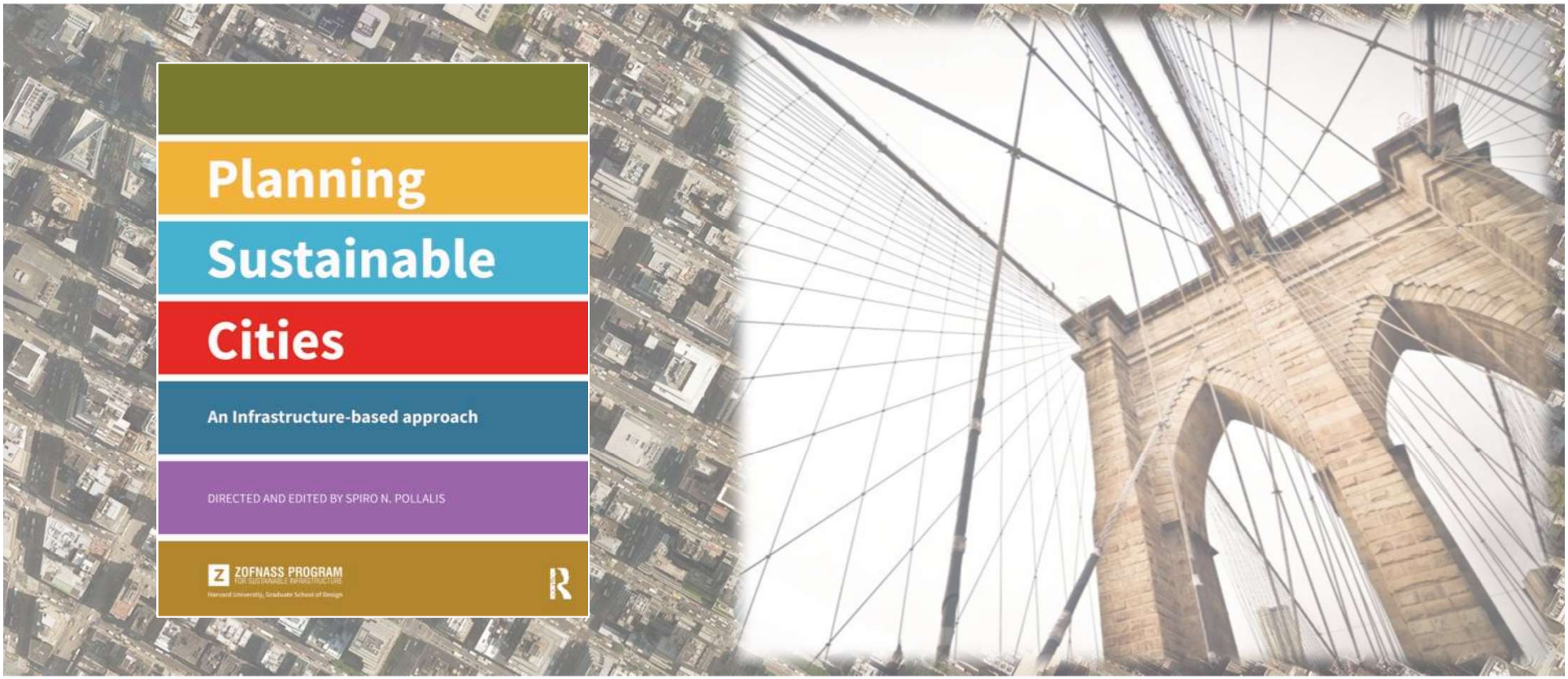
“INTEGRATION”
IN THE DEVELOPMENT OF INFRASTRUCTURE



International Expert Meeting on Sustainable Infrastructure
Fuzhou, October 22-23, 2018

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Planner of New Cities and Sustainability Advisor

ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

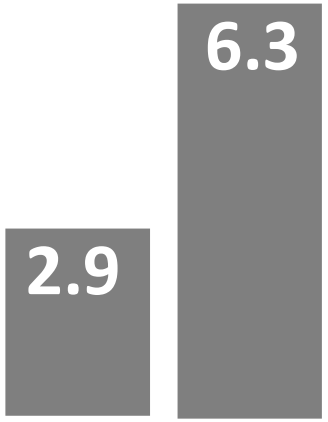
Harvard University
Graduate School of Design

Urbanization Challenges

High living standards in urban centers in the developed world combined with rapid urbanization on the developing world bring increased resource consumption and waste production

Urban centers face challenges:

- Lack of resources
- Overloaded infrastructure
- Pollution
- Extreme weather phenomena



