MEDIA BRIEF

Heatwaves and the social impact of climate risks

Data and resources from CMCC on climate risks and unequal impacts in European cities

As Europe grapples with record-breaking heat and intensifying climate extremes, large urban areas such as Rome and Milan are becoming risk hotspots. With heatwaves projected to rise both in frequency and intensity, and vulnerable communities bearing the brunt of inequalities in access to cooling. CMCC research warns that cities must adapt - not just with data and technology, but with fairness and foresight.

In this media brief:

Climate change affects human health in Europe through increasing warming and increased frequency and intensity of extreme heat events. Heatwaves are already leading to increased fatalities and negative health effects, also due to a growing urban population.

Story ideas:

- The heat divide: How European cities are failing the most vulnerable
- How urban design can make us safer and healthier
- Are cities prepared for the coming heatwaves?
- Surviving the heat, but at what cost?
- Can green be cool? How urban nature reduces heat and inequality

How heat affects labour

Key messages

- Globally, more than **2.4 billion workers are exposed to excessive heat** at work annually.
- Future climate change is projected to reduce the **total global labour** supply by 18 percentage points in sectors less exposed to heat, and **by 24.8 points in sectors where workers are more exposed to extreme heat**, such as agriculture and construction, under a 3.0°C warming scenario.
- **Total labour in the EU** is expected to decline by 0.3% under a low emissions scenario, and **by 1.0%** under a medium emissions scenario by the end of the century.
- **Heat-related worker deaths are on the rise globally**, including in China, India and the Middle East. **Over 10,000 workers** are estimated to die every year in the Gulf countries due to heat stress.
- Climate change impacts on the labour force are one of the most important sources of economic losses, with **projected GDP losses of 5.9% in South Asia and 3.6% in Africa** by the end of the century. **In Europe, GDP is projected to decrease by almost 0.5 percentage point by 2050** in the moderate warming RCP4.5 scenario.

Workers, especially those in outdoor or physically demanding jobs, are increasingly exposed to dangerous heat stress, with climate change already impacting labour supply. In 2024 alone, **over 100 million working hours were likely lost in the UK** due to extreme heat. These impacts are global and at the same time unequally distributed, affecting both low- and high-income countries.

Warming affects both labour supply and the productivity of workers during their working hours (labour productivity), with both projected to decrease under future climate change in most parts of the world.

Heatwaves cause increased risk of discomfort, limitations in physical functions and capabilities, and ultimately also injuries and heat-related illnesses such as heat cramps, heat exhaustion, and potentially fatal heat stroke. However, many countries, including Italy, the UK and Bangladesh still do not have a statutory maximum working temperature, lack enforceable heat thresholds, and have failed to implement policies that protect workers from heat stress during hot summers and heatwaves.

"What we need is proactive labour protection policies. Policies that take local contexts into account and not one size-fits-all type policies. It is in the economic interests of the employers to provide adequate protection to workers."
CMCC scientist **Shouro Dasgupta**

High-exposure sectors such as **agriculture and construction** are projected to **experience the greatest losses** under future climate change, with the projected declines highest **across Africa, Asia, and Oceania**. Labour losses are also expected in low-exposure sectors such as **manufacturing and utilities**.

These labour impacts lead to considerable reductions in GDP and welfare, with **projected GDP losses of 5.9% in South Asia and 3.6% in Africa**. Mitigation efforts can deliver global health and economic co-benefits across all sectors and regions, but adaptation will likely be important for protecting workers from increased heat stress, even if warming is limited to 1.5°C.

"Increased costs to firms in terms of lost production, higher health care expenditure or insurance coverage are the economic impacts one usually associates to heat stress on the labour force. Nonetheless, indirect impacts, those that spread from the affected sectors to the overall economic system, albeit less detectable, are equally relevant and by no means a concern just for 'hot developing economies'. For instance, in the moderate warming RCP4.5 scenario these could reduce EU GDP by almost half a percentage point by 2050."
CMCC scientist **Francesco Bosello**

In the 2022 Lancet Countdown Report on Health and Climate Change, Dasgupta together with Professor Elizabeth Robinson (Grantham Research Institute) examine how **heatwaves are undermining global access to food**. By combining individual-level food insecurity data from 103 countries with high-resolution climate data, they find that rising temperatures and more frequent heatwaves and droughts are **reducing crop yields, disrupting supply chains, and limiting food availability**.

