



GREEN INFRASTRUCTURE

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Green Infrastructure (GI) - Concept

- Nature based solutions in addressing climate change mitigation and adaptation measures within urban environments
- **GI =**
 - Protecting, enhancing nature
 - natural processes are consciously integrated into spatial planning and territorial development(EC, 2013)
- Examples: urban forest, coastal habitat restoration, green roofs



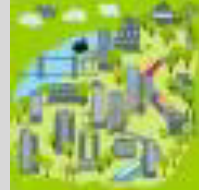
This is John Grey

Green Infrastructure (GI): Interventions and nature-based solutions



Green infrastructure

- ✓ Tree Pits/ Retention Cells
- ✓ Bioswales
- ✓ Green Roofs
- ✓ Roof Top Planters
- ✓ Green Facades and Green walls



Green city

- ✓ 'Daylighting' Rivers
- ✓ Vegetation Buffer Zones
- ✓ Urban Forest
- ✓ Urban Farming
- ✓ Mangrove and Wetland Restoration
- ✓ Riparian Buffer Zones and Ecological Parks
 - Green Park Connectivity

Source: Wilson, 2017

Tree Pits/ Retention Cells

- ✓ Single pit vs Stormwater Tree Trench System
- ✓ High degree of water take up
- ✓ Increase the capacity of water capture
- ✓ Improve the resilience of the trees
- ✓ Location: pavements or parking lots
- ✓ Systems require maintenance every 5-10 years

