



URB401: Systems Approaches for Urban Transitions

Combining
Green-Blue-Grey
Infrastructures

Beate Jessel

November 5, 2025

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



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

= *"the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions"*

Fulmer, J. (2009). "What in the world is infrastructure?". PEI Infrastructure Investor (July/August): 30–32

= *"the basic systems and services that are necessary for a country or an organization to run smoothly, for example ..."*

Definition from Oxford's Learner's Dictionary

Name some Examples of Infrastructure Components

Universities
Private Gardens
Noise barriers
Roads
Sewers
Cinemas
Forests
Schools
Parks
Coasts
Libraries
Playgrounds
Allotment Gardens
Markets
Botanical Gardens
Arable Land
Airstrips
Waterways
Theatres
Restaurants
Green Riverbanks
Rivers & Streams
Hospitals
Grassland
Railways
Internet Connection
Museums
Green Roofs
Lakes & Ponds
Street Green
Power Lines
Car Parks
Public Spaces
Cemetaries
Dams and dykes

Name 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

Green infrastructure has become a key element in European policy

EU Green Infrastructure Strategy (EU-COM 2013)

defines Green Infrastructure (GI) as:

*“a strategically planned **network of natural and semi-natural areas** with other environmental features designed and managed **to deliver a wide range of ecosystem services**. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, **GI is present in rural and urban settings.**”*



EUROPEAN
COMMISSION

Brussels, 6.5.2013
COM(2013) 249 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF THE REGIONS

Green Infrastructure (GI) — Enhancing Europe’s Natural Capital

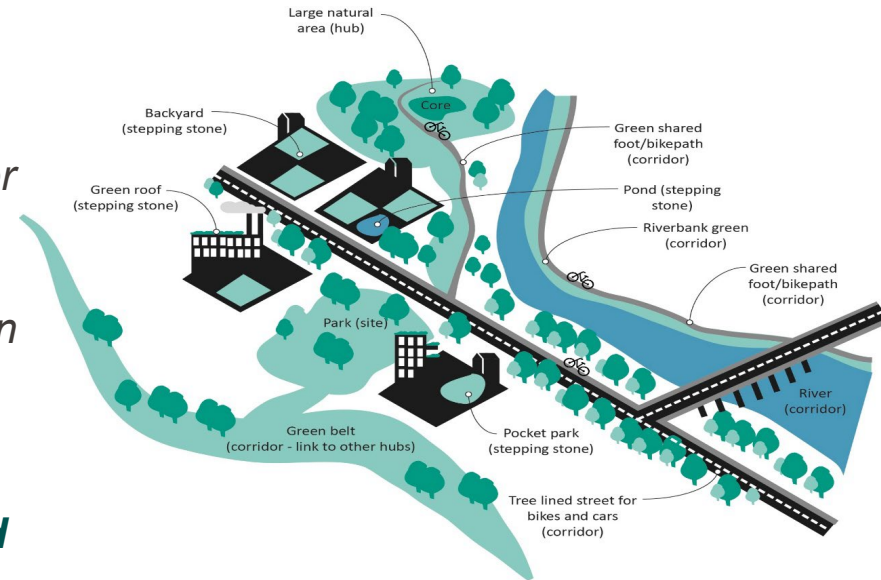
{SWD(2013) 155 final}

...and in Urban Planning

Green Infrastructure (GI) definition as:

*“a strategically planned **network of natural and semi-natural areas** with other environmental features designed and managed **to deliver a wide range of ecosystem services**. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, **GI is present in rural and urban settings.**”*

...essential to our living conditions
 ...contributing to a broad range of policy objectives, e.g. biodiversity, climate change adaptation, social cohesion, participation, green economy, human health

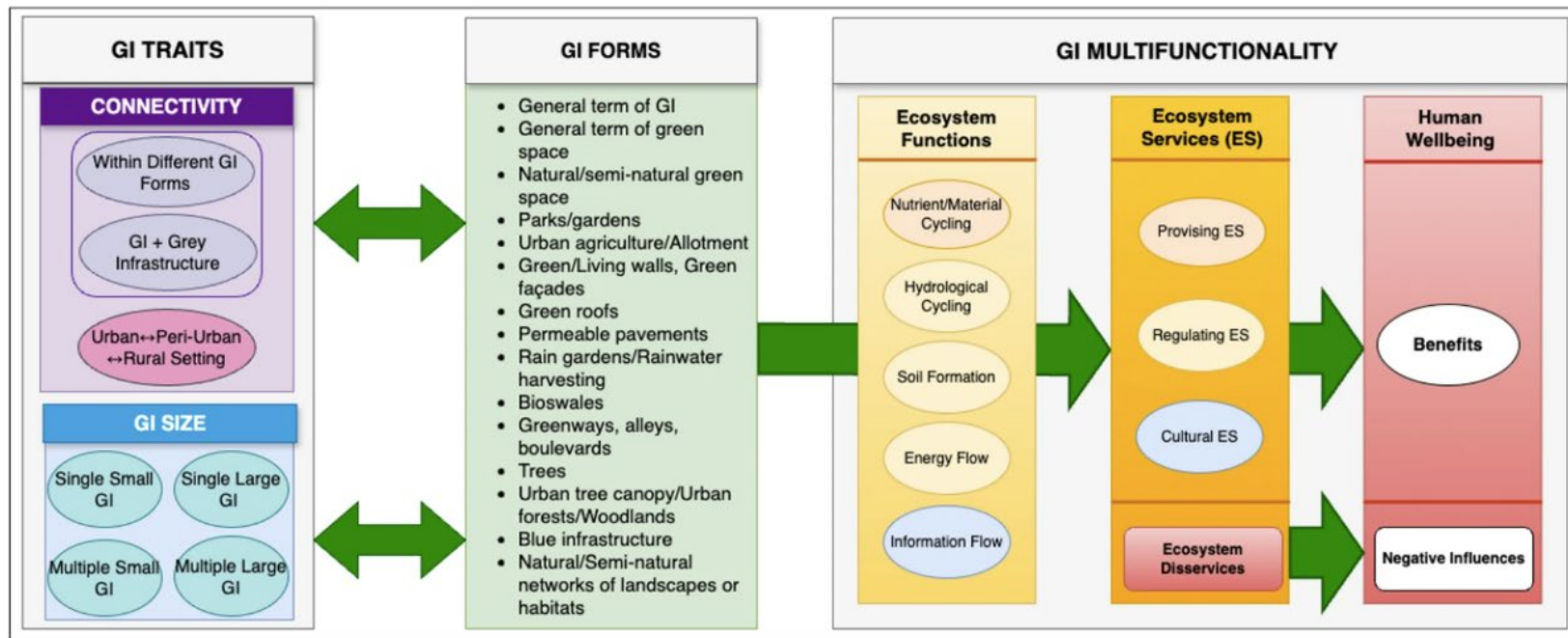


Elements to be integrated into an urban green infrastructure on different scales (Artmann, Grunewald & Bastian 2017)

