Sistema Nazionale per la Protezione dell'Ambiente

CITIES IN TRANSITION: ITALIAN MUNICIPALITIES TOWARDS ENVIRONMENTAL SUSTAINABILITY

INTEGRATED ASSESSMENT OF URBAN ENVIRONMENT

Summary document

SNPA Council Resolution. Session of 16.06.2022. Doc.n.172/22

REPORT DI SISTEMA
SNPA | **31 bis** 2022

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LIST OF ACRONYMS

ACI	Italian Automobile Club
ANCI	National Association of Italian Municipalities
ASL	Local Health Care Agency
ARPA/APPA	Regional/Provincial Agencies for Environmental Protection
ARTA	Abruzzo Regional Environmental Protection Agency
CESISP	Research Centre in Economics and Regulation of Services, Industry, and the Public Sector
DEP Lazio	Department of Epidemiology Lazio Regional Health Service - Italy
ICESP	Italian Platform of Actors for the Circular Economy
ENEA	Italian National Agency for New Technologies, Energy and Sustainable Economic Development
ISPRA	Italian Institute for Environmental Protection and Research
ISTAT	Italian National Institute of Statistics
LPT	Local Public Transport
MiTE	Italian Ministry of Ecological Transition (now MASE, Italian Ministry of Environment and Energy Security)
OECD	Organisation for Economic Co-operation and Development
PRTR	Pollutant Release and Transfer Register
RAU	Report on the Quality of the Urban Environment
SINA	National Environmental Information System
SDGs	Sustainable Development Goals
SNPA	National System for Environmental Protection

The National System for Environmental Protection (SNPA) has been operational since 14 January 2017, the date on which Law no. 132 of 28 June 2016 'Establishment of the National System for the Protection of the Environment and Regulation of the Italian Institute for Environmental Protection and Research' came into force.
It constitutes a true Network System that merges into a new identity the individual components of the pre-existing System of Environmental Agencies, which involved the 21 Regional (ARPA) and Provincial (APPA) Agencies, in addition to Italian Institute for Environmental Protection and Research (ISPRA).
The law assigns to the new body fundamental tasks such as inspection activities within the scope of environmental control functions, monitoring of the state of the environment, control of sources and factors of pollution, research activities aimed at supporting its functions, technical-scientific support to the activities of state, regional and local bodies that have active administration tasks in the environmental field, and the collection, organisation and dissemination of environmental data that, together with statistical information deriving from the aforementioned activities, will constitute official technical reference to be used for the purposes of activities falling within the competence of the public administration.
Through the SNPA Council, the System expresses its binding opinion on Government measures of a technical nature in the environmental field and informs the Ministry for Environment and Energy Security and the Permanent Conference for Relations between the State, the Regions and the Autonomous Provinces of Trento and Bozen of the advisability of interventions, including legislative ones, for the pursuit of institutional objectives. This activity is also carried out through the production of documents, mainly Guidelines or Reports, published on the SNPA System website and the persons acting on its behalf are not responsible for the use that may be made of the information contained in these publications.

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Abstract
Cities play a central role in the transition towards sustainability, they are key drivers of change.
"Cities in transition: Italian regional capitals towards environmental sustainability" has the ambition to explore environmental sustainability through three strategic lens: quality of life, circularity and resilience to the impacts of climate change. What comes out is a work where the 21 major Italian cities are at the core of the analysis, and where particular attention is given to the temporal evolution of cities' main environmental themes in order to help local administrators and all stakeholders in the complex – but needed – path towards an ecological and just transition.

Key words: urban sustainability, quality of life, circularity, resilience to climate change, integrated valuation, urban policies.

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PRESENTATION

It is in my dual role as President of the Italian Institute for Environmental Protection and Research (ISPRA) and of the National System for Environmental Protection (SNPA) that I present with great satisfaction the SNPA Report *"Cities in Transition: italian regional capitals towards environmental sustainability"* as the first result of an integrated approach to the study of the evolution of environmental quality in Italy's main capitals.

The ecological transition of an urbanised country such as Italy passes through cities: it is in urban contexts that many of the environmental challenges are played out, from climate change, to the transition from a linear to a circular economy, to the crisis of the man-environment relationship, such as that represented by the COVID-19 pandemic. Urbanisation is one of the major global trends of the 21st century: more than 55% of the world's population lives in urban areas, a percentage that is expected to increase to around 70% by 2050 with foreseeable environmental impacts in terms of pollution, waste production, land consumption.

The centrality of the urban dimension in environmental policies is well known within ISPRA, which since 2004 has produced the Report on the Quality of the Urban Environment, a document that over the years has become a reference for insiders and users thanks to the enormous collection of data provided and indicators populated. Over time, this product has become a work of the entire SNPA, with the active involvement of thematic experts from the Regional and Autonomous Provincial Agencies for the Protection of the Environment.

"Cities in Transition: italian regional capitals towards environmental sustainability" represents the first experimentation that SNPA has carried out in terms of integrated assessment of the quality of the urban environment: reading environmental issues through specific magnifying glasses, moving from a 'theme-centric' to a 'city-centric' approach, and analysing the trends in the last five years of available data are the three main innovative aspects compared to the past. Hence, a document that places the 20 regional capitals and Bozen at the centre of its analysis, analysing the evolution over time of the multiple environmental issues that govern the daily lives of citizens through the perspective of three different, but interconnected, keys to interpretation: livability, which investigates the relationship between environment and health; circularity, aimed at analysing efficiency in the use of natural resources, materials and energy; and resilience to climate change, aimed at focusing on the city's ability to react and adapt to climate change.

In placing each municipal reality at the centre, the main objective of the document is to analyse the environmental changes that are occurring in the various contexts in order to arrive, in the final discussion, at an overall framework that can best guide local administrators in both the implementation and verification of environmental sustainability interventions and policies. The elements of comparison between municipalities are intended to encourage an exchange between administrations, thus enabling the most advanced experiences to be replicated.

The National Recovery and Resilience Plan represents our country's great opportunity to turn the tide and accompany cities in a transformation process that will create the right conditions for sustainability, efficiency and prosperity.

The Ministries are working on the allocation of resources: these are huge sums - 191.5 billion euro - of which a substantial part (more than 60 billion euro) will be dedicated to the green revolution and ecological transition. Municipalities will be among the protagonists of this great transformation, the transition of urban areas towards environmental sustainability.

Stefano Laporta
ISPRA President
President of SNPA Council

INTRODUCTION

Cities play a key role in the transition toward a more sustainable future for people and the planet [1] . Environmental pressures and health issues are concentrated in them, whose impacts are amplified by the current climate crisis.

The challenges facing local administrators require new tools and models of analysis capable of identifying and implementing the best possible solutions to optimise the use of natural resources and ensure the well-being and prosperity of citizens. In this perspective, the environmental assessment of a system as articulated as that of contemporary cities represents a challenge both on the analytical and methodological levels. In this context, the National System for Environmental Protection (SNPA) has been collecting and analysing data on the urban environment since 2004, through the annual publication of the SNPA Report "*Quality of the Urban Environment*" (RAU).

Thus, fifteen years after the first RAU, it has been decided to make a change of perspective and put the individual municipality at the centre, migrating from a 'theme-centric' to a 'city-centric' approach and directing all the know-how matured by ISPRA/SNPA in recent years towards an assessment of the various environmental issues for each individual city that is as integrated as possible. Another innovative element is the reference time window, with an analysis of the last available five-year period (and more, where possible), which makes it possible to appreciate changes over time and alert decision makers to any trajectories that are misaligned from the objectives of sustainability.

Finally, three keys were identified to read the path towards sustainability of the 20 regional capitals plus Bozen: livability, circularity in the use of natural resources, materials and energy, and resilience to climate change. For each of these, specific frameworks were identified, taken from the panorama of international and European literature, which made it possible to identify the main themes and possible indicators to be selected, thus providing an approach of complementarity and synergy between the keys identified.

[1] Cities play pivotal roles in shifting to green, sustainable future — European Environment Agency (europa.eu)

OBJECTIVES AND STRUCTURE OF THE DOCUMENT

This Synthesis Document is an extract from the integral Document "*Cities in Transition: italian regional capitals towards environmental sustainability*", hereafter referred to as the "Assessment Document", and focuses only on the indicators graphically represented in the curves.

The Assessment Document and, consequently, the Synthesis Document, have the following two aims:

- to describe the quality of the urban environment through new magnifying lenses, the three integrated reading keys;
- to analyse the evolution over time of environmental issues and actions implemented at local level.

But if the Assessment Document is addressed, in its complexity, to a broader target of stakeholders, with particular reference to technicians, researchers and practitioners working in the field of urban sustainability, the Synthesis Document is addressed not only to citizens, but above all to local, regional and national administrators and decision-makers, with the ultimate aim of providing useful elements to support the development of environmental policies of urban relevance at all levels and to transform criticalities into opportunities for a new model of city management.

Like the Assessment Document, the Synthesis Document is divided into three parts:

- **Part I** provides a brief overview of the methodological aspects;
- **Part II** proposes a summary reading of the results obtained for each city and for each of the three keys, accompanied by ring graphical representations illustrating the trends (improvements or worsening) of the most significant indicators, over the time span considered;
- **Part III** presents a discussion of the results, followed by concluding remarks.

PART I
URBAN ENVIRONMENT INTEGRATED ASSESSMENT: METHODOLOGICAL ASPECTS

READING KEYS

LIVABILITY

The "Livability" reading key aims to interpret the broader concept of sustainability through the relationship between environment and health, with a view to describing the main environmental determinants of citizens' health in an integrated manner.
To this end, on the basis of an extensive bibliographic review and an analysis of the national and international scientific literature, the following three works were chosen as references:

1. *Healthy environment, healthy lives: how the environment influences health and well-being in Europe* (EEA, 2020)[2], a recent report by the European Environment Agency investigating how environmental quality in Europe affects people's health and well-being. Its analytical approach only superficially addresses state, pressure and driver indicators, but focuses on the effect and exposure dimensions of the eDPSEEA model (ecosystems-enriched drivers, pressures, state, exposure, effect, actions). This study identifies a number of macro-themes that can provide elements to represent the various possible environmental impacts on health and well-being. In particular, it examines: green and blue infrastructures, air quality, noise pollution, climate change, water quality, hazardous chemicals, indoor air quality, electromagnetic pollution, impacts of multiple stressors.

2. *Urban Health Index* (OMS, 2014)[3], a 2014 World Health Organization (WHO) report, in which an index - 'Urban Health Index' (UHI) - is proposed to analyse the impact of environmental determinants on human health in urban areas. The index is constructed from a set of standardised indicators and combined together through the calculation of the geometric mean. The meaning and usefulness of a UHI depends closely on the choice of indicators, which is the most delicate aspect of the methodology. Depending on the themes, aspects and indicators chosen, different UHIs can therefore be obtained. What is proposed in the WHO report is a reference framework within which to operate for the selection of useful indicators to represent the state of health of an urban area. To this end, five themes ("rubrics") are selected: health, environment, geography, economy and socio-demographic themes. For each of them, a number of domains are also made explicit with which to associate the indicators. The theme 'Environment', which is useful for our purposes, is divided into the domains: infrastructures, built environment, transport, water quality, air quality, contaminants, noise pollution.

3. European Healthy Cities Network (WHO) [4] , activated by the WHO European Office more than 30 years ago with the aim of interpreting the state of health and well-being of European citizens through four dimensions: health, health services, environment, socio-economic conditions.
With regard to the environmental dimension, the focus is on the following macro-themes: Air pollution; Water quality; Sewage collection; Household waste treatment; Green spaces; Derelict industrial sites; Sports and leisure facilities; Pedestrianization; Cycle routes; Public transport access; Public transport range; Linving spaces.

Selected macro-themes
Air quality, Water, Noise pollution, Mobility and transport, Green infrastructures, Soil and land, Industrial activities.

[2] Healthy environment, healthy lives: how the environment influences health and well-being in Europe. EEA Report n. 21/2019.
[3] WHO Centre for Health Development (Kobe, Japan), Weaver, Scott, Dai, Dajun, Stauber, Christine, Luo, Ruiyan. et al. (2014). The urban health index: a handbook for its calculation and use. World Health Organization.
[4] https://www.euro.who.int/en/health-topics/environment-and-health/urban-health/who-european-healthy-cities-network

CIRCULARITY

A 'Circular City' as defined by the Ellen MacArthur Foundation[5], contains within itself all the principles of the circular economy, i.e. reduction, reuse and recycling of resources. In the new circular city vision, the aim is therefore to increase economic competitiveness, environmental sustainability and social inclusion, in order to solve or minimise some of the main problems of man-made environments. In September 2015, the United Nations adopted the 2030 Agenda for Sustainable Development, defining 17 Goals (SDGs) some of which are directly related to the circular urban approach, in particular the eleventh, aimed at *'Making cities and human settlements inclusive, safe, durable and sustainable*'. In 2017, more than 60 European local governments joined the Seville Declaration, which aims to promote circular economy policies within cities. In the absence of a nationally consolidated reference framework on this topic, the selection of indicators for the 'Circularity' key was based on an extensive bibliographic research and a careful analysis of national and international scientific literature, which made it possible to identify 5 reference frameworks of particular interest.

1. *Circular Economy Network* (ENEA, 2019), contains 10 proposals, the sixth of which focuses on the importance of cities in the consumption of natural resources, especially soil, water and waste production and management. The report highlights the need to focus on revitalising the quality of cities through the identification of integrated urban regeneration programmes, following the European 'green cities' model.

2. Italian Stakeholder Platform for the Circular Economy (ICESP, 2019), constitutes a place of convergence and comparison of the various initiatives underway in Italy related to the circular economy organised through working groups. Working Group 5 'Circular Cities and Territories'"[6], addresses the issue in its publication 'The Transition to Circular Cities'.

3. Measuring circular economy targets in urban centres (CESISP – Università Milano Bicocca, 2020)[7], develops tools for assessing the environmental policies of urban centres. The indicators considered can be useful for analysing the impact of new legislative or regulatory proposals and represent a valuable tool for measuring the effectiveness of the measures adopted.

4. *The circular economy in cities and regions* (OECD). The OECD survey [8] collected data and information on the situation of the circular economy in 31 cities and 3 regions and the main tools, obstacles and good practices. All identified initiatives are inspired by the concept of the '3Ps' (OECD 2016): People, Policies, Places.

5. *Urban Agenda for the EU. Issues and mapping paper on indicators for circular economy transitions in cities*[9]. The Urban Agenda for the EU is a joint effort by the European Commission, Member States and European cities to strengthen urban policies on a number of topics, including the circular economy. The document provided a comprehensive and balanced mapping of indicators across themes. The report emphasises that, considering the limitations of the mapping process, the suggested indicators are only meant to support discussions and further work on the circular economy at the urban level.

Selected macro-themes. Soil and Land, Green Infrastructures, Water, Waste, Mobility and Transport, Certifications, Energy.

[5] The circular economy: a transformative Covid-19 recovery strategy (ellenmacarthurfoundation.org)

[6] https://www.icesp.it/sites/default/files/DocsGdL/Rassegna_GdL5_2018_L%27economia%20circolare%20nelle%20aree%20urbane%20e%20periurbane.pdf

[7] https://www.unimib.it/sites/default/files/il_valore_della_circular_economy_a_milano_classifica.pdf

[8] https://www.oecd.org/regional/cities/circular-economy-cities.htm

[9] https://ec.europa.eu/futurium/en/system/files/ged/urban_agenda_partnership_on_circular_economy_-_indicators_for_ce_transition_-_issupaper_0.pdf

RESILIENCE TO CLIMATE CHANGE

The 'Climate Change Resilience' key aims to explore the pathways that municipalities under analysis are taking in order to reduce their vulnerability and respond more effectively to climate-related shocks and stresses. At the international level, specific models have been developed to support local authorities in designing and implementing urban resilience strategies. Analyzing the different approaches and the extensive scientific literature available in the international context, three frameworks have been identified and are described below.

1. *Guide for Climate-Resilient Cities: an Urban Critical Infrastructures approach – TECNUM, Escuela de Ingenieros, Universidad de Navarra*[10].
The work designs a guide for assessing and improving the level of resilience against Climate Change (CC), considering urban Critical Infrastructures (CI) as key agents for enhancing the capacity of cities to cope with and recover from climate change-related crises. The approach follows a three-step process, proposing within it the stakeholders that should take part. It provides a valuable tool for a qualitative assessment of resilience and the degree of implementation of implemented government policies, offering cities the opportunity to observe their situation and identify opportunities and challenges to support the development of strategies to strengthen their resilience.

2. *Indicators for resilience cities – OECD Regional Development Working Papers 2018/02*[11].
The OECD Council of Ministers identifies four resilience factors: economic, social, environmental and institutional dimensions. Within the four macro-areas, relevant indicators are identified. The Resilient Cities Framework is a model to provide an operational definition of a 'resilient city'. It outlines the drivers that identify what resilience looks like in an urban context and the policy mechanisms that could be beneficial.

3. *CRI – City Resilience Index, by Rockfeller Foundation/ARUP*[12]. It proposes a framework to be used as a study lens to understand the complexity of cities, identify areas of criticality and risk, and identify available resources to prepare a plan of actions and programmes to improve their resilience. The CRI consists of 4 categories: Health and Wellbeing of Individuals, Infrastructures and Ecosystems, Economy and Society, Leadership and Strategy, which in turn are each divided into 3 objectives. Taken together, the 12 objectives constitute the resilience of a city exposed to a wide range of stresses. The framework includes 52 resilience indicators that are assessed through 156 questions, drawing on both qualitative and quantitative data. The answers to these questions are aggregated and presented according to the 12 objectives. The importance of the 12 objectives depends on the urban context and the challenges a city faces. Contributing to the achievement of the 12 objectives are 'qualities' that distinguish a resilient city from one that is not (reflective, robust, redundant, resourceful, inclusive, flexible, integrated). These qualities are considered important in the prevention of trauma and stress and can be observed and monitored in relation to the different assets, systems, behaviours and practices implemented in the city.

Selected macro-themes

Energy, Water, Forms of urbanisation, Soil and land, Green infrastructures, Health, Socio-demographic structure.

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[10] "Guide for Climate-Resilient Cities: An Urban Critical Infrastructures Approach," Sustainability, MDPI, Open Access Journal, vol. 11(17), pages 1-19, August - Cinta Lomba-Fernández & Josune Hernantes & Leire Labaka, 2019

[11] https://www.oecd-ilibrary.org/docserver/6f1f6065-en.pdf?expires=1645360993&id=id&accname=guest&checksum=3A2ACA197C9F5747873AFD9D6781DA57

[12] City Resilience Index https://www.cityresilienceindex.org

SAMPLE OF MUNICIPALITIES

The document considers the single municipality as the object of the study, introducing a city-centered approach. The sample of municipalities was outlined on the basis of a choice that could guarantee the following criteria:

- national coverage and homogeneous distribution throughout the country;
- existence of three different demographic clusters (> 500,000 inhab.,> 100,000 inhab. and <100,000 inhab.);
- presence of urban areas responding to different territorial, geomorphological and climatic characteristics (coastal, plain, hilly, mountain).

The choice of the selected municipalities is addressed to pursue the criteria of inclusiveness and completeness. The aim is to set, as far as possible, an exhaustive vision of the entire national territory, characterized by a profound geographical, geological, climatic, socio-economic and anthropological richness; such elements contribute to the development of the territory. The sample of municipalities therefore coincided with the 20 regional capitals plus the municipality of Bozen (Figure 2). For the purpose of the analysis, the administrative limits rather than the urban area including its offshoots (conurbation phenomena) were considered, as it is difficult to represent and standardize for the various issues, despite the awareness that urban dynamics - especially those concerning environmental problems - cannot be limited to the administrative limit.

The basic choice of the municipal border is also inspired by some important premises:

- greater ease in finding the data to be processed and a guarantee of comparability on a national scale, as the main official sources collect the data referring to this territorial level;
- administrative limit coinciding with the scale at which local political decisions are made, thus making the environmental analysis policy-oriented and directly transferable to the decision-makers (mayors, councilors, etc.).

Figure 2: The 21 sampled municipalities: Turin, Aosta, Genoa, Milan, Bozen, Trento, Venice, Trieste, Bologna, Florence, Perugia, Ancona, Rome, L'Aquila, Campobasso, Naples, Bari, Potenza, Catanzaro, Palermo and Cagliari

INDICATORS

Environmental indicators summarise the wide range of data on the environment, helping to understand whether observed conditions are within certain expectations.
In the case of the urban environment, the intention is to be able to assess the performance of a city in order to provide governance with reliable information on whether performance meets the criteria deliberated by governance. It is therefore necessary to have and analyse quality variables at the municipal level, allowing an overview of the determinants, risks, impacts, shocks and stress conditions to which the urban environment is subjected.
ISPRA organises the data on indicators of the urban environment in the urban areas database (in Italian), built not only for the purpose of drawing up the 'Report on the Quality of the Urban Environment (RAU)', but also with the aim of providing the public with a unified access point to information on the state of the environment in urban areas to supplement the data provided by the National Environmental Information System (SINA) and the services made available within the National Infrastructure for Spatial Information and Environmental Monitoring. The set of indicators most capable of representing the given macro-theme for the three keys of interpretation "Livability", "Circularity", "Resilience to climate change", was obtained by drawing from the aforementioned database and was subsequently integrated with new indicators. The selection was made according to the following criteria:

- direct significance for the key;
- availability of geographical coverage for the 21 municipalities;
- availability of temporal coverage for a minimum period of 3 to 5 years;
- consistency with the topics of municipal competence/regulatory scope;
- quantitative character.

The selection process led to the identification of a number of 67 indicators.
The assignment of indicators to a specific reading key was decided on the basis of their prevailing significance, but it must be considered that they often have a transversal relevance that is independent of the classification made. For example, the indicator "*inhabitants living in areas of medium hydraulic hazard*", included in the key reading “Livability” as it is representative of a direct relationship between environment and health, is certainly also of interest in the perspective of Climate Change Resilience; the indicator "*total water losses*", included within the key reading Resilience, also provides useful indications from the perspective of the Circularity context.
The indicators chosen present some limitations, both linked to the territorial scale of reference (municipal administrative boundary) and to the lack of 'qualitative' information capable of providing a more in-depth knowledge of the specificity of the different contexts and phenomena. Moreover, the same selection operation in some cases entailed forgoing the use of specific indicators, potentially more relevant, but lacking the necessary continuity in terms of historical series or completeness of geographical coverage. For the same reason, not all the indicators used present the same level of updating: the need to look back into the past while ensuring a homogeneous picture among the realities analysed prevails, even in this case, over the need to offer the most up-to-date picture possible.
Below are the summary description tables of each indicator accompanied by the following information:

- unit of measure
- time interval of the data
- source of data
- motivation for the choice

Table 1 Indicators for the key Livability. Downloadable data by clicking on the name of the macro-theme (in Italian).

Key LIVABILITY					
Macro-theme	**Indicator**	**Unit**	**Data time interval**	**Data source**	**Reason for choice**
AIR QUALITY	*PM10*	µg/m^3	2013-2020	SNPA; ISPRA elaboration	Relevance of the pollutant to human health: there is evidence, for example, of an association between acute exposure to PM10 and an increase in both mortality and hospital admissions for heart and respiratory diseases
	Nitrogen dioxide (NO_2)	µg/m^3	2013-2020	SNPA; ISPRA elaboration	Relevance of the pollutant to human health: adverse effects include altered respiratory function especially in sensitive individuals
	Ozone (O_3)	µg/m^3	2013-2020	SNPA; ISPRA elaboration	Relevance of the pollutant to human health: it is responsible for irritation of eye mucous membranes and the first airways, coughing, broncho-obstructive phenomena and impaired respiratory function. It can also cause serious problems to ecosystems and material goods
WATER	*Purified waste water complying with emission standards*	%	2009, 2012, 2014, 2016, 2018	UWWTD questionnaire 2019, processed by ISPRA	Non-compliance of wastewater with legal values leads to negative effects on both human health (e.g. proliferation of harmful bacteria and viruses) and ecosystem health (e.g. fish mortality, water eutrophication, etc.).
NOISE POLLUTION	*Noise sources with exceedances of regulatory limits*	Number/ 100.000 inhabitants	2015-2019	SNPA (Noise Observatory ISPRA)	Noise pollution represents a pressure on the health and quality of life of the population
MOBILITY and TRANSPORT	*Availability of pedestrian areas*	m^2/100 inhabitants	2008-2019	ISTAT	Pedestrian areas contribute to sustainable mobility: it does not produce pollution and, at the same time, provides benefits in terms of health and psycho-physical well-being
	Density of bicycle lanes	km per 100 km^2 of municipal area	2011-2019	ISTAT	Cycle paths contribute to sustainable mobility: they do not produce pollution and, at the same time, provide benefits in terms of health and psycho-physical well-being
GREEN INFRASTRUCTURES	*Density of public green*	% of municipal area	2015-2019	ISTAT	Public green spaces provide numerous environmental and social benefits (e.g. urban heat island mitigation, recreation and physical activity, pollutant abatement, etc.)
	Availability of usable public green space	m^2/inhab.	2015-2019	ISTAT	The presence of usable and accessible public green spaces is a determinant of health and contributes to the psycho-physical well being of citizens
	Incidence of protected natural areas	% on municipal area	2015-2019	ISTAT	Protected natural areas contribute to urban biodiversity and the environmental quality of cities
SOIL AND LAND	*Anthropogenic sinkholes*	number	2015-2020	Historical and journalistic sources, ISPRA elaboration	Sinking events result in sinkholes in the ground and health hazards, associated with loss of life, damage to property and real estates
INDUSTRIAL ACTIVITIES	*PRTR Plants*	number	2015-2019	ISPRA	The presence of industrial pollutant sources leads to environmental and human health pressures

Table 2 Indicators for the Circularity key. Downloadable data by clicking on the name of the macro-theme (in Italian).

Key CIRCOLARITY					
Macro-theme	**Indicator**	**Unit**	**Data time interval**	**Data source**	**Reason for choice**
SOIL AND LAND	*Land consumed on municipal territory*	% of municipal area	2016-2020	Cartography SNPA, elaboration ISPRA	Land consumption causes the loss of a non-renewable natural resource and its ecosystem services
	Net land consumption per capita	m^2/inhabitant	2016-2020	Cartography SNPA, elaboration ISPRA	Land consumption causes the loss of a non-renewable natural resource and its ecosystem services
WASTE	*Municipal waste production per capita*	kg/inhab/year	2015-2019	ISPRA	The indicator includes both what is recovered and what is disposed of, and has a positive value if it decreases because it means less environmental and social impact due to the disposal of non-recyclable or recoverable waste in landfills or incinerators, in the direction of recycling and the circular economy
	Organic waste production per capita	kg/inhab/year	2015-2019	ISPRA	Separate collection of the organic fraction has a positive value, as it is a fraction almost entirely sent for recovery, in the direction of valorising waste as a resource and no longer as waste
	Separate waste collection	%	2015-2019	ISPRA	The indicator is useful for monitoring the achievement of the EU directives' reference targets
WATER	*Water delivered per capita*	l/inhab/day	2012-2018	ISTAT	The decrease in water consumption may be related to more sustainable resource use behaviour, but also to infrastructures leaks or water rationing episodes
MOBILITY and TRANSPORT	*Electric and hybrid cars*	% of total car fleet	2015-2020	ACI	Share of low-emission cars
	Passengers carried by local public transport per inhabitant	number of passengers per inhabitant per year	2011-2019	ISTAT	Indicator on the use of mass public transport services, more sustainable than private transport
GREEN INFRASTRUCTURES	*Loss of agricultural, natural and semi-natural areas*	ha	2015-2020	ISPRA	Loss of a non-renewable resource (permeable soil) and its ecosystem services due to urban transformations
	Urban gardens	m^2	2011-2019	ISTAT	Urban gardens contribute to soil conservation, experimentation with sustainable cultivation practices and self-production of food and sharing of natural resources

Table 3 Indicators for the Resilience to Climate Change key. Downloadable data by clicking on the name of the macro-theme (in Italian).

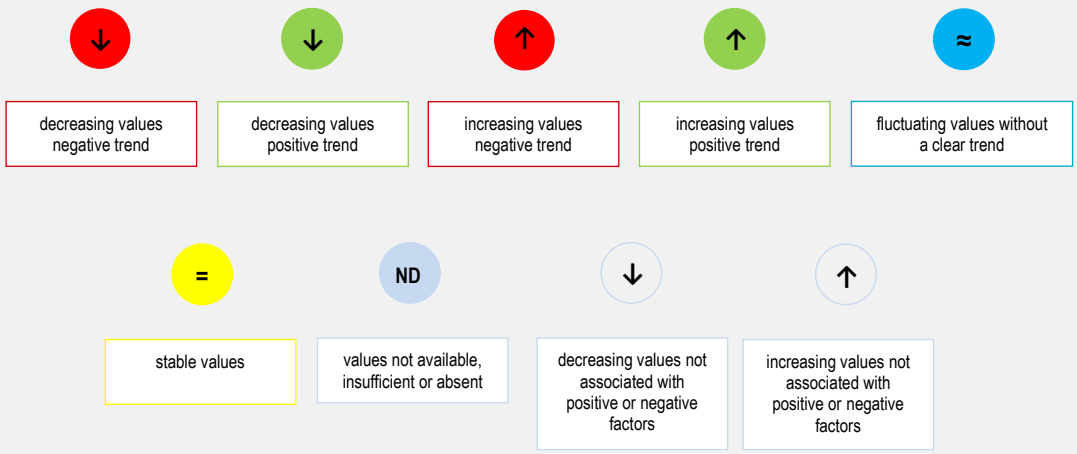
KEY RESILIENCE TO CLIMATE CHANGE					
Macro-theme	**Indicator**	**Unit**	**Data time interval**	**Data source**	**Reason for choice**
SOIL AND LAND	*Impermeable surfaces on non-consumed land*	ha	2016-2020	Cartography SNPA, elaboration ISPRA	Inability of impermeable surfaces to absorb large amounts of water and mitigate urban heat islands
	Impermeable surfaces on reversible consumed land	ha	2016-2020	Cartography SNPA, elaboration ISPRA	Inability of impermeable surfaces to absorb large amounts of water and mitigate urban heat islands
WATER	*Total water losses*	%	2012-2018	ISTAT	Capacity of the water system to preserve a natural resource and its resilience to the drought event
HEALTH	*HHWW alert days level 2 and 3*	number	2015-2019	DEP Lazio/Ministry of Health	Indication of the number of alert days provided by the city-specific warning and forecast system
	Change in excess heat wave mortality	%	2015-2019	DEP Lazio/Ministry of Health	Health impact in terms of mortality associated with the summer period (15 May-15 September). Together with 'level 2 and level 3 HHWW alert days' assesses the health impact of heatwaves in the summer period and the effectiveness of the alert system and prevention plan to reduce adverse effects over time.
GREEN INFRASTRUCTURES	*Vegetated surface area over urbanised surface area*	%	2016-2020	Cartography SNPA, elaboration ISPRA	Role of vegetated and permeable surfaces in reducing the risk of flooding and mitigating urban heat islands
SOCIO-DEMOGRAPHIC STRUCTURE	*Population aged 0-4 years*	%	2015-2020	ISTAT	Population group most vulnerable to the adverse impacts of climate change
	Population aged 65 years and over	%	2015-2020	ISTAT	Population group most vulnerable to the negative impacts of climate change
	Average income per taxpayer	€	2016-2019	ISTAT and Ministry of Economy, elaboration ISPRA	Wealth contributes to easier access to services, information and opportunities

HOW TO READ THE GRAPHS

Graphic synthesis is the simplification of a form or concept, extracting its most relevant attributes to express a clear and precise idea.
Using the formula of concentric rings, appropriate summary graphs were created, inserted within each textual synthesis framework constructed for a common piece of data and a given key. The technique used allowed several sets of data to be plotted simultaneously, showing all the parts of each set at a glance.

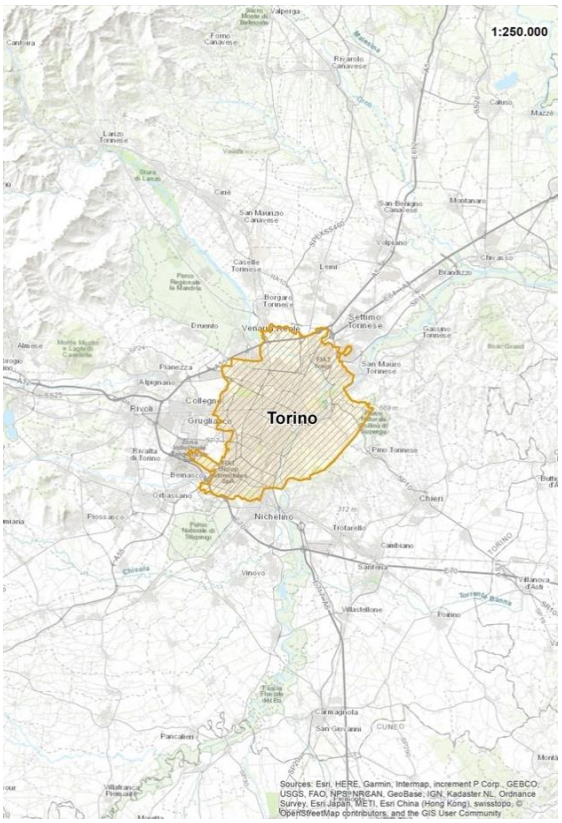
The result is a graphical representation capable of providing a synoptic view that, like a magnifying glass, focuses on the trends of the indicators related to the different macro-themes for each of the three keys for reading an individual city.
The choice was made with the intention of creating communicative symbols that are ideal for conveying the environmental state of the city to the reader in the most immediate, comprehensible and appealing manner.

Table 4 Legend for the trend each indicator can take



PART II
RESULTS

TURIN

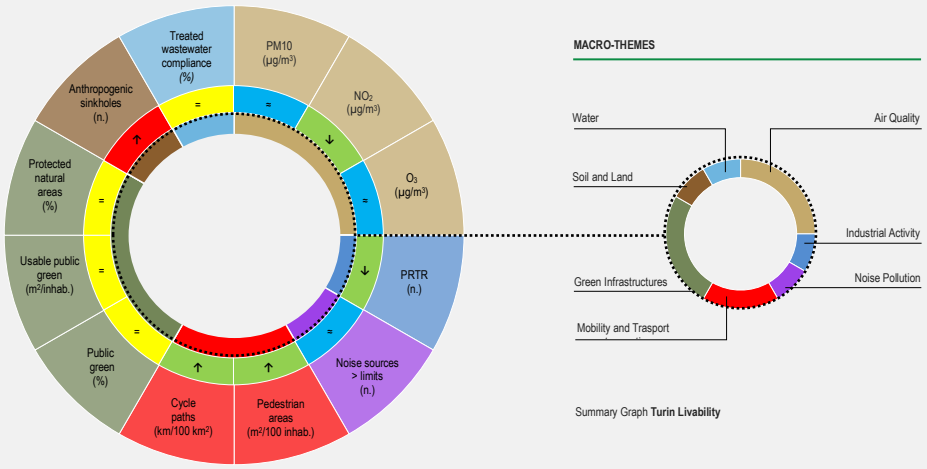


THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**857,910**
RESIDENT POPULATION 2015 (N)	**884,710**
POPULATION DENSITY (PEOPLE/KM^2)	**6,596**
AVERAGE INCOME PER CAPITA (€)	**18,585**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**130.1**
ALTIMETRICAL ZONE	**PLAIN**

TURIN LIVABILITY - SUMMARY

The picture of livability in Turin is characterised by improvements in some areas, situations of substantial stability and some criticalities. The first positive datum refers to air quality, which shows a decreasing trend in NO_2 concentrations over the period 2013-2020, while for PM10 the underlying trend is not statistically significant, although lower values are appreciated in the last 3 years compared to the previous 5. The trend in O_3 concentrations is stable, but the long-term objective of 120 µg/m³, calculated as the maximum daily value of the average O_3 concentration over 8 consecutive hours, was exceeded in 2020 at all stations. In contrast, there were no exceedances of the information (180 µg/m³) and warning (240 µg/m³) thresholds. Very good signs in the area of urban waste water treatment: in the period from 2009 to 2018, all waste water produced by the city was stably purified and complied with emission standards. For the mobility and transport sector as a whole, a virtuous picture emerges in which an increase in the supply of forms of soft mobility can be observed: approximately 166 km of cycle paths per 100 km² of surface area, the highest value among municipalities observed, and a 61.6 per cent increase in pedestrian areas from 2008 to 2019. Finally, the number of PRTR establishments at municipal level slightly decreased from 17 to 16 between 2015 and 2019. The picture of green infrastructures describes a substantial stability: the per capita availability of usable public green space (about 22 m²/inhabitant) and the incidence of protected natural areas on the total municipal surface area (about 7.5%) remain unchanged, but the 15% of municipal territory destined for public green places Turin among the municipalities with the highest values in the sample examined. In the years 2015-2019, the trend in the number of noise sources monitored per 100,000 inhabitants found to be above the limits appears to be fluctuating with a downward trend, reporting in 2019 an incidence of 1.4 sources, a low value compared to the sample of 21 municipalities. There has also been an upward trend in the number of anthropogenic sinkholes over the last decade, with the value of 36 being medium-high compared to other municipalities in northern Italy: this trend is to be ascribed above all to leaks in the hydraulic network.



Summary Graph **Turin Livability**

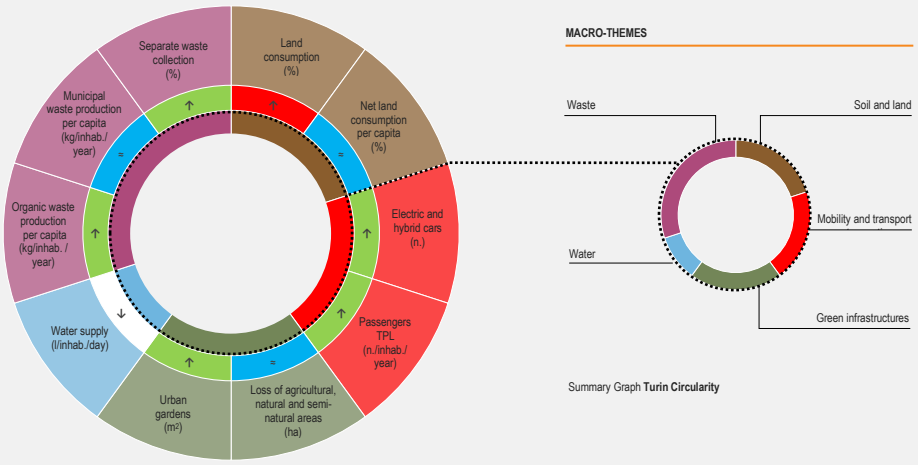
TURIN CIRCULARITY - SUMMARY

The analysis of the indicators selected to better understand the municipal administration's efforts towards a circular approach to the use of resources returns a picture with several positive notes and some possible areas for improvement.

Performance regarding policies to promote urban gardens, regulated green areas for agricultural self-production for socio-recreational purposes, is good: in fact, these areas have increased by 2.8 hectares since 2013, destined to increase further with the forecasts of the recently approved Green Infrastructures Strategic Plan. Positive note also for the percentage of separate waste collection, which increased by 12% in the five-year period 2015-2019, reaching values of 47.7%. Performance in the area of sustainable mobility is good, with a constant increase in demand for local public transport (LPT) of +41.7% compared to 2011, a percentage that places Turin among the cities in the sample with the highest values.