TODAY: 1 out of 2 people lives in a city

IN 2050: 2 out of 3 people will live in a city

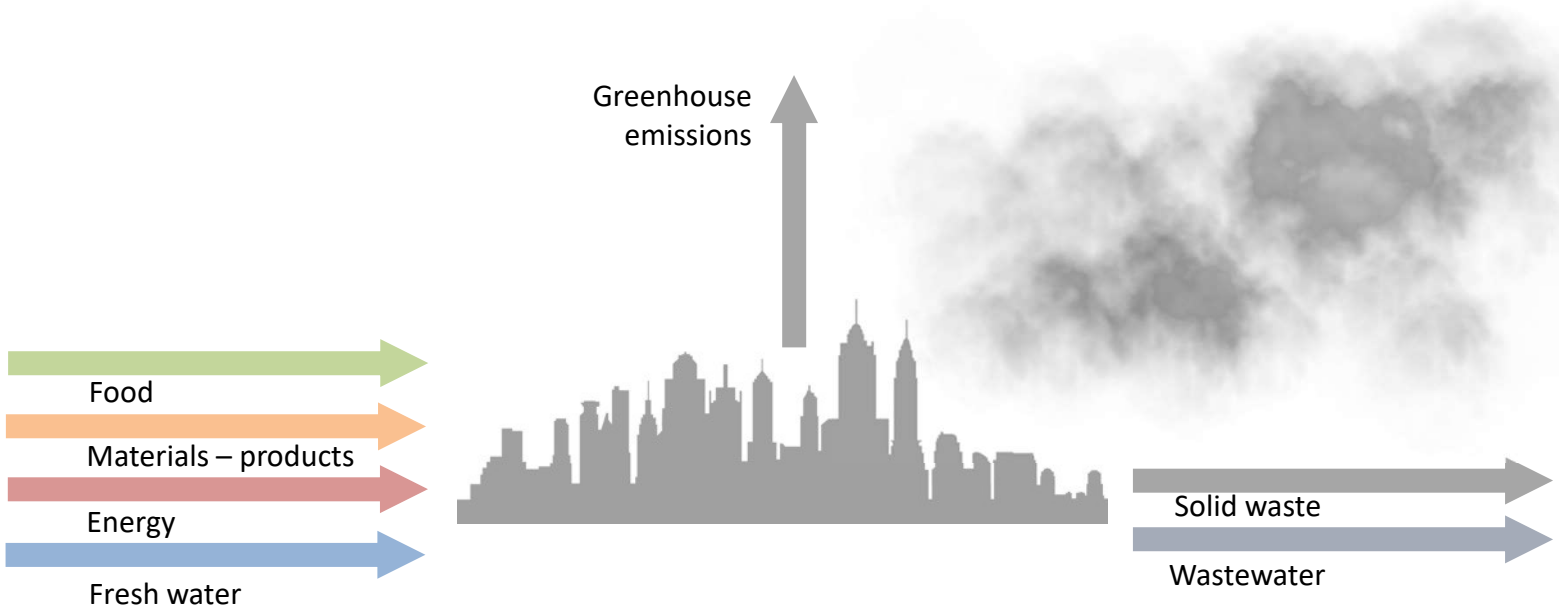
Source: Living Planet Report 2012, WWF

Rapid population growth creates the need for compact, high density cities

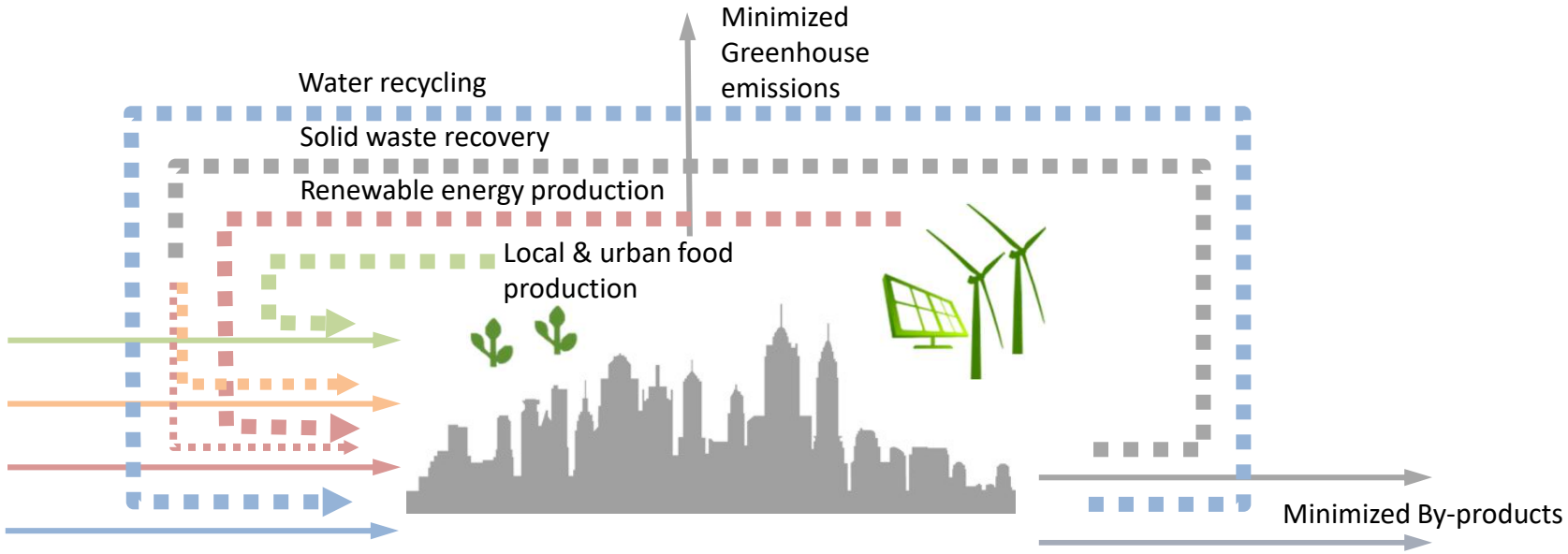
Accommodating the world's urban growth by 2030 at Los Angeles' density would cover almost half of the European Union. At Hong Kong's density, the global urban population would take up less than half of Italy

Source: LSE Cities

Current cities consume a vast amount of resources while polluting the natural environment and downgrading quality of life.

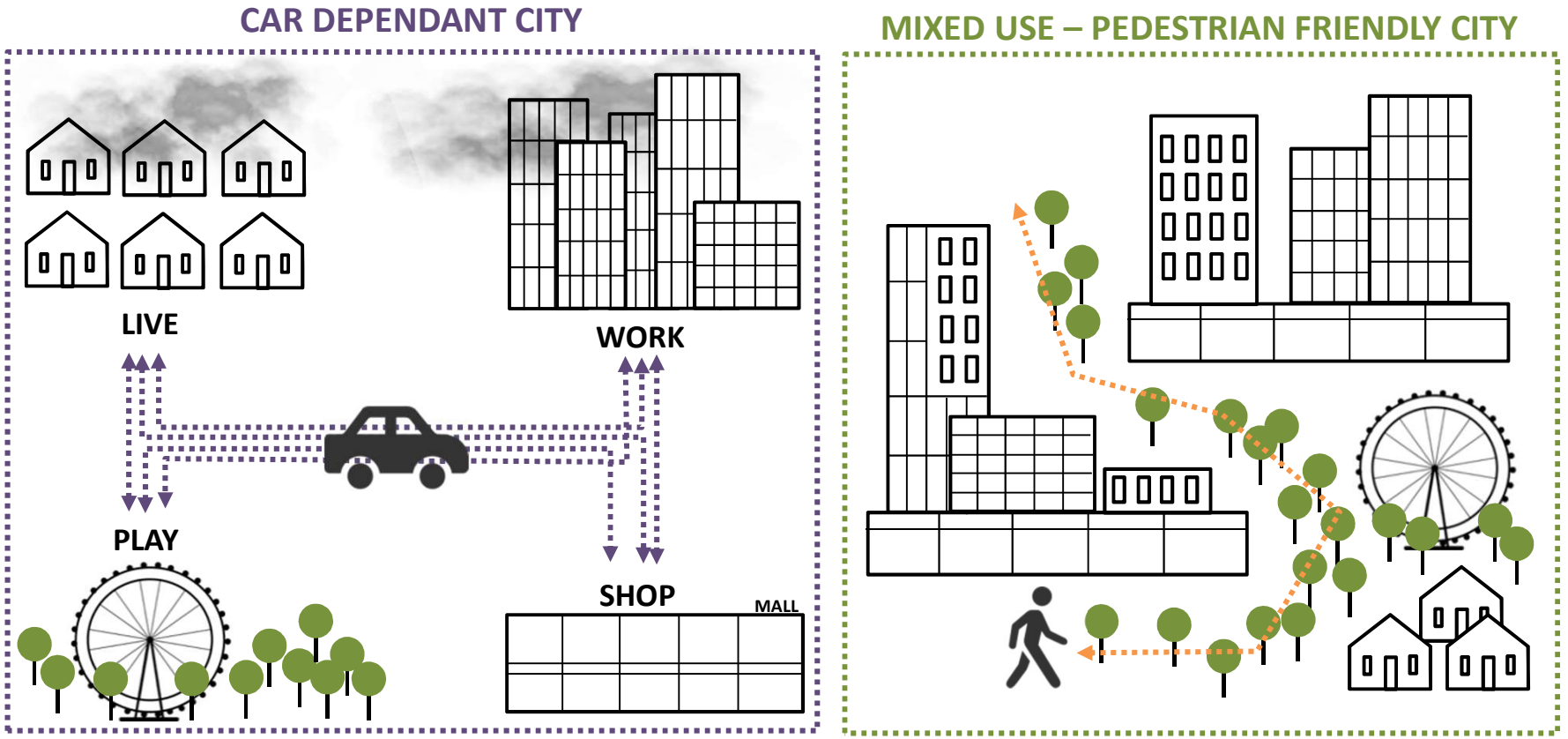


A Sustainable city should be able to work as a 'closed circuit', producing, recycling and reusing resources through **integrated infrastructure planning.**



As an example:

The polluted, inefficient, private car dependent city, should be replaced based on the principles of a pedestrian friendly and mixed use city.



The Zofnass Program for Sustainable Infrastructure

The Zofnass Program at Harvard was established in **2008.**

It develops **know-how, tools, and methodologies** for rating and planning sustainable infrastructure and cities.

It is based on the **unique collaboration of academic experts and industry specialists.**

ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

Harvard University
Graduate School of Design

The Sustainability Industry Advisory Board:

AUTODESK. BARCLAYS Bentley CDM Smith ch2m
Ecology and Environment Golder Associates HNTB IDB Inter-American Development Bank
Kiewit LA Metro Louis Berger Otak The Nature Conservancy
NV5 POWER ENGINEERS Stantec TRC WHI WREN HOUSE INFRASTRUCTURE

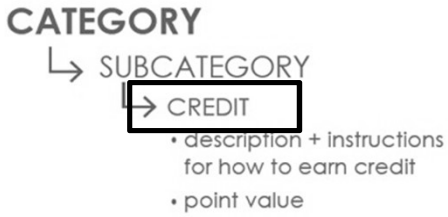
The Zofnass Program Approach

The Zofnass Program identifies **7 infrastructure systems** and organizes sustainable infrastructure **criteria into 5 categories of impact.**

Envision Credits

There are 60 credits in all.