Integration of Green Infrastructure into the Built Environment	Urban Green Infrastructure at Site Scale	Urban Green Infrastructure at City and District Scale	Urban Green Infrastructure at Regional and National Scale
Roadside trees and hedges	Pocket Parks	City/district parks	Regional Parks
Green buildings (e.g. green roofs and facades)	Private Gardens	Forest parks	Road and Railway networks
Green space in built-up areas	Cemeteries	Lakes	Regional greenbelts
Greenery in residential spaces	Ponds and streams	Rivers and floodplains	National Parks
Greening of social infrastructure	Small woodlands in developed areas	Major recreational spaces	Open countryside
Greening of commercial/ industrial spaces	Playgrounds	Brownfields	Long distance trails
Greenery along transport infrastructure	Sport grounds	(Former) mineral extraction areas	
Greening of water management systems	Greened city squares	Agricultural land	
De-sealing/dismantling of built infrastructure	Allotments	Viticulture	
	Vacant land		

Relationship between Urban Green Infrastructure, GI Multifunctionality and Ecosystem Services

(Li & Carter 2025)



Key principles for planning green infrastructures



Edinburgh:
Open Space Strategy

Intertwining or combining different functions to enhance the capacity of urban green space to deliver valuable goods and services.



Berlin:
Landscape Programme

Enhancing connections between different green spaces in order to increase social, ecological or abiotic connectivity. Spatial and functional connectivity both to be considered



Malmö: Open stormwater management

Considering urban green as a kind of infrastructure, integrated and coordinated with other urban infrastructures (e.g., built-up structure, transport infrastructure, water management system) in terms of physical and functional relations.



Illustration: R. Hansen



Aarhus: park redevelopment in a social housing area

Discovering and balancing the interests of different stakeholders, to increase the multiple benefits and services.

Role of green infrastructure in urban systems

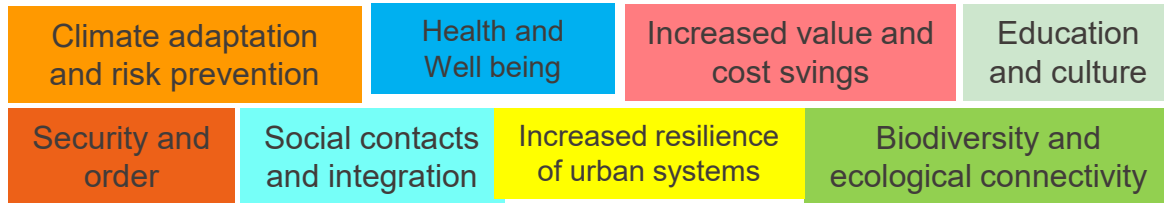
Urban Green Infrastructure shall....

...integrate different kinds of urban nature + grey potentials



Urban Green Infrastructure

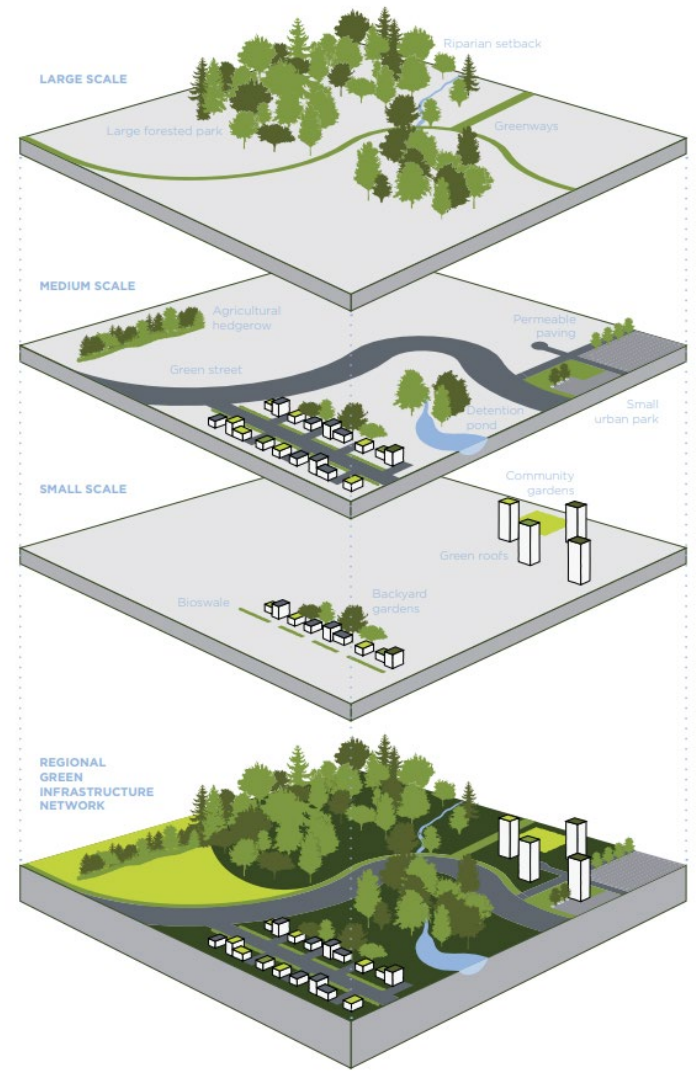
...provide multiple benefits (ecosystem services)



...involve different stakeholders



Green infrastructure on different scales – forming networks together



But also consider the role of social infrastructure

Social infrastructure refers to

..the networks of spaces, facilities, institutions and groups that support affordance for social connection in public and quasi-public spaces and facilitate a whole range of social activities in cities.

(Latham & Layton 2019, 2022)



<https://www.fes.de/artikel-in-gute-gesellschaft-17/smart-city-in-der-sozialen-stadt-menschen-in-den-mittelpunkt-stellen>

Key principles for planning social infrastructures

(Latham & Layton 2019, p. 8)

- Abundance of provision
- Diversity of infrastructures – Do they provide a broad range of activities
- Maintenance
- Accessibility
- Provision should be responsive to people's wants and needs
- Capture an ethos of democratic living



<https://www.fes.de/artikel-in-gute-gesellschaft-17/smart-city-in-der-sozialen-stadt-menschen-in-den-mittelpunkt-stellen>

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.