In addition, the incidence of hybrid/electric cars on the total car fleet grows by more than 2 percentage points, reaching 2.7% in 2020, with the weight of plug-ins reaching more than 8% in 2020, the highest value in the sample considered.

Among the areas in which more incisive policies are needed to remedy particularly critical situations are the percentage of land consumed on the municipal surface, which stands at 66% throughout the historical series, indicating a spatial configuration tending towards saturation, and the per capita production of organic waste, which, although it has accelerated sharply in the last year with an increase of almost 10 percentage points, a positive sign after a period of substantial balance, remains among the medium-low values in the sample. The daily per capita supply of drinking water over the seven-year period considered (2012-2018) also remains at a significantly higher level than the national value (215 l/inhab/day in 2018).

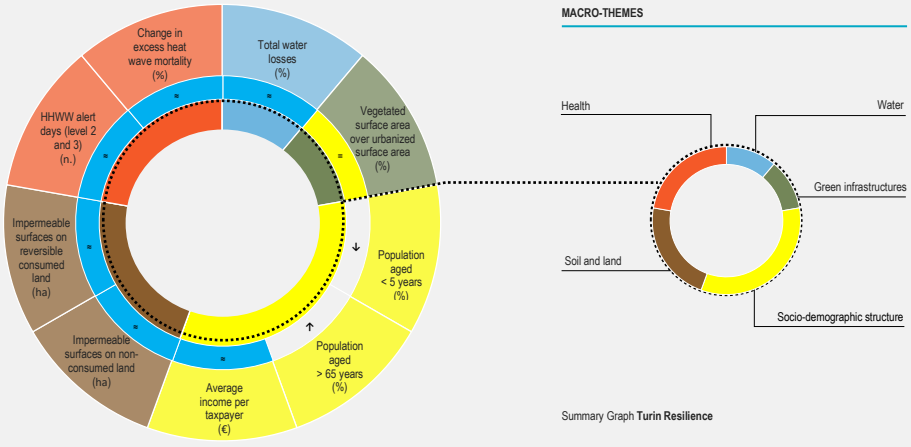


Summary Graph **Turin Circularity**

TURIN RESILIENCE - SUMMARY

The analysis of selected indicators in order to understand how the municipality is responding to climate change paints a rather heterogeneous picture, characterised by positive notes in some areas and situations with potential for improvement. Total water losses fluctuated over the seven-year period 2012-2018, but were still well below the national figure, standing at around 29% in 2018. Even for green infrastructures, strategic resources for the adaptation of cities to climate change, there is a situation of stagnation, with a percentage of vegetated area - public and private - over urbanised area of about 29% for the period 2016-2020, stably among the lowest values in the sample. This confirms a critical situation linked to soil sealing, with 52 hectares of new impermeable surfaces between 2015 and 2020, created both at the expense of natural or semi-natural areas and of lands consumed in a reversible manner, such as construction sites or earthen surfaces. The removal of open spaces and green areas from the city by impermeable surfaces can play a negative role on the local climate by contributing to amplifying the urban heat island phenomenon and the impacts generated by extreme weather events.

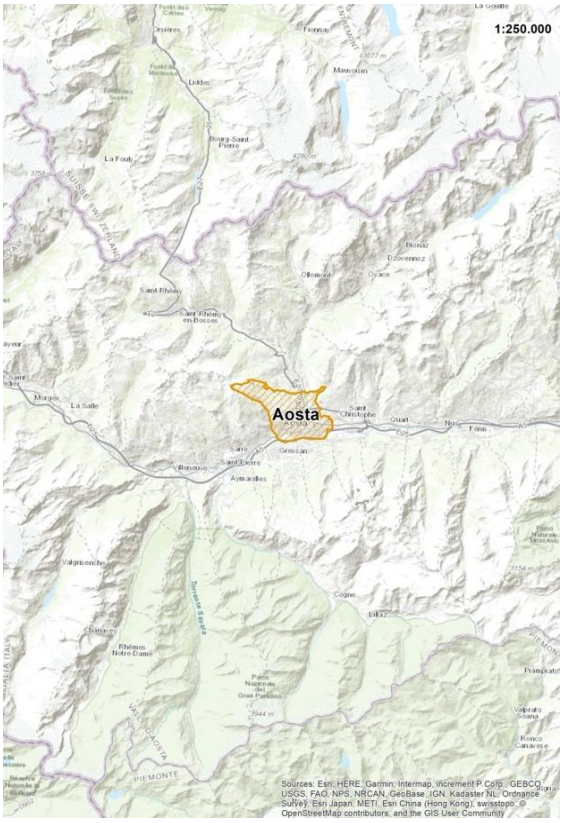
Stable in the 2015-2019 period, on the health front, is the change in excess mortality in the summer season of the population over 65 associated with heat waves, 13 in 2019, which, however, places Turin's values among the medium-high ones of the sample (6% in 2019). The indicators relating to the socio-demographic structure describe, as a whole, the potential responsiveness of the population to climate-related hazards: the population aged 0-4 years and the population aged 65 years and over characterise population groups that are particularly sensitive to climate change. Although slight (from 25.5% in 2016 to 26% in 2020), the increase in the population with an older age, in association with the data on the summer mortality of the over-65s, suggests the need to prepare adaptation policies aimed at increasing their capacity to respond to climate-related hazards. Finally, the average income per taxpayer, which, at €25,994 in 2018, shows rather high values in the sample, provides indications of the wealth of the population potentially associated, from a resilience perspective, with a higher level of access to services, opportunities and information.



Summary Graph **Turin Resilience**

AOSTA


Image source: Pixabay



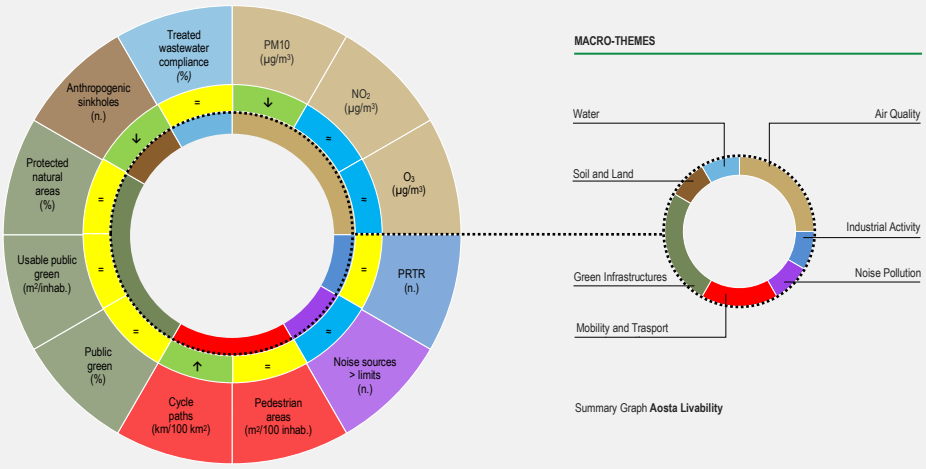
THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**33,916**
RESIDENT POPULATION 2015 (N)	**34,521**
POPULATION DENSITY (PEOPLE/KM^2)	**1,586**
AVERAGE INCOME PER CAPITA (€)	**18,237**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**21.4**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

AOSTA LIVABILITY - SUMMARY

The indicators observed to characterise the livability of the capital of the Valle d'Aosta denote a heterogeneous picture marked by improvements in some areas and situations of substantial stability in others. The first positive data refers to air quality, which shows a downward trend in PM10 concentrations over the 2013-2020 period. As far as NO_2 is concerned, on the other hand, the underlying trend is not statistically significant, even if lower values are appreciated in the last 3 years compared to the previous 5. A stable trend is seen for O_3, for which the long-term objective of 120 µg/m³, calculated as the maximum daily value of the average ozone concentration over 8 consecutive hours, was exceeded at all stations, while the information (180 µg/m³) and warning (240 µg/m³) thresholds were not exceeded. The area of mobility and transport shows a consistent increase in the density of bicycle lanes from 2011 to 2014 (19.4 %) and a steady decrease in the proportion of Euro 0-3 standard cars to one third of the 2015 values in 2020. The availability of pedestrian areas, on the other hand, shows a stable trend over the last decade, standing at 5.9 m²/100 inhabitants, one of the lowest values among those observed in the sample. The number of anthropogenic sinkholes, which occurred in the past due to the presence of underground voids within the historic centre, remains at very low values of 6 events over the last decade. A steadily positive situation is found in the water sector, where in the period 2009-2018 the entire organic load produced by the city was purified and complied with the emission standards set by the reference legislation. Possible margins for improvement can be identified in some areas that, while not showing specific criticalities, could be better addressed through more incisive policies. This is the case, for example, in the area of noise pollution in which a fluctuating, but upward trend was observed in the years 2015-2019 in the number of noise sources controlled with exceedances of regulatory limits per 100,000 inhabitants: in 2019, exceedances were recorded for both controlled sources.

On the urban green areas front, values of per capita availability of usable public green areas (17.7 m²/inhabitant) substantially unchanged in the five-year period 2015-2019 and a limited percentage of protected natural areas (0.4%), in line with the lowest values in the sample, compensated, however, by the presence of green areas that can be easily reached in a maximum of 15/20 minutes on foot or by bicycle from the city centre.



Summary Graph **Aosta Livability**

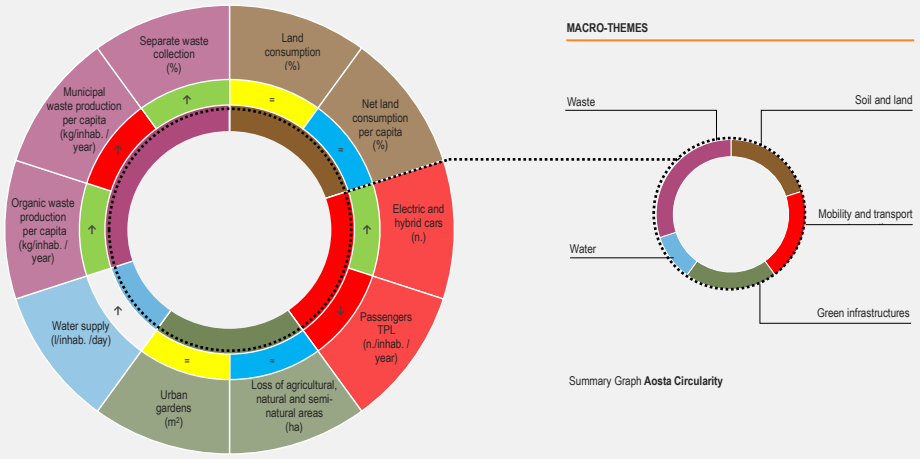
AOSTA CIRCULARITY - SUMMARY

On the circularity front, Aosta shows positive trends in two areas: waste and mobility. Indeed, the percentage of differentiated waste collection is growing significantly, reaching 69.2% in 2019 thanks to a fairly constant increase over the five-year period 2015-2019 with values of 2.8% in the last year. These data place Aosta among the municipalities in the sample with the highest value of this indicator. The production of organic waste also increased (+60%) between 2015 and 2019. The share of electric and hybrid cars in the total car fleet is also on the rise, rising from 0.2% in 2015 to 1.2% in 2020: specifically, plug-in hybrid cars in 2020 accounted for 32.1% of the total number of hybrid and electric cars, but the figure must be considered in relation to the substantial share of rental car registrations.

Margins for improvement can be identified in some areas that, while not showing particular criticalities, could be better targeted through more careful and effective policies: this is the case, for example, of green infrastructures, which have registered unchanged areas destined for urban gardens since 2011, with values that will stand at 1.2 ha in 2019 and an incidence of about 2% of the total public green. The loss of agricultural, natural and semi-natural areas is contained, which, only in the period 2019-2020, exceed one hectare due to soil consumption. On the soil and land sector front, Aosta records a per capita net land consumption that varies from about 0.2 m^2/inhabitant in 2015-2016 to about 0.3 m^2/inhabitant in 2019-2020 in correspondence with the greater, albeit slight, land consumption recorded over the period.

On the water resource front, there was an increase in the daily per capita supply of water for drinking use in the period 2012-2018, which was significantly higher than the national value (215 l/inhabit/d) with the peak of the series being 296 l/inhabit/d reached in 2018.

In the waste sector, the positive separate collection figure is offset by the growth in the per capita production of total municipal waste (+5.7% in the 2015-2019 period, with a value of 479 kg/inhabitant in 2019). Greater efforts are also desirable in the field of mobility and transport, to counteract, in particular, the decrease in demand for local public transport observed from 2011 to 2019 (-61%), which reached a minimum value of 12.5 passengers per year/inhabitant, outlining a low propensity of citizens to use this form of transport.

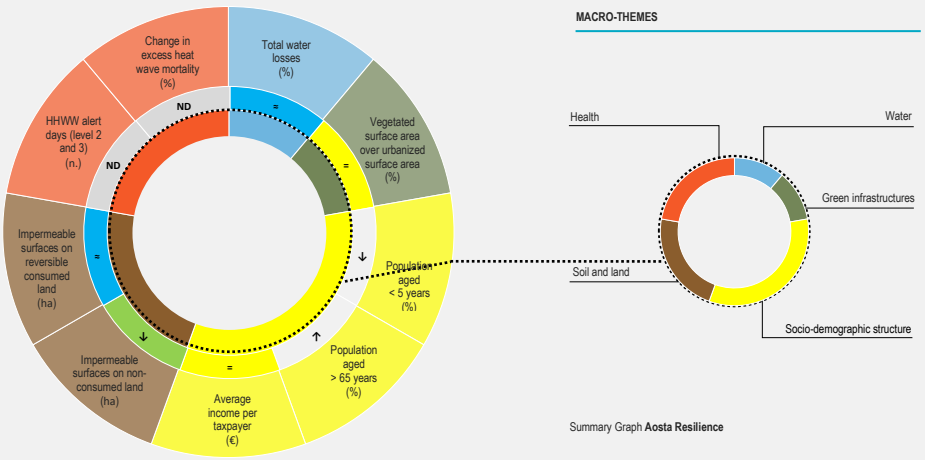


Summary Graph **Aosta Circularity**

AOSTA RESILIENCE - SUMMARY

Improvements in resilience to climate change over the period considered can be attributed exclusively to the positive signal shown by the indicator impermeable surface on non-consumed land (natural or semi-natural areas) which shows a decreasing trend, except for 2020 when a very slight increase is recorded. Aosta is among the municipalities with the lowest level of impermeable surfaces among those analysed, equal to 1 ha between 2015 and 2020. There are also sectors which, while not showing critical issues of particular gravity, could be better addressed through more careful and effective policies: on the water resource front, although Aosta presents values below the national figure throughout the period considered (2012-2018), total water losses in distribution are nevertheless recorded at around 30% in 2018, the highest value recorded since 2015; as regards green infrastructures, the 51% of vegetated surface of public and private property on the urbanised surface remains stable over time (2016-2020) and in line with the intermediate values of the sample. This trend does not, therefore, show an increasing trend of permeable and vegetated surfaces that are so important for adaptation to climate change impacts (flooding and/or flood risk, urban heat islands).

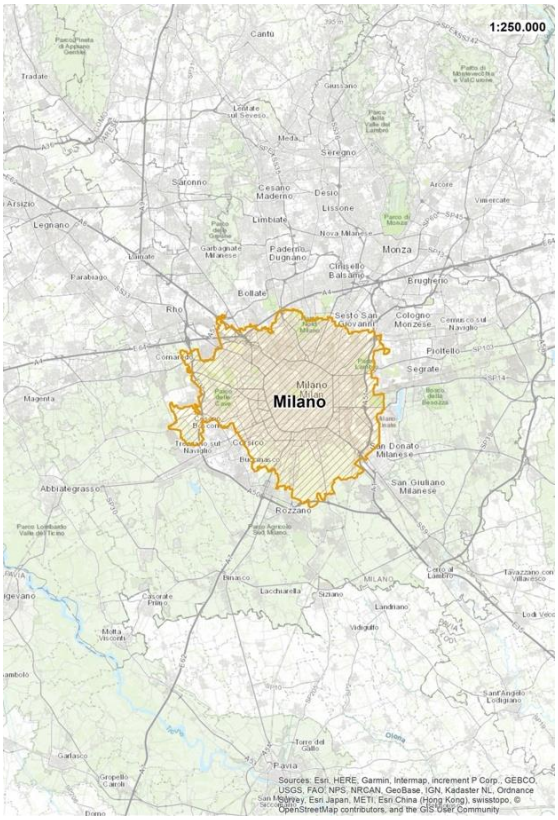
The indicators relating to the socio-demographic structure describe, as a whole, the population's ability to respond to climate-related hazards such as heat waves, intense precipitation events, droughts, thus providing useful indications to the administration on the trend of certain parameters on which to focus attention, also for the purpose of implementing appropriate policies: the population aged 0-4 years characterises a group of the population that is particularly sensitive to climate change, which is currently decreasing (from 4% in 2016 to 3.5% in 2020) while the population aged 65 years and over describes another fragile portion of the population, which is currently increasing (from 26.7% in 2016 to 27.8% in 2020). These trends suggest the need to devise adaptation policies that pay particular attention to the older population category and aim to increase its resilience to climate-related criticalities. Finally, the average income per taxpayer, which provides an indication of the population's wealth accompanied by the potential level of access to services, opportunities and information, with €. 23,994 in 2018 maintains Aosta in line with the intermediate values of the sample.



Summary Graph **Aosta Resilience**

MILAN


Image source: Pixabay



THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**1,406,242**
RESIDENT POPULATION 2015 (N)	**1,339,812**
POPULATION DENSITY (PEOPLE/KM^2)	**7,740**
AVERAGE INCOME PER CAPITA (€)	**25,242**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**181.7**
ALTIMETRICAL ZONE	**PLAIN**

MILAN LIVABILITY - SUMMARY

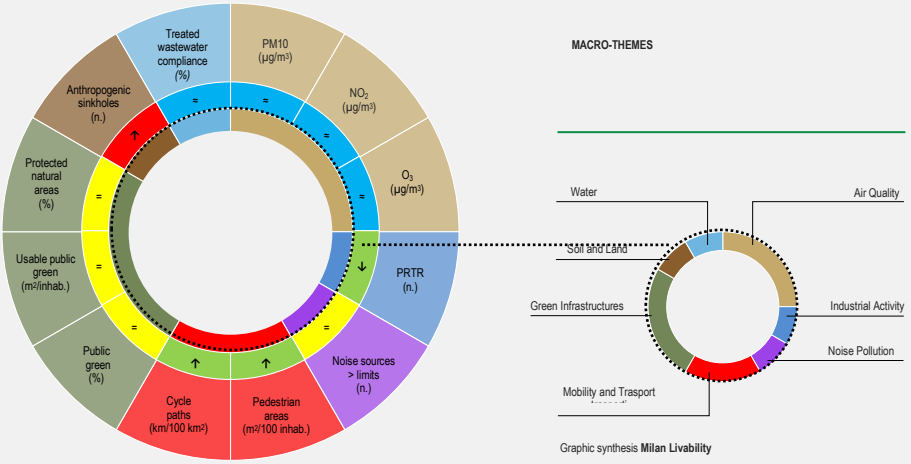
The picture of the livability of the city of Milan shows improvements in some areas, situations of substantial stability and also some criticalities.

The first positive fact concerns the increase in the offer of forms of soft mobility: the availability of pedestrian areas increases by 86.7% from 2008 to 2019 and reaches 54.8 m^2/100 inhabitants, just as the density of bicycle lanes is constantly growing from 2011 to 2019 (+71%) and allows Milan to reach the second highest value in the series.

On the industrial activities side, there is a decrease in the number of PRTR establishments at municipal level from 28 to 22, which nevertheless remain among the highest values within the sample of municipalities analysed. Situations of general stability or fluctuation are described by the trend in the percentage of purified wastewater that complies with emission standards (between 2012 and 2016 there is a situation of non-compliance of one of the three plants serving the municipality of Milan with values at 92% that in 2018 rose again to 96%) and in the number of noise sources controlled with exceedances of legal limits, which reaches considerable values. Green infrastructures also show little increase both in terms of density of public green on the municipal surface area (13.8% in 2019) and in terms of per capita availability of usable public green space (17.5 m^2/inhabitant in 2019): in the five-year period considered, public green areas increase but so does the resident population. The values of the incidence of public green areas on the municipal area are among the highest in the sample.

As far as air quality is concerned, in the period 2013-2020 for PM10, NO_2 and O_3 the underlying trend is not statistically significant even if, limited to PM10 and NO_2, lower values are appreciated in the last 3 years than in the previous 5. The long-term objective for O_3 of 120 µg/m³, calculated as the maximum daily value of the average concentration over 8 consecutive hours, was exceeded at all stations in 2020, while there were no exceedances of the information threshold (180 µg/m³) and the alert threshold (240 µg/m³).

Finally, with regard to soil and land aspects, the number of anthropogenic sinkholes events has increased in recent years, mainly due to leaks in the hydraulic network of underground utilities. Milan holds the record among cities in Lombardy and has rather high values (37) over the last decade among cities in northern Italy.

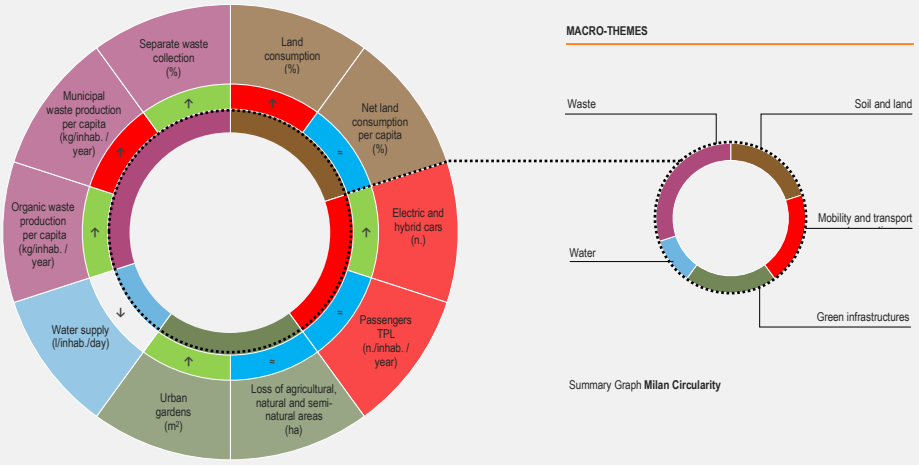


Graphic synthesis **Milan Livability**

MILAN CIRCULARITY - SUMMARY

From the perspective of circularity various advances are found: in the area of policies for the shared use of public green spaces, for example, there is an increase in the area allocated to urban gardens (+115% from 2011 to 2019), while in the area of water resources there is a decrease in the amount of water supplied per capita. In 2018, in fact, 365 l/inhabitant per day were disbursed for authorised uses, compared to 428 l/inhabitant per day in 2012, although this is still one of the highest values compared to the sample in the period 2012-2018.
As far as waste is concerned, the percentage of separate waste collection over the five-year period 2015-2019 showed a constant increase of about 17% to reach 61.3% in the last year, a figure that keeps Milan among the average values of the sample. Constant growth over the five-year period 2015-2019 is also noted for the per capita production of organic waste (10%) with values that keep Milan in the average range of the sample. This indicates that waste is increasingly being properly disposed of.

Signs of positivity are also being shown by the mobility sector, with demand for local public transport, which, although down by 6.3%, maintains fairly high values compared to the sample of 21 municipalities considered. Alongside a modest increase in the car fleet, however, is the figure for the percentage of electric or hybrid cars, already over 4%, which is among the highest values among the municipalities surveyed.
Milan does, however, show some problems to report: a percentage of land consumed on the municipal surface area among the highest of the regional capitals (just over 58% in the period) and a fluctuating per capita net land consumption in the period considered. Sustainable land use policies therefore need more attention. Also on the waste front, more incisive initiatives are needed to reverse the trend of steadily increasing per capita urban waste production (2.1%), with the exception of 2017.



Summary Graph **Milan Circularity**

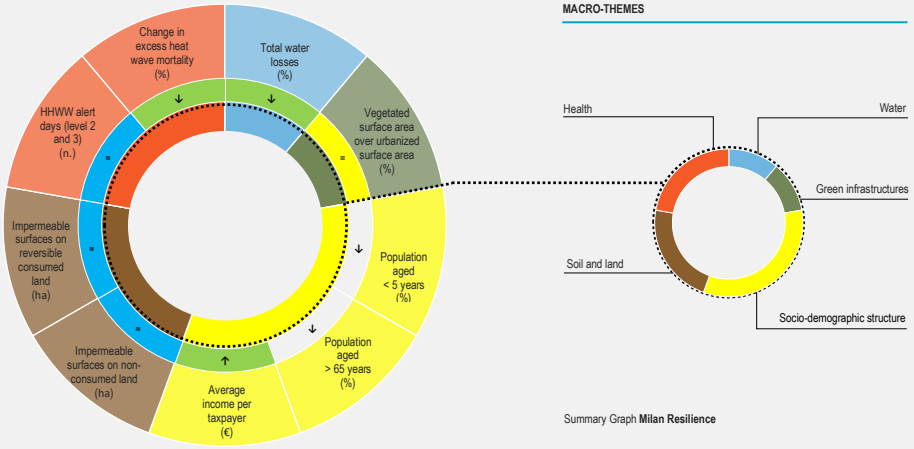
MILAN RESILIENCE – SUMMARY

On the climate change resilience front, a picture is outlined that alternates substantially stable situations with some positive signs in various fields. As far as water resources are concerned, Milan appears, among those analysed, to be the most virtuous municipality in the entire 2012-2018 period, with values of the percentage of total water losses in distribution always below 20%: the lowest figure in 2018 was around 14%, well below the national value (42%). There are also positive signs on the health front in the 2015-2019 period: the change in excess mortality in the over-65 population in the summer season shows, in fact, a decreasing trend and places Milan among the lowest values in the sample (6% lower than expected in 2019). There is evidence of a reduction in excess mortality equal to or lower than expected values from 2017 onwards.

Less clear signals were recorded on the soil and land front. In fact, the values relating to the sealing of natural or semi-natural areas and of reversible consumed land (building sites or rammed-earth surfaces) are fluctuating and therefore without a clear trend in the 2016-2020 period, the latter being among the highest values found in the sample in the last two years. The Seveso flooding in 2019, and two violent storms in 2020, highlight situations of fragility in the face of flooding events with consequent flooding of roads, businesses, ground-floor urban premises and subways, closure of metro stations and problems with train traffic.

Green infrastructures, a strategic resource for adapting to climate change, does not show any increase in the vegetated surface area - of both public and private property - over the urbanised surface area, which remains below 36%, one of the lowest values in the sample analysed.

In terms of socio-demographic structure, there are decreasing trends both for the population aged 0-4 years (from 4.3% in 2016 to 4% in 2020), consistent with the trend in all the municipalities analysed, and in terms of the percentage of the population aged 65 years and over (from 23.9% in 2016 to 23% in 2020), a figure in contrast with the municipalities in the sample. Although decreasing, these population groups still require, due to their specific situation of fragility, adequate adaptation policies aimed at favouring the response to critical climatic conditions. With an average income per taxpayer of €35,336 in 2018, Milan presents values that are among the highest within the sample, thus denoting a favourable situation in terms of the population's level of wealth potentially associated, in terms of resilience, with a good level of access to services, opportunities and information.



Summary Graph **Milan Resilience**

BOZEN

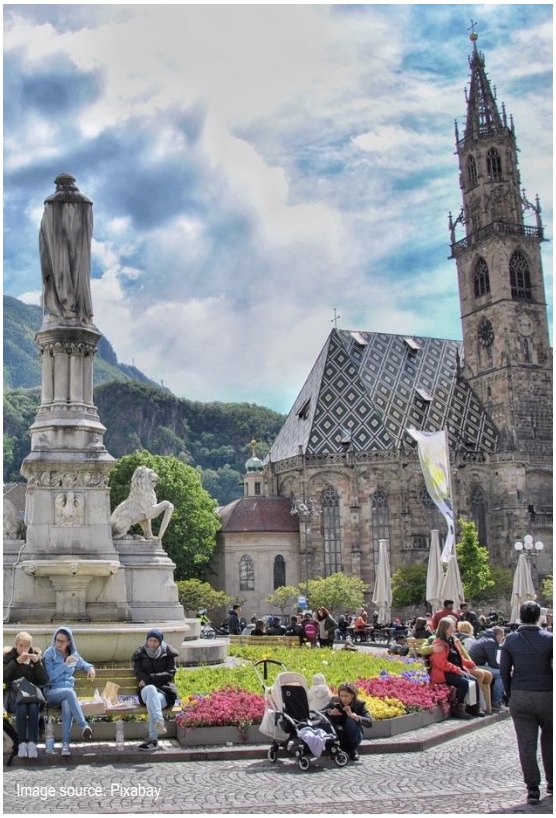
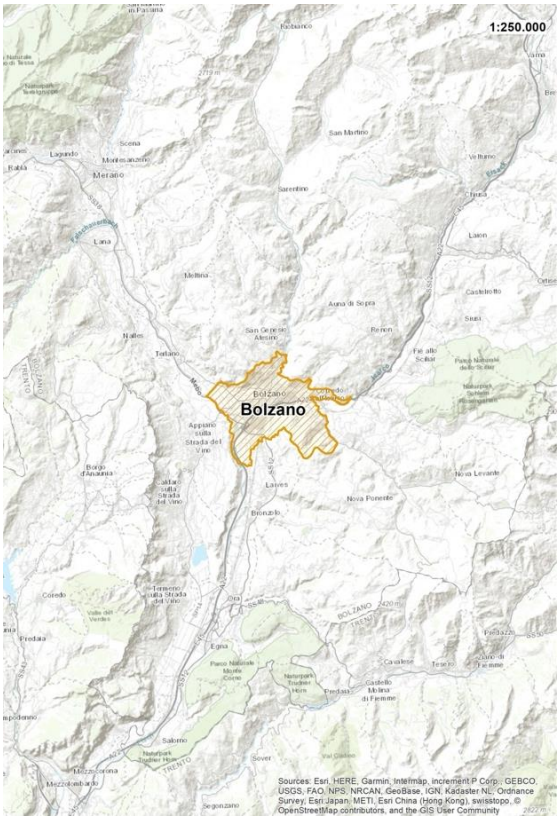


Image source: Pixabay



THE CONTEXT

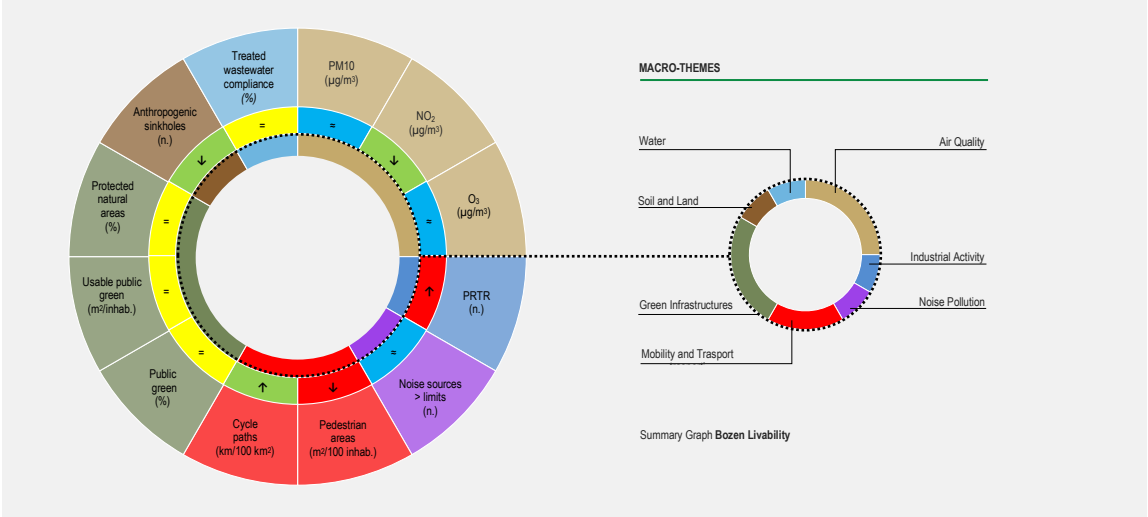
SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**107,843**
RESIDENT POPULATION 2015 (N)	**105,921**
POPULATION DENSITY (PEOPLE/KM^2)	**2,062**
AVERAGE INCOME PER CAPITA (€)	**21,042**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**52.3**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

BOZEN LIVABILITY – SUMMARY

From the picture of livability in Bozen, an initial positive datum emerges in relation to air quality, which shows a decreasing and statistically significant trend for NO_2 values, while for PM10 and O_3 a fluctuating trend is observed without statistically significant trends, although the levels of atmospheric particulate matter are still among the lowest recorded in Italy.

A virtuous figure concerns the percentage of purified wastewater that complies with emission standards, with values close to 100% in the period 2009-2018, and with an almost stable but certainly positive situation. On the other hand, as far as noise pollution is concerned, a fluctuating trend in the number of noise sources monitored with exceedances of regulatory limits can be seen in the period analysed, with an incidence per 100,000 inhabitants of 7.4, which is among the high values in the sample analysed in 2015-2019. However, the municipality has not yet approved the acoustic classification plan for its territory, but has prepared, as of 2017, the strategic noise map in accordance with Directive 2000/49/EC. The indicators on soft mobility show, on the one hand, an increase in the density of cycle paths (+6.4%) with a value of of 103.6 km/100 km^2 of land area (one of the highest values observed in the sample), but on the other hand a gradual decrease since 2008 in the availability of pedestrian areas (-7.6%) with a value in 2019 of 27.9 m^2/100 inhabitants. It is therefore desirable to pay more attention to this particular critical issue and adopt more incisive policies. The picture of green infrastructures describes a substantial stability: an unchanged per capita availability of usable public green spaces (13.8 m^2/inhabitant) and a density of public green space on the municipal area of 4.5%. The incidence of protected natural areas on the total municipal surface area (0.2%) also remained constant over the period considered. The apparent scarcity of green areas in the municipal territory is, however, compensated for by the possibility of walking in peri-urban green areas, which can be easily reached in a short time on foot or by cable cars.

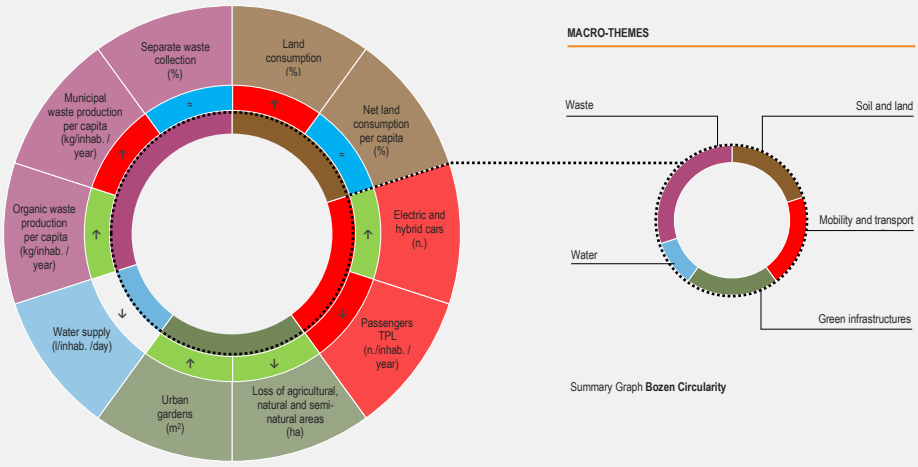
With reference to soil, it is noted that the number of anthropogenic sinkholes is very low (only 7 since 2010) with a decreasing trend and no events in 2020 and 2021. Finally, a limited increase in industrial plants is observed: the number of PRTR plants has increased from 4 to 5 at municipal level and from 14 to 16 at provincial level in the period 2015-2019.



Summary Graph **Bozen Livability**

BOZEN CIRCULARITY - SUMMARY

On the circularity front, improvements can be seen in several fields. In particular, in the sphere of green infrastructures, the increase in the area of municipal land allocated to urban gardens, starting in 2016 and reaching 12,150 m² in 2019, and the containment over the years of the loss of agricultural, natural and semi-natural areas, which occurs at a rate of 1.75 hectares per year over the five-year period 2015-2019, is appreciable.
As far as the percentage of separate waste collection is concerned, a fluctuating trend has been seen over the five-year period 2015-2019, although, compared to the total for the period, there is an increase of 6.2%, with values reaching 67% in 2019. The per capita production of organic waste in the first four years of the five-year period also followed a constant trend, with the exception of a minimal decrease in 2017 and then a peak in growth in the last year: in the total of the period, the growth stands at 5.7% (133.7 kg/inhabitant in 2019). These increases outline proper waste disposal. The situation is different for per capita production of municipal waste, which reached 518.2 kg/inhabitant in 2019 and grew steadily (15.4%) over the five-year period 2015-2019, thus requiring more effective policies with a view to sustainability.
Lights and shadows for the mobility and transport sector. The share of electric and hybrid cars is significant, reaching 2% of the car fleet in 2020. However, the reduction in the number of passengers transported per inhabitant per year by local public transport (LPT), equal to -20.4% in 2019 compared to 2011, is a figure worthy of particular attention from the perspective of circularity and suggests serious reflection for the purposes of future planning of sustainable mobility in the city.
The situation regarding per capita net land consumption seems to be moving in the right direction, decreasing, albeit slightly, and the percentage of land consumed on the municipal territory is around 26% for the period 2016 - 2020, demonstrating that the policies adopted are moving in the direction of sustainability.



Summary Graph **Bozen Circularity**

BOZEN RESILIENCE - SUMMARY

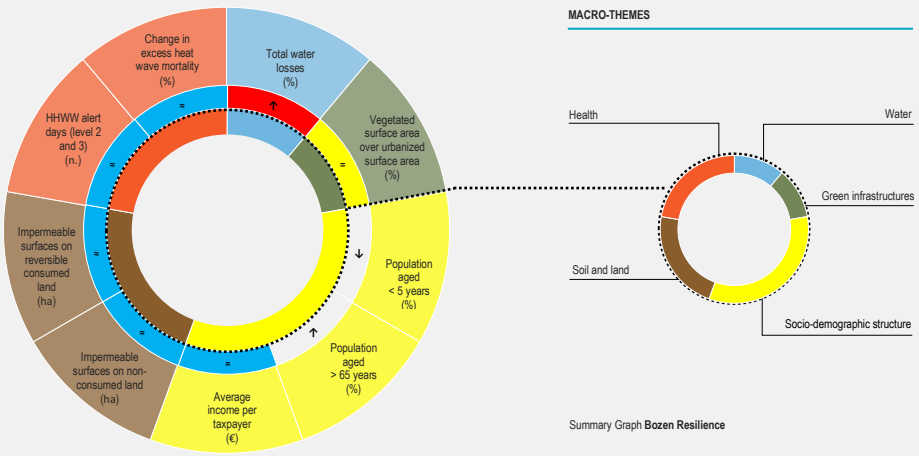
The analysed indicators show no clear progress on the climate resilience side, with mostly fluctuating or stable trends.

As far as green infrastructures is concerned, a situation of stagnation is recorded, with values of the percentage of vegetated area, both publicly and privately owned, over the urbanised area at around 51% for the period 2016-2020: this figure is among the intermediate values of the sample. In 2018, 52% of the vegetated surfaces are covered with tree cover, an important component especially for its thermoregulatory function in summer.

