

ESPON



Co-funded by
the European Union
Interreg

CASE STUDY REPORT //

Imola

Italy

Case Study Report // January 2026



This CASE STUDY REPORT is conducted within the framework of the ESPON 2030 Cooperation Programme, partly financed by the European Regional Development Fund.

The ESPON EGTC is the Single Beneficiary of the ESPON 2030 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway and Switzerland.

This delivery does not necessarily reflect the opinions of members of the ESPON 2030 Monitoring Committee.

Coordination:

Gavin Daly, Nicolas Rossignol, Laura Dimitriu (ESPON EGTC)

Authors

Carolina Cantergiani, Adriana Aguirre, María Ayelen Calvet, Gemma García (TECNALIA); Rik De Vreese, Ian Whitehead, Päivi Pelli (EFI); Yoann Clouet, Tannya Pico, Alice Jelmini, Mariana Binder (iUE)

Advisory group

Bogdan Micu (RO), Kris De Craene (BE)

Information on ESPON and its projects can be found at www.espon.eu.

The website provides the possibility to download and examine the most recent documents produced by finalised and ongoing ESPON projects.

ISBN: 978-2-919839-70-4

© ESPON 2030

Published in Luxembourg

Layout and graphic design by BGRAPHIC, Denmark

Printing, reproduction or quotation is authorised provided the source is acknowledged and a copy is forwarded to the ESPON EGTC in Luxembourg.

Contact: info@espon.eu

CASE STUDY REPORT //**Imola**

Italy

Case Study Report // January 2026

Disclaimer

This document is a case study report.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2030 Cooperation Programme.

The final version of the report will be published as soon as approved.

Abbreviations	7
ESPON GILL Project	8
1 Imola in a Nutshell	9
1.1 Context	9
1.2 Green Infrastructure – Policy Overview	10
1.2.1 National Planning Framework for Green Infrastructure	10
1.2.2 Regional and Local Policies regarding Green Infrastructure	10
1.3 Imola Objectives on Green Infrastructure	11
1.4 Data Context	11
2 Implementation of ESPON-GILL Methodology in Imola	13
2.1 ESPON-GILL Map of Modules	13
2.2 Module 1: Definition of Local Policy Goals and Baseline Analysis	14
2.2.1 Action 1.1: Analysis of Local Baseline for the Definition of GI Goals	14
2.2.2 Action 1.2: Gathering and storing Data	17
2.2.3 Action 1.3: Definition of Scope and Delimitation of Study Area	17
2.3 Module 2: Definition of GI Demand	19
2.3.1 Action 2.1: Definition and Prioritisation of the Challenges for the GI Demand	19
2.3.2 Action 2.2: Mapping of the GI Demand (Action 2.2)	19
2.4 Module 3: Definition of Green Infrastructure Provision	24
2.4.1 Action 3.1: Development of a GI Map	24
2.4.2 Action 3.2: Selection of ESS for Analysis, Based on GI Demand	28
2.4.3 Action 3.3: ESS Spatial Analysis to Define Current GI Provision	29
2.5 Module 4: Unmet Demand Evaluation	37
2.5.1 Action 4.1: Spatial Analysis of GI Unmet Demand	37
2.6 Module 5: GI Deployment Map	40
2.6.1 Action 5.1: Opportunity Mapping Development	40
2.7 Module 6: Inform Planning	43
2.7.1 Action 6.1: Definition of GI Interventions for Integration into Local Planning	43
3 Barriers and enablers to Imola GI development	45
3.1 Analysis by dimension	45
4 Interactions along the project	47
5 Results and Final Remarks	50
5.1 Summary of key results on GI demand	50
5.2 Final Remarks	50
6 References	51

List of maps, figures, charts and tables

List of maps

Map 1 - Imola & NCI: Administrative Boundaries.....	9
Map 2 - Imola: Land-Use and Land-Cover.....	18
Map 3 - Imola: Spatial Analysis of Flood Risks	20
Map 4 - Imola: Spatial Analysis of Recent Flooding Events.....	21
Map 5 - Imola: Flooding Demand Area.....	21
Map 6 - Imola: Spatial Analysis of Heat Stress.....	22
Map 7 - Imola: Spatial Analysis of Heat Stress.....	23
Map 8 - Imola: Heat Stress Demand.....	24
Map 9 - Imola: Green Infrastructure Map.....	25
Map 10 - Imola: Green Infrastructure in the Urban Core.....	28
Map 11 - Imola: Soil Infiltration Capacities.....	30
Map 12 - Imola: Water Infiltration Capacities.....	31
Map 13 - Imola: Cooling Capacities	34
Map 14 - Imola: Cooling Capacities in the Urban Core	35
Map 15 - Imola: Heat Mitigation	35
Map 16 - Imola: Heat Mitigation in the Urban Core	36
Map 17 - Imola: Spatial Analysis of GI and ESS (Infiltration) Demand	37
Map 18 - Imola: Spatial Analysis of GI and ESS (Infiltration) Demand	38
Map 19 - Imola: Flooding - Unmet Demand Area	39
Map 20 - Imola: Heat - Challenge Area	39
Map 21 - Imola: Heat - Unmet Demand Area.....	40
Map 22 - Imola: Flooding - Opportunity Map.....	41
Map 23 - Imola: Heat - Opportunity Map	42

List of figures

Figure 1 Modules of ESPON GILL Methodology	13
Figure 2 - Stakeholder Meeting 1: Screenshots of the Used MIRO Board	47
Figure 3 - Stakeholder Meeting 2: Screenshots of the Used MIRO Board	48

List of tables

Table 1 - Data Inventory	17
Table 2 - GI Inventory: Main and Sub-Categories.....	27
Table 3 - GI Inventory: Statistics by Category.....	28
Table 4 - InVEST Cooling Module: Physical Parameters.....	32

Abbreviations

AMSS	Metropolitan Agenda for Sustainable Development
ARPAE	Regional Environmental Agency
CC	Cooling Capacity
CS	Case Study
EAFRD	European Agricultural Fund for Rural Development
EAFRD	European Agricultural Fund for Rural Development
ERDF	European Regional Development Fund
EU	European Union
GI	Green Infrastructure
HMI	Heat Mitigation Index
ISPRA	Institute for Environmental Protection and Research
LST	Land Surface Temperature
NETP	National Ecological Transition Plan
NRRP	National Recovery and Resilience Plan
PGRA	Flood Risk Management Plan
PTM	Metropolitan Territorial Plan
PUG	General Urban Plan
SHC	Stakeholder Consultation
UN	United Nations
WAR	Water Infiltration Capacity

ESPON GILL Project

ESPON GILL responds to the content outlined in the GCP Action Plan and indirectly supports other actions in the plan. The project has supported the six committed territories in the development, delivery, and implementation of the ESPON GILL Methodology, which is intended to be transferable and applicable to other regions across Europe. The task consists of multiple consultation and interaction, where the case studies teams were able not only to provide access to local knowledge, relevant documents, and data, but also to share their insights, provide guidance, compare their progress, and consequently to apply the method in their policy processes.

The contributions of the case studies in setting the scene, identifying needs, providing data, and validating the methodology were essential to the success of ESPON GILL. However, **it is important to note that the inputs provided by the participating municipalities – expressed in form of analysis, expectations, or preferences – do not constitute any formal commitment. The information shared is not legally binding in any way.**

Their involvement is aimed exclusively at validating the methodology and providing insights for its improvement by testing it in a real-world environment. This approach ensures that the ESPON GILL Methodology becomes as useful and relevant as possible for any municipality wishing to apply it in its own territory.

The municipalities designated as the Six ESPON GILL Case Studies are: Târgu Mureș (RO), Roeselare (BE), Tampere (FI), Imola (IT), Jastrebarsko (HR) and Sopot (PO).

This report focuses on Imola, Italy.

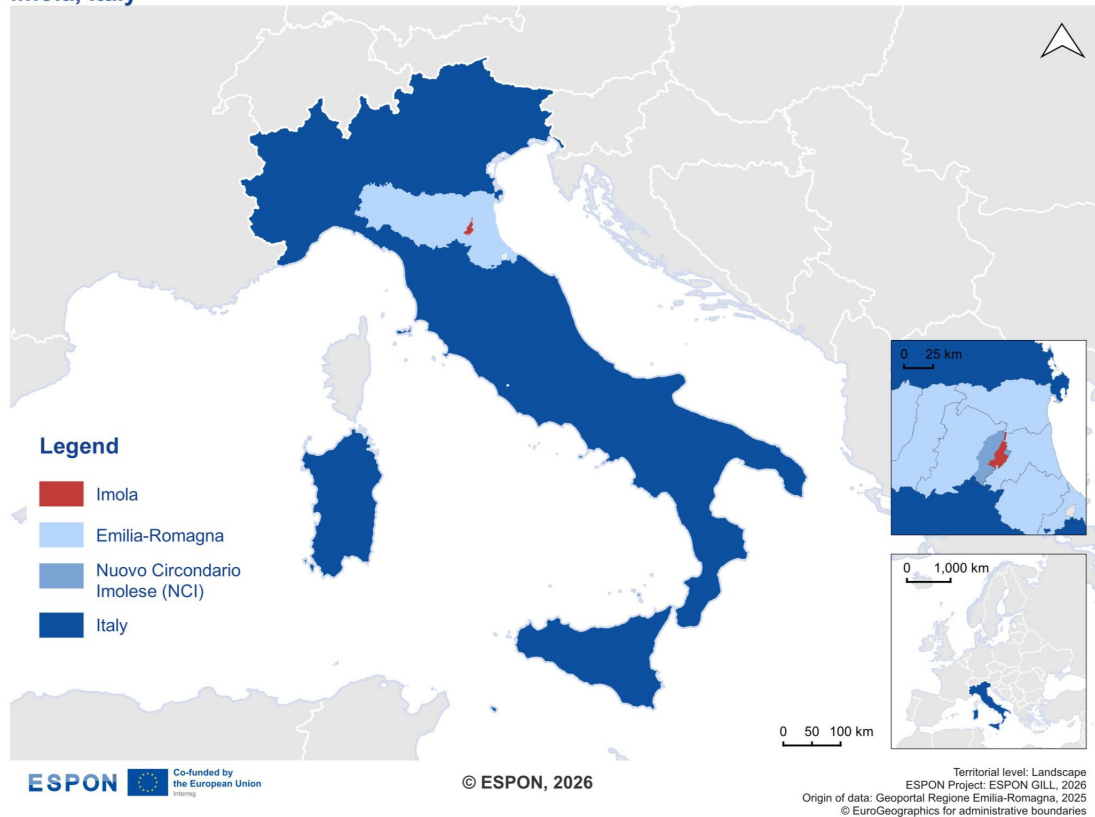
1 Imola in a Nutshell

1.1 Context

Imola is a medium-sized city and municipality located in northern Italy, within the Metropolitan City of Bologna, in the Emilia-Romagna region (Map 1). The city lies along the Santerno River, at the interface between the Po Valley plain and the first Apennine foothills. This geographical position gives Imola a mixed urban, agricultural, and peri-urban structure.

Imola is part of the Nuovo Circondario Imolese (NCI), a union of ten municipalities in the eastern part of the Bologna metropolitan area. The municipality covers approximately 205 km² and has a population of about 70,000 inhabitants.

Imola, Italy



Map 1 - Imola & NCI: Administrative Boundaries

Imola has large agricultural zones, mainly located in the flat areas north of the city. The southern part of the municipality is predominantly covered by rural areas, with a hilly landscape. Imola includes key natural areas, including the Parco delle Acque Minerali, located south of the city beyond the Santerno River, Parco Tozzoni, which is a large public park, and Bosco della Frattona, a regional protected natural reserve preserving remnants of ancient hill forests and hosting significant biodiversity.

1.2 Green Infrastructure – Policy Overview

1.2.1 National Planning Framework for Green Infrastructure

Italy does not have a single, dedicated national strategy for Green Infrastructure (GI). At the national level, GI is supported through several strategic planning and funding frameworks that address biodiversity protection, climate adaptation, and urban sustainability. The frameworks are the following:

- National Recovery and Resilience Plan (NRRP, 2021)
- National Biodiversity Strategy to 2030 (updated 2023)
- National Ecological Transition Plan (NETP, 2022)
- National Programme Metro Plus (PN Metro+, 2021–2027)

Overall, in Italy, spatial planning governance is multi-level and decentralised. Planning competences are delegated to regions and municipalities, making local spatial plans (e.g. *Piani Strutturali*, *Piani Urbanistici Generali*, and *Piani Operativi*) the main legally binding tools through which Green Infrastructure can be implemented. There is no national planning act specifically addressing GI; instead, national authorities provide strategic guidance, sectoral policies, and alignment with EU directives and funding instruments (e.g. European Regional Development Fund (ERDF), European Agricultural Fund for Rural Development (EAFRD), NRRP).

Green Infrastructure principles are addressed across multiple policy sectors, including spatial planning, water management, biodiversity conservation, agriculture, forestry, and climate adaptation. However, integration remains uneven, and GI is often treated implicitly rather than as a structured planning component.

1.2.2 Regional and Local Policies regarding Green Infrastructure

At sub-national level, GI is framed within a multi-level planning system, where regional and metropolitan strategies are progressively translated into inter-municipal (NCI) and local planning instruments.

At the regional level, Emilia-Romagna provides the strategic and funding frameworks that integrate climate actions, biodiversity protection and sustainable development objectives. Key instruments include the Emilia-Romagna Regional ERDF Programme 2021–2027, which provides financial resources to green transition priorities, the Emilia-Romagna Pact for Work and Climate (2023), providing a political and strategic framework for biodiversity, and the Regional Strategy for Sustainable Development 2030, aligning regional policies with the UN 2030 Agenda.

Together, these regional frameworks define strategic priorities and funding conditions, while the concrete planning and implementation of GI are carried out at metropolitan, and particularly at local levels.

At the metropolitan level, GI is addressed through strategic planning instruments developed by the Metropolitan City of Bologna. The main references are the Metropolitan Territorial Plan (PTM, 2021) and the Metropolitan Agenda for Sustainable Development (AMSS, 2021), which define objectives, strategies, and especially key quantitative targets for environmental protection across the metropolitan area.

At the inter-municipal level, the NCI plays a key role in adapting and translating metropolitan strategies through shared spatial planning, specifically through The General Urban Plan (PUG, 2023). This defines common strategies and actions for the sustainable development of the ten municipalities and includes explicit GI objectives.

Finally, these strategies are then operationalised into strategic projects at the local level. In this context, Imola has developed a strong local approach to Green Infrastructure, implemented under the CICLICA¹ strategy

¹ <https://www.comune.imola.bo.it/argomenti/lavori-pubblici/ciclca-citta-per-il-clima-che-cambia>

(City for the Changing Climate), which includes six innovative and concrete GI initiatives, some of which have received national and international recognition.

1.3 Imola Objectives on Green Infrastructure

Imola is characterised by a predominant green territorial structure. Green infrastructure areas cover around 80% of the municipal territory, mainly due to the extensive presence of agricultural and semi-natural land. The city also includes around 29,000 trees distributed across urban and peri-urban areas.

As part of the Metropolitan Agenda for Sustainable Development (AMSS, 2021) and the municipal CICALICA strategy, Green Infrastructure is identified as a key instrument to support climate adaptation, territorial resilience, and quality of life in Imola. Planned actions and objectives relate to:

- Reduction of urban heat and summer temperatures, through the creation of a continuous and connected urban green structure and the enhancement of vegetated and permeable areas.
- Flood risk reduction and management of intense rainfall, including the de-sealing of impermeable surfaces, increased infiltration, runoff reduction, temporary water retention, and controlled water discharge.
- Improvement of environmental quality and liveability, supporting health, well-being, and equitable access to green spaces for residents and visitors.
- Strengthening green continuity at urban and peri-urban scale, integrating green areas with public spaces and mobility corridors.

1.4 Data Context

Data were collected from national, regional, metropolitan, and local sources, covering spatial, environmental, and climatic information.

At the national level, data were obtained from ISPRA national database:

- Heat Evapotranspiration: raster dataset which provides spatial mapping of evapotranspiration conditions.

At the regional level, datasets are accessible through the Regional Geoportal – Emilia-Romagna (*Geoportale Ambiente*) or through ARPAE (*Agenzia regionale per la prevenzione, l'ambiente e l'energia dell'Emilia-Romagna*) for spatial data on:

- Orthophoto, land use land cover, urban greenery, tree inventory, urban green areas, flood risks areas, and water infiltration, soil properties.
- Hourly air temperature observations for the municipality of Imola.

At the metropolitan level, datasets are accessible through the Metropolitan Geoportal – Città Metropolitana di Bologna for spatial data on:

- Land-use and ecological datasets for natural ecosystems (agricultural land, forest ecosystems, shrubland, riparian zones, wetlands); protected areas (Natura 2000, parks and reserves); Hydrographic networks and active watercourses; administrative boundaries; spatial information on buildings, streets, parks.

At the local level, datasets are accessible through Local Geoportal – Imola WebSit (Territorial Information System) for datasets on:

- Urban parks and formal greenspaces; neighbourhood green areas, public gardens, playground and institutional/historical greenspaces.

