Ecosystem Services in urban areas and environmental quality

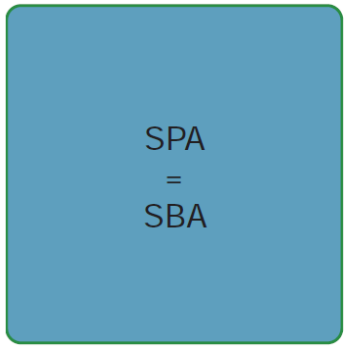
Fausto Manes, Alessandro Sebastiani
Sapienza University of Rome

Round Table: “ECOSYSTEMS AND THEIR SERVICES FOR HUMAN WELL-BEING”

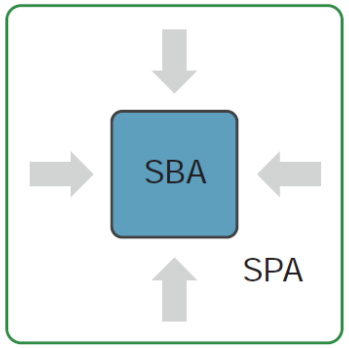
ECOSYSTEM SERVICES AND URBAN GREEN

Social benefits	Recreation opportunities, improvement of home and work environments, impacts on physical and mental health. Cultural and historical values of green areas
Aesthetic and architectural benefits	Landscape variation through different colors, textures, forms and densities of plants. Growth of trees, seasonal dynamics and experiencing nature. Defining open space, framing and screening views, landscaping buildings
Climatic and physical benefits	Cooling, wind control, impacts on urban climate through temperature and humidity control. Air pollution reduction, sound control, glare and reflecti-on reduction, flood prevention and erosion control
Ecological benefits	Biotopes for flora and fauna in urban environment
Economic benefits	Value of market-priced benefits (timber, berries, mushrooms ect.), increased property values, tourism

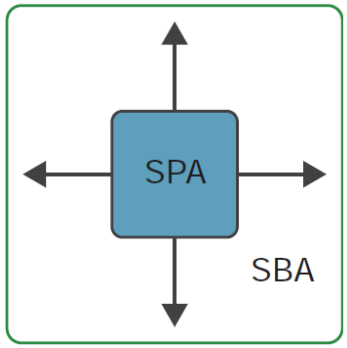
Service Providing Areas (SPA), Service benefiting Areas(SBA) and Service Connecting Areas (SCA)



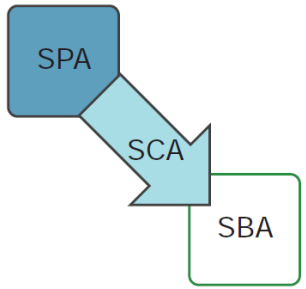
a) "in situ": SPA e SBA Are identical



b) central': surrounding area supplies / acts on the central benefiting area



c) 'omnidirectional': directed on all sides - to larger surrounding area



d) 'directional' – spatially separated from each other (e.g., slope dependent)

Types of spatial relations of Service Providing Areas (SPA), Service Benefiting Areas (SBA) and Service Connecting Areas (SCA) (from Burkhard & Maes, 2017)