In relation to total water loss, there is an upward trend, although the values remain below the national figure of 42% in 2018; the lowest value was recorded in 2013 with 19.5% and the highest in 2016 with 32.9%.

In terms of soil sealing processes, Bozen shows fluctuating values, with an expansion between 2015 and 2020 of about 13 ha, of which 3 ha of new impermeable surfaces at the expense of natural or semi-natural areas, and 10 ha on reversibly consumed land such as building sites or earthen surfaces.

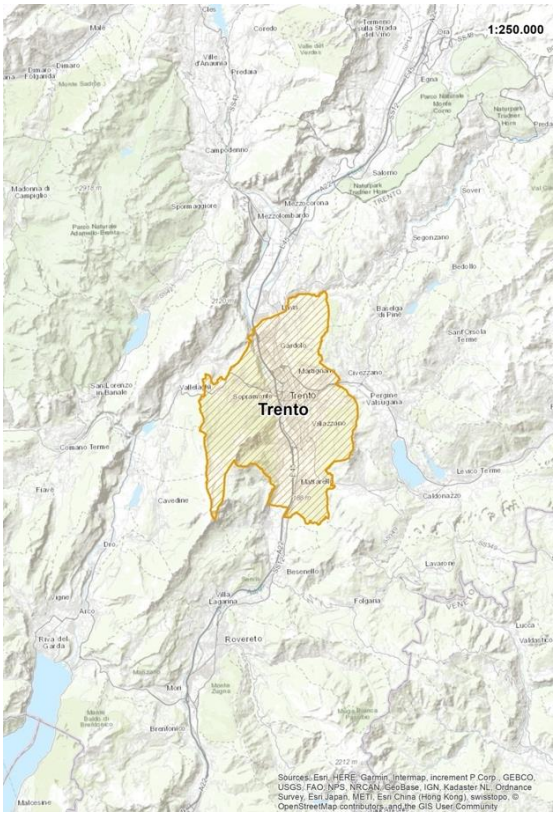
With regard to health aspects, with particular reference to the variation in excess mortality (%) and heat wave alert days, the values fluctuate over the period 2015-2019 but, for the second indicator, data are among the highest within the sample (26 days in 2019). In this sense, the need for adaptation policies aimed at coping with the possible consequences of heatwaves on the most fragile population categories (children and the elderly) should be highlighted: the percentage of the population aged 0-4 years is currently decreasing between 4.7% in 2016 and 4.3% in 2020; the percentage of the population aged 65 years and over is, on the other hand, slightly increasing, from 23.6% in 2016 to 23.8% in 2020. This circumstance highlights the need for adaptation policies increasingly geared towards strengthening the response of this demographic group to the problems associated with climate change. Finally, the average income per taxpayer, at €26,889 in 2018, provides an indication of the population's wealth accompanied by the potential level of access to services, opportunities and information: this value is among the highest within the sample of municipalities analysed.



Summary Graph **Bozen Resilience**

TRENTO


Image source: Pixabay

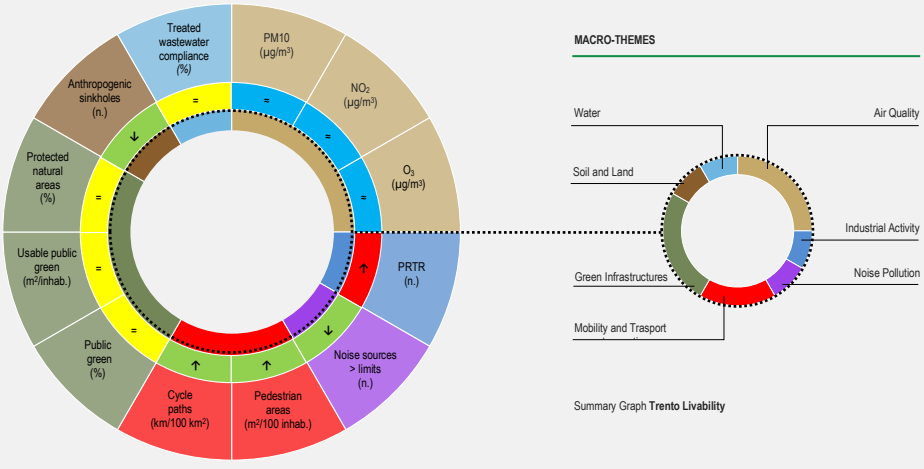


THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**120,641**
RESIDENT POPULATION 2015 (N)	**117,404**
POPULATION DENSITY (PEOPLE/KM²)	**764**
AVERAGE INCOME PER CAPITA (€)	**19,430**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**157.9**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

TRENTO LIVABILITY - SUMMARY

The first positive data for Trento's livability refers to air quality which, although showing no statistically significant trends for the air pollutants analyzed, shows a favorable situation in 2020 with no exceedances of the annual limit values for NO_2 and PM10. For the latter, the values recorded in the years considered are among the lowest in Italy. As for O_3, on the other hand, in 2020 the long-term objective of 120 µg/m³, calculated as the maximum daily value of the average ozone concentration over 8 consecutive hours, was exceeded at all stations, while there were no exceedances of the information threshold (180 µg/m³) and the alert threshold (240 µg/m³). Another positive figure concerns the percentage of purified wastewater complying with emission standards with high values throughout the analyzed period: from a low of 97.8 percent in 2009 to 99.9 percent in 2018. The situation regarding noise pollution is also positive: in the period analyzed, the number of noise sources controlled with exceedances of regulatory limits per 100,000 inhabitants shows a decreasing trend with a value as of 2019 of 0.8, significantly lower than the average incidence of 2.2 assessed in the 2015-2019 period. In fact, out of two sources monitored, only one was found to be exceeded; Trento has also updated its Noise Classification Plan. As regards soft mobility, a favorable situation is shown both in terms of the density of bicycle paths (+41.1%), with a value as of 2019 of 42.1 km/100 km² of land area, and in relation to the availability of pedestrian areas (+495.4% since 2008) with a value as of 2019 of 52.4 m²/100 inhabitants, among the highest values recorded. Also positive is the picture of green infrastructures, which, while showing substantial stability from 2015 to 2019, as of 2019 registers high values: 30.6 m²/inhabitant of usable public green space per capita and a density of public green space on the municipal area that stands at 30.4 percent, thanks to the presence of extensive wooded areas. The incidence of protected natural areas on the total municipal area (6.6 percent) has also remained constant. In reference to soil, it is shown that the number of anthropogenic sinkholes is very low - only 8 from 2010 to date - with one event in 2020 and none in 2021. Finally, industrial facilities are increasing: the number of PRTR establishments, in fact, in the period 2015-2019 has increased from 4 to 6 at the municipal level and from 43 to 56 at the provincial level.



Summary Graph **Trento Livability**

TRENTO CIRCULARITY - SUMMARY

The improvements observed on the circularity front mainly concern the management of separate waste collection, which reached 82.5% in 2019, placing Trento among the municipalities with the highest value within the sample analysed. The per capita production of organic waste also grew steadily in the period 2015-2019, with the exception of a minimal drop in 2017 before returning to growth in the last year. Over the period as a whole, growth amounted to 9.3%.

In the field of green infrastructures, the actions implemented to promote the shared use of vegetated areas have led to an increase in the areas set aside for urban gardens (+67% in 2019 compared to 2011), giving a boost to the regeneration and care of the local territory.

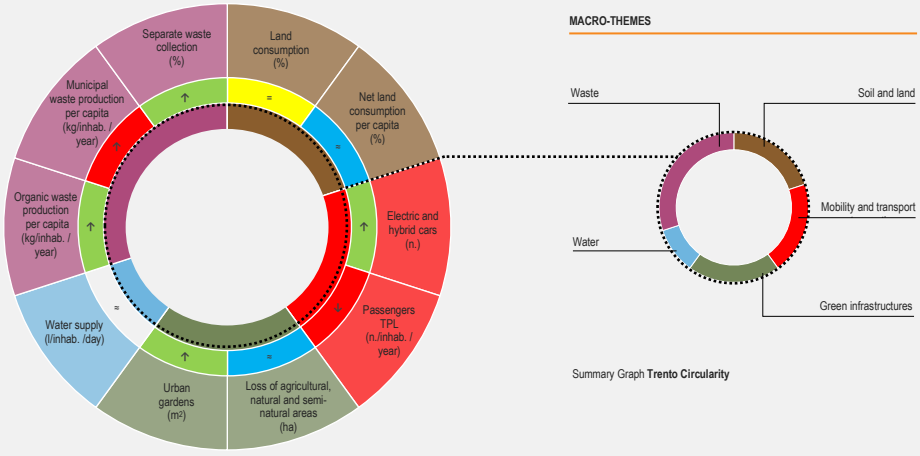
In the field of mobility and transport, the endowment of the car fleet with electric and hybrid cars has achieved a marked increase, so much so that a doubling of the quota to 3.7% has been seen in 2020.

Possible margins for improvement, on the other hand, can be identified in some areas that require more precise and effective policies.

In particular, the amount of land consumed on the municipal territory shows a value of 17% in all the periods taken into consideration (2016-2020) with a net land consumption per capita that presents the same trend against a slight increase in population. A similar situation, which deserves more attention from sustainability policies, is found for the loss of agricultural, natural and semi-natural areas, which has been constant between 2015 and 2019 with a rate of about 5 ha/year less permeable surfaces.

With regard to the demand for local public transport, although it declined steadily from 2011 to 2016, a partial recovery was seen in the three-year period 2017-2019, with 162.1 passengers per year/inhabitant.

On the other hand, more attention needs to be paid to the per capita production of urban waste, which reached 476.7 kg/inhabitant in 2019: over the five-year period 2015-2019, there has been a steady growth, with the exception of 2017, with a percentage increase over the period of 12.4%.



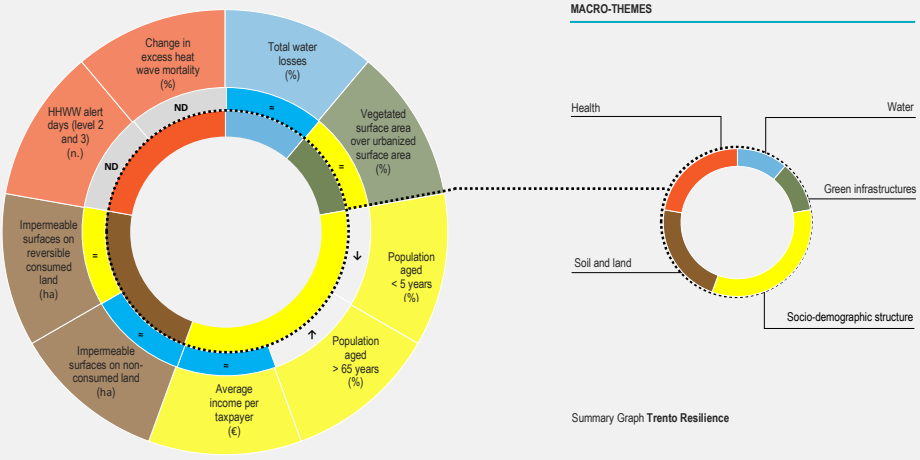
Summary Graph **Trento Circularity**

TRENTO RESILIENCE - SUMMARY

The picture of resilience to climate change does not return significant improvements over the period considered. A favourable factor is the benefit of the presence of vegetated and permeable areas, for which the municipality of Trento records high values compared to the sample of 21 municipalities, with a percentage of both publicly and privately owned vegetated area in the urban area of 59%, stable over the period 2016-2020. The situation of total water losses over the seven-year period 2012-2018 seems to fluctuate, although they remain well below the national figure (42%), with values of 27% in 2012, 22% in 2016 and 24.6% in 2018.

Less favourable signals are instead detected in terms of soil sealing: Trento is among the municipalities with the highest percentage of impermeable surfaces on non-consumed land with 4.5 ha between 2015 and 2020 of consumption affecting natural areas. The values show a fluctuating trend over the period considered.

The indicators relating to the socio-demographic structure describe, as a whole, the population's responsiveness to climatic hazards such as heat waves, intense precipitation events, droughts, thus providing useful indications to the administration on the trend of certain parameters: the percentage of the population aged 0-4 years characterises a group that is particularly sensitive to climate change, which is currently decreasing, from 4.4% in 2016 to 4.1% in 2020; the percentage of the population aged 65 years and over describes another portion of the fragile population that is instead increasing, with a figure ranging from 22.1% in 2016 to 23.1% in 2020, highlighting a growing need to implement adaptation policies increasingly geared towards the older population; the average income per taxpayer, amounting to 25.789 € in 2018, provides indications on the wealth of the population accompanied by the potential level of access to services, opportunities and information and positions Trento among the municipalities with the highest values in the sample considered.



Summary Graph **Trento Resilience**

VENICE

Fonte immagine: Pixabay

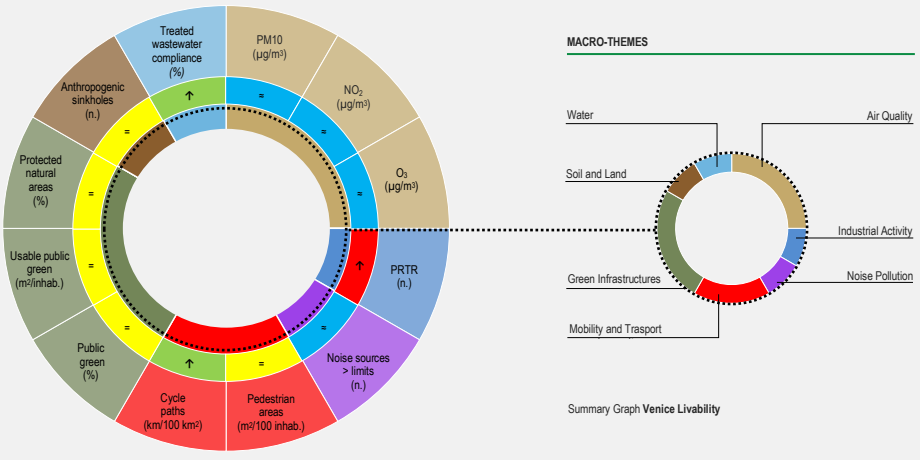
THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**258,685**
RESIDENT POPULATION 2015 (N)	**262,970**
POPULATION DENSITY (PEOPLE/KM^2)	**622**
AVERAGE INCOME PER CAPITA (€)	**18,245**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**415.9**
ALTIMETRICAL ZONE	**PLAIN**

VENICE LIVABILITY - SUMMARY

The analysis of indicators pertaining to the key of livability returns a heterogeneous picture for Venice, characterised by many improvements in some areas and some situations of substantial stability or criticality in others. First of all, there is a favourable situation in the trend of some air quality indicators: in 2020 there were no exceedances of the annual limit value (40 µg/m³) for PM10. For NO_2 in 2020, neither the annual limit value (40 µg/m³) nor the hourly limit value (200 µg/m³, not to be exceeded more than 18 times per year) was exceeded. Mobility and transport indicators show an increase in the density of cycle paths equal to +39.7% since 2011 to reach 34.6 km/100 km² in 2019, while the availability of pedestrian areas, while remaining constant over time, is at a very high level compared to the other municipalities under review (510 m²/100 inhabitant), also favoured by the particular geographic conformation of the Veneto capital. The per capita availability of usable public green space in 2019, equal to 39.5 m²/inhabitant, stable without significant variations over the five-year period (2015-2019), represents one of the highest values among those observed. The number of anthropogenic sinkholes is practically insignificant: only two episodes in the last two decades, both recorded in 2020.

Significant improvements are desirable in some areas. In the area of municipal wastewater treatment, for example, the percentages of purified wastewater and wastewater complying with emission standards were just over 83% in 2009 to over 90% in 2018, with a decline in 2012 when the percentages were just over 78%. Public green areas, mostly consisting of areas of historical and monumental interest, occupy 2.6% of the municipal territory as of 2015, which is one of the lowest values in the sample of municipalities under review. Some critical issues can be identified in a few areas that could be attentively monitored and addressed through more incisive and targeted policies: the long-term ozone objective of 120 µg/m³, calculated as the maximum daily value of the average concentration over 8 consecutive hours, was exceeded at all stations; there were exceedances of the information threshold (180 µg/m³, at one station) but not of the alert threshold (240 µg/m³). In 2019, 19 noise sources were monitored, which in 65% of cases showed criticality, resulting in an incidence of monitored noise sources with exceedances of legal limits of 5 per 100,000 inhabitants.



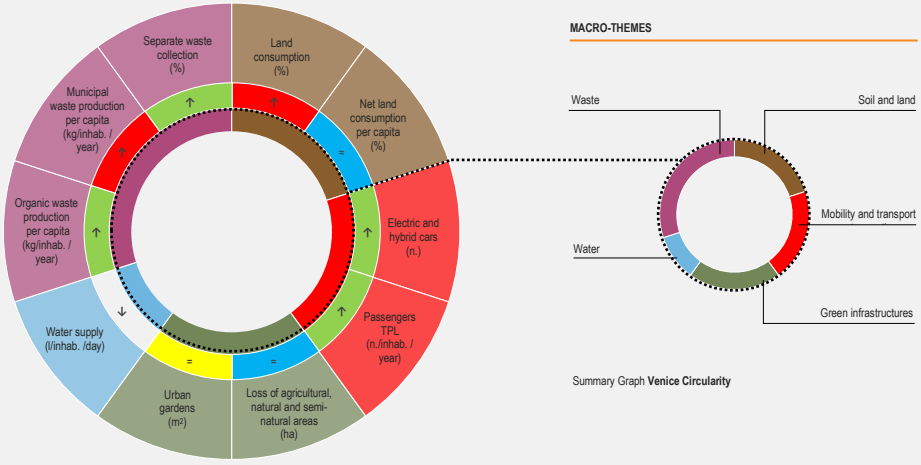
Summary Graph **Venice Livability**

VENICE CIRCULARITY - SUMMARY

On the subject of circularity, improvements can be seen especially in the areas of mobility and waste: in the first case, the indicators show a strong demand for local public transport (844.1 passengers per inhabitant per year, +21.1% compared to 2011), also favoured by the particular geographical conformation of the lagoon city, in addition to a steady increase in the share of hybrid/electric cars in the total fleet, which will rise from 0.4% in 2015 to 2.4% at the end of 2020. In the waste sector, the percentage of separate waste collection reaches 61.7% in 2019, following a constant growth rate throughout the five-year period (2015-2019). The per capita production of organic waste also shows a positive, steadily growing trend, with an increase of 13.6% and a significant rise in the last year (8.9%). This value is also one the highest among those analysed in the study, placing Venice in second place in the sample.

Possible margins for improvement can be identified in some areas where more effective policies are needed: as far as green infrastructures is concerned, the area allocated to urban gardens remained stable from 2011 to 2019, with values around 8,542 m^2 in 2019. Under the topic of soil and land, the percentage of land consumed on municipal territory stands at 34% in 2020, up from 2016. This value is average compared to the other municipalities considered, but in the last year policies have been initiated to restore some areas that were originally sealed.

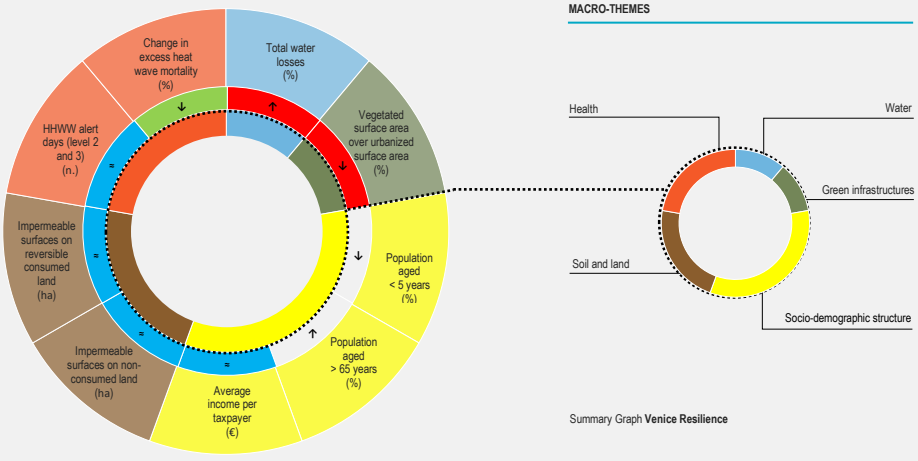
Particular attention should be paid to the issues of greenery and waste: between 2015 and 2020, 137 ha of agricultural, natural and semi-natural surface area were lost, with a trend that has not been linear over the years, with very high values between 2016-2017 and 2018-2019 and lower values in the other years, but still higher than most of the municipalities observed; the per capita production of urban waste, the highest among the municipalities under consideration, reached 674.6 kg/inhabitant in 2019, growing steadily since 2015. As in the case of the other cities of art, the role played by the enormous annual influx of tourists must be considered for Venice, with significant repercussions on the levels of waste production and, consequently, its management. Even in the area of water resources there is a criticality for the water supplied per capita per day for authorised uses, which always presents values that are among the highest in the sample examined; although in 2018 the indicator is 318 l/inhabitant per day, a significant decrease compared to the maximum values observed in 2015 and 2016 (352 and 353 l/inhabitant per day, respectively).



Summary Graph **Venice Circularity**

VENICE RESILIENCE - SUMMARY

There are few positive notes in relation to the climate change resilience key for the city of Venice. On the health aspects, the variation of excess mortality in the summer season (%) and heat wave alert days indicate a decreasing trend for the former and a fluctuating one for the latter (9 days in 2019), with low and medium-low values within the sample. On the other hand, among the criticalities found, a worsening of the situation regarding total water losses is reported over the seven-year period 2012-2018, which increase from 35.6% (2012) to 42% (2018), probably due to emergency situations that occurred on the aqueduct network, the elimination of the minimum committed and the reduction of commercial users. In this respect, Venice presents intermediate values within the sample. Even for green infrastructures, which are important for mitigating the urban heat island effect and reducing the risk of flooding, there is a decrease, with values of the percentage of public and private vegetated area on the urbanised surface ranging from 39.6% (2016) to 39% (2020), among the lowest in the sample. Given the morphological complexity of the territory, characterised essentially by housing crossed by canals, one third of the municipal surface area is characterised by hydraulic risk: we therefore cite the high allocations foreseen by the Ministry of Ecological Transition in the Plan Stralcio Aree Metropolitane (Metropolitan Areas Master Plan) aimed at interventions to solve the problem. A critical issue is confirmed for Venice related to soil sealing, which registered values of no less than 73 ha of new impermeable surfaces, built both to the detriment of natural or semi-natural areas (28 ha), and of impermeable surfaces on reversible consumed land such as, for example, construction sites or beaten earth surfaces (45 ha). With regard to the socio-demographic structure, which describes the responsiveness of the population to climate-related hazards, the following are reported: a decrease in the percentage of the population aged 0-4 years, with values between 3.5% (2016) and 3.2% (2020); an increase in the percentage of the population aged 65 years and over from 27.8% (2016) to 28.1% (2020). These trends underline the need to prepare appropriate adaptation measures aimed at favouring, in particular, the response of the older population category to climate events and their consequences. The average income per taxpayer of €24,562 in 2018 describes a context of intermediate wealth of the population within the sample, which is associated with an average level of access to services, opportunities and information compared to the other municipalities.



Summary Graph **Venice Resilience**

TRIESTE


Image source: Pixabay

THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**201,613**
RESIDENT POPULATION 2015 (N)	**202,244**
POPULATION DENSITY (PEOPLE/KM^2)	**2,369**
AVERAGE INCOME PER CAPITA (€)	**18,627**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**85.1**
ALTIMETRICAL ZONE	**COASTAL HILL**

TRIESTE LIVABILITY- SUMMARY

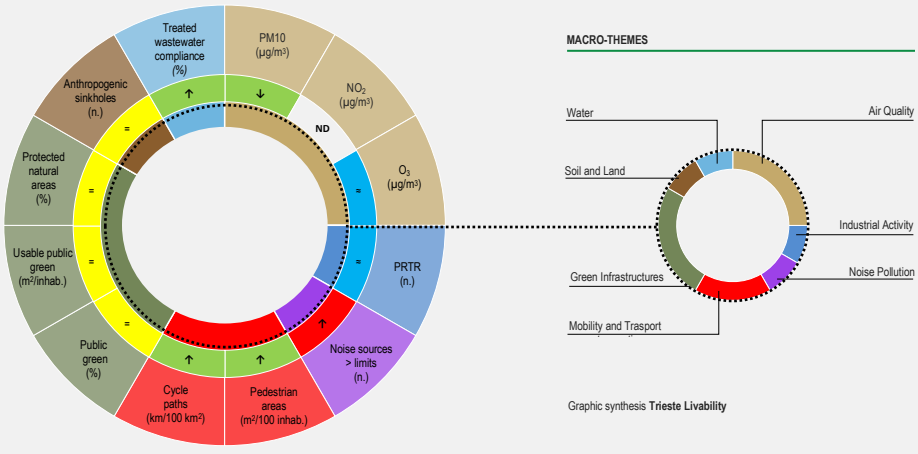
A first positive fact concerning the livability of Trieste relates to air quality, which shows a statistically significant downward trend in the values of annual average concentrations of PM10 over the period 2013-2020: in 2020 there were no exceedances of the annual limit value (40 µg/m³) nor of the daily limit value (50 µg/m³ not to be exceeded more than 35 times in a year). In 2020, for NO_2, neither the annual limit value (40 µg/m³) nor the hourly limit value (200 µg/m³ not to be exceeded more than 18 times in a year) was exceeded. Mobility and transport indicators also show a good increase in the supply of soft mobility, with the availability of pedestrian areas increasing by 28.5% compared to 2008 (50.7 m^2/100 inh. in 2018) and the density of cycle paths increasing by 21.3% compared to 2011 (27.8 km/100 km^2). In the area of municipal wastewater treatment, the entire organic load produced was purified from 2009 to 2018, while the percentage of wastewater that complied with emission standards was always rather low and below 30% from 2009 to 2016. The situation improved considerably in 2018, when the figure of almost 74% was reached, which is still low compared to the sample of cities analysed.

Public green areas have occupied 14.6% of the municipal territory since 2015, with a prevalence of wooded and uncultivated green areas, which together make up about 70% of the total public green areas; in addition, one third of the municipality is covered by protected natural areas, thanks to the presence of extensive Natura 2000 network sites that protect above all the peculiar Karst territory.

In the soil and land sector, the number of anthropogenic sinkholes is 10 since 2010, with a constant trend of one or two episodes per year in the last three years.

More incisive policies are needed in some areas in order to address the criticalities that have emerged: in 2019, 11 noise sources were checked and noise criticalities were found in all cases, bringing the value of incidence of noise sources exceeding legal limits per 100,000 inhabitants to 5.5, higher than the average value of 4.5 over the last 5 years; in the years considered, in fact, the trend in the number of noise sources checked per 100,000 inhabitants that exceeded the limits appears to be increasing.

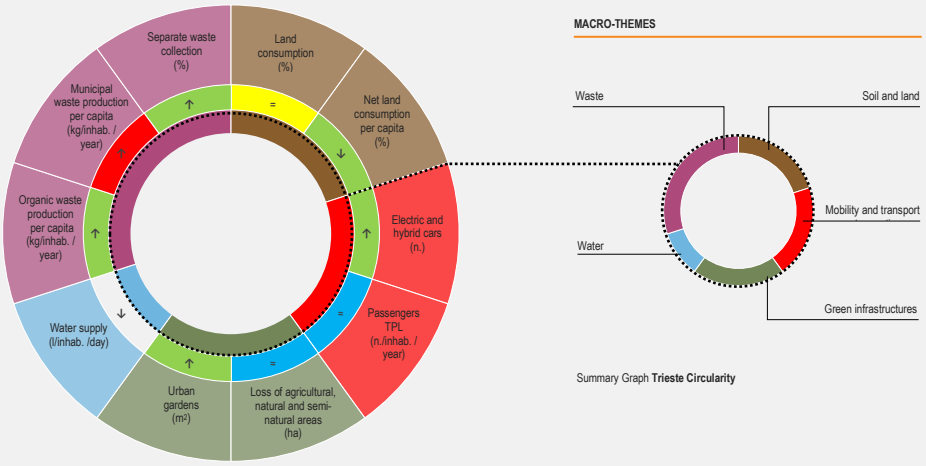
With regard to O_3, the long-term objective of 120 µg/m³, calculated as the maximum daily value of the average concentration over 8 consecutive hours, was exceeded at all stations in 2020. However, neither the information threshold (180 µg/m³) nor the alert threshold (240 µg/m³) was exceeded.



Graphic synthesis **Trieste Livability**

TRIESTE CIRCULARITY - SUMMARY

Within the circular economy Trieste shows improvements in particular in the areas of waste, green infrastructures, water, mobility and transport.
On the waste front, the percentage of separate waste collection in 2019 reached 42.2%, marking an increase of 6.9% compared to 2015, although this value is among the low to medium ones within the sample. The figure for the per capita production of organic waste, which reached 47.4 kg/inhabitant in 2019, also shows an exponentially increasing trend over the five-year period 2015-2019 (55.6%). The values remain, however, among the lowest in the sample.
On the subject of green infrastructures, the area allocated to urban gardens increases significantly from 2012 to 2019, reaching 4,290 m^2 in 2019, although this value remains low compared to the other municipalities observed. The rate of loss of agricultural, natural and semi-natural areas, on the other hand, shows a variable trend over the years, with values below 5 ha from 2015 to 2020, and stands at 0.5 ha in 2020. In terms of water resources, the daily per capita water supplied for authorised uses, while always presenting values above the national level (215 l/inhabitant/d), is in constant decline: from a value of 338 l/inhabitant/d in 2012, in 2018 it reaches the lowest value in the series, at 276 l/inhabitant/d. However, for the entire period (2012-2018) Trieste remains in the range with the highest values within the sample of 21 municipalities analysed.
The share of hybrid/electric cars in the total car fleet is increasing, reaching 2.4% at the end of 2020 from 0.4% in 2015.
Further possible advances in the direction of environmental sustainability can be achieved in some areas through more punctual and effective policies: the demand for local public transport (LPT) remained stable, following a very discontinuous trend, from 2011 to 2019 (347.0 passengers per year/inhabitant in 2019, equal to +0.1% compared to 2011); the percentage of land consumed on the municipal territory stood at 32.4% in 2020, a stable value compared to 2016 and on average compared to the other municipalities considered.
Finally, the need for more incisive policies is identified on the issue of per capita urban waste production, which reached 47.4 kg/inhabitant in 2019, a sharp increase from 2015 to 2019 (+55.6%). It should be noted, however, that these values are among the lowest of the municipalities surveyed.

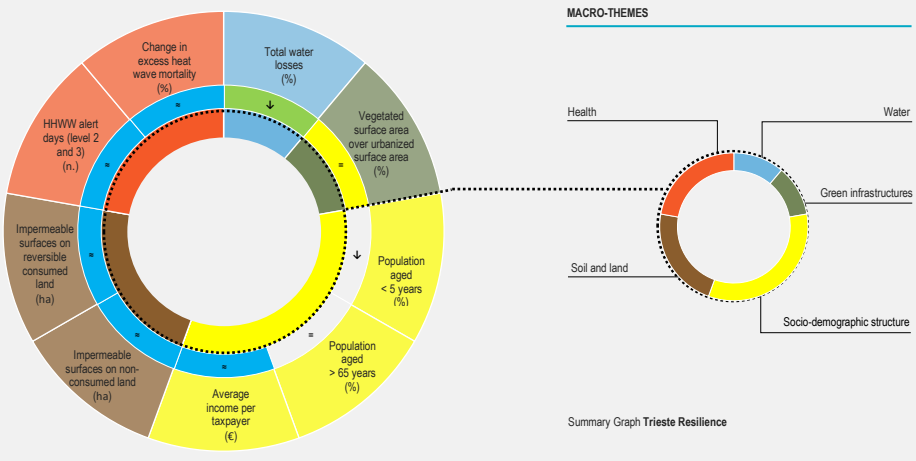


Summary Graph **Trieste Circularity**

TRIESTE RESILIENCE - SUMMARY

The picture of resilience to climate change that emerges from the analysis of the indicators for Trieste suggests the need to better target certain policies in order to make them more effective. For example, in the area of water, total water losses in distribution are high, although decreasing and thus improving in recent years, with 46.8% in 2015 dropping to 41.5% in 2018, still remaining below the national threshold (42%). With regard to health aspects, in the 2015-2019 period the greatest excess of mortality in the over-65 population, equal to +5%, is recorded in 2015 coinciding with the summer with the highest number of heat wave alert days (27). With regard to the number of heat wave alert days, there is a variable trend over the period, with the municipality having one of the highest values in the sample (22 days in 2019). Soil sealing also shows a variable trend over the period with values that are among the lowest among the analysed municipalities in 2020. On the subject of green infrastructures, the publicly and privately owned vegetated area on the urbanised surface (51%), remains constant over time (2016-2020) and in line with the intermediate values of the sample, and therefore does not indicate a trend towards an increase in permeable surfaces that is so beneficial with respect to the growing risks of flooding and/or inundation.

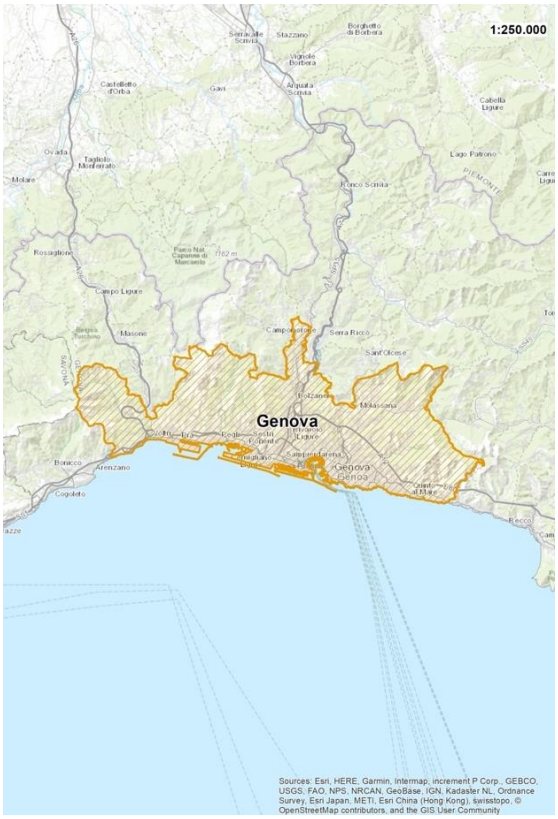
The analysis of the socio-demographic structure, aimed at providing indications on the potential responsiveness of the population to climate-related hazards such as heat waves, intense precipitation events, droughts, shows a decrease in the percentage of the population aged 0-4 years from 3.6% (2016) to 3.2% (2020) and a substantially unchanged situation regarding the percentage of the population aged 65 years and over (28.6% in 2020). However, one must bear in mind the need to direct appropriate adaptation policies towards these fragile categories which, due to their physiological characteristics, do not have a high capacity to respond to climate change. With regard to the picture concerning the wealth of the population, which is accompanied by the level of access to services, opportunities and information, the average income per taxpayer, with a value of €24,023 in 2018, is among the average values with respect to the sample of municipalities.



Summary Graph **Trieste Resilience**

GENOA

Image source: Pixabay



THE CONTEXT

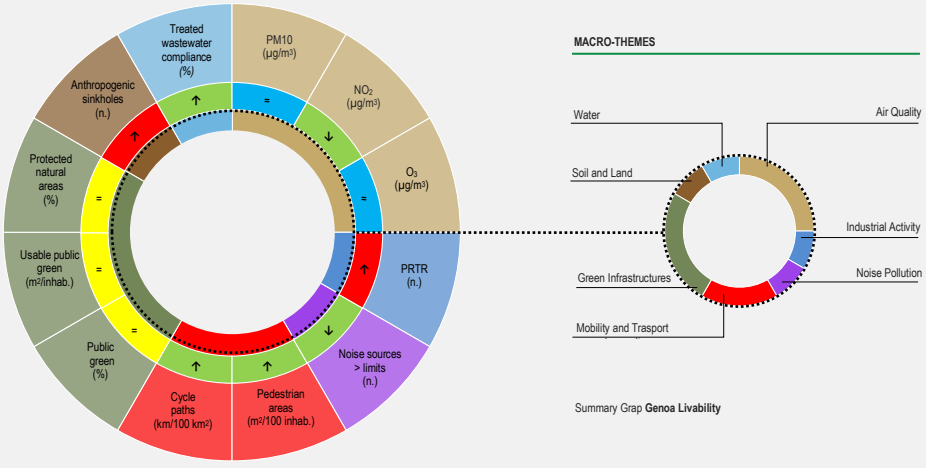
SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**565,752**
RESIDENT POPULATION 2015 (N)	**584,649**
POPULATION DENSITY (PEOPLE/KM^2)	**2,354**
AVERAGE INCOME PER CAPITA (€)	**19,223**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**240.3**
ALTIMETRICAL ZONE	**COASTAL MOUNTAIN**

GENOA LIVABILITY- SUMMARY

Among the positive data for the livability of Genoa are those referring to air quality in that for PM10 in 2020 there were no exceedances of the annual limit value (40 µg/m³) nor of the daily limit value (50 µg/m³) and for NO_2 in 2020 there was no exceedance of the annual limit value (40 µg/m³) nor of the hourly limit value (200 µg/m³). Furthermore, a statistically significant trend of decreasing concentrations was found for NO_2 in the period 2013-2020. The mobility and transport indicators paint a picture in which an increase in the supply of forms of soft mobility is observed, with +45.2% availability of pedestrian areas reaching 7.6 m^2/100 inhabitants (2019) and a tenfold increase in the density of bicycle lanes, which stand at 5.5 km/100 km^2 (2019), albeit at low levels compared to the other municipalities observed. The percentage of purified wastewater was always above 99% from 2009 to 2018, as was compliance with emission standards, with the exception of 2009 when, however, the value was above 90%. On the noise pollution front, there has been a gradual decrease in the average incidence of sources exceeding regulatory limits per 100,000 inhabitants within the municipal territory, which stood at 0.8 in the 2015-2019 period.

On the other hand, a certain stationarity is noted for some areas for which an improvement would be desirable. In particular, from 2015 to 2019 the density of public green areas, largely made up of wooded areas, does not deviate from 5%; similarly, the incidence of protected natural areas stands at 26.3% (2019) of municipal territory protected for the conservation of biodiversity, both values in line with intermediate values within the sample of municipalities considered. The per capita availability of usable public green space also does not show significant changes, settling at around 6 m^2/inhabitant in 2019, below that of the other municipalities under consideration.

There are also some critical issues that require more incisive policies: the number of anthropogenic sinkholes, amounting to 25 in the last decade, shows an increasing trend in the years 2015-2020, favoured above all by exceptional rainfall events and dysfunctions in the hydraulic network. As far as O_3 is concerned, the long-term objective of 120 µg/m³, calculated as the maximum daily value of the average ozone concentration over 8 consecutive hours, was exceeded at all stations; there was also one day when the information threshold (180 µg/m³) was exceeded at one station, but no exceedance of the alert threshold (240 µg/m³).



Summary Grap **Genoa Livability**

GENOA CIRCULARITY - SUMMARY

Improvements on the circular economy front for the city of Genoa can be seen in the waste, water and mobility and transport sectors.

