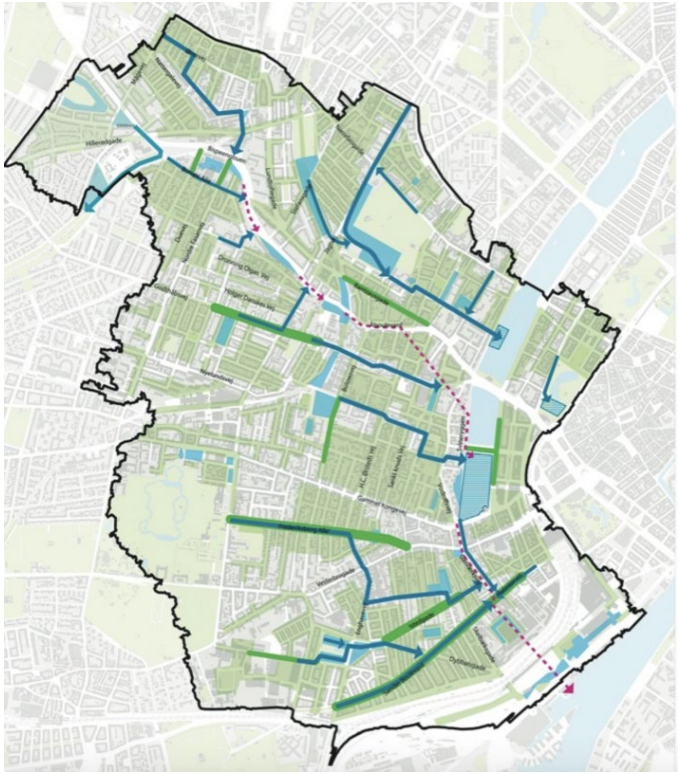
Copenhagen Cloudburst Management Plan



https://stadtundgruen.de/artikel/wolkenbruch-in-kopenhagen-17724
Rambøll/Atelier Dreiseitl

2012 Flood Master Plan,
dividing the city into 12 real rainwater catchment areas, regardless of municipal boundaries.

In the catchment areas development of measures based on integrated principles:

- **Ecological:** Rainwater management through green roofs, troughs, channels and retention areas.
- **Social:** Redesign of streets and squares into attractive recreational areas with play and sports facilities.
- **Integration:** Technical infrastructure (drainage) + social amenity value + nature experience

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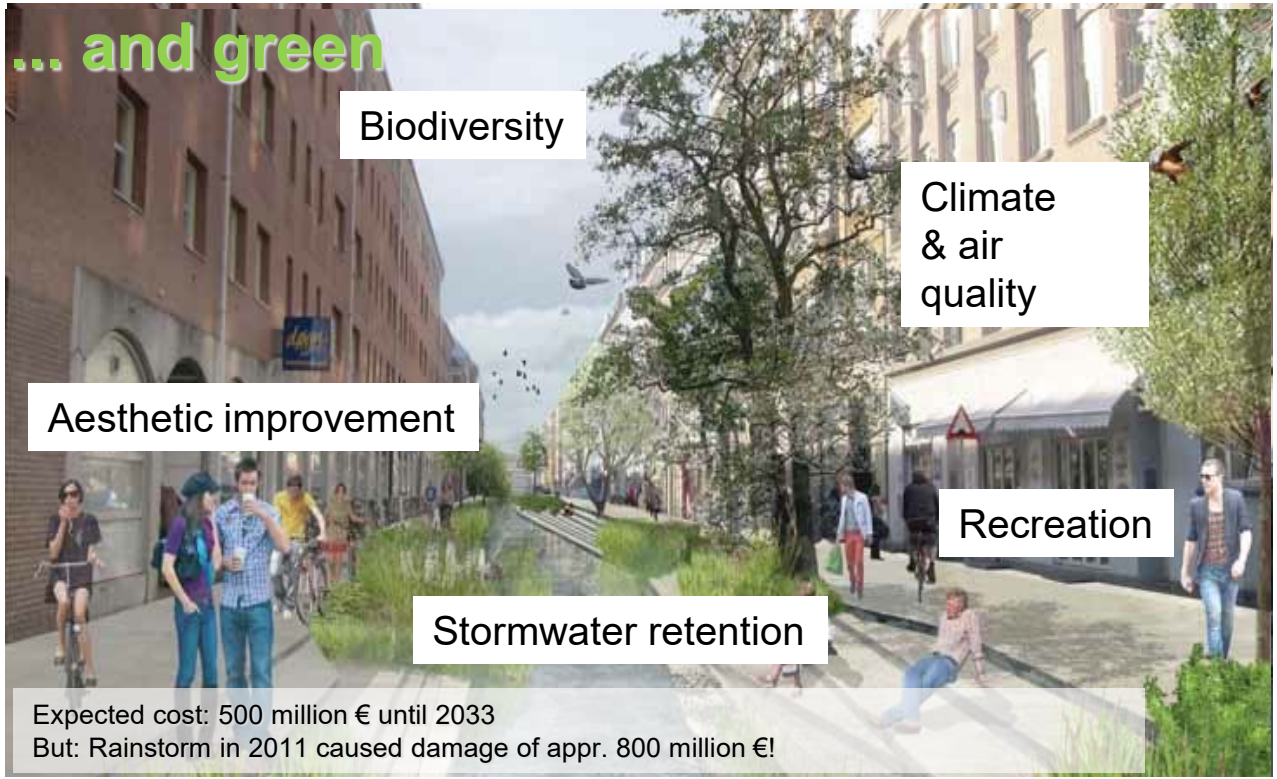
Copenhagen Cloudburst Management Plan

