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URBAN HEAT MAPPING IN ITALY WITH GEO

Copernicus is being used to analyse the urban heat landscape of the municipality of Turin, in Italy. With tools like this, GEO aims to create a Global Heat Resilience Map by 2030.

THE CHALLENGE

Urban heat is an increasingly urgent challenge as rapid urbanization combines with climate change to raise temperatures in cities faster than in surrounding rural areas. This phenomenon, known as the urban heat island effect, occurs because buildings, roads, asphalt, and concrete absorb and store heat during the day, then release it slowly at night. As a result, cities remain hotter for longer, especially during summer heatwaves. The loss of trees and vegetation worsens the problem by removing natural shade and cooling through evapotranspiration, while waste heat from traffic, air conditioning, and industry adds further warming. The consequences of urban heat are significant. Higher temperatures increase the risk of heat exhaustion, heat stroke, dehydration, and cardiovascular stress, particularly for vulnerable groups such as older adults, children, low-income households, and people with existing medical conditions. Heat also increases electricity demand as households and businesses rely more heavily on cooling systems, placing strain on power grids and raising the risk of outages during extreme weather.

In addition, hotter conditions worsen air pollution by accelerating the formation of ozone and smog, contributing to respiratory illness and reduced quality of life. Urban heat also deepens inequality. Neighbourhoods with limited tree cover, poor housing quality, and fewer public services often experience the highest temperatures and the greatest health impacts. As climate change drives more frequent and intense heatwaves, these disparities are expected to grow. Addressing urban heat requires coordinated planning, infrastructure investment, and public health action. Effective measures include expanding tree canopy, parks, and green roofs; using reflective "cool roofs" and pavements; improving building insulation and natural ventilation; and ensuring access to affordable cooling. Cities can also implement heat warning systems, cooling centres, and targeted support for vulnerable residents.

Policymakers play a critical role by embedding heat resilience into planning rules, building codes, and social protection systems. By combining environmental design with public health preparedness, cities can reduce heat risk, improve livability, and build resilience to rising temperatures.

More information on
www.sebs360.eu

HOW SATELLITES CAN HELP

The SDGs-EYES Heat Health Risk Assessment is a tool designed to help monitor how extreme heat affects public health. Developed under the lead of the Epidemiology Unit of the Local Health Authority Torino 3 (SEPI), part of the Regional Epidemiological Network of Piemonte, it brings together climate data and information on population vulnerability to produce clear indicators that support decision-making by policymakers and public health authorities. The service identifies urban areas where heat stress coincides with the presence of at-risk populations and provides possible mitigation measures.

By integrating climate reanalysis data from the Copernicus Climate Change Service with other satellite data (such as Sentinel-2), health data, urban context and census-derived socio-economic and demographic indicators, a risk indicator is produced that reflects climate hazard, exposure and vulnerability. The tool was developed through collaboration with local health agencies, researchers, urban and environmental experts, and regional institutions, ensuring that priority areas and vulnerable groups - such as older people and those with chronic health conditions - are properly identified.

Users can explore interactive maps showing heat hazard, exposure, vulnerability, and overall risk, alongside other relevant geographic information. The platform also allows users to view graphs and download data that align with national and international health reporting standards. Overall, it can help to:

- Identify potential mitigation measures
- Enable micro-targeting of investment
- Support monitoring of intervention impact
- Allow annual performance tracking
- Integrate with heat action plans

The pilot solution is based on user needs expressed by the Turin municipal administration which is evaluating its use to support activities the city is preparing for the summer 2026.

The service will be provided by SEPI and CMCC whilst this, and other solutions, are being evaluated by the GEO as the basis for a global heat resilience service to be available from 2030.