Additional local-scale Land Surface Temperature (LST) data were provided for the municipality of Imola through data collection activities carried out within the Cool Noons project (Interreg), based on thermal camera surveys used to assess macro- and micro-climatic conditions in selected urban areas.

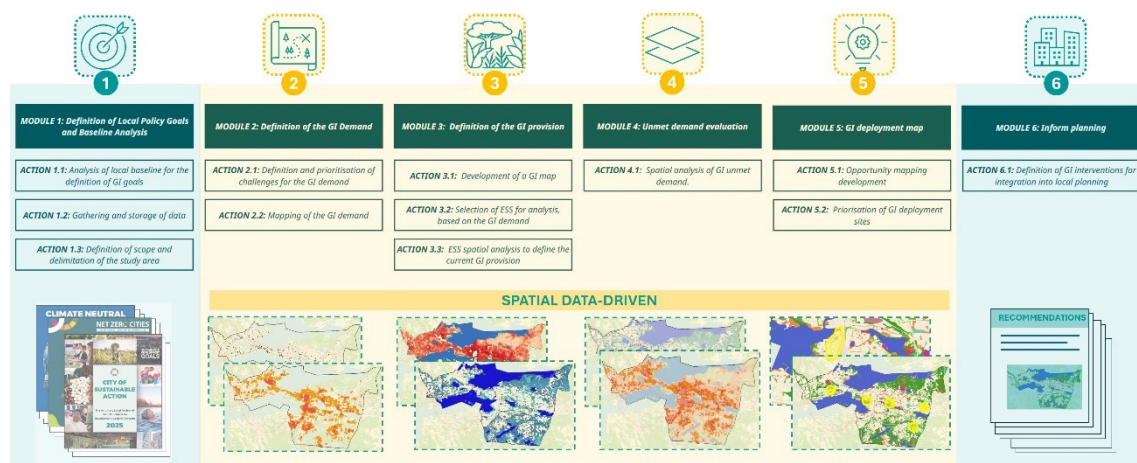
2 Implementation of ESPON-GILL Methodology in Imola

2.1 ESPON-GILL Map of Modules

ESPON GILL project aims to develop an **evidence-based, robust, scalable, and user-friendly methodology to guide policymakers and practitioners in quantifying the demand for Green Infrastructure (GI) at the local level**. The **ESPON GILL Methodology** emphasises the multifunctional, interconnected, and strategically planned nature of GI, facilitating its integration into urban planning processes. It links biophysical data—such as land-use, GI delineation, and characterisation of GI components—with both quantitative and qualitative expert assessments of ecosystem services (ESS) provision and demand, while also accounting for governance and socio-economic contexts.

The methodology is organized into standalone yet interconnected modules, each addressing a key component of the methodological process (Figure 1). This modular structure enables users to apply the methodology either sequentially or independently, depending on local priorities, available resources, previous work, and policy objectives. Each module generates specific outputs that can inform subsequent modules, facilitate collaboration with municipal departments, and support engagement with external stakeholders and civil society.

Figure 1
Modules of ESPON GILL Methodology



The ESPON-GILL Methodology has been applied at the landscape and urban level in Imola. Modules 1 to 5 were successfully implemented, enabling a comprehensive assessment of GI provision, demand and unmet demand, validated through the local stakeholder consultations. Module 6 was partially implemented, with its result being a proposal for a structured approach to support the integration of GI interventions within local planning instruments.

2.2 Module 1: Definition of Local Policy Goals and Baseline Analysis

2.2.1 Action 1.1: Analysis of Local Baseline for the Definition of GI Goals

For this Action, municipal plans and legislative instruments at both the local and national levels were identified, and their relationship with GI was assessed. These documents were also screened for objectives related to GI at the municipal level.

Methods applied / Resources used

Key documents, namely policy and planning frameworks and instruments, were collected, reviewed and analysed to identify GI-related content.

At the national level, the following frameworks were taken into consideration:

- National Recovery and Resilience Plan (NRRP, 2021)
- National Biodiversity Strategy to 2030 (updated 2023)
- National Ecological Transition Plan (NETP, 2022)
- National Programme Metro Plus (PN Metro+, 2021–2027)

Review of regional frameworks:

- Emilia-Romagna Regional ERDF Programme 2021–2027
- The Emilia-Romagna Pact for Work and Climate (2023)
- Regional Strategy for Sustainable Development 2030

Review of metropolitan frameworks:

- The Metropolitan Territorial Plan (2021)
- The Metropolitan Agenda for Sustainable Development (AMSS, 2021)

Review of local frameworks:

- The General Urban Plan (PUG, 2023)
- CICLICA strategy (City for the Changing Climate, 2022 -)

To validate the identified documents, collect policy and planning frameworks, and discuss the main objectives of the case study, bilateral meetings were held with representatives from the Metropolitan City of Bologna.

Results

National level:

At the national level, GI was found to be not explicitly defined nor regulated within the spatial planning system. National policies address GI only indirectly through sectoral objectives on biodiversity, climate adaptation and sustainability.

National Recovery and Resilience Plan (NRRP, 2021):

- Within NRRP, Mission 2 (Green Revolution and Ecological Transition) allocates about €55 billion (28.6% of total NRRP funds). Specific measures support the protection and enhancement of urban and peri-urban green areas (around €210 million).
- Key targets for 2021–2026 include planting 4.5 million trees and shrubs, creating 4,500 ha of new forests, and improving environmental quality in 14 metropolitan cities.

National Biodiversity Strategy to 2030 (updated 2023):

- The strategy aims to designate 30% of national land and sea areas as protected, with 10% strictly protected, and to restore 30% of degraded habitats and species, strengthening the Natura 2000 network and ecosystem restoration actions.

National Ecological Transition Plan (NETP, 2022):

- The NETP sets national targets for biodiversity, ecosystem services, and green infrastructure, including the expansion of protected areas from 10.5% to 30% and the reinforcement of monitoring and governance systems.

PN Metro Plus (PN Metro+, 2021–2027):

- PN Metro+ supports sustainable development in the 14 metropolitan cities, with a total budget of €2.6 billion (Bologna: €142 million). Under *Priority 2 - Environmental Sustainability*, the programme promotes climate adaptation, ecosystem-based approaches, biodiversity protection, and urban green infrastructure.

Regional level:

At the regional level, GI is not defined as a standalone planning category but is addressed through strategic frameworks and funding programmes related to climate action, biodiversity, and sustainable development.

Emilia-Romagna Regional ERDF Programme 2021–2027:

- The programme provides financial resources to green transition priorities, including decarbonisation, biodiversity, urban resilience, and the protection and enhancement of green spaces in cities and peri-urban areas. These priorities create concrete funding opportunities for GI-related actions at metropolitan and municipal levels.

The Emilia-Romagna Pact for Work and Climate (2023)

- It provides a shared political and strategic framework, promoting the protection of biodiversity, the expansion and upgrading of urban green spaces, and the sustainable management of natural resources and parks. Green Infrastructure is recognized as a cross-cutting tool supporting climate adaptation, environmental quality, and social well-being.

Regional Strategy for Sustainable Development 2030:

- This strategy aligns regional policies with the UN 2030 Agenda and promotes integrated approaches to environmental, economic, and social sustainability. It encourages local authorities and stakeholders to adopt nature-based and ecosystem-based solutions.

Metropolitan level:

At the metropolitan level, GI is more clearly addressed through strategic planning instruments that translate national and regional objectives into spatial strategies and quantitative targets.

The Metropolitan Territorial Plan (2021):

- It structures its vision around five main objectives. Among these, *Strategy 1 - Soil Protection* is particularly relevant for Green Infrastructure, as it aims to safeguard natural ecosystems, soil resources, water availability, and environmental quality, recognising GI as a key tool to ensure healthy living conditions and ecological functionality across different territorial contexts.

The Metropolitan Agenda for Sustainable Development (AMSS, 2021):

- This document aligns metropolitan policies with the UN 2030 Agenda. It explicitly recognises Green Infrastructure as essential for climate change adaptation, territorial resilience, and ecosystem service enhancement, and sets a quantitative target to increase urban green space to 45 m² per capita by 2030, representing a 50% increase compared to 2014.

Local level:

As GI is not directly defined in the national or regional planning system, the responsibility for its development and implementation lies with the inter-municipalities unions (in the case of Imola and the NCI, via the PUG – General Urban Plan), and especially with the municipalities, via GI-related, site-specific initiatives (e.g. CICLICA).

The General Urban Plan (PUG, 2023):

- It defines common strategies and actions for the sustainable development of the ten municipalities that belong to the NCI. The PUG includes explicit Green Infrastructure objectives, including:

- recognising existing green infrastructure as structural invariants
- improving the ecological functionality of the hydrographic network through reforestation and increased vegetation.
- supporting green and organic agriculture.
- promoting widespread reforestation policies.
- strengthening existing green spaces within urban areas.

The PUG also provides a definition of GI, which “Refers both to aspects that promote resilience, mitigation, and adaptation to climate change, and to aspects related to accessibility and public enjoyment within the city and the surrounding territory” (PUG, 2023).

CICLICA Strategy (City for the Changing Climate):

- CICLICA includes six initiatives addressing concrete GI objectives. A summary of each of them can be found below.

1. Hydraulic Risk Reduction and Safety of Urban Areas Adjacent to the Santerno River, from Ponte Tosa to the Railway Bridge (2025):

- The project focuses on reducing flood risk and improving the safety of urban areas along the Santerno River through hydraulic works and landscape reconfiguration. It combines river engineering with green and nature-based solutions to enhance ecological quality and resilience of river-adjacent public spaces.

2. Greenery that Unites: Ideas in Motion

- This project aims to co-design a green area through citizen participation, focusing on public space enhancement. It looks at turning open public spaces into places for socialising, inclusion, and climate change mitigation.

3. Cool Noons – Climate-Adapted Public Spaces (2022):

- This Interreg project addresses urban heat stress by redesigning public spaces exposed to extreme temperatures. It introduces shading, vegetation, and nature-based solutions to reduce thermal discomfort and improve liveability during heat waves.

4. Urban Regeneration for Climate Adaptation – Viale Andrea Costa:

- A street-scale urban regeneration project focused on climate adaptation. It integrates green infrastructure measures such as tree planting, permeable surfaces, and shaded areas into the redesign of public space to mitigate heat and improve environmental quality.

5. PINQuA: Regeneration of the Northern Urban Quadrant – Imola Railway Area:

- A comprehensive regeneration project targeting the northern urban area near the railway. The intervention combines green infrastructure, sustainable mobility, and urban renewal to improve connectivity, environmental performance, and overall quality of the urban fabric.

6. Urban Green Infrastructure and Sustainable Mobility:

- This project integrates reforestation and green corridors with cycling and pedestrian networks. It promotes sustainable mobility while enhancing ecosystem services, urban comfort, and residents' well-being.

The CICLICA framework defines GI in the Imola context as follows: “The urban green infrastructure of the city of Imola is defined as a continuous system composed of historic public parks, the riverside park, newly created public parks and gardens, urban gardens, and marginal areas - whether they are linear spaces left over from roadways, compensation areas awaiting use, or disused areas - integrated into a network by rows of trees lining roads or pedestrian and cycling paths.”

Building on this definition, during the first case study (CS) consultation, the local team defined GI as “not merely about decorative greenery or providing superficial comfort.” According to them, “it plays an active role in promoting sustainability, improving the environment, and combating climate change.” In this sense, they consider that “the projects presented – developed under the CICLICA framework by the Municipality of Imola

- serve this purpose by addressing issues such as urban heat islands and temperature reduction, contributing to climate change mitigation."

2.2.2 Action 1.2: Gathering and storing Data

This action consisted of the systematic collection, consolidation, and organization of relevant socioeconomic, biophysical, and land-use data that can be georeferenced and processed to assess the demand for GI within the municipality. The activity built upon the completed data inventory and roadmap, incorporating verified information from European, national, regional, metropolitan and local sources.

Methods applied / Resources used

1. Data inventory

Information layers were gathered through local, metropolitan, regional, national, EU and other sources (Table 1).

Level	Sources
Local	Imola online cartography & database – WebSite (Territorial Information System): urban parks and formal greenspaces; neighbourhood green areas, public gardens, playground and institutional/historical greenspaces.
Metropolitan	Bologna Metropolitan geoportal: land-use and ecological datasets for natural ecosystems (agricultural land, forest ecosystems, shrubland, riparian zones, wetlands); protected areas (Natura 2000, parks and reserves); Hydrographic networks and active watercourses; administrative boundaries; spatial information on buildings, streets, parks.
Regional	Regional Geoportal – Emilia-Romagna (<i>Geoportale Ambiente</i>): Orthophoto, land use land cover, urban greenery, tree inventory, urban green areas, flood risks areas, water infiltration and other soil ESS & properties. ARPAE (<i>Agenzia Regionale per la Prevenzione, l'Ambiente e l'Energia dell'Emilia-Romagna</i>): Hourly air temperature observations for the municipality of Imola.
National	ISPRA national database: heat Evapotranspiration dataset which provides spatial mapping of evapotranspiration conditions.
European	Copernicus Land Monitoring Service: Soil imperviousness, Urban Atlas, LUISA EEA data catalogue: WISE Freshwater data JRC data catalogue: KIP Inca datasets
Other	OpenStreetMap: orchards, farmland, recreation ground, allotments), small-scale urban elements (e.g. flowerbeds) and more landscape natural features (e.g. Grassland, wetland, mud, wood, scrub).

Table 1 - Data Inventory

2. Bilateral Meetings with CS:

A consultation with ARPAE, the Regional Environmental Agency, was carried out to validate and collect spatial and statistical data, and to discuss data gaps at the local level.

Results

A centralised GIS repository was developed, compiling a large amount of data related to the development of GI at the local level. The repository was organised according to the modules of the methodology and their different data requirements.

2.2.3 Action 1.3: Definition of Scope and Delimitation of Study Area

This action involved the selection of specific study areas within the municipality, based both on data availability and spatial relevance. The process aimed to ensure that the definition was particularly relevant in relation to the selected challenges and their territorial implications.

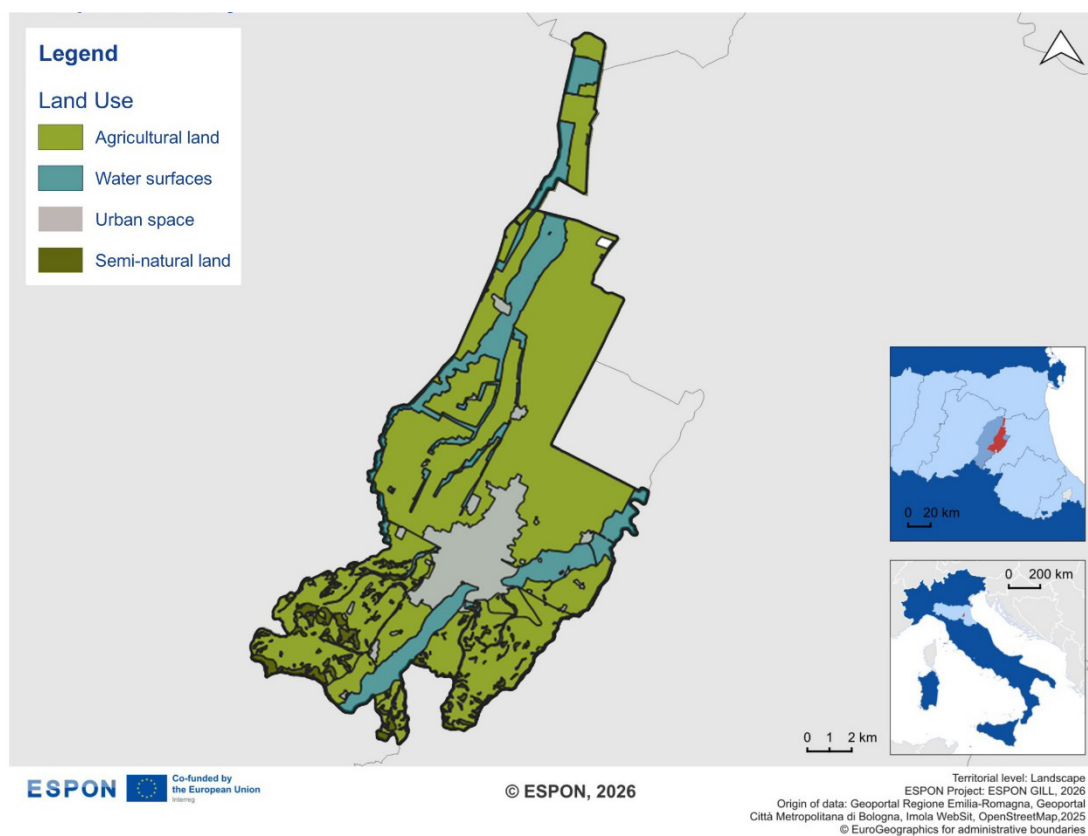
Methods applied / Resources used

The study area delimitation was carried out using a GIS-based spatial analysis, combining various datasets. Two main tasks were therefore performed:

1. Analysis of general local land use and land cover – based on datasets collected at regional level. This step was the initial approach to the territory and allowed for a general understanding of the municipality's land use categories and extension, particularly in relation to the dynamics surrounding the urban core.
2. Assessment of possible challenge areas at local level. Having understood the general land use structure of the region and taking into consideration the selected challenges (flooding as Challenge 1 and heat stress as Challenge 2), the study area is delineated, ensuring its characteristics align and point towards risk areas related to the challenges.