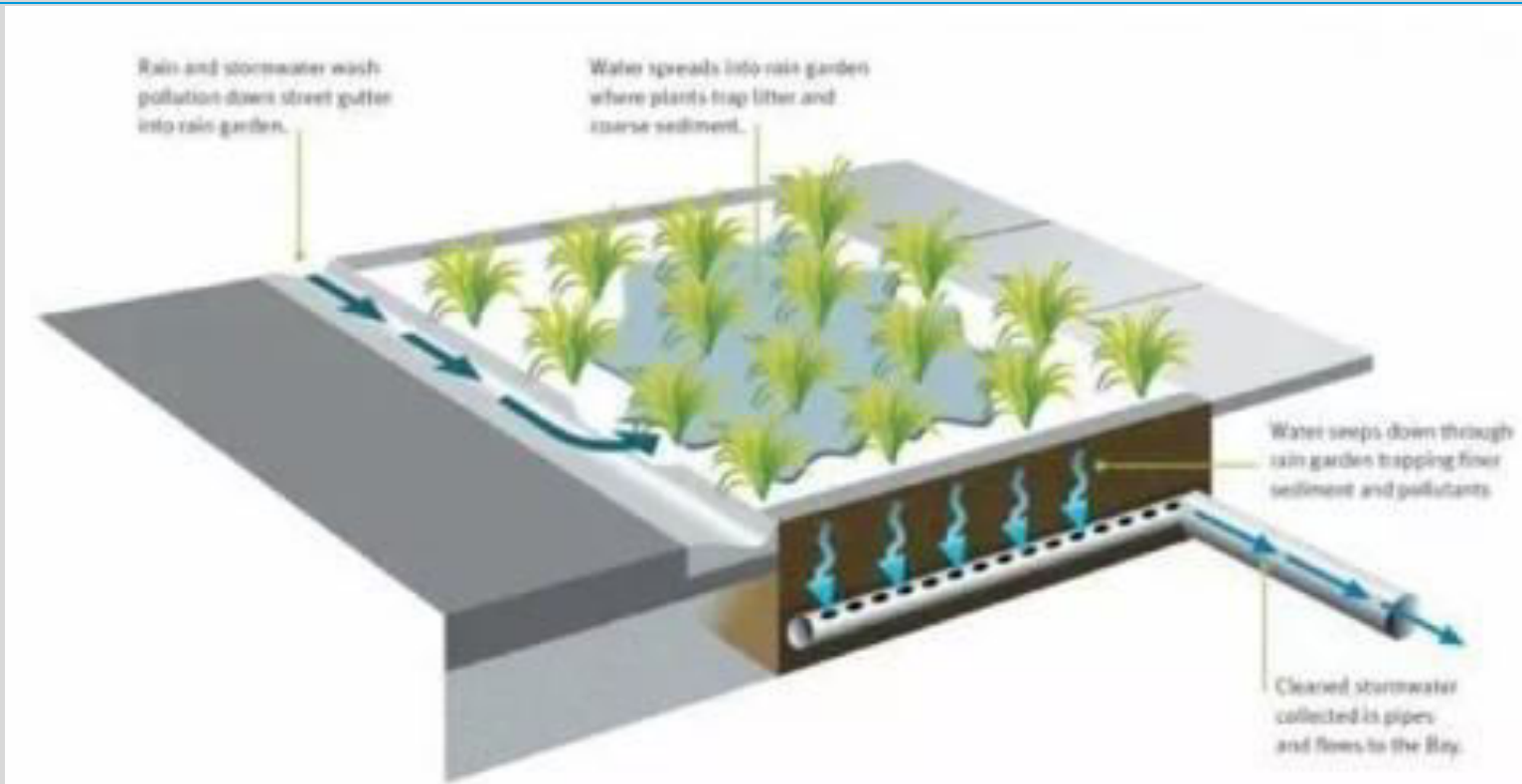
Source: Wilson, 2017



Bioswales

- ✓ Stable rainfall events
- ✓ Catches a significant amount of pollutants
- ✓ Systems require regular maintenance
- ✓ Don't look beautiful during periods of drought
- ✓ System require replace periodically

Source: Wilson, 2017



Green Roofs

- ✓ Benefits of heating and cooling requirements of building
- ✓ Reducing usage of air conditioners
- ✓ Do not require additional space
- ✓ Urbanizing cities, and locations with high land values
- ✓ Water availability
- ✓ Weight → need reinforcement

Source: Wilson, 2017



Green Roofs



1) Chongqing Taoyuanju Community Center, Chongqing, China © Sergio Grazia

2) Meydan Shopping Centre. World Architects. Photo © Cristóbal Palma



3) © Michael Moran/OTTO for Andrew Berman Architect



Roof Top Planters

- ✓ Planter boxes, contained gardens
- ✓ Suitable for flat roof houses
- ✓ Improved air quality, reducing energy demand
- ✓ Less costly
- ✓ Rental buildings
- ✓ Self-produced food and promote biodiversity
- ✓ Need reinforcement

Source: Wilson, 2017



Green Facades and Green walls

- ✓ Office, commercial and apartment buildings
- ✓ Aesthetic values
- ✓ Solar radiation absorbed by construction materials
- ✓ Cooling costs
- ✓ Require readily available water
- ✓ Public awareness and contact with nature

Source: Wilson, 2017



Green Facades and Green walls



‘Daylighting’ Rivers

- ✓ The process of removing obstructions (such as concrete or pavement) which are covering a river, creek, or drainage way and restoring them to their previous condition.
 - ✓ Increasing storage capacity/flood management
 - ✓ Reduce downstream/localized flooding
 - ✓ Require space, financial/labor intensive
 - ✓ Co-benefits (property value, pollution control, landscape, wildlife)
 - ✓ Require high maintenance
- Source: Naturally Resilience Community, 2017