In 2020, the increased frequency of heatwave days – compared to the 1981–2010 average – led to a **3.7 percentage point rise in moderate-to-severe food insecurity, affecting an estimated 98 million additional people**. Heat exposure also reduces people's ability to work, thus lowering income, and weakening purchasing power, further threatening food access.

Climate change also indirectly raises the risk of infectious diseases in Europe, including dengue, Vibrio, and West Nile virus, due to shifting environmental conditions. **Furthermore, both gradual temperature increases and acute climate shocks**, such as droughts and heatwaves, have a clear negative impact on **children's health**.

The relationship is complex and non-linear, with regional variation: **countries like Saudi Arabia, Chad, and Burkina Faso** are projected to face the highest medium-term increases in child mortality, while **Sudan, Ethiopia, and Mali** face greater long-term risks. The study underscores that meeting **low-emission targets**, in line with the Paris Agreement, could significantly reduce these health risks for children worldwide.

"Climate change has already become an issue of justice and equity. If we talk about impacts such as climate-induced migration and displacement, it is generally the poorest people in a country who live on the coastal lines who will be hit the most by sea-level rise. In terms of labor productivity, the greatest impacts are on sectors such as agriculture and construction, where relatively low-income workers work: they are more vulnerable due to the nature of their work, and they are also more exposed to weather-related events."
CMCC scientist **Shouro Dasgupta**

Cooling poverty and inequalities

Key messages

- Air conditioning ownership **increases household electricity consumption by 36% on average globally**.
- Air conditioning presence will **grow from the current global average of 28% to 41-55% by 2050**.
- The rate of access to air conditioning will be **unequal across countries**. For example, African countries will see between 9-15% penetration rates, well short of the global average.
- Cooling electricity consumption in the residential sector may reach 976-1,393 TWh annually, resulting in **additional 670-956 Mt of CO_2 emissions** comparable to the entire annual emissions of major industrialized nations such as Germany and Indonesia.
- Low-income households in developing countries allocate up to **8% of their budget** on electricity for cooling, compared to high-income households that spend only **0.2-2.5%** of their expenditure on air conditioning use.
- **Air conditioning has the largest marginal effect on residential electricity consumption** compared to other drivers, including income,

electricity prices, and other household appliances like refrigerators and televisions.

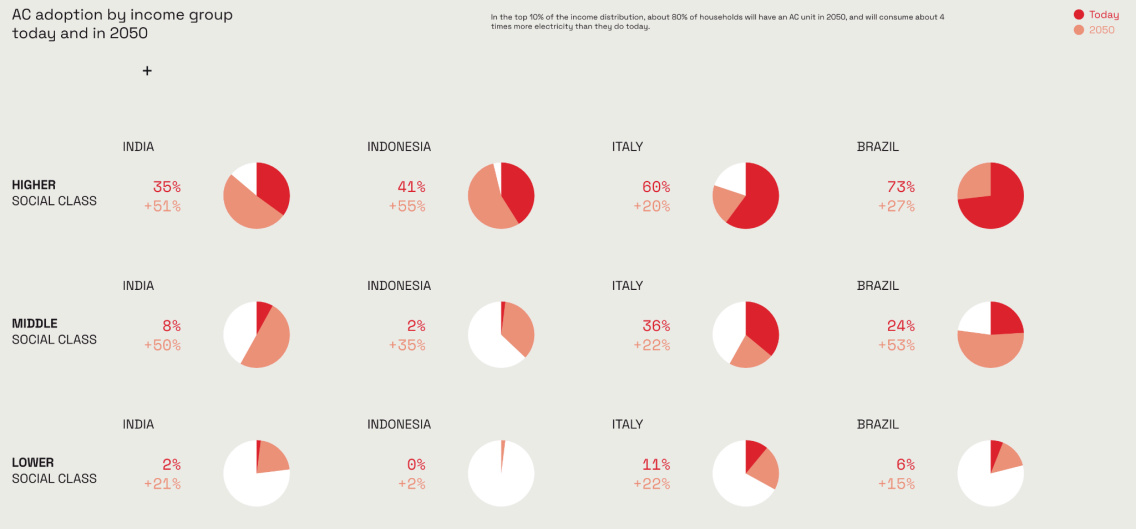
- Renewables such as **solar could help mitigate cooling electricity demand**, with households in areas with more solar generation associated **with 25% less electricity for cooling**.