Results

According to land use and land cover datasets from the Regional Geoportal (2023), around 70% of the municipal territory consists of agricultural and semi-natural land (Map 2). As a result, the analysis focuses on the urban core of Imola, where GI demand and exposure to flood risk and heat stress are likely higher.



Map 2 - Imola: Land-Use and Land-Cover

2.3 Module 2: Definition of GI Demand

2.3.1 Action 2.1: Definition and Prioritisation of the Challenges for the GI Demand

Through this action, the main challenges to be addressed through GI were defined. These challenges serve as a framework for identifying priority areas where GI can generate the highest environmental and social benefits. Furthermore, they provide guidance for the development of targeted actions and the assessment of potential impacts at the urban scale.

Methods applied / Resources used

1. Policy and planning instrument analysis

A policy and planning framework screening and analysis were conducted to identify the most urgent urban challenges. Focus was given to local plans under the CICLICA framework, that highlight reduction of urban heat and summer temperatures, and flood risk reduction and management of intense rainfall as key challenges that need urgent attention at the local level.

2. Stakeholder Consultation (SHC2):

The main challenges were identified during the second Stakeholder Consultation (SHC) using a MIRO board. Participants were also asked to prioritise these challenges. It was confirmed that the challenges mentioned are consistent with local regulations and align with the environmental issues.

The territorial and urban challenges identified and listed by the CS during SHC2 are the following:

- Pollution
- Biodiversity loss
- Flooding
- Equity and health
- Urban Heat Island – lack of thermal regulation

3. Bilateral meeting with CS:

A follow-up discussion was held to validate the identified challenges with the CS representatives.

Results

Based on the above-mentioned methods, and given the availability of data for applying the methodology, the main challenges to be addressed through the methodology for Imola at the urban level were defined as:

1. Flood risks
2. Heat stress

2.3.2 Action 2.2: Mapping of the GI Demand (Action 2.2)

Through this action, the goal was to identify and spatially characterise the demand areas in relation to the challenges identified in 2.1.

- For Challenge 1, the analysis focused on identifying flood risks areas, and areas affected by recent flooding events.
- For Challenge 2, the analysis focused on identifying areas at the urban level affected by heat stress / lack of thermal regulation.

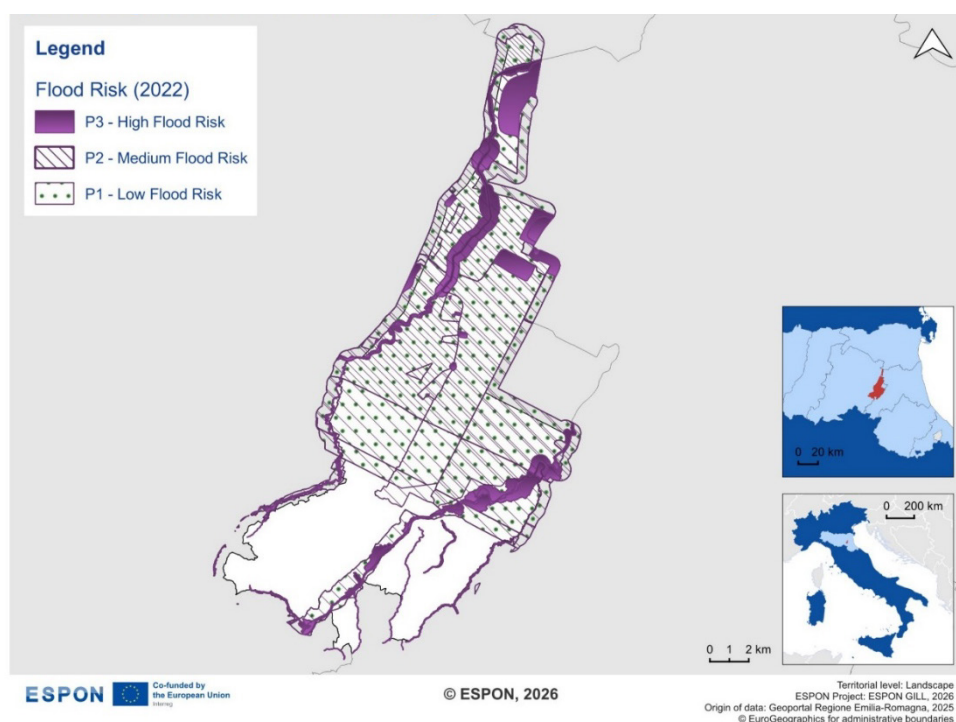
Methods applied / Resources used – Challenge 1

1. Flood risk areas spatial analysis

Geographic information and spatial datasets related to flood hazards were obtained from metropolitan and regional geoportals. Spatial mapping for Challenge 1 relied particularly on the 2022 regional flood-risk datasets, which classify the territory into three degrees of flood hazard.

These datasets and their classification system follow the official guidance² provided by the Emilia–Romagna Region. The hazard scenarios for floodable areas define three levels of flood risk (Map 3), which were applied directly to the Imola area:

- P1 - Low Flood Risk
 - Rare, extreme-intensity flood events
 - Return period: up to 500 years
 - Represents areas with low probability of flooding
- P2 - Medium Flood Risk
 - Less frequent flooding
 - Return period: 100-200 years
 - Represents areas with medium probability of flooding
- P3 - High Flood Risk
 - Frequent flooding scenarios
 - Return period: 20-50 years
 - Represents areas with high probability of flood events

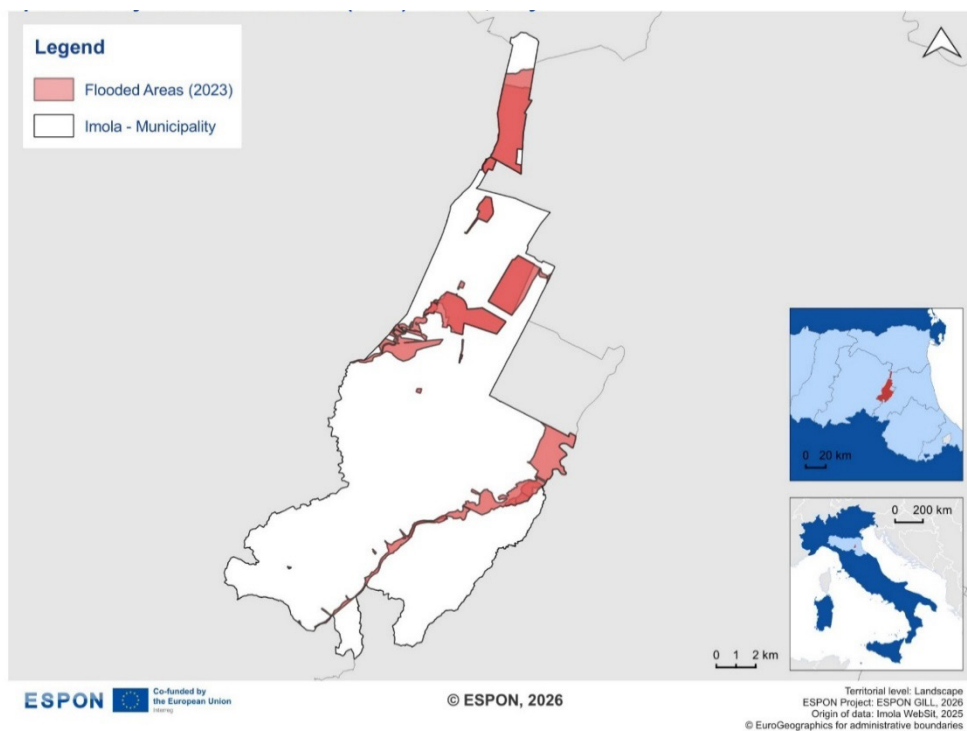


Map 3 – Imola: Spatial Analysis of Flood Risks

2. Analysis of recent flooding events

A desk-based review and analysis of recent flooding events was conducted through local sources (Imola Municipality website), with particular focus on floodings that took place in May 2023 and that affected the urban core of Imola (Map 4). These events were particularly disruptive for the city centre of Imola, causing damages to densely populated neighbourhoods and to the areas of the Enzo and Dino Ferrari Motor Racing Circuit. A spatial analysis of these affected areas was held to further define the demand area for this challenge, with datasets from the regional geoportal (2023).

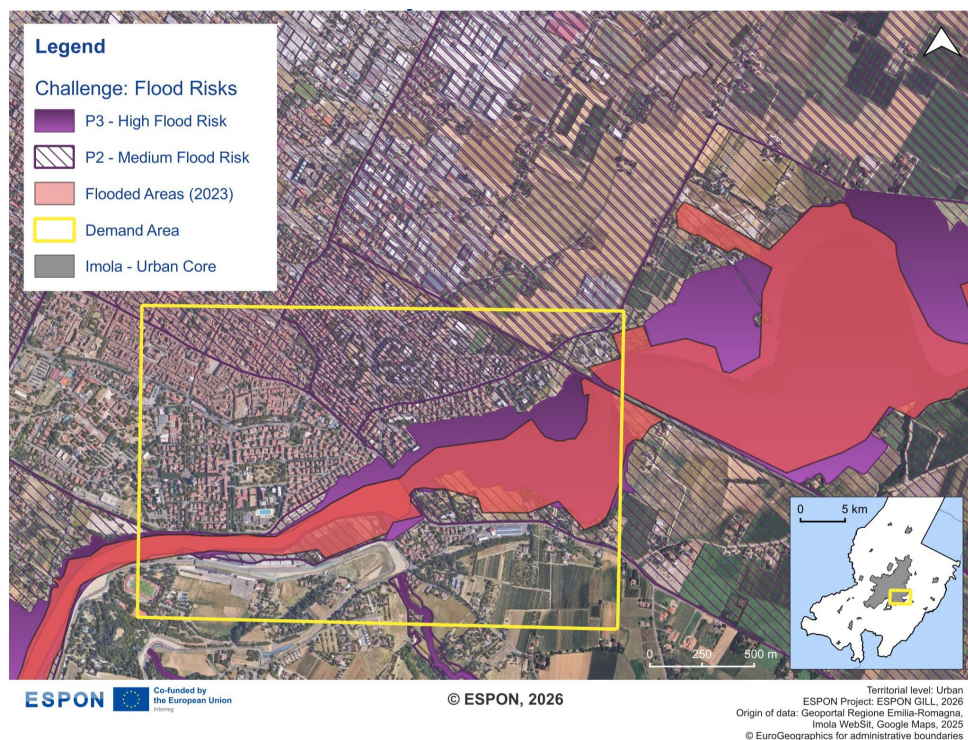
² https://ambiente.regione.emilia-romagna.it/it/suolo-bacino/sezioni/piano-di-gestione-del-rischio-alluvioni/guida_utilizzodati_download_mappe_2022_alli.pdf



Map 4 - Imola: Spatial Analysis of Recent Flooding Events

Results – Challenge 1

Combining flood risk areas scenarios (Map 3) for the River Santerno – being the one affecting the urban core - as well as the analysis of recent flooding events (Map 4), the demand area related to Challenge 1 focuses on densely inhabited urban areas in the urban core of Imola, which are considered flood risk areas (P2 & P3) and which were particularly affected by the flood events of May 2023 (Map 5).

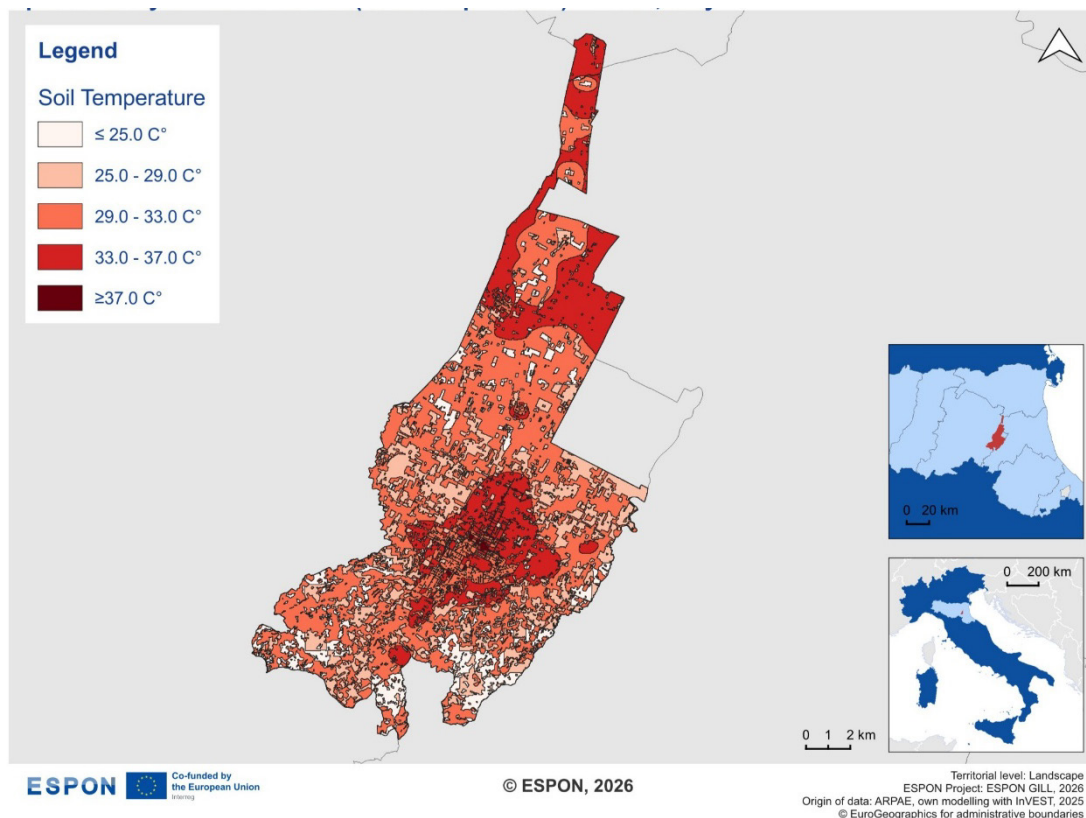


Map 5 - Imola: Flooding Demand Area

Methods applied / Resources used – Challenge 2

1. Spatial analysis heat stress areas

Spatial analysis of heat stress was carried out using the InVEST Cooling Module, based on soil surface temperature data from Summer 2025, derived from ARPAE observations (Map 6). The resulting map shows higher soil temperatures in the dense urban core of Imola.



Map 6 - Imola: Spatial Analysis of Heat Stress

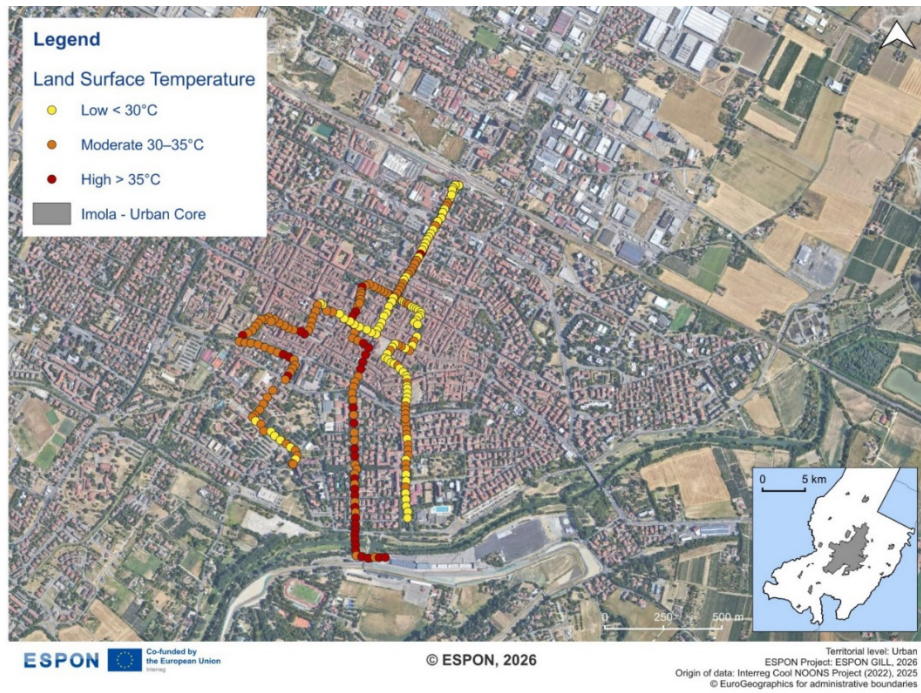
2. Bilateral meeting with CS and local spatial data analysis

A bilateral meeting was held with the CS representatives to discuss and validate the challenge map, and to define possible demand areas in the urban core of Imola. In this regard, Imola representatives provided access to local data collected through their involvement in the project Cool Noons (Interreg, 2022), which focuses particularly on heat island mitigation in Imola. The data includes Land Surface Temperature (LST) information collected through thermal camera images that determine the macro- and micro-climate for specific areas in the urban area of Imola. These areas represent the most crowded/visited areas identified by the City as suffering from high temperatures/lack of thermal regulation and are positioned along three defined popular paths (Map 7).