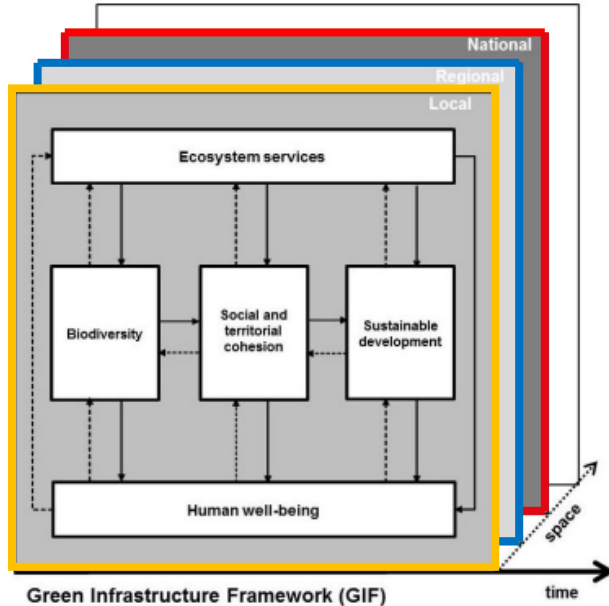
- **Blue-green systems:** Combination of green spaces with technical water management solutions (e.g. retention areas, infiltration basins)
- **Energy and transport systems:** Integration of trees to shade roads, photovoltaics in green roofs or greening of noise barriers
- **Smart City & Nature-Based 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**

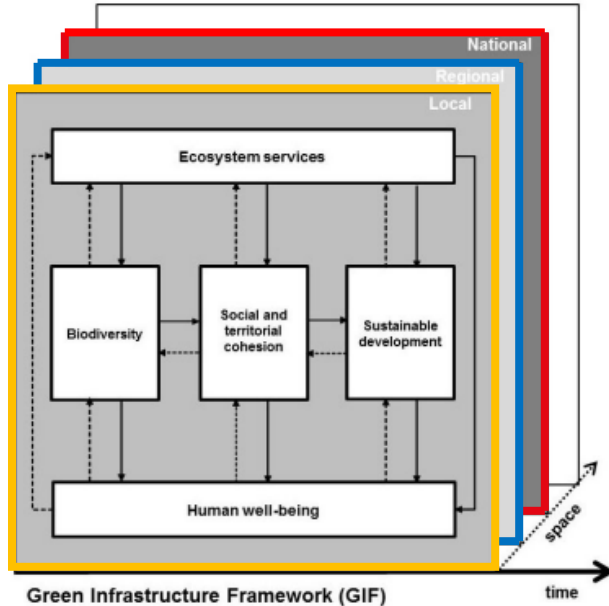
- ❖ provides ecological and social services,
- ❖ complements and relieves technical infrastructures
- ❖ and contributes significantly to the resilience, sustainability and quality of life of the city.

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

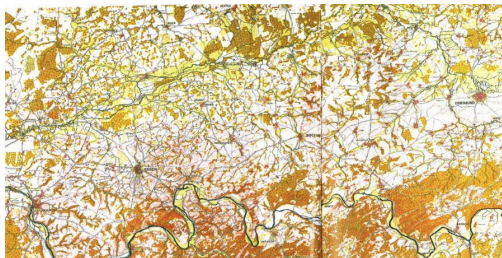


IBA Emscher Park, Germany
Singapore
Copenhagen, Denmark

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

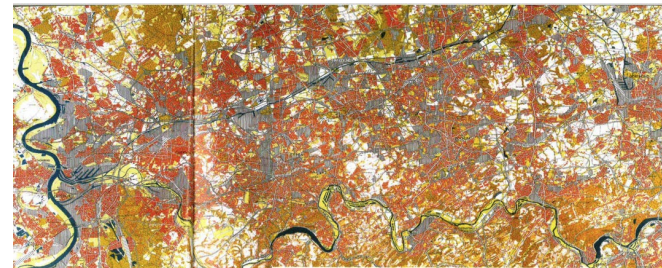


IBA Emscher Park, Germany



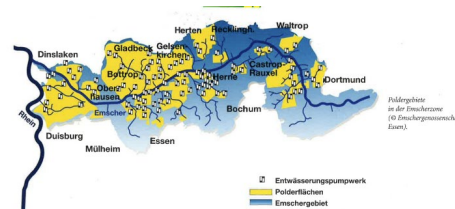
The core area of the Ruhrgebiet in 1840...

...and in 1970



Ecological situation

- As a result of the industrial and montane past, heavily populated, fragmented and industrially dominated landscape.
- Numerous damages caused by mining, e.g. contaminated soils and waters
- Subsidence due to mining requires water to be pumped out in a large part of the Ruhr region to prevent flooding
- Emscher as a canalized and heavily polluted river



Pohtergebiete
in der Emscherzone
(© EmscherGenossenschaft
Essen)

Socio-economic situation:

- Coal and steel crisis in the 1960s and 1970s (share of employees working in the secondary sector decreased from 61,3 % in 1961 to 33,3 % in 2000): Structural change and phasing out of coal mining, need for economic reorientation.
 - Declining population on the one hand with very high population density of approx. 2000 inhabitants/sq. km on the other hand.
 - Numerous closed mines and industrial sites - question of subsequent use; in the course of restructuring, numerous architectural testimonies to the old coal and steel industry threatened to disappear.
 - Poor image of the Ruhr region as a region characterized by environmental problems is an obstacle to the relocation of new companies
- Decision by the state government of North Rhine-Westphalia and the North Rhine-Westphalian Ministry of Housing, Urban Development and Transport **to support structural change by means of an international building exhibition.**



Industrialized landscape in the Ruhrgebiet at the beginning of the 20th century

IBA Emscher Park (1989 – 1999) – Key Activities

- New utilisation of industrial buildings and industrial sites
 - Creation of the Emscher Landscape Park
 - Ecological restoration of the Emscher River System
 - Development of new working conditions
 - Development of new housing forms
- Towns, companies, architects, citizens and interest groups were asked to make single project proposals that would fit into one of these central guidelines

IBA Emscher Park – Key Activities

- **New utilisation of industrial buildings and industrial sites**
- Creation of the Emscher Landscape Park
- Ecological restoration of the Emscher River System
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²²
Zollverein Coal Mine and Coking
Plant Essen