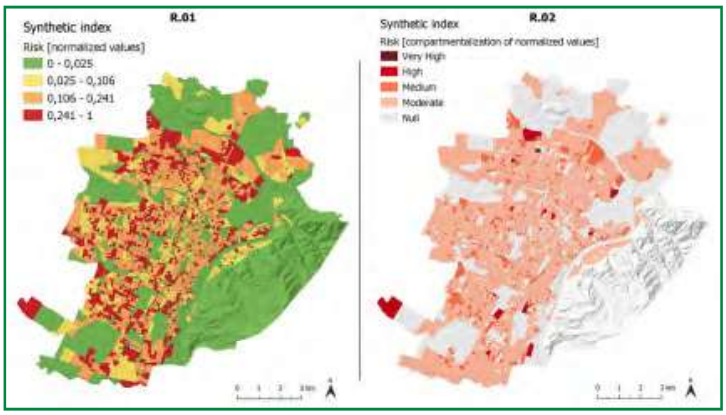

Figure 2: Heat risk map for the municipality of Turin (credits: Melis et al, 2025)*

* Melis G, Ellena M, Zengarini N, Di Gangi E, Ricciardi G, Costa G. Social vulnerability in climate change effects in a large city in Northern Italy: the Turin case study within the Climactions project. Epidemiology & Prevention. 2025;49(2-3):86-96. doi:10.19191/EP25.2-3.S1.060.

The satellite data:

Sentinel-2 carries an innovative wide swath high-resolution multispectral imager with 13 spectral bands. The combination of high resolution, novel spectral capabilities, a swath width of 290 km and frequent revisit times provides unprecedented views of Earth.

Copernicus Sentinels data are available under an open and free data policy.

Sentinel-2 data can be accessed at https://dataspace.copernicus.eu

More info:
https://sentinels.copernicus.eu

The GEO Work Programme Activity

SDGs-EYES was a Horizon 2020 project aimed at **boosting the European capacity for monitoring Sustainable Development Goals (SDGs) using data from Copernicus**. It has developed a **portfolio of decision-making tools** to monitor those SDGs indicators related to the environment, aligning with the **EU Green Deal priorities and challenges**. The services are **aligned with GEO goals** and especially the Urban Heat Mapping **which could form an element of the GEO global heat resilience service.**

The Service Provider

CMCC Foundation (Euro-Mediterranean Centre on Climate Change) is a research organisation that conducts and promotes scientific and applied research activities within the scope of international climate change research. CMCC aims to gain indepth knowledge of climate variability, along with the causes and consequences. CMCC has been leading the project to develop the Urban Heat Mapping tool.

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

www.cmcc.it

Figure 3: Turin landscape. Credits: Poliflash, Politecnico di Torino.

WHO IS CONCERNED?

Excessive temperatures in urban areas concern many categories of stakeholder – indeed, all of the citizens and businesses in a city like Turin. Of increasing concern for health authorities, **SEPI** has been developing tools to help manage the problem.

Residents are the most immediately affected, especially older adults, young children, low-income households, outdoor workers, and people with chronic health conditions. These groups are more exposed to heat stress, dehydration, respiratory illness, and other heat-related health impacts, particularly during prolonged heatwaves. Communities living in neighbourhoods with limited tree cover, dense construction, and poorquality housing often face the highest temperatures and greatest risks.

Municipal governments and especially urban planners have a major stake in addressing urban heat because they shape how cities are designed and managed. Decisions on green spaces, building materials, zoning, transport systems, and cooling infrastructure all influence urban temperatures. Energy providers are similarly affected, as higher demand for air conditioning can strain power networks and increase the risk of outages.

Public health authorities are also highly concerned because extreme heat increases hospital admissions, emergency call-outs, and mortality rates. Health systems must prepare for spikes in demand during hot weather, while also improving early warning systems and community outreach to vulnerable populations.

Businesses and employers, particularly those relying on outdoor labour or heat-sensitive operations, are concerned since high temperatures reduce productivity and increase occupational health risks. Finally, insurers, investors, and property owners are increasingly focused on urban heat because it can damage infrastructure, reduce asset values, and raise long-term costs. Urban heat is therefore both a public health challenge and an economic resilience issue affecting entire cities.