This additional information enabled the spatial mapping of challenge 2, identifying – over the paths – the areas most affected by high LST (and most vulnerable to heat stress) at the urban level. LST values were grouped into three degrees of stress (low, moderate, high) according to thresholds used in scientific literature to identify surface-driven heat exposure. Studies show that $LST > 35^{\circ}\text{C}$ is associated with higher potential for heat stress. However, since no universal thresholds were identified, the following classification, based on specific data collected for Imola, was used.

As mentioned, these areas are identified according to three different degrees of stress:

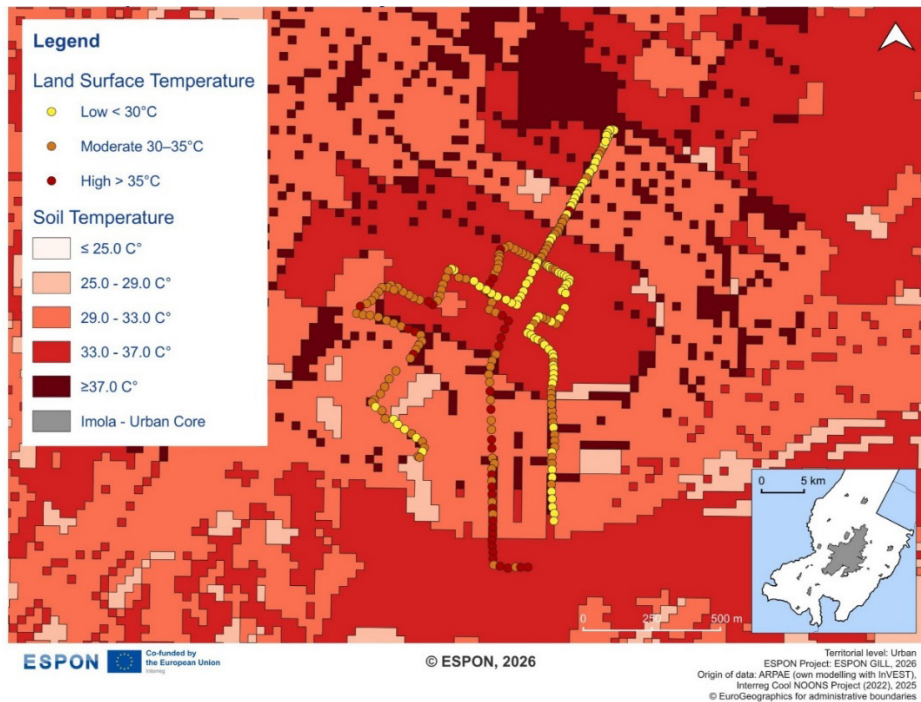
- Risk 1: lower stress zones – $LST < 30^{\circ}\text{C}$
- Risk 2: moderate stress zones – $LST 30\text{--}35^{\circ}\text{C}$
- Risk 3: high stress zones – $LST > 35^{\circ}\text{C}$



Map 7 - Imola: Spatial Analysis of Heat Stress

Results – Challenge 2

The combined analysis of soil temperature and local LST data highlights a clear concentration of heat stress within the urban core of Imola. The soil temperature spatial analysis (Map 6) shows that the highest temperature values (33.0–37.0 °C and >37.0 °C) are concentrated in the city's main urban core. These areas also correspond to the location of the three urban paths, which represent the most visited and crowded areas of the city and where several segments show moderate and high LST values (Map 7). Therefore, the demand area related to Challenge 2 is defined within the urban core of Imola, focusing on the most frequented areas, which are also the most affected by heat stress (Map 8).



Map 8 - Imola: Heat Stress Demand

2.4 Module 3: Definition of Green Infrastructure Provision

2.4.1 Action 3.1: Development of a GI Map

Through this action, a comprehensive spatial dataset of existing GI assets was created and standardised into a consistent typology applicable across the urban scale, with the goal of assessing the current provision of GI within the city of Imola. This process involved identifying, collecting, harmonising, and classifying multiple spatial datasets into the GI types identified throughout the project.

Methods applied / Resources used

A multi-source spatial data collection and harmonisation workflow was used to map and classify GI. The methodology relied on the integration of official regional, metropolitan, local, and open-source datasets into a GIS under one main layer. The main methodological steps included:

1. Spatial analysis

Collection of spatial datasets from public geoportals:

- Regional Geoportal – Emilia-Romagna (*Geoportale Ambiente*): Provided datasets on land use/land cover, urban greenery, tree inventory, and urban green areas classified at regional level.
- Metropolitan Geoportal – Città Metropolitana di Bologna (PTM Metropolitan Territorial Plan 2021): provided land-use and ecological datasets for natural ecosystems (agricultural land, forest ecosystems, shrubland, riparian zones, wetlands); protected areas (Natura 2000, parks and reserves); Hydrographic networks and active watercourses. These layers were key for mapping GI at the landscape level.
- Local Geoportal – Imola WebSit (Territorial Information System): provided detailed municipal datasets on urban parks and formal greenspaces; neighbourhood green areas, public gardens, playground and institutional/historical greenspaces. These datasets were key for mapping GI at the urban level.

Integration of OpenStreetMap (OSM) as complementary data source:

- OSM data were used to validate or supplement official datasets, especially in areas where local or metropolitan layers were incomplete. OSM contributed information on land-use categories at the urban level (e.g. orchards, farmland, recreation ground, allotments), small-scale urban elements (e.g. flowerbeds) and more natural features (e.g. grassland, wetland, mud, wood, scrub).

2. Harmonization into pre-defined GI typologies and GI inventory

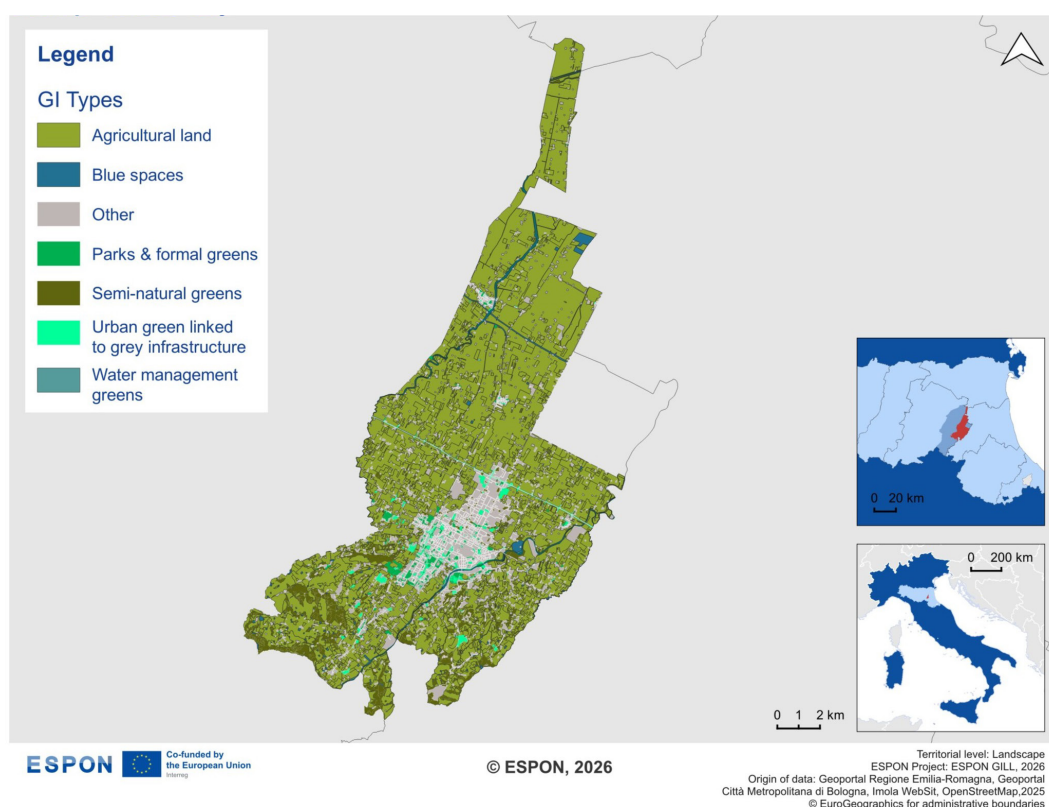
All collected spatial layers were imported into GIS and harmonized and classified under pre-defined GI categories and sub-categories:

- Urban Green Areas Connected to Grey Infrastructure
- Parks and Formal Greenspaces
- Semi-natural Greenspaces
- Agricultural Land
- Green Areas for Water Management
- Blue Spaces

3. GI map and inventory validation with CS representatives

A consultation with local stakeholders was held to discuss the inventory and the map, verify data accuracy and completeness, ensuring that the GI map, particularly at the urban core, captures all relevant GI (Map 9).

Results



Map 9 - Imola: Green Infrastructure Map

The complete GI inventory based on the pre-defined GI categories (Table 2):

GI Main Category	GI Sub-category	Attribute Name (translated)	Source
Agricultural land	Arable land	Agricultural areas of special naturalistic and landscape interest of the reclaimed plain	Metropolitan

GI Main Category	GI Sub-category	Attribute Name (translated)	Source
Semi Natural Green-spaces		Agricultural areas of the Alluvial Plain	Metropolitan
		Agricultural areas of the Reclaimed Plains	Metropolitan
		Agricultural areas in mountain–hillside in-travel valley zones	Metropolitan
		Agricultural areas in recharge zones type A	Metropolitan
		Agricultural areas on alluvial terraces vineyard	Metropolitan OSM
		Grassland	OSM
		Meadow	OSM
		Orchard	OSM
		Horticulture	OSM
		Forest	Metropolitan
		Parks and reserves	Metropolitan
		Protected areas and nature 2000 sites	Metropolitan
		Frattona Forest	Local
		Shrubland	Metropolitan
		Forest	Metropolitan
Parks and Formal Greenspaces	Neighbourhood green-space	Calanchivo ecosystem	Metropolitan
		Sand dunes	OSM
		Quarry	OSM
		Scrub	OSM
		Green area Dal Monte	Local
		Green area Lorde	Local
		Green area Mirabal	Local
		Green area Sansone	Local
		Green area Baden-Powell	Local
		Green area Cavallari	Local
		Green area Gullace	Local
		Green area Hack	Local
		Green area Ildegarda di Bingen	Local
		Green area Lavandaie (Le)	Local
		Green area Levi Montalcini	Local
		Green area Lombardi	Local
		Green area Marcellino	Local
		Green area Mozzoni	Local
		Green area Parco dell'Amicizia	Local
		Green area Saleem	Local
		Green area San Giovanni Paolo II	Local
		Green area Tabanelli	Local
		Green area Valla	Local
		Green area Victims of the Mafia	Local
		Garden Anders	Local
		Garden Anselmi	Local
		Garden Arendt	Local
		Garden Costa	Local
		Garden Croci	Local
		Garden Curti	Local
		Garden Dal Monte Casoni	Local
		Garden Martelli	Local
		Garden Marziale	Local
		Garden Mendes	Local
		Garden Minardi	Local
		Garden Nagy	Local
		Garden Trombetti	Local
		Vittoria Guadagnini	Local
		Garden (generic)	Regional
		Lawn (prato)	Regional
		Park Acque Minerali	Local
	Large urban park		

GI Main Category	GI Sub-category	Attribute Name (translated)	Source
	Historical park/garden	Park della Pace	Local
		Park Tozzoni	Local
		Park Acque Minerali	Local
		Park della Pace	Local
		Park Vittime dell'11 settembre 2001	Local
		Park Vittime della strage del 2 agosto 1980	Local
		Park Vittime di Cernobyl	Local
		Park Martiri delle Foibe già Limonaia	Local
		Pinewood "13 May 1944"	Local
		Garden San Francesco d'Assisi	Local
		Garden dell'Antifascismo	Local
		Garden Donatori del Sangue	Local
		Garden Donatori di Vita	Local
		Garden Europa Unita	Local
		Garden Barnabè	Local
		Garden Aviatori d'Italia	Local
		Garden Cardinale Dino Staffa	Local
		Garden Rambaldi	Local
		Giuseppina Strepponi	Local
		Scarabelli Square (Piazzetta Scarabelli)	Local
Urban green areas connected to grey infrastructure	Cemetery and church-yard	Cemetery (Cimitero)	Regional
		Grass	OSM
		Village green	OSM
	Tree alley and street tree/hedge	Trees (albero isolato)	Regional
	Street green and green verge	Aiuola (flowerstrip)	Regional
		Flowerbed	OSM
	Green parking areas	Galletti parking	Local
		Recreation ground	OSM
Green areas for water management	Riparian zones	Mountain, hill, and plain riparian zones	Metropolitan
		Plain riparian zones	Metropolitan
	Swales/filter strips	Mud	OSM
		Basin	OSM
Blue spaces	River/stream Wetland	Active watercourses	Metropolitan
		Humid Zone (wetland)	Metropolitan
		Water	OSM
		Reservoir	OSM
		Shingle	OSM

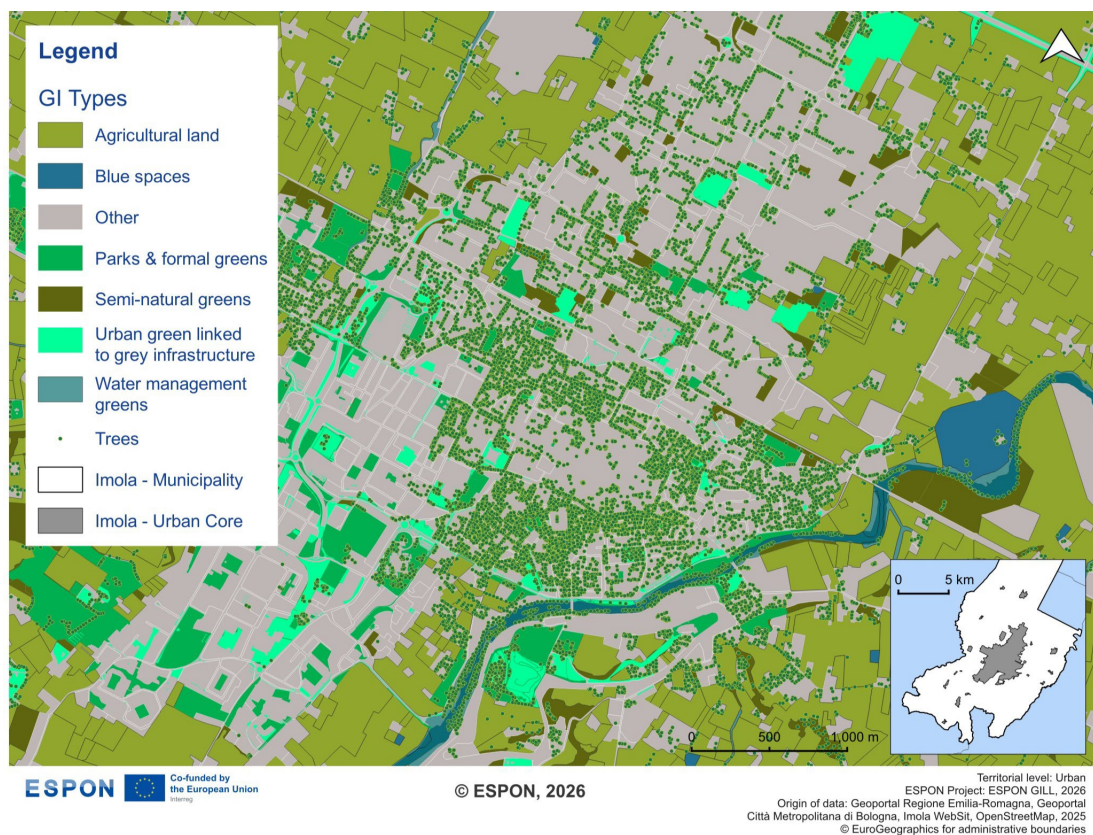
Table 2 - GI Inventory: Main and Sub-Categories

Statistics by category of GI (Table 3):

GI_Main	Total Hectares	% of total
Blue spaces	640.9	3
Water management greens	326.1	1.5
Semi-natural greens	1207.7	5.7
Other	3387.3	16
Agricultural land	15104.7	71.1
Urban green linked to grey infrastructure	239.1	1.1
Parks & formal greens	321.2	1.6

Table 3 - GI Inventory: Statistics by Category

This data, however, does not include tree information. According to regional data from 2022, there are 28,928 trees, with many of them in the main urban core of Imola.



Map 10 - Imola: Green Infrastructure in the Urban Core

2.4.2 Action 3.2: Selection of ESS for Analysis, Based on GI Demand

Based on the assessed challenges, following the identification of the GI demand's spatial dimension, and according to the data availability and the consultation with the CS representatives, this action focused on identifying and prioritizing specific Ecosystem Services (ESS) that contribute to mitigating the challenges identified above.