Vegetation Buffer Zones

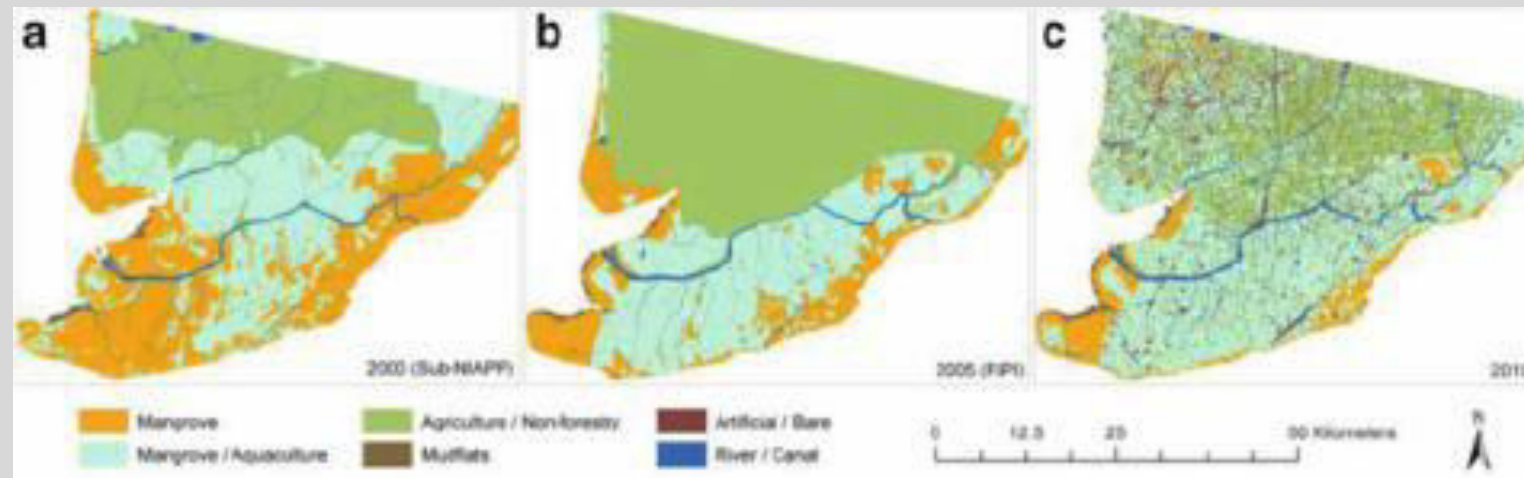
- ✓ Reduced impacts from dust storms, flash flooding
- ✓ Increased biodiversity
- ✓ Slowing down water movement, wind barrier
- ✓ Creating habitat, improving cooling and air quality
- ✓ Selection of species is crucial





Mangrove – wetland restoration

- Significant factor in adapting to climate change, through mitigating the effects of storm surges, sea level rises and salt water intrusion
- Strong relationships between coverage & density and reduction in property damage (Barbier et al 2013)
- High carbon storage ecosystem
- Biodiversity and livelihoods support
- Recreational purpose
- Etc.