According to an International Environmental Agency report, **10 new air conditioning (AC) units will be sold every second for the next 30 years**, bringing the number of installed cooling units worldwide to 5.6 billion by 2050. However, in 2016 alone **more than 20% of EU households faced difficulties in keeping their homes cool during heatwaves**, with research showing that this was due to a combination of both energy poverty and poor housing quality.

Cooling poverty refers to the financial burden of cooling on lower-income households, particularly in developing countries. The term includes both the **inability to afford adequate cooling technology** and the regressive nature of the costs incurred, whereby a disproportionate **share of household budgets** is set aside for the electricity needed for cooling by lower-income households.

Standing on the shoulders of established definitions of *energy poverty* – which traditionally focused on heating needs – cooling poverty extends its scope to address the emerging challenge of staying cool in an increasingly hot world. First outlined by CMCC researcher **Antonella Mazzone**, **systemic cooling poverty** encompasses the state of available cooling provision for outdoor working, education, health, and refrigeration purposes.

> *"The concept has many important policy implications as it points at the importance of addressing the risks related to heat exposure with effective coordination between different sectors, such as housing, healthcare, food and agriculture, and transport."*
> CMCC researcher **Enrica De Cian**



Caption: The Cooling Solution is a scientific project that uses photography to investigate how people of different socioeconomic backgrounds around the world adapt to high temperatures. Source: The Cooling Solution

A recent CMCC study offers the first global assessment of how air conditioning affects electricity use. Analyzing data from 25 countries covering **62% of the world's population**, researchers found that owning an air conditioner increases household electricity consumption by 36% on average.

However, the impact varies sharply by region, highlighting how cooling impacts nations both differently and unequally, with air conditioning **increasing average electricity consumption by about 68% in Africa, 10% in Italy, and 7% in non-European OECD countries.**

The study also highlights stark inequalities in cooling affordability. While high-income households spend just 0.2% to 2.5% of their budget on air conditioning, **the poorest households can spend up to 8%**. A vicious cycle that sees poorer households face the greatest financial burden.

"In developing countries, a substantial fraction of households that adopt air conditioning will be low income, and will face significant expenditure burdens to attain thermal comfort, raising the spectre of cooling poverty."
CMCC researcher Giacomo Falchetta

