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# NEW CHALLENGES FOR XXI CENTURY CITIES

## Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation


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TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2024 volume of TeMA Journal propose articles that deal the effects of global warming, the ageing of population, the reduction of energy consumption from fossil fuels, the immigration flows from disadvantaged regions, the technological innovation and the optimization of land use.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. The articles are included in main scientific database as Scopus (from 2023), Web of Science (from 2015) and the Directory of Open Access Journals (DOAJ). It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

TeMA Journal of
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The cover image shows older people climbing Via Raffaele Morghen's stairs in Naples (Source: TeMA Journal Editorial Staff).

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

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**REVIEW NOTES – Urban Practices**

# Global warming or global warning? A review of urban practices for climate change adaptation in Europe

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban Practices section aims at presenting recent advancements on relevant topics that underline the challenges that the cities have to face. This note provides an overview of the challenges that global warming poses and the risks in terms of climate change that it generates for territories and cities. The challenges that adaptation to climate change commonly faces are outlined, and a brief review of European case studies is carried out. Finally, the results of the review are discussed highlighting some key threads of climate adaptation practices and three significant examples of climate change adaptation in urban areas are reported, within a perspective of integration and sharing of know-how on the topic.

**Keywords**
Climate Change; Adaptation; Urban practices; Case studies; Europe

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# 1. Introduction

The year 2023 was the warmest year on record in global temperature since 1850. In the 12-month period between February 2023 and January 2024 the average global temperature exceeded pre-industrial levels by 1.5°C and the world air and ocean temperature has dangerously increased as well (Climate Copernicus, 2024). The rising temperature trend is gradually altering ocean and winds currents, precipitation patterns, and the internal dynamics of ecosystems: a phenomenon commonly referred to as climate change. This series of gradual alterations generates an increase in the frequency and severity of climatic extreme events that cause significant damage to the environment, people and the economy. Climate change also acts as a risk multiplier, worsening and exacerbating the condition of social groups that are already vulnerable or in a previous state of crisis due to other factors (European Climate Risk Assessment, EEA, 2024).

According to the official UN definition "since the 19th century, human activities have been the main factor behind climate change, which is mainly attributable to the combustion of fossil fuels (such as coal, oil and gas) that produces heat-trapping gases" (UNRIC, 2024). Reducing greenhouse gas emissions is indeed key to slowing and limiting global warming. However, even under the most optimistic scenarios of complete decarbonization of anthropogenic activities – as agreed by International Parties within the Paris Agreement – the effects of global warming, including climatic changes, will not stop immediately, and the effects will continue to develop and manifest themselves for several more years. It therefore emerges as a pressing necessity to adapt the built environment and the human society in order to cope with the disruptive effects of climate change in the short term, preserving crucial ecosystems and protecting human lives, while implementing mitigation long-term measures.

Europe is the fastest-warming continent in the world, heating at about twice the global rate. The European Environment Agency report "European climate risk assessment 2024" identifies 36 climate risks with potentially severe consequences across Europe and highlights how the relative levels on the severity scale have already reached critical levels. This analysis shows how urgent and priority it is to adapt cities both in the built environment and in the social organisation in order to cope with these extreme climatic events, reducing the vulnerability of urban systems and the related climate risks. On this matter, aiming for a more sustainable city model supporting the ecological transition means putting in place a coordinated system of strategies, actions and interventions to overcome the great challenges that cities today are called to respond to for the reduction of the effects of climate change (Gaglione & Ayiine-Etigo, 2021).

# 2. Climate change adaptation

The UNFCCC (United Nation Framework Convention on Climate Change) definition of climate adaptation reads as follows: "Adaptation refers to adjustments in ecological, social or economic systems in response to actual or projected climate stimuli and their effects. It refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change". This definition is aligned with those given by the IPCC and the EEA, and it configures this practice as a process of system variation, aimed at reducing its vulnerability or, similarly, increasing its resilience.

This concept began to take shape with the start of the scientific debate on climate change between the 1980s and 1990s. The general scientific output related to climate change has seen a slow and gradual increase with a significant acceleration after 2006, the year from which specific issues around mitigation, adaptation and resilience also began to feature in the climate change debate (Boulanger, 2023).