The Primary Users

The Epidemiology Unit (SEPI) of the Local Health Authority TORINO 3 (ASLTO3) is part of the regional epidemiological network of agencies that jointly provide public health observatory services. Since its establishment in 1994, SEPI has carried out epidemiological research and health promotion activities at a national, regional and local level. To this end, it deals with the development, maintenance, and analysis of the main regional health information systems. It conducts epidemiological studies on a wide range of indicators measuring diverse health dimensions and public health areas. Moreover, SEPI manages the Turin Longitudinal Study (TLS), a monitoring system that studies the social determinants of health, in order to explain the principal mechanisms from which inequalities in health and healthcare may originate, evaluate their impact in the population, identify potentially effective preventive actions, and evaluate the possible role of policies in reducing social inequalities in health.

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WHAT ARE THE BENEFITS?

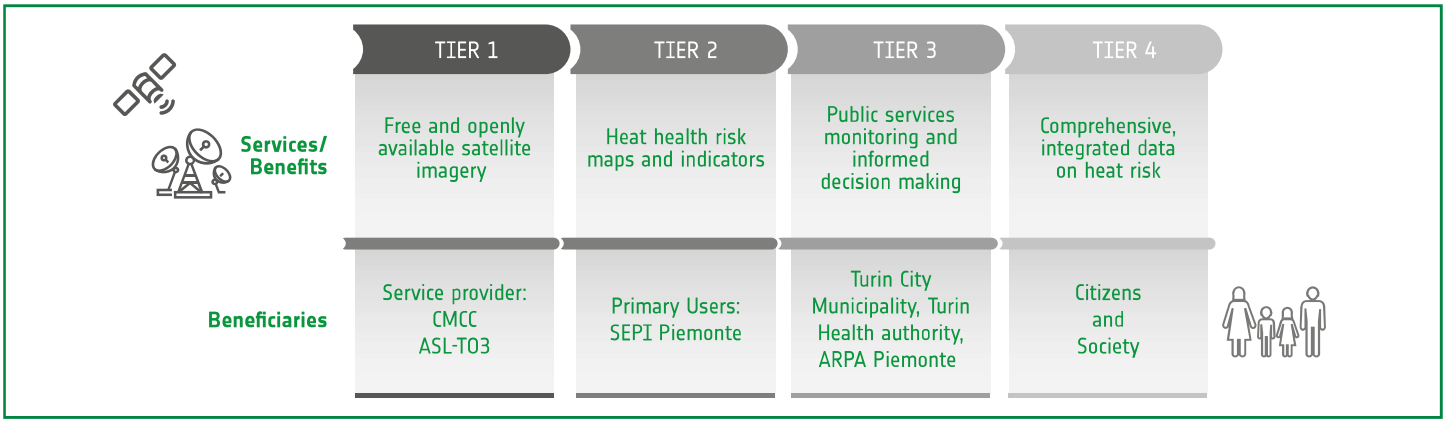

Figure 4: Value chain of the main stakeholders and beneficiaries

Improved understanding of urban heat islands allows municipalities such as Turin to target investments more effectively and reduce the impacts of extreme temperatures. Measures such as tree planting, water features, and reflective roofs can create healthier and cooler urban environments. Using detailed spatial temperature data ensures that interventions are focused on the areas of greatest need, maximizing impact and value for money.

The benefits are substantial. Lower temperatures can reduce heat-related illness and hospital admissions, generating savings for healthcare systems. In a metropolitan area the size of Turin, even a small reduction in admissions could save hundreds of thousands of euros annually. Cooling cities also reduces pressure on electricity networks. Studies* show that a 1ºC temperature reduction can lower electricity demand by 1–4%, cutting energy costs and delaying expensive grid upgrades such as new substations or reinforcement works. There are broader economic gains as well. Heat lowers labour productivity, particularly for outdoor workers, and increases absenteeism and occupational health risks. Even modest temperature reductions can improve productivity across the urban economy. Additional benefits include fewer emergency call-outs, lower building cooling costs, and increased property values in greener, more attractive neighbourhoods. Most importantly, reducing urban heat saves lives. Extreme heat is becoming one of Europe's deadliest climate risks, with more than 62,700 heat-related deaths reported across Europe in 2024 according to research published in Nature Medicine**. Even small reductions in heat-related mortality can deliver major gains in public health and life expectancy across large city populations.