Methods applied / Resources used

1. Identification of ESS relevant to GI demand:

Following policy goals and particularly priority GI demands, the most relevant ESS for GI provision assessment was determined.

2. Stakeholder Consultation (SHC2):

The main ESS were confirmed during the second Stakeholder Consultation (SHC) using a MIRO board. Participants were also asked to prioritise these ESS.

Results

1. For flood risks – the selected ESS was water infiltration (regulation runoff and base flows; regulation of peak flows; surge and flood wave mitigation). This ecosystem service is based on the ability of vegetation

to regulate base and peak water flows and runoffs, and to store excess water in green spaces such as floodplains.

2. For heat stress – the selected ESS was cooling and heat mitigation (regulation of temperature and humidity, including ventilation and transpiration at local scales). This ecosystem service is based on the ability of vegetation to mediate the ambient atmospheric conditions (micro- and meso-climate) through evapotranspiration.

2.4.3 Action 3.3: ESS Spatial Analysis to Define Current GI Provision

Through this action, an analysis of the spatial distribution of ESS was carried out:

- For ESS 1, the focus was the spatial analysis of water infiltration.
- For ESS 2, the focus was the spatial analysis for cooling and heat mitigation.

Methods applied / Resources used – Water Infiltration

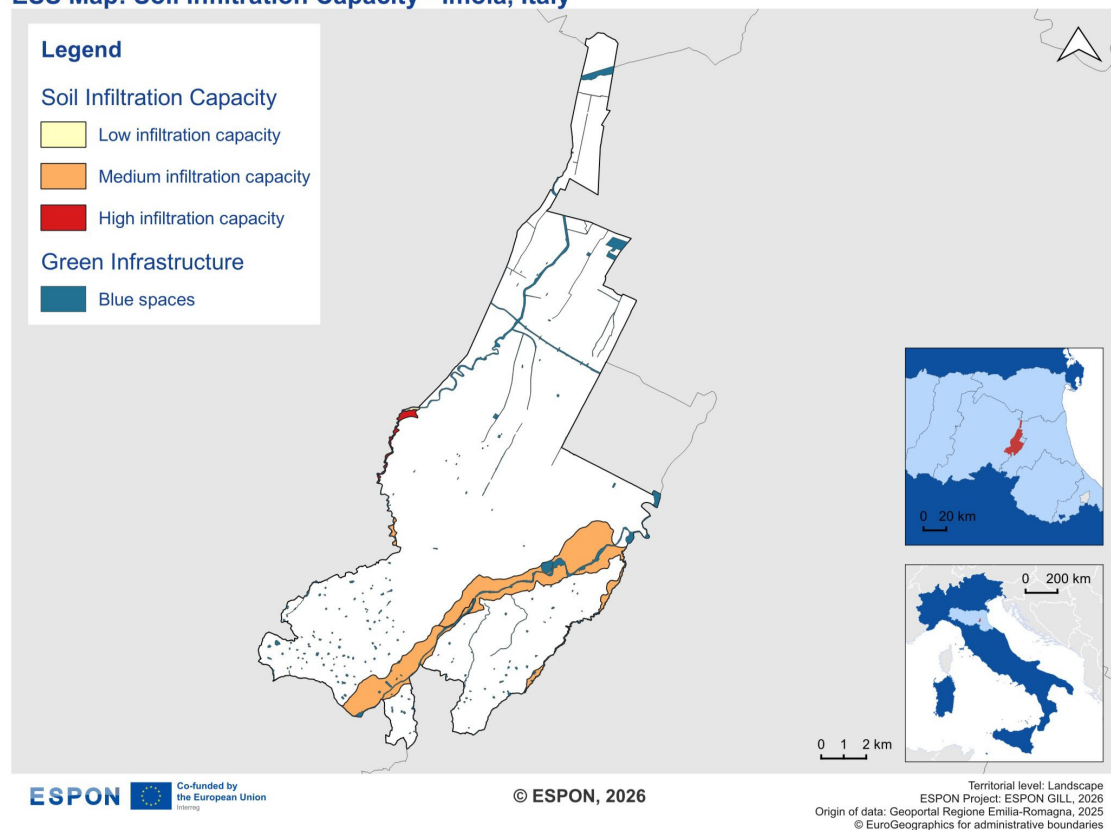
Selection of spatial datasets from public geoportals and spatial analysis:

1. Regional Geoportal – Emilia-Romagna (*Geoportale Ambiente*): spatial datasets on soil capacity (2021) were identified. They include information on soil infiltration capacity and flood-risk conditions.

Accompanying this dataset, a guide³ classifies soils into three groups, according to different degrees of capacity for water infiltration (Map 11). The classification is as follows:

- III: Low infiltration capacity – soils subject to frequent flooding accompanied by some crop damage
- II: Medium infiltration capacity – soils subject to occasional harmful capacity
- I: High infiltration capacity – soils not subject to harmful flooding

³ https://mappegis.regione.emilia-romagna.it/gstatico/documenti/dati_pedol/CAPACITA_USO.pdf

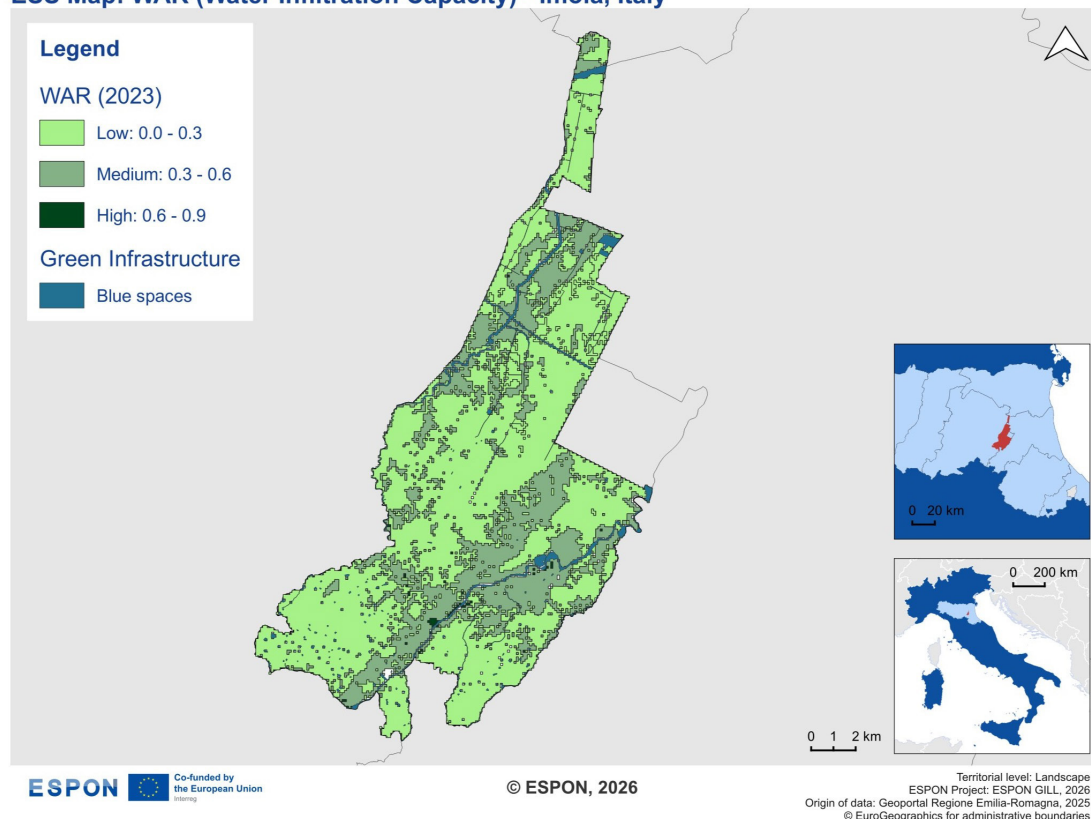
ESS Map: Soil Infiltration Capacity - Imola, Italy**Map 11 - Imola: Soil Infiltration Capacities**

2. Regional Geoportal – Emilia-Romagna (*Geoportale Ambiente*): spatial data on soil capacity and ecosystem services (2023), including water infiltration capacity (WAR) (Map 12).

According to the accompanying technical guide, water infiltration is defined under Water regulation / control of runoff, which reflects potential flood mitigation through soil functions, such as storage, filtration, and transformation of nutrients and water.

WAR is classified as follows:

- WAR 1 (0.0–0.3): Low water infiltration capacity
- WAR 2 (0.3–0.6): Medium water infiltration capacity
- WAR 3 (0.6–0.9): High infiltration capacity

ESS Map: WAR (Water Infiltration Capacity) - Imola, Italy**Map 12 - Imola: Water Infiltration Capacities****Results – ESS Water Infiltration**

The spatial analysis of both datasets (soil infiltration capacity (from 2021) and WAR ecosystem service mapping (from 2023)) shows that medium to low infiltration capacity is prevalent across large parts of the municipal territory, particularly in agricultural and peri-urban areas. Areas with medium to higher infiltration capacity are mainly concentrated along the Santerno River corridor and in urbanized zones in the urban core of Imola.

However, when these results are compared with recent flooding events in the Emilia-Romagna plain (particularly those from 2023), and with the spatial extent of flooded areas within the urban core of Imola, limitations in the accuracy and temporal representativeness of the datasets become evident. As also noted in the technical guides⁴ from regional sources (Regione Emilia-Romagna), increasingly intense and concentrated rainfall events may reduce effective soil infiltration capacity over time, particularly in areas currently classified as having medium or high infiltration capacity, such as those along the Santerno River. These considerations highlight a potential mismatch between the mapped infiltration capacity and observed flood impacts and are therefore considered in the following analysis steps.

⁴ https://mappegis.regione.emilia-romagna.it/gstatico/documenti/dati_pedol/CAPACITA_USO.pdf

Methods applied / Resources used – Cooling / Heat Mitigation

I. Approach and dataset selection for ESS: InVEST urban cooling model spatial analysis

Due to increased heat waves and thermal pressures, especially at the urban scale, assessing heat mitigation becomes a priority for Imola. However, this requires datasets that are either not available at the local (or regional) scale or that lack granularity⁵ for the case of Imola. The developed InVEST Urban Cooling Module⁶ addressed this limitation. The model calculates an index of heat mitigation based on shade, evapotranspiration, and albedo, as well as distance from cooling islands (e.g. parks). The following steps were taken to complete the module – also informed by the guidelines developed by LINKS foundation within the scope of the UP2030 project and Milano metropolitan area case study implementation: “Ecosystem Services Assessment of Urban Green Areas in Milan: A Methodology based on the open-source tool InVEST”:

- Creation of land use/land cover raster from land use shapefiles from regional geoportal (2023).
- Biophysical table: a table mapping each LULC codes to biophysical data – with each LULC value having a corresponding entry in the table.
 - The physical parameters were assigned by AI-based on planning-level, literature and EU-level references and assumptions, and were not locally calibrated.

lucode	kc	green_area	shade	albedo	building intensity
1	0.2	0	0.2	0.18	0.95
3	0.3	0	0.35	0.1	0.85
6	0.5	0	0.7	0.25	0.7
8	0.2	0	0.15	0.2	0.5
11	1.2	1	1	0.2	0
12	1.1	1	1	0.25	0
13	1	1	0.8	0.3	0
14	0.9	1	0.2	0.25	0
15	0.5	0	0	0.3	0
17	1.2	0	0	0.05	0

Table 4 – InVEST Cooling Module: Physical Parameters

- Area of interest: vector – map of the Imola municipal boundary over which the results are aggregated and summarized.
- Evapotranspiration: raster from ISPRA database, which provides national-scale mapping of Potential Evapotranspiration (ETP) in raster format, with a 1 × 1 km spatial resolution (2022).
- Reference air temperature: A single scalar value (°C) representing air temperature without UHI influence, used as a baseline. The reference air temperature was defined as the average nocturnal air temperature under summer conditions, representative of periods with maximum Urban Heat Island (UHI) intensity. Hourly air temperature observations for the municipality of Imola were obtained from the ARPAE meteorological station dataset⁷. The analysis focused on the summer period (June 1 – August 31) and on evening–nighttime conditions, selecting observations recorded at 22:00, when land-use effects on air temperature are most pronounced. For the year 2022, all temperature values meeting these temporal criteria were extracted and averaged. The resulting mean air temperature,

⁵ Zawadzka, J. E., et al. (2021)

⁶ <https://naturalcapitalalliance.stanford.edu/invest/urban-cooling>

⁷ ARPAE ERG5 Dataset: <https://dati.arpae.it/dataset/erg5-interpolazione-su-griglia-di-dati-meteo>

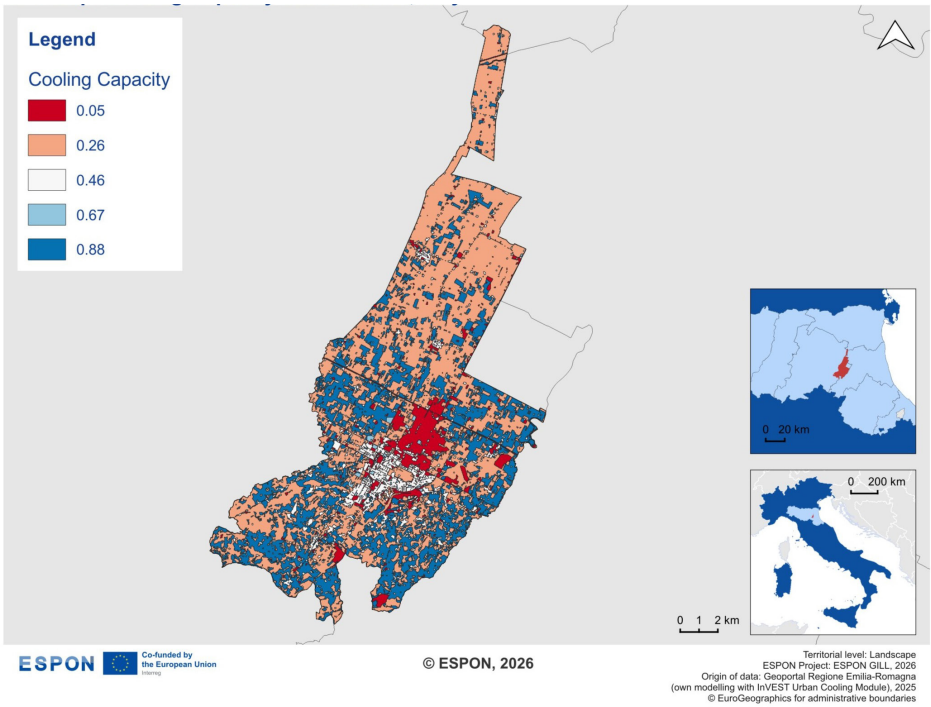
equal to **22.8 °C**, was adopted as the reference air temperature for Imola and used for the calibration of the model.

- UHI effect: The UHI effect was quantified as the temperature difference between the maximum air temperature observed during the summer period (June–August 2022) and the reference nighttime air temperature (mean at 22:00 over the same period). For Imola, this resulted in a UHI effect of 15.87 °C.
 - $T_{\max}=38.7$
 - $T_{\text{ref}}(22:00 \text{ mean}) = 22.83369565 \text{ °C}$
 - $\Delta T=38.7-22.83369565=15.87 \text{ °C}$
- Air Blending distance: represents the radius within which air temperatures are spatially averaged to account for atmospheric mixing processes. Air mixing in urban environments is influenced by temperature gradients, wind conditions, and physical obstacles such as buildings and terrain. To realistically represent these effects, it is necessary to consider the influence of surrounding areas within a defined mixing radius. Based on the reported and suggested InVEST scientific literature a search radius between 500 and 600 meters has been shown to provide reliable results (Schatz and Kucharik, 2014; Lonsdorf et al., 2021). Consistent with these findings, an air blending distance of **600 m** was adopted for the city of Imola.
- Maximum cooling distance: The maximum cooling distance represents the distance over which green areas larger than 2 hectares exert a cooling effect on the surrounding urban environment. For green spaces exceeding this threshold, the cooling effect is assumed to extend beyond the boundaries of the green area and influence adjacent areas. This distance is set to **450 m**, in accordance with values suggested in InVEST references.
- Cooling capacity calculation method: can be based on two alternative approaches: the Factors method or the Intensity method. The Factors approach uses weighted values of shade and albedo as predictors of air temperature and is typically applied to daytime scenarios. The Intensity approach relies on building intensity (i.e., built density) as the primary predictor and is generally used for nighttime scenarios. For this application, the Factors method was selected.