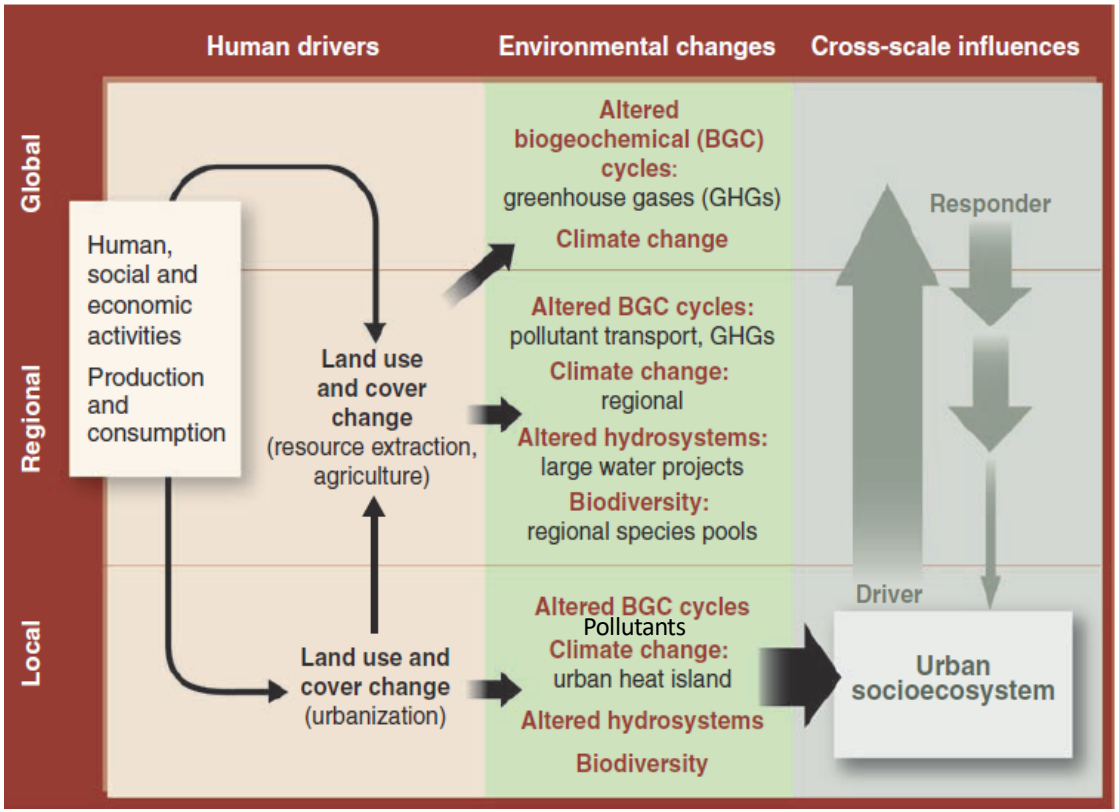
UN - SUSTAINABLE DEVELOPMENT GOALS

SDG11: *Sustainable cities and communities* " reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality… provide universal access to safe, inclusive and accessible, green and public spaces".

EU BIODIVERSITY STRATEGY FOR 2030

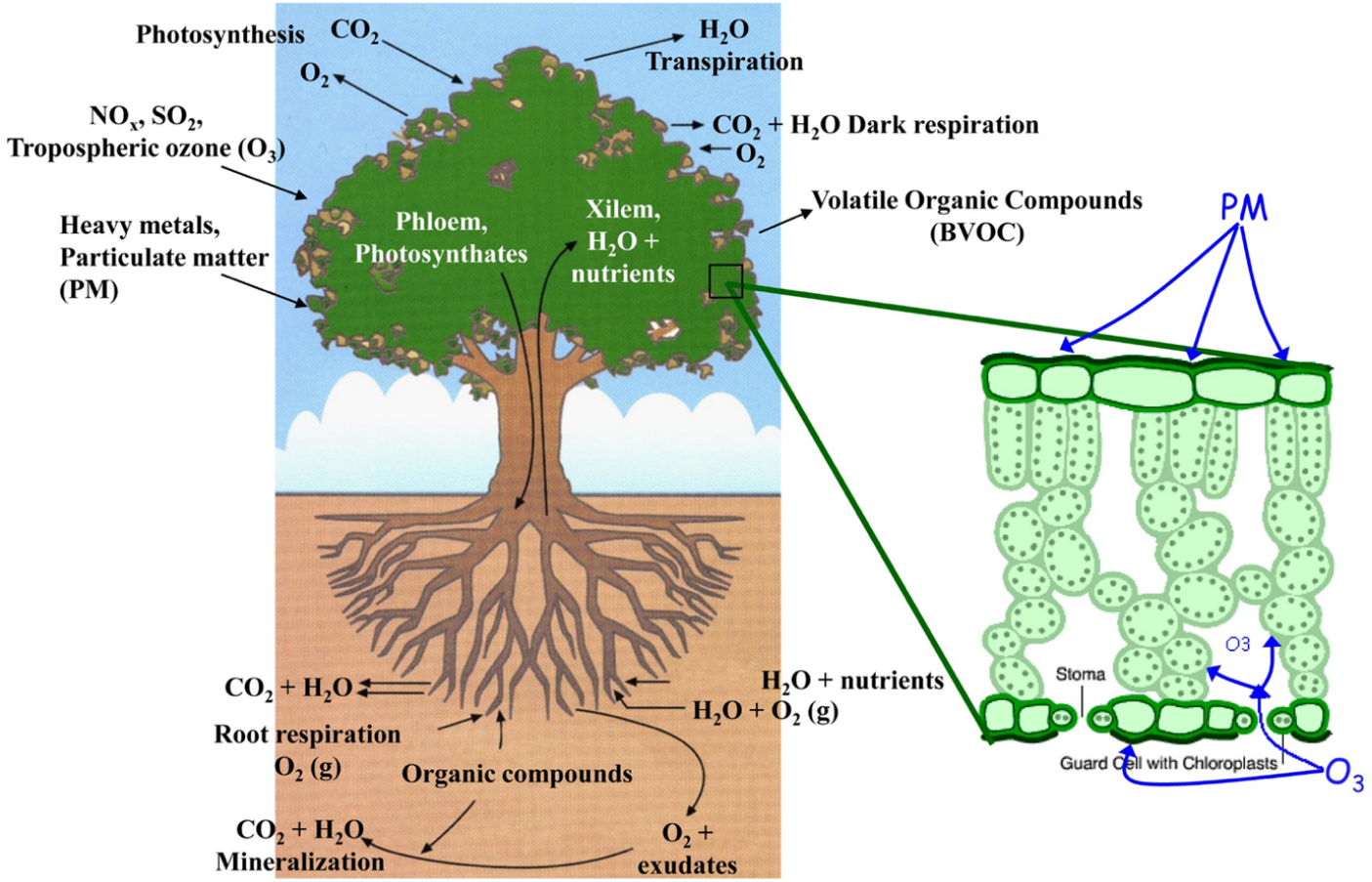
"The promotion of healthy ecosystems, green infrastructure and nature-based solutions should be systematically integrated into urban planning, including in public spaces, infrastructure, and the design of buildings and their surroundings".