The concept of shared space: integration of grey ...



Københavns Kommune 2012

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Copenhagen Cloudburst Management Plan - Linking the three Infrastructure Levels

1. Grey or Technical Infrastructure

> comprises the technical, underground, and structural systems for water drainage and storage:

- Large underground tunnels and retention basins channel rainwater specifically to lakes or the sea.
- Pumping stations and sewer systems have been modernized to prevent overloading during heavy rainfall.
- These systems form the "backbone" of the cloudburst management plan and ensure operational reliability in extreme situations.

<u>Role in the overall system:</u>

> Provides hydraulic safety – it comes into play when the blue-green surface solutions reach their limits.

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Copenhagen Cloudburst Management Plan - Linking the three Infrastructure Levels

2. Blue-Green Infrastructure

> landscape architecture and ecological measures implemented at the surface level that manage water while simultaneously creating ecological and social added value:

- Parks, streets, and squares have been redesigned to form temporary retention areas during heavy rainfall (e.g., Sankt Kjelds Kvarter, Tåsinge Plads).
- Infiltration areas, green roofs, swales, channels, and biotopes retain and purify water.
- Water is made visible as a design element, enhancing the urban climate and biodiversity.

<u>Role in the overall system:</u>

> First line of defense against heavy rainfall – delays runoff, increases evaporation, and simultaneously provides recreational spaces.

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Copenhagen Cloudburst Management Plan - Linking the three Infrastructure Levels

3. Social Infrastructure

> Integrating technical flood protection with urban design and social function:

- Multifunctional open spaces: Squares, parks, and streets serve as recreational and meeting places in everyday life – and become retention basins during heavy rainfall.
- Participation and co-design: Citizens, local businesses, and initiatives were actively involved in planning and implementation.
- Improved quality of life: Projects create attractive, safe, and green urban neighborhoods with higher property values, increased biodiversity, and a better microclimate.

Role in the overall system:

> Ensures social acceptance and ensures that climate adaptation is perceived as added value – not as a limitation.

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Copenhagen Cloudburst Management Plan - Linking the three Infrastructure Levels

Infrastructure Type	Function	Connection
Grey	Technical safety, drainage in extreme events	Complements blue-green systems, absorbs excess water
Blue-Green	Retention, evaporation, cooling, biodiversity	Reduces strain on grey systems, improves quality of life
Social	Use, acceptance, co-production	Enables implementation and maintenance of solutions in the neighborhood

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Green-grey infrastructures

Roof greening & urban farming

Stormwater management

River restoration

Green cycling routes

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Copenhagen Cloudburst Management Plan

What has been achieved so far (strengths)

Systemic, visible rethinking in urban planning,

Consolidation of numerous individual projects under a common master plan

Preventive investments pay off

Testing innovative, multifunctional design concepts

What has not (yet) been achieved (weaknesses)

The system is not (yet) complete — vulnerability to extreme events remains

Financing and scaling: too reliant on public funds

Long-term maintenance/operation is challenging

Space/property conflicts and social issues

Underestimated technical complexity in integrating new solutions in old infrastructure.