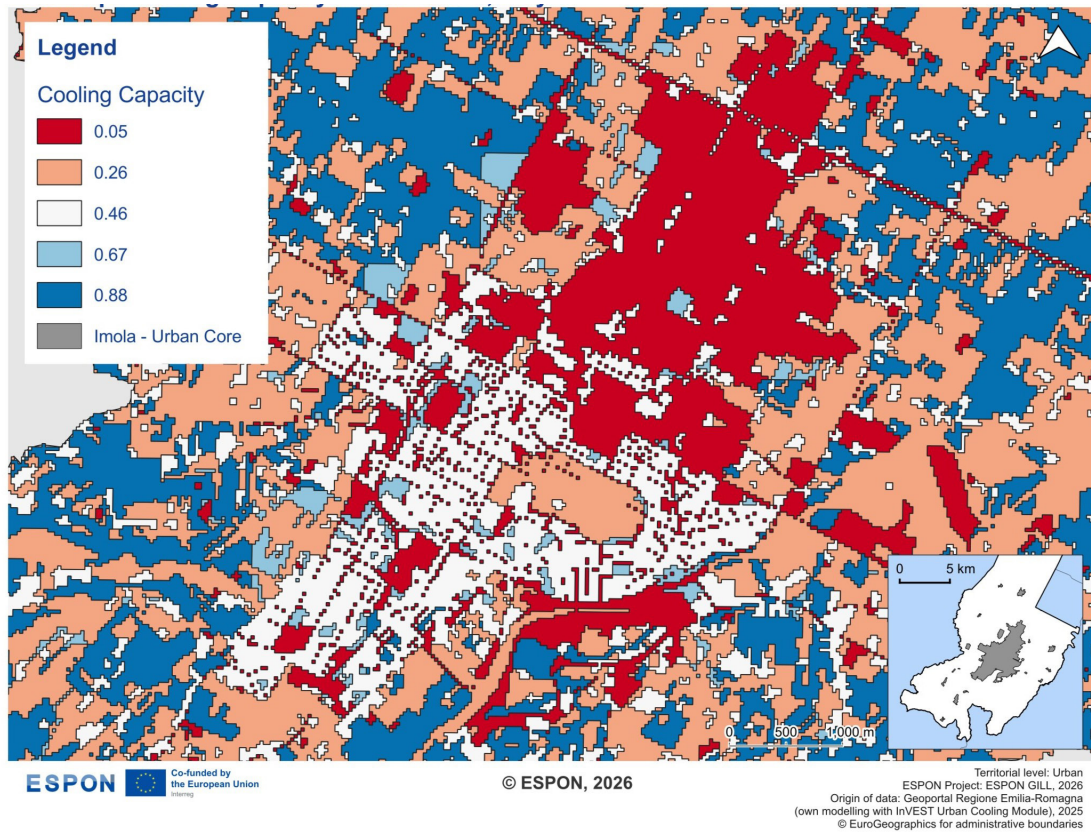
Results – ESS Heat Mitigation

The Urban Cooling Model results in various outputs, including two main summarizing raster images, which were then converted into vectors for readability and layers harmonization (Maps 13-14).

1. Cooling Capacity (CC): computes the cooling capacity index for each pixel based on local shade, evapotranspiration, and albedo.

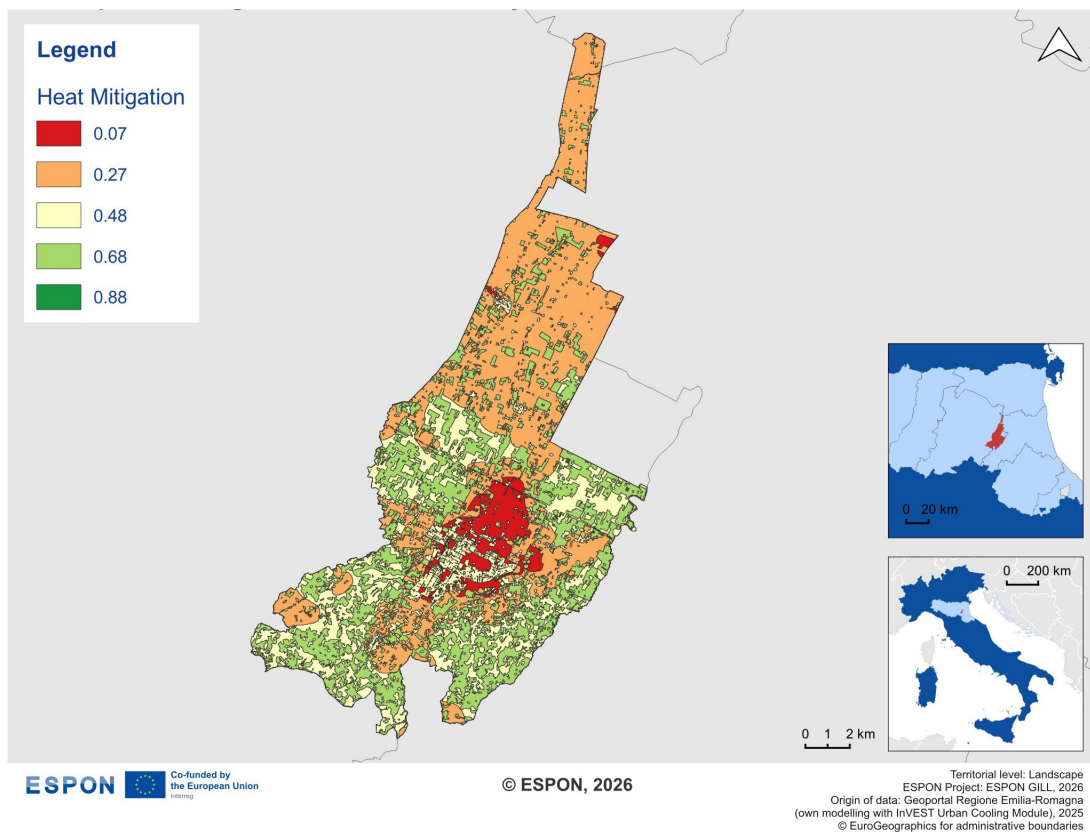


Map 13 - Imola: Cooling Capacities

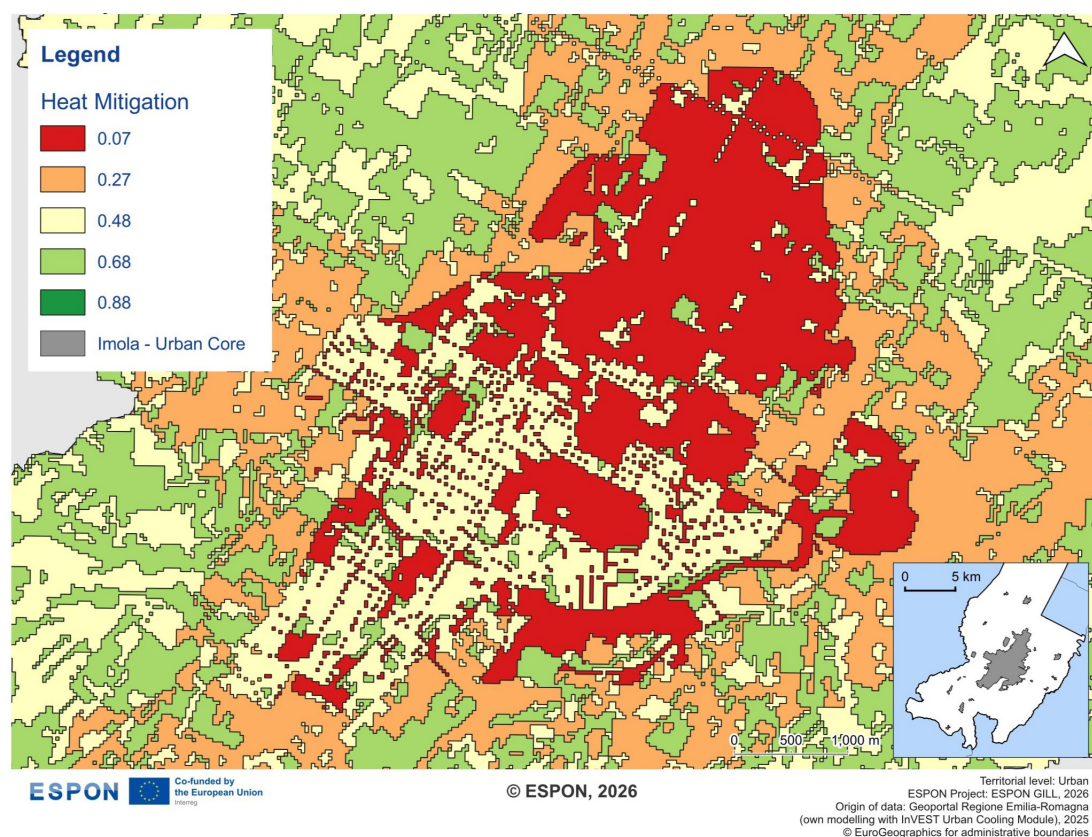


Map 14 - Imola: Cooling Capacities in the Urban Core

- Heat Mitigation: computes Heat Mitigation Index (HMI), to calculate the CC effect of large green spaces (>2 ha) on surrounding areas (Maps 15-16).



Map 15 - Imola: Heat Mitigation



Map 16 - Imola: Heat Mitigation in the Urban Core

These maps represent the final output of the InVEST model and highlight a low cooling capacity and heat mitigation index in the dense urban core of Imola, particularly in areas characterized by continuous built-up fabric, industrial buildings, and major infrastructures such as railway lines and primary road corridors. In contrast, higher cooling capacity values are observed in correspondence with the main urban and peri-urban green areas, where vegetation cover and evapotranspiration contribute more effectively to local temperature regulation. The maps also show a clear contrast between the urban core, where cooling capacity is consistently low, and the surrounding agricultural and semi-natural areas, which show generally higher cooling capacity values. This spatial pattern reflects the role of extensive vegetated and permeable surfaces in supporting regional cooling processes.

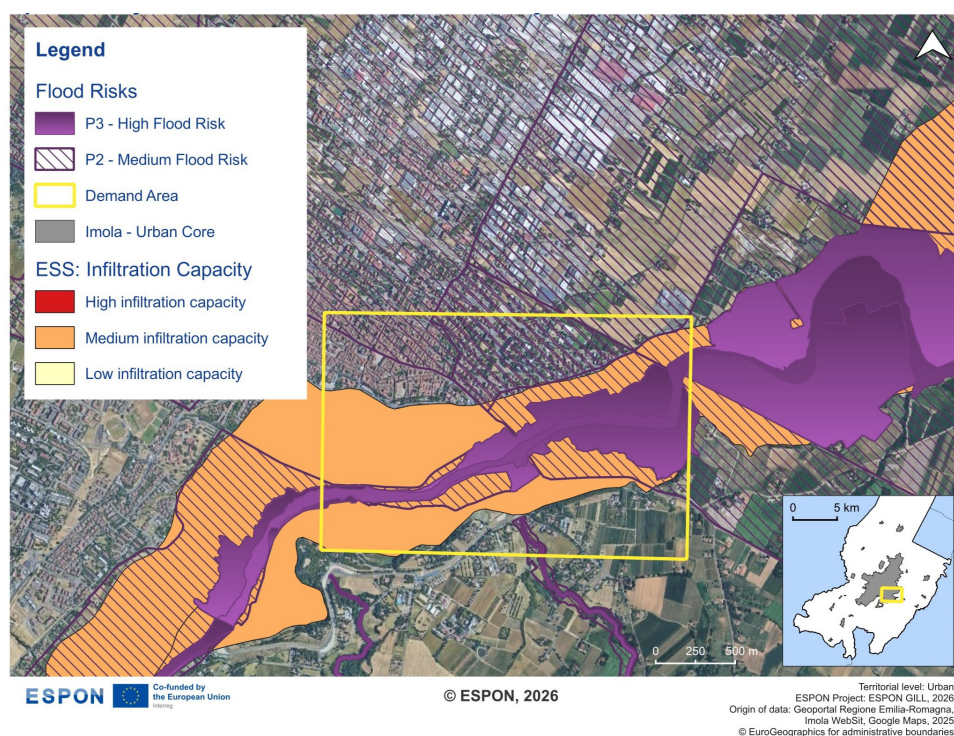
2.5 Module 4: Unmet Demand Evaluation

The aim of Module 4 is to identify spatial mismatches where GI demand is not fully addressed by existing GI. It provides a spatially explicit assessment of unmet demand.

2.5.1 Action 4.1: Spatial Analysis of GI Unmet Demand

Methods applied / Resources used – Flood Risks and Water Infiltration

The analysis of GI unmet demand focused on identifying areas where soil infiltration capacities of the green infrastructure do not compensate or match the zones where flood risks are also high, meaning water cannot be sufficiently retained, infiltrated or controlled. The main input for this analysis was taken from the results of Action 2.2 and Action 3.3, spatial maps which were overlapped and compared (Map 17).

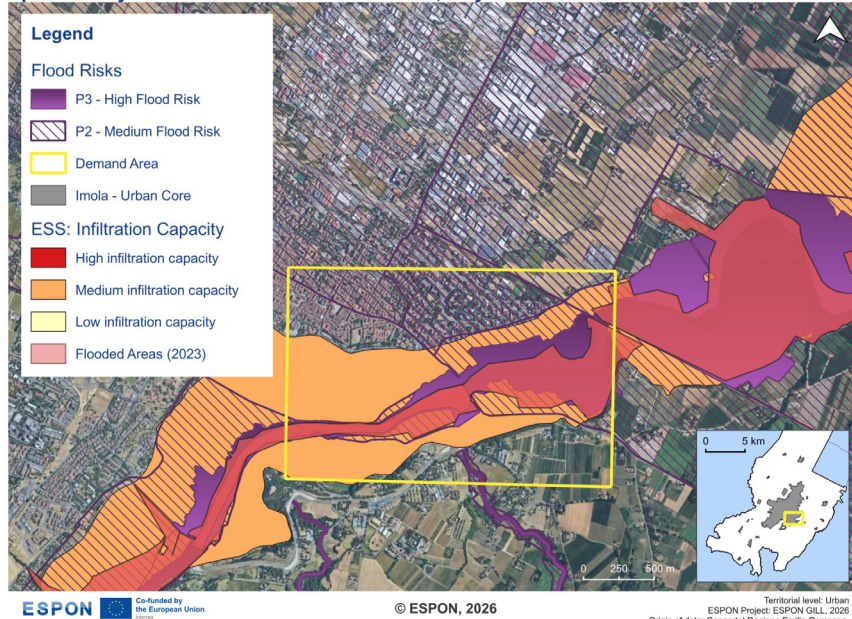


Map 17 - Imola: Spatial Analysis of GI and ESS (Infiltration) Demand

When considering only the areas categorized as with high infiltration capacities within the entire municipal territory, it became clear that they are insufficient in respect to the areas with high flood risks. The GI demand in the analysed zone, defined under Action 2.2 as the demand area, is met by medium infiltration capacity areas.

However, when considering the empirical data obtained from recent flooding events (Map 18, showing the spatial effects of floods from 2023), it becomes evident that the flood risk areas were not properly served by the existing ESS provision, and still resulted in floodings. This spatial data points at the data limitations mentioned in Action 3.3, leaning towards the hypothesis that areas that are currently classified as having medium or high infiltration capacities (such as those along the Santerno River) are likely characterized by low infiltration capacities instead.

Spatial Analysis of GI and ESS Demand - Imola, Italy



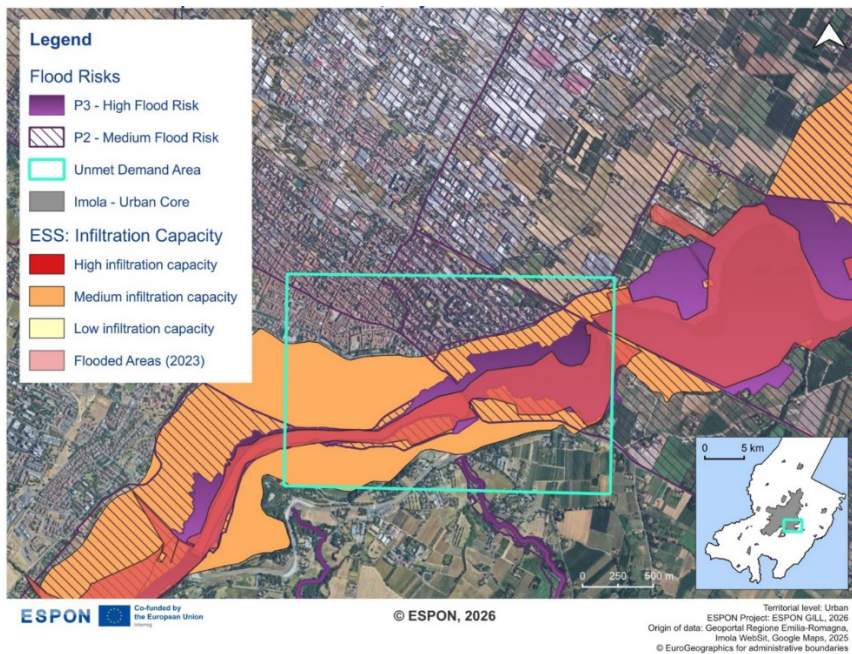
Map 18 - Imola: Spatial Analysis of GI and ESS (Infiltration) Demand

Results – Unmet Demand for Flood Risks

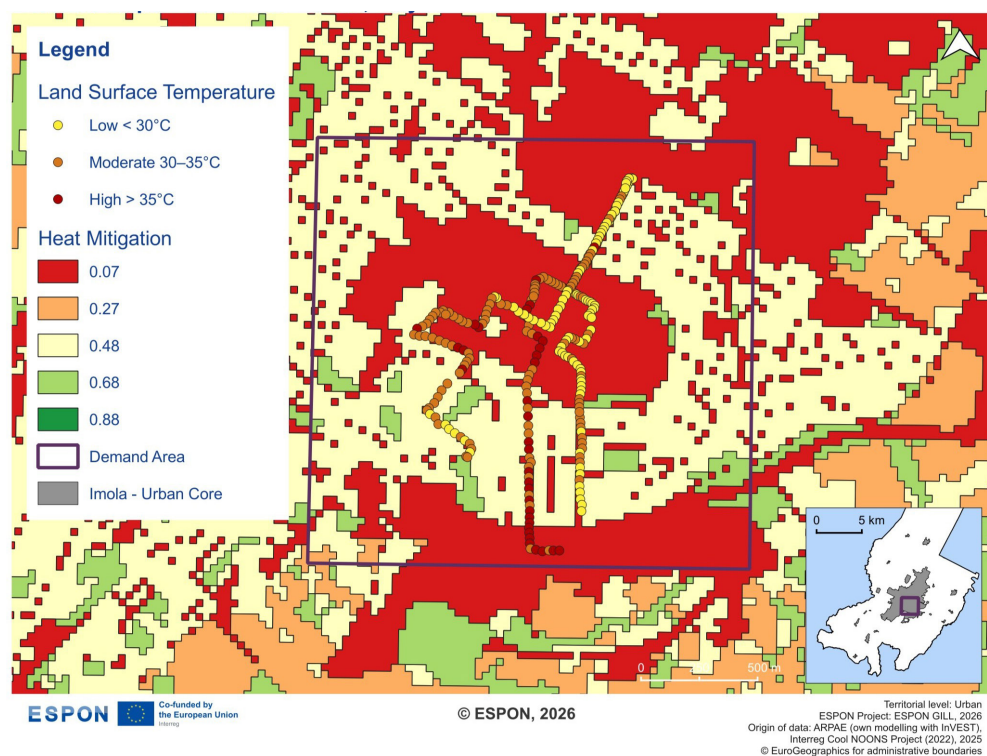
As a result of the analysis, it becomes clear that despite the existence of GI in the demand area, the associated ESS provision is lower than the corresponding demand. The unmet demand area remains thus equivalent to the demand area (Map 19).