URBAN "SOCIECOSYSTEM" AND ENVIRONMENTAL ALTERATIONS



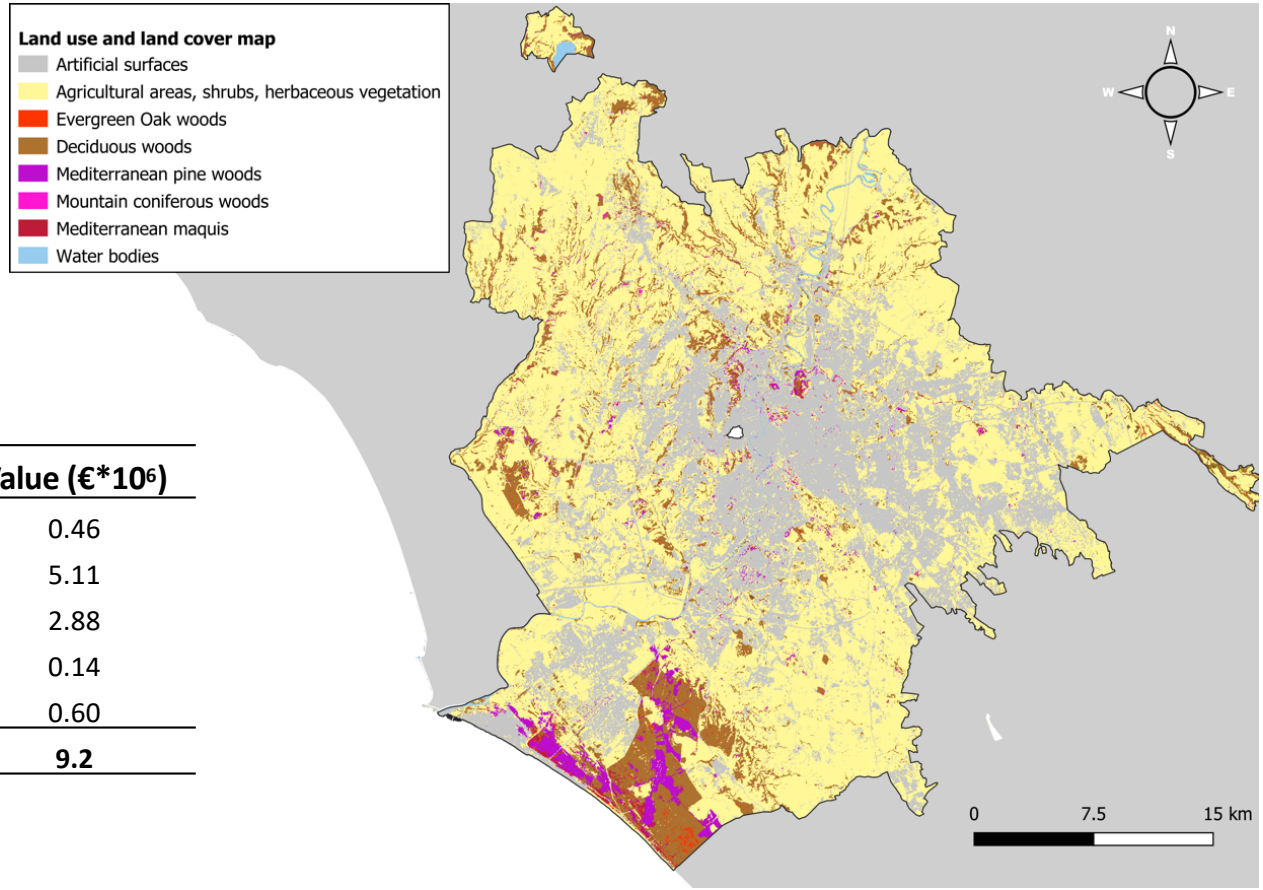
Framework showing urban socioecosystem (lower right) as a driver of (upward arrows) and responder to (downward and horizontal arrows) environmental change. Land change to build cities and support their populations drives local to global alterations of biogeochemical cycles, climate, hydrosystems, and biodiversity. Large local environmental changes are greater than those that filter down from global environmental change (horizontal black arrow). Not all possible interactions and drivers are shown (Modified from Grimm et al., 2008).