- A credit comprises a **sustainability indicator on an aspect of environmental, social, or economic concern.**
- Each credit section presents a description and evaluation criteria for how to earn points associated with the credit.



QUALITY OF LIFE
13 Credits

1 PURPOSE
QL1.1 Improve Community Quality of Life
QL1.2 Stimulate Sustainable Growth and Development
QL1.3 Develop Local Skills and Capabilities

2 WELLBEING
QL2.1 Enhance Public Health and Safety
QL2.2 Minimize Noise and Vibration
QL2.3 Minimize Light Pollution
QL2.4 Improve Community Mobility and Access
QL2.5 Encourage Alternative Modes of Transportation
QL2.6 Improve Accessibility, Safety & Wayfinding

3 COMMUNITY
QL3.1 Preserve Historic and Cultural Resources
QL3.2 Preserve Views and Local Character
QL3.3 Enhance Public Space

QL0.0 Innovate or Exceed Credit Requirements

LEADERSHIP
10 Credits

1 COLLABORATION
LD1.1 Provide Effective Leadership & Commitment
LD1.2 Establish a Sustainability Management System
LD1.3 Foster Collaboration and Teamwork
LD1.4 Provide for Stakeholder Involvement

2 MANAGEMENT
LD2.1 Pursue By-Product Synergy Opportunities
LD2.2 Improve Infrastructure Integration

3 PLANNING
LD3.1 Plan Long-Term Maintenance and Monitoring
LD3.2 Address Conflicting Regulations and Policies
LD3.3 Extend Useful Life

LD0.0 Innovate or Exceed Credit Requirements

RESOURCE ALLOCATION
14 Credits

1 MATERIALS
RA1.1 Reduce Net Embodied Energy
RA1.2 Support Sustainable Procurement Practices
RA1.3 Use Recycled Materials
RA1.4 Use Regional Materials
RA1.5 Divert Waste from Landfills
RA1.6 Reduce Excavated Materials Taken Off Site
RA1.7 Provide for Deconstruction and Recycling

2 ENERGY
RA2.1 Reduce Energy Consumption
RA2.2 Use Renewable Energy
RA2.3 Commission and Monitor Energy Systems

3 WATER
RA3.1 Protect Fresh Water Availability
RA3.2 Reduce Potable Water Consumption
RA3.3 Monitor Water Systems

RA0.0 Innovate or Exceed Credit Requirements

NATURAL WORLD
15 Credits

1 SITING
NW1.1 Preserve Prime Habitat
NW1.2 Preserve Wetlands and Surface Water
NW1.3 Preserve Prime Farmland
NW1.4 Avoid Adverse Geology
NW1.5 Preserve Floodplain Functions
NW1.6 Avoid Unsuitable Development on Steep Slopes
NW1.7 Preserve Greenfields

2 LAND+WATER
NW2.1 Manage Stormwater
NW2.2 Reduce Pesticides and Fertilizer Impacts
NW2.3 Prevent Surface and Groundwater Contamination

3 BIODIVERSITY
NW3.1 Preserve Species Biodiversity
NW3.2 Control Invasive Species
NW3.3 Restore Disturbed Soils
NW3.4 Maintain Wetland and Surface Water Functions

NW0.0 Innovate or Exceed Credit Requirements

CLIMATE AND RISK
8 Credits

1 EMISSIONS
CR1.1 Reduce Greenhouse Gas Emissions
CR1.2 Reduce Air Pollutant Emissions

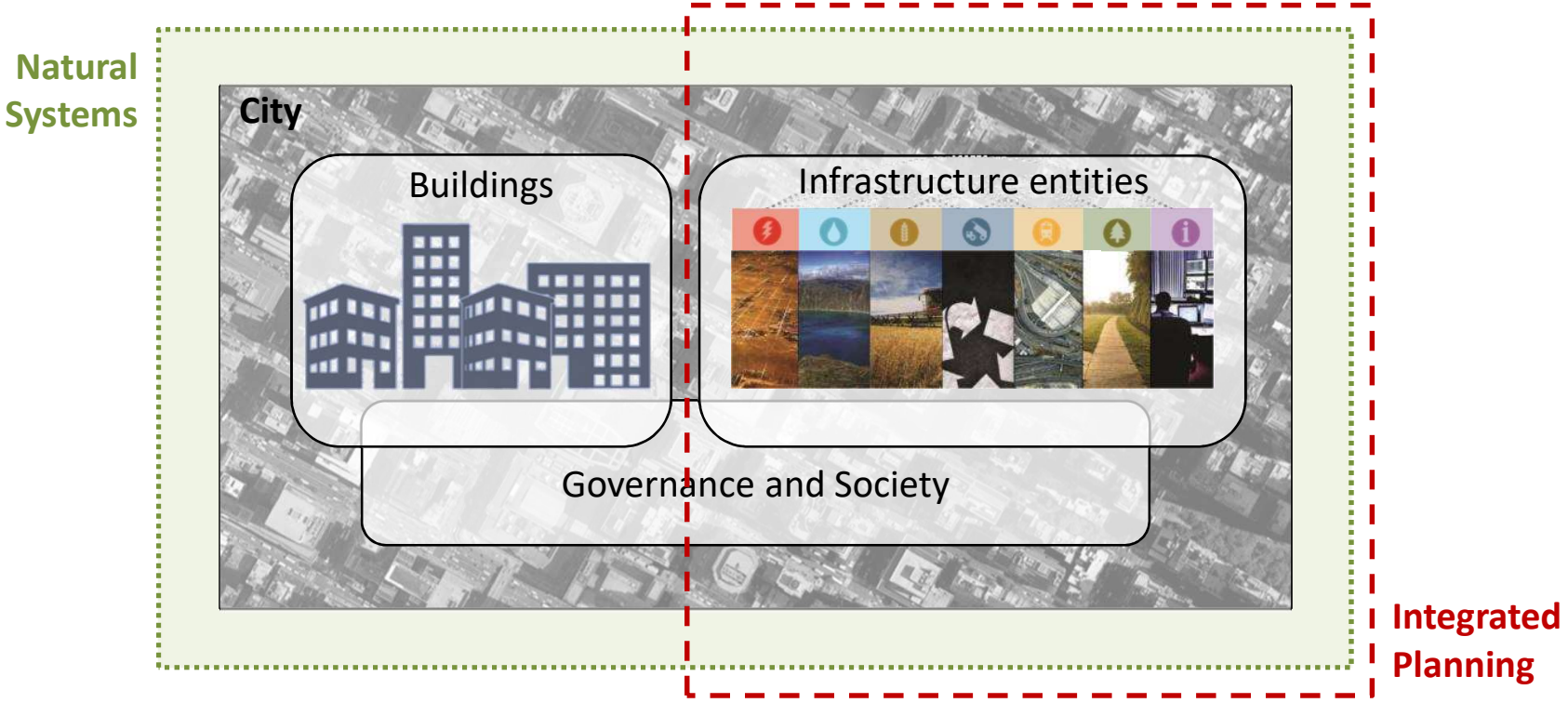
2 RESILIENCE
CR2.1 Assess Climate Threat
CR2.2 Avoid Traps and Vulnerabilities
CR2.3 Prepare For Long-Term Adaptability
CR2.4 Prepare for Short-Term Hazards
CR2.5 Manage Heat Island Effects