Former coal dumps as
new landmarks, example:
Rheinelbe coal dump



Gasometer Oberhausen

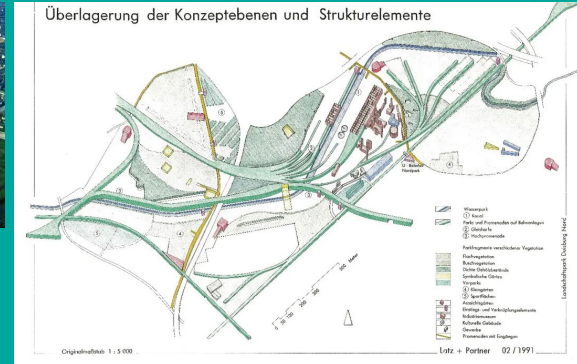
IBA Emscher Park – Central guideline principles

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Landscape Park “Duisburg Nord”



Initial situation 1988



Basic concept according to the design by Latz & Partner 1991

A new type of landscape park, created on old industrial wastelands

Industrial nature as an essential design element + element of the ecological infrastructure:

- Processual development of the park with nature and interested citizen groups
- Integration of existing elements and structures
- Elaboration of the "Genius Loci"
- Development of a new image of landscape that abandons conventional aesthetic ideals
- Park maintenance oriented to ecological aspects

IBA Emscher Park – Key Activities

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Landscape Park “Duisburg Nord” – some impressions



IBA Emscher Park – Key Activities

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No traditional park, but

- A regional network of parks, open space and paths
- Combination of industrial heritage and nature
- An unconventional, polycentric park for 5,2 Mio inhabitants
- Cooperation of 20 municipalities and 2 counties
- to create a coherent system of parks and green spaces over a linear extension of approx. 85 km and ca. 450 km² total area

The Emscher Landscape Park – an example of Green Infrastructure and one key element of the IBA

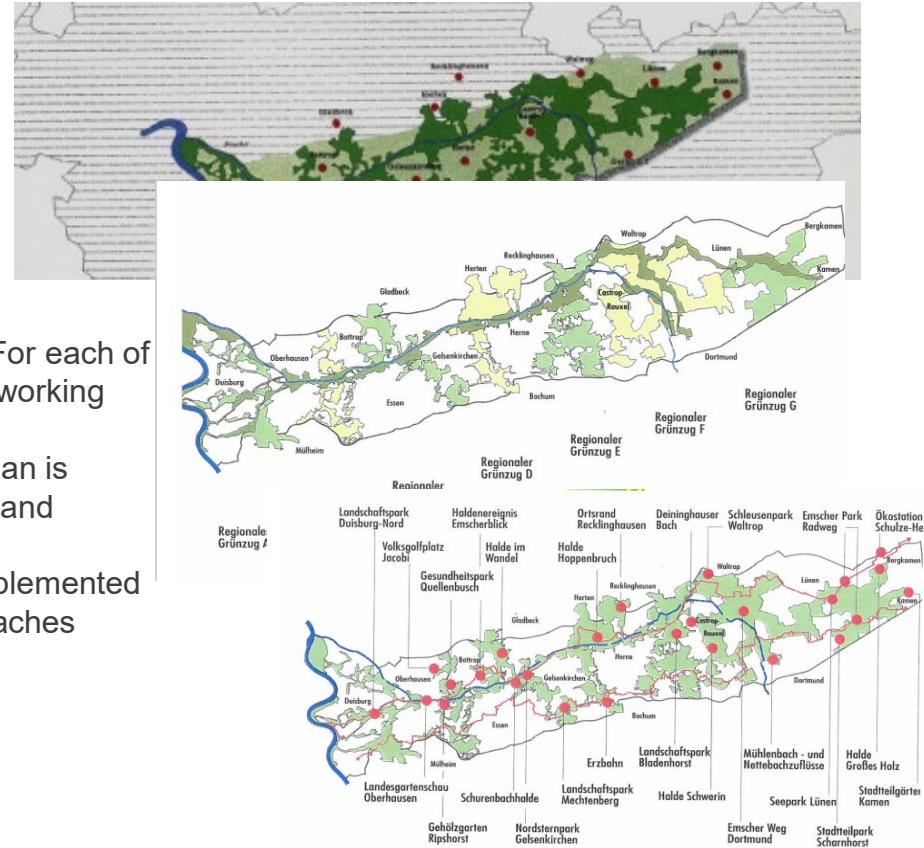
Built up of 3 layers:

I. A network of interconnected green spaces stretching for about 80 km in an east-west direction. The participating municipalities are connected by an interconnected park system.

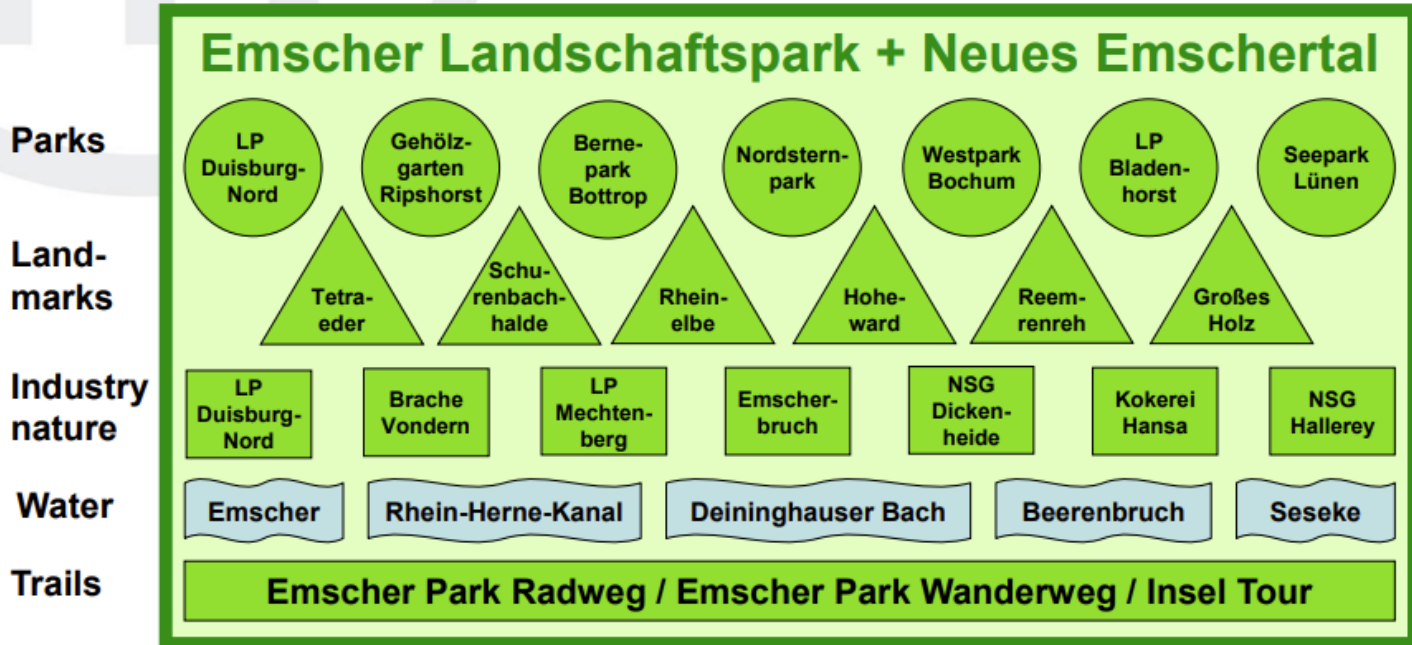
II. Seven regional green corridors as open spaces running in a north-south direction:

- Are the place for inter-municipal cooperation: For each of the green corridors there is an inter-municipal working group of the adjacent municipalities
- For each green corridor, a formal framework plan is developed from the ideas of the municipalities and stakeholders
- Individual projects are brought forward and implemented
- Bring together top-down and bottom-up approaches

III. Selected projects in the green corridors



The Emscher Landscape Park – Park elements



The scheme shows only selected elements of the park!

The Emscher Landscape Park – Main elements

Parks



Nordsternpark Gelsenkirchen, Landscape Park Duisburg-Nord

Landmarks



Schurenbachdump Essen, Dump Rheinelbe Gelsenkirchen, Tetraeder Bottrop

The Emscher Landscape Park – Main elements

Industrial Nature



Landschaftspark Duisburg-Nord, Zollverein-Park mit Rückriem-Skulptur und Gleispark Frintrop

The Emscher Landscape Park – Main elements

Water



Emscher River, Rhein-Herne-Canal und Deinighauser Stream
before and after restoration

The Emscher Landscape Park – Main elements

Leisure trails



Emscher Park bike path and bridge Ripshorst, Erzbahntrasse, Emscher Park hiking trail

IBA Emscher Park – Key Activities

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<https://climate-adapt.eea.europa.eu/en/mission/solutions/mission-stories/the-emscher-restoration-story19>

- **Transforming the Emscher from an open sewage collection channel into a predominantly near-natural, above-ground river with an ecological riverbed**
- **Building a central underground sewage system with large treatment plants and canals so that dirty water and rainwater are separated and sewage is reliably treated.**

What has been achieved by the IBA Emscher park?

Economic and governance aspects



- A lock-in situation can be overcome by the actors involved - when they are systematically encouraged (123 of about 400 projects submitted by various stakeholders were realized)
- No focus only on high-tech technologies per se (i.e. without base in the industrial past of the region). Instead, re-orientation towards technologies related to the existing industries' expertise, such as energy technology, waste disposal and other environmental technologies.
- A strategy explicitly based on “renewal from within” was successful as being combined with intense stakeholder involvement and bottom-up initiatives.
- The standard land values in the vicinity of many park sites have demonstrably and significantly increased.

What has been achieved by the IBA Emscher park?

Economic and governance aspects

Route Industriekultur per Rad



www.radrevier.ruhr

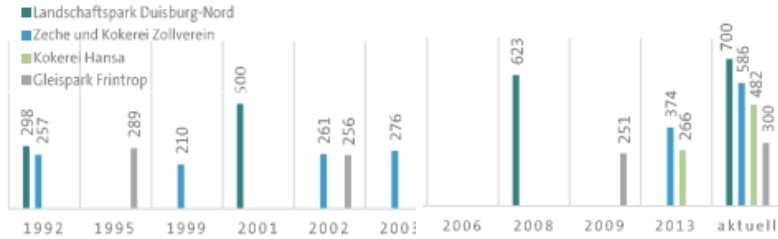


Promoting „industrial tourism“ as in former mines, cooking plants and steelworks as an innovative approach:

- The Emscher Park has 206 km of cycle paths, for which an annual tourist added value of approx. 41.5 million euros has been determined (Evaluation Report Emscher Park 2019).
- The former coal dumps and landmarks of the Emscher Landscape Park have become elementary components of the region's tourism marketing and shape the image of the region.
- New impulses for industrial and urban tourism have served as a model for other regions.

What has been achieved by the IBA Emscher park?

Ecological aspects

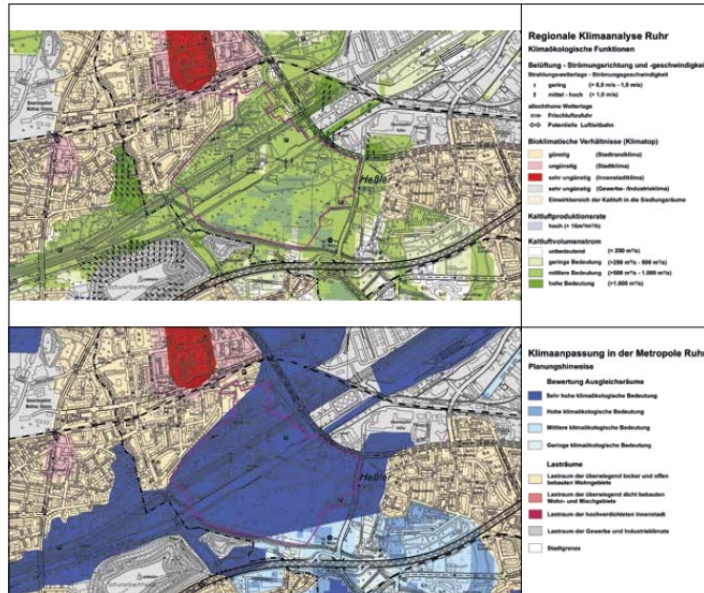


Development of the flora of some important Industrial natural areas (number of species; Evaluation Report Emscher Park 2019)

- Very high regional importance of various sites of the Landscape Park for biodiversity.
- Supported by extensive and cost-effective maintenance management (maintenance costs in Duisburg North Landscape Park about € 0.64 per sqm and year, which is significantly below the German average of € 1.19 per sqm and year; Evaluation Report Emscher Park 2019).

What has been achieved by the IBA Emscher park?

Ecological aspects



Climate-ecological function of the Duisburg North Landscape Park (above: Ventilation and cold air, below: Assessment of the climatic balancing function; Evaluation Report Emscher Park 2019)

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- Sub-areas of the IBA Emscher Landscape Park such as the Duisburg North Landscape Park or the Zollverein Coal Mine Park have a proven very high significance as climatic compensation areas.