Urban Forest - Urban Farming

Biodiversity

**Recreational
area**

Air quality

Carbon sink

**Climate
regulation**



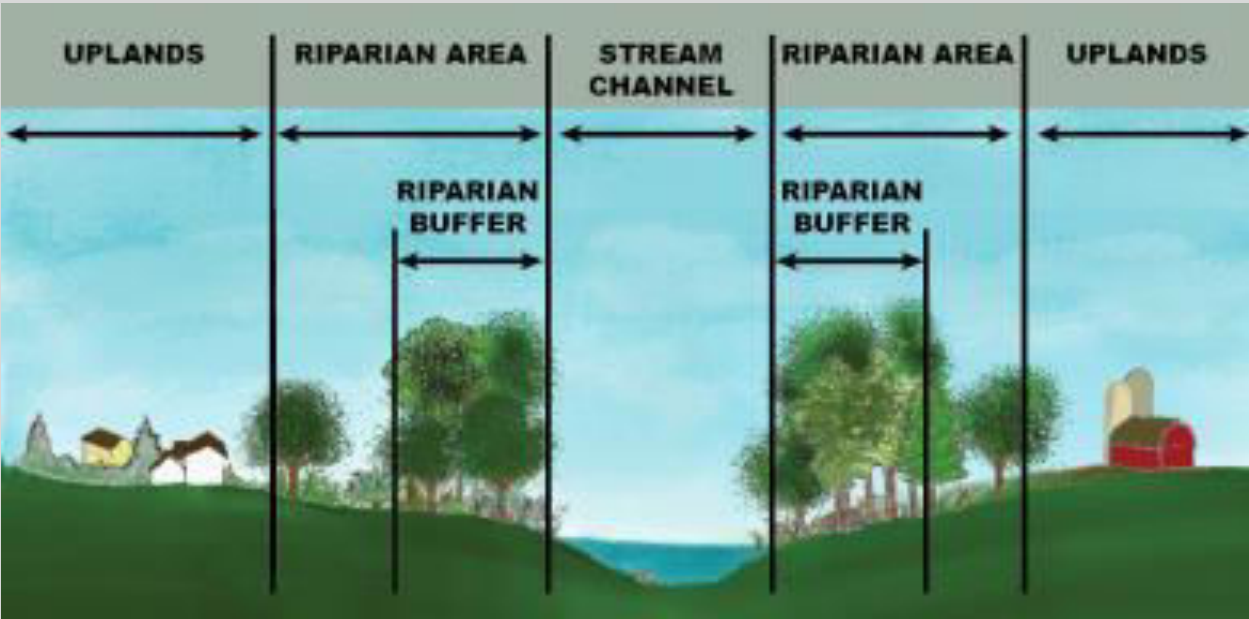
**Healthy
community**

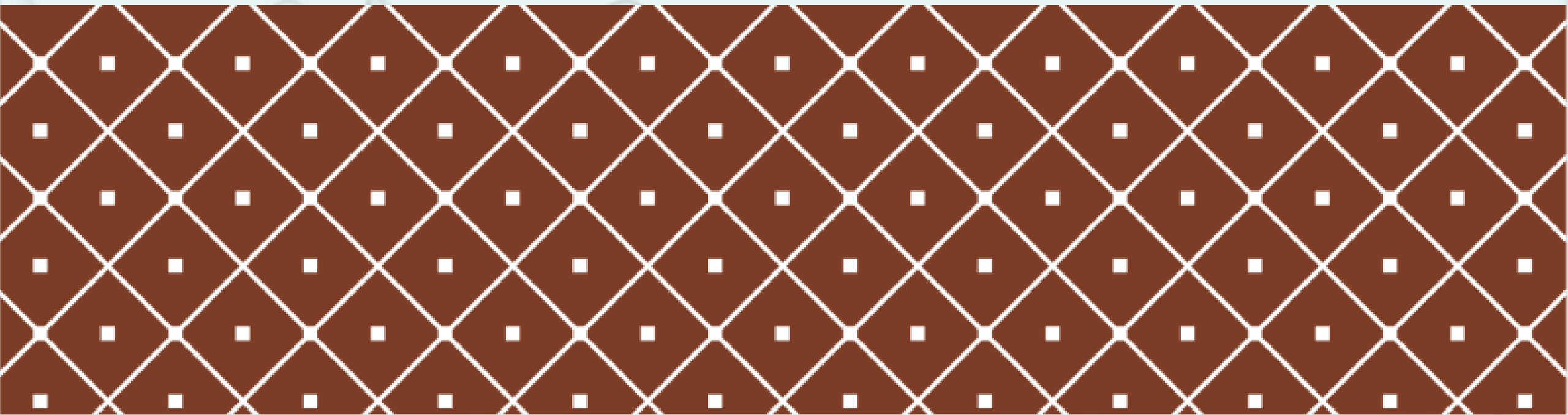
**Spatial
planning**

**Choice of
species**

**City
resilience**

Riparian Buffer Zones, Ecological Parks and Green Park Connectivity

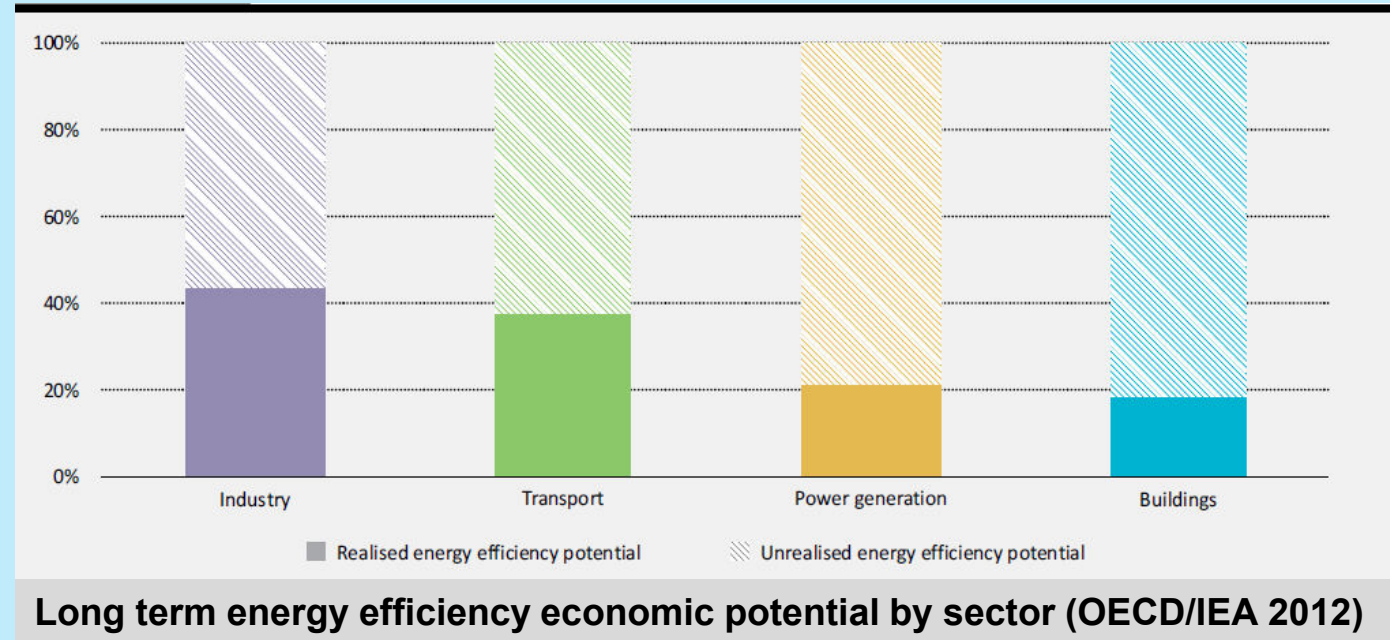




RESOURCE AND ENERGY EFFICIENCY

Actions taken at different levels of government with the aim of achieving resource and energy efficiency

- Defining a **long-term vision** and strategy
- Providing a supportive **national legal framework** (e.g. building standards)
- **Integrating** resource and energy efficiency goals into the different national policy areas
- Adjusting the degree of **decentralization** of competencies of authorities
- **Funding** local measures
- Funding **research and knowledge development** on resource and energy efficiency
- Raising **awareness** of resource and energy efficiency
- Enabling the development of **new business models** related to recycling and reusing



Green building



The Crystal, London, UK:

- Run entirely on electricity – the majority of which is generated by photovoltaic solar panels