Soil–plant–atmosphere relations and interactions with atmospheric pollutants: tree species can remove air pollutants from the atmosphere



Modificato da: Schnoor et al., 1995

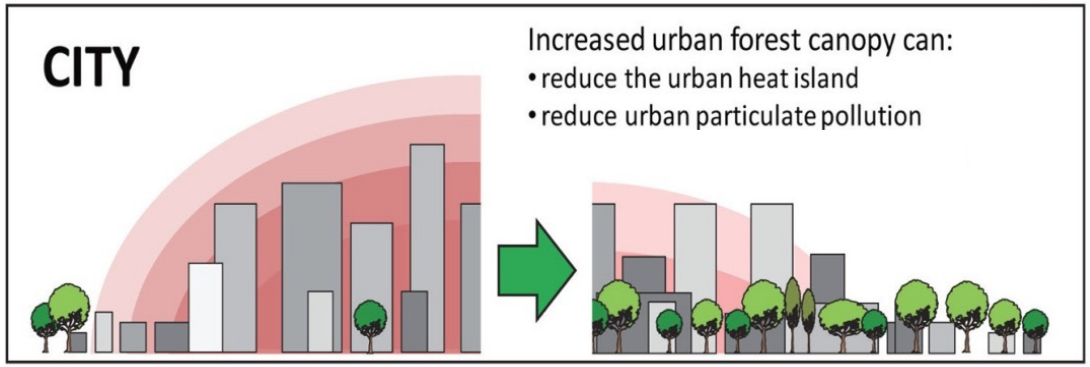
Land use and land Cover Classification of the Municipality of Rome and PM_{10} removal



PSVC	Mg	Value (€*10⁶)
Evergreen Oak woods	14.80	0.46
Deciduous Woods	163.1	5.11
Mediterranean Pine woods	92.00	2.88
Mountain Coniferous woods	4.59	0.14
Mediterranean Maquis	19.34	0.60
total	**293.83**	**9.2**

The figure shows the land use and land cover in the Municipality of Rome. In the table, the **PM_{10} removed**, expressed **as total removal** (Mg) **and its monetary value** (€·10^6), is reported. Data (Sentinel-2) refers to year 2016