The percentage of differentiated waste collection reached 35.5%, with a fairly constant increase over the five-year period 2015-2019, although remaining among the lowest values with reference to the other municipalities considered; the per capita production of urban waste in 2019 also reached 493.5 kg/inhabitant, decreasing steadily over the five-year period 2015-2019, with the exception of 2019, when the indicator rose again.

In the seven-year period 2012-2018, the water supplied per capita for authorised uses shows a continuous decline, standing at 216 l/inhabitant per day in 2018 (it was 276 l/inhabitant per day in 2012), which falls among the lowest values compared to the sample of municipalities analysed.

On the mobility and transport front, there is a growing share of electric/hybrid cars (2.3% at the end of 2020), which supports the renewal of the fleet towards the purchase of more sustainable vehicles.

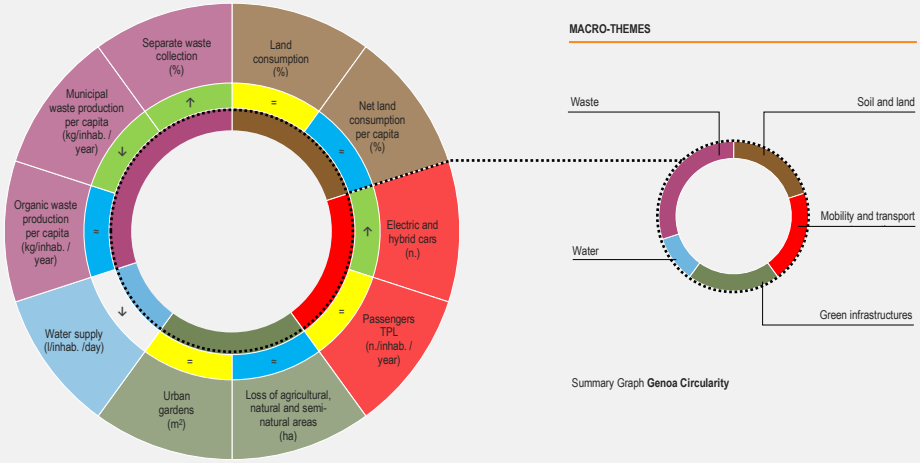
As far as green infrastructures is concerned, there is a limited loss of agricultural, natural and semi-natural areas with a low rate of land consumption, which stands at less than 2 ha, with slight fluctuations in the historical series.

More punctual and effective policies in the mobility and transport sector could cope with a certain stagnation in the demand for local public transport (264.9 passengers per year/inhabitant in 2019, i.e. +0.4% compared to 2011).

Genoa has the lowest value among those surveyed within the sample of municipalities of per capita production of organic waste, reaching 27.5 kg/inhabitant in 2019. In the five-year period 2015-2019, the indicator reached a growth peak between 2015 and 2016 (+9.4%), but shows a fluctuating trend over the entire period.

The percentage of land area consumed has remained at 23.7% throughout the historical series, an average value compared to the other municipalities considered.

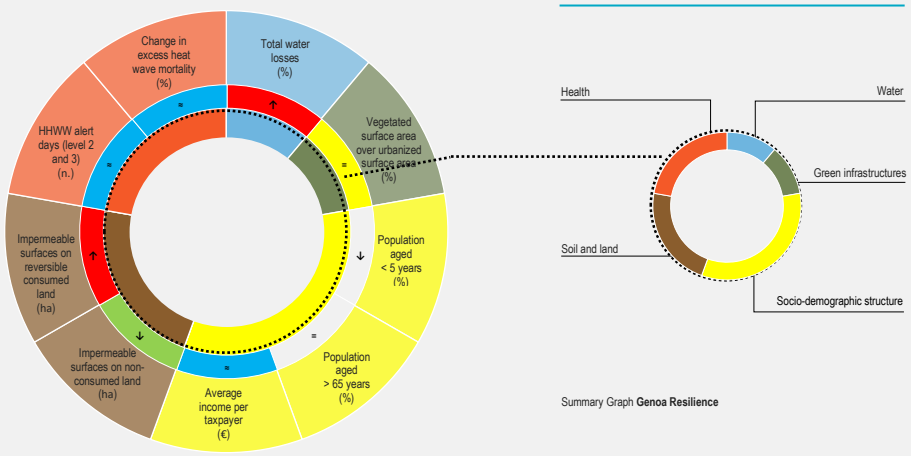
Also unchanged since 2013 is the surface area allocated to urban gardens, aimed at rescuing marginal territories from degradation and encouraging sociality and citizen participation: the surface area stands at 3,500 m^2, among the lowest values in the sample.



Summary Graph **Genoa Circularity**

GENOA RESILIENCE - SUMMARY

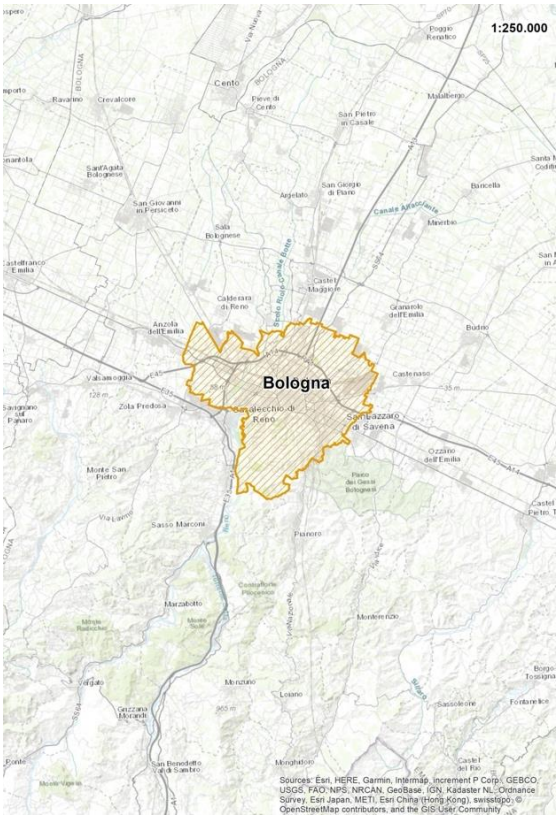
The positive signal found on the front of resilience to climate change in the period considered can be attributed to the trend of impermeable surfaces on non-consumed land (natural or semi-natural areas) which shows a decrease, placing Genoa among the municipalities with the lowest values (0.3 hectares in 2020). On the contrary, impermeable surfaces on reversible consumed land (e.g. building sites or rammed earth) show an increasing trend with values among the highest in the sample (1.8 hectares in 2020). In the case of Genoa, the high landslide hazard should be noted, which is around 90% of the municipal territory, while 5% of the territory is characterised by flood hazard: the resources allocated by MiTE for the Ligurian capital received a great boost following the flooding events of 2012. In 2018 and 2019, the municipal territory of Genoa was affected by flooding events of particular severity, with damage associated with flooding, small landslides and subsidence of stretches of roads, as well as consequences due to intense sea storms. These events highlight the need to continue on the path of activating effective policies aimed at strengthening the resilience of the territory in the face of increasingly violent extreme weather events. The data on water shows water losses of about 39% in 2018, a significant increase compared to 2012 (29.2%), although they remain below the national average (42%). On the health front, the number of heat wave alert days decreases over the five-year period (2015-2019) from 15 to 13 while the change in excess mortality (%) reaches 1% in 2019, placing the municipality in an intermediate position in the sample. A stagnation situation is also recorded for green infrastructures, with values of the percentage of vegetated area, both publicly and privately owned, over the urbanised area at around 50% for the period 2016-2020. As far as the socio-demographic structure is concerned, and in particular the trend of the most fragile population categories, there is a decreasing percentage of the population aged 0-4 years, with values rising from 3.5% (2016) to 3.1% (2020), and a mostly stable percentage of the population aged 65 years and over, which stands at 28.5% in 2020, among the highest values in the sample. It is on this category of the population that adaptation policies must increasingly focus. With an average income per taxpayer of €24,020 in 2018, which describes an intermediate level of wealth of the population within the sample, one can assume an average level of access to services, opportunities and information compared to the other municipalities analysed.



Summary Graph **Genoa Resilience**

BOLOGNA


Image source: Pixabay



THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**395,416**
RESIDENT POPULATION 2015 (N)	**385,190**
POPULATION DENSITY (PEOPLE/KM^2)	**2,807**
AVERAGE INCOME PER CAPITA (€)	**21,476**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**140.9**
ALTIMETRICAL ZONE	**INLAND HILL**

BOLOGNA LIVABILITY- SUMMARY

Among the positive signs relating to the livability of Bologna, there is a statistically significant downward trend in NO_2 concentrations, while for PM10 and O_3 the underlying trend is not statistically significant; the interannual fluctuations are attributable to the natural fluctuations of the seasonal component. On the other hand, for PM10 in 2020 there were no exceedances of the annual limit value (40 µg/m³) and the daily limit value (50 µg/m³ not to be exceeded more than 35 times in one year) was exceeded in one out of three stations. In contrast, the O_3 long-term objective of 120 µg/m³, calculated as the daily maximum value of the average ozone concentration over eight consecutive hours, was exceeded at all stations and the information threshold (180 µg/m³) was exceeded for three days at one station but no exceedance of the alert threshold (240 µg/m³) occurred.

The indicators in the area of mobility and transport paint a positive picture related to the increase in cycle paths, which in 2019 reached 96.9 km/100 km² of surface area: these values are among the highest in the sample of 21 municipalities observed. The availability of pedestrian areas also increased, albeit slightly, from 2008 to 2019 (+5.3%), reaching 29.3 m²/100 inhabitants.

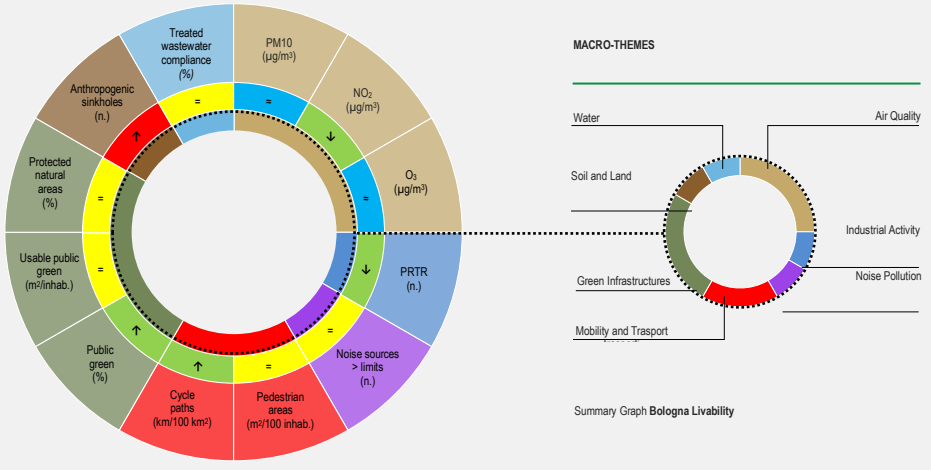
Green infrastructures show a slight increase in the density of public green areas in the municipality since 2015, standing at 6.1% in 2019.

On the industrial activities front, there has been an 11% decrease (2015-2019) in the number of PRTR establishments (8 in 2019) in the municipal territory.

The situation regarding the entire organic load produced by the municipality, purified and compliant with the emission standards set by the reference legislation throughout the period 2009-2018, is stable.

A substantially stable trend is also observed for the number of sources monitored with exceedances of legal limits: in 2019, 53% of the sources monitored were found to exceed the limit values, resulting in a population incidence of 4.6 sources with exceedances of regulatory limits per 100,000 inhabitants. Stable trends are observed in the per capita availability of usable green space, which is around 21 m²/inhabitant in the period 2015-2019, and in the incidence of protected natural areas, which in 2019 is 26.5% of the entire municipal area.

A critical situation is found in the number of anthropogenic sinkholes, which increased in the years 2015-2019 mainly due to leaks in the hydraulic network: the 32 events recorded in the last 10 years are among the medium-high values found in the northern municipalities.



Summary Graph **Bologna Livability**

BOLOGNA CIRCULARITY - SUMMARY

Positive signs for Bologna on the circularity front can be seen with the increase in the area destined for urban gardens, which in 2019 stood at 16.6 ha, in line with the highest values in the sample of the 21 municipalities considered, with a progressive increase compared to the 7.6 ha recorded in 2011.

The percentage of separate waste collection in 2019 also reached 54.2%, an increase of 5.2%; this is followed by the per capita production of organic waste, which is also growing positively with a value of 77.1 kg/inhabitant in 2019. However, more incisive policies are needed in the waste sector with regard to the production of municipal waste per capita, which shows a fluctuating trend over time, settling at a value of 578.8 kg/inhabitant in 2019, with a total increase of 4.2%, among the highest in the sample.

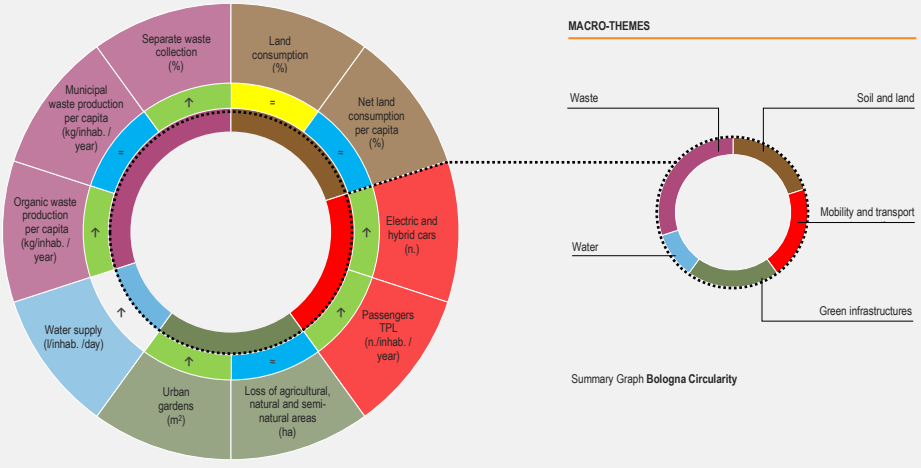
The data on mobility and transport are positive, with a marked increase in the share of electric and hybrid cars reaching just over 5% at the end of 2020, the highest value among the municipalities considered, and in the number of passengers per year/inhabitant transported by local public transport amounting to 301 passengers per year/inhabitant (2019), an increase of 19.9% compared to 2011.

In Bologna, values between 13 and 14 ha of net land consumption are observed in 2015-2016, 2016-2017 and 2018-2019, decreasing to around 4 ha in 2019-2020.

In 2017-2018 there is an important restoration process with about 13 ha of soil recovered. On the other hand, the percentage of consumed land on the municipal territory stands at 34% throughout the reporting period. With regard to net per capita land consumption, 2019-2020 shows the lowest value of the historical series, except for the period in which there was restoration with the lowest land consumption over the entire series; there is also a slight increase in the resident population.

With regard to the water supplied per capita for authorised uses, over the seven-year period 2012-2018, it shows values in line with the national figure (215 l/inhabit/d), reaching 225 l/inhabit/d in 2018. Starting in 2012 with a value of 235 l/inhabitant/g, intermediate within the sample, from the following year it presents values among the lowest in the sample.

Margins of improvement are instead evident for policies concerning the green infrastructures sector: Bologna has maintained, albeit with a variable trend in the years considered, a rate of 15 ha of agricultural, natural and semi-natural areas lost each year between 2015 and 2019; in the last year the phenomenon has decreased, settling at a loss of 4.5 ha, concentrated almost entirely (4.1 ha) on herbaceous areas in urban areas. This value is in line with the intermediate values found within the investigated dataset.

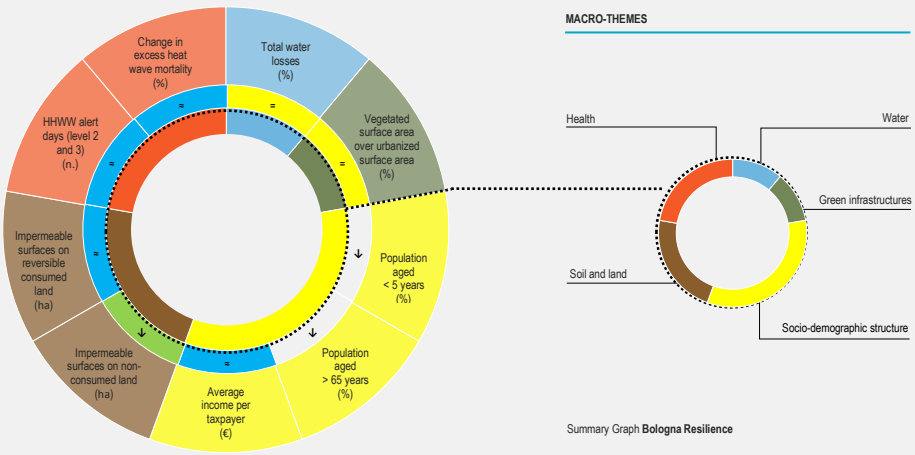


Summary Graph **Bologna Circularity**

BOLOGNA RESILIENCE - SUMMARY

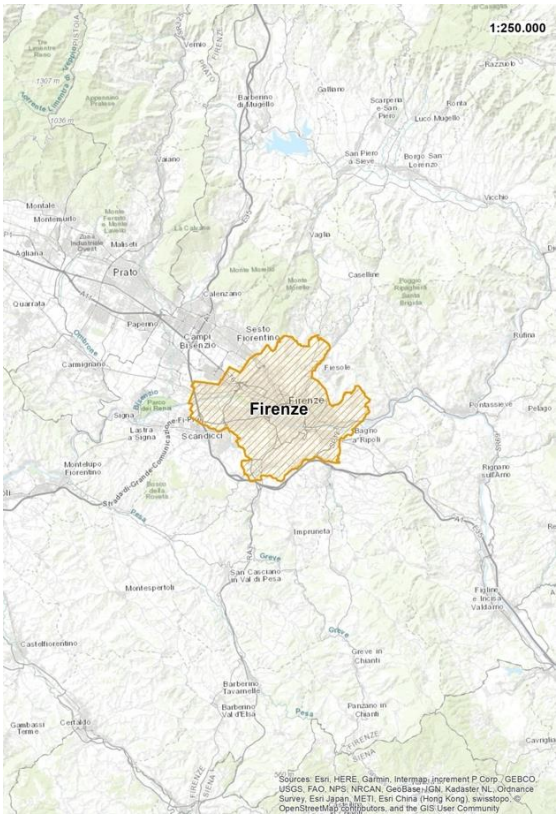
The analysis of the indicators selected to frame Bologna's ability to respond to climate change shows a decreasing trend in the sealing of natural and semi-natural soils (0.9 hectares in 2019-2020). This data therefore seems to indicate a slowdown in the processes of land transformation that subtract permeable soil, thus capable of draining even abundant rainfall and maintaining adequate microclimatic conditions, in favour of areas with artificial cover.

A stationary situation is noted with regard to the vegetated surface over urbanised area, which stands at 50% throughout the five-year period 2016-2020. This issue is already at the attention of the municipality, which has implemented various actions with the aim of optimising the use of public and private green areas as a fundamental resource for the quality of the environment and the health of citizens. The presence of vegetated and permeable areas contributes, in fact, to mitigating the risk of landslides and flooding in the city, with a thermoregulating action that is also beneficial, especially in summer. On the water resource front, the municipal drinking water distribution network shows total percentage losses of less than 30% in the period 2012-2018, with a peak of 28.1% in 2018. This figure is among the lowest in the sample of municipalities considered. The excess mortality in the population over 65, equal to +8%, is recorded in 2015 in conjunction with the highest number of days at risk to health associated with heat waves (17 days of alert). Since 2017, mortality has been equal to or lower than expected despite an average number of 9 alert days per year. With regard to the socio-demographic structure, the population aged 0-4 years seems to reflect the decreasing trend at national level. With the decrease in the population aged 65 years and over from 25.8% to 24.9% over the period 2016-2020, however, there is a counter trend to the sample, already observed in the case of Milan. The average income per taxpayer, which is significant in terms of the wealth of the population and, therefore, the potential access to services, opportunities and information, is €28,496, one of the highest values in the sample.



Summary Graph **Bologna Resilience**

FLORENCE



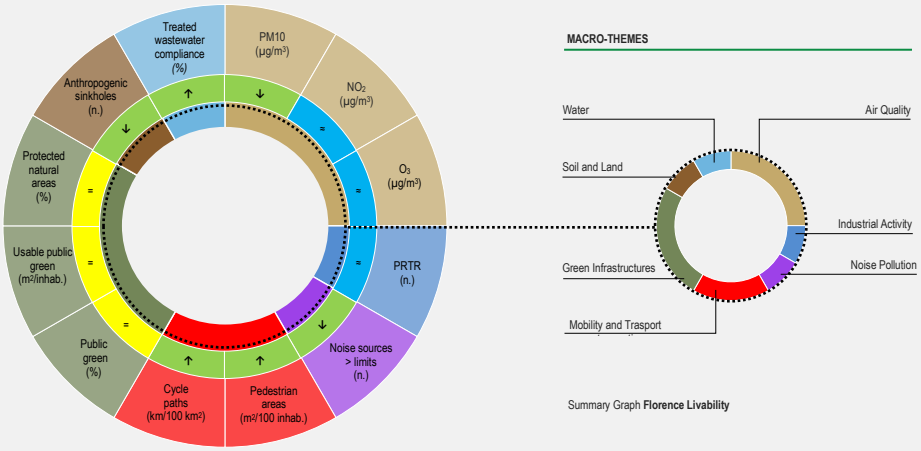
THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**366,927**
RESIDENT POPULATION 2015 (N)	**376,841**
POPULATION DENSITY (PEOPLE/KM^2)	**3,586**
AVERAGE INCOME PER CAPITA (€)	**20,056**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**102.3**
ALTIMETRICAL ZONE	**INLAND HILL**

FLORENCE LIVABILITY - SUMMARY

The indicators observed in order to understand the main changes that have taken place in recent years in terms of livability show a picture characterised by positive and/or stable trends over time for most areas. An initial promising figure relates to air quality, which shows a downward trend in PM10 concentrations over the 2013-2020 period. On the water resources front, the percentage of compliant purified wastewater increased from just under 80% in 2009 to 100%, or almost 100%, from 2014 to 2018. As far as noise pollution is concerned, the trend in the number of noise sources checked per 100,000 inhabitants, found to be above the legal limits, is decreasing: this indicator stands at 0.5, in line with the values found over the last four years (2016-2019) and significantly lower than the average value calculated over the last five years (3.8). The positive trend also continues for mobility, with a doubling from 2011 to 2019 in terms of kilometres of bicycle lanes, from 49.8 to 99.7 km/100 km^2 of surface area. The availability of pedestrian areas also increased to 110.8 m^2/100 inhabitants in 2019. For both indicators, the values are among the highest in the sample.

Over the last decade, a steady and moderate number of anthropogenic sinkholes can be observed, amounting to 13 since 2010. Since 2020, there is a decreasing trend: no sinkhole events are observed in 2020 or in the first half of 2021. No significant changes are evident on the subject of green infrastructures. The percentage of public green areas on the municipal surface has been constant since 2015: with an incidence of 8%, however, Florence is characterised by one of the highest values within the sample. There is no substantial increase, compared to 2015, even in terms of per capita availability of usable green space, which in 2019 stands at 19.7 m^2/inhabitant, in line with the intermediate values found among the 21 municipalities surveyed. The figure for protected territory for nature values also remains stable at 10.9%, thanks to the presence of two Natura 2000 network sites and protected natural areas of local interest. Finally, with regard to the industrial activities active in the municipal area, after a fluctuating trend in the 2015-2019 period, the number of PRTR establishments returned to 3 in 2019, as at the beginning of the period.



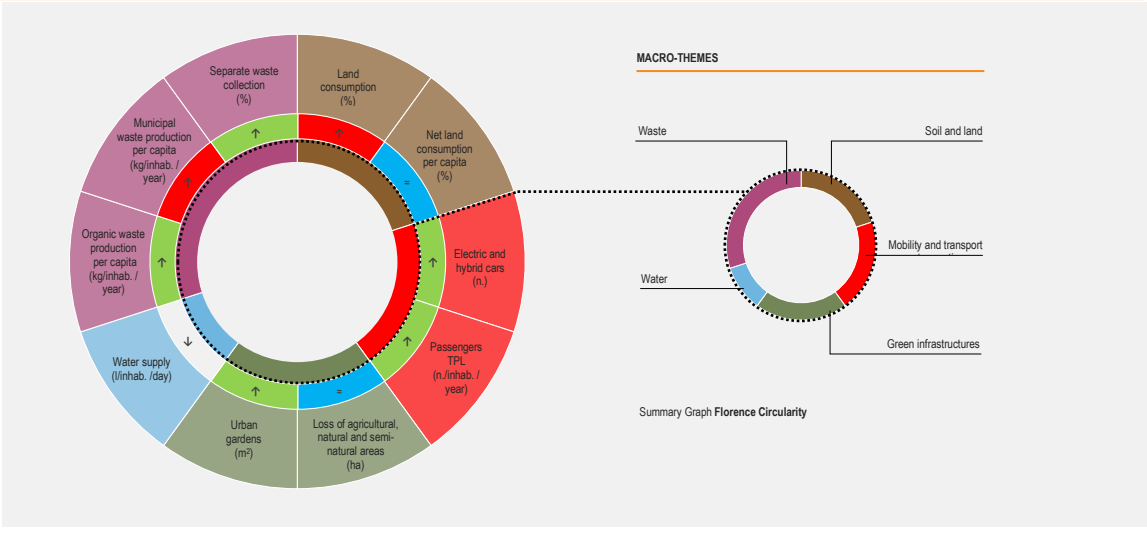
Summary Graph **Florence Livability**

FLORENCE CIRCULARITY - SUMMARY

The analysis of the indicators selected to understand the municipal administration's efforts towards a circular approach to the use of resources returns for the Tuscan capital a picture with some positive notes and several areas with possible margins for improvement. There are good signs emerging from the trend of the areas allocated to urban gardens, which show an increase of 72.8% over the 2011-2019 historical series, settling at around 7.6 hectares in 2019. This value is among the highest within the sample of municipalities. Both the percentage of separate waste collection, at 54% in 2019, and the per capita production of organic waste, at 129.3 kg/inhabitant/year in 2019, grew over the five-year period (16.4%). This indicator also shows constant growth, at 15.5% over the five-year period, a high average value within the sample. The situation on the mobility and transport front is encouraging: demand for local public transport (LPT) grows significantly from 2012 to 2019, reaching 305 LPT passengers per inhabitant per year, equal to +36.8% in 2019 compared to 2011, and there is also a growth of almost two percentage points in the share of hybrid/electric cars in the total car fleet, in the years analysed, reaching 2.4% at the end of 2020. The picture drawn in terms of circularity also highlights some critical issues. In fact, the data on land and territory record an average high percentage of land consumed on the municipal territory for all years of the 2016-2020 period (42% of artificial surfaces) and an increase in net land consumption per capita over the same period. The need for more effective policies also emerges for the waste sector. Over the 2015-2019 period, in fact, there is a constant growth in the per capita production of urban waste, amounting to about 670 kg/inhabitant/year in 2019 which is the second highest value in the sample. This figure is also influenced, as in all cities of art, by the influx of tourists.

Although contained and fluctuating over time, the loss of agricultural, natural and semi-natural areas corresponds to 17 ha in the last year (2020), placing Florence among the municipalities in the sample with the highest values.

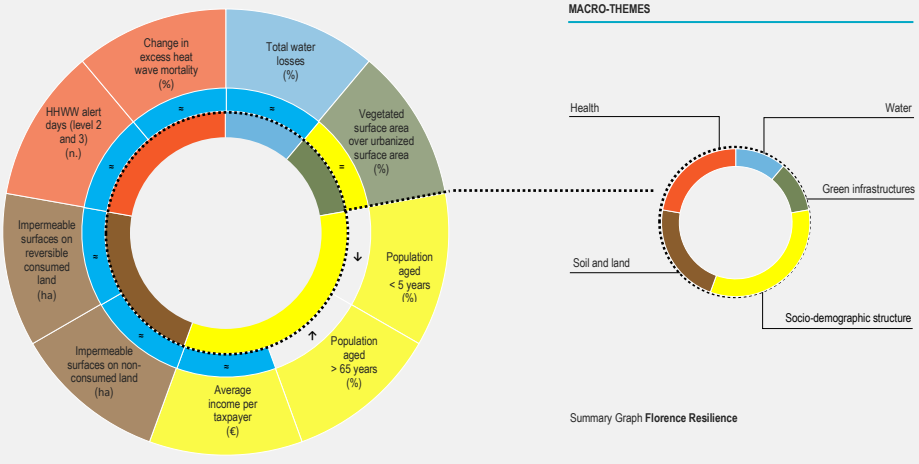
Finally, with regard to the use of water resources, over the period 2012-2018, the water supplied per capita for authorised uses is in continuous decline, starting from a value of 253 l/inhabitant per day in 2012 and settling at 200 l/inhabitant per day in 2018, below the national average value (215 l/inhabitant per day) and among the lowest values with respect to the sample of municipalities analysed.



Summary Graph **Florence Circularity**

FLORENCE RESILIENCE - SUMMARY

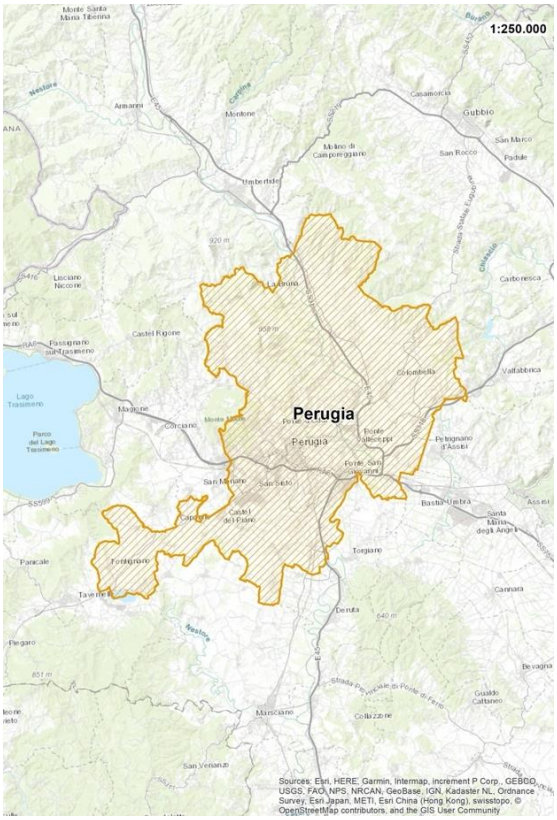
The indicators pertaining to the key reading of resilience to climate change return for Florence a picture characterised by fluctuating trends and some substantially stable situations, with several possible margins for improvement. Over the period considered (2012-2018), in fact, the total losses in distribution are fluctuating between values always above 40%, with the maximum in the historical series being around 47.1% (2015). Regarding the topic of green infrastructures, a stable value is shown for the incidence of public/private green on the urbanised area, which amounts to about 52% of the municipal territory (2020). The percentage of tree cover over total vegetation in 2018 also stands at around 35%. It is considered useful to direct the municipal administration's efforts towards increasing vegetation cover in view of the fact that this sector is decisive on many resilience fronts (e.g. urban heat island mitigation, hydrogeological risk reduction). As regards soil and land, it is noted that between 2015 and 2020, 5 ha of impermeable surfaces are observed, 3 of which involved natural or semi-natural areas and 2 reversible consumed land, i.e. land surfaces or building sites. Overall, the situation does not seem to show clear trends, with data, however, fluctuating within the upper range of values for the sample considered. For the purposes of implementing appropriate policies useful for enhancing the population's capacity to respond to climatic hazards, it is important to note that the health data denote a summer mortality rate for the over-65 population in the 2015-2019 period that is in line with or lower than expected, despite the slight upward trend in the number of days of alert. Given the general fragility of children and the elderly with respect to critical climatic conditions, the data on heat waves should be carefully studied in relation to the trend of the socio-demographic structure. These indicators show, in fact, a decrease in the population aged 0-4 years and an increase in the population aged 65 years and over from 25.9% (2016) to 26.3% (2020) in line with the national trend. It is therefore on the older population that climate change adaptation policies must focus most closely in order to strengthen its resilience. With an average income per taxpayer of €27,205 in 2018, Florence emerges as one of the municipalities with the highest levels of wealth within the sample, capable of ensuring the population, therefore, the best possibilities of access to services, opportunities and information with a view to resilience.



Summary Graph **Florence Resilience**

PERUGIA


Image source: Pixabay



THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**164,880**
RESIDENT POPULATION 2015 (N)	**164,227**
POPULATION DENSITY (PEOPLE/KM²)	**367**
AVERAGE INCOME PER CAPITA (€)	**16,410**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**449.6**
ALTIMETRICAL ZONE	**INLAND HILL**

PERUGIA LIVABILITY - SUMMARY

The picture that emerges from the analysis of livability returns, for Perugia, strengths and areas on which more incisive policies are desirable.

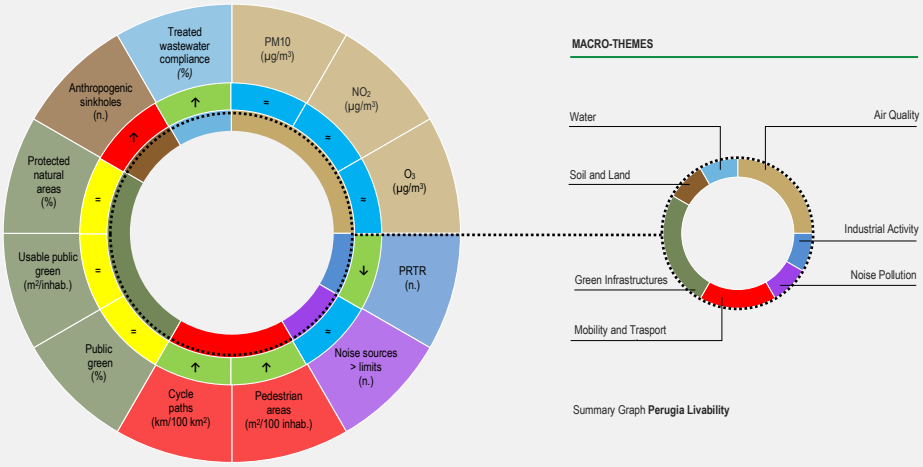
The performance of urban wastewater treatment is good: from 2014 to 2018, purified wastewater was almost all compliant with emission standards, while in 2009 it was 94% and 92% in 2012. On the mobility and transport front, there are positive signs. The density of bicycle lanes remains constant from 2011 to 2017, at 2.0 km/100 km^2 of land area, increasing in 2019 to 3.5 km/100 km^2 of land area (+78.8%), a value that is nevertheless very low compared to the other 20 municipalities. The availability of pedestrian areas increased slowly from 2008 to 2012 to more than double from 2013 and remain constant until 2019, reaching a value of 24.3 m^2/100 inhabitants (+151.8% in the period 2008-2019). With regard to industrial activities in the municipality, in the 2015-2019 period, there is a slight decrease in the number of PRTR establishments from 11 to 9.

In terms of air quality, there is no statistically significant trend for NO_2, PM10 and ozone concentrations in the period 2013-2020. On the other hand, in 2020 for PM10 there were no exceedances of the annual limit value (40 µg/m³) nor of the daily limit value (50 µg/m³), and neither for NO_2 were there exceedances of the annual limit value (40 µg/m³) nor of the hourly limit value (200 µg/m³). The long-term objective for O_3 of 120 µg/m³, calculated as the maximum daily value of the average ozone concentration over eight consecutive hours, was exceeded on only one day, and there were no exceedances of the information threshold (180 µg/m³) or the alert threshold (240 µg/m³).

As far as noise pollution is concerned, the number of noise sources monitored per 100,000 inhabitants that exceeded regulatory limits shows a fluctuating trend over the years; in 2019, this indicator was 6.1, higher than the average incidence over the five-year period 2015-2019 (4.3).

No substantial changes can be reported for the green infrastructures indicators in the 2015-2019 period. In fact, the values of public green density (2.3% of the municipal area), of the incidence of protected natural areas (20.5%) and of the per capita availability of usable public green (32.8 m^2/inhabitant) remain constant.

In Perugia, finally, 33 anthropogenic sinkholes have been recorded over the last 10 years, an average high value within the sample and comparable with what has been recorded in the great metropolis of the North (Milan and Turin).



Summary Graph **Perugia Livability**

PERUGIA CIRCULARITY - SUMMARY

The analysis of the indicators selected to better understand the municipal administration's efforts towards a circular approach and the use of natural resources, returns for Perugia a picture with some positive notes and several areas that require more careful and effective policies.

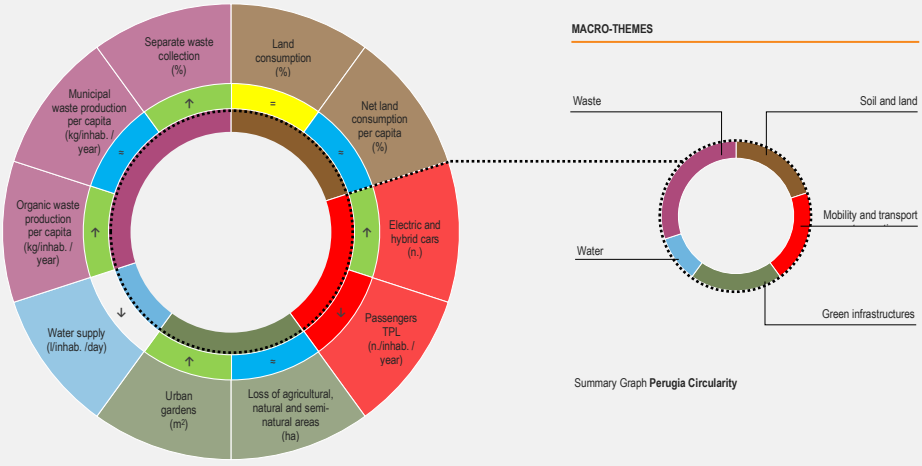
There are positive signs on the green infrastructures front, with an increase in the period 2011-2019 of the areas set aside for urban gardens, for a total of about 7 hectares in the territory of Umbria's capital in 2019, a figure in line with the average values found in the dataset. The data on the loss of agricultural, natural and semi-natural areas in the municipal territory is decreasing, although it varies greatly over the 2016-2020 period considered: the greatest loss values concerned the 2016-2019 period, with -8.20 and -16 ha, respectively. The protection of these permeable and vegetated areas must be considered an important objective for the circularity of natural resources and sustainable development.

The waste sector performs well in terms of separate waste collection with a steady increase (23.1%) in the percentage over the five-year period 2015-2019, reaching 71.1% in the last year (2019), the second highest value among those found in the sample of 21 municipalities. The per capita production of organic waste also shows an upward trend over the long term (2015-2019), with a marked increase in the last year of 11.9%. For this indicator, Perugia has the highest value among the municipalities surveyed. On the other hand, the trend in the per capita production of urban waste is less clear: in 2019 it reaches 570.4 kg/inhabitant, with a slight increase over the five-year period (3.4%).