- The building's roof collects rainwater, while sewage is treated, recycled and re-used onsite.

(c) Pawel Libera, LightRocket, Getty Images



Vanke Center, Shenzhen, China:

- Being tsunami proof – Shenzhen sits on China's south coast, next to Hong Kong
- Photovoltaic solar panels sit atop the structure's roof
- All furniture, doors and floors are made from bamboo.

(c) View Pictures, Universal Images Group, Getty Images



Rene Cazenave Apartments; San Francisco:

- Built as an urban regeneration project
- Filtered ventilation, low emitting materials, ample daylight and views combine,
- Combination of high efficiency lighting and hydronic heating,
- Water is carefully managed

Green building

- Green building is the practice of creating structures and using processes that are **environmentally responsible** and **resource-efficient** throughout a **building's life-cycle** from siting to design, construction, operation, maintenance, renovation and deconstruction.
- This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

Green building is also known as a sustainable or high performance building.

Energy (concept, design, installation, audit...)

Water (harvesting, efficiency, filtration)

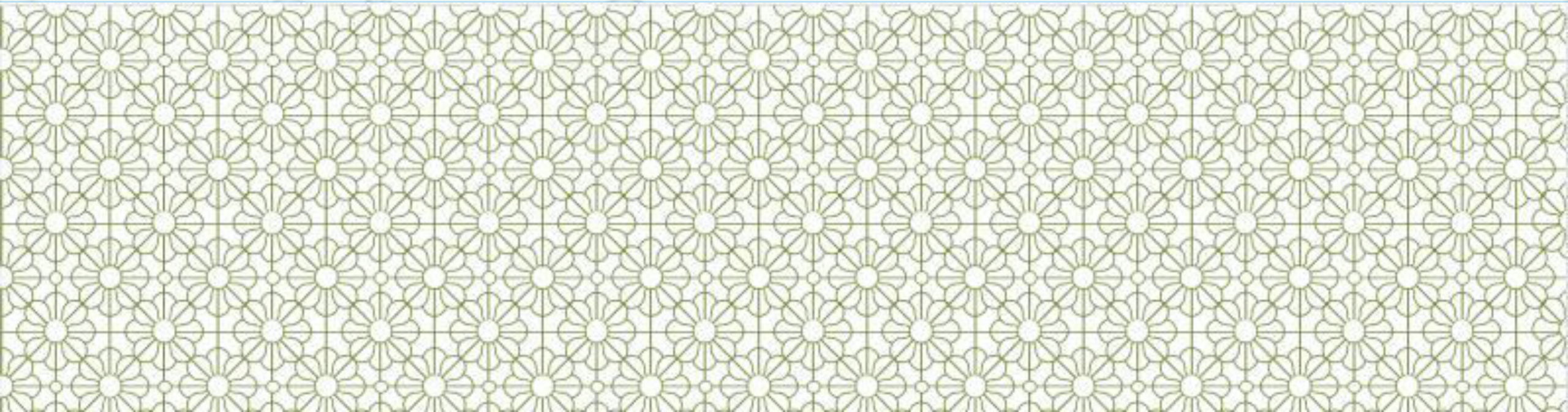
Waste water (recycled water)