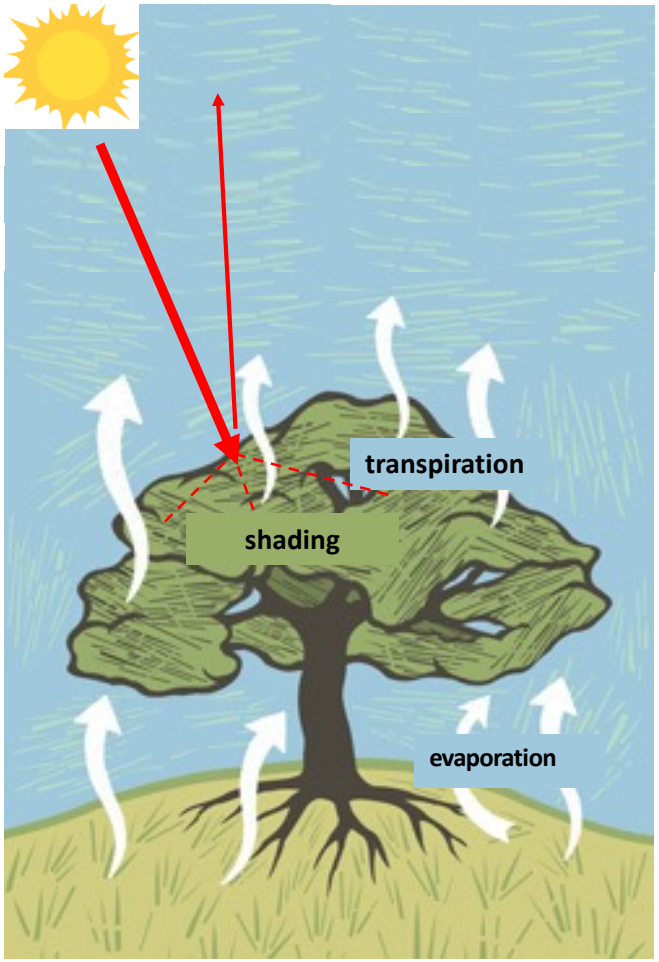
Urban Heat Island effect mitigation



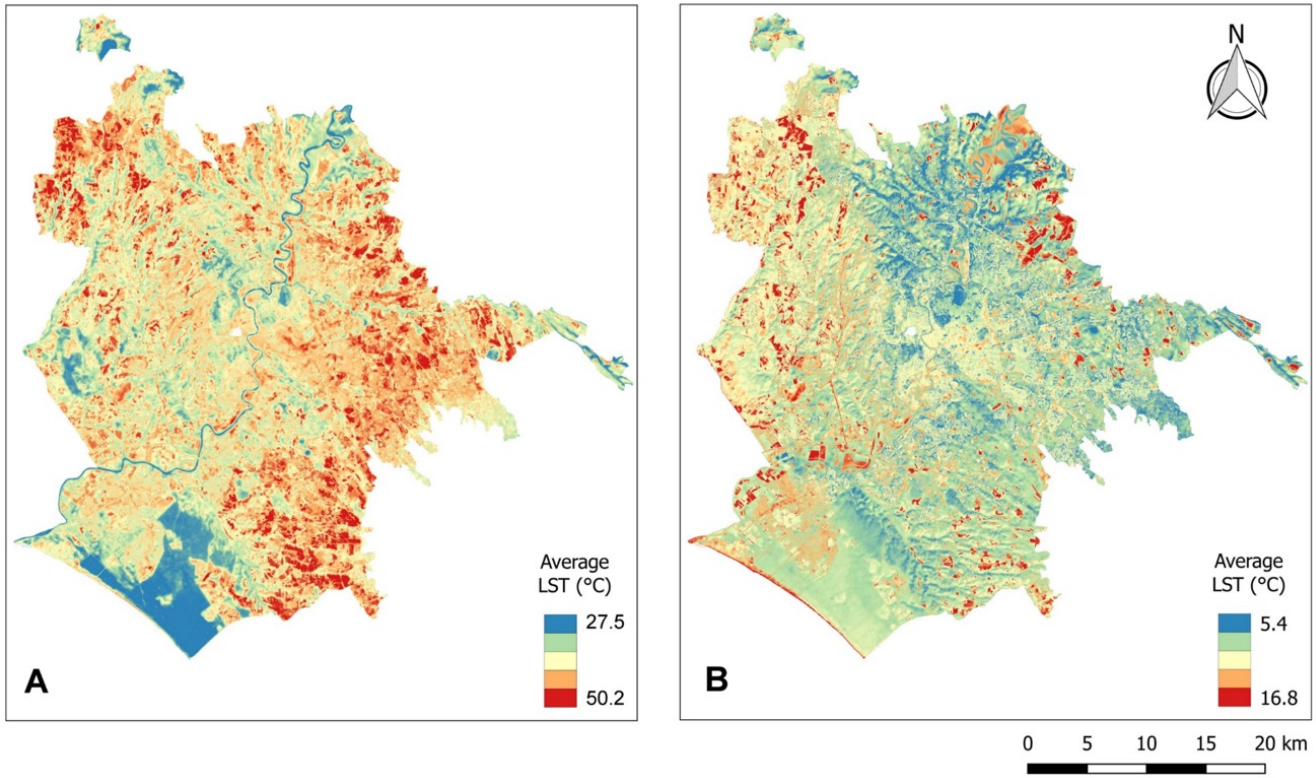
Modified from Livesley et al., 2016

- Urban temperatures can be **12 °C** higher than the one of the surrounding rural areas

- The vegetation mitigates the urban heat island effect by means of **shading** and **transpiration**



Municipality of Rome:
Land Surface temperature – average LST (Landsat-8 data)