Lights and shadows for the mobility and transport sector: while on the one hand there is a 1.7% increase in the share of hybrid/electric cars in the total car fleet, rising from 0.2% (2015) to 1.9% (2020), more critical are the signs concerning the demand for local public transport, which shows a significant decrease of 43.8% from 2011 to 2019.

A stationary situation, on the other hand, in terms of land consumed on the municipal territory, which results to be around 11% in 2020, a value that is still among the lowest within the sample. The values of net land consumption per capita fluctuate over the same period.

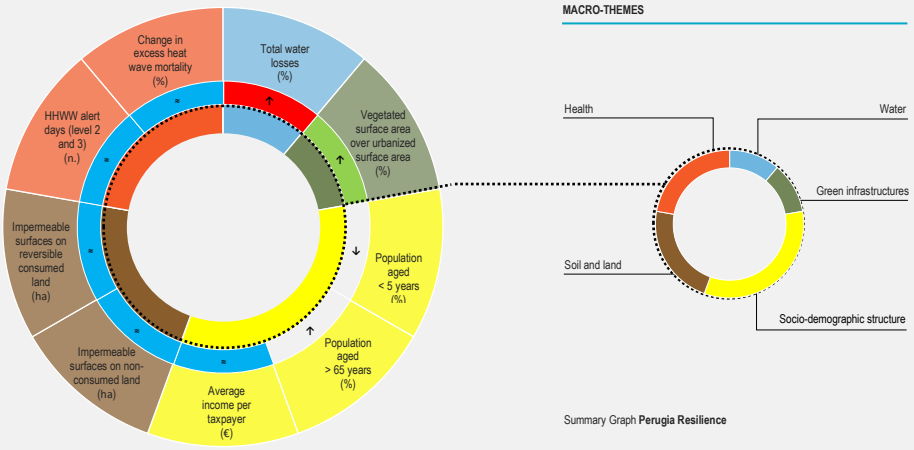
Finally, with regard to water resources, the per capita volume of water supplied daily for authorised uses is significantly lower than the national figure (215 l/inhabitant per day) and does not vary significantly, reaching 185 l/inhabitant per day in 2018, one of the lowest values recorded in the 21 regional capital municipalities considered.



Summary Graph **Perugia Circularity**

PERUGIA RESILIENCE - SUMMARY

The Umbrian capital does not present a particularly significant performance in terms of resilience to climate change and also shows a marked criticality on the issue of water resources.
In fact, the total water losses in distribution worsen in the period considered, with values above 35% and up to the maximum of 45.1% in 2018, which corresponds to medium-high values in the sample analysed.
With a slightly upward trend in the 2016-2020 period, the value related to green infrastructures in the municipal territory presents about 70% of vegetated surface over urbanised surface: this figure is high within the sample of cities and denotes the administration's commitment on this issue. In fact, it is relevant to mention among other things: the participation in the LIFE CLIVUT project, the tree vegetation health monitoring systems and the urban forestation and green corridor projects with neighbouring municipalities.
The trend of both the sealing of natural and semi-natural soil and of reversible consumed land (e.g. building sites or rammed-earth surfaces) fluctuates over time: for the former there is a trend towards low-medium values in 2020, while the latter is among the average data of the sample, on which there is therefore room for improvement.
On the subject of health, fluctuating values are reported and are among the highest in the sample analysed: in the period 2015-2019 the summer mortality rate for the over-65s shows a greater excess in the years with a higher number of alert days, respectively +16% in 2015 and +41% in 2019.
The fragile categories of the population in Perugia, i.e. children under 5 and the over-65s, show a trend in line with the national tendency: the percentage of the youngest decreases from 4.3% (2016) to 3.6% (2020) and that of the oldest increases from 23.5% (2016) to 24.3% (2020), the latter falling within the average values within the sample. In this perspective, therefore, the importance of implementing adequate adaptation policies aimed at strengthening the capacity of the most fragile categories to respond to climate-related shocks and stresses should be emphasised.
Finally, as regards the picture relating to the wealth of the population, which is associated with the level of access to services, opportunities and information, we report an average value, within the sample, of the average income per taxpayer of €23,129 in 2018.



Summary Graph **Perugia Resilience**

ANCONA

Image source: Pixabay

THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**99,077**
RESIDENT POPULATION 2015 (N)	**100,458**
POPULATION DENSITY (PEOPLE/KM^2)	**793**
AVERAGE INCOME PER CAPITA (€)	**17,599**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**124.9**
ALTIMETRICAL ZONE	**COASTAL HILL**

ANCONA LIVABILITY - SUMMARY

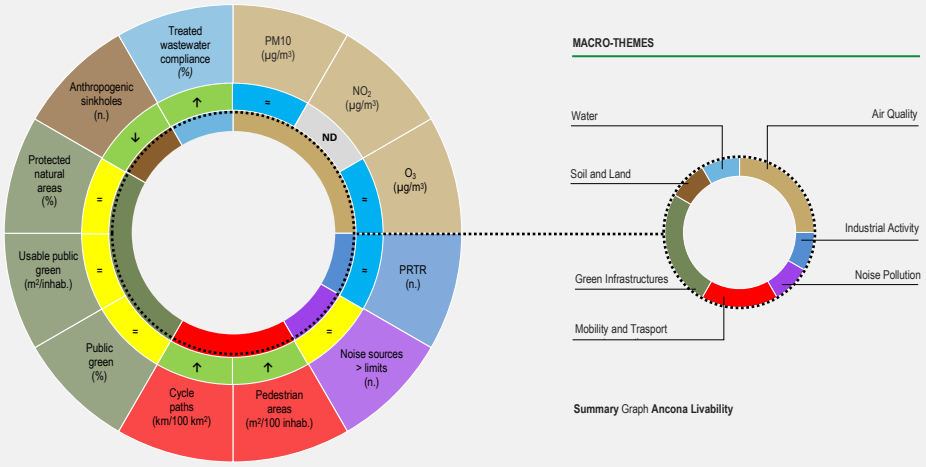
It is the areas of mobility and transport, water resources and land and soil that show good performance in terms of livability in the Marche capital.

The first positive sign concerns, in fact, the density of bicycle lanes: the figure remained constant from 2011 to 2014 (2.6 km/100 km^2 of land area) and then increased in 2015 and 2017, and remained at 3.6 km/100 km^2 of land area in 2019, +36.2% compared to 2011. The availability of pedestrian areas also increased slightly from 2008 to 2019 (+8.0%) to 10.5 m^2/100 inhabitants. Although increasing, both indicators nevertheless show values among the lowest in the sample, highlighting the need for more effective policies on urban soft mobility.

With regard to urban waste water treatment, the percentage of purified waste water that complies with emission standards ranges from its lowest of around 93% (2009) to 98.5% (2018), intermediate values within the sample.

A decreasing trend is also to be reported for the number of anthropogenic sinkholes, which fell from 15 sinkholes in 2010 to only 1 case recorded in 2020 and none in the first half of 2021.

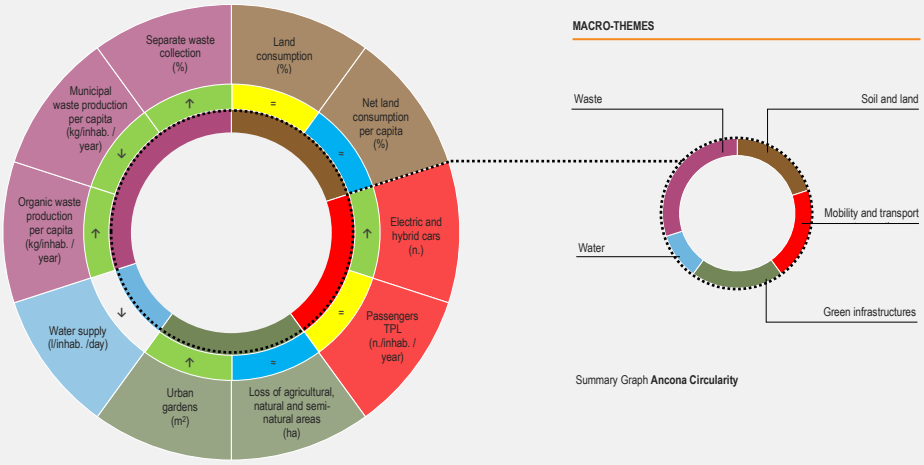
As far as air quality is concerned, in 2020 there were no exceedances of the annual limit value for PM10 (40 µg/m³) nor of the daily limit value (50 µg/m³). For NO_2, there were also no exceedances of the annual limit value (40 µg/m³) nor of the hourly limit value (200 µg/m³) in 2020. In contrast, the long-term objective for O_3 of 120 µg/m³, calculated as the maximum daily value of the average ozone concentration over 8 consecutive hours, was exceeded, but neither the information threshold (180 µg/m³) nor the alert threshold (240 µg/m³) was exceeded. The trend in the number of noise sources monitored per 100,000 inhabitants that exceeded the limits was stable in the years 2015-2019: in 2019 there were 3 out of 5. The green infrastructures indicators in the five-year period 2015-2019 did not change significantly. In fact, the density of public green on the municipal territory (4.2% in 2019) remains constant, in line with the intermediate values found in the sample of cities considered, the per capita availability of usable green (35.7 m^2/inhabitant), in line with the highest values in the sample, and the incidence of protected areas (25.4%) thanks to the presence of the Conero Regional Natural Park, important for biodiversity conservation and outdoor recreation. On the industrial activities front, the number of municipal PRTR industrial facilities fluctuates between 2 and 8 units with zero variation between the extremes of the period observed.



Summary Graph **Ancona Livability**

ANCONA CIRCULARITY - SUMMARY

Ancona shows many areas of potential improvement in terms of circular economy and sustainable use of resources in the period considered.
In terms of green infrastructures, the area allocated to urban gardens is doubling from 1.8 ha (2011) to 3.6 ha (2019). From September 2020, the municipality of Ancona will make available 'social vegetable gardens' for a period of six years to improve the quality of life of the over-65s.
It is on the subject of waste that the Marche capital presents a picture of overall improvement, with continuous growth in the percentage of separate waste collection over the five-year period 2015-2019 (9.3%) and values of 57.6% achieved in the last year. For the per capita production of organic waste, there has been a slight increase over the last three years to 102.1 kg/inhabitant in 2019, while there has been a slight decrease in the per capita production of municipal waste (496.6 kg/inhabitant in 2019), with intermediate values within the sample.
Interesting data on mobility and transport show the growth of the electric and hybrid car fleet to 1.9% of the total fleet in 2020 compared to 0.3% in 2015. Possible margins for improvement can be identified in some areas that could be better targeted through timely and effective policies. The loss of agricultural, natural and semi-natural areas, which has always recorded values of around 2 ha (between 2015 and 2019), increases to 7 ha between 2019-2020, of which around 6 ha concerned tree (2.7 ha) and herbaceous (2.9 ha) areas. With regard to the number of passengers transported per inhabitant per year by local public transport, there is a discontinuous trend, reaching almost the same value in 2019 as in 2011 (115.0 passengers per year/inhabitant or +0.8% in 2019 compared to 2011).
More effective and incisive policies are needed in the 'soil and land' sector, since the net per capita land consumption in 2020 is about 7 ha, which is a higher value than those recorded in previous years. Furthermore, with reference to land consumption, a constant value of 17% is recorded throughout the period 2016-2020 resulting still low compared to the values within the sample. Finally, on the water resource front, a gradually decreasing daily volume of water delivered is reported, starting from 255 l/inhabit/d (2012) to stand at 228 l/inhabit/d (2018), a low value within the sample.



Summary Graph **Ancona Circularity**

ANCONA RESILIENCE - SUMMARY

As regards climate change resilience, a situation of substantial stability or variability without a clear trend for Ancona is reported, with a specific criticality in the water sector.

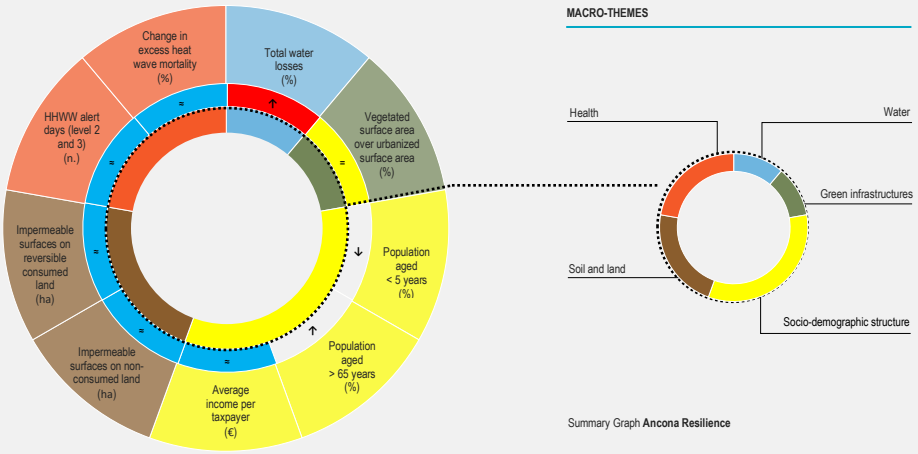
Over the seven-year period 2012-2018, in fact, total water losses in the municipal drinking water distribution network show a clear increase from 2015 to reach a maximum of 29.5% in 2018. The values remain, however, below 30% and are among the lowest values found within the sample.

The analysis of the data on the vegetated surface area over the urbanised area, which is about 58% over the entire historical series (2016-2020), shows a good endowment of both public and private greenery, with values on the borderline between the medium and high end of those found in the sample. In relation to this issue, however, action could be taken on increasing tree cover, which was photographed at 12% in 2018.

There are several areas where spatial policies could contribute to improving urban resilience. In Ancona, soil sealing between 2015 and 2020 remained below 5 ha (about 2.5 ha of impermeable surfaces on reversible consumed land and about 1.5 ha on natural and semi-natural areas) and over the years new sealing was less than 1 ha, with the exception of 1.3 ha impermeable surfaces on reversible consumed land, recorded in 2017-2018.

As far as the socio-demographic situation is concerned, the indicators return trends in line with the national tendency, with a decrease in the percentage of the population <5 years old from 3.8% (2016) to 3.4% (2020) and an increase in the percentage of the population >65 years old from 25.6% in 2016 to 26.5% in 2020. The latter, in particular, are among the highest values in the sample and highlight the need for climate change adaptation policies that are more attentive to such a fragile population category as the elderly. On the other hand, the trend in average income per taxpayer is fluctuating and in 2018 reaches its highest value (€23,925) which falls, however, among the intermediate ones in the sample.

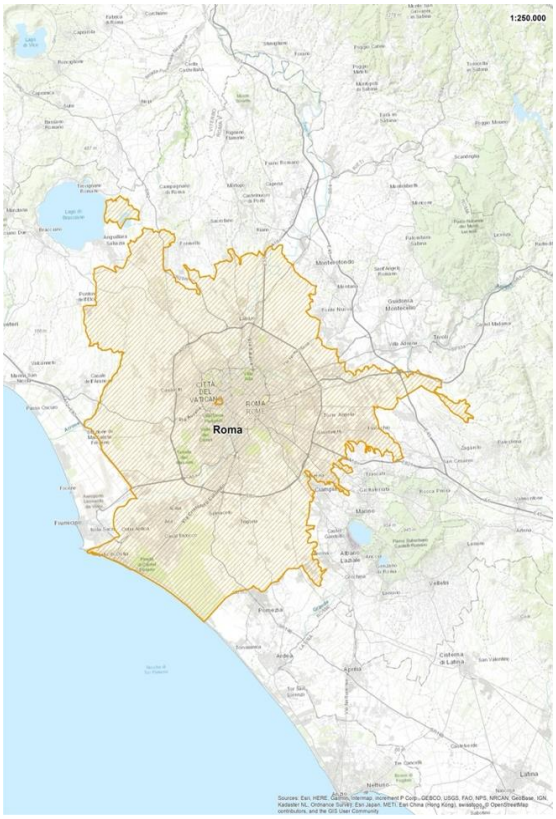
Finally, as regards health and the risks associated with extreme temperature events, despite the slight upward trend in the number of days of heat wave warnings, the mortality rate for the over-65 population remains in line or lower than expected. An exception is reported in 2015, when a mortality peak of +15% was recorded, which in any case places Ancona in line with the intermediate values found in the sample.



Summary Graph **Ancona Resilience**

ROME


Image source: Pixabay



THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**2,808,293**
RESIDENT POPULATION 2015 (N)	**2,776,835**
POPULATION DENSITY (PEOPLE/KM^2)	**2,181**
AVERAGE INCOME PER CAPITA (€)	**18,678**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**1,287.4**
ALTIMETRICAL ZONE	**PLAIN**

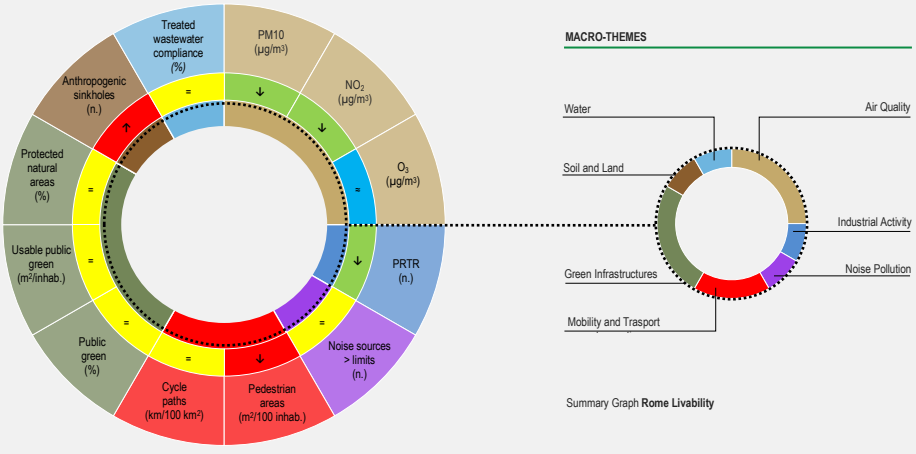
ROME LIVABILITY - SUMMARY

The analysis of the environmental indicators selected to understand the quality of life aspects returns, for the capital of our country, a picture characterised by some areas of improvement overlaid, however, by some specific criticalities.

The situation regarding PM10 and NO_2 improves, whose concentration decreases over the period 2013-2020, while for O_3 the underlying trend appears substantially monotonous. The performance regarding urban waste water treatment is good: the percentage of purified waste water that complies with emission standards is stably above 95% with respect to the load generated, reaching a value of 97.5% in 2018, in line with the intermediate values of the sample of cities analysed.

The situation regarding noise pollution in the capital is stable: the number of noise sources controlled with exceedances of legal limits per 100,000 inhabitants remains constant over the five-year period 2015-2019 (2.6). More effective policies are needed in the field of sustainable mobility capable of reversing the negative trend observed in the availability of pedestrian areas, which declined discontinuously from 2008 to 2019 (-7.9%), down to 14.0 m^2/100 inhabitants in 2019; but it is also necessary to meet the growing demand for cycle mobility through an increase in the density of cycle paths, which has remained substantially unchanged since 2013 and is equal to 19.3 km/100 km^2 of land area in 2019 (-2.4% compared to 2011). Public green spaces also require more attention as an important resource for the quality of the environment and the health of citizens. In the five-year period 2015-2019, however, there is no appreciable increase either in the density of public green on the municipal surface (3.7% of the entire territory, equal to 4,800 ha) or in the per capita availability of usable public green (17.1 m^2/inhabitant). In addition to public green areas, Roman citizens have the privilege of being able to enjoy an extensive, but substantially unchanged, system of protected natural areas covering 32% of the municipal territory.

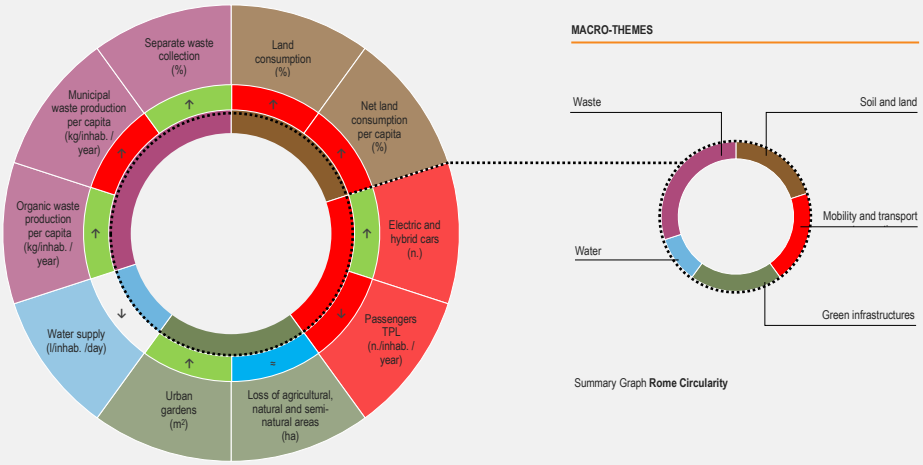
On the other hand, the situation regarding the Capitoline city's soil and territory is delicate, with an increase in the number of anthropogenic sinkholes over the five-year period 2015-2020, with an average of around one hundred events per year over the last decade. The main causes of sinkholes are the presence of underground cavities, mostly quarries for the extraction of construction materials, and deficiencies in the underground utility network. With regard to industrial activities in the municipality, there was a 21% decrease in the number of PRTR establishments between 2015 and 2019, which is still among the highest values in the sample.



Summary Graph **Rome Livability**

ROME CIRCULARITY - SUMMARY

Substantially balanced is the positive performance with respect to the critical issues encountered on the circular use of resources.
In particular, the percentage of separate collection in the last year (2019) reached 45.2% with an overall increase of 16.4% over the five-year period 2015-2019. The same period also witnessed a steady growth in the per capita production of organic waste, with the exception of the 88 kg/inhabitant in the last year (-2.8%) which, however, did not reverse the positive sign of the entire period (10.5%).
As far as urban gardens are concerned, there was a total increase of 1.6 ha in the period 2011-2019, an increase of 80% compared to 2011, for a total of 3.5 ha. Also with regard to mobility and transport, the municipality shows an increase of 2.5 % in the share of electric/hybrid cars in the total car fleet from 2015 to 2020. More incisive should be the policies on the most critical sectors.
Rome is the regional capital with the highest value of net land consumption in all the years considered. The increase rises from 46 ha in 2016 to 123 ha in 2020. The percentage of land consumed on the municipal territory is about 23% for the entire period and the per capita net land consumption increases from 0.16 m²/inhabitant (2016) to 0.44 m²/inhabitant (2020), a figure that is not very high, however, since Rome is the most populous of the 21 cities considered. The demand for local public transport also decreased steadily from 2011 to 2019 (318.2 passengers per year/inhabitant, -43.2%).
As far as the per capita production of urban waste is concerned, in 2019 it reached 602.5 kg/inhabitant: in the first three years of the five-year period 2015-2019 there was a substantial balance, followed by a strong growth in 2018 (8 kg/inhabitant) and a slight decrease in the last year (-0.4%), with a trend for the period that was nevertheless positive (2.7%). The role played by tourist influxes should be highlighted here, with all the large cities of art having the highest values in the sample.
Rome is the city that recorded the highest value, compared to the sample, of loss of agricultural, natural and semi-natural areas between 2015 and 2020: 464 ha of surfaces were converted to artificial land, with an increasing intensity from -67 ha (2015-2016) to -131 ha (2019-2020). Between 2015 and 2019, 29 ha covered by trees were also lost, half of them in urban areas and as many as 11 ha in natural areas.
Finally, on the water resource front, there is a per capita volume of water delivered daily in the seven-year period 2012-2018 that, while showing values above the national figure (215 l/inhabit/d), denotes a decline with the lowest value of 245 l/inhabit/d in 2018.



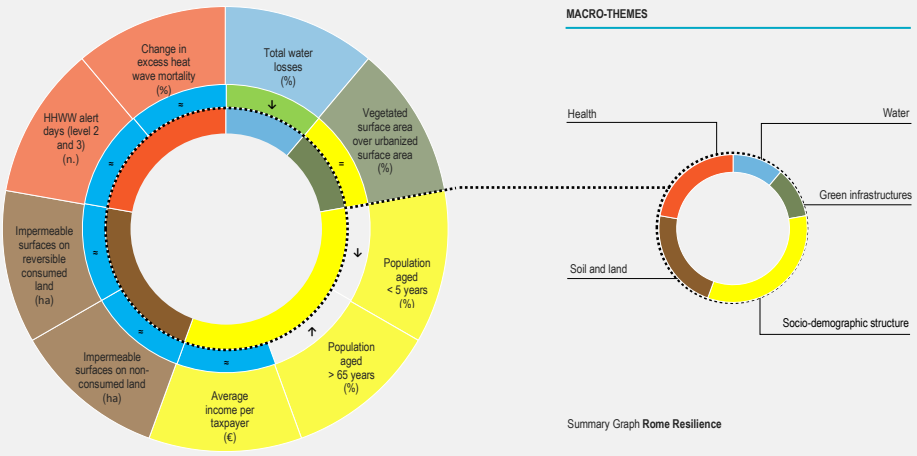
Summary Graph **Rome Circularity**

ROME RESILIENCE - SUMMARY

The picture of resilience to climate change presents itself with substantially fluctuating trends over time and a positive note on the water resources front. Although the drinking water distribution network, in the period 2012-2018, presents a rather high level of total water losses, with values ranging between 38% and 47%, in 2018 a minimum value of about 38.1% is highlighted, achieved thanks to the investments on the network made in recent years. Important and fundamental margins for improvement are to be found in the reading of the topic soil and land. The impermeable surfaces on non-consumed land (natural and semi-natural areas) and the impermeable surfaces on reversible consumed land (building sites, earthen surfaces) show a fluctuating trend over time. The highest value of soil sealing is recorded between 2015 and 2020 with 188 ha, divided almost in half between non-consumed and reversible consumed land. Between 2019 and 2020, the total amount of impermeable surfaces (17 ha) involved natural and semi-natural areas. The sealing values of these areas are among the highest within the sample for the entire period.

With respect to the vegetated surface of public and private property within the urban belt, Rome records a stable figure of 56%, resulting among the intermediate values within the sample. The presence of vegetated and permeable areas contributes to mitigating the risk of landslides and flooding in the city, and is an important indicator for understanding the capacity of an urban system to cope with the risks of climate change.

With regard to health, indicator trends also fluctuate. The variation in excess mortality of the over-65 population peaks at +8% in 2015, coinciding with the summer with the highest number of days at risk to health (heat wave alerts of 21 days.). In line with the national trend, the socio-demographic structure indicates a decrease in the percentage of the population aged 0-4 years from 4.4% (2016) to 3.8% (2020) and an increase in the percentage of the population aged 65 years and over from 22.1% (2016) to 22.8% (2020). These figures highlight the need to implement adaptation policies geared towards strengthening, for the most part, the ability of the elderly to react to the stresses and shocks resulting from climate change. With an average income per taxpayer of €27,766 in 2018, Rome shows high levels of wealth compared to the sample of municipalities considered, potentially associated with a greater capacity of the population to access services and information in a resilient perspective.



Summary Graph **Rome Resilience**

L'AQUILA

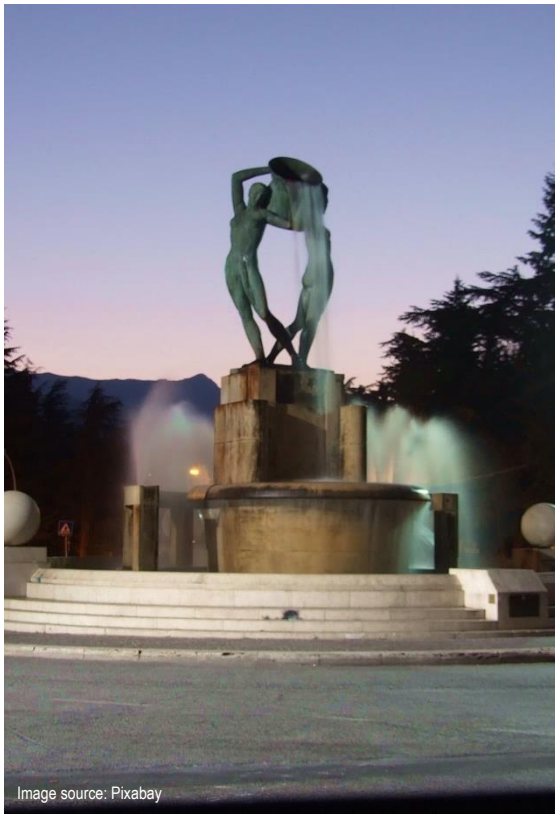
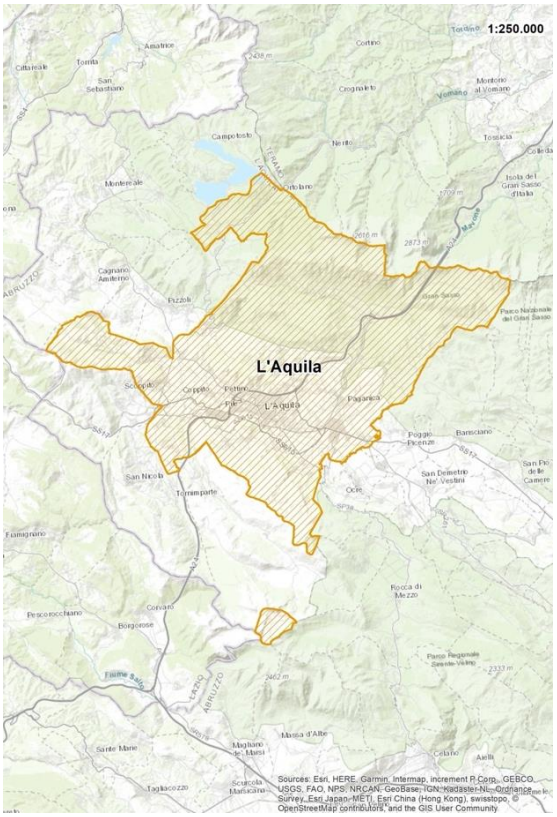


Image source: Pixabay

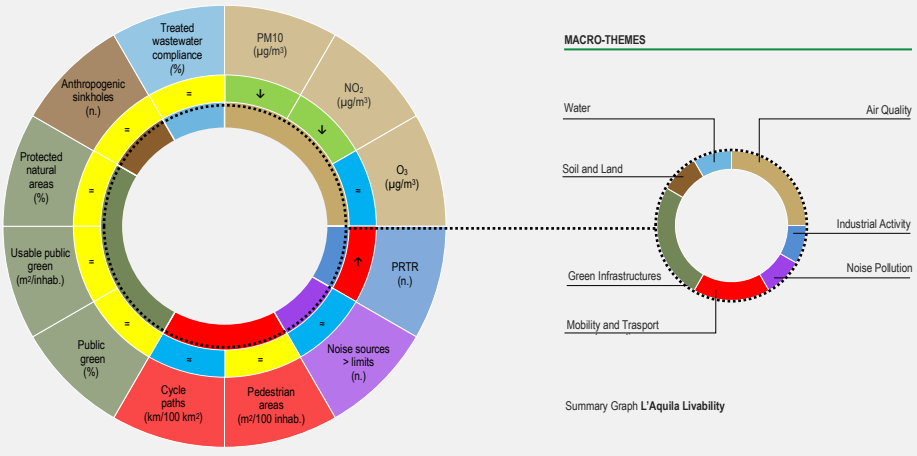


THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**70,019**
RESIDENT POPULATION 2015 (N)	**70,371**
POPULATION DENSITY (PEOPLE/KM^2)	**148**
AVERAGE INCOME PER CAPITA (€)	**16,176**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**473.9**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

L'AQUILA LIVABILITY – SUMMARY

The analysis of the indicators selected to understand the quality of life aspects returns, for the municipality of L'Aquila, a picture characterised by some areas of improvement and others for which greater efforts and more incisive policies are desirable. In the case of air quality, while concentrations of some air pollutants, such as PM10 and NO_2, are decreasing over the seven-year period 2013-2020, for O_3 the underlying trend is not statistically significant and exceedances of the long-term value are observed at all stations in 2020. The performance regarding the treatment of urban waste water is good: the entire load of purified waste water has been found to be stably compliant with the emission standards set by the reference regulations over the entire 2009-2018 period. The issue of noise pollution, on the other hand, is to be noted, due to the repercussions it may cause on the psycho-physical state of the population, since the number of noise sources monitored with exceedances of legal limits increased in the five-year period 2015-2019, with medium-high values within the sample. There is also room for improvement in mobility and transport policies, which should be aimed at increasing the availability of pedestrian areas and cycle paths in the territory. These indicators, which represent strategic levers for promoting more sustainable modes of travel, nevertheless maintain rather low values within the sample, with 1.4 km/100 km^2 of cycle track density (2019) and 10.8 m^2/100 inhabitants of pedestrian areas (2018). The density of public green areas in the municipal area also still appears to be insufficient, amounting to about 0.4 per cent for an area of about 180 ha, which is among the lowest values in the sample. Despite the high incidence of protected natural areas on L'Aquila's territory (50.1% as of 2019) policies more oriented to the development of urban green spaces for aggregation and recreation, so important for people's sociality and physical and mental regeneration, are desirable. The number of anthropogenic sinkholes recorded since 2010 is low (9) and only one sinkhole event is reported in 2020. However, some events were observed in 2009 following the seismic event in Abruzzo with epicentre in the L'Aquila area. Finally, with regard to polluting sources of industrial origin due to the presence these figures of production complexes, the indicators show an increase from 0 to 2 in the number of PRTR establishments at municipal level between 2015 and 2019. These figures are in line with the lowest values found in the sample.



Summary Graph **L'Aquila Livability**

L'AQUILA CIRCULARITY - SUMMARY

On the circularity front, L'Aquila shows good performance in several areas and a specific criticality in the mobility and transport sector. In particular, although the percentage of separate waste collection in 2019 is still low (36.8%), over the five-year period (2015-2019) there has been constant growth, with an increase of 9.4% and +1.2% in the last year. With regard to the per capita production of municipal waste and the per capita production of organic waste, however, the signs are less clear. In particular, the increase in municipal waste production per capita over the entire five-year period 2015-2019 is positive (5.1%), while that of the last year is negative (-1.1%), reaching 500.2 kg/inhabitant in 2019. As for the per capita production of organic waste (54.3 kg/inh in 2019), there is a substantial balance throughout the five-year period.

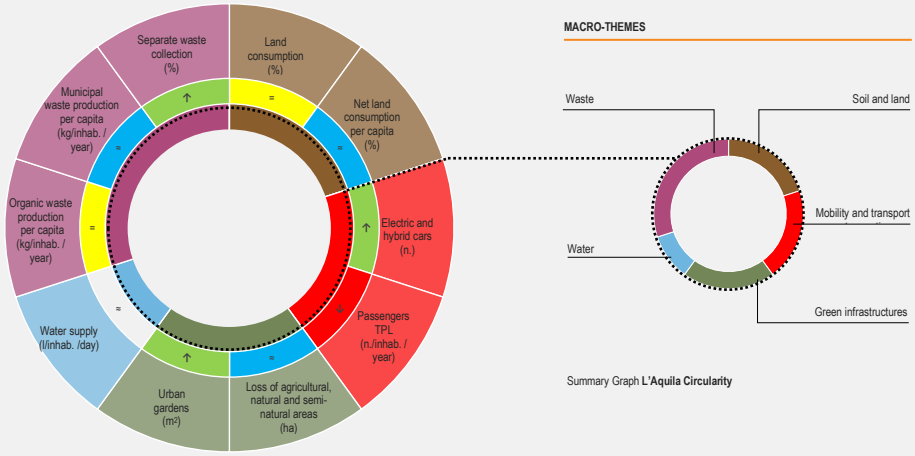
The incidence of hybrid/electric cars on the total car fleet is improving, rising from 0.1% at the end of 2015 to over 1% at the end of 2020.

Despite the increase in 2015, the areas used as urban gardens by the administration remained constant at 8,640 m^2, while the loss of agricultural, natural and semi-natural areas peaked in 2017-2018, with about 30 ha of new artificial land, and then settled at just over 10 ha in the last two years. It is interesting to point out that since 2017 the class most affected by land loss is that of tree cover in the natural environment, with about 8 ha between 2017-2018, 5 ha between 2018-2019 and 3 ha in the last year.

On the subject of soil, the percentage of land consumed on municipal territory stands at around 5% for all years and is also the lowest among the regional capitals. Per capita net land consumption follows the trend with a maximum of 4.2 m^2/inhabitant in 2018 and about 2 m^2/inhabitant in 2020.

On the other hand, more effective and incisive policies are needed with regard to the issue of local public transport: the demand for local public transport has, in fact, decreased discontinuously from 2011 to 2019 (-14.3%), settling at 45.2 passengers per year/inhabitant (2019).

L'Aquila, finally, shows high values within the sample for the per capita volume of water supplied daily for authorised uses, which in 2018 stood at 336 l/inhabitant per day: this figure is, however, the lowest in the series since 2012.



Summary Graph **L'Aquila Circularity**

L'AQUILA RESILIENCE - SUMMARY

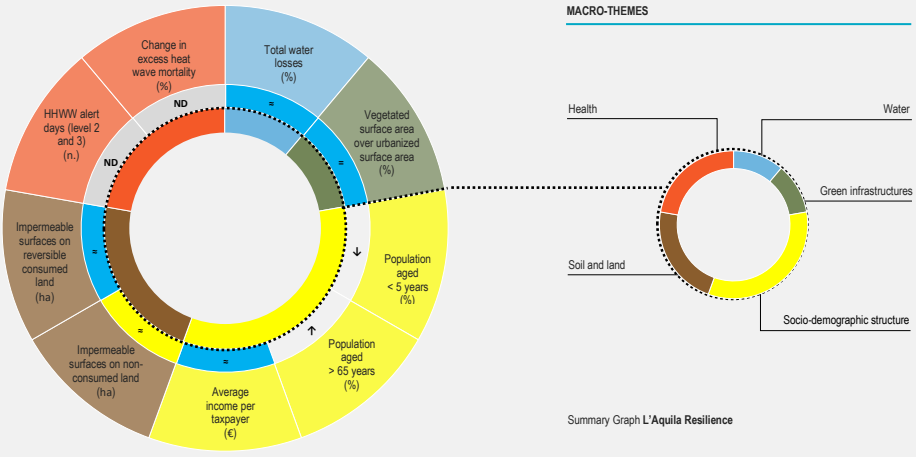
The indicators pertaining to the key to understanding resilience to climate change outline a picture with situations that fluctuate over time and others that are substantially stable.

Reaching a value of 68% of vegetated surface over the urban area in 2020, Abruzzo's capital city ranks steadily among the municipalities with the largest surface area of vegetated and permeable areas, giving the territory a good potential for mitigating the risk of landslides and flooding in the city, as well as greater thermoregulating capacities with respect to the dangers associated with heat waves.

With regard to the problem of soil sealing, it is reported that approximately 6 ha of natural soil was artificialised between 2015 and 2020. For almost all periods analysed, new impermeable surfaces affected natural and semi-natural areas to a greater extent than reversibly consumed areas such as construction sites or rammed earth surfaces.