Sources: Hockenos 2025; https://interlace-hub.com/cloudburst-management-plan-copenhagen

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Exemplary Approaches on a small Scale: Transforming Streets into vibrant Spaces

Transforming Streets + Neighborhoods into vibrant Spaces

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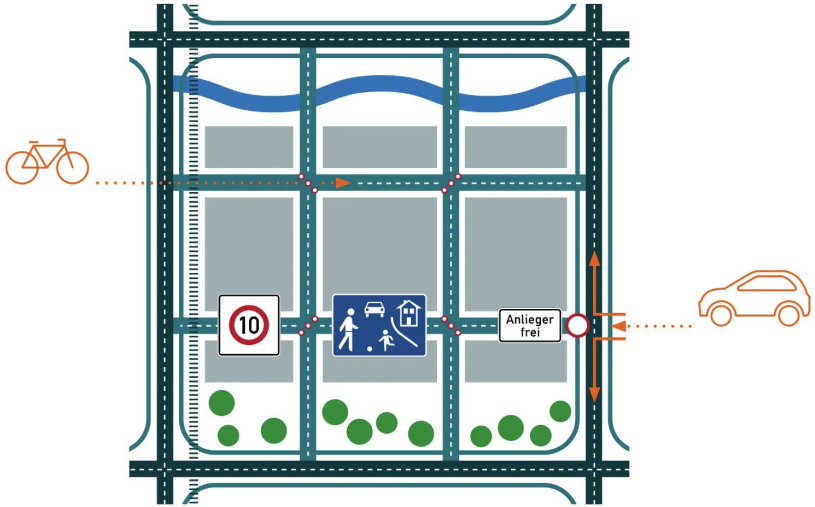
Superblocks (“Superilles” in Catalan)



Schematic representation of a superblock

https://www.kiezblocks.de/wp-content/uploads/2021/06/CC_Kiezblocks_Grafik_2021.jpg

Primarily a concept for traffic calming:

- Several apartment blocks are being combined to create a traffic-calmed zone. Through traffic will be prohibited, and traffic will instead be diverted to the surrounding streets.
- This has the effect of calming traffic and creating new places to linger and promotes further benefits such as heat reduction.
- The first superblock was implemented in 2018 by Salvador Rueda in Barcelona, and since then this concept has spread to various countries.

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Transforming Streets + Neighborhoods into vibrant Spaces

Superblocks (“Supergrätzl” in Vienna)

Superblock (Supergrätzl) Favoriten in Vienna: Yellow - traffic-calmed and greened streets within the superblock, blue - streets on the outer edges with through traffic

(all pictures: https://www.wien.gv.at/stadtplanung/supergraetzl-favoriten)

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Transforming Streets + Neighborhoods into vibrant Spaces

Superblocks (“Supergrätzl” in Vienna)

Important features of Vienna's Superblocks

Traffic calming: Through traffic is prevented by a system of one-way streets and traffic management measures and is diverted to the surrounding streets. Only local traffic is permitted.

Urban design: The newly gained space allows for wider sidewalks, narrower roadways, and the conversion of parking spaces. The freed-up space is used for more green areas, benches, play areas, and other meeting places.

Heat reduction: Increased greening and less asphalt contribute to an improved microclimate.

Learning experience: The Superblock in Favoriten serves as a test case to examine the effects of the concept and to gain insights for the entire city.

Transforming Streets + Neighborhoods into vibrant Spaces: Superblocks

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Impact of traffic calming measures in the St. Antoni superblock in Barcelona (Ajuntament de Barcelona 2023)

	2017	2019	Veränderung
Air quality (Carrer de Borrell / Carrer de Tamarit)			
• NO_2	57 µg/m³	38 µg/m³	-33 %
• PM_{10}	24 µg/m³	23 µg/m³	-4 %
Noise (Carrer de Borrell / Carrer de Tamarit)			
• Vormittag	66,6 dB	62,5 dB	-4,1 dB
• Nachmittag	65,5 dB	60,2 dB	-5,3 dB
• Nacht	61,1 dB	55,7 dB	-5,4 dB
Traffic			
• Carrer de Borrell (verkehrsberuhigte Straße)	7.216	1.266	-82 %
• Carrer de Viladomat (erste Parallelstr zur Borrell)	8.498	10.266	+21 %
• Carrer de Villarroel (zweite Parallelstr zur Borrell)	12.416	12.382	-0,3 %
Traffic in total	28.130	23.914	-15 %
Pedestrians (Carrer de Tamarit)	11.990	15.407	+28 %

Transforming Streets + Neighborhoods into vibrant Spaces: Superblocks

Potentials and application areas

Particularly well-suited for densely populated urban areas with high population density and little green space.