What has been achieved by the IBA Emscher park?

Ecological aspects

Classification 1: The 4 kinds of urban nature (Kowarik 2018)



Foto: Thomas Arnett

Nature 1: Remnants of pristine landscapes



Foto: Ulrichstill

Nature 2: Patches of agrarian landscapes



Foto: Thomas Arnett

Nature 3: Designed urban greenspaces



Foto: Gabe Laddop

Nature 4: Novel wild urban ecosystems

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- Sub-areas of the IBA Emscher Landscape Park such as the Duisburg North Landscape Park or the Zollverein Coal Mine Park have a proven very high significance as climatic compensation areas.
- "Industrial nature" could be widely established as urban nature of the 4th kind and the general awareness of it could be increased.

What has been achieved so far (strengths)

Model character: The IBA is perceived worldwide as a blueprint for the transformation and redevelopment of old industrialised cities and regions.

Image change as a significant contribution to enabling people to develop a new sense of identification with their surroundings.

The focus on ecological restoration - significantly improved the quality of life and housing in the region, complemented the old industrial infrastructure by an ecological infrastructure.

Testing new approaches to planning and cooperation

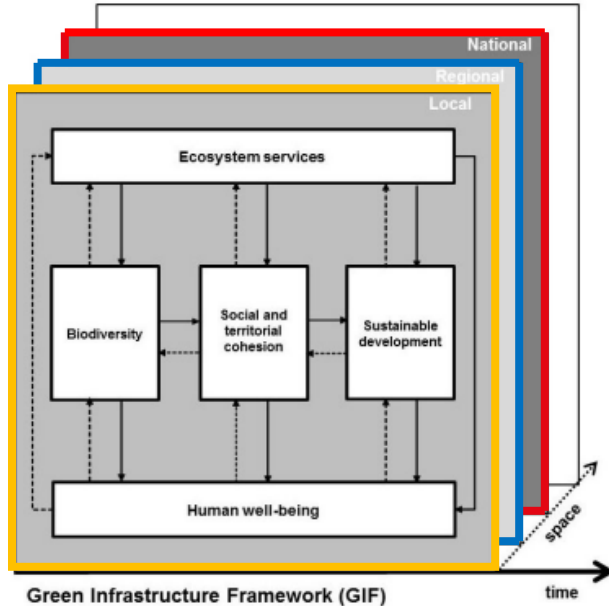
What has not been achieved (weaknesses)

Only a minor direct effect on employment or the creation of many new jobs.

Some of the new model housing estates were later rated negatively by certain target groups.

Problems remain in the Emscher region (e.g. socially disadvantaged residential areas, environmental pollution).

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



Singapore

Singapore – National Circumstances limit the Solution Space



Dense urban landscape

- » Small, low-lying, highly urbanised and dense island state
- » Accommodate housing, commercial centres, transport hubs
- » High population density of 8,000 per sq km



Over 47 % of the land covered by greenery

Limited alternative energy options

- » Less favourable climatic conditions for large scale deployment of hydro, wind and geothermal
- » Solar energy is the best option but limited by intermittency and land constraints
- » 95% electricity generated from natural gas



Export-oriented and open economy

- » Lack of natural resources and hinterland
- » Manufacturing, finance and business services are pillars of our economy

Integrated Urban Infrastructure Planning in Singapore

Levels of integration: National level

Master plan, concept plan and GreenPlan

Singapore's Urban Redevelopment Authority (URA) regularly draws up a concept plan (long-term planning over 40-50 years) and a master plan (every 5-10 years), which integrate land use, transport, water and green systems.

- These plans coordinate grey (transport, energy), blue (water), green (open space, biodiversity) and social infrastructure (housing, education, health) across the board.

GreenPlan 2030 (launched 2021) is a whole-of-nation strategy to promote Singapore's national agenda on sustainable development

Whole-of-government approach

Institutions such as the URA, National Parks Board, Public Utilities Board (PUB) and Housing & Development Board (HDB) work together, e.g. through programmes such as

- Active, Beautiful, Clean Waters (ABC Waters), led by PUB
- City in a Garden and City in Nature, led by NParks
- Sustainable Singapore Blueprint (interministerial)

Singapore – From “Garden City” to “City in Nature”

How Visions have developed to promote transition processes:

1963: A tree-planting campaign was launched to start the transformation from an industrial city to a more liveable one

1967: Garden City – Greening as Urban Branding

Vision to create „a garden city beautiful with flowers and trees“

Campaign launched with the aim of making the dusty, industrial city more liveable by planting trees along the streets and creating parks, while at the same time strengthening Singapore's international image.

1970s-1980s: Focus on planting trees long roads and later to introduce colorful flowering trees to beautify the streetscape

2000s: City in a garden - Urban integration & iconic projects

The vision evolved to integrate greenery across the entire urban area, with the goal of allowing people to move through interconnected green space

2021s: City in Nature - From greening the cityscape to functional nature

Focus on urban ecosystem services, on ‘biophilic design’ that incorporates naturalistic planting into buildings and financial incentives for skyscraper greenery.

“City in Nature” as one pillar of Singapore’s Green Plan 2030 (launched in 2021)

SG GREEN PLAN

The Singapore Green Plan 2030 is a national sustainability movement which seeks to rally bold and collective action to tackle climate change.

It is a living plan which will evolve as we work with Singaporeans and partners from all sectors to co-create solutions for sustainability. Let's work together to make Singapore a green and liveable home.

City in Nature

Green, Liveable and Sustainable Home for Singaporeans

- Develop over 130 ha of new parks, and redevelop around 170 ha of existing parks with more lush vegetation and natural landscapes by 2026
- Plant 1 million more trees, and have every household within a 10-minute walk from a park by 2030
- Add 1000ha of green spaces by 2035

Green Government

Public sector will lead by example

- Peak public sector carbon emissions around 2025, ahead of national target
- Use tools and levers, including procurement, to influence others towards sustainability practices and awareness

Sustainable Living

Strengthen Green Efforts in Schools

- Work towards two-thirds reduction of net carbon emissions from schools sector by 2030
- At least 20% of schools to be carbon neutral by 2030

Green Commutes

- 75% of all trips to be on mass public transport by 2030, up from 64% today
- Triple cycling path network to 1,320km by 2030 from 460km in 2020
- Expand rail network to 360km by early 2030s, from around 230km today

Green Citizenry:

Reduce waste and consumption

- Reduce amount of waste to landfill per capita per day by 20% by 2026, and 30% by 2030
- Reduce household water consumption to 130 litres per capita per day

Energy Reset

Cleaner-energy Vehicles

- Cease new registrations of diesel cars and taxis from 2025, and require all newly-registered cars to be of cleaner-energy models from 2030
- 7 EV-ready Towns with chargers at all HDB carparks by 2025
- Expand network of electric vehicle charging points to 60,000 by 2030

Greener Infrastructure & Buildings

- Green 80% of Singapore's buildings (by Gross Floor Area) by 2030
- 80% of new buildings (by Gross Floor Area) to be Super Low Energy from 2030
- Best-in-class green buildings to see 80% improvement in energy efficiency (over 2005 levels) by 2030

Sustainable Towns & Districts

- Reduce energy consumption in HDB towns by 15% by 2030

Green Energy

- Quadruple solar energy deployment by 2025
- Green Singapore's electricity supply by tapping on cleaner electricity imports

Green Economy

Sustainability as New Engine of Jobs and Growth

- New Enterprise Sustainability Programme to help local enterprises adopt sustainability practices
- Develop Singapore to be a carbon services hub, and a leading centre for green finance in Asia and globally by 2030
- Develop Jurong Island to be a sustainable energy and chemicals park by 2030

New Investments to be Carbon and Energy Efficient

- Seek new investments to be among the best-in-class in energy/ carbon efficiency

Resilient Future

Safeguarding our Coastlines against Rising Sea Levels

- S\$5b dedicated to coastal and drainage flood protection measures
- Formulation of coastal protection plans for City-East Coast, North-West Coast (Lim Chu Kang and Sungei Kadut) and Jurong Island by 2030

Safeguarding Food Security

- Produce 30% of our nutritional needs locally and sustainably by 2030, through developing land and sea space and skilled workers, funding support, and promoting R&D

Keeping Singapore Cool

- Moderate the rise in urban heat with cool paint and by increasing greenery

Jointly led by:

Integrated Urban Infrastructure Planning in Singapore

Levels of integration: City level

Integration of blue and green infrastructure

Watercourses (e.g. Kallang River, Bishan-Ang Mo Kio Park) are being redesigned as large-scale multifunctional open spaces:

Flood protection (blue) + biodiversity (green) + Recreation (social)

Linkage with grey infrastructure

Drainage, transport and energy systems are closely linked to green components:

- Green roofs and green facades support rainwater management.
- Transport routes integrate green axes and foot/cycle connections (Park Connectors Network)

Social integration

When planning of 'New Towns' (e.g. Punggol, Tengah), schools, health centres, parks and community facilities are systematically integrated into the urban layout.

Integrated Urban Infrastructure Planning in Singapore

Levels of integration: City level

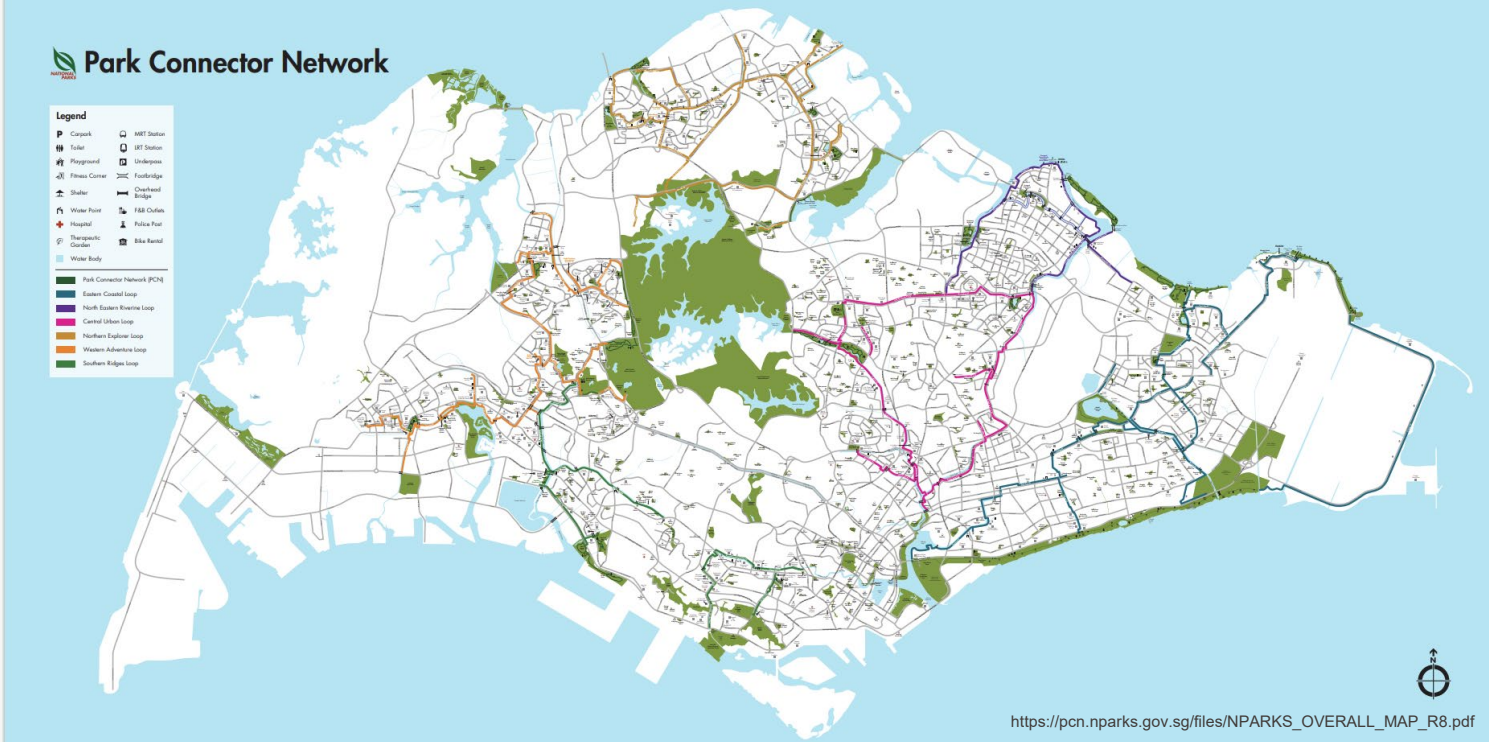
Park Connector Network



[https://pcn.nparks.gov.sg/aboutrecreationalconnectivity/#~:text=The%20Park%20Connector%20Network%20\(PCN,and%20natural%20areas%20across%2](https://pcn.nparks.gov.sg/aboutrecreationalconnectivity/#~:text=The%20Park%20Connector%20Network%20(PCN,and%20natural%20areas%20across%2)