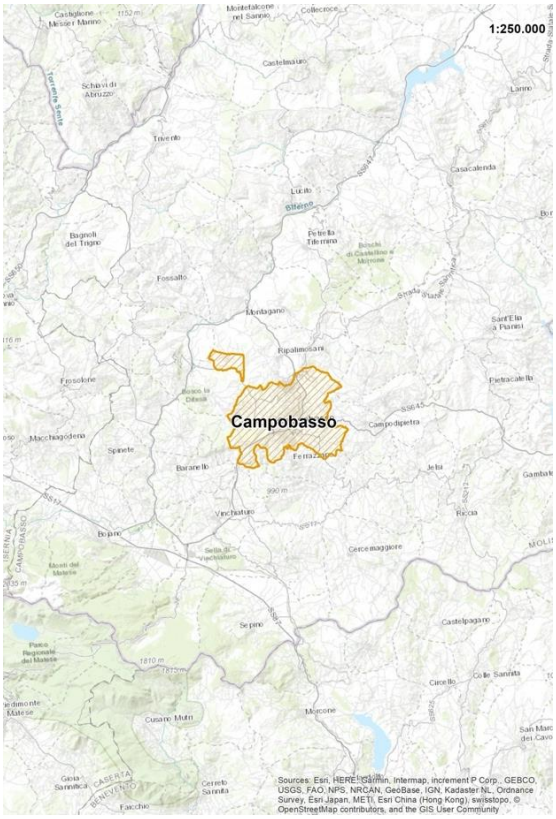
On the water resource side, total water losses don't show a clear trend in the period 2012-2018, also due to the consequences of the 2016 earthquake events. Values reach 47.3% in 2018, a result slightly lower than the maximum recorded in the series and amounting to 47.7% in 2012, which is however higher than the national average value of 42%.

The indicators relating to the socio-demographic structure, which characterise the fragile population groups, are in line with national trends: in particular, the percentage of the population aged 0-4 years decreases from 4.1% (2016) to 3.9% (2020), while the percentage of the population aged 65 years and over increases from 22.5% (2016) to 23.9% (2020). As in most of the municipalities considered, in the case of L'Aquila there is a clear need for policies that are more oriented in particular towards the elderly population, in order to increase their capacity to respond to the critical climatic conditions and their consequences. Finally, the average income per taxpayer reaches the highest value in 2018 with €23,127, on average with the remaining municipalities in the sample. From a resilience perspective this value, which describes the population's level of wealth, assumes a sub-optimal context of access to information, services and opportunities.



Summary Graph **L'Aquila Resilience**

CAMPOBASSO

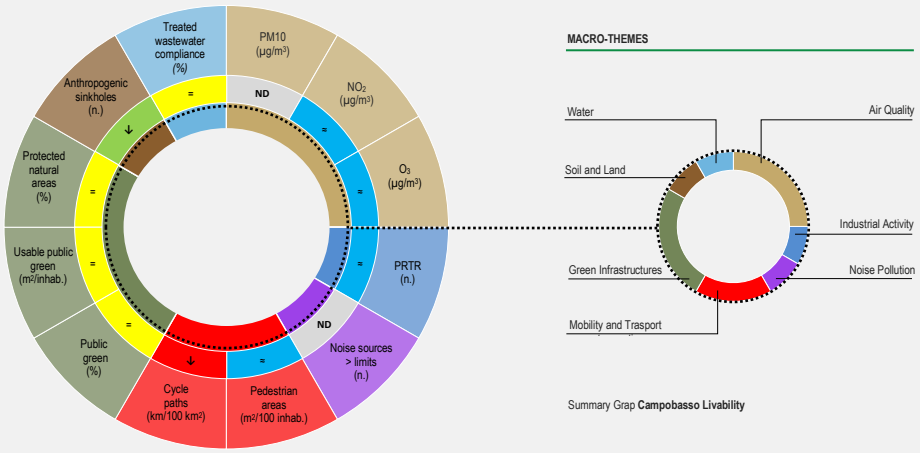


THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**48,337**
RESIDENT POPULATION 2015 (N)	**48,715**
POPULATION DENSITY (PEOPLE/KM²)	**861**
AVERAGE INCOME PER CAPITA (€)	**14,290**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**56.1**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

CAMPOBASSO LIVABILITY - SUMMARY

The picture emerging from the indicators selected for the livability key describes, for Campobasso, many situations that are substantially stable or variable without a clear trend over time. However, it is worth highlighting the positive data on the percentage of purified wastewater that complies with emission standards, which is always very high: from a minimum of 96% (2009) to a maximum of 100% (2014), and then to a value of 98% (2016 and 2018). The number of land sinkholes (anthropogenic sinkholes) also shows a positive trend, with 15 events recorded in the last decade and a decreasing trend: only one episode was recorded in 2020 and none in the first half of 2021. On the other hand, more effective policies are needed in the field of sustainable mobility, especially in the direction of a higher density of bicycle lanes, which shows a negative trend over the period 2008-2019 until it reaches zero in 2019. The availability of pedestrian areas shows a variable trend over the years without a clear trend, with values standing at 12 m²/100 inhabitants in 2019, although still in line with the lowest figures found in the sample. More attention should also be paid to public green policies, which show a situation of substantial stagnation in the values of density of public green on the municipal surface (1%) and per capita availability of usable public green (14 m²/inhabitant). Campobasso also hosts, within its municipal boundaries, protected natural areas that in 2019 account for 4.5 per cent of the entire municipal area (mostly Natura 2000 sites), for a total of about 200 ha. These areas are also easily accessible to citizens, such as the Castello Monforte Park and the San Giovannello Pinewood located in central areas, while the Faiete Woods - Monte Vairano, which is slightly more peripheral, can still be reached in a few minutes even by public transport. With regard to air quality, there is no statistically significant trend of decreasing or increasing NO_2 and O_3 concentrations in the period 2013-2020. In 2019, there were no noise sources monitored with phonometric measurements by ARPA. In the only year in which sources were monitored and found to be above regulatory limits (2015), the municipality is in line with the lowest values found in the sample. Finally, with regard to industrial activities at municipal level, the number of PRTR establishments fluctuates between 0 and 1 with zero variation between the extremes of the observed period (2015-2019).



Summary Grap **Campobasso Livability**

CAMPOBASSO CIRCULARITY - SUMMARY

Lights and shadows are observed in terms of circularity for the municipality of Campobasso. In particular, it has very low per capita net land consumption values and is the regional capital with the least land consumption in 2020. The highest land consumption occurred between 2016-2017 and 2017-2018 (around 4 ha/inhabitant).

In the waste sector, the per capita municipal waste production in 2019 reaches 437.2 kg/inhab. Over the five-year period 2015-2019, a fluctuating but decreasing trend (-0.4%) was observed. In contrast to per capita production, the percentage of separate collection has soared over the five-year period, especially between 2017 and 2018, reaching an increase over the period of 121.1%. The increase in the last year is even 29.5%, with values of 28.6% in 2019. The per capita production of organic waste in 2019 reaches 38.3 kg/inhabitant. The trend over the five-year period is the same as for separate collection, showing a long-term increase of 400.6% and in the last year of 58.7%.

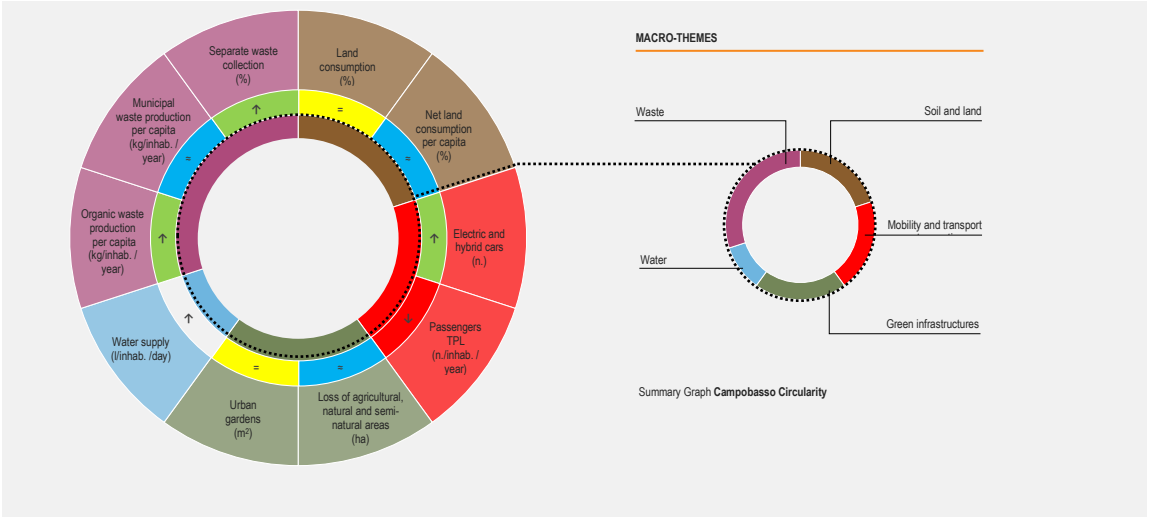
Margins for improvement can be identified in the areas of mobility and transport and green infrastructures. The incidence of hybrid/electric cars on the total car fleet is still substantially stationary at 0.8% at the end of 2020, up from 0.1% at the end of 2015.

Until 2019 there were no areas set aside for urban gardens in Campobasso. However, the inauguration in June 2021 of a shared vegetable garden resulting from the redevelopment of an uncultivated area by the Centro Sociale Anziani di Colle dell'Orso in cooperation with the municipal administration is noted.

Between 2015 and 2020 the values of the loss of agricultural, natural and semi-natural areas due to land consumption are less than 4 ha/year showing a variable trend: between 2017-2018-3.9 ha are registered, half of which on natural tree and herbaceous soil in urban areas. A similar value (-3.5 ha) is observed between 2016-2017 with the loss of agricultural and natural herbaceous soil. In the other years, the value of the indicator is below 1 hectare, and in 2020 the value expressed by this indicator is among the lowest values recorded in the sample of the 21 municipalities considered.

More effective and incisive policies need to be put in place in the mobility and transport sector with regard to the demand for local public transport, which declined discontinuously from 2011 to 2019 (-28.7%), settling at 41.3 passengers per year/inhabitant.

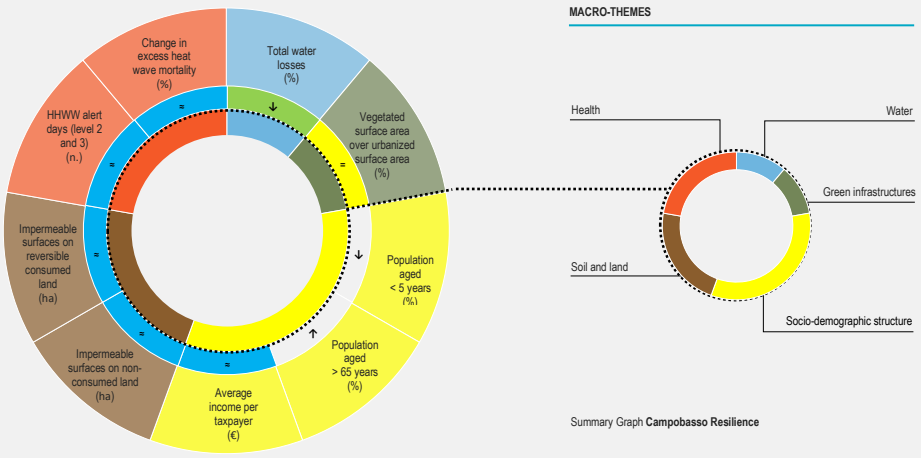
Finally, with regard to water resource management, the daily per capita supply of water for drinking use was 257 l/inhabit/d in 2018, significantly higher than in 2012, when the value was 184 l/inhabit/d.



Summary Graph **Campobasso Circularity**

CAMPOBASSO RESILIENCE - SUMMARY

The indicators pertaining to resilience to climate change return a picture characterised mostly by variable situations over time without a clear trend.
Although the infrastructural situation of the drinking water distribution network remains critical, with total water losses exceeding 50% throughout the 2012-2018 period, the latest figure recorded in 2018 (56.8%) shows a rather substantial reduction in losses compared to previous years when the percentage was 65%. However, the values remain high within the sample.
For green infrastructures, representing a strategic resource for climate change adaptation in urban areas, there is a substantially unchanged figure over the entire 2016-2020 time series of the vegetated area - both publicly and privately owned - over the urbanised area, at 67%.
Between 2015 and 2020, less than 2 ha of new impermeable surfaces were recorded: Campobasso is therefore among the municipalities with the lowest values of this indicator. On the health aspects, a fluctuating trend is recorded in the period 2015-2019, with a slight upward trend, both in the number of heat wave alert days (30 in 2019) and in the change in excess mortality of the over-65 population (12% in 2019). Both values are among the highest in the sample in 2019.
The indicators relating to the socio-demographic structure, which characterise the less resilient population groups, are in line with national trends both in terms of the decrease in the percentage of the population aged 0-4 years, which rises from 3.5% (2016) to 3.3% (2020), and the increase in the percentage of the population aged 65 years and over, which rises from 23.4% (2016) to 25.1% (2020). With the possible increase in extreme temperature events due to climate change, it will therefore be necessary to put in place actions and measures to increase the resilience of the elderly.
The average income per taxpayer reached its highest value in 2018 with €21,159 per taxpayer, below the average of the municipalities in the sample. This value, which portrays the population's level of wealth, thus denotes a context of limited capacity to access information, services and opportunities compared to the rest of the sample.



Summary Graph **Campobasso Resilience**

NAPLES


Image source: Pixabay

THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**948,850**
RESIDENT POPULATION 2015 (N)	**963,521**
POPULATION DENSITY (PEOPLE/KM²)	**7,978**
AVERAGE INCOME PER CAPITA (€)	**11,023**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**118.9**
ALTIMETRICAL ZONE	**COASTAL HILL**

NAPLES LIVABILITY - SUMMARY

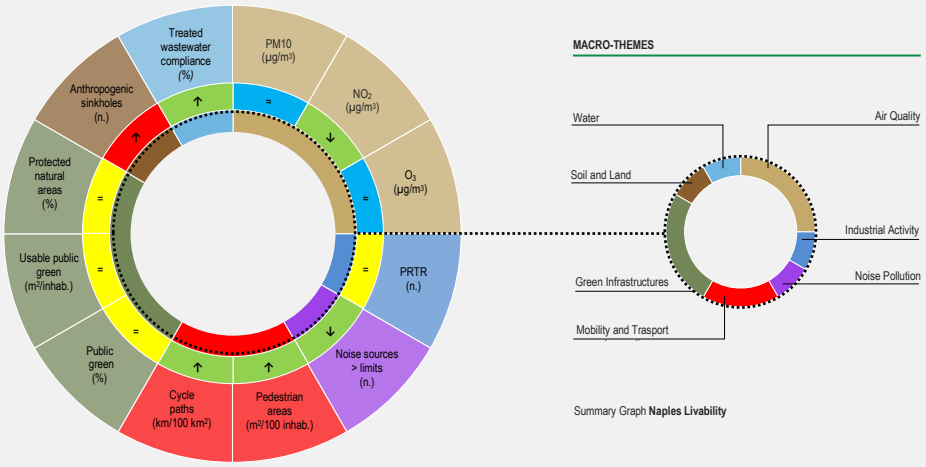
Naples shows many areas of improvement in terms of livability, but more incisive policies and more action in the direction of sustainability are desirable.

The situation regarding air quality in the capital of Campania is on a positive note thanks to the reduction in NO_2 concentrations observed in the 2013-2020 period, while for PM10 and O_3 the underlying trend appears substantially monotonous, and the interannual fluctuations are attributable to the natural fluctuations of the seasonal component.

The performance of policies on water treatment, noise pollution and sustainable mobility is good: the percentage of purified wastewater that complies with emission standards is increasing (93.1% as of 2018), the number of noise sources exceeding legal limits is decreasing, and the availability of bicycle lanes is increasing, with a 19.8% increase in the 2012-2019 period. Pedestrian areas are also growing, with +68.1% in 2019 compared to 2008 and values of 47.0 m^2 per 100 inhabitants, in line with the highest values recorded in the sample of 21 municipalities observed. These trends show a clear and progressive improvement towards urban sustainability goals.

The progress observed in the area of public green areas which are a strategic resource for the quality of life and the environment, is less evident. In fact, there are no appreciable increases either in the density of public green areas (9.6%) on the municipal surface area or in the per capita availability of usable public green areas (9 m^2/inhabitant), and even the incidence of protected natural areas (24%) remains unchanged in the five-year period 2015-2019. These green areas are important for psychophysical well-being and the protection of urban biodiversity.

The situation regarding soil and land is delicate. With a very high number of anthropogenic sinkholes in the last decade (305), in fact, Naples ranks second among the cities considered. The main cause of sinkholes is the presence of underground cavities, mostly quarries built for the extraction of Campania's yellow tufa, which form a network of tunnels beneath the urban fabric. However the dysfunction of underground utility networks often acts as a concomitant cause. The sinkholes that have occurred are of considerable size and are therefore a cause for concern. On the industrial activities front, the number of PRTRs at the municipal level is constant and equal to 2 in the period 2015-2019.



Summary Graph **Naples Livability**

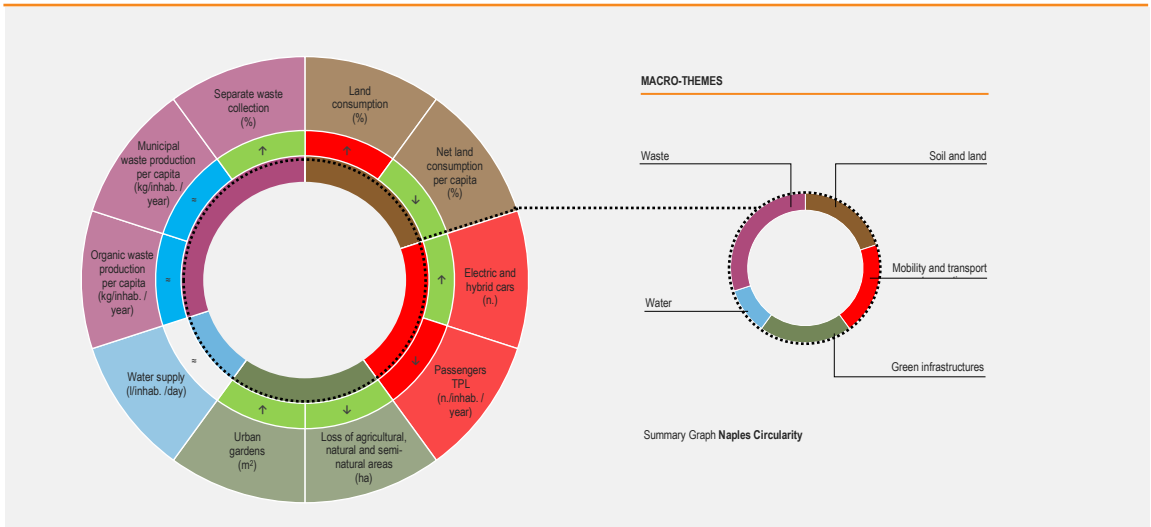
NAPLES CIRCULARITY - SUMMARY

Lights and shadows alternate in the picture of circularity that emerges from the analysis of indicators for the municipal territory of Naples. As of 2019, urban gardens cover about 11.7 ha of municipal area, an increase of more than 10 ha compared to 2011. A growing trend, on the other hand, for the loss of agricultural, natural and semi-natural areas decreases between 2015 and 2020: in the first years the rate stood at about 8 ha, down to about 3 ha/year in the last two years. A total of 17 ha of urban herbaceous soil, 4 ha of agricultural herbaceous soil and 5 ha of natural herbaceous soil were lost between 2015 and 2020, to which 2 ha of tree cover in urban areas and 3 ha in natural areas should be added. Good performance also for the hybrid/electric car indicator on the total car fleet, which shows signs of improvement, rising from just under 0.1% (2015) to 0.5% (2020).

Positive signs also for the waste sector: the percentage of differentiated waste collection in the five-year period 2015-2019 is growing steadily (49.7%), settling at 36.2% in the last year, although it remains among the lowest values among those recorded in the sample.

On the other hand, possible improvements could be pursued in the areas of soil and land, mobility and waste. The net per capita land consumption indicator shows, in fact, a decreasing trend, from 0.09 m^2/inhabitant (2016) to 0.03 m^2/inhabitant (2020).

The per capita production of organic waste in 2019 reaches 57.2 kg/inhabitant: in the first four years of the five-year period 2015-2019 this indicator shows a constant growth, while in the last year it shows a sharp decrease (-20.3%); the increase for the period is however 25.3%. Municipal waste production per capita also shows a non-linear trend over the period, with an increase of 2% and substantial stability in 2019. The values are, however, among the highest in the sample. On the other hand, critical issues emerge in the areas of local public transport (LPT) and soil protection on which more effective policies should be focused. The demand for local public transport has, in fact, decreased significantly from 2011 to 2019, reaching 119.9 passengers per year/inhabitant transported by LPT, or -40.4% in 2019 compared to 2011. The percentage of land consumed on the municipal territory is close to 62% in the 2016-2020 period, among the highest values recorded in the municipalities considered, highlighting urbanisation tending towards saturation. Lastly, as regards water resources the per capita volume of water delivered daily for authorised uses presents, during the seven-year period 2012-2018, fluctuating values which are nevertheless intermediate within the sample.

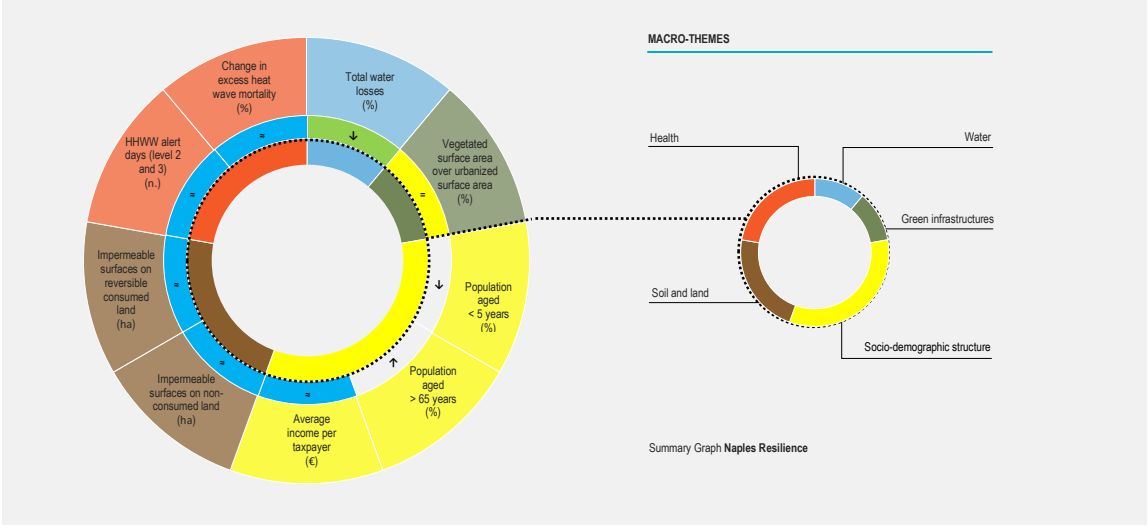


Summary Graph **Naples Circularity**

NAPLES RESILIENCE - SUMMARY

The analysis of descriptive indicators of resilience to climate change reveals a picture characterised substantially by fluctuating trends without a significant trend over time.
On the water resource management front, however, Naples shows a clear positive sign, with a reduction in total water losses from 41.2% in 2012 to 31.6% in 2018: these figures are both below the national average value of 42%. Substantially unchanged is the figure for the vegetated surface - of both public and private property - on the urbanised area, at 34%, one of the lowest values in the sample analysed. As far as soil is concerned, it should be noted that between 2015 and 2020 more than 60% of the new impermeable areas (8 ha) were built on natural or semi-natural areas (5 ha) and about 37% on reversible consumed surfaces (3 ha), such as building sites or rammed earth surfaces. In 2020, both values are among the lowest within the sample. In 2019, there was a particularly significant flooding event in Naples, which resulted in traffic blocks and flooding of hospital facilities, caused by the inability of the sewerage system to effectively drain the enormous amount of water that fell to the ground in just a few minutes.

As far as health aspects are concerned, the period 2015-2019 shows a fluctuating trend with no clear trend in both the number of heat wave warning days (8 in 2019) and excess mortality due to heat waves (5% in 2019). The summer mortality of the over-65 population remains lower than expected. It should be pointed out, however, that the socio-demographic structure indicators, which are descriptive of the fragile population groups, reflect national trends in the decrease in the proportion of the population aged 0-4 years, which falls from 4.5% (2016) to 4.1% (2020), and in the increase in the proportion of the population aged 65 years and over, which rises from 19.1% (2016) to 20.3% (2020). The protection of fragile groups, with particular reference to the older population, must therefore be placed at the centre of adaptation policies in order to strengthen their capacity to respond to increasingly frequent extreme weather events.
The average income per taxpayer, which describes the picture of the population's wealth that is also associated with the potential level of access to information, services and opportunities, reaches its highest value in 2018 at €21,927, below the average for the municipalities in the sample.



Summary Graph **Naples Resilience**

BARI


Image source: Unsplash

THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**315,284**
RESIDENT POPULATION 2015 (N)	**318,031**
POPULATION DENSITY (PEOPLE/KM²)	**2,685**
AVERAGE INCOME PER CAPITA (€)	**14,636**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**117.4**
ALTIMETRICAL ZONE	**PLAIN**

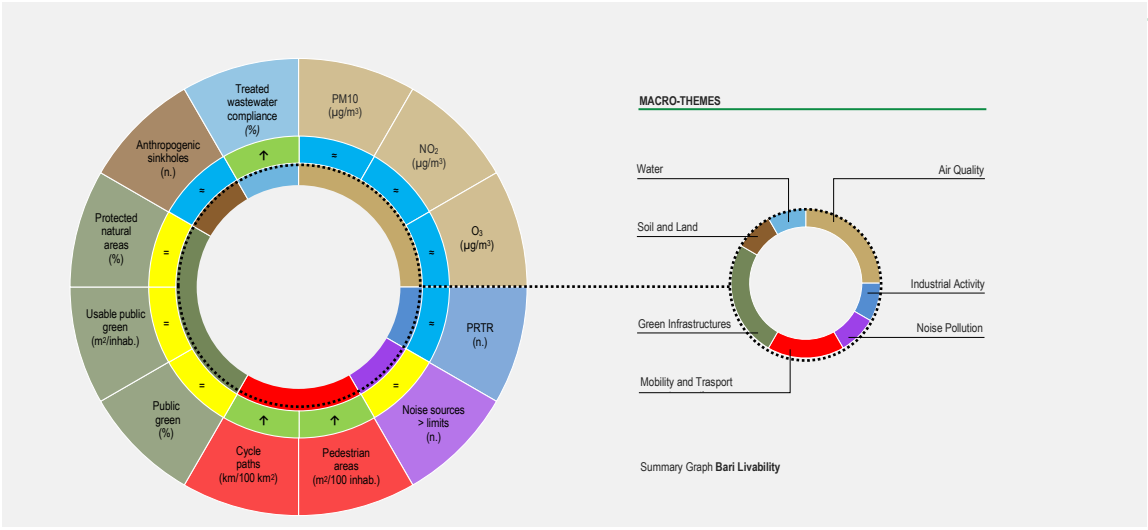
BARI LIVABILITY - SUMMARY

While on the mobility and water resource front Bari shows significant improvements, the general picture seems to be essentially stationary or variable, but without clear trends.

Regarding the progress, there are notable efforts to increase the supply of soft mobility infrastructures, both in terms of density of bicycle lanes and pedestrian areas: the former triples in 2019 compared to the three-year period 2011-2013, reaching 26.4 km/100 km^2 while the latter increases by 227.8% in 2019 compared to 2008 with 53.8 m^2/100 inhabitants, a high value within the sample. A clear improvement is also seen for the percentage of purified wastewater out of the total generated that complies with emission standards, rising from 43% in 2009 to 78% in 2018. Although the values are improving they remain, however, among the lowest in the sample.

A stable positive situation concerns the controlled noise sources for which no exceedances of regulatory limits were found in the years 2017-2019. There is also a good trend in the number of anthropogenic sinkholes, which has been decreasing over the last two years, although fluctuating over the five-year period 2015-2020, and in any case with a high average number of events recorded over the last 10 years (24).

Also the PRTR establishments located within the municipality, starting with a number of 8 (2015), with a fluctuating trend, are stabilised at 7 facilities (2019). Although not significantly critical, some areas could be better addressed through stronger policies. The density of public green areas, for example, has remained substantially unchanged over the five-year period 2015-2019, with an incidence on the municipal territory of 2.5% and a per capita availability of usable public green areas of 8.5 m^2/inhabitant in 2019. Approximately 2% of the municipality's territory is covered by protected natural areas (such as the Lama Balice Regional Natural Park, which covers 500 ha within the municipality), a figure also substantially unchanged since 2015. With regard to air quality, in the period 2013-2020 there is no statistically significant trend for PM10, NO_2 and O_3; on the other hand, in 2020 there were no exceedances of the annual limit for PM10 (40 µg/m³) nor of the daily limit value (50 µg/m³), nor were there exceedances of the annual limit value (40 µg/m³) and the hourly limit (200 µg/m³) for NO_2. With regard to O_3, there were no exceedances of the information threshold (180 µg/m³) and the alert threshold (240 µg/m³), while the long-term objective of 120 µg/m³, calculated as the daily maximum value of the average ozone concentration over 8 consecutive hours, was exceeded at all stations.



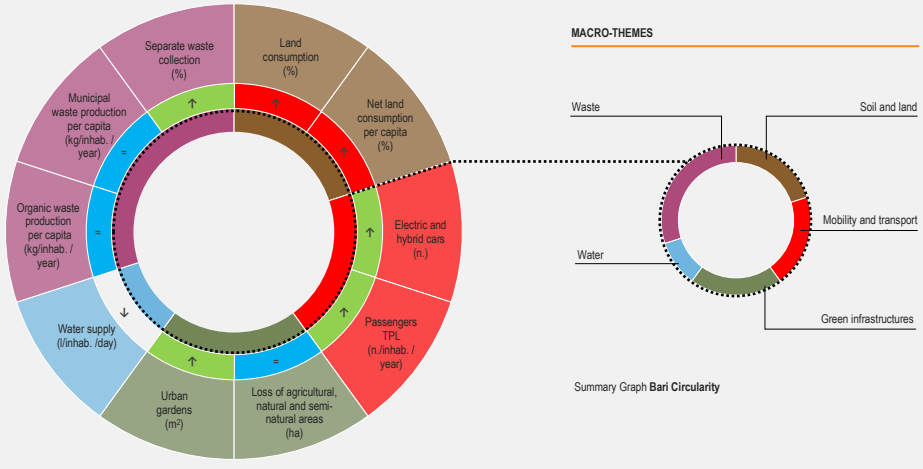
Summary Graph **Bari Livability**

BARI CIRCULARITY - SUMMARY

There are several improvements on the circularity front: first and foremost is the increase in the number of areas entrusted to citizens and associations for the cultivation of urban gardens, equal to about 296% more (2019) than in 2018, which places Bari among the municipalities with the highest values within the sample considered. In fact, urban gardens are part of the municipal administration's programme to redevelop some of the city's uncultivated areas with the collaboration of volunteers, neighbourhood citizens and enthusiasts. Differentiated waste collection is also growing steadily at around 28% in the five-year period 2015-2019, reaching around 43% in 2019, a figure that still characterises the municipality's average performance compared to the sample. Bari has also made significant progress in the area of mobility and transport: the demand for local public transport has increased, albeit discontinuously, from 2011 to 2019 (+31.3%), settling at almost 82 passengers per year/inhabitant, while the incidence of electric/hybrid cars has grown to just over 1% by the end of 2020. On the other hand, it is on the issue of land consumption that Puglia's capital city shows positive signs towards the European target of zero soil consumption, standing as the regional capital with the highest net land consumption (about 18 ha in 2020) after Rome. The loss of agricultural, natural and semi-natural areas is quite variable over the years, going from -9.4 ha between 2015 and 2016 to about -20 ha for the following two years, and reaching -33 ha between 2018-2019 to return to about -18 ha in the last year, a value in line with the highest found in the sample. More careful policies to safeguard a non-renewable resource such as soil therefore seem desirable.

The values of per capita collection of organic waste and per capita production of urban waste are variable over time, without a clear trend: in the first case, there is substantial stability in the five-year period 2015-2019, with the exception of a strong growth (18%) between 2017 and 2018, followed by a significant drop in the last year (-20.4%), with values that are in any case among the medium-low in the sample, while for the second, Bari remains at fairly high levels (around 587 kg/inhabitant in 2019).

Finally, on the water management front, in the municipality of Bari, the daily per capita supply of water for drinking has undergone a significant reduction in the period 2012-2018, from 241 l/inhabitant/d in 2012 to 187 l/inhabitant/d in 2018. These are, however, the lowest values within the sample.



Summary Graph **Bari Circularity**

BARI RESILIENCE - SUMMARY

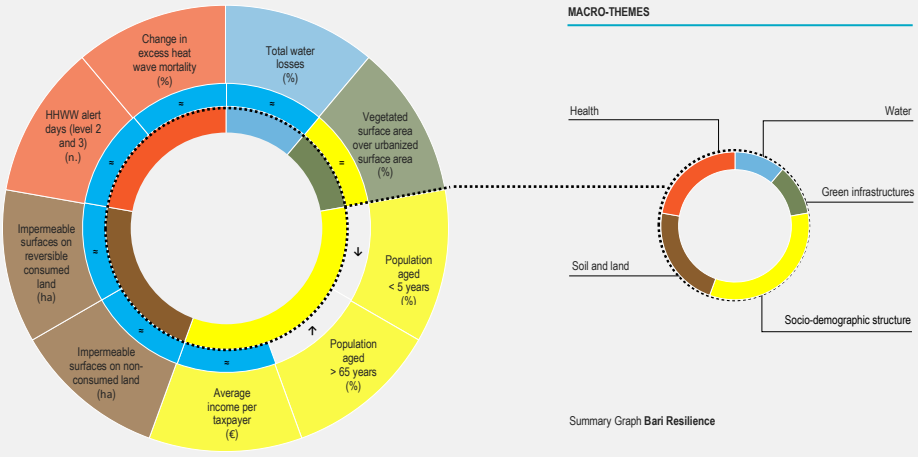
The analysis of the indicators selected in order to provide a picture of the path undertaken by the municipality of Bari to respond to the challenge of climate change, shows a territory characterised by some fluctuating situations with possible margins for improvement in different areas.

First of all, we point out the level of total water losses in distribution that, in the 2012-2018 period, is always above 40%, but with a decrease in 2018 (48.8%) compared to the intermediate data of the series (52.3% in 2015): the values remain, however, among the highest in the sample. Looking at the data on the presence of green and permeable areas, which represent important elements for the mitigation of the risk of landslides and flooding, Bari appears to have about 47% of vegetated area, both public and private, over the urbanised area in the period 2016-2020: this value suggests that there may be a potential for development and growth. The tree component accounts for 31% of the total green areas. As far as soil sealing is concerned, the indicators observed do not show a constant trend, but in the period 2015-2020 there were 22 ha of impermeable surfaces on natural (non-consumed) soil and 17 ha on already reversible consumed land, such as building sites or earthen surfaces.

The indicators observed for the health theme, i.e. the change in excess mortality of the population over 65 (%) (26% in 2019) and the number of heat wave alert days (7 in 2019), do not show a clear trend over the period 2015-2019.

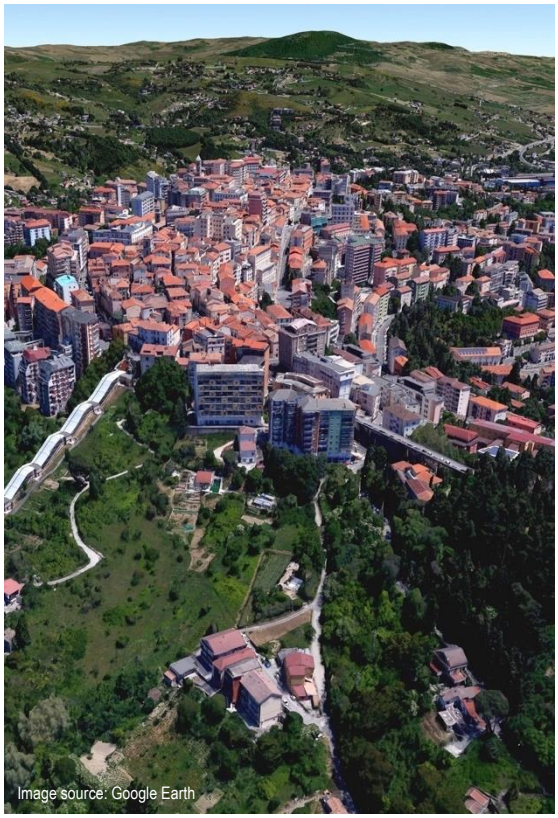
Finally, the indicators relating to the socio-demographic structure show a decreasing trend in terms of the percentage of the population aged 0-4 years, which rises from 3.8 % (2016) to 3.4 % (2020); on the contrary, there is an increase in terms of the percentage of the population aged 65 years and over, which rises from 23.2 % (2016) to 24.5 % (2020). These figures are both in line with the intermediate values of the sample. As in the case of most of the cities analysed, the upward trend of the over-65 population calls for adaptation policies aimed at enabling this demographic group in particular to better cope with the challenges posed by climate change.

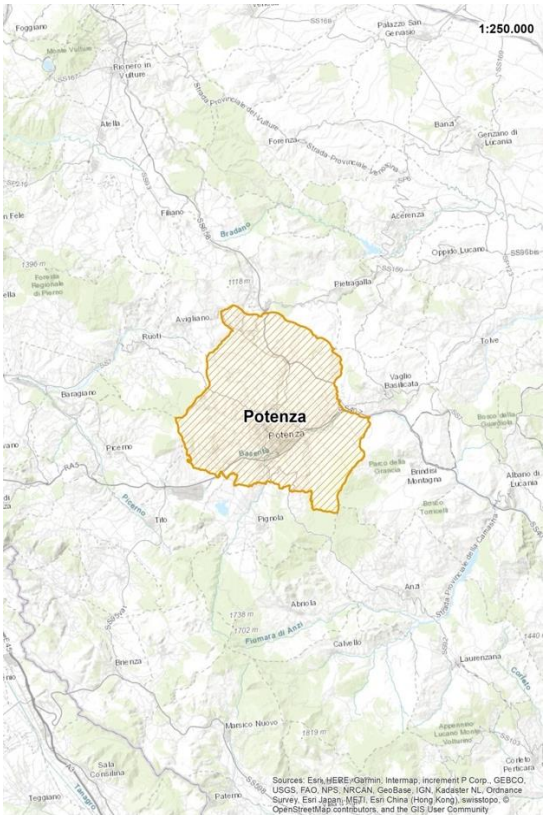
With an average income per taxpayer of €22,547 in 2018, Bari shows an intermediate level of wealth of the population compared to the sample with which, in terms of resilience, it is assumed that a suboptimal possibility of access to services, opportunities and information is therefore associated.