Traffic calming measures increase road safety and improve the quality of outdoor spaces.

Superblocks are a climate change adaptation measure.

Potential climate and health outcomes are the highest in more deprived urban area (Brenner et al. 2024)

Points of criticism

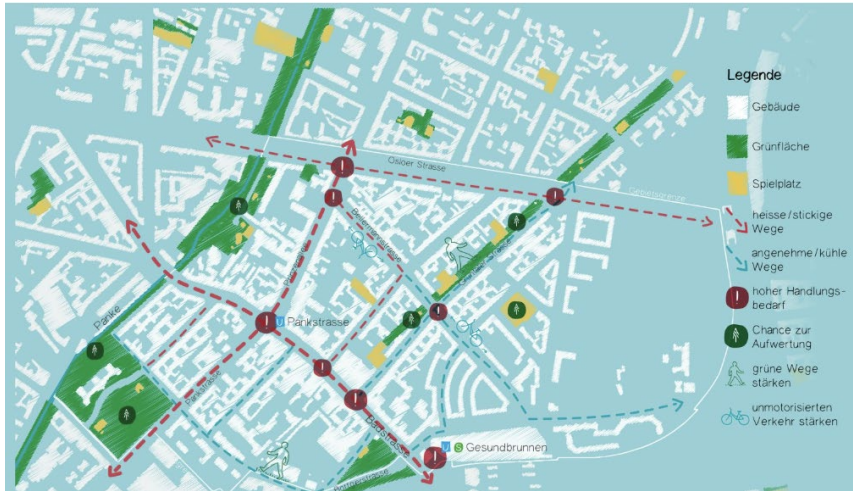
Parking shortage due to the elimination of parking spaces - residents feel restricted in their mobility and sometimes have to resort to expensive parking options outside the town.

Shifting traffic to other areas

Exacerbating inequalities in the city

Transforming Streets into vibrant Spaces ...there are still many other initiatives and activities

"Climate adaptation on the road" – Badstrassen-Kiez* Berlin



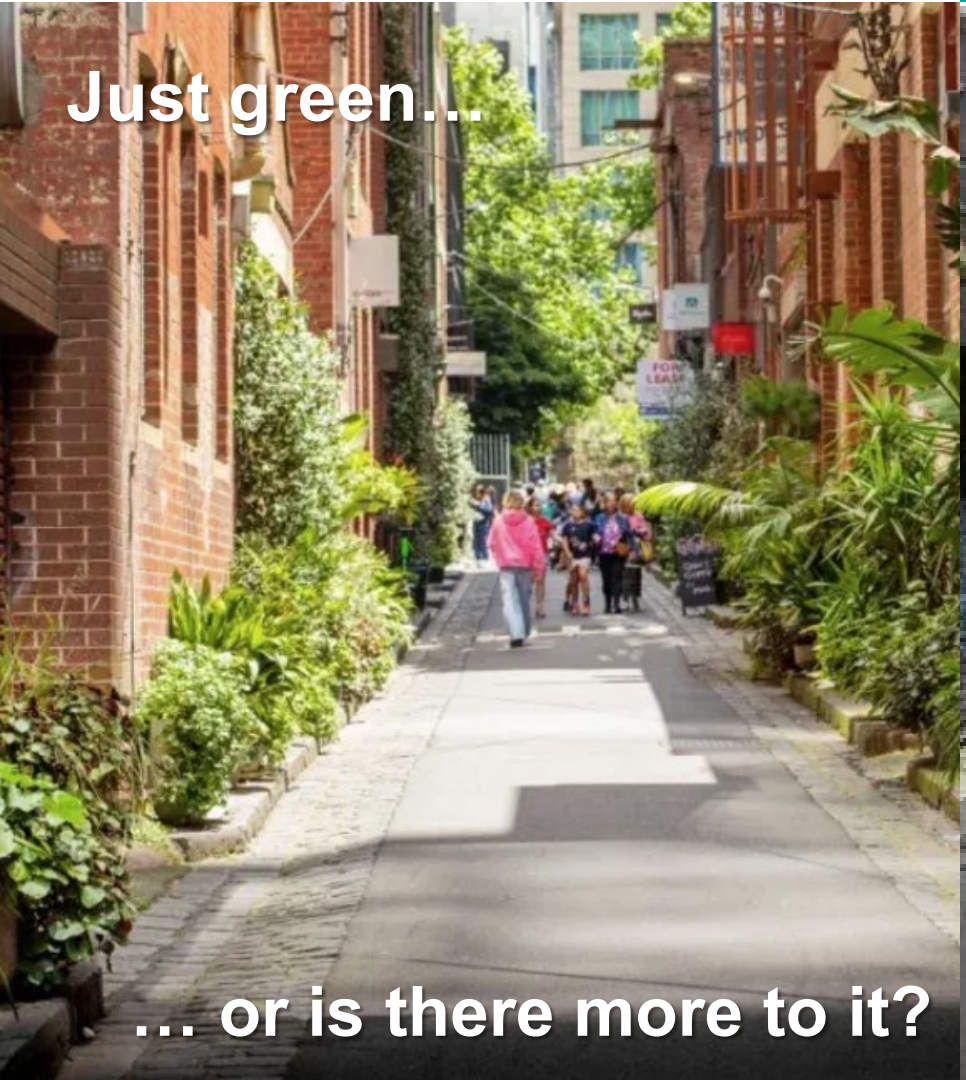
Participatory climate strategy:
In on-site and online campaigns with local residents, the potential and deficits of the neighbourhood with regard to the local urban climate are identified
...and measures are implemented together.