CR0.0 Innovate or Exceed Credit Requirements

The Zofnass Program Approach – The City as a System

The Zofnass program considers **the city as a system,** where:

- Infrastructure development is inextricably linked to city scale planning
- Infrastructure processes & entities constitute the infrastructure systems of the city
- The Buildings are the main end users (clients) of infrastructure systems



Sustainable City Planning is a **High-level Integrated Planning.**

Integration is needed in multiple levels between:

- the more traditional practices of urban planning and engineering,
- the decision making processes of stakeholders,
- the natural systems and the human settlements, and
- the infrastructure elements among themselves

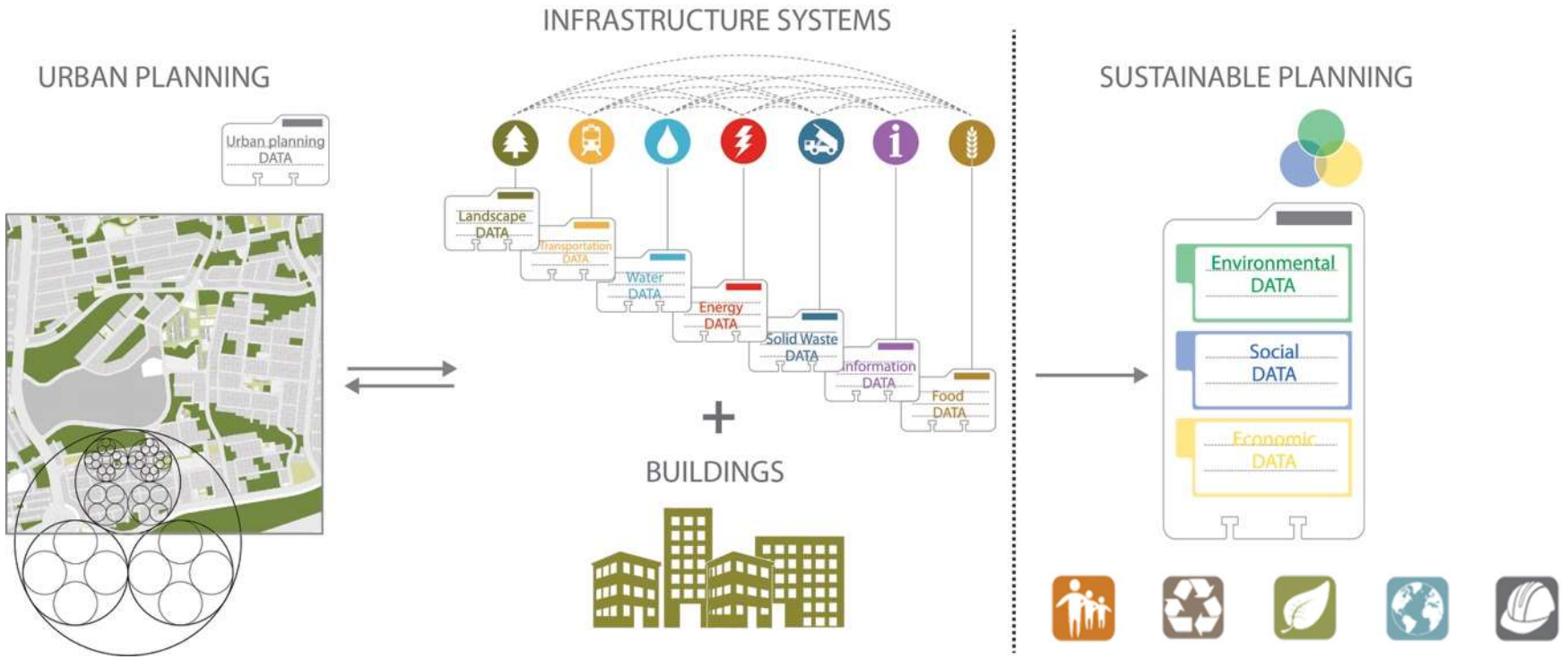
Main objective:
Development of infrastructure systems through a unified and **integrated decision making process** at a high level and cross-disciplinary efforts. Through this process/methodology, we achieve both **efficiency and compatibility**.

Three distinct and **fully integrated parts** define the sustainability of cities:

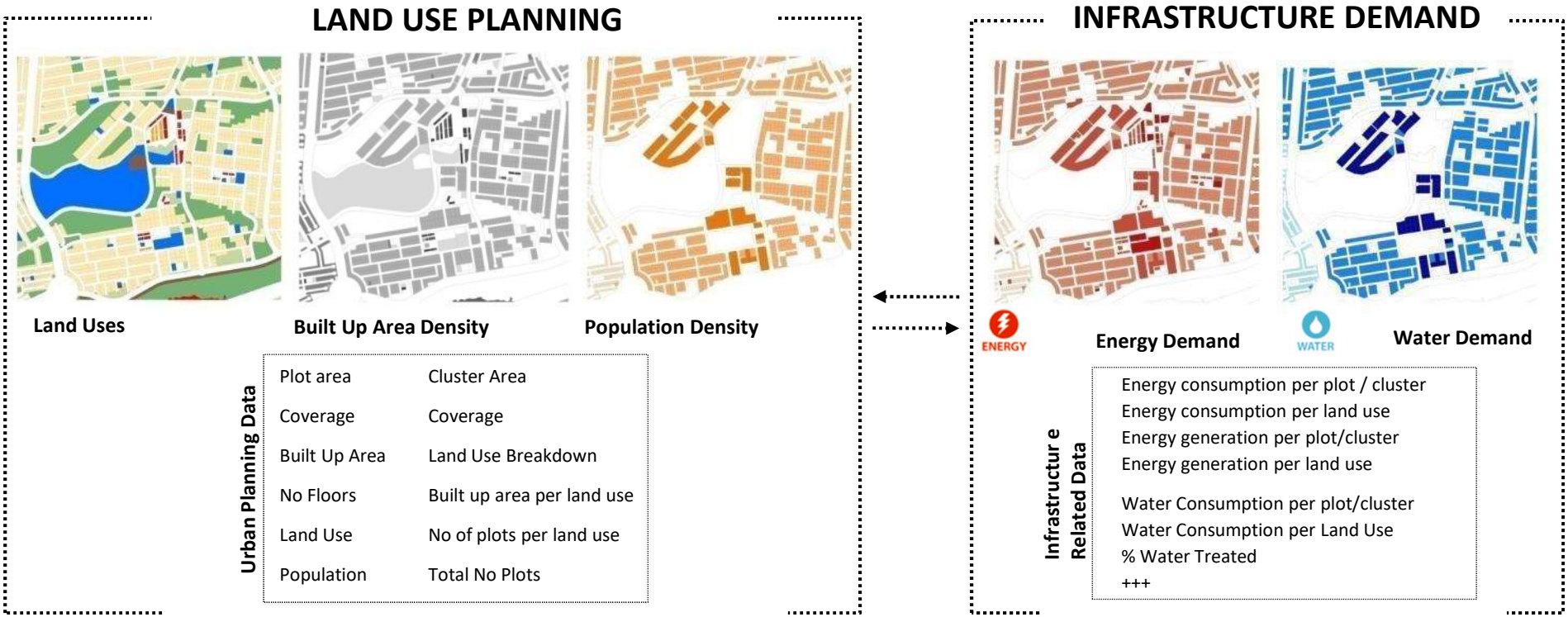
(a) the planning of the city: land use and density, and