Over the last 15 years, the topic has become central to the scientific debate on climate change, although it has not yet assumed the centrality of mitigation, a topic that is at the core of major international agreements and forums, primarily COPs and the Paris Agreement. However, organisations and bodies dedicated to this key issue such as the Adaptation Committee (AC) and the Nairobi Working Programme (NWP) have been implemented at the international level under the coordination of the UNFCCC, and most importantly, the

Cancun Adaptation Framework established the process for the elaboration of National Adaptation Plans (NAPs), tools that each country is required to develop to reduce its vulnerability to the impacts of climate change, with the ultimate goal of integrating climate adaptation into existing and new policies.

With the increasing centrality given to the topic of climate adaptation in scientific production and the development of NAPs for several countries, there are numerous climate adaptation actions and measures that have been developed and just as many that are continuously being developed and put into practice. Since urban systems are complex due to the multitude of physical and functional elements upon which climate change has effect, it is crucial to design integrated plans and strategies to mitigate and adapt (Guida & Pennino, 2022). Moreover, given the importance of the climate change phenomenon at the global level, collaboration at the academic and institutional level is strongly needed and encouraged in order to share best adaptation practices to enable their replication in other similar contexts. To this end, several repositories exist that collect climate adaptation best practices and make them open access for all scholars, policy makers, and other interested users. In this series of review notes, some of the aforementioned repositories will be analysed and a few case studies extracted from the collection will be reported.

At the European level, there is an official European Union website: the European Climate Adaptation Platform Climate-ADAPT.

## 3. A review of Climate-ADAPT case studies

Given its above-average rate of warming, Europe is one of the continents that is already experiencing noticeable effects of climate change. Climate risks threaten energy and food security, ecosystems, infrastructure, water resources, financial stability and people's health (European Climate Risk Assessment, EEA, 2024). On the other hand, Europe is one of the countries most committed to the ecological and energy transition, and is at the forefront of climate change standards, practices and studies, both in terms of mitigation and adaptation.

Since 2020, all EU Member States (MS) have a national adaptation policy framework officially adopted (e.g. National Adaptation Strategy (NAS), mostly followed by a National Adaptation Plan (NAP) or Sectoral Adaptation Plans (SAP)) covering a broad range of climate change adaptation options and measures (Medri, 2020). Moreover, in February 2021, the European Commission adopted the European Strategy on Adaptation to Climate Change, with which it put in place a strategy to adapt to the inevitable impacts of the phenomenon and become climate resilient by 2050 (Directorate-General for Climate Action of the European Commission, 2021). In addition to the legal implications and European strategies, the European Union has numerous tools for collecting and sharing data on the phenomenon, including the European Climate and Health Observatory and the European Climate Data Explorer.

Among these valuable tools is the European Climate Adaptation Platform: Climate-ADAPT. This platform was created in cooperation between the European Commission and the European Environment Agency (EEA) with the aim of supporting European countries in adapting to climate change and is managed with the support of the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA). The platform enables organisations and stakeholders involved in climate change adaptation to share and consult information and data on climate change, vulnerability of different regions, and climate change adaptation strategies, actions and tools, including a collection of case studies from several European cities.

For the selection of the case studies to be presented in this review note, the English-language case studies uploaded on the platform in the last 5 years were analysed, for a total of 48 case studies. Case studies covering all adaptation sectors and climate impacts were analysed for all European countries.

For the selected sample of case studies, we report graphs of some of the most relevant indicators: country where the intervention took place, scale of the intervention (administrative level at which the intervention was carried out), climate impacts addressed and/or sectors affected.

The graph in Fig.1a shows that the majority of cases has taken place in Spain, Italy and Germany. There are no cases at all for Bulgaria, Croatia, Estonia, Ireland, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland and Romania.