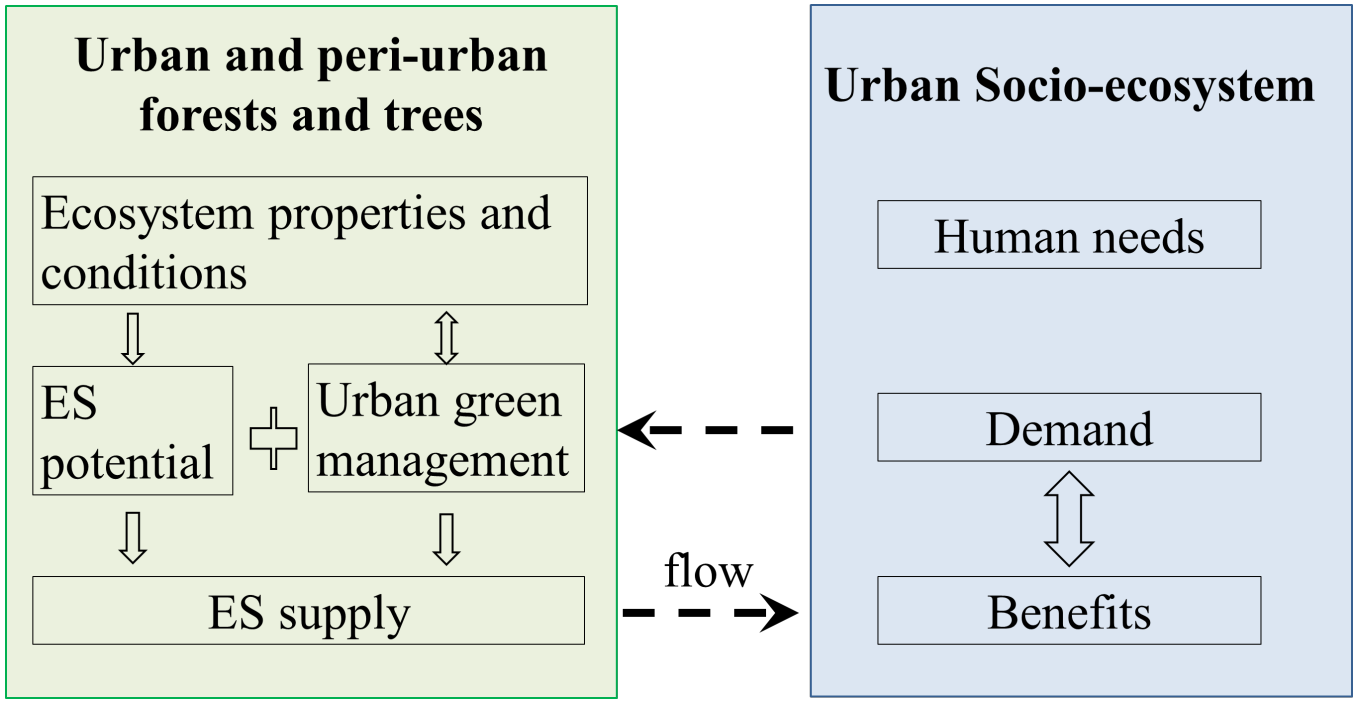


Maps of summer (a) and winter (b) LST (°C). Average LST of four years for each season is presented (2013, 2015, 2016, 2017 for summer; 2014, 2015, 2016, 2017 for winter).

(Da Marando et al., 2019 – Ecological Modelling)

Ecosystem Services supply and demand in Urban Areas

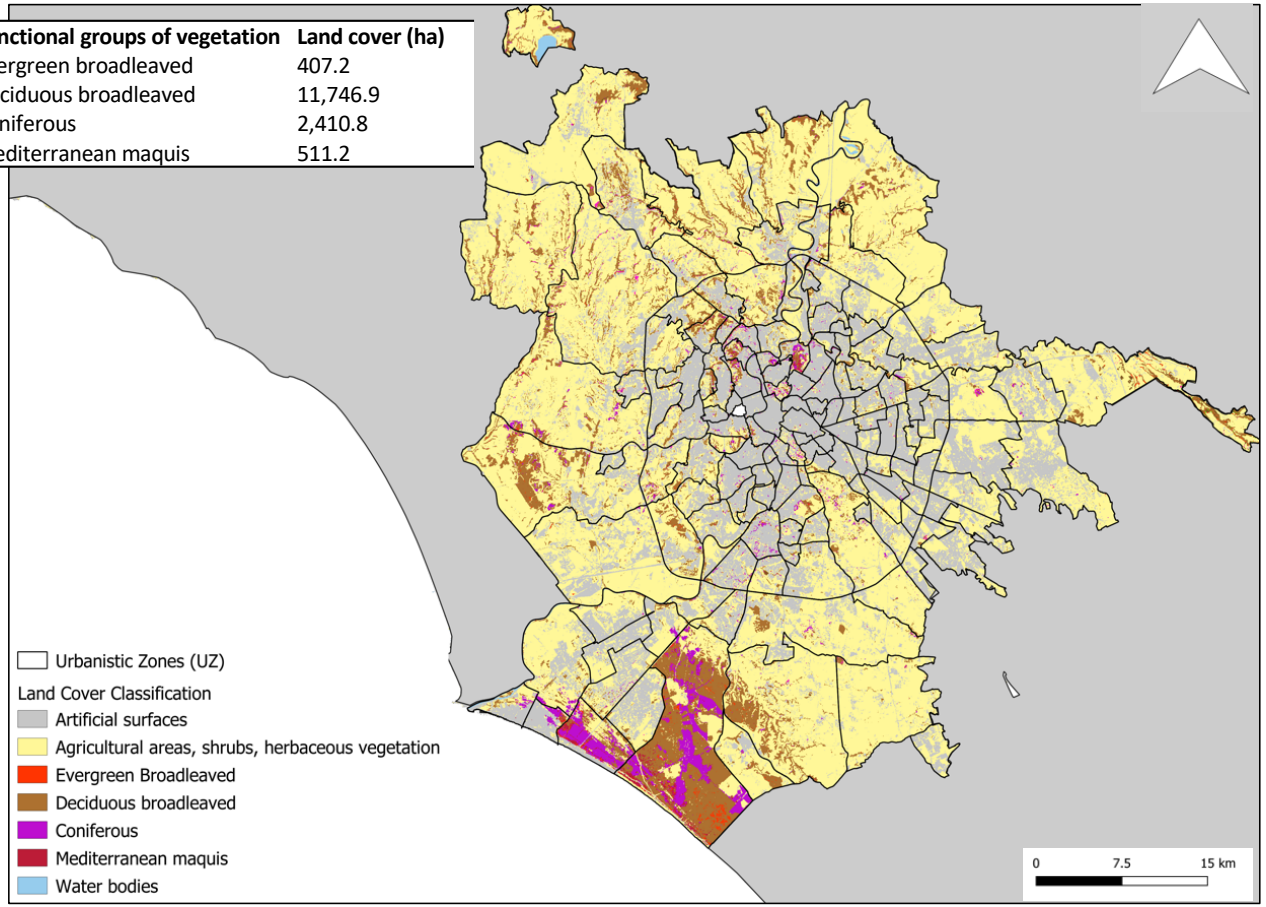
The concept of Ecosystem Services highlights the link between nature and population. Urban and peri-urban forests and street trees provide Ecosystem Services to the socio-economic system, which influences their quality and quantity