(b) the planning of infrastructure, and

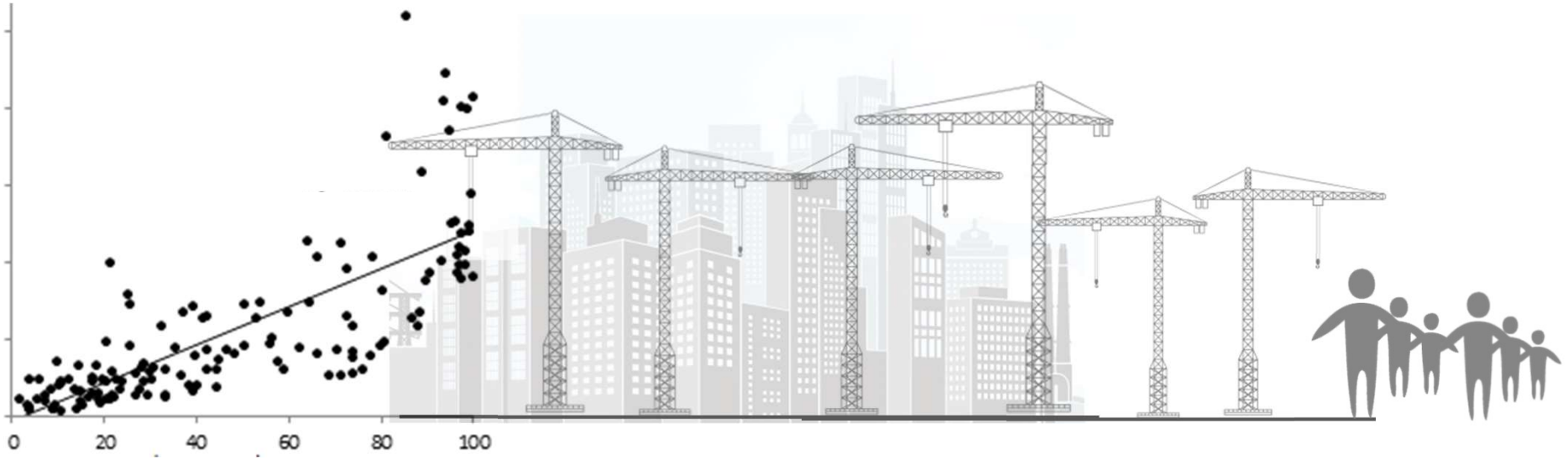
(c) the environmental load (consumption and production) of the buildings



(a) Urban planning determines the number of end-users and the demand for services and resources, which infrastructure should cover.

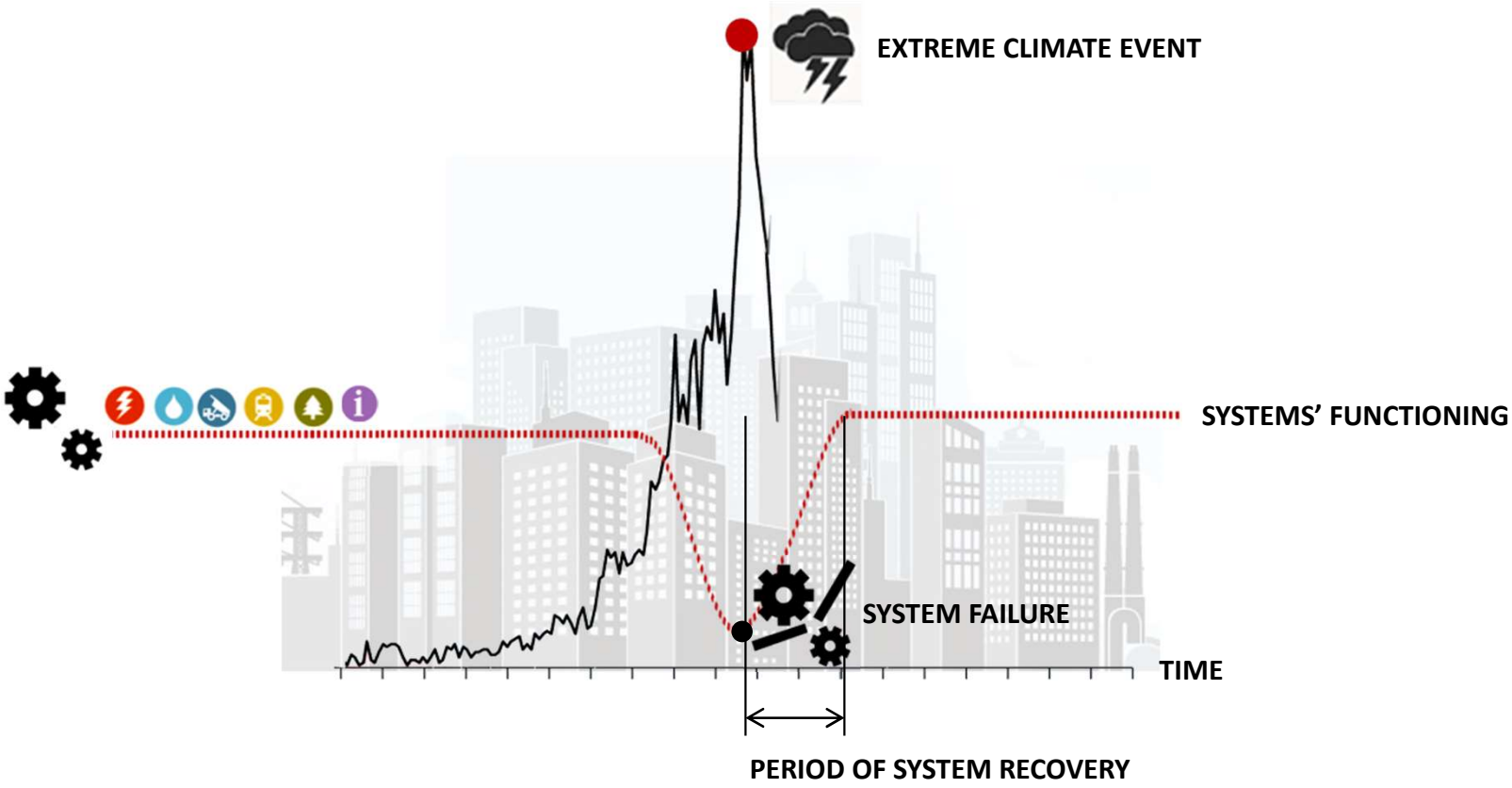


(b) Infrastructure provides the quality and type of services that affect the financial development of the city and its social environment.