https://klimakiezbadstrasse.wordpress.com/

* Kiez = Neighbourhood

Transforming Streets into vibrant Spaces

The „Green Your Lane-way Project“, Melbourne

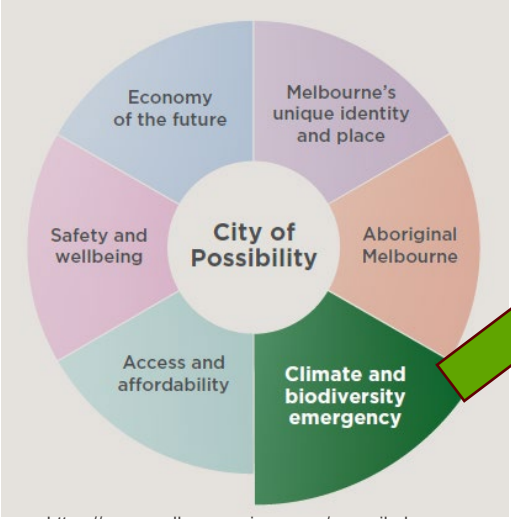

Just green…
… or is there more to it?

The "Green Your Laneway Project", Melbourne

Beeing part of a broader context (Melbourne Council Plan)

Melbourne Council Plan 2021-25

- sets the strategic direction for the city for the next four years
- based on six strategic fields + objecties



https://www.melbourne.vic.gov.au/council-plan

CLIMATE AND BIODIVERSITY EMERGENCY

Over the next four years, we will prioritise our environment and take urgent action to reduce emissions and waste in order to protect public health, strengthen the economy and create a city that mitigates and adapts to climate change. The City of Melbourne declared a climate and biodiversity emergency in 2019.

Our priorities

- City of Melbourne is a leading city globally that sets the standard in climate action.
- Lead the transition towards zero net emissions for the city.
- Eliminate waste through circular economies.
- Spaces and buildings showcase world-leading sustainable design principles to enhance liveability and lead innovative responses to climate change, including protecting communities from the impact of extreme weather events.
- Resilient and safe communities that are adapting to the public health impacts of climate change.
- Biodiversity, habitat, green spaces, water quality, and tree canopy cover are increased in the city.