***Read more about cooling poverty and the Cooling Solution on CMCC's digital magazine* Foresight.**

Our cities are getting warmer: All the key data

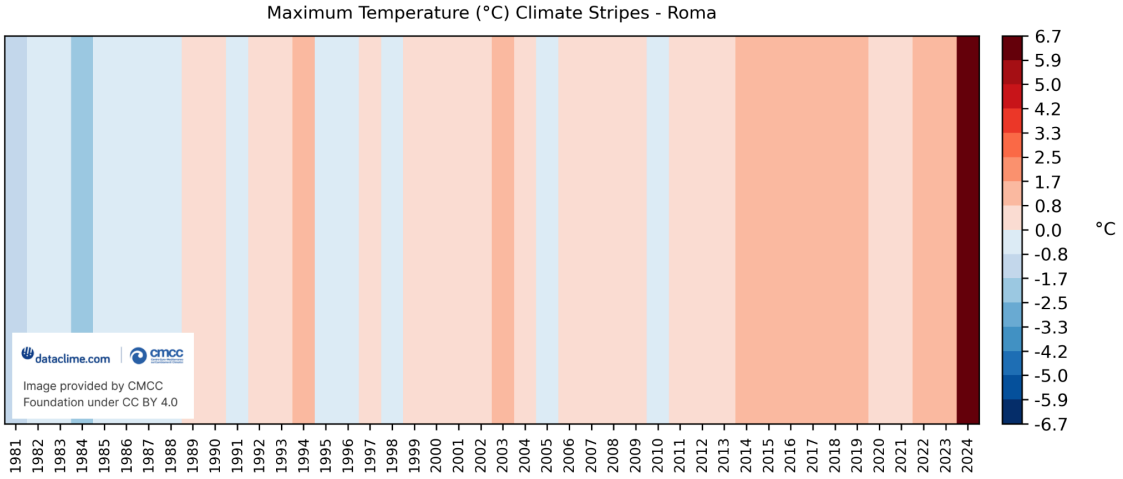
Key messages

- **Heatwaves in Europe are on the rise**, with **57% more people exposed** to them in the decade from 2010 to 2019 compared to the preceding ten year period.
- Without adaptation measures, **annual fatalities** from extreme heat could rise from 2,700 deaths per year currently to approximately **30,000 or 50,000 by 2050**, with 1.5°C or 2°C global warming, respectively.
- **The 2003 European heatwave caused 70,000 excess deaths**, highlighting the health risks of rising urban temperatures.
- **2024 was the hottest year since 1991 for Rome**, with an average temperature of **19.7°C**, **2.5°C above the 1991–2020 average**.
- The Italian capital recorded **36 tropical nights** (+30 compared to the 1991–2020 average), **5.4 more summer heatwaves**, and **53 days of extreme heat stress** (feels-like temperature >45°C), **29 more than the historical average**.
- **Urban environments intensify climate risks**, especially **urban heat islands (UHI)**, whereby cities become significantly warmer than surrounding rural areas due to heat-absorbing materials, lack of vegetation, and concentrated human activity.
- Cities in Europe can be **up to 9°C warmer** than vegetated surroundings due to the UHI effect, contributing to almost **90,000 deaths** between 2000 and 2020.
- **The UHI effect disproportionately affects vulnerable populations** – elderly, low-income, and marginalized communities – who often live in less energy-efficient homes and have less access to green spaces or cooling infrastructure.

June 2025 brought record-breaking heat across western Europe, marking **the warmest June on record** for the region with an average temperature of 20.49°C, slightly surpassing the previous 2003 record. Two intense heatwaves triggered very strong heat stress across western and southern Europe, with feels-like temperatures reaching **48°C in parts of Portugal**. Spain experienced its hottest June in 64 years, and England recorded its highest June temperatures since 1884. Globally, much of North America and central Asia also saw above-average warmth, with **record-breaking temperatures** in the eastern part of the Asian continent.

In 2024, **Rome recorded its hottest year on record**, with sharp increases across all heat-related indicators, according to the CMCC Climate Monitoring Report in collaboration with Rome's municipal administration. Compared to the 1991–2020 average, tropical nights, extremely hot days, and heatwaves have all intensified, and are projected to increase in the future, with **summer heatwaves projected to rise by up to 186% by 2050**.

The report also highlights a decrease in annual rainfall alongside more frequent episodes of intense and violent precipitation, providing ultra-high-resolution data to support targeted climate adaptation planning at the local level.