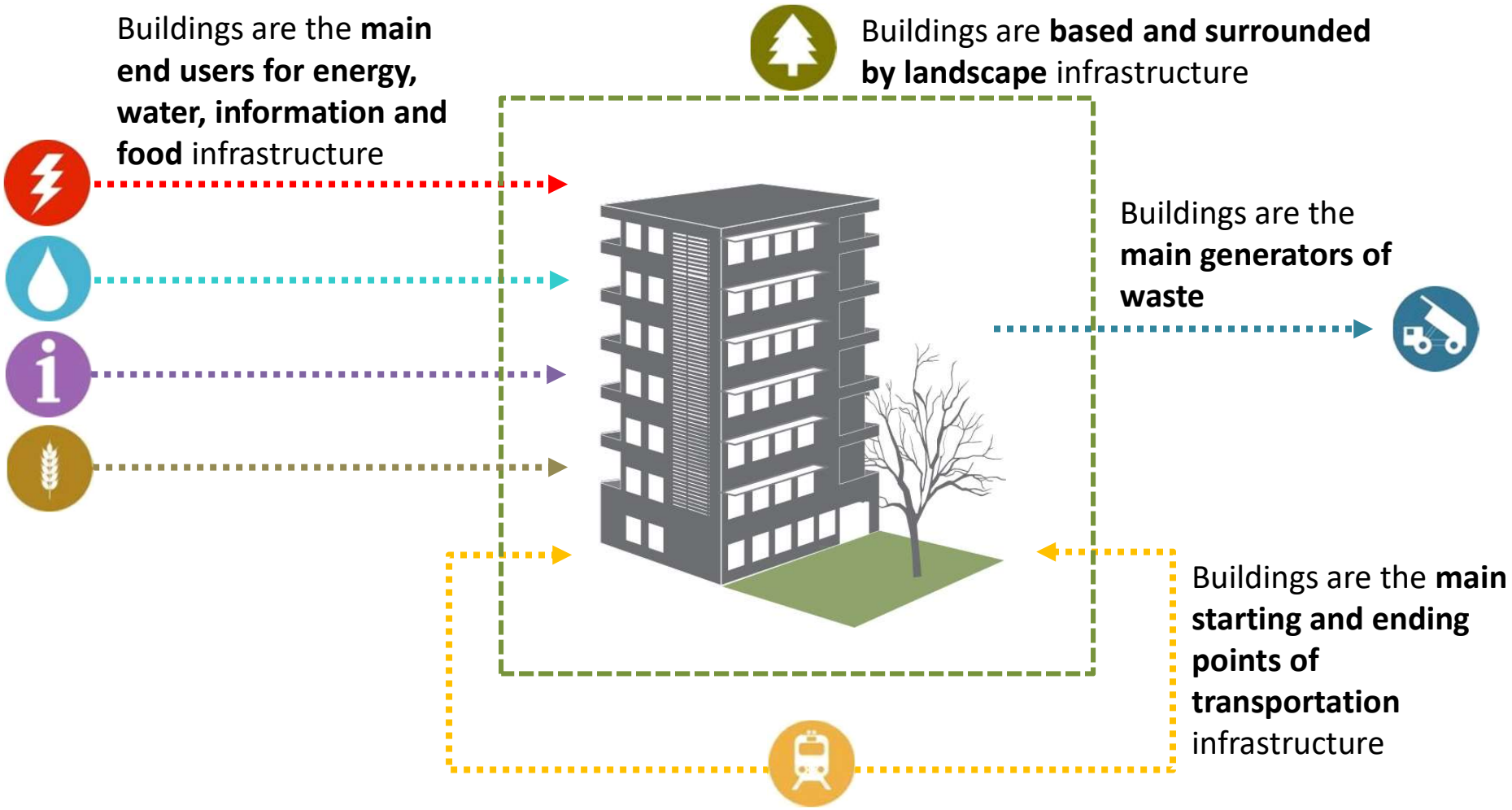
FINANCIAL DEVELOPMENT ⇠⇢ **INFRASTRUCTURE** ⇠⇢ **SOCIAL DEVELOPMENT**

(b) Infrastructure also determines the city's resilience against extreme events.



INFRASTRUCTURE ⋯⋯▸ **CITY'S RESILIENCE – CAPACITY FOR FAST RECOVERY**

(c) Buildings, as clients-components of each infrastructure system, become critical for a sustainable city.



The Zofnass Program Tools

A number of tools and methodologies have been developed worldwide for **buildings** for the best implementation of sustainability principles and integrated and innovative planning.

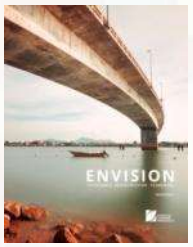
Two tools have been developed **by the Zofnass Program** to translate the principles of sustainability and resilience **for infrastructure and cities** into day-to-day decision-making.

Buildings → **Multiple tools available** → U.S. Green Building Council LEED USGBC +

e.g. LEED

Infrastructure & Cities → **Zofnass Program at Harvard** →

Project scale



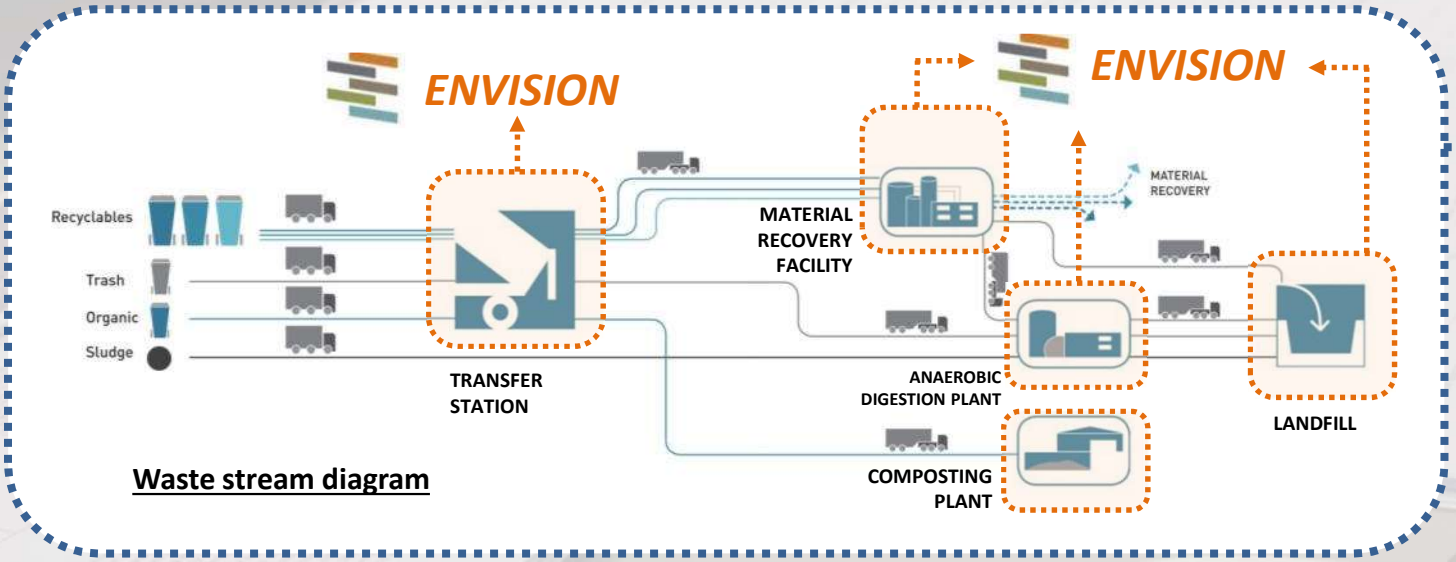
Envision® Rating Tool +

City scale

Sustainable **Planning Guidelines**

Relation between the two Zofnass Tools

Infrastructure entities are managed as **integrated components** of extended systems.