Concerning the administrative level at which the interventions were implemented, as visible in the graph in Fig.1b, the majority were carried on at the local level, followed by national and sub-national strategies (the latter refer to sub-national administrative entities or geographical regions, such as river basins). In addition, there are 4 supranational cases, identified as "Transnational Region" measures, which are implemented across different nations for reasons of geographical or climatic continuity, as in the case of large transnational river basins. Then there are 10 actions that were developed in cooperation between several administrative levels, generally at local level in collaboration with regional or national authorities.

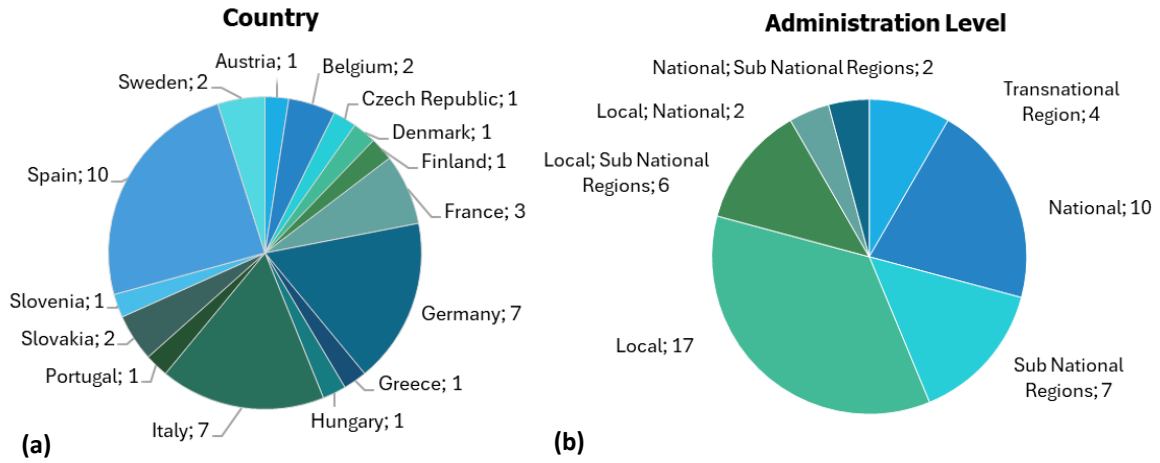



**Fig.1 (a) Country of implementation; (b) Administration level where the case study of the selected sample was implemented**

As stated in the ETC/CCA Technical Report on Key Type of Measures for adaptation to climate change, while often targeting the same vulnerable systems and problems, climate change options and measures are highly heterogeneous in the way they are organised, labelled and described across EU Member States (Medri, 2020). For this reason, a pool of experts from the ETC/CCA and the EEA drew up the above-mentioned report "Rationale, approach and added value of Key Type of Measures for adaptation to climate change" in 2020, which describes how the labelling system of climate change adaptation measures for the EU was developed from the category system defined in the IPCC Fifth Annual Report, a system also used in the cataloguing of the case studies on the Climate-ADAPT platform.

For the realisation of this review note, a great deal of information was collected for each case study, including KTM, Sub-KTM and their specifications. However, as pointed out by the researchers who prepared the report, many of the measures present a strong heterogeneity and are difficult to place in a single category. For this reason, in this review, it was decided to categorise the measures into 5 qualitative categories, which simplify the identification of some common trends among the adaptation measures analysed in the sample. The categories refer to the climate impact in question or the sector affected by the phenomenon, and are:

- Extreme Temperatures: this category includes all measures to combat the effects of climate change on people and/or the built environment caused by rising temperatures, extreme heat and heat waves;
- Water: this category includes all adaptation measures affecting watercourses and precipitation, including causes and effects of flooding, runoff, salinisation of river deltas, river water pollution, etc.;
- Extreme Temperatures/Water: this category includes measures that act on the effects of climate change on ecosystems that are highly dependent on water, such as forests, farms, agricultural areas, and thus

includes all phenomena such as droughts, water scarcity, alteration of ecosystems and reduction of biodiversity in natural environments caused by temperature increase;

- Health: this category includes all measures that are exclusively related to the effects of climate change on human health, directly or indirectly. These include the spread of viruses, invasive species carrying viruses or substances harmful to humans, and the effects of climate change on the mental health of the population;
- Governance: in this last category, we find all measures, generally national or supranational, aimed at fostering cooperation, information sharing, more effective organisational structures for adaptation to climate change through staff training, information provision and academic cooperation.