Summary Graph **Bari Resilience**

POTENZA





THE CONTEXT

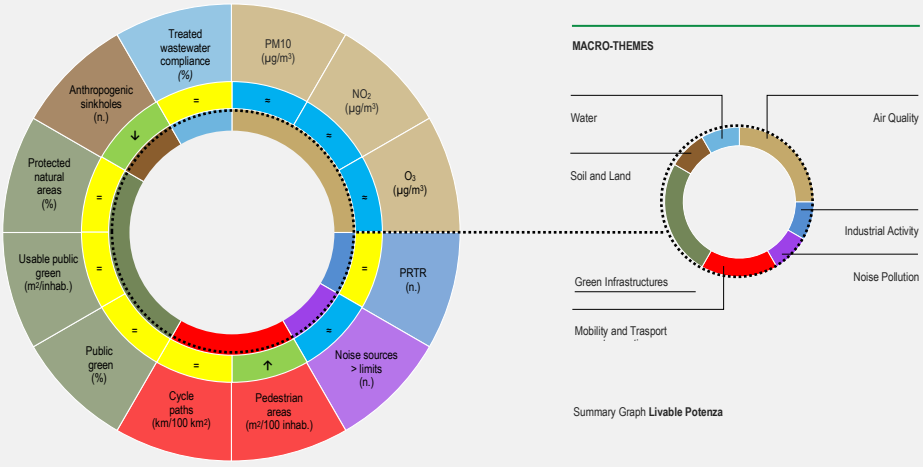
SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**66,393**
RESIDENT POPULATION 2015 (N)	**66,751**
POPULATION DENSITY (PEOPLE/KM²)	**378**
AVERAGE INCOME PER CAPITA (€)	**14,483**
GEOGRAPHICAL DATA	
LAND AREA (KM²)	**175.4**
ALTIMETRICAL ZONE	**INLAND MOUNTAIN**

POTENZA LIVABILITY - SUMMARY

An undoubtedly positive sign for Potenza in terms of livability concerns the availability of pedestrian areas, which, while remaining among the lowest values in the sample of 21 municipalities, increased from 2008 to 2016 and then remained constant until 2019, settling at 12.9 m^2/100 inhabitants. This figure is equal to +144.8% compared to 2008. The phenomenon of anthropogenic sinkholes seems to be limited: there were 9 events in the last decade, while in 2020 there were 2 episodes and in the first half of 2021 there were no events. Another stable situation concerns the percentage of purified wastewater that complies with emission standards, which is always above 90% with peaks of 100% in 2009, 2012 and 2018.

Green infrastructures are among the sectors where situations are stable, although improvable: both the density of public green areas on municipal territory (6% as of 2019, in line with the sample's intermediate figures) and the per capita availability of usable green areas, with about 27 m^2/inhabitant as of 2019, one of the highest values in the sample, remain virtually unchanged from 2015 to 2019. In terms of protected natural areas, the only Natura 2000 network site (SCI Monte Li Foi) present in the territory accounts for only 0.9% of the municipal territory, which is among the lowest values in the sample.

The number of PRTR establishments present in the municipal territory, in the 2015-2019 period, also remains constant and is equal to 2. Among the areas with room for improvement is the number of noise sources controlled with exceedances of regulatory limits, the trend of which in the 2015-2019 period appears to be fluctuating and in the last year shows a value of 3 sources with exceedances per 100,000 inhabitants. As far as air quality is concerned, there is no statistically significant trend for PM10, NO_2 and O_3 in the period 2013-2020; on the other hand, no exceedances of the annual limit value for PM10 (40 µg/m³) or of the daily limit value (50 µg/m³) were recorded in 2020, nor were there exceedances of the annual limit value (40 µg/m³) and the hourly limit value (200 µg/m³) for NO_2. In contrast, the long-term objective for O_3 of 120 µg/m³, calculated as the maximum daily value of the average O_3 concentration over 8 consecutive hours, was exceeded at all stations, while there were no exceedances of the information threshold (180 µg/m³) and alarm threshold (240 µg/m³). Finally, significantly more effective policies are needed on the issue of cycling: from 2011 to 2019, the density of bicycle lanes is, in fact, zero, the only case among the cities investigated.



Summary Graph **Livable Potenza**

POTENZA CIRCULARITY - SUMMARY

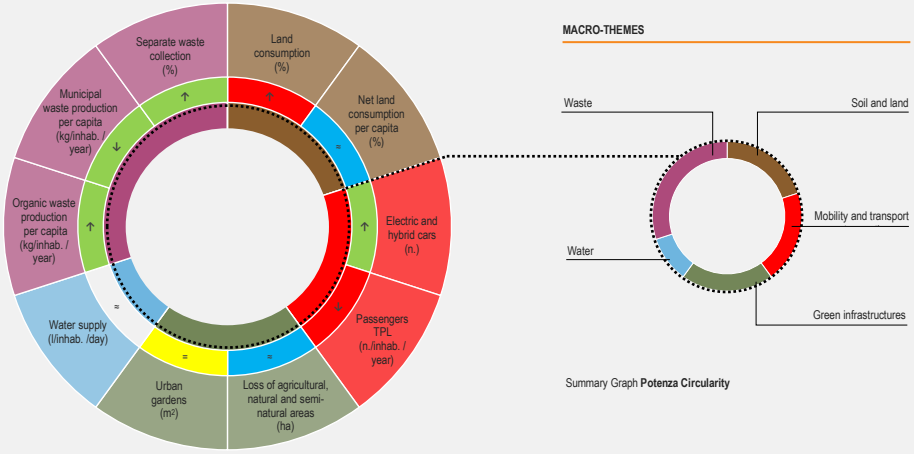
Potenza's progress on the road to circularity is witnessed by the exponential growth in the percentage of separate waste collection, which exceeded 64% in 2019, with an increase of 214.7% in the five-year period 2015-2019. It therefore reaches the most virtuous municipalities in the sample. Furthermore, the production of organic waste exceeded 100 kg/inhabitant in the same year, with an increase of over 10% in 2019 and medium-high values compared to the sample. In the five-year period considered, there is also a constant decrease in the per capita production of urban waste, with the exception of the last year (+4%): the values of this indicator are the lowest among those analysed in the sample.

Slight progress, albeit still rather limited, is seen in the mobility and transport sector where there is a slight increase in the share of electric/hybrid cars in the total: the values (less than 1%) are however still very low.

There is a slight increase in the trend of land consumption: although testifying to a less worrying situation than in the other contexts analysed (11% of the land area consumed on municipal territory between 2016 and 2020), it goes against the European target of zero soil consumption, and should therefore be monitored over time to ensure the protection of a non-renewable resource such as soil.

Signs of criticality are found in the demand for local public transport, which shows a significant contraction in the period 2016-2019, reaching a minimum value of 18.5 passengers per year/inhabitant in 2019.

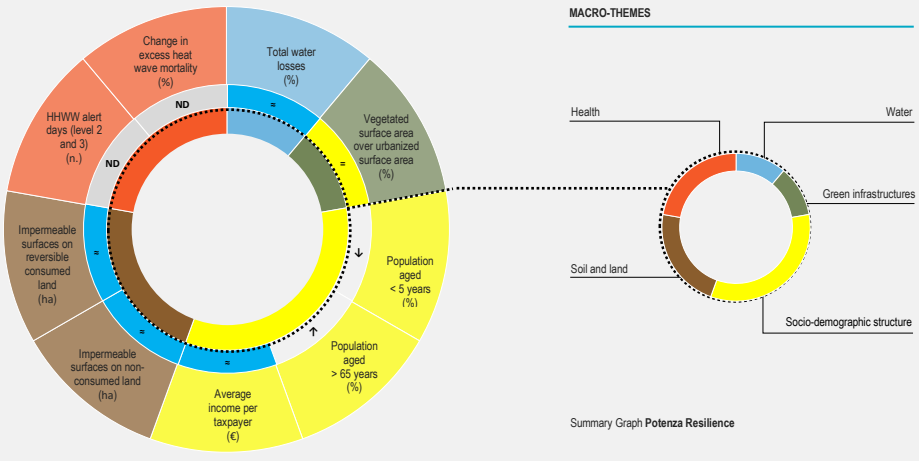
Finally, stable or variable without a clear trend are the following indicators: the loss of agricultural, natural and semi-natural areas which, since 2015, amounts to about 7 hectares of land per year on average with a non-linear trend; the area allocated to urban gardens which, with a total area affected of 3,900 m^2, remains constant until 2019 from 2014; and, finally, the water supplied per capita which stands at 233 l/inhabitant per day in 2018, higher than the national average of 215 l/inhabitant per day.



Summary Graph **Potenza Circularity**

POTENZA RESILIENCE - SUMMARY

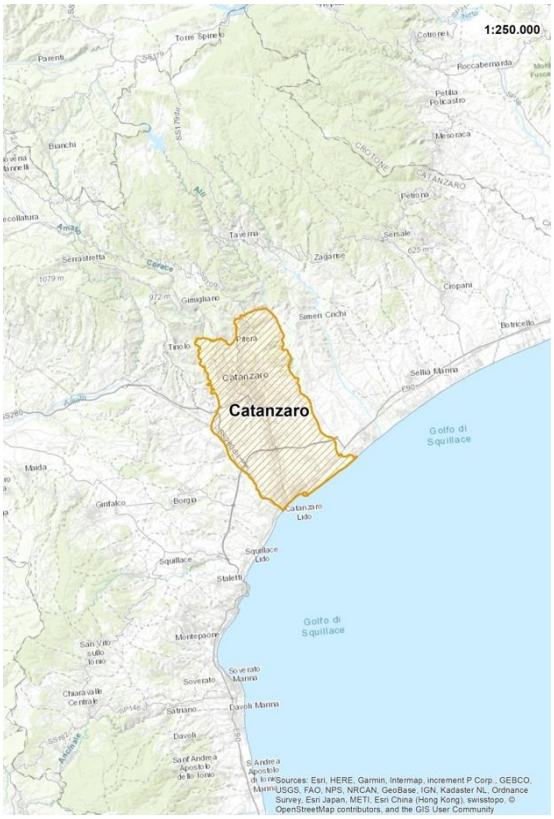
The analysis of the indicators selected for the purpose of understanding how Potenza is trying to respond in terms of resilience to climate change, sketches a picture consisting mostly of stationary or variable situations without a clear trend, although in some cases both critical and positive notes are identified. These include, first of all, a major problem with the drinking water distribution network: in fact it is characterised by considerable total network losses, with values that even reached 70% in 2015, making it one of the highest in the sample. In 2018, the indicator was 48.9%. With regard to green infrastructures, Potenza is among the regional capitals with the highest recorded percentage of vegetated surface, both public and private, in urban areas (70%), which has remained stable since 2016. Tree cover over vegetated surface area stands at 13% in line with the geographical characteristics of Basilicata. These indicators are very important in order to understand the territory's capacity to cope with potential risks from climate change and thus assess its resilience. On the subject of soil, in the 2016-2020 period, Potenza is among the municipalities in which the percentage of new impermeable soil on non-consumed land (natural areas) is lower: about 30% (equal to about 1.5 ha) of the new impermeable soil was on natural or semi-natural areas, while the remaining 70% (about 3 ha) involved areas that were already degraded. Finally, the indicators related to the socio-demographic structure show a situation consistent with the trends of the analysed municipalities: the percentage of the population aged 0-4 years shows a decreasing trend from 3.7% in 2016 to 3.3% in 2020; the percentage of the population aged 65 years and over, on the contrary, is increasing, recording a value of 23.6% in 2020. Adaptation policies that are more attentive, in particular, to older population groups are therefore needed, with the aim of increasing their resilience to climate-related hazards. The values recorded for the average income per taxpayer indicator, which marked its highest value in 2018 with €22,020, are among the lowest in the sample and show a fluctuating trend. The low level of wealth of the population thus accounts, in a resilience key, for more limited access to services, opportunities and information by the population.



Summary Graph **Potenza Resilience**

CATANZARO


Image source: Pixabay

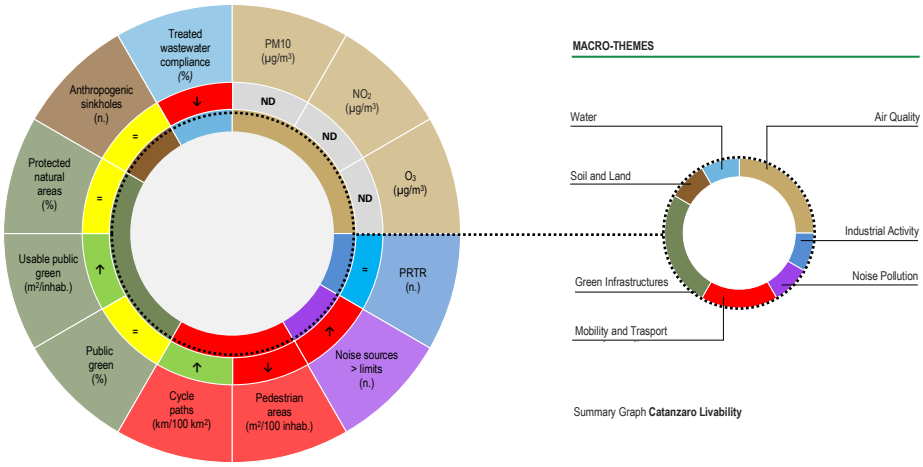


THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**87,397**
RESIDENT POPULATION 2015 (N)	**89,372**
POPULATION DENSITY (PEOPLE/KM^2)	**775**
AVERAGE INCOME PER CAPITA (€)	**12,340**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**112.7**
ALTIMETRICAL ZONE	**COASTAL HILL**

CATANZARO LIVABILITY - SUMMARY

Green space and sustainable mobility are the areas in which Catanzaro shows the most obvious progress in recent years.
Indeed, with 13.7 km/100 km^2 of land area, the density of cycle paths doubles in 2019, after a period of stability in 2011-2017, when this indicator was 6.6 km/100 km^2. Significantly more effective policies must be adopted on the issue of pedestrian mobility: from 2008 to 2016, the availability of pedestrian areas remained constant at around 1.5 m² per 100 inhabitants, the lowest figure observed among the 21 municipalities, before falling completely to zero in 2017 until 2019.
A positive note also for the per capita availability of usable public green space: in 2019 the municipality guarantees each resident citizen 13 m^2 of usable public green space, an increase of 2.2 m^2 compared to 2015 (+20%). Less linear is the trend in the number of PRTR establishments within the municipality, which fluctuates between zero and 2 in the period 2015-2019, to cancel again in 2019. A stable situation, which does not show any particular criticality and is in line with the average of the municipalities examined, is represented by the density of public green areas on the municipal surface, which remains substantially unchanged in the five-year period 2015-2019 and, as of 2019, is equal to 4.5% of the municipal surface, with a composition represented mainly by wooded areas. There are no protected natural areas.
The phenomenon of anthropogenic sinkholes is contained, with 15 events recorded in the last decade, a lower number than in other municipalities in Calabria. In the years 2018-2020 there is a constant trend; in 2020 three episodes were recorded and in the first half of 2021 no events have been recorded yet.
As far as air quality is concerned, the data series available for this municipality do not have sufficient numbers to carry out statistical trend analysis for PM10, NO_2 and O_3. Among the most significant critical issues is the trend in the percentage of purified wastewater complying with emission standards, which reached 85% from 2012 to 2016. However, in 2018 both purification plants serving the municipality were found to be non-compliant. Another area which needs more targeted policies concerns the noise sources monitored per 100,000 inhabitants that were found to exceed regulatory limits: in the years 2015-2019 the trend is increasing, reporting in 2019 as many as 9 cases of exceedance out of 14, which corresponds to an incidence of 10.3 sources with exceedances per 100,000 inhabitants. This value is the highest found within the sample of municipalities.



Summary Graph **Catanzaro Livability**

CATANZARO CIRCULARITY - SUMMARY

The analysis of the indicators selected in order to describe the path taken by Catanzaro towards a circular approach in the use of resources, returns a heterogeneous picture: lights and shadows in the waste sector, slight progress in mobility and transport, and areas requiring greater attention in terms of environmental policies.

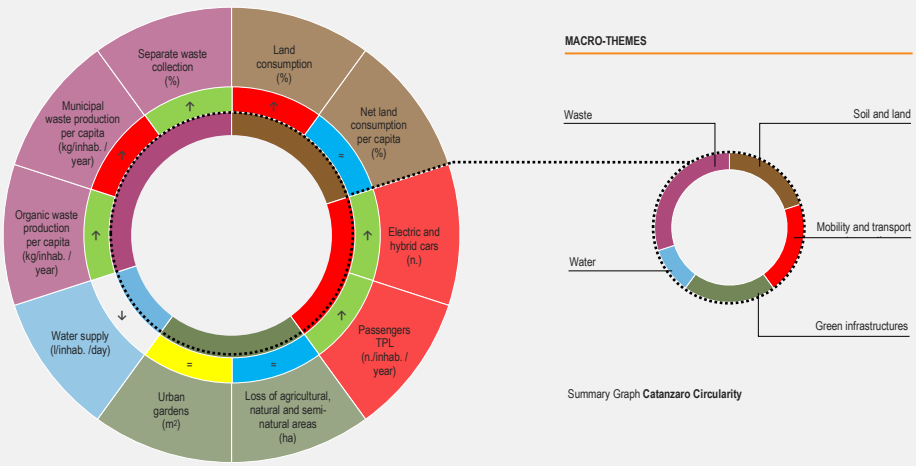
On a very positive note, the percentage of differentiated waste collection reached 67% in 2019, with an increase of 577.1% over the five-year period 2015-2019. These values allow Catanzaro to excel among the municipalities analysed. There was also slight growth in the per capita production of organic waste, which reached 132.8 kg/inhabitant in 2019: considering that in 2015 the collection of these fractions was practically nil, since 2016 there has been a steady increase to 2.2% in the last year, with medium-high values within the sample.

With regard to the per capita production of urban waste, Catanzaro shows the second lowest value in the sample: over the five-year period 2015-2019, production fell until 2017 and then rose again in the following two years, reaching a value of 420.4 kg/inhabitant (2019).

Looking at the data on land consumption, it is reported that the percentage of land consumed on municipal territory is slightly increase to around 19%, while net per capita land consumption goes from 1.5 m^2/inhabitant in 2016 to 0.3 m^2/inhabitant in 2020, with no significant change in population. Green infrastructures present potential areas for improvement, on which it will therefore be necessary to direct more careful policies. The first regards the creation of urban gardens, which are still not present in the urban territory while the second concerns the loss of agricultural, natural and semi-natural areas, which affected 14 ha, in the two-year period 2016-2017, to then settle at a value of less than 4 ha. Finally, it should be noted that between 2015 and 2020 13 ha of herbaceous agricultural land was replaced by artificial soil.

There is also room for improvement in the area of mobility and transport, where the selected indicators show an increase in demand for local public transport, which, however, remains at low values (49.5 passengers per year/inhabitant), and a limited presence of electric and hybrid cars, with an incidence of close to 1% of hybrid/electric cars on the total car fleet.

Finally, there is a significant reduction in the daily per capita supply of water for potable use, which at the beginning of the seven-year period 2012-2018 corresponded to 296 l/inhabitant/day while in 2018 it reached 230 l/inhabitant/day.



Summary Graph **Catanzaro Circularity**

CATANZARO RESILIENCE - SUMMARY

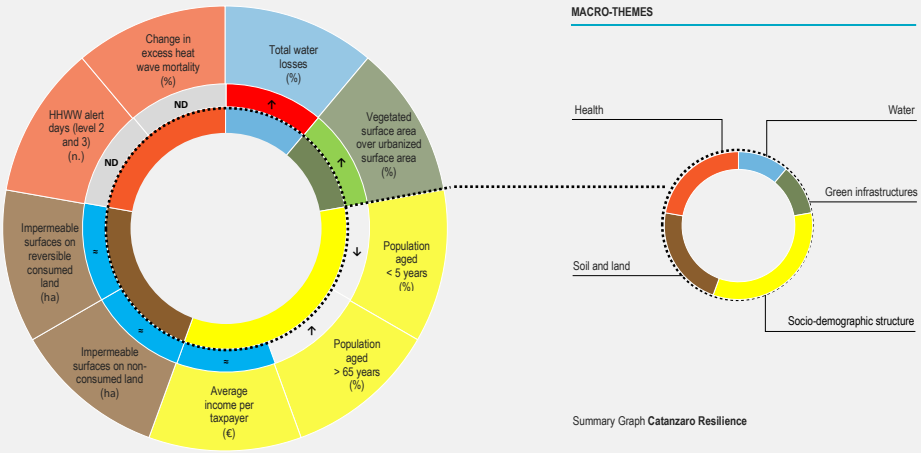
The improvements recorded in terms of resilience to climate change relate in particular to the issue of green infrastructures: the percentage of public and private vegetated area rises from 63% to 64% over the period examined (2016-2020), with tree cover reaching 46% of the total vegetated area in 2018. The presence of vegetated and permeable surfaces plays a key role on the resilience front, as they help reduce the risk of flooding and mitigate urban heat islands.

On the other hand the condition of the water infrastructures is rather critical, as it is characterised by heavy total water losses in distribution with values exceeding 50% throughout the 2012-2018 period. In 2018 Catanzaro, with 57.8% of total losses, is the regional capital with the highest value of the indicator within the sample.

With regard to the topic of soil and land, it should be noted that between 2015 and 2020, approximately 3 ha of soil were sealed, 2 of which concern natural areas and 1 relates to areas already consumed in a reversible manner such as, for example, construction sites or rammed earth surfaces. In addition, in 2017 there was a flooding event that brought to light some of the territory's fragilities with respect to intense rainfall, causing geomorphological and hydraulic disruptions that involved the city area and caused the rupture of the Santa Domenica municipal aqueduct.

The indicators relating to the socio-demographic structure, the percentage of the population aged 0-4 years and the percentage of the population aged 65 years and over, both of which characterise population groups that are particularly sensitive to climate change, reflect national trends, with the former decreasing (from 4.1% in 2016 to 3.9% in 2020) and the latter increasing (from 20.9% in 2016 to 22.6% in 2020). Therefore, the greatest efforts should be concentrated on the older population groups in order to contain the possible impacts that extreme weather and climate events could cause in the near future.

The average income per taxpayer indicator, which provides an indication of the population's wealth, to which the degree of access to services, opportunities and information is correlated, in a resilience perspective, reaches its highest value of €20,864 in 2018. However, this figure remains, throughout the period, among the lowest values within the sample.



Summary Graph **Catanzaro Resilience**

PALERMO


Image source: Pixabay

THE CONTEXT

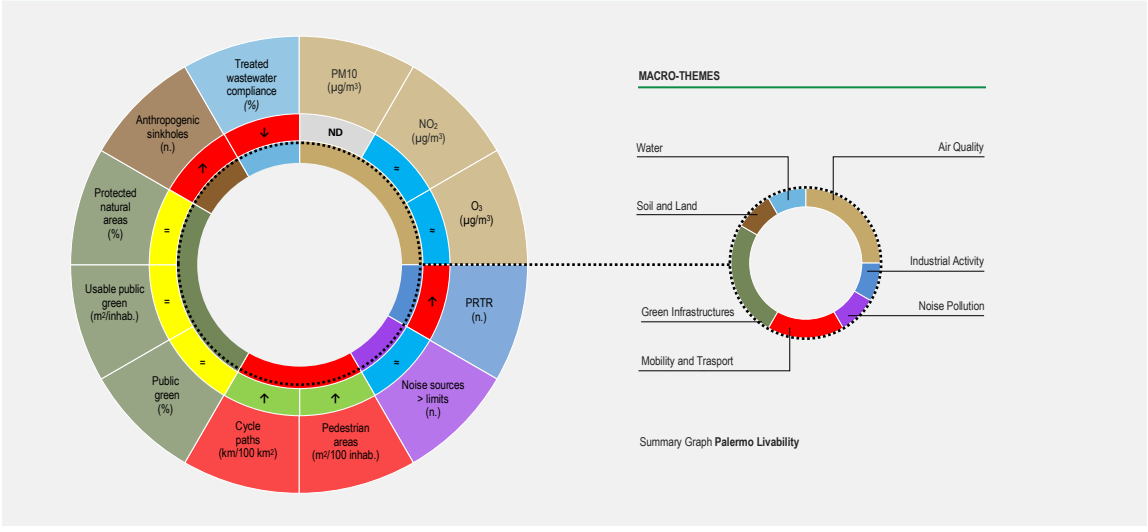
SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**647,422**
RESIDENT POPULATION 2015 (N)	**661,091**
POPULATION DENSITY (PEOPLE/KM^2)	**4,032**
AVERAGE INCOME PER CAPITA (€)	**11,310**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**160.6**
ALTIMETRICAL ZONE	**PLAIN**

PALERMO LIVABILITY - SUMMARY

The picture of livability in Palermo shows interesting progress on the issue of mobility, with an increase in the supply of infrastructures for soft mobility, so beneficial to the environment and health: the density of bicycle paths more than doubled from 2011 to 2019, when there were 29.4 km of paths/100 km^2 of land area, while from 2008 to 2019 the availability of pedestrian areas increased tenfold, reaching 60.4 m^2/100 inhabitants, one of the highest values compared to the other municipalities observed. The incidence of protected natural areas on the municipal surface show a stable situation over the 2015-2019 period, but at medium-high values: the municipality protects about 30% of its territory thanks to the presence of 7 Natura 2000 network sites and the Monte Pellegrino Oriented Nature Reserve (over 1000 ha). Stationary, and in line with the intermediate values of the sample, is also the density of public green areas on the municipal surface equal to about 5% in the five-year period 2015-2019. The per capita availability of usable public green space also remains constant at about 11 m^2/inhabitant, a value that is low compared to the sample and which highlights the need for policies aimed at increasing the presence of accessible green spaces for the psycho-physical wellbeing of the population. In the area of noise pollution in the years 2015-2019, the trend in the number of noise sources checked per 100,000 inhabitants that were found to be above the limits appears to be fluctuating; in 2019, 17 sources were found to have critical noise levels out of a total of 55 checked. An area in which, on the other hand, more incisive policies are desirable concerns the treatment of urban waste water: in 2009, the entire organic load was found to be non-compliant with emission standards, but from 2012 to 2016 there was an improvement with a percentage of purified waste water that complied with emission standards of 27%, which then fell to 5% in 2018, a value that is among the lowest in the sample of 21 cities analysed.

Also the issue of anthropogenic sinkholes deserves attention, as it is mostly due to the presence of underground cavities underneath the historic centre, in addition to dysfunctions in the underground utilities network: over the last decade, there have been more than 60 such sinkholes. On the industrial activities front, the number of PRTR establishments present within the municipal territory rises from 2 to 4 in the 2015-2019 period.

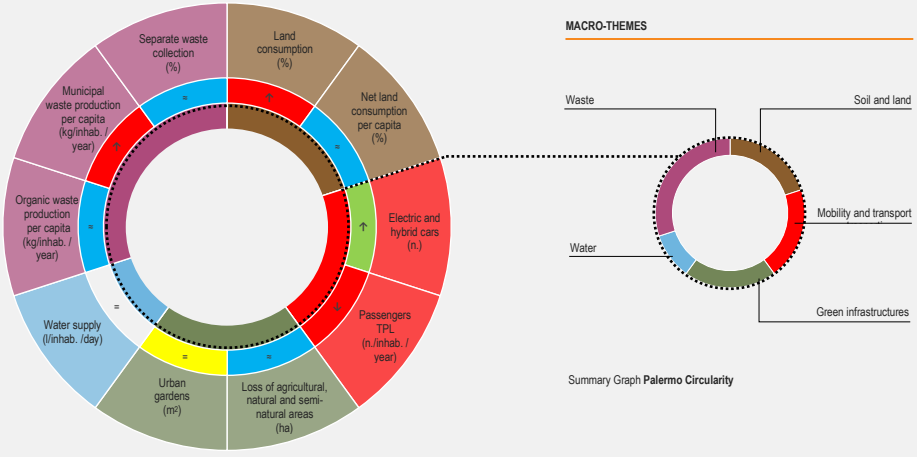
With regard to air quality, the background trend for NO_2 and O_3 over the period 2013-2020 is not statistically significant. In addition, the available data series of PM10 did not have sufficient numerosity to carry out a statistical trend analysis.



Summary Graph **Palermo Livability**

PALERMO CIRCULARITY - SUMMARY

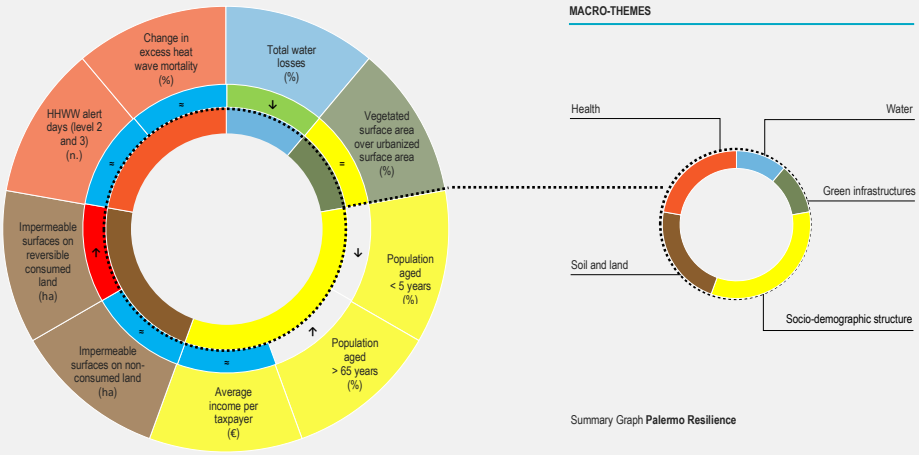
More critical than positive performance is observed for Palermo on the circularity front. Mobility and transport sector show an albeit slight improvement, with the incidence of electric/hybrid cars on the total car fleet rising from 0.1% at the end of 2015 to 0.8% at the end of 2020.
On the other hand, demand for local public transport is decreasing, albeit discontinuously (-15.4% in 2019 compared to 2011), which stands at 38.7 passengers per year/inhabitant, a value in line with the lowest recorded within the sample of the 21 municipalities considered.
For the area relating to land and territory, there is no clear trend in net land consumption per capita, while around 40% of the land consumed on the municipal surface over all the reference years makes Palermo one of the regional capitals with high average values.
In terms of green infrastructures, there is no increase between 2011 and 2019 in the areas allocated to urban gardens (3 ha), which represent areas of growing value for the shared and sustainable use of green spaces, and there is a loss of agricultural, natural and semi-natural areas, concentrated mainly in urban areas, equal to 38 ha in the years 2015-2020.
In the municipal drinking water distribution network, over the 2012-2018 period, the per capita volume of water daily supplied for authorised uses is always lower than the national value (215 l/inhabit/d), standing at 175 l/inhabit/d in 2018, the lowest value among the regional capitals. There are also lights and shadows on the waste front: the per capita production of urban waste grows over the five-year period 2015-2019 to reach 583.1 kg/inhabitant/year in 2019, while there are no clear trends for separate waste collection, at 17.4% in 2019, among the lowest values in the sample considered. The per capita production of organic waste is also increasing (40.1 kg/inhabitant/year in 2019): for this indicator, Palermo is among the lowest values in the sample.



Summary Graph **Palermo Circularity**

PALERMO RESILIENCE - SUMMARY

Critical, from the point of view of resilience, but slightly improving, is the situation regarding the percentage of water losses. Although this value is above 45% for the entire 2012-2018 period, in the last year the percentage reached the lowest in the analysed series (45.7%).
There are several areas where there is room for improvement. In the case of soil and land, it should be noted that between 2015 and 2020, 18 ha of soil were sealed, affecting in particular 10 ha of natural or semi-natural areas. It is important to point out that two particularly significant storm events which occurred in Palermo between 2019 and 2020, respectively, brought to light some of the territory's fragilities with respect to heavy rainfall. In addition to causing heavy damage to road infrastructure, homes and businesses, as well as blocking the historic centre, the 2020 event claimed two victims. Another area where substantial progress is desirable is that of greenery - both public and private - which plays an important role both in terms of thermoregulation and mitigation of high temperatures, and in reducing the risk of hydrogeological instability. On this front, throughout the five-year period 2015-2019 Palermo recorded a stable incidence of vegetated areas of about 42% over the urban area, in line with the lowest values found in the sample.
Finally, in the five-year period 2015-2019 there was a concomitance of a higher excess mortality of the over-65 population in the years with a higher number of heat wave alert days, +20% in 2017 and +13% in 2015, respectively. Considering the demographic trend towards an increase in the percentage of the population > 65 years of age, rising from 19.5% (2016) to 21.2% (2020), albeit among the lowest values in the sample, there is a need to prepare measures aimed at protecting this category against the expected increase in extreme events due to climate change such as heat waves. On the contrary, the percentage of the population < 5 years of age is decreasing over the period 2016-2020, standing at 4.3% in the last year.
With an average income per taxpayer of €21,244 in 2018, Palermo shows a low level of wealth compared to the sample of municipalities which suggests, in terms of resilience, a more limited possibility of accessing services, opportunities and information related to climate change.



Summary Graph **Palermo Resilience**

CAGLIARI

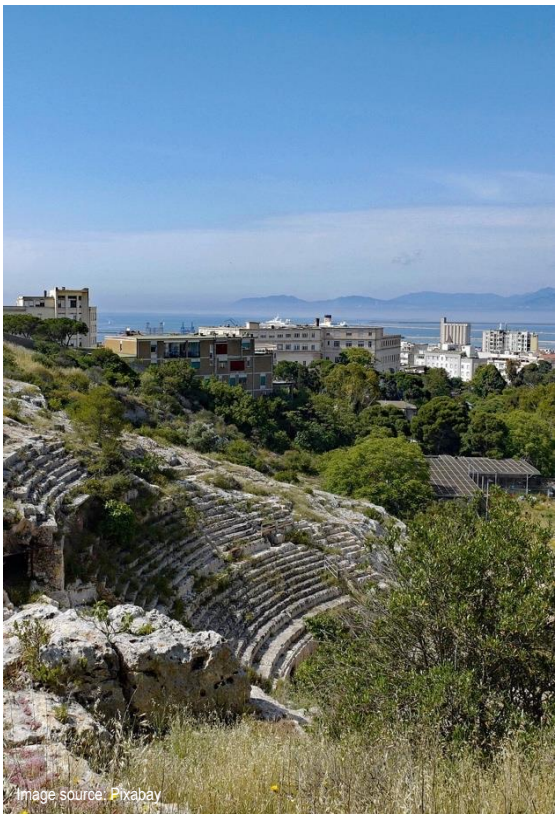


Image source: Pixabay

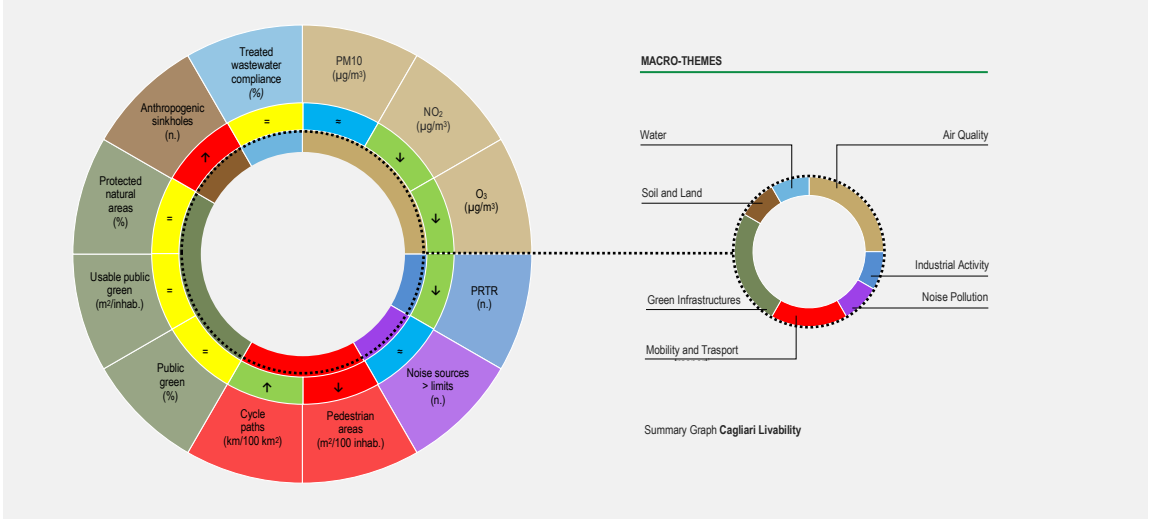
THE CONTEXT

SOCIO-DEMOGRAPHIC DATA	
RESIDENT POPULATION 2020 (N)	**151,005**
RESIDENT POPULATION 2015 (N)	**151,959**
POPULATION DENSITY (PEOPLE/KM^2)	**1,785**
AVERAGE INCOME PER CAPITA (€)	**17,592**
GEOGRAPHICAL DATA	
LAND AREA (KM^2)	**84.6**
ALTIMETRICAL ZONE	**PLAIN**

CAGLIARI LIVABILITY - SUMMARY

The first positive data on Cagliari's livability front refers to air quality, which shows decreasing, and statistically significant, trends in the values of average O_3 and NO_2 concentrations. In particular, for NO_2 in 2020 there were no exceedances of the annual limit value (40 µg/m³) and the hourly limit value (200 µg/m³) was never exceeded. For O_3 in 2020 there were no exceedances of the long-term objective of 120 µg/m³, calculated as the daily maximum value of the average ozone concentration over 8 consecutive hours, the information threshold (180 µg/m³) and the alert threshold (240 µg/m³). For PM10, the underlying trend appears essentially monotonic and inter-annual fluctuations are attributable to the natural fluctuations of the seasonal component. In 2020, neither the annual limit value (40 µg/m³) nor the daily limit value (50 µg/m³) was exceeded. The supply of infrastructure dedicated to cycling is on the rise: the density of cycle paths has grown significantly since 2011, when 7.8 km/100 km² were recorded, to almost quadruple in 2019, reaching 30.6 km/100 km². In terms of industrial activities, the number of PRTR establishments at municipal level decreased by 75% in the period 2015-2019.

The situation is steadily positive for the percentage of purified wastewater meeting emission standards, which is always above 98%. On the green infrastructures front, the values of the indicators observed are very high, although constant over the 2015-2019 period: the density of protected natural areas, equal to 51.6%, the density of public green areas, equal to 10% and constant from 2015 to 2019, and the availability of usable green areas, which stands at 25.7 m²/inhabitant in 2019.
With regard to noise pollution, in the municipal territory, 5 service and/or commercial activities were monitored by ARPA following citizen complaints/reports in 2019. In all cases, exceedances of regulatory limit values were detected, resulting in an incidence of sources with exceedances on the population per 100,000 inhabitants of 3.3, lower than the average value of 5.3 calculated over the 2015-2019 period.
Among the critical issues encountered is, in particular, a very high number of anthropogenic sinkholes, which amounted to 92 in the last decade. More incisive policies are also needed to reverse the trend in the availability of pedestrian areas, which decreases by 33.7% over the period 2008-2019, to 64.3 m²/100 inhabitants (2019). These are, however, high values within the sample.



Summary Graph **Cagliari Livability**

CAGLIARI CIRCULARITY - SUMMARY

Cagliari's improvements on the circular economy front concern several areas, in particular waste, mobility and transport.

Regarding the former, the indicators paint a virtuous picture as they show an overall decrease in per capita urban waste production in the 2015-2019 period of 18.4%. In the last year, the reduction was considerable, and amounted to approximately 100 kg/inhabitant, standing at 474.1 kg/inhabitant, a figure that is among the lowest in the sample.