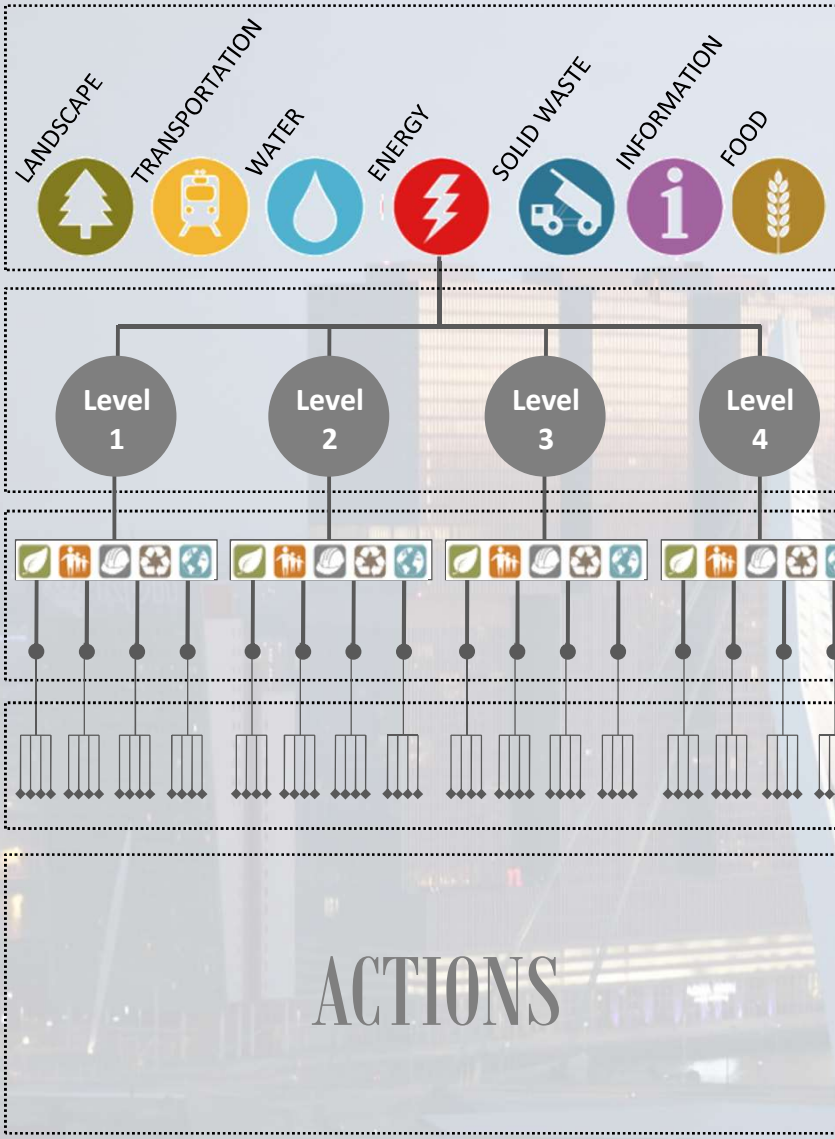


Zofnass Sustainable *Planning Guidelines*

Both tools are tailored to the needs of the industry and they provide:

- Objectivity in assessing sustainability
- Common ground for the stakeholders' collaboration
- Guidance in the decision making process
- Improved competiveness of stakeholders and recognition

Zofnass Sustainable Planning Guidelines



Each Infrastructure System is decoded in **four "System Levels".**

System Levels:
- Group processes and entities within the systems
- Organize a high level planning and decision making process

Sustainability Objectives are set for each System Level based on the Zofnass categories of impact.

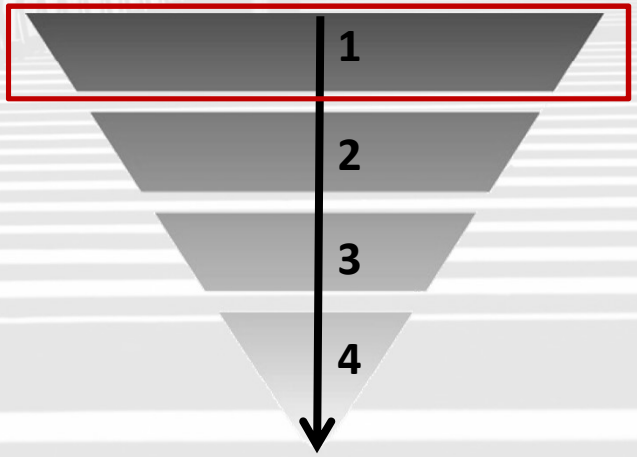
Each Objective is then analyzed into one or more **Planning Guidelines**.

The Planning Guidelines do not describe specific solutions. Their role is to prompt project teams to **develop a set of Actions** adapted to the individual context-project.

To ensure a sustainable infrastructure system **the four "system levels":**

To ensure a sustainable infrastructure system **objectives and strategies have a hierarchy**

Every infrastructure system has as its first strategy **"SAVING"**, the reduction of consumption, to reduce the demand for infrastructure.



SAVING/ Reduce demand

Less Need
Less Installed Capacity for Infrastructure

The Planning Guidelines:

- **do not prescribe specific actions** to reach the sustainability objectives
- **determine the direction of planning** and they leave specific actions open-ended
- facilitate the **development of customized actions** to each city's unique context, conditions, and priorities
- **promote innovation**, allowing the incorporation of new or improved technologies as they become available

A **systemic approach** is emphasized in the Zofnass Planning Guidelines.

Infrastructure systems are considered as **sub-systems of the city** that should function **in synergy**.

Synergies usually refer to:

- Reducing the **initial demand** of other systems and the challenges for their operation
- Connecting **by-products** and feedstock needs
- Optimizing **placement** of entities
- **Combining** entities
- **Mitigating** negative impacts of processes

Zofnass Sustainable Planning Guidelines: Synergies

GUIDELINES

OBJECTIVES		GUIDELINES	SYNERGIES
W1 WATER CONSUMPTION			▲ TO + WITH ▼ FROM
● W1.1. Reduce Water Consumption in the building sector	W1.1.1.	Guide, assist, and motivate communities for rational use of water	
	W1.1.2.	Set long-term goals and standards for reducing Water Consumption in the building sector	
	W1.1.3.	Promote on-site harvesting of rainwater and recycling of water	
● W1.2. Reduce Water Consumption in the Energy system	W1.2.1.	Reduce water volume required for Energy Supply and Energy Generation	
● W1.3. Reduce Water Consumption in the Landscape system	W1.3.1.	Reduce water required for Landscape Maintenance	
● W1.4. Reduce Water Consumption in the Food system	W1.4.1.	Reduce water required for Food Production and Food Processing	

Zofnass Sustainable Planning Guidelines: Synergies

RELEVANT GUIDELINES

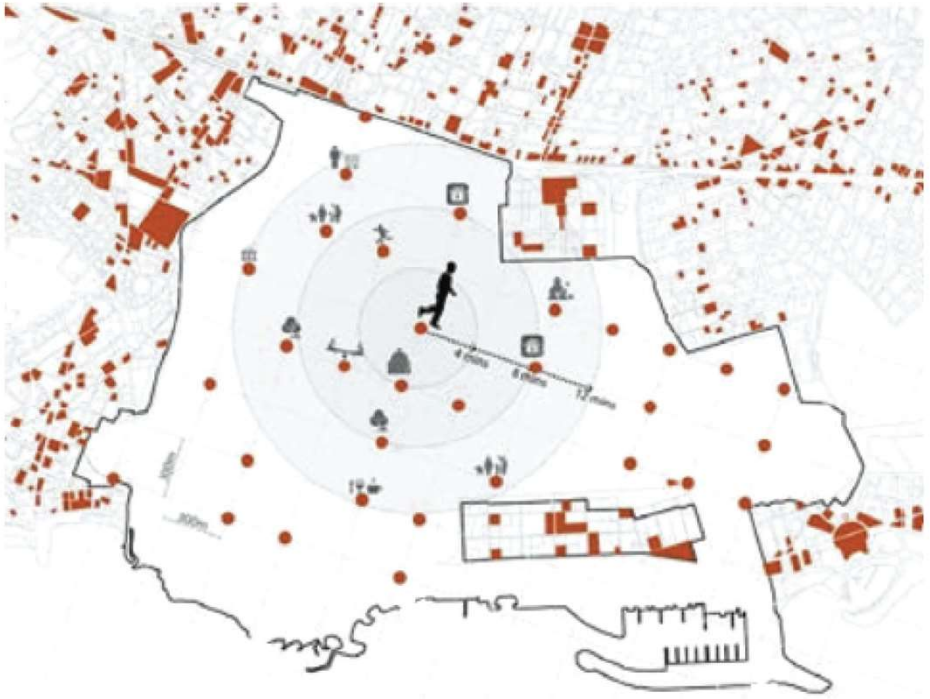
GUIDELINES		RELEVANT GUIDELINES	
W1 WATER CONSUMPTION		FROM ● ▸ 💧 ▸ ● TO + ● WITH	
W1.2.1.	Reduce water volume required for Energy Supply and Energy Generation	E2.4.2.	Take into consideration available Water resources when planning Energy Supply mix
		E3.11.1.	Promote water-efficient technologies in Energy Generation facilities
W1.3.1.	Reduce water required for Landscape Maintenance	L4.8.1.	Set long-term goals and standards for reducing Water Consumption in Landscape Maintenance
		L4.8.2.	Use native plants of low water requirements
		L4.8.3.	Construct and operate efficient Landscape irrigation systems
		L4.8.4.	Harvest rainwater for Landscape Maintenance where possible
W1.4.1.	Reduce water required for Food Production and Food Processing	F2.8.2.	Promote efficient agriculture irrigation systems
		F2.8.3.	Promote crops suitable to local climate and Water resources
		F4.7.1.	Promote water-efficient technologies in Food Processing (Provide incentives for Water recycling in Food Processing)

12.2 | PLANNING STRATEGIES AND INFRASTRUCTURE SYSTEMS FOR HELLINIKON

2. MINIMIZATION OF CAR USE AND CONNECTIVITY WITH THE ADJACENT MUNICIPALITIES

The provision for easy and quick access while mitigating car use was central to the design. A dense network of cycling and pedestrian paths is developed across the area, which is dotted with multiple points of interest and activities. The suggested path configuration is a rectangular grid of 1000 ft x 1000 ft (300 m x 300 m), a 4-minute walking distance. Superimposing this layer on the site's topography and distributing land uses, an alternative and safe crossing of the site has been created, promoting a healthier way of life.

Furthermore, the existing public transportation networks (tram, metro, and bus lines) along and near the boundaries of the site are extended throughout the site, enhanced with the distribution of parking areas and transit stations along them, aiming to reduce energy consumption and greenhouse gas emissions.



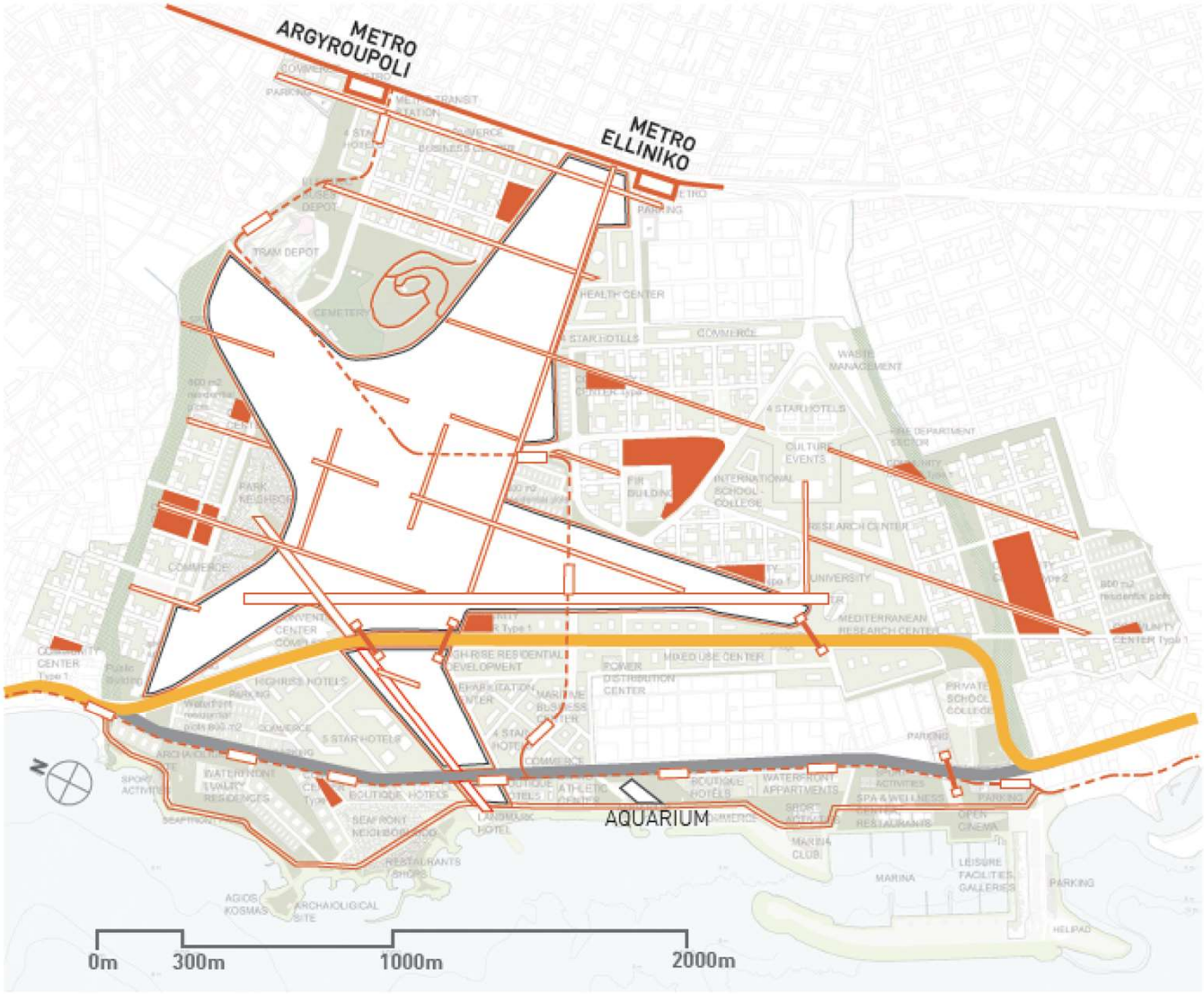
Zofnass Sustainable Planning Guidelines: Actions

	GUIDELINES	ACTIONS
	OBJECTIVE T4.8. Maintain the integrity of natural-world elements and systems	
T4.8.1.	Avoid the construction of Transportation Networks on undeveloped land	Reuse of an existing runway to host the development's new main avenue and diversion of the current high traffic flow along the coast.
T4.8.3.	Minimize natural Landscape alteration for the construction of Transportation Networks	Maintenance of Hassani hill's current topography and the canoe-kayak venue's hill and lake land relief.
T4.8.4.	Protect natural habitats and wildlife corridors and compensate for their fragmentation or disruption by Transportation Networks	Restoration of the existing streams, integration of the proposed promenades along their axis with the site's pedestrian network, and minimization of their crossings by other types of transportation networks.
T4.8.7.	Develop vegetation configurations for Transportation Networks to provide habitats	Incorporation of lanes with various plant species or with arboreous vegetation where adequate, along the site's different road types.
T4.8.8.	Adapt plant selection for Transportation Networks to local context	Protect native plants by avoiding the introduction of invasive species along lanes of the different road types.

Zofnass Sustainable Planning Guidelines: Actions

SUSTAINABLE ACTION

Connect local centers with low-emission transportation networks.



RELATED GUIDELINES

T4.5, T4.3.1, T4.5.1, T3.6.1

NETWORKS AND ATTRACTORS

- Metro stations
- Tram line stations
- Main walking and recycling axes
- Pedestrian bridges
- Local community centers
- Relocated Poseidonos Avenue
- Existing Poseidonos Avenue

The Zofnass approach serves as **a common platform for multiple stakeholders** as opposed to "Silo approache"s and disconnected projects:

- **Identifies synergistic effects of strategies** to combine entities and avoid replicated effort and costs, connect by-products and feedstock needs and reduce initial demand
- **Synergies can enable a systems approach to financing rather than only project finance**, altering perceptions of cost, e.g. multiple cross-sector revenue streams through shared problem solving
- **Helps balance consumption and demand** for infrastructure:
  less demand → less production need →less installed capacity for infrastructure→ less cost


Thank you!
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The Zofnass Program at Harvard:
http://research.gsd.harvard.edu/zofnass/menu/about/
http://zofnass.gsd.harvard.edu/planning/
http://zofnass.gsd.harvard.edu/water_infotool
The Envision Rating System:
http://sustainableinfrastructure.org/envision/