Solid waste management (3Rs)

Materials (Carbon footprint, locally available etc.)

Life Cycle Assessment

- [EU guidelines](#)
- <https://www.ifu.com/knowtheflow/>
- <https://energy.gov/eere/femp/building-life-cycle-cost-programs>
- [BEES](#) (Building for Environmental and Economic Sustainability)



GREEN SPACE

Context and trends

- The struggle against aridity over centuries has fundamentally shaped cultural and technical methods of interacting with the landscape, resulting in many vernacular practices.
- The formation of old settlements in the region was highly interlocked with the ecological structure of the land.
- With modernization, many vernacular practices gradually faded away, largely due to urbanization and rising modernization of methods and techniques.
- Rapid urbanization in the last two decades has modified and changed the integration of culture and the physical landscape and has led to destruction of long-established ecological-cultural systems.
- Western ideals of progress and globalization shifted the desire away from continuity and connection with the historic, cultural relationships in landscapes to the extent that the interests of many decision makers are focused on imported materials, technologies, forms and concepts.
- An appreciation for the modern look of the city has emerged.

Where do they locate?

- There has been a long history of designed public open spaces in the region: these include public and private courtyards, the souk or the bazaar, and even the narrow shaded alleyways in the dense residential urban fabric



The benefits of green space

- Ornamented function
- Micro climate regulation
- Quality of life (biking, walking, play ground)
- Mental health
- Biodiversity in city
- Carbon storage
- Flood prevention
- Prevent soil erosion/desertification



Are they available?