*Understanding the synergy between heat waves and the built environment: a three-decade systematic review informing policies for mitigating urban heat island in cities. K. Joshi, A. Khan, P. Anand & J. Sen
**https://www.reuters.com/sustainability/climate-energy/europe-had-over-62700-heat-related-deaths-2024-report-finds-2025-09-22/

Societal

Reduced hospital admissions and mortality risks are the most important benefits for urban societies.

Environmental

Greener cities with more targeted planting of trees to provide a more pleasant environment within the city.

Economic

Turin metropolitan area has a population of 2.2m people. In Italy, heat related hospital admission are estimated to range from 20-30 per 100,000 in an average year suggesting around 5,000 heat-related admissions. Assuming that 1% (ie 50 admissions) may be saved through measures taken to reduce temperatures for vulnerable populations and that each hospital admission costs approx. €5k a saving of €250k could be anticipated.

Regulatory

Better informed policy making to protect citizens and improve economic output.

***Heat-related respiratory hospital admissions in Europe in a changing climate: a health impact assessment: Christofer Åström, Hans Orru , Joacim Rocklöv, Gustav Strandberg, Kristie L Ebi, Bertil Forsberg.
****The economic benefit of implementing assisted reproductive technology within a national health system: insights from the Italian model. A. Marcellusi, M. Scortichini, G. Guarnotta, M. Connolly and A. Busnelli.

EXTENDED IMPACT

Cities all over the world are warming faster and becoming more vulnerable to extreme heat because global climate change and local urban characteristics reinforce each other. Hot days are becoming hotter and warm nights staying warmer. Heatwaves are lasting longer. Without adaptation measures such as greening, reflective materials, and heat-resilient planning, urban heat will become one of the most serious climate risks facing cities. The investment required is significant, hence tools to help prioritise the works are valuable to optimise the capital outlay. Satellite-based urban heat monitoring helps to manage risks. It can shift cities from having a reactive response to preventative financial and social management, with significant economic benefits and even more important contribution to a better quality of life for city residents and workers. Knowledge on hot spots and well grounded mitigation measures will lead to reduced stress on the population, reduced hospitalisations, reduced energy use and more agreeable living conditions.

The Group on Earth Observations (GEO) is evaluating the SDG4Eyes urban heat mapping service along with other tools to create a Global Heat Resilience Map by 2030.

ABOUT THE SEBS4GEO PROJECT

The SeBS4GEO project is a spin-off of the Sentinel Benefits Study (SeBS) and is conducted by EARSC (European Association of Remote Sensing Companies) for the European Space Agency (ESA). The project has the goal to support the GEO Work Programme Activities to showcase their benefits derived from the use of Sentinel data. The study cases contribute to the development and consolidation of the GEOValue GEO EO Impact Assessment Toolkit (GIAT).

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The impact analysis of this case has been conducted in the context of the GIAT development and validation. While the toolkit is aimed at ex-post analysis with operational services, in this particular case, the test is extended to an ex-ante impact assessment which has been supported by the stakeholders concerned.
We acknowledge that the understanding of the case was supported by discussions with Antonella Passani from T6 Ecosystems srl, Mattia Scalas (CMCC) and Nicolas Zengarini (EPI). We thank them for their valuable insights and availability.

Do you know an interesting case demonstrating the benefits derived from the use of Sentinels data?

Email info@earsc.org

More Information on Sentinels Benefits Studies:

www.sebs360.eu

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The Sentinels Benefits Study is funded by the EU and ESA.
The views expressed in this study cannot be taken to reflect the official position of the EU or of ESA.

Figure 5: Turin. Credits: Poliflash, Politecnico di Torino.

> ***"I think the service can become a really useful support for identifying priority areas for intervention and for planning more targeted actions where climate change impacts are compounded by social vulnerability and fragility factors."***
>
> *Aldo De Angelis, medical doctor, Local Health Authority "City of Turin"*