Differentiated waste collection increased over the same period by 117.6%, reaching 64.3% in 2019, which is among the medium-high values of the sample. Finally, the per capita production of organic waste also rose by 85.5% over the period, reaching 143 kg/inhabitant in 2019. These are, in this case, high values within the sample.

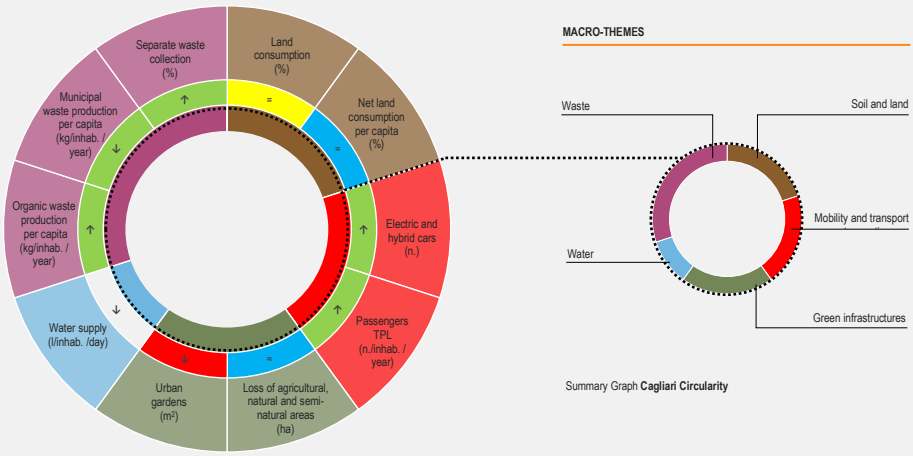
The overall picture is also positive with regard to mobility: demand for local public transport grows discontinuously from 2011 until 2018 and then shows a significant leap in 2019, up 32% compared to 2011, to 211.6 passengers per year/inhabitant, the highest value among the municipalities of the South.

The share of electric and hybrid cars is also growing, from 0.2 per cent in 2015 to 1.5 per cent in 2020, representing the highest values among southern municipalities. The trend of areas destined for urban gardens, important places for socialising and sharing resources, is decreasing: from 2013 to 2015, ISTAT data indicated the presence of 875 m^2 of urban gardens, while in 2019 the initiative is no longer declared.

There is also no clear trend in the loss of agricultural, natural and semi-natural areas, which follows a non-linear trend over time, with the highest value recorded in 2017-2018 and equal to 10 ha of agricultural, natural and semi-natural areas lost; in 2020 the value recorded (0.4 ha) is among the lowest among the 21 municipalities analysed.

Finally, the percentage of land consumed on municipal territory remained substantially stable at 42% for the entire historical series under examination, a medium-high value compared to the other municipalities considered.

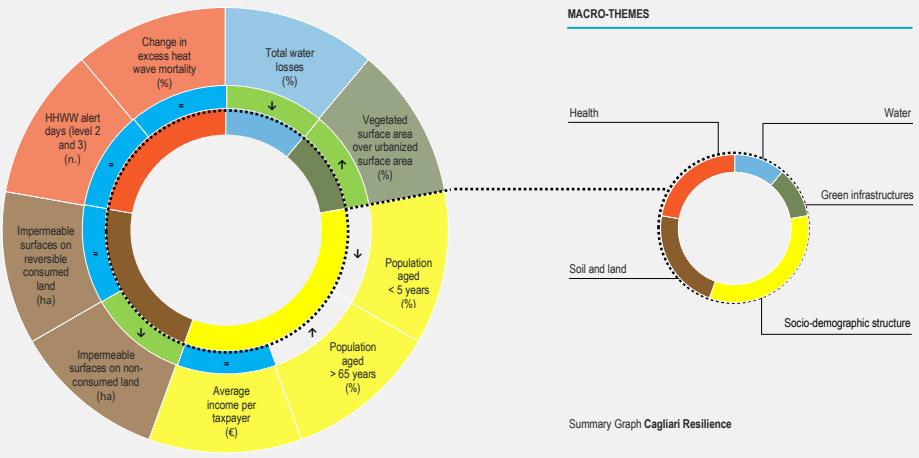
On the water resource front, the daily per capita supply of water for drinking purposes has undergone a significant reduction in the period 2012-2018, starting from 2015 (251 l/inhabit/d). In 2018, this value is 246 l/inhab/g while at the beginning of the seven-year period it was 274 l/inhab/g.



Summary Graph **Cagliari Circularity**

CAGLIARI RESILIENCE - SUMMARY

The indicators analysed to outline the municipality's ability to cope with climate change and its impacts, return a picture characterised by slight improvements in different areas. In the 2012-2018 period, the percentage of water losses denotes considerable losses in distribution, with values always above 50%. This figure makes Cagliari particularly vulnerable to water resource management during drought periods. However, there has been a downward trend since 2015, with the lowest value in 2018 (54.7%). The percentage of vegetated area over urbanised area also shows a positive trend, rising from 33% in 2016 to 36% in 2020, although the values remain among the lowest in the sample. With regard to soil sealing, 7 ha of soil was sealed between 2015 and 2020, including 3 ha of natural or semi-natural areas. The sealing of non consumed land is decreasing over time. In recent years the values are in line with the lowest values found in the sample. In 2016 and 2020, there were two particularly significant flooding events in the Cagliari area, which highlighted some of the area's fragilities in relation to particularly heavy rainfall with damages caused in the airport area (2016) or the flooding of roads, shops and basements (2020). On the subject of health, the trend of the indicators does not show a clear correlation in the five-year period 2015-2019. The indicator excess mortality variation of the population over 65 (%) shows the highest values in the years 2015 and 2019 (11%); the indicator number of heat wave alert days shows a decreasing trend in the last two years analysed (4 days in 2019). The indicators related to the socio-demographic structure, such as the percentage of population aged 0-4 years and the percentage of population aged 65 years and over, which characterise population groups that are particularly sensitive to climate change, reflect national trends. The former decreases from 3% in 2016 to 2.6% in 2020 and the latter increases from 26.5% in 2016 to 27.9% in 2020. As the risk associated with extreme weather events increases, the need to implement policies to protect the most fragile groups becomes more pressing. The average income per taxpayer indicator (€25,887 in 2018), which provides information on the wealth of the population, to which the degree of access to services, opportunities and information is correlated, places Cagliari in a medium-high position compared to the sample of municipalities.



Summary Graph **Cagliari Resilience**

PART III
DISCUSSION AND CONCLUSIONS

From the analysis of the results, a heterogeneous picture emerges that certainly reflects the local peculiarities characterising the different urban realities, while also highlighting specific trends that are prevalent in all - or almost all - of the territories observed. The information obtained from reading the data is twofold, since, on one hand, trends indicating the evolution of a given phenomenon over the period of time considered can be deduced, and on the other, it is possible to appreciate the values of the individual municipality in relation to the other realities considered. The assessment of trends depends on the nature of the indicator itself: both indicators for which high values correspond to favourable conditions (HiB or 'higher is better') and indicators for which favourable conditions are found with low values (LiB or 'lower is better') were analysed. In addition to these aspects, it is also necessary to consider the values of the indicators in relation to a given situation, since - for example - stability in a trend may mean unchanged criticality or, on the contrary, constant optimal conditions, depending on the values at which the indicator is found for a given municipality; a worsening trend in a phenomenon may, on the contrary, be more or less worrying depending on whether it concerns higher or lower values. An example of this is the trend of the total water loss indicator: the municipality of Palermo shows an improving trend (down arrow and green colour in the ring graph) but with values that still denote important and heavy losses higher than the national figure (42% in 2018) and reaching 45.7% in 2018 (the lowest value in the series). This situation could be more worrying than in a municipality such as Bozen, for example, which, despite being marked by an up arrow and red colour, still remains below the national figure.
In order to understand whether the direction taken by the Italian capitals is consistent with respect to the goals of environmental sustainability, a reading of the results with reference to the goals and/or targets of the UN 2030 Agenda is presented below, where possible.

Livability

Target 11.6 - *By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.*

Air quality seems to show some positive signs, with trends of atmospheric particulate matter (PM10) and nitrogen dioxide (NO_2) statistically decreasing significantly in many of the towns monitored. Less favourable is the situation for ozone (O_3), resulting from precursor pollutants associated with car traffic, combustion processes and volatile organic compounds, which shows a fluctuating trend in most municipalities.

However, it should be emphasised that the reference values for short-term and/or long-term exposure to all the above-mentioned pollutants, updated in 2021 by the World Health Organization (WHO), are exceeded in all of the monitored municipalities. In fact, the WHO wanted to give a strong impetus to the identification and adoption of more ambitious and structural actions aimed at reducing the pollutants that are still associated with very high values of pathologies or premature deaths. The European Commission recently identified the target to be pursued by 2030 as part of the 'zero pollution strategy': to reduce the number of premature deaths attributable to air pollution by 55% compared to 2005. This implies reaching and respecting the levels indicated by the WHO in the recent revision of the air quality guidelines. Although we have embarked on a path of continuous improvement in air quality, it is evident how far we still are from achieving conditions that can guarantee greater safety for the health of the population.
The sectors on which action needs to be taken in an integrated manner, on a local, regional and national scale, are those of energy production, civil heating, transport, energy efficiency of buildings, agriculture and animal husbandry. The source of pollutant emissions linked to industrial activities must also be considered, which, even when not located within municipal administrative boundaries, can exert environmental pressure on surrounding areas. In the period 2015-2019, the number of establishments in the PRTR register in municipal areas shows increasing values, albeit in limited cases, such as in Bozen, Trento, Venice, Genoa, L'Aquila and Palermo. This does not necessarily mean that the pressure on the urban environment is increasing, since this condition mostly depends on the type of plant or on an increased awareness of operators regarding the legal obligation. However it does however account for an increase in the possible sources of pollutants of industrial origin within urban realities or in the surrounding area. The challenge in this case is to

always guarantee the use of BAT (Best Available Technology) in the management of the plants, in compliance with the prescriptions, in order to minimise any environmental impact associated with the operation of the plants themselves.

Target 6.3 - *By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.*

The percentage of purified wastewater complying with the emission parameters in relation to the load generated by the agglomeration or agglomerations corresponding to the city shows a situation of substantial stability at almost optimal values in most of the municipalities analysed. In some cases, there are also tendencies to improve over the period considered: Venice exceeds 90% in 2018 while remaining among the low values in the sample, Trieste reaches 74% in 2018 while remaining at low percentages, Genoa shows improvements although at already high levels, Ancona, Florence and Perugia reach the mid-range of the sample, with the latter reaching almost total compliance from 2014 to 2018, Naples reaches 93% in 2018 which brings it close to the mid-range of the sample and Bari reaches 78% in 2018 while remaining among the lowest values in the sample. More critical situations are, on the other hand, recorded in Catanzaro where, from 85% of purified wastewater complying with the emission standards between 2012 and 2016, there is non-compliance of both purification plants in 2018, and in Palermo where the lowest values are found compared to the sample of cities analysed (only 5% compliant in 2018).

Target 3.6 - *By 2020, halve the number of global deaths and injuries from road traffic accidents.*

Target 11.2 - *By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.*

It is undoubtedly the area of mobility and transport that is making the most obvious progress in recent years within the key of livability.

On the soft/active mobility offer front, important progress has been recorded in most of the realities observed: regarding the density of bicycle lanes, with the exception of Campobasso, the only data in countertendency with respect to the sample with decreasing values from 2011 to 2014 and a zeroing until 2019, Rome which records a non-linear trend with an overall decrease in the period (-2, 4%) and Potenza, which recorded a zero value for the entire period, a positive upward trend prevails in the sample, with Turin showing the most virtuous picture in 2019 with 166 km of cycle paths per 100 km^2 of surface area, followed by Milan and Bozen, both with more than 100 km of cycle paths per 100 km^2 of surface area in the same year. The significant progress made by many cities in the investigated period (2011-2019) should also be noted: Genoa increased its endowment tenfold, although it still remains at decidedly low values (5.5 km/100 km^2), Cagliari quadrupled with 30.6 km/100 km^2, Bari showed values almost three times those of the three-year period 2011-2013 (26.4 km/100 km^2), Florence, Catanzaro and Palermo doubled their values compared to 2011. Finally, the number of bicycle lanes recorded in 2019 in Perugia (3.5 km/100 km^2), Ancona (3.6 km/100 km^2) and L'Aquila (1.4 km/100 km^2) is still very low.

With regard to the availability of pedestrian areas, favoured by its particular geography, it is Venice that leads by far with 510 m^2/100 inhabitants (2019). Florence is also an exception, the only case in which values exceed 100 m^2/100 inhabitants, reaching 110.8 in 2019. By contrast, all the remaining municipalities in the sample remain well below the threshold of 100 m^2/100 inhabitants, with values below 10 m^2/100 inhabitants only for Genoa (7.6 m^2/100 inhabitants) and Aosta (5.9 m^2/100 inhabitants). The trends are, however, in most cases towards an increase in pedestrian areas in the period from 2008 to 2019: Palermo increases its endowment tenfold, settling at 60.4 m^2/100 inhabitants, Trento registers an increase of 495.4% since 2008 (52.4 m^2/100 inhabitants) and Bari registers +227.8% in the decade analysed (53.8 m^2/100 inhabitants). On the other hand, the trends in Bozen (-7.6%), Rome (-7.9%), Catanzaro (-100%) and Cagliari (-33.7%) are in contrast as a decrease in pedestrian areas in the period considered is noted.

The offer of so-called soft mobility, intended to encourage citizenship to pedestrian and bicycle travel, and therefore sustainable, is by now becoming a reality

in the daily lives of city dwellers: supporting this form of mobility more and more is certainly one of the main challenges for city governing bodies as it stems from the urgency to contain the harmful emissions generated by urban vehicular traffic and to promote the psycho-physical well-being of the population.

Target 11.7 - *By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.*

With regard to public green areas, considered in the context of livability for the psycho-physical benefits they offer citizens, such as reducing anxiety and stress, improving moods, stimulating sociability and physical exercise, as well as a more adequate air quality thanks to the pollutant filtering capacity of vegetation, the situation is essentially stable, with a density of public green areas often not exceeding 5% of the municipal territory, and with maximum values of around 30% in Trento, which naturally has a significant woodland heritage. In 2019, besides Trento, only Turin (15.3%), Trieste (14.6%) and Milan (13.8%) exceed the 10% threshold. On the other hand, the percentages for L'Aquila (0.4%), Campobasso (1%), Perugia (2.3%) and Bari (2.5%) remain particularly low.

In most cases, the picture described by the availability of usable public green space is also stable, with the highest values recorded in 2019 in Venice (39.5 m^2/inhabitant), Ancona (35.7 m^2/inhabitant) and Perugia (32.8 m^2/inhabitant) and values of less than 10 m^2/inhabitant found in Genoa (6.1 m^2/inhabitant), Bari (8.5 m^2/inhabitant) and Naples (8.9 m^2/inhabitant). Of particular note is the +20% increase recorded in Catanzaro, which guarantees each citizen 13 m^2/inhabitant in 2019, an increase of 2.2 m^2/inhabitant since 2015.

Finally, the values of the incidence of protected natural areas on the municipal surface are also unchanged, confirming almost zero values for Milan and Catanzaro, while percentages above the 50% threshold in 2019 are recorded for Venice (62.8%), Cagliari (51.6%) and L'Aquila (50.1%).

The indicators analysed for the purpose of characterising the green component useful for making our cities more livable do not show significant progress, as the UN Agenda for Sustainable Development and the European Biodiversity Strategy to 2030 would instead require .

Hopefully, the recent ministerial programmes for urban and peri-urban forestation promoted by the Ministry of Ecological Transition - as well as those for the protection and enhancement of urban and extra-urban greenery that will be financed by the National Recovery and Resilience Plan - can contribute to increasing the natural capital of Italian cities.

Target 11.5 - *By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.*

Target 1.5 - *By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.*

Anthropogenic sinkholes represent an issue in the territory of our cities, i.e. soil sinkholes that cause the formation of chasms of even considerable metric dimensions (e.g. 1 m deep by 1 m in diameter). They can cause damage to infrastructures and the built heritage with sometimes even loss of life. Turin, Milan, Genoa and Bologna in the north, Rome and Perugia in the centre, Cagliari, Naples, Bari and Palermo in the south have recorded the highest number of these events in the last decade. With an average of 100 events per year and a total of 1,088 events since 2010, Rome has won the title of chasm capital of Italy and Europe, also due to the large size of its territory: here, the main cause is the presence of underground cavities, mostly quarries for the extraction of building materials, which form a network beneath the urban fabric and are often not reclaimed after use. In Naples, which follows Rome in terms of the number of sinkhole events in the decade (305), the main cause is attributed to the presence of underground cavities created for the extraction of Campania's yellow tufa, which is superimposed, as a concomitant cause, by the dysfunction of underground utility networks.

In other cases, anthropogenic sinkholes are linked to runoff from the ground below the road surface due to

inadequate underground utility networks (e.g. water leaks from pipes).

No target

Some situations in which there was a significant increase in the number of noise sources monitored with exceedances of the legal limits per 100,000 inhabitants in the 2015-2019 period (e.g. in 2019 Catanzaro reached a value of 10.3, Trieste 5.5 and L'Aquila 4.3). However, all the remaining municipalities in which stable or fluctuating situations have been recorded but which are still in a high range compared to the sample (e.g. Bozen, Perugia, Aosta) must be considered.

Circularity

Target 6.1 - *By 2030, achieve universal and equitable access to safe and affordable drinking water for all.*

While access to safe and affordable drinking water is certainly a guaranteed goal in all our cities, the level of water consumption is the indicator to be observed from the perspective of circularity. Although a reduction is generally desirable, the variation over time in the indicator of water supplied per capita, and in particular its decrease, cannot be traced with certainty to a 'circular' change in the consumption style of end users, as it is linked to other factors including, for example, the use of different methodologies both in the calculation of unmeasured volumes and in the metering systems, a possible contraction of non-residential users present in the urban fabric, the adoption of rationing measures. In the sample analysed, there is a general downward trend in the water supplied per capita, except for Campobasso (+40% approx.), Aosta (+10% approx.) and Potenza (+7% approx.) for which an increase from 2012 to 2018 is found. Although steadily decreasing, the values of water delivered per capita for Milan in 2018 (365 l/inhabitant/day), L'Aquila (336 l/inhabitant/day) and Venice (318 l/inhabitant/day) remain quite high, while the figures for Palermo (175 l/inhabitant/day), Perugia (185 l/inhabitant/day), Bari 187 l/inhabitant/day) and Florence (200 l/inhabitant/day) are lower in the same year than the national value of 215 l/inhabitant/day.

With the demographic increase, and the consequent increase in demand, and the climate crisis that threatens its availability, the water resource is under increasing stress: water saving, reuse and re-use are the imperative response to a management that is not always sustainable and represent the pillars of the necessary paradigm shift towards a circular approach.

Target 11.2 - *By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.*

As already highlighted for the 'livability' key, also in terms of circularity there is clear progress in the mobility and transport sector. The percentage of electric and hybrid cars out of the total car fleet is, in fact, the only indicator with a more or less consistent positive trend throughout the sample, testifying to an indisputable trend towards zero-emission, cleaner, less noisy and, in general, technologically innovative mobility. The most significant progress recorded in Bologna is of particular note: it has risen from just over 1% (2015) to over 5% (2020), reaching the largest share compared to the remaining municipalities in the sample. Furthermore, Milan increases from 1% in 2015 and exceeds 4% in 2020. Despite the positive trend, Catanzaro (0.98%), Campobasso (0.84%), Potenza and Palermo (0.81%) and Naples (0.48%) still remain below 1% in 2020.

To counterbalance this positive sign, for many municipalities a reduction in the number of passengers transported per inhabitant per year by local public transport (LPT) in the period 2011-2019 is observed. This figure describes a low propensity to use public transport, a solution that is certainly more sustainable than private transport: in fact, the demand for LPT decreases in Aosta (-61%), Perugia (-43.8%), Rome (-43.2%), Naples (-40.4%), Campobasso (-28.7%), Potenza (-25.2%), Bozen (-20.4%), Trento (-16.5%), Palermo (-15.4%), L'Aquila (-14.3%), Milan (-6.3%). On the other hand, there is a more or less consistent increase in the rest of the sample, with percentages over 40% in Turin. In 2019, Venice is the municipality with the highest values, thanks also to the particular conformation of the lagoon city, with 844.1 passengers per year/inhabitant, followed by Milan which still shows high numbers albeit decreasing (533.8 passengers per year/inhabitant). Finally, Aosta (12.5) and Potenza (18.5) are below 20 passengers per year/inhabitant.

Target 15.1 - *By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.*

With regard to the loss of agricultural, natural and semi-natural areas, there are mostly fluctuating trends in most of the sample, with the highest values recorded in Rome where 464 ha were converted to artificial soil between 2015 and 2020, with the loss increasing from 67 ha (2015-2016) to 131 ha (2019-2020), and Aosta which, on the contrary, exceeds the hectare loss only between 2019 and 2020. Compared to the 2015-2016 period, in 2019-2020 Florence increases its losses tenfold (from about 1.5 ha to over 16 ha) while Ancona and L'Aquila triple them (from about 2.2 ha to over 7 ha in the first case and from about 4.7 ha to over 14 ha in the second).

Target 2.4 - *By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.*

It is the general increase in the areas allocated to urban gardens in the municipalities analysed that provides a positive signal on the issue of food security and sustainable agriculture on a local scale. The use of public areas for self-produced food and socialising contributes, in fact, to the conservation of soil functions and the circularity of resources. Urban gardens, which are clearly growing in many of the capitals in the sample, produce environmental benefits, protecting biodiversity, fostering short and sustainable food supply chains and promoting the 'km 0' culture, but also social benefits, since these spaces are often intended for fragile groups of the population - such as the elderly - as part of social inclusion projects, sometimes becoming places where lessons are passed on to the youngest, who are stimulated to rediscover direct contact with nature and its products.

While there has been an increase in the period 2011-2019 in almost all the provincial capitals analysed, particularly evident in Naples with an increase of more than 10 ha (+1230%), situations of stationarity are also reported in Palermo (3 ha), Aosta (1.2 ha) and Venice (0.8 ha), while in Campobasso and Catanzaro no areas used as urban gardens are recorded until 2019. A decreasing trend is detected only in Cagliari, since the initiative is no longer declared from 2016 onwards. In 2019, Bologna (16.6 ha) and Naples (11.7 ha) show the highest values within the sample.

Target 11.3 - *By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.*

Target 15.3 - *By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.*

Red light for many of the analysed municipalities on the front of the percentage of land consumed on municipal territory.

In the five-year period analysed (2016-2020), L'Aquila stands at around 5%, the lowest percentage among the regional capitals, while with 66% Turin holds the highest value in the sample analysed, indicating a spatial configuration tending towards saturation, followed by Naples with 62%. In general, there is a tendency to increase the amount of land consumed on municipal territory (%), with more or less high values over time, and situations of substantial stability, particularly for the municipalities of Aosta, Genoa, Trento, Trieste, Bologna, Perugia, Ancona, L'Aquila and Campobasso.

Less clear are the signs concerning net per capita land consumption, which records the highest values in 2020 in the municipality of L'Aquila (2 m^2/inhabitant).

The processes involving the gradual transformation of surfaces that were originally agricultural, natural or semi-natural into areas with artificial coverage for the purpose of constructing new buildings, infrastructures, commercial, logistical and productive settlements are still active in the realities observed and far from the objective required by Europe and the United Nations of zeroing net soil consumption by 2050. These phenomena continue at a rate that is no longer sustainable, also due to the absence of effective and incisive regulatory interventions and a homogeneous framework of guidelines at a national level. Soil consumption is strongly interconnected and transversal to all interpretations precisely because of the multiple ecosystem services that soil provides. However if, on the

one hand, 'soil consumption' means amplification of the urban heat island in cities or reduction of drainage capacity with respect to extreme hydrological phenomena with regard to the issue of resilience to climate change, on the other hand it should be considered how this phenomenon is oriented by urbanisation drivers that increasingly concern the concept of circularity of cities. In fact, the circular city reduces its environmental impact in terms of resource use by aiming at the recovery and reuse of degraded or disused urban spaces, at regeneration in a resilient key, avoiding the irreversible and further consumption of an essentially non-renewable resource such as soil.

Target 11.6 - *By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.*

Target 12.5 - *By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.*

With more or less significant upward trends in the percentage of separate waste collection in all regional capitals in the five-year period 2015-2019, the circularity phase concerning the recycling of materials seems to show very positive signs.

With 82.5% in 2019, Trento is the most virtuous capital within the sample over the five-year period considered (2015-2019), followed by Perugia, the only municipality to exceed 70% in 2019. Palermo, on the other hand, is still below 20% (17.4%), despite registering an increase over the period of about +115%. Particularly significant increases over the period are seen for Catanzaro (+577.1%) and Potenza (+214.7%). If in 2015 there were only two cities with separate waste collection above 60% (Trento and Bozen), in 2019 these will become nine (Aosta, Milan, Bozen, Trento, Venice, Perugia, Cagliari, Potenza, Catanzaro).

Waste is therefore no longer conceived as the final stage of the product to be destined for landfills, but is reintroduced into the production chain as an input for a new cycle in response to the growing scarcity of resources and, above all, to the increase in waste produced also dictated by lifestyles marked by 'disposable'. More sustainable waste management, based on reducing production, increasing separate collection and recycling of materials, is therefore essential in order to reduce the use of landfills and the associated environmental impacts.

Consistent with the upward trend in separate waste collection is, with the exception of Ancona which from 2015 to 2019 shows a very slight decrease (-1.5%), also the per capita production of organic waste, with Perugia recording the highest value of 151.1 kg/inhabitant/year of the entire sample over the entire 2015-2019 period analysed and Genoa the lowest value in 2019 (27.5 kg/inhabitant/year). Signs of strong change emerge from the analysis of the data of Potenza, which in 2019 exceeds 100 kg/inhab/year, starting from an almost nil figure at the beginning of the series, Catanzaro, which rises from 4.5 kg/inhab/year in 2015 to 132.8 in 2019 (+2,870.8%) and, finally, Campobasso, which reaches 38.3 kg/inhab/year in 2019 (+400.6%).

According to the European Package for the Circular Economy, organic waste, the largest component of separate waste collection, can no longer be sent to landfills from 2024: if collected and treated correctly, this type of waste can represent a fundamental resource for obtaining fertiliser (compost) and renewable energy (biogas). The developed indicator therefore accounts for a first step in a virtuous circle in which waste can be transformed into a resource.

Lights and shadows on the trend of per capita production of urban waste are pointed out: in the five-year period 2015-2019, more virtuous situations such as, for example, those found in Cagliari (-18.4%), Catanzaro (-12.1%) and Potenza (-7.7%) are contrasted by a general upward trend of even more than 10 percentage points (Bozen with +15.4%, Palermo with +13.7%, Trento with +12.4%, Trieste with +11.3% and Venice with +10.2%) and values to 2019 exceeding 600 kg/inhabitant/year (Venice with 674.6; Florence with 665.7 and Rome with 602.5). These data are certainly influenced by the tourist influxes that characterise the main Italian cities of art.

On the issue of waste production, therefore, significant initiatives and policies are still needed to contain its increase, such as, for example, education on conscious consumption of goods and services, incentives for composting, or actions to promote the use of recycled paper in offices, etc.

Resilience

Target 6.4 - *By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.*

Total water losses are an atavistic problem in Italy's municipal networks. An analysis of the data shows how system inefficiencies are high, with total water losses in the distribution network in some cases even very heavy, with values exceeding 50% in Catanzaro (57.8%), Campobasso (56.8%) and Cagliari (54.7%) in 2018. If, however, in the former case there is an increase in the period 2012-2018 (+11.2%), in the Molise and Sardinia capitals there are overall downward trends of -21.9% and -6.5% respectively. Positive trends towards the reduction of losses are also recorded in Naples (-23.3%), Potenza (-13.6%), Trento (-8.9%), Palermo (-8%), Turin (-6.1%), Trieste (-4.6%), Rome (-3.3%), and L'Aquila (-0.8%), albeit with fluctuations over the period. But it is the upward trends in leakage over the period that are of greatest concern: compared to 2012 in 2018 in Florence, the increase is 15 percentage points, in Perugia 10.6 and in Genoa almost 10. Although Milan shows the most virtuous picture within the sample, with values always below 20%, the percentage is still significant and equal to 14.3% in 2018.

The huge quantities of water that are dispersed by not reaching end users lead to a very serious waste of a resource that climate change is increasingly threatening, with more frequent, intense and lasting drought events. These inefficiencies therefore compromise the resilience of the realities analysed, undermining their ability to cope with periods of water scarcity and sometimes necessitating recourse to water rationing measures.

Target 3.4 - *By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.*

Faced with the increasing risk of mortality associated with heat waves, prevention and the promotion of psychophysical wellbeing in cities also involve increasing natural areas. Among the many benefits of green areas in the city, in terms of resilience to climate change, the presence of vegetated surfaces in the municipal area essentially performs two important functions: the first is that of mitigating urban heat islands, and consequently promoting the psycho-physical health and wellbeing of the population during the hottest periods; the second one is associated with the capacity of these surfaces to reduce the risk of flooding/infloods thanks to the permeability of the soils and to absorb large quantities of water resulting from more intense precipitation events.

The indicator “vegetated area over urbanised area”, like many of the indicators related to green infrastructures, basically shows a stable situation for all municipalities. With about 70% of vegetated surface on urbanised surface, Potenza remains the capital with the highest values in the sample throughout the 2016-2020 period, followed by Perugia (69.8%) and L'Aquila (68%). On the other hand, the percentages for Turin (29%), Naples (34%), Milan and Cagliari (36%) are very small, although the latter shows the most significant increase over the period, rising from about 33% to 36%. For Venice, there is a slight downward trend over the period.

More closely linked to the theme of health, the indicators relating respectively to the number of days of heat wave alerts and the change in the over-65 mortality rate in the summer season do not show significantly critical trends overall, but rather situations of variability over the period considered. With more than 20 days of alerts in 2019, Campobasso (30), Bozen (26), Perugia (25), Trieste (22) are the municipalities with the most frequent events associated with high temperatures and weather conditions that may lead to adverse health effects, particularly in susceptible population subgroups (i.e. alert level 2) or true heat waves corresponding to high-risk conditions that persist for three or more consecutive days (i.e. alert level 3): in both cases, the alert of health and social services occurs. In the 2015-2019 period, in some cases (e.g. Turin with +17% in 2015, Milan with +16% in 2015, Venice with +4% in 2015, Trieste with +5% in 2015, Genoa with +10% in 2015, Bologna with +8% in 2015, Perugia with +16% and + 41% in 2015 and 2019 respectively, Rome with +8% in 2015, Palermo with +20% and +13% in 2017 and 2015 respectively), summer mortality shows a greater excess in years with a higher number of alert days. The trend of these indicators should also be carefully analysed in view of the data on the most fragile population categories (< 5 years and > 65 years).

Indeed, the study of the socio-demographic structure within the resilience key provides very useful elements for decision-makers in order to orient adaptation policies towards the most vulnerable categories. The trend of the indicators considered describes a situation homogeneously tending towards a decrease in the percentage of the population <5 years of age for all the municipalities analysed and, apart from rare cases of counter-trend (Milan and Bologna) or substantial stability (Trieste), an increase in the percentage of the population >65 years of age. This datum, already predictable due to the known demographic dynamics of our country, suggests the need for adaptation policies in the municipalities of the sample to be directed with increasing attention towards the older group of the population, generally considered less resilient in the face of change and with a lower propensity or capacity to respond in the event of emergency situations.

Target 11.3 - *By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.*

Soil sealing, caused for example by covering land with concrete or asphalt materials, is one of the biggest problems in modern cities, where the reduced absorption capacity of the soil is combined with the effects of increasingly frequent and intense rainfall as a result of climate change. Asphalt or concrete surfaces also contribute to the amplification of the so-called 'urban heat island' effect in urban centres where temperatures are up to 4-5 °C higher than in suburban areas. The indicators analysed, oriented to investigate the transformations that occur at the expense of non-consumed land (e.g. natural or semi-natural areas) or reversible consumed land (e.g. construction sites or beaten surface), show a situation of substantial variability over the period considered without particularly significant trends. In the 2015-2020 period it is by far Rome that records the highest overall value of natural and semi-natural area sealing (about 96 ha), followed by Venice and Bari, the only municipalities, in addition to the capital, to exceed 20 ha in the period (28 and 22.2 ha respectively) and by Turin (about 14.8 ha) and Perugia (about 11.4 ha). The capital itself also shows the highest value of imperviousness on reversible consumed land with more than 90 ha also in this case (92.6 ha). In this second case, the values of Venice (approx. 45 ha), Turin (approx. 37 ha), Milan (approx. 28.1 ha), Bari (approx. 17.4 ha), Perugia and Bologna (approx. 13.3 ha), and Bozen (approx. 10.3 ha) are also worth mentioning.

The increase in the intensity and duration of intense rainfall phenomena, combined with hydrogeological instability of the territory and aggravated by the effects of unstoppable land consumption, today puts the population living in urban settlements increasingly at risk. Loss of movable and immovable property, destruction of buildings, up to accidents and death are the consequences to which the population exposed to such risks can be exposed, often without the possibility of reacting or finding safe places to protect themselves. Avoiding building in at-risk areas is the first duty that territorial governing bodies have for the safety of the population, which is necessarily followed by a policy to secure areas currently at risk in order to reduce the exposure of the population. Information and increased awareness are further useful tools that can increase the ability of citizens to react or know how to behave in the face of the hydraulic threat.

Without an SDG target

The average income per taxpayer, which accounts for the level of wealth of the population and, with it, the level of access to services, opportunities and information, shows fluctuating values in the 2016-2019 period, with values varying in the sample from €34,531 in Milan (2019) to €20,273 in Catanzaro (2019), denoting a strong inhomogeneity within the sample.

Responding to the urban environmental challenges described in this document requires transformations, technological innovations, new models of development and urban governance that can accompany the ecological transition of today's cities towards systems that are truly more environmentally sustainable. While in some areas the change of course seems to be already clearly underway, thanks also to the new technologies available (e.g. electric or hybrid cars), on other fronts Italy's capitals still seem to be proceeding slowly and with difficulty.

The image of a city on a human scale, in which asphalt gives way - at least in part - to trees and lawns, people prefer to travel by bicycle along safe and available cycle paths or use shared systems, such as car sharing, is

perhaps still a long way off, because the citizen will no longer be responsible for the end of life of the car but simply a user of a service. An ambitious project, and apparently unrealistic to date, is the idea of the 15-minute city, a model of sustainable city proposed in the election programme of the mayor of Paris Anne Hidalgo, later also taken up in the election campaigns of the mayors of Milan and Rome, which aims to reorganise urban spaces so that citizens can find everything they need within a 15-minute walk: work, including co-working, schools, health services, recreation and meeting places.

Even harder to imagine is the 'sponge city' model, an urban planning approach currently being experimented in China in response to an increasingly looming climate threat, which aims to promote the absorptive capacity of urban settlements through parks, permeable or draining floors, buildings covered with green walls and roofs: here, water is collected and conserved so that it can be reused in times of drought. Or the 'forest-cities', prototypes of the new generation of cities, green and compact, capable of absorbing large quantities of carbon dioxide and pollutants, limiting the energy demands of buildings, reducing urban heat island phenomena and providing inhabitants with all the pisco-physical benefits that only nature can provide. Examples of innovative solutions such as these are already available, even in Europe: from Barcelona, the first flooding resilient city in the world thanks to its Deposito de retencion de agua de lluvia, to the resilient neighbourhood of San Kjeld (Copenhagen), born from the redevelopment of an old working-class area of the city, to the water squares of Rotterdam which, in the event of a flood, are transformed into enormous water collection basins mitigating the runoff phenomenon and storing excess water for irrigation of the surrounding green areas. There is no shortage of Italian examples: City Life (Milan), one of the largest urban regeneration projects in Europe, and the Bosco Verticale inside the Centro Direzionale in Milan, are now symbolic places and architectures of an Italy that looks to the future towards a sustainable renewal of cities.

Equally distant may seem to be a city in which infrastructures, vehicles and buildings are conceived, in a circular perspective, as the combination of durability, easy maintenance and material recovery, the use of resources, matter and energy is efficient, the key word is 'reuse' and waste is reduced to a minimum.

The models of livable, resilient and circular cities are only apparently disjointed but in the scenario of the urban reality of the future they are strongly interconnected.

The challenges facing cities in terms of resource use, the health of their inhabitants, and risk management are the keys to orienting urban regeneration programmes towards promoting natural capital and landscape, improving the provision of ecosystem services, and the environmental regeneration of degraded areas. Transversal to all models is certainly the objective of limiting soil consumption, with the ultimate and urgent aim of reaching the European target of its zeroing and ensuring a sustainable recovery of our territories.

In the city areas earmarked for new urban plans, there is often no provision for actions aimed at recovering river strips or maintaining the minor hydrographic network, including rainwater collection systems and sewerage pipes. The location of areas intended for new urbanisation in areas with a high propensity to instability has in fact led to a considerable increase in risk. The urbanised areas or areas to be expanded in the future, exposed to high hydraulic criticality, would therefore require a land governance policy that is attentive to the present risk condition, which would take the form of structural interventions (e.g. expansion reservoirs, embankments, hydraulic regulation, etc.) and non-structural interventions (e.g. special constraints, reconversion and mitigation of the risk itself).

The themes of greenery, urban reforestation and a renewed relationship between man and nature, in which the latter does not remain relegated to the margins of people's living places but becomes an active part of them, are becoming fully-fledged among the most promising measures to counteract the causes and consequences of the current climate emergency. Witness the recent urban reforestation programmes and those aimed at experimental climate change adaptation interventions promoted by the Ministry of Ecological Transition. The latter initiative, in particular, represents the first experimentation of climate change adaptation interventions at the urban level in Italy with the ultimate aim of increasing the resilience of settlement systems subject to the risks generated by climate change, with particular reference to heat waves, extreme rainfall and drought phenomena. Increasing green areas, restoring

soil permeability, increasing the storage capacity and reuse of water resources are the main measures identified to strengthen cities' ability to respond to increasingly extreme climatic phenomena and, at the same time, reinforce circularity practices in the management of the integrated water cycle.

In order to perform their important functions, however, the natural and semi-natural systems of our cities must be planned and managed through appropriate governance tools such as the Census, the Regulations and the Green Plan, which represent valuable opportunities to rethink the development and transformation of urban spaces with a view to circularity and urban regeneration (e.g. reclamation of marginal areas and brownfields, reconversion and de-sealing of sealed surfaces), as well as an important tool to fight climate change because they are aimed at preserving green areas, effective carbon sinks, and limiting the main threats to the preservation of green and blue infrastructures including urbanisation and infrastructure construction resulting in habitat fragmentation.

The framework outlined with the selection of indicators presented here, although not exhaustive nor without limitations as already specified in the introductory description of this document, has proposed an initial integrated reading of the paths that Italian cities are taking towards the objectives of environmental sustainability. The set of indicators used will necessarily have to be updated and adapted according to the cognitive needs and in-depth analysis of those aspects not adequately dealt with today due to the unavailability of sufficient spatial or temporal coverage of the data series. These are, in particular, the issues of circularity, which require a broadening of the perspective to the complete cycle, from the production and consumption of materials to waste management, from reuse and recovery to valorisation into a second material, and resilience, a concept that is still difficult to summarise in numerical terms given the complexity and diversity of the quantities involved.

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