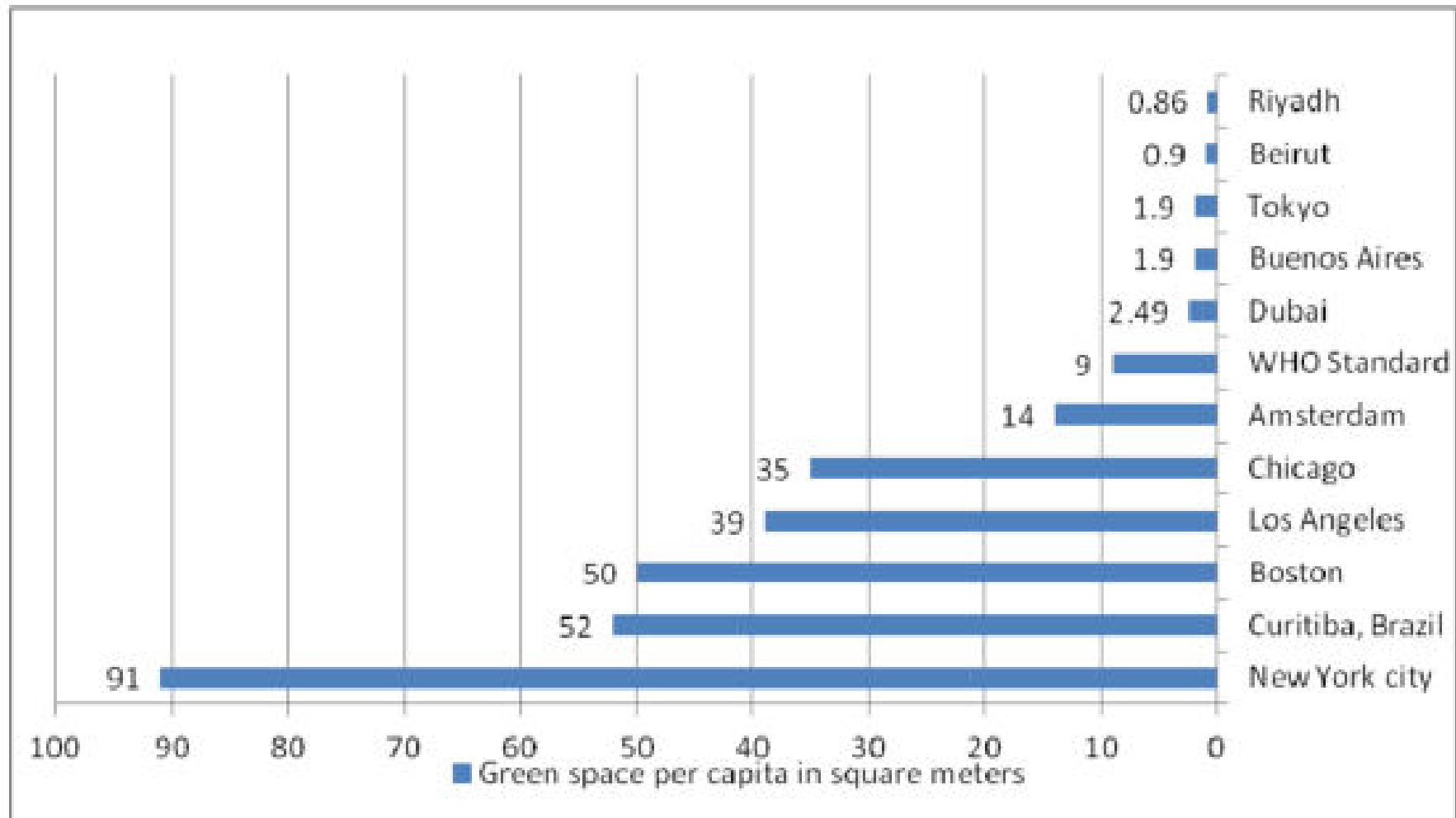


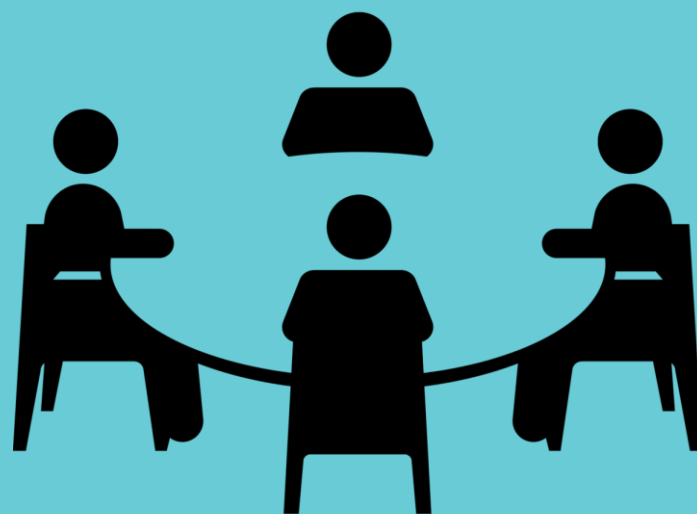
Fig. 1. Green space per capita in selected cities (prepared by the author).

Source:
Almayouf 2013

Examples of gardens and green public space



Source:
Almayouf
2013



GROUP WORK

Greening YOUR City – Taking action !

Form in groups

Based on the discussions of previous days and:

1. Identify at least 3 potential interventions of GI for your city
2. Discussion what are their co-benefits (CC adaptation, CC mitigation, environment, resource efficiency, economic, social etc.)
3. Prioritize and choose **the most** beneficial and feasible intervention
4. Draw an implementation plan, including:
 - Vision/goal
 - Steps/tasks
 - Location
 - Timeline
 - Involved stakeholders
5. Or Writing a Terms of Reference (TOR) for recruiting technical assistance team