How we'll measure progress

INDICATOR	TARGET OR DESIRED TREND
Municipal greenhouse gas emissions.	33% reduction (from 2015 baseline by 2025)
On-road transport emissions.	Decrease
Installed battery storage capacity in the municipality.	Increase
Household waste produced.	10% reduction (by 2025)
Municipal waste diverted from landfill.	50% increase (by 2025)
Alternative water use.	Increase
Stormwater quality.	Increase
Hospital admissions in relation to extreme weather events.	Decrease
Percentage of tree canopy cover in the public realm.	27% (by 2025)
Number of trees planted in the municipality.	2400 plus number of trees removed in previous year, or 3000, whichever is more
Area of native understorey habitat in the public realm.	Increase

The “Green Your Laneway Project”, Melbourne

Beeing part of a broader context

Other urban concepts and strategies linked to the "Green the Laneway" project include:

Urban Forest Strategy

with the goal of increasing the city's tree canopy cover by 2040

Total Watermark – City as a Catchment (Water Strategy)

Concept that views the city as a holistic watershed, with the aim to use rainwater more efficiently, minimize flooding, and reduce reliance on drinking water.

Greening the laneways often involves installing infiltration areas (bioswales) and using rainwater to irrigate the new plants.

- "Green the Laneway" is not an isolated project, but an integrated initiative that addresses several strategic fronts simultaneously to realize Melbourne's vision of a sustainable and climate-resilient city.

The "Green Your Laneway Project", Melbourne

Implementation: Different stakeholders + greening models

Three models for laneway greening….

(1) **Community driven:** City gives guidance and administrative support to help community groups create green areas in public spaces, using a permit process.

(2) **Business and community driven:** Supporting private greening projects in private spaces with co-funding by the City

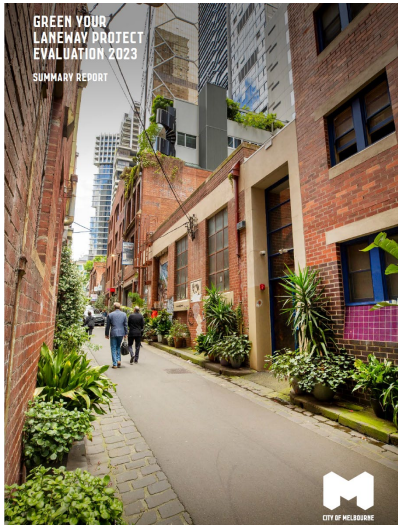
(3) **Council driven:** Public-owned greening in public spaces

…provide different ways for financing + implementation

What laneway greening is being initiated?		
	Community driven greening on council-owned or managed land such as footpaths.	The Community members will require a greening permit. Provide administrative support, guidance materials and information.
	Business driven greening on private buildings.	The community members or business might be eligible for co-funding. Provide administrative support, guidance materials and information.
	Council driven greening.	Seek opportunities to incorporate into capital works, and consult with community and stakeholders as required.

The "Green Your Laneway Project", Melbourne

After 5 years: Evaluation + Lessons learnt



Evaluation:

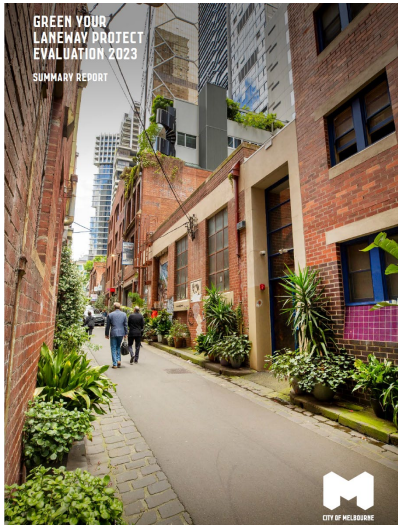
- Asking for feedback from
  > The laneway communities
  > The City of Melbourne Project Team
  > The Parks and Gardens Advisory Committee
- Carrying out a cost-effectiveness analysis of different greening approaches and ownership models

	Greening	Social	Environmental	Economic
Indicators	Tree Canopy	Public safety	Temperature	Property values
	Plant Diversity	Quality of life	Biodiversity	Employment
	Green Wall Cover	Occupancy/Activity		Business benefits
		Social values		

Selected indicators for evaluation (ISILC & CAUL, Developing indicators for assessing laneway greening)

The "Green Your Laneway Project", Melbourne

After 5 years: Evaluation + Lessons learnt



Lessons learnt:

- …. social outcomes, e.g.
  > being realistic about the time involved
  > how to promote social coherence
  > support volunteer networks
- … environmental and technical outcomes, e.g.
  > effective maintenance
  > most appropriate plant species and technical items such as watering systems
- … economic and project governance outcomes, e.g.
  > cost-intensive projects didn't always lead to long-lasting greening
  > residents often interested in taking responsibilities – better support for resident greening
  > crucial to have long-lasting agreements about ownership arrangement and funding maintenance