As can be seen from the graph in Fig.3 regarding the analysed sample of cases, this categorisation shows that there are clearly predominant trends in climate change adaptation measures. Indeed, the interventions are almost equally distributed among the five categories, highlighting how the identified sectors, in relation to specific climate impacts, are those of greatest interest and pressure in the current European framework.

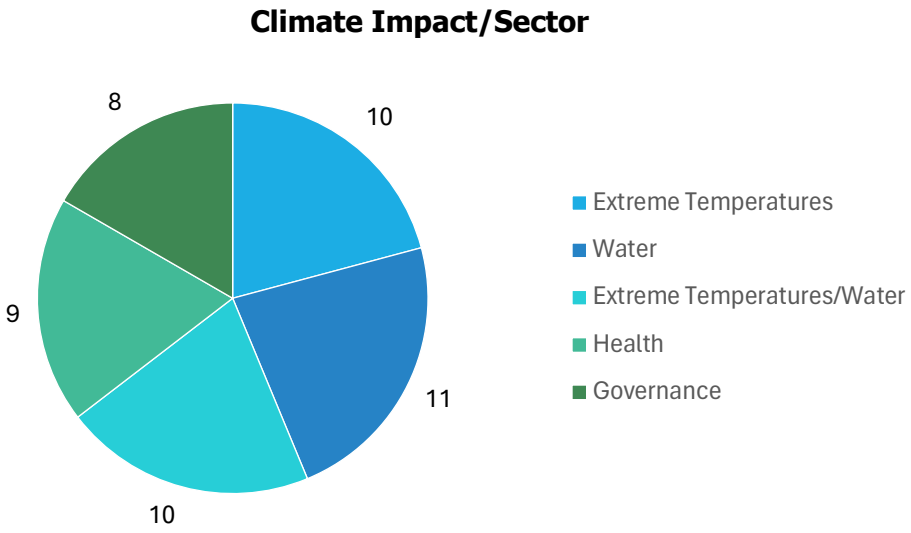



**Fig.2 Categories of the climate change adaptation case studies analysed in this review note**

## 4. Considerations from case studies

The review of the case studies reveals a great deal of information about the spread and location of the case studies, the types and climate impacts of greatest concern.

In terms of dissemination, it appears that most of the case studies were implemented in the largest and most populous countries in Europe, with Spain in first place, followed by Germany and Italy, and France. A number of smaller and less populous but committed European countries then emerge, including Sweden, Belgium and Slovakia. By contrast, countries in the Balkans and Eastern Europe are almost completely absent.

With regard to the type of interventions, there is a considerable multiplicity. Interventions implemented at local or regional level are generally more focused on the physical, built or natural environment and include actual interventions, monitoring tools or strategies, or interaction with the users of the places in question. Strategies at the national or transnational level, on the other hand, are generally at the technological, organisational, or governance level, and focus on sharing practices, training personnel, early warning systems, coordinating interventions, and improving cooperation between different administrative bodies affected by the phenomena addressed.

The data on trends in climate impacts dealt with/sectors affected is significant, as they clearly show predominant sectors for climate change adaptation.

The predominant category, albeit by only one case, is Water. This is not surprising, as one of the most evident phenomena of climate change is the variation in rainfall patterns, which has significant effects on rivers and streams in terms of flooding and runoff, which in turn have serious consequences on the natural and built environment, significant fallout and economic losses, as well as constituting a risk to people, and a very strong cause of anxiety, post-disaster shock, and threat to the mental health of people impacted or threatened by these phenomena. In fact, the case studies on watercourses include both physical interventions on them, protection and management through nature-based-solutions, monitoring interventions and early warning systems, but also financial instruments for reducing the vulnerability of the threatened population and psychological support programmes for people affected by the aforementioned phenomena.

Among the most prevalent categories, tied for second, is that concerning all phenomena due to extreme temperatures, which includes all actions aimed at adapting the built environment to mitigate the effects of increasingly frequent extreme temperatures. These include new construction or renovation of existing buildings by significantly increasing green areas, integrating trees and plants, nature-based systems for cooling and lowering temperatures. An interesting aspect of this category of interventions is that they often involve public facilities, managing to reach a large part of the population and especially some of the most vulnerable groups, including children and the elderly.

Then there is a third predominant category, which is the one that encompasses all phenomena related to water resource management in agricultural, river or forestry contexts. Phenomena such as droughts, water scarcity, and impoverishment of biodiversity due to high temperatures are a major threat to crops, forests and mountain habitats, but also to tourism in some areas. This type of climatic impact is confirmed as one of the most widespread. The interesting aspect is precisely the location of the interventions, since they are not located exclusively in the Mediterranean area, where the phenomenon of heatwaves is most keenly felt, but there are also relevant cases in Germany, Belgium and Sweden, countries generally considered less affected due to their different climate and geographical position.

A surprisingly present category is the health sector. Nine actions concern the development of new risks to human health caused by rising temperatures, of which one is related to the treatment of eco-anxiety, two to the invasion of invasive marine species harmful to humans, and no less than six actions to study, monitor or counter the spread of new viruses from tropical areas generally transmitted by mosquitoes, including dengue, West Nile Virus or tick-borne encephalitis. The risk of the spread of new and more infectious viruses from tropical areas is an issue that emerged strongly in late 2023 and early 2024 due to the increased spread of dengue in South America, and also due to the increased sensitivity of the topic following the Covid-19 pandemic. However, these case studies show that the phenomenon is far from recent and is already receiving attention at European level, as some of them were implemented almost 20 years ago.

The last category, slightly lower with eight case studies, is governance measures. This category of interventions includes numerous projects implemented at the regional or transnational level to coordinate the study, monitoring and cooperation actions in climate adaptation of administrative or geographical regions. Among these initiatives, two significant trends emerge, the first being the integration of adaptation measures into policies or interventions already in place or being implemented, making adaptation a necessary and integrated requirement throughout the development process of the interventions themselves. The second concerns the training of professionals most affected by the issue, including two interventions entirely dedicated to health professionals, who play a key role in addressing the effects of climate change.

As relevant examples three case studies were identified for their readiness and replicability, for the multiplicity of aspects they deal with, and for the possibilities that the integrated actions they indicate concern several urban levels simultaneously. The three cases refer to three different categories defined previously: Extreme Temperatures, Governance and Water, and were implemented in three different countries. The first one, belonging to the "Water" category, refers to a "Grey" intervention, i.e. the realisation of a physical

infrastructure, in particular a hydraulic infrastructure system to limit the effect of contaminated water spilling into the sea following extreme rainfall phenomena, carried out in Rimini, Italy. The second , belonging to the "Governance" category, shows an example of mainstreaming climate adaptation, integrating this practice into the design and implementation of public infrastructure on city territory, through an example in the city of Jena, Germany. The third intervention, belonging to the "Extreme Temperatures" category, refers to a complex adaptation system at the urban scale for the crescendo phenomenon of heat stress, including a heat prediction and warning system, integrated with targeted actions at the urban level and awareness and involvement interventions implemented in the city of Antwerp, Belgium. They are illustrated in the following data sheets.

**1.1 Protecting bathing water quality from sewage overflow in Rimini, Italy**

During heavy rainfall events, Rimini frequently experienced combined sewage system overflows which caused local surface flooding in the city and direct discharge of untreated, diluted wastewater into the sea. The resultant contamination of sea water was posing health risks and necessitated frequent implementation of bathing bans on the city's beaches, with negative impacts on tourism.
The Municipality of Rimini set up and continues to implement an Optimized Seawater Protection Plan (*Piano di Salvaguardia della Balneazione Ottimizzato – PSBO*), which included the creation of a separated sewage collection system, improvement of the sewage treatment system and construction of storage tanks for overflow water. After the finalization of the sewerage system works on Rimini's northern coast in 2020, the discharges of untreated wastewater into the sea have been drastically reduced. Despite continuing occurrence of heavy rainfall events, the number of bathing bans implemented has decreased.
Public works on the street surfaces, necessary during renovation of the sewage system, provided an opportunity to transform streets and parking areas on the waterfront into an urban park ("*parco del mare*") with green areas and space for recreational activity that simultaneously functions as a barrier against coastal flooding.

Source: Climate-ADAPT; Feb 27, 2024

Retrieved from: https://climate-adapt.eea.europa.eu/en/metadata/case-studies/protecting-bathing-water-quality-from-sewage-overflow-in-rimini-italy

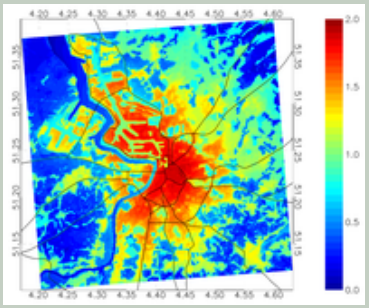
**1.2 Mainstreaming climate change adaptation into urban planning: greyfield land redevelopment in Jena, Germany**

In Jena, adaptation has been integrated in urban planning thanks to public awareness, public institutional support, and investments in collaboration and research. Detailed cost-benefit analyses inform decision-making for interventions such as the greyfield land redevelopment.
Jena is a city of about 108,000 inhabitants and – due to its specific geographic location – is exposed to various climate change-related risks, whereas heatwaves are the most relevant. Climate projections for Jena expect a substantial increase of this risk in the future. Under the frame of "JenKAS - Jena Climate Adaptation Strategy", a concept for adapting the city to climate change impacts was developed between 2009 and 2012 as part of a project funded by the Federal Ministry of Transport, Building and Urban Development and the Federal Institute for Research on Building, Urban Affairs and Spatial Development. The overall goal of the project was to lay the ground for mainstreaming climate change adaptation into urban planning.
The redevelopment of the Inselplatz – a 3 hectares inner city square mainly used as parking area – into a new campus of the Friedrich Schiller University was one of the first practical interventions for which the JenKAS approach was applied. As part of the planning process economic assessments were conducted to determine the most suitable bundle of adaptation measures to reduce local heat risk and to improve the local climate of this specific area in the medium and long-term perspective.

Source: Climate-ADAPT; May 08, 2020

Retrieved from: https://climate-adapt.eea.europa.eu/en/metadata/case-studies/mainstreaming-climate-change-adaptation-into-urban-planning-greyfield-land-redevelopment-in-jena-germany

### 1.3 Adapting to heat stress in Antwerp (Belgium) based on detailed thermal mapping



The city of Antwerp, facing increasing heat stress, has adopted adaptation measures at the city-wide, local and citizen scale. This includes the development of a heat forecast and warning system, which has raised awareness at the political level. However, challenges remain for communication and technical integration.

The city of Antwerp, in order to better understand the problem of heat stress, commissioned the research organization VITO to map the current and future temperatures and thermal comfort in the city. The research results indicate that the urban heat island of Antwerp exacerbates the impact of climate change on the urban population as the amount of heatwave days in the city raises twice as fast as in the rural surroundings. To tackle the problem of heat stress in the city, adaptation measures at three different scales (city-wide, local and the individual citizen) are put forth. At the city-wide scale, the installation of green roofs is made mandatory for new or renovated buildings with a suitable roof, as are permeable and green parking lots. The regulations also aim to increase albedo of public buildings. At the local scale, the thermal comfort is improved by installing fountains and ponds, planting trees and creating parks in public spaces that are renovated, while involving inhabitants through citizen science measurement campaigns. Finally, a dedicated heat forecast and warning system is put in place to minimize the health impacts to individual citizens.

Source: Climate-ADAPT; Apr 07, 2020

Retrieved from: https://climate-adapt.eea.europa.eu/en/metadata/case-studies/adapting-to-heat-stress-in-antwerp-belgium-based-on-detailed-thermal-mapping

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