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The report "Building resilience: being young and getting old in a hotter Europe" is part of a series of reports on the topic Climate Action in which our experts highlight specific data, facts and science that are needed to plan and build safe and resilient future urban environments.

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Urban Insight

Building resilience: being young and getting old in a hotter Europe

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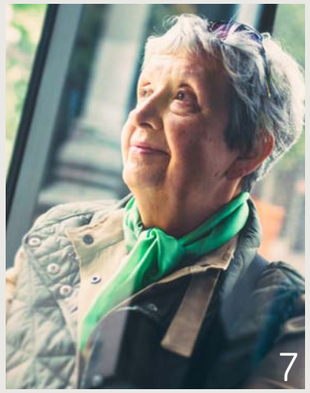
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Building resilience: being young and getting old in a hotter Europe

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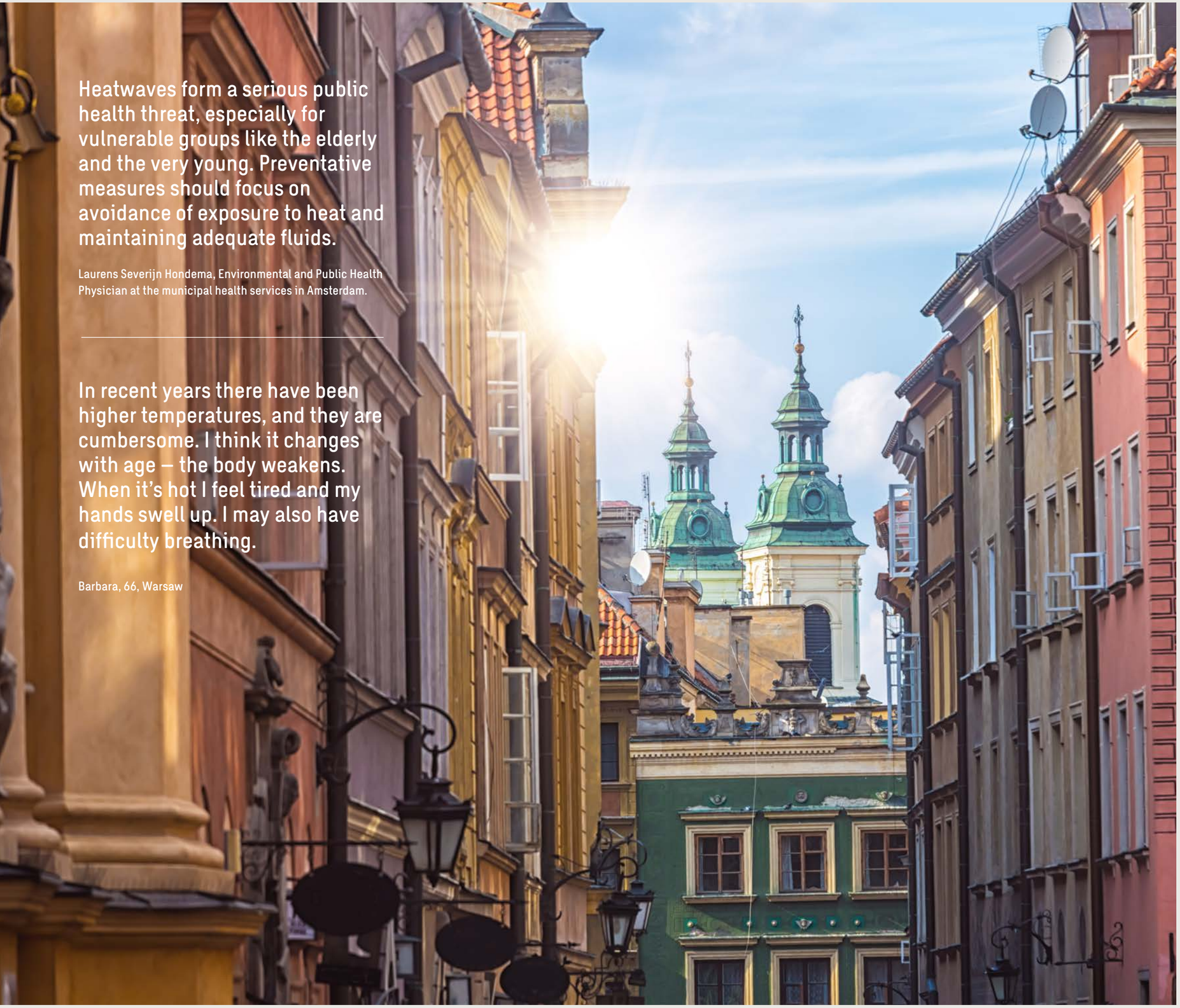


Heatwaves form a serious public health threat, especially for vulnerable groups like the elderly and the very young. Preventative measures should focus on avoidance of exposure to heat and maintaining adequate fluids.

Laurens Severijn Hondema, Environmental and Public Health Physician at the municipal health services in Amsterdam.

In recent years there have been higher temperatures, and they are cumbersome. I think it changes with age – the body weakens. When it's hot I feel tired and my hands swell up. I may also have difficulty breathing.

Barbara, 66, Warsaw

Foreword

Recent years have brought new high temperature records across Europe, with the summer of 2019 witnessing record highs across France, the Netherlands, the UK, Belgium and Germany[1]. These hot days might be enjoyable for some, but they also pose a significant and growing health risk to our families and communities.

Urban environments are affected by high temperatures. They are home to more of us than ever before – while half of Europeans (52%) were urban dwellers in 1950, the numbers had increased to 74% by 2015, with the trend set to continue.[2]

While climate threats like flooding receive a lot of attention because of their vast economic impacts, the threat of extreme heat does not. More European citizens die from heatwaves than natural hazards like flooding, pollution, wildfires and earthquakes[3]. Cities have got to decide how to address this threat, while improving their sustainability and liveability.

Certain groups in cities are more vulnerable to heatwaves than others, such as young children and older people. While the proportion of younger people in Europe is not set to change, Europe is getting older, and the elderly are particularly at risk. In Europe, the number of people over 65 is rapidly increasing, with those over 80 expected to more than double from 5.6% in 2018 to 12% by 2060.[4]

Cities will face multiple shocks and stresses in the future, with the vulnerable usually paying the highest price. The coronavirus pandemic is also bringing this to light. We need to manage how we develop our buildings and public spaces in our cities to protect our most vulnerable.

This Urban Insight Report, "Building resilience: being young and getting old in a hotter Europe", aims to put urban heat on the agenda. Based on interviews with specialists and European citizens, we explore and address how we can create sustainable, liveable cities using the concept of urban resilience.

Three global Sustainable Development Goals are in focus in this report:

Urban heat

Extreme heat events – heatwaves, and hot days and nights – will increase in intensity, frequency and duration in the future due to anthropogenic climate change[5]. Impacts will be felt across Europe, and cities in particular will be vulnerable due to their agglomeration of people, infrastructure, and economic activity. Additionally, the southern and central parts of Europe will encounter the most substantial change in summer temperatures.[6,7]

Although the specifics are uncertain, current worst-case scenario projections show that 72% of European cities may experience an increase in maximum high temperatures of 10°C by 2100, compared with historical temperatures (1951-2000).[7] Even if we stabilise carbon emissions, we are still expected to experience higher temperatures and higher extremes in the future.

INCREASE IN HEATWAVES
In a worst-case scenario (RCP 8.5), the number of heatwave days will likely increase by the following across Europe. The RCP 8.5 scenario relates to a global temperature increase by the end of the century of up to 4.8°C[43]. This demonstrates the importance of taking action as part of the Paris Agreement to ensure the global temperature increase remains below 2°C.

Athens	Barcelona
43%	44%
London	Rotterdam
19%	20%
Stockholm	Warsaw
35%	13%

Predicted increase in heatwave days in the future (2051-2100), compared with historic levels (1951-2000) for a worst case scenario (RCP 8.5).[7]

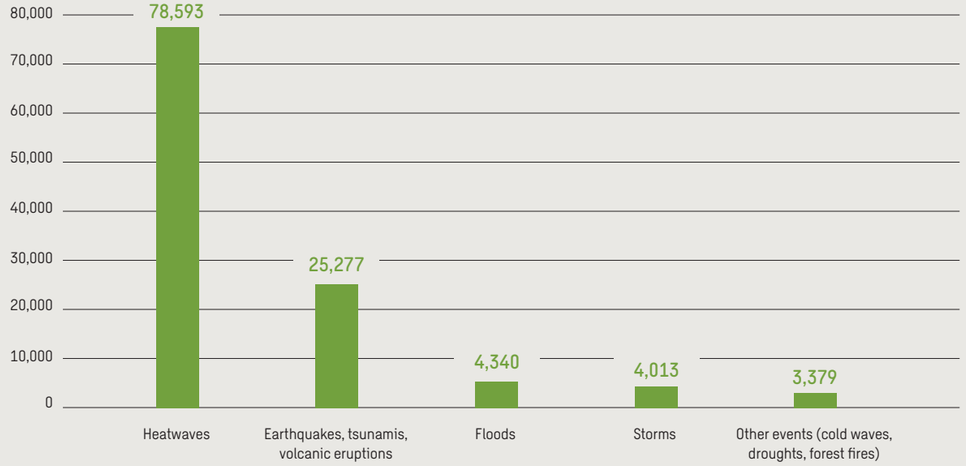
More Europeans die from heatwaves than all other natural hazards combined. This includes earthquakes, tsunamis, volcanic eruptions, floods storms, cold waves, droughts, and forest fires.

Predicting the future is tricky. The increase in heatwaves shown in the figure below can vary depending on the different scenarios used to project future climate. (For more information on different projections (RCPs), as well as on other impacts of climate change across Europe, check out the 2017 EEA report in the References[43]). Whilst this uncertainty needs to be taken into account in policymaking, future projections are still vital in helping us to prevent the worst-case scenarios from becoming reality.

IMPACTS ON HEALTH
Extreme heat events are linked to a multitude of health impacts[8]: dehydration, heatstroke and exhaustion, increases in incidence of disease (cardiovascular, respiratory and cerebrovascular) and increases in premature death. The elderly, infants and young children, those with pre-existing health problems and those in hospital or bedridden are most at risk. While these groups are physiologically more sensitive to heat, how people subjectively experience heat is also important and depends on a complex interaction of many factors[9,10,11]:

- Physiological. Previous long periods of hot weather can result in physical acclimatisation, reducing the negative impact on the human body.
- Local climate. Humidity, air temperature, shading and windchill all impact on how heat is experienced.
- Socio-economic. Being socio-economically disadvantaged affects your experience of extreme heat – for example, due to the quality of available housing, the availability of affordable mitigation measures like air conditioning, and proximity to green spaces.
- Psychological. Spending time in urban greenery can improve perceived well-being, alleviating the perception of thermal discomfort.

FATALITIES FROM NATURAL HAZARDS
Fatalities from natural hazards in 33 European countries during 1980-2017. Fatalities from heatwaves make up 68% of all deaths related to natural hazards.[3]



It's a shocking fact that more Europeans die from heatwaves than all other natural hazards combined[3]. From 2000 to 2018, floods – a visible threat that governments spend a lot of money on mitigating – killed over 700 people across Europe.[12] But in comparison, in just one year the death toll due to extreme heat across Europe exceeded 70,000 people.[13] This was in 2003, the deadliest year in recent European history (not including the coronavirus pandemic).

As well as increasing mortality, heatwaves impact hundreds of millions every year due to health problems, water shortages, power blackouts, wildfires, pollution and infrastructure damage.[8,14] Furthermore, when temperatures indoors or outdoors exceed 25°C, worker productivity declines by 2% per degree on average.[15] Such declines in productivity can have huge economic impacts.

URBAN HEAT ISLAND EFFECT