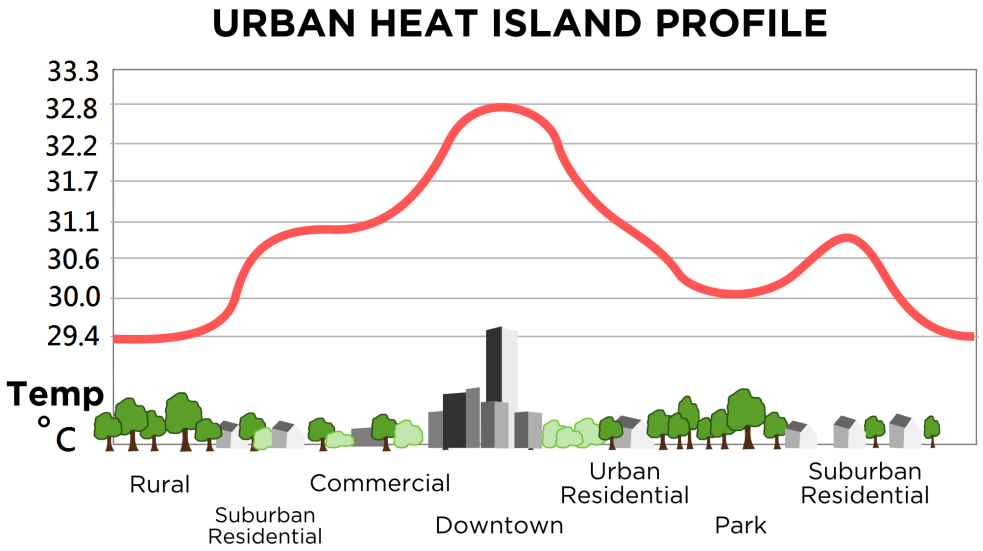
Caption: Climate stripes for Rome metropolitan area showing maximum temperature trends, sourced from the Dataclime platform. These stripes represent variations in daily maximum temperatures, a key input used to assess heatwave-related indicators. Anomalies are calculated relative to the 1981–2010 climatology.

Read more about CMCC's first interactive climate monitoring service for the city of Rome.

Just as world temperatures increase consistently, urban areas heat up even faster. Urbanization rates in Europe are expected to increase to 84% by 2050, compared to 75% in 2020. At the same time, climate change will lead to an increase in **heat stress** in urban areas across the EU, with heatwaves – now considered **the deadliest natural disaster globally**, causing hundreds of thousands of casualties each year – are projected to become more frequent and severe, particularly in urban environments.

Urban Heat Islands: Risk hotspots

The *Urban Heat Island* (UHI) is defined as a temperature difference between urban and rural areas, caused by the excess of emitted heat and by the use in cities of heat-absorbing building materials such as metal, concrete, and brick, as well as a scarcity of vegetation that reduces cooling through evaporation and transpiration.



Credits: CMCC

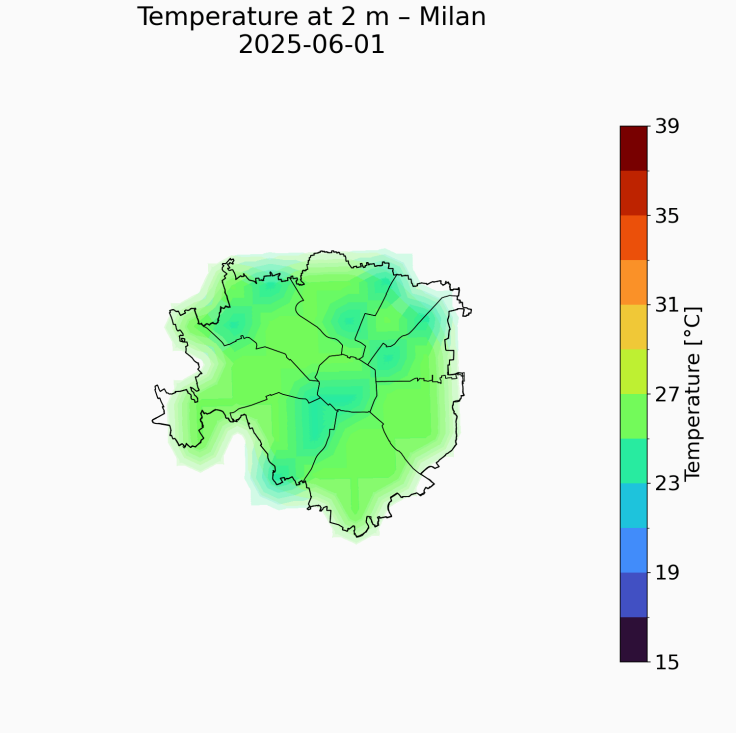
The UHI effect can impact human health both directly and indirectly, increasing mortality and morbidity - especially among **vulnerable groups** such as elderly or low-income populations, who are often concentrated in urban areas where the UHI is highest, and have limited access to cooling infrastructure or green space. For this reason, **people who live in cities are usually more affected by extremely high temperatures or heat waves compared to people who live in suburban or rural areas**.