Methods applied / Resources used – Cooling and Heat Mitigation

The analysis of GI unmet demand focused on identifying areas where measured land surface temperatures were critical despite the existing ESS provision of heat mitigation/cooling capacities, particularly due to low temperature regulation capacity levels. The main input for this analysis was taken from the results of Action 2.2/3.3, spatial maps displaying heat stress points and mitigation capacities, overlapped and compared (Map 20).



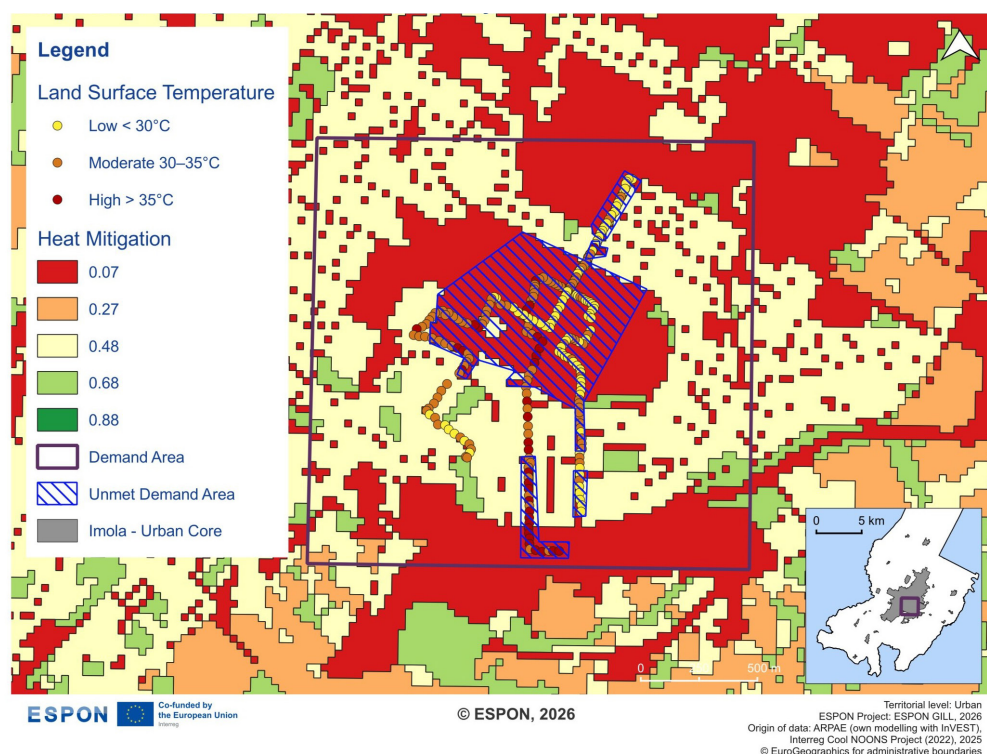
Map 19 - Imola: Flooding - Unmet Demand Area



Map 20 - Imola: Heat - Challenge Area

Results – Cooling and Heat Mitigation

The unmet demand area is thus identified in those zones where the assessed LST paths, particularly through high and moderate points of heat stress, overlap with the lowest heat mitigation capacity areas (Map 21).



Map 21 - Imola: Heat - Unmet Demand Area

2.6 Module 5: GI Deployment Map

2.6.1 Action 5.1: Opportunity Mapping Development

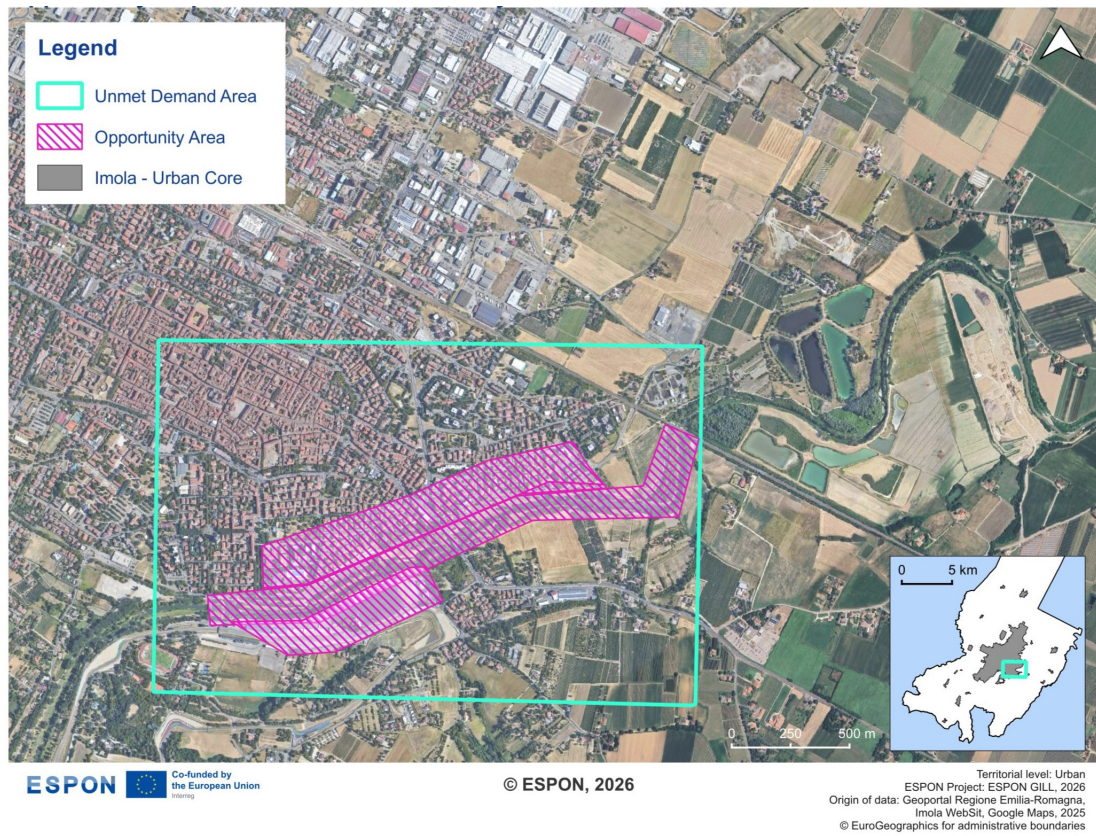
Methods applied / Resources used – Flood Risks and Water Infiltration

1. Spatial analysis: physical, spatial, and contextual constraints were assessed to determine where GI can potentially be implemented.
2. Bilateral meeting with Imola: a meeting was held with the CS representatives, to get their input and validate the results of the spatial analysis. As a result of this consultation, an opportunity map was co-created to identify priority areas for GI deployment, integrating local preferences and knowledge on existing and / or planned intervention points. These were mainly related to the *CICLICA* interventions.

Results – Flood Risks

The identified priority areas are situated between Viale Dante and the station bridge, along the Santerno corridor and its adjacent neighbourhoods. The main selected opportunity areas correspond to the those that are consistently most affected by flooding events, both in rainfall intensity and precipitation amounts (as it happened during the flooding of May and November 2023), as well as the areas that are addressed as part of the local plan for flood risk mitigation (2025). Flood-affected areas around the urban stretch of the river (Map 22) are assigned the highest priority for intervention, according to the local stakeholders. Hence, the identified opportunity areas include:

- The Campanella neighbourhood (North of the Santerno river)
- The Colombarina neighbourhood (North of the Santerno river)
- The Enzo and Dino Ferrai Autodromo (South of the Santerno river)

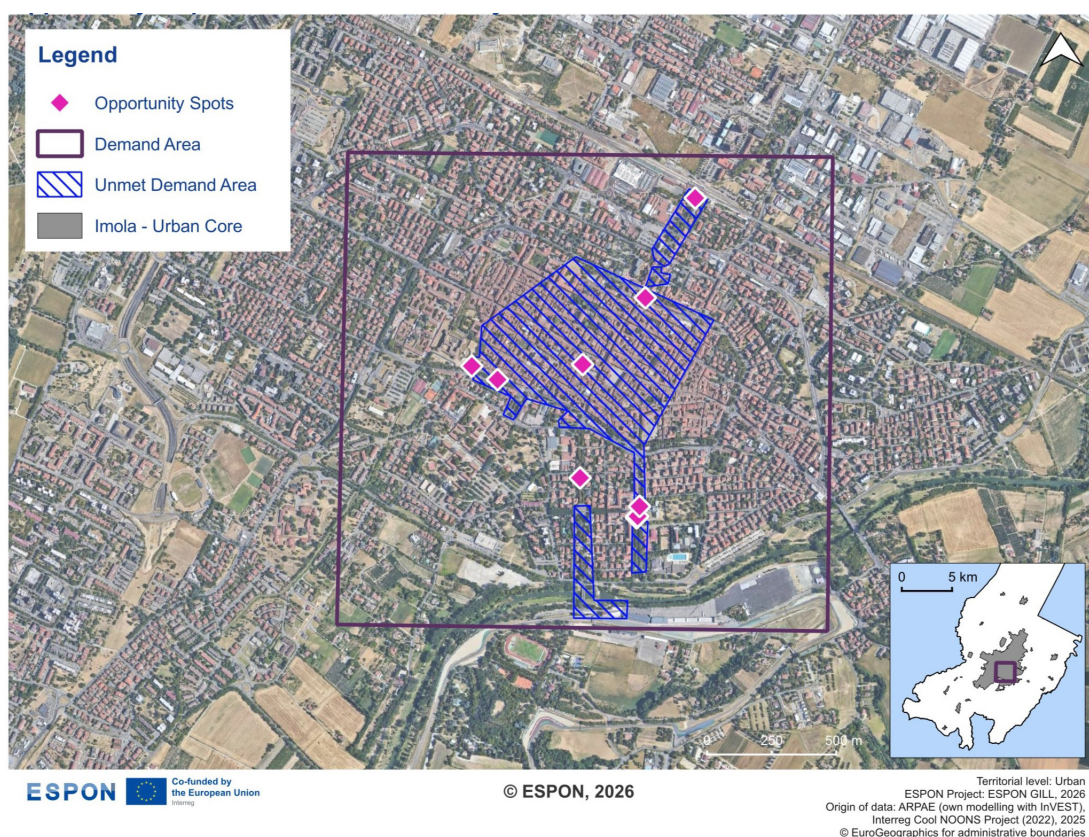


Map 22 - Imola: Flooding - Opportunity Map

Methods applied / Resources used – Heat Mitigation

1. Spatial analysis: physical, spatial, and contextual constraints were assessed to determine where GI can potentially be implemented.
2. Bilateral meeting with Imola: a meeting was held with the CS representatives, to get their inputs and validate the results of the spatial analysis. The identified unmet demand area and subsequent opportunity map were cross-checked and informed by the intervention points that resulted from the Cool Noons project (which aims at decreasing urban heat island effects in Imola). As a result of this consultation, an opportunity map (Map 23) was co-created to identify priority areas for GI deployment, integrating local preferences and knowledge on existing and/or planned intervention points (notably those from Cool Noons).

Results – Heat Mitigation



Map 23 - Imola: Heat - Opportunity Map

As a result of this action, the areas identified as part of the opportunity map were aligned with priority intervention points from the Cool Noons project (in high need to address urban heat island effects). These correspond not only to 'red' spots (with high LST) along the three analysis paths, but also to points with medium and low LST, which follow other project intervention priority criteria, related to housing, vulnerable community residences, schools, and equitable access to green spaces.

2.7 Module 6: Inform Planning

2.7.1 Action 6.1: Definition of GI Interventions for Integration into Local Planning

This case study partially addressed this methodological module.

A structured approach to support the definition and integration of GI interventions within local planning instruments is proposed, based on the application of the ESPON GILL Methodology in Imola.

Methods applied / Resources used – 1

The following steps are suggested to be followed for the development or integration of GI interventions in local planning. Additionally, as previously mentioned, existing initiatives and planned interventions that contribute to GI development in Imola have been identified.

1. Identification of suitable GI types to be deployed in the priority areas
2. Development of context specific GI types
3. Feasibility assessment of proposed GI interventions: in relation to existing planning instruments, zoning regulations, land-use designations, and municipal strategies, with the aim of identifying planning barriers and enablers for their implementation.

Results - 1

Rather than producing formal GI guidelines, the outcome of the process in Imola supports the integration of GI into local planning by aligning proposed interventions with ongoing projects and existing regulatory frameworks.

Key actions for this include establishing a set of GI type descriptions, defining spatial allocation criteria and functional objectives, and outlining implementation considerations, aligned with existing planning regulations and ready for integration into municipal planning instruments.

The outcomes of this report and the results of applying the GILL methodology in Imola align with and complement the current Santerno River Flood Risk Reduction Project⁸. Planned works of the project are:

- Cleaning and reshaping of the riverbed
- Widening and lowering of floodplains on both the left and right banks
- Upgrading of sewer outfalls and installation of backflow prevention valves
- Construction of rock revetments in areas most affected by riverbank erosion
- Redevelopment of the riverside park, including replanting of trees and creation of pedestrian paths

They additionally support the objectives of the PGRA⁹ (*Piano di Gestione del Rischio di Alluvioni*), the regional flood risk management framework for the Po Valley, which aims to reduce impacts on people, property, and the environment.

⁸ <https://www.comune.imola.bo.it/argomenti/lavori-pubblici/ciclica-citta-per-il-clima-che-cambia/riduzione-del-rischio-idraulico-e-messa-in-sicurezza-delle-aree-urbane-adiacenti-al-fiume-santerno-dal-ponte-tosa-al-ponte-ferro-via>

⁹ <https://pianoalluvioni.adbpo.it/>

Methods – 2

The following steps were followed for the integration of GI interventions in local planning, particularly aligned with existing projects.

1. Mapping of GI types
2. Alignment with the Interreg Cool Noons project, which includes small-scale interventions such as benches, water fountains, and trees, geolocated for precise placement (see a map of the interventions [here](#)¹⁰).

Results – 2

- Priority areas include the dense city centre, the three most-used public paths, and surrounding nodes (squares, streets, public facilities).
- Interventions emphasize:
 - Shade provision through trees and green structures
 - Creation of cooling corridors connecting public spaces
 - Use of permeable surfaces to reduce surface heat
 - Installation of water points
 - Small-scale “cooling nodes” integrated into a continuous urban green network
- This approach balances thermal comfort, equity, and urban connectivity.

These actions provide a possible basis for future integration of heat mitigation measures into municipal planning instruments.