The "Green Your Laneway Project", Melbourne

Broad participation process

Laneway visions

Four green laneway concepts


Coromandel Place


Guildford Lane


Meyers Place


Katherine Place

https://participate.melbourne.vic.gov.au/greenlaneways/laneway-visions

The "Green Your Laneway Project", Melbourne

Broad participation process

Community consultation

What we heard	Our actions
There is strong public support for this project – we received many encouraging and positive messages and expressions of interest in more projects like this.	Strong community support has validated our significant commitment to this project and underlines how much desire there is for greening in our community.
There is a need for quality maintenance and practical design given the challenges of the urban environment.	Detailed design has proceeded in close consultation with our maintenance specialists and industrial designers to deliver robust, easy-to-maintain greening.
Heritage and smoking are common points of concern and interest for Melburnians.	Designs were passed to a heritage advisor to ensure they do not compromise heritage values. Interest in no-smoking areas was flagged to health promotion specialists, who have been focused on a campaign in universities. Traders in some lanes have indicated willingness to provide ashtrays. Clearing of butts in planters is within the scope of the maintenance contract.
Biodiversity matters to Melbournians, with many suggesting planting that creates and supports urban habitat.	Council ecologists working on our Nature in the City strategy were consulted to seek advice on planting that encourages biodiversity. This has been factored into the selection of species, although a primary focus is on choosing plants with good chances of flourishing in the challenging laneway environment.

https://participate.melbourne.vic.gov.au/greenlaneways/laneway-visions

The "Green Your Laneway Project", Melbourne

Project's biggest takeaways, according to a SWOT analysis

(provided by Sofia Di Nunzio 2025, in a student's project)

Strengths	*Weaknesses*
→ Creation of new green spaces, enhancing the aesthetic appeal of the laneways; → Mitigation of the urban heat island effect; → Increase of the urban canopy; providing shading and cooling; → Increasing foot traffic for local retailers; → Improved well-being of local communities; → Increase community engagement in governance processes;	→ Lack of maintenance and engagement by communities leads to unsuccessful projects; → Reduced environmental impact at an urban scale; → Reduced stormwater management: the adopted solutions have a limited water retention capacity;
Opportunities	*Threats*
→ Long term sustainability; → Increase biodiversity in the future; → Create new green corridors linked to other green infrastructure in the city; → Boost local social and economic activities; → Implement different greening models; → Social justice: promoting and implementing community-driven governance processes; → Strengthening communities; → Reduce vandalism; → Environmental justice - secure appropriate access to green spaces for everyone;	→ Plant pests; → Lack of adherence by communities; → Lack of funds, in the case of co-financed projects; → Vandalism;

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Exemplary Approaches on a small Scale: Greening grey Zones – Mobilising the potentials of Grey Infrastrcuture

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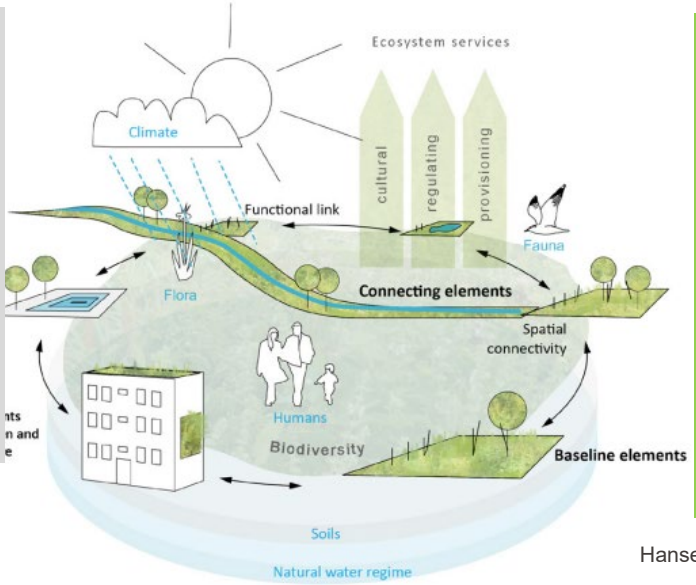
Land backdrop for an urban green infrastructure

Grey potential areas, e.g.