> *"The population exposure is certainly linked to the physical exposure of the city district to heat. The built-up areas within the cities collect solar energy during the day and release it during the night. Therefore, the urban contexts heat up and stay much warmer than the surrounding green areas, even during the night."*
> Margaretha Breil, urban planner and researcher at CMCC

A recent study by CMCC, CNR, and other leading European institutions, reveals **widespread social inequality in access to green spaces across 14 major European urban areas**, highlighting a **critical environmental justice issue in urban climate adaptation**.

“In all the urban areas analyzed, lower-income residents, tenants, immigrants and the unemployed, experience more difficulties accessing green cooling services due to the unfavorable urban and social layout of many European cities. In contrast, upper-income residents, nationals and homeowners experienced above-average cooling provision.”
CMCC researcher **Giacomo Nicolini**

Cities can be up to **+9°C warmer** than vegetated areas due to the UHI effect, with heatwaves causing nearly **90,000 deaths in Europe between 2000 and 2020**. This reveals how **effective emission reductions and adaptation can play a critical role in reducing risk exposure**.



Caption: GIF showing temperature (2m above ground) in Milan from June 1 to July 8, 2025. The period from June 24 to 27 highlights a heatwave event, classified by ARPA Lombardia as a strong heat stress episode for Milan. *Click the image to view the animated GIF.*

The number of hot days, as well as the intensity and frequency of heatwaves is expected to rise under all future climate change scenarios, particularly for cities in the Mediterranean area and in Eastern Europe. Without any adaptation measures, **annual fatalities from extreme heat in Europe could rise from the current 2,700 deaths per year to approximately 30,000 under 1.5°C warming, 50,000 under 2°C, and 90,000 under a 3°C warming, by 2100.**

The European Union accounted for more than a third of heat-related mortality among the elderly, with 104,000 out of the 296,000 global deaths recorded in 2018. The same year, there was a 33% increase in heat-related deaths in the EU compared to the 2000 to 2004 baseline.

"It's not only greener or more urbanized areas that influence risk exposure. We should also consider the characteristics of buildings, proximity to hospitals and availability of public spaces with air conditioning, among others. The combination of different factors allows us to express the complexity of the concept of risk associated with UHIs."
CMCC and Politecnico di Torino researcher **Guglielmo Ricciardi**

Read more about a case study on urban heat islands and related health risk inequalities in the city of Turin.

How is Europe adapting to extreme heat?

CMCC scientists analyzed **National Adaptation Plans (NAPs)** of **11 European countries**, identifying top climate hazards - including floods, droughts, sea level rise, and shifts in **temperature and rainfall** - and common adaptation measures. Countries often focus on **institutional coordination**, **early warning systems**, **risk mapping**, and **public awareness**, while **structural measures** remain more common than nature-based or financial solutions –highlighting both progress and existing gaps.

Despite growing exposure to extreme weather, especially **heatwaves in Southern Europe**, adaptation implementation across the EU remains uneven. Few countries have **legally binding measures** or mechanisms for regular policy review. As climate risks accelerate, action is needed to **strengthen policy**, **improve coordination**, and **protect vulnerable groups**. Faster implementation is essential to build resilience in **cities, ecosystems, and public health**.

Recognizing the need for precise tools to understand and address these risks, CMCC researchers have advanced urban climate modeling. Tested in cities like Rome and Milan, the model **significantly improves the simulation of UHIs and urban dry islands**, capturing localized temperature variations with high spatial and temporal detail.

"This is a powerful tool for medium-scale climate simulations, enabling better analysis of urban heat dynamics, enhancing risk assessments and supporting adaptation strategies at the local scale."
CMCC researcher **Angelo Campanale**