¹⁰ <https://www.google.com/maps/d/u/o/edit?mid=1lEUZqQXW5Efm67MwFmRYHsYCT6dSsOo&usp=sharing>

3 Barriers and enablers to Imola GI development

3.1 Analysis by dimension

	Enabling factors Supportive policies, funding, and stakeholder engagement approaches that can accelerate GI adoption	Barriers Regulatory constraints, financial limitations, and lack of expertise that can hinder progress
Institutional and organisational	Clear multi-level structure, with NCI (Nuovo Circondario Imolese) providing governance structure that supports coordinated planning, technical capacity and alignment of GI objectives across municipalities.	GI is not explicitly defined nor regulated at national/regional level, and responsibilities are decentralised and fragmented. This can slow down scaling and standardisation.
Engagement and coordination	Existing inter-municipal structure (NCI) + metropolitan coordination supports shared priorities and joint projects.	Many actors + plans + funding lines may create risk of “project – by – project” delivery - CICLICA approach should be brought and prioritized to other areas of the NCI. Need for co-design and engagement of citizens – as it was done through COOL Noons.
Political	Strong policy and planning frameworks (metropolitan and local levels): AMSS (2022) explicit target on GI, PTM (2021) focus on soil/ecosystems, PUG (2023) specifies GI objectives, CICLICA gives a visible political framework and concrete implementations at local level.	GI can remain “project-based” instead of systematically embedded everywhere.
Socio-cultural	CICLICA interventions link GI to public space quality and well-being (for residents and tourism) + “use value” of GI (parks, daily mobility, river areas)	Equity goals require active design/participation (present in COOL Noons but not mentioned in other interventions). Social and spatial justice for climate interventions, existing data should be coupled with equality and vulnerable data of citizens.
Biophysical	Imola “green” (semi-natural areas, parks)	High exposure: Santerno flood risk areas + urban heat concentration in the urban core -> GI must “perform” under extremes
Knowledge	Strong data availability across levels (regional/metropolitan) + local data collection from CICLICA interventions (Cool Noons especially) strengthens evidence-based considerations.	Data inconsistencies/temporal limits and uneven definitions make it harder to compare, justify developments. Need for efficient and cohesive way of gathering data – simplify data collection, particularly for UHI and flooding.

	Enabling factors Supportive policies, funding, and stakeholder engagement approaches that can accelerate GI adoption	Barriers Regulatory constraints, financial limitations, and lack of expertise that can hinder progress
Financial	Multiple funding channels: NRRP/PNRR, ERDF regional programme (explicit GI actions), PN Metro+, local projects already funded (e.g., tree planting + maintenance). Current interventions prove good use of EU funds and regional funds – key aspect, especially with end of PNRR	Funding often project-based and limited. Need for new funding sources with end of PNRR.

4 Interactions along the project

SHCr

The meeting was structured into two main parts. The first session was informative: the ESPON GILL team introduced the project and its objectives, presented the proposed methodology, and discussed the development process along with key requirements for successful implementation. The second session was interactive and participatory, focusing on identifying expectations from the case studies and exchanging information on the status and needs regarding GI. A MIRO board was used to facilitate collaboration and visualization of inputs.

First bilateral meeting

The first meeting with Imola took place at the end of April, where we had an in-depth discussion about the policy and planning context in Imola and the broader NCI area. Topics included policy instruments for GI at the metropolitan/regional level, planning instruments for GI at the local level (specifically the CICALICA strategy and the specific GI projects), as well as the local definition and objectives of GI (Figure 2).

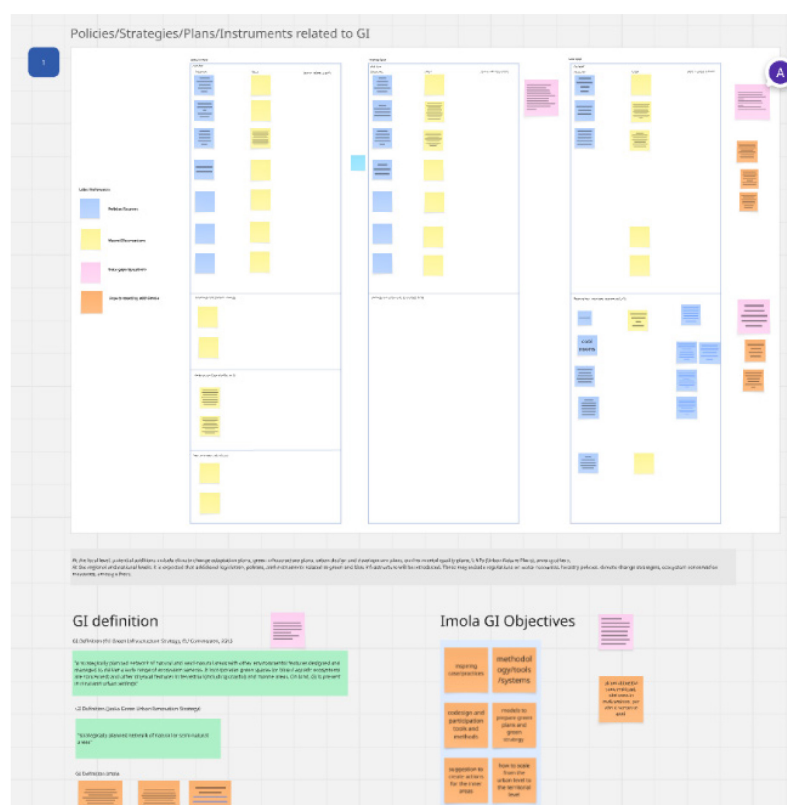


Figure 2 - Stakeholder Meeting 1: Screenshots of the Used MIRO Board

Overall, a significant amount of data on GI, ESS, and ESS demand is publicly available, particularly at the metropolitan and regional level. However, at the local level, we were unable to identify accessible data sources beyond a few PDF maps. Despite this, Imola is actively engaged in several targeted projects and initiatives related to GI, demonstrating a strong and innovative local approach to its development.

Second bilateral meeting

Consultation with Arpa, the regional environmental agency, to validate and collect spatial and statistical data, and to discuss data gaps at the local level. Catalogues and data sources at the regional level were shared, particularly those related to ecosystem services (ESS) and ESS demand. Data sources at the metropolitan level

were also validated, and a discussion followed regarding data gaps, especially the lack of publicly available spatial data at the local level (Figure 3).



Figure 3 - Stakeholder Meeting 2: Screenshots of the Used MIRO Board

Stakeholder Consultation 2

In this exchange, the prototype of the methodology was presented and the main challenges for the city were requested through a MIRO dynamic.

Additionally, at this stage, the identification of ecosystem services they would be interested in assessing was requested, considering the challenges they had previously identified.

Third bilateral meeting

In this meeting, the identified challenges were validated, and a request for contacts from the Interreg COOL NOONS project was made, to collect data related to Challenge 2: heat stress.

Fourth bilateral meeting

An online meeting was held with two researchers, representatives from the Bologna Metropolitan Area. During this exchange, they explained their involvement in the Interreg COOL NOONS project and outlined the objectives for Imola within the project's scope, focusing particularly on those related to urban heat islands.

As a result of this meeting, access was provided to Imola's Land Surface Temperature (LST) data at the local level, obtained through data collection that was held as part of their involvement in the COOL NOONS project. Specifically, the information refers to thermal camera images that determine the macro- and micro- climate for specific areas in the urban area of Imola.

Fifth bilateral meeting

A meeting with researchers and representatives from the Bologna Metropolitan Area was held. Among them, one representative from the city of Imola, who shared a deep understanding of the study area. During the meeting, progress on the cartographic implementation of the ESPON GILL Methodology was presented, notably the identification of challenges, and the development of GI and ESS maps at the urban scales.

First, an overview of the ESPON GILL Methodology was provided, explaining how it was being implemented in the Imola Case Study, including the different modules, steps, and engagement with case study representatives. Then, the mapping progress was discussed, and feedback was collected. Focus was put on the Challenge Maps, GI Maps, ESS Maps and Demand Map. All in all, the GI categorization and inventory were discussed (validating the integration of different attributes), module outputs were cross-checked with the results of the COOL NOONS project, maps were validated, and new inputs were gathered. The upcoming steps

were addresses, and a date was fixed for another meeting, to further work together on Module 5 of the Methodology.

In general terms, it was a very productive meeting, both because important feedback and new inputs for data were gathered, and because case study representatives expressly found it very insightful – they mentioned it would be good to share this information with the Imola administration, who put a lot of effort into GI for climate resilience and would highly benefit from the quantitative data gathered thus far. The data is seemingly also relevant for the Interreg Cool Noons project, who focused more on qualitative data (heat stress and tourism) and would also benefit from these maps and spatial information.

Sixth bilateral meeting

The meeting focused on the development of the Opportunity Map and Module 5. The discussions built on the information the CS collected from the Interreg Cool Noons project and were informed by planned and future GI interventions that are part of the CICLICA project. The main take-aways follow below.

- Priority intervention areas related to Heat Stress:
 - The analysis should not only / forcibly consider red spots (with high LST), but also the orange (medium LST) and yellow ones (low LST) according to other priority areas – such as housing, vulnerable community residences, schools, and equity in access to green spaces.
 - Since participatory and priority mapping was conducted with the Cool Noons project, part of the prioritization will feed directly from those inputs.
 - River area: although green and blue spaces are available –and present in higher quantities compared to more central areas of the city that are less green–, this area is very subjective to heat stress and high temperatures and deserves more attention to mitigate heat.
- Priority intervention areas related to Flooding:
 - We should refer to the current flood mitigation project and interventions points along Santerno River.

The meeting served also to discuss and validate the barriers and enablers table.

Stakeholder Consultation 3

The third and final consultation meeting included an overview of the ESPON GILL Methodology, delivered by the coordination team, with insights informed by its application in the six case study regions. Partners of the project gave brief presentations of the implementation of the project in each of the case study regions, to give CS representatives an overview of how the process unfolded in other contexts, both in terms of the policy framework and in terms of geographical conditions and available GI types in each region. Explaining how diverse (or similar) challenges were addressed showed diverse perspectives and enriched the exchange.

Feedback was gathered on the general usefulness of the application of the ESPON GILL Methodology in the local context of the CS regions, as well as on the barriers and enablers that were encountered throughout the process.

5 Results and Final Remarks

5.1 Summary of key results on GI demand

Policy context: Italy has no dedicated national GI framework, which means that the provision of GI is mainly shaped through regional and metropolitan targets (PTM, AMSS) and implemented through the NCI PUG and concrete municipal projects.

Two priority challenges drive the GI demand: flood risks (along the Santerno river) and heat stress (in the urban core): flood demand concentrates along the Santerno corridor within the urban core, where P2–P3 risk areas overlap with the areas affected by the May 2023 floods. Heat demand is concentrated in the urban core: the soil temperature map shows the highest values (33–37°C and >37°C) in the dense centre, and the three paths (most visited/crowded areas) identified by the Interreg Cool Noons project are located precisely there, with many segments showing moderate and high LST.

GI: around 80% of the municipal territory is green overall (mostly agricultural and semi-natural land), while urban GI is more limited in terms of territorial extension. The GI map confirms that agricultural land accounts for the highest proportion (≈71%), with smaller shares of parks/formal greens and urban green linked to grey infrastructure.

ESS: For water infiltration/WAR, both regional datasets show mainly low–medium infiltration across the municipality, with relatively higher values concentrated around river corridors; however, observed flood impacts in 2023 show that “mapped capacity” does not fully translate into protection in the most exposed urban areas. For cooling/heat mitigation, InVEST outputs show lowest cooling capacity and heat mitigation in the dense urban core, while higher values cluster in and around larger green areas and peri-urban landscapes. This confirms that the city centre is structurally more vulnerable to heat.

Opportunity mapping points towards two main planning directions (not “new opportunity areas”):

- In the case of flooding: the Santerno corridor and adjacent neighbourhoods. Priority lies around the urban stretch of the river where flooding is fastest or most impactful (e.g., Campanella, Colombarina, Autodromo area), aligned with the 2025 Santerno River Flood Risk Reduction project. Planning focus: interventions include riverbed/floodplain works, overflow space, upstream/downstream retention and urban de-sealing where runoff concentrates.
- For heat stress: dense urban centre and key public paths. Priority is placed along the three most used paths and surrounding nodes (squares, streets, public facilities), not only “red” hot spots but also strategic places for equity (schools, vulnerable groups, low-access areas). Planning focus: interventions include improving shading and planting trees, cooling corridors, developing permeable surfaces, water points, and small-scale “cooling nodes” connected into a continuous urban green structure.

5.2 Final Remarks

Considerations from the Methodology implementation: The GILL methodology mainly served to quantify and spatially confirm where GI deficits are highest, showing that priority and unmet-demand areas align well with the existing local plans (notably those from the CICLICA project), as well as with the intervention areas identified by the Interreg Cool Noons project. The application of the methodology in Imola provided a clear evidence base to strengthen GI actions and integrate them into planning and policy development beyond individual projects.

6 References

- ARPAE - Agenzia regionale per la prevenzione, l'ambiente e l'energia dell'Emilia-Romagna (2025). ERG5 Dataset: *Hourly and Daily Weather Dataset since 2001*. Available at: <https://dati.arpae.it/dataset/erg5-interpolazione-su-griglia-di-dati-meteo>
- Autorità di Bacino del Po. (2024). *Piano di Gestione del Rischio di Alluvioni* (PGRA). Retrieved January 13, 2026, from <https://pianoalluvioni.adbpo.it/>
- Città Metropolitana di Bologna (2021). *Agenda Metropolitana per lo Sviluppo Sostenibile* (AMSS). Retrieved from: https://www.cittametropolitana.bo.it/agenda_sviluppo_sostenibile/
- Città Metropolitana di Bologna (2021). *Piano Territoriale Metropolitano* (PTM). Retrieved from: https://www.ptmbologna.it/ptm_approvato
- Città Metropolitana di Bologna. Geoportale (n.d.). Available at: <https://cartografia.cittametropolitana.bo.it>
- Comune Imola. Geoportale (n.d.). Available at: <https://temi.comune.imola.bo.it>
- Copernicus Land Monitoring Services (n.d.). Urban Atlas. Available at: <https://land.copernicus.eu>
- European Commission (2013). *Green Infrastructure (GI) Enhancing Europe's Natural Capital*, (COM(2013) 249 final). CELEX 52013DCo249. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52013DCo249>
- Governo Italiano (2021). *Piano Nazionale di Ripresa e Resilienza* (PNRR). Roma: Ministero dell'Economia e delle Finanze. Retrieved from: <https://www.governo.it/sites/governo.it/files/PNRR.pdf>
- ISPRA – Institute for Environmental Protection and Research (2025). *Dataset on Evapotranspiration*. Available at: <https://indicatoriambientali.isprambiente.it/it/risorse-idriche-e-bilancio/evapotraspirazione-reale>
- Ministero dell'Ambiente e della Sicurezza Energetica (2022). *Piano Nazionale per la Transizione Ecologica*. Retrieved from: <https://www.mase.gov.it/portale/piano-per-la-transizione-ecologica-pte->
- Ministero dell'Ambiente e della Sicurezza Energetica - Direzione Generale Patrimonio Naturalistico e Mare (2023) *Strategia Nazionale per la Biodiversità al 2030*. Retrieved from: <https://www.mase.gov.it/portale/strategia-nazionale-per-la-biodiversita%C3%A0-al-2030>
- Ministero delle Infrastrutture e dei Trasporti (2021). *Programma Nazionale Metro Plus e Città Medie Sud 2021-2027* (Metro Plus). Retrieved from: <https://www.pnmetroplus.it/home-2/pon-metro-plus-21-27/>
- Nuovo Circondario Imolese (2023). *Piano Urbanistico Generale* (PUG). Retrieved from: <https://www.nuovocircondarioimolese.it/pug/pug>
- Regione Emilia-Romagna (2021). *Emilia-Romagna Pact for Work and Climate (Patto per il Lavoro e per il Clima)*. Retrieved December 18, 2025, from: <https://www.regione.emilia-romagna.it/pattolavoroeclima>
- Regione Emilia-Romagna (2021). *Programma operativo FESR 2021-2027 – Emilia-Romagna*. Retrieved from: <https://fesr.regione.emilia-romagna.it/programmi-e-strategie/2021-2027>
- Regione Emilia-Romagna (2022.) *Strategia regionale per lo sviluppo sostenibile 2030* (Agenda 2030). Retrieved from: <https://www.regione.emilia-romagna.it/agenda2030/strategia-sviluppo-sostenibile>
- Regione Emilia-Romagna - Geoportale. (n.d.). Available at: <https://geoportale.regione.emilia-romagna.it/>
- Stanford University - Natural Capital Alliance. *Urban Cooling*. Retrieved January 9, 2026, from <https://naturalcapitalalliance.stanford.edu/invest/urban-cooling>
- Zawadzka, J.E., Harris, J.A. and Corstanje, R. (2021). *Assessment of heat mitigation capacity of urban greenspaces with the use of InVEST urban cooling model, verified with day-time land surface temperature data*. Landscape and Urban Planning, 214, 104163. <https://doi.org/10.1016/j.landurbplan.2021.104163>

ESPON



Co-funded by
the European Union
Interreg

espon.eu



ESPON 2030

ESPON EGTC
11 Avenue John F. Kennedy
L-1855 Luxembourg
Grand Duchy of Luxembourg
Phone: +352 20 600 280
Email: info@espon.eu
www.espon.eu

The ESPON EGTC is the Single Beneficiary of the ESPON 2030 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway, and Switzerland.

Disclaimer

This delivery does not necessarily reflect the opinion of the members of the ESPON 2030 Monitoring Committee.