<https://pcn.nparks.gov.sg/alexandra-queensway-pc/>



Integrated Urban Infrastructure Planning in Singapore

Levels of integration: Large-scale restoration projects



Bishan-Ang Mo Kio Park – Integration of Blue, Green and Social

Integrated Urban Infrastructure Planning in Singapore

Levels of integration: Neighbourhood and Building Level

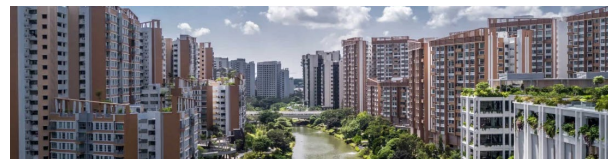
Designing housing estates as micro-systems that integrate

- Grey infrastructure (energy and wastewater systems, solar energy)
- Green infrastructure: roof gardens, community gardens
- Blue infrastructure: rainwater harvesting, permeable surfaces
- Social infrastructure: neighbourhood centres, playgrounds, senior citizens' rooms

Building level, architecture, e.g.

Kampung Admiralty: Vertical urban structure combining senior citizens' apartments, clinic, park, shopping centre and roof gardens, integration of all four infrastructures in a small space

Marina Barrage: Simultaneously flood protection (grey/blue), leisure facility (social), green space (green)



Punggol Ecotown



Kampung Admiralty



Marina Barrage

https://en.wikipedia.org/wiki/Marina_Barrage#/media/File:Marina_Barrage_Closeup_300522.jpg

Singapore's integrated Approach

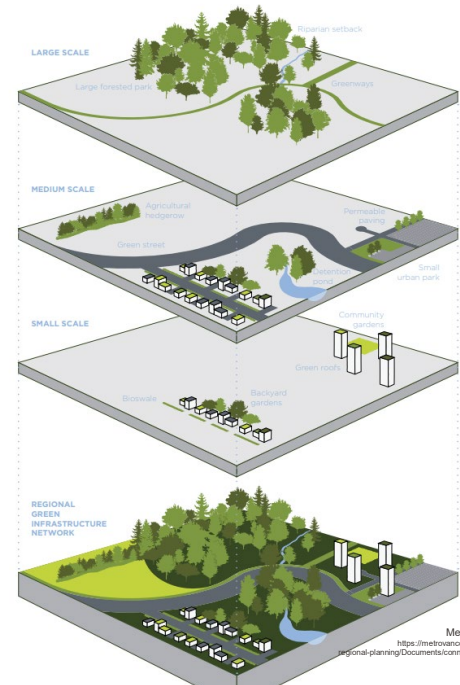
Consistent integration of the various types of infrastructure across all scales (“hybrid approach”),

Across all scales

> being embedded in planning frameworks and guidelines, and

> applying the following key principles:

1. Multifunctionality – every area serves multiple purposes
2. Synergies between ecology, technology and social issues – no sector plans in isolation
3. Data and technology-based control – Smart Nation initiative, real-time monitoring of energy, water and transport
4. Resilience and climate adaptation – particularly with regard to sea level rise and heat
5. Participation and education – community engagement is encouraged (urban gardening, Clean Waters Volunteers)



Singapore's integrated Approach

Why Singapore's approach is noteworthy

Holistic integration of blue, green, grey, and social systems

Model for climate resilience and liveability

Strong inter-agency coordination

Active integration of social dimensions

Global learning model (replicable frameworks)

Remaining challenges

Limited space and land-use trade-offs

Maintaining ecological authenticity:
Much of Singapore's infrastructure is ornamental, not fully ecologically functional

High maintenance needs + costs:
Balancing technical efficiency with natural processes can be costly and labour-intensive

Limited participatory governance:
Despite active participation, decision-making continues to be predominantly top-down.

Climate extremes may exceed current capacities

- The various types of infrastructure (grey, blue, green, social) should not be considered in isolation, but rather as an integrated whole.
- Integrating them across different scales creates numerous synergies.
- However, this requires long planning horizons.
- Although the necessary investments are considerable, they are lower than the costs that would otherwise arise in the event of damage or during transition processes, and they pay for themselves in the long term.

Some Take-Aways



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Some References

- CLC (Centre for Liveable Cities Singapore, 2025): Building Liveable Sustainable Cities. A Framework for the Future. <https://knowledgehub.clc.gov.sg/liveability-framework/overview/#9eaa70691be397614f0dda09634c6e7f>
- Hansen, R. & Pauleit, S. (2014): From Multifunctionality to Multiple Ecosystem Services? A Conceptual Framework for Multifunctionality in Green Infrastructure Planning for Urban Areas. *Ambio* 2014, 43: 516-529. <https://link.springer.com/article/10.1007/s13280-014-0510-2>
- Hansen, R.; Werner, R.; Pauleit, P.; Born, D.; Barzt, R.; Kowarik, I; Lindschulte, K.; Becker, C.W. & Schröder, A. (2017): Urban Green Infrastructure. A foundation for attractive and sustainable cities. Pointers for municipal practice. Published by Federal Agency for Nature Conservation (BfN), 32 pp. https://www.bfn.de/sites/default/files/2021-10/ugi_broschuere_eng.pdf
- Latham, A. & Layton, J. (2019): Social infrastructure and the public life of cities: Studying urban sociality and public spaces. *Geography Compass*. 2019; <https://doi.org/10.1111/gec3.12444>
- Latham, A. & Layton, J. (2022): Social Infrastructure: why it matters and how urban geographers should study it. *Urban Geography*, Vol. 43, Issue 5, 659-668. <https://doi.org/10.1080/02723638.2021.2003609>
- Li, L. & Carter, J. (2025): Exploring the relationship between urban green infrastructure connectivity, size and multifunctionality: a systematic review. *Landsc.Ecol.* (40), 3: 40-61. <https://doi.org/10.1007/s10980-025-02069-1>
- Metro Vancouver (o.J.): Connecting the Dots. Regional Green Infrastructure Network Resource Guide. <https://metrovancover.org/services/regional-planning/Documents/connecting-the-dots.pdf>
- Regionalverband Ruhr (2020): Evaluierungsbericht 2019, 120 pp. https://www.rvr.ruhr/fileadmin/user_upload/01_RVR_Home/02_Themen/Umwelt_Oekologie/Emscher_Landschaftspark/PDFs/2019_2020__Evaluierungsbericht_Emscher_Landschaftspark.pdf