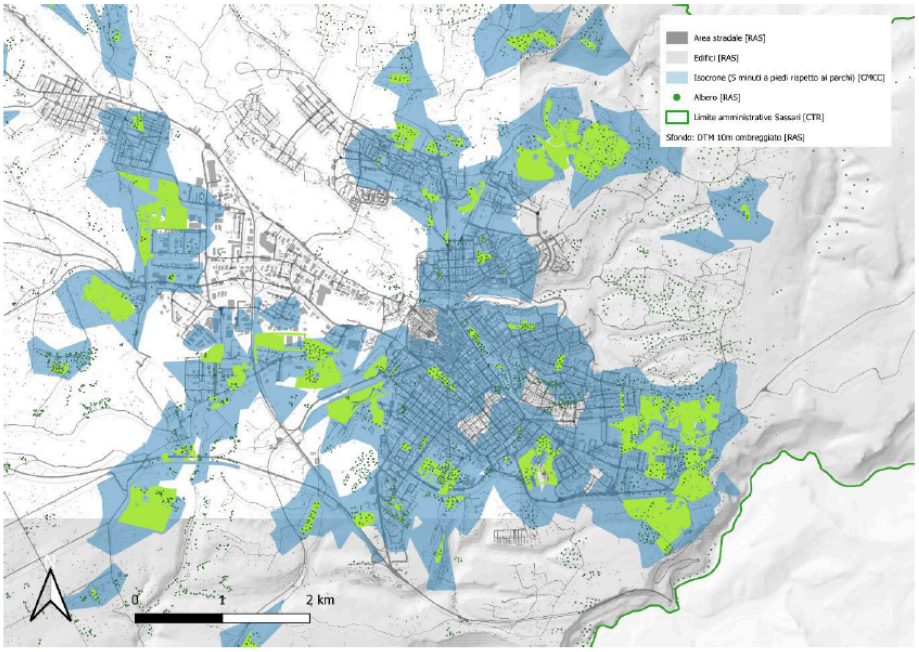
Nature-based solutions feature in 91% of local adaptation plans analyzed in recent European Environment Agency reports. These solutions provide cooling and water retention while offering recreation spaces and pollution reduction benefits. However, effective adaptation requires combining nature-based approaches with other interventions, including physical infrastructure.

"Green spaces play a crucial role in enhancing both adaptation and mitigation in urban areas, contributing to achieve the goals of EU Green Deal and fostering the transition towards a more sustainable future"
CMCC principal scientist **Paola Mercogliano**

CMCC climate models confirm observed data, including urban heat island (UHI) effects recorded during the extreme summer of 2017 in cities like **Rome and Milan**, where night-time temperatures were around **3°C higher than surrounding rural areas**. In **Bologna**, 2023 data show a persistent UHI effect of about **1.5°C** across all seasons - confirmed by both observations and models.

Beyond analysis, **CMCC researchers are also testing and evaluating urban adaptation solutions**. In **Brescia**, CMCC simulations assessed the cooling effect of street-level interventions - like planting trees and replacing pavement with reflective materials - showing a measurable **drop in surface and radiant temperatures**.

In **Sassari**, CMCC contributed to the city's updated Local Climate Adaptation Plan with **heat exposure and vulnerability maps**, including satellite-based surface temperature analysis. The study identified **industrial areas as urban heat hotspots** and provided **maps of potential climate refuges** (e.g. air-conditioned public spaces) and **green space accessibility zones** - defined as areas reachable on foot within five minutes - offering useful insights for local policymakers.



Caption: Map of green space accessibility in Sassari, showing areas reachable on foot within five minutes—potentially offering cooler zones during heatwaves.

In this context, CMCC's first Climate Monitoring Report for Rome represents a paradigm shift in how cities can harness scientific knowledge for climate adaptation. The report exemplifies the EU Mission on Adaptation to Climate Change, which supports at least 150 European regions and communities in becoming climate-resilient by 2030. Rome is **among the 100 European cities selected to achieve climate neutrality by 2030**, making it a pilot case for Europe.

What is the way forward? Bringing science and policy together to explore adaptation measures – from nature to technology-based – that are both effective at improving resilience and equitable.

CMCC experts are available to share their insights with interested parties, including journalists.

Contacts:

- **Mauro Buonocore**, Press Officer, CMCC
  mauro.buonocore@cmcc.it
  tel. +39 0832 1902411 - mob. +39 3453033512
- **Marina Menga**, Press Office, CMCC
  marina.menga@cmcc.it
  tel: +39 0832 1902411, ext. 303