- Roofs and facades
- Access and open spaces of residential, commercial, social or office buildings
- Traffic areas (roads, railways)
- Schoolyards



Basic green elements

- Remnants of pristine landscapes
- traditional cultural/agrarian landscapes
- designed urban green spaces
- urban-industrial nature, novel wild urban ecosystems

Hansen et al/BFN Federal Agency for Nature Conservation, 2017

- All types of vegetated and water-imprinted areas and individual elements can be components of green infrastructure, irrespective of ownership and origin
- Forming a spatially and functionally coherent network that supports biodiversity and fosters quality of live by providing multiple ecosystem services

Mobilizing the Potentials of Grey Infrastructure

Redevelopment of commercial buildings and areas (here: Park 20/20, Hoofddorp, Netherlands)

https://sempergreenwall.com/de/neuigkeiten/gruene-gewerbegebiete-weg-mit-den-grauen-betonwuesten/


https://globalgoalsberlin.de/projekt_ggb/gruen-macht-schule

Schoolyards transformed into learning and experiential spaces (example from Berlin)

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Mobilizing the Potentials of Grey Infrastructure Hamburg's Green Roof Strategy

City-wide initiative focused on retrofitting existing buildings and requiring green roofs for new constructions to create a greener, more climate-resilient urban environment

Based on four pillars:

1. **Financial incentives** (subsidies covering up to 60% of costs for voluntary greening),
2. **Dialogue** (Awareness campaigns, stakeholder engagement + dedicated communication by the city),
3. **Regulation** (strategy is integrated into legally binding instruments; increased standards over time),
4. **Science** (Partnership with scientific institution like HafenCity University, evidence-based policy).

© J.C. Kottmeier, Imanuel Rosenberg

Green roof in Hamburg-Ottensen

https://www.hamburg.de/politik-und-verwaltung/behoerden/bukea/themen/energie/energielotsen/praxisbeispiel-gruendach-dachlounge-290840

- Since the strategy was launched in 2014, approximately 44 hectares of new green roofs have been added (reaching a total of 168 ha), with about 35% on industrial and business buildings.

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Mobilizing the Potentials of Grey Infrastructure Hamburg's Green Roof Strategy

Hamburg's vision for diverse green roofs in the St. Georg district

https://www.hamburg.com/resource/blob/1057974/a5544533af6cba7305c0d8c58946fa96/d-more-green-roofs-for-hamburg-data.pdf

How can grey infrastructure be activated for green, blue and social infrastructures?

1. Retrofitting with Green and Blue Elements

e.g. permeable surfaces: replacing traditional non-pervious asphalt and concrete with permeable pavers or porous concrete in parking lots, sidewalks, and road shoulders - allows rainwater to infiltrate the ground, reducing runoff and recharging groundwater.

Green roofs and walls: utilizing unused roof and facade space on existing buildings for vegetation

"Daylighting" streams: Restoring buried or culverted streams ("daylighting") back into open channels integrated with parklands - can provide natural floodplains, ecological corridors, and significant recreational value.

2. Optimizing Existing Systems

e.g. Smart Water Management: Using advanced technology like "smart" pumps to recirculate stored rainwater from below-ground attenuation systems for irrigation or other non-potable uses, making grey infrastructure work for green purposes.

Combining the structural support and control functions of existing grey infrastructure (e.g., pipes, levees) with the natural water regulation and absorption capabilities of blue and green infrastructure (e.g., wetlands, floodable parks) to create a more resilient, multifaceted flood management approach.

3. Fostering Social Benefits

Creating Public Spaces: Reallocating space from vehicle-centric grey infrastructure (like wide boulevards or car parks) to public "green socialstructures" such as parks, community gardens, playgrounds, and sports courts.

4. Policy and Financial Frameworks

e.g. foster policy support: Strengthening policies and regulations at the local and regional levels to mandate or incentivize the integration of nature-based solutions into urban planning and building design.

Leveraging partnerships: Building strong partnerships between engineers, urban planners, ecologists, policymakers, the private sector, and communities to ensure holistic and effective implementation.

Some Take-Aways

- Transformation takes place on both a large and small scale, meaning it also occurs through the sum of many small projects and activities.
- It is important that individual (interesting in themselves) projects do not stand alone, but are embedded in overarching concepts and contexts.
- For implementation, in addition to ecological expertise and financing, governance aspects and the connection to legal regulatory options must be considered equally.

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