Modified from Syrbe et al., 2017

Land use and land cover classification and representation of the division into 155 Urban Zones of the Municipality of Rome (Sentinel-2 data)

Functional groups of vegetation	Land cover (ha)
Evergreen broadleaved	407.2
Deciduous broadleaved	11,746.9
Coniferous	2,410.8
Mediterranean maquis	511.2



Experimental approach

Four **Composite Indicators**, representing the **supply** and the **demand** for the Ecosystem Services of Air Quality Improvement and Urban Heat Island effect Mitigation, were computed using the available data

- Data selection
- Normalization
- Aggregation

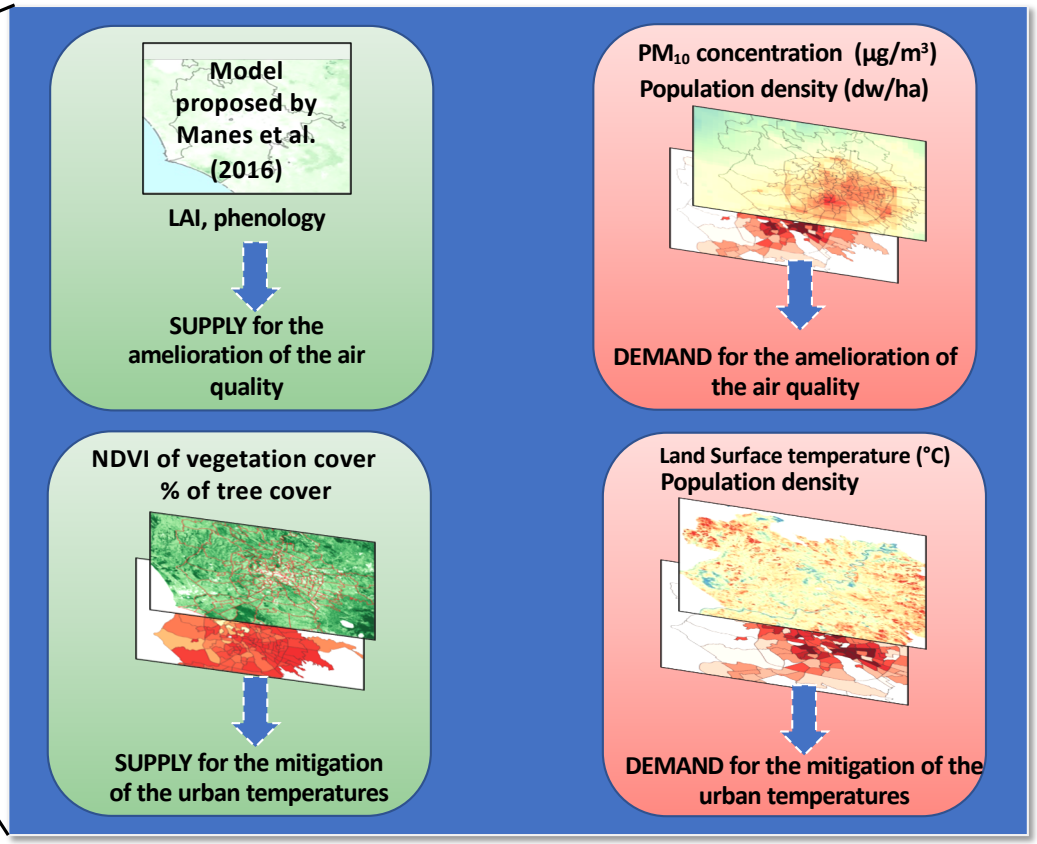
Construction of the Composite Indicators

- Cluster analysis

Identification of the mismatch areas

- Overlay of the mismatch areas

Identification of the Priority Intervention Areas



Experimental approach

Mismatch area for each of the considered Regulating Ecosystem Service were overlapped in order to find **Priority Intervention Areas.** For the Municipality of Rome, **57 Urban Zones** (18 % of the total area of the Municipality) are figured as **Priority Intervention Areas** that need immediate implementation of forests, parks and gardens.

- Data selection
- Normalization
- Aggregation

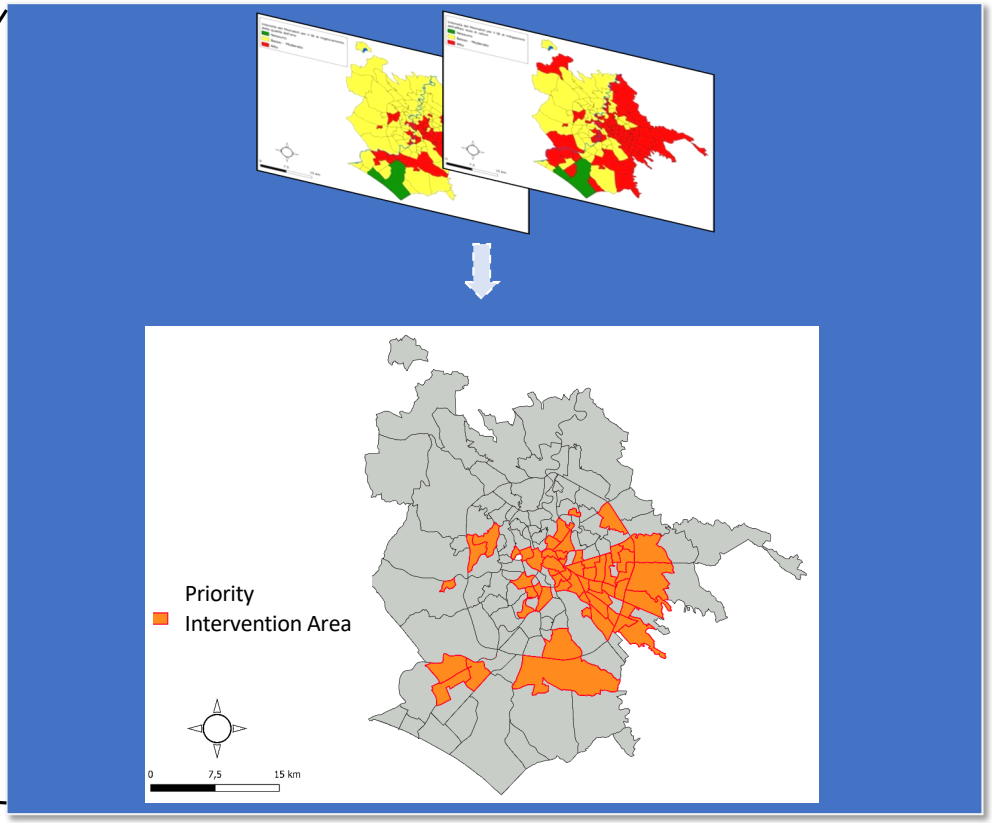
Construction of the Composite Indicators

- Cluster analysis

Identification of the mismatch areas

- Overlay of the mismatch areas

Identification of the Priority Intervention Areas



TAKE HOME MESSAGES

The mismatch assessment allows to define **Priority Intervention Areas for the Municipality of Rome, where specific Ecosystem Services** (PM_{10} removal and local climate mitigation) **should be enhanced.**

Prioity Intervention Areas have a predominantly **compact urban structure** and **high population density.**

According to the EU Biodiversity Strategy for 2030, **increasing the quantity, quality and resilience of urban and peri-urban forests through the enhancement of the Urban Green Infrastructure Network is pivotal for the sustainable development of urban areas**.

In Mediterranean areas, already characterized by summer drought**, Climate Change is likely to influence functional processes of urban and peri-urban vegetation as well as the provision of Ecosystem Services.**

Stakeholders should be provided with **multidisciplinary guidelines** in order to **implement Nature-Based Solutions** aimed at supporting human health and wellbeing in urban areas, as stated also by the recent EU Project “EnRoute”, which involved 16 European City labs.

Thanks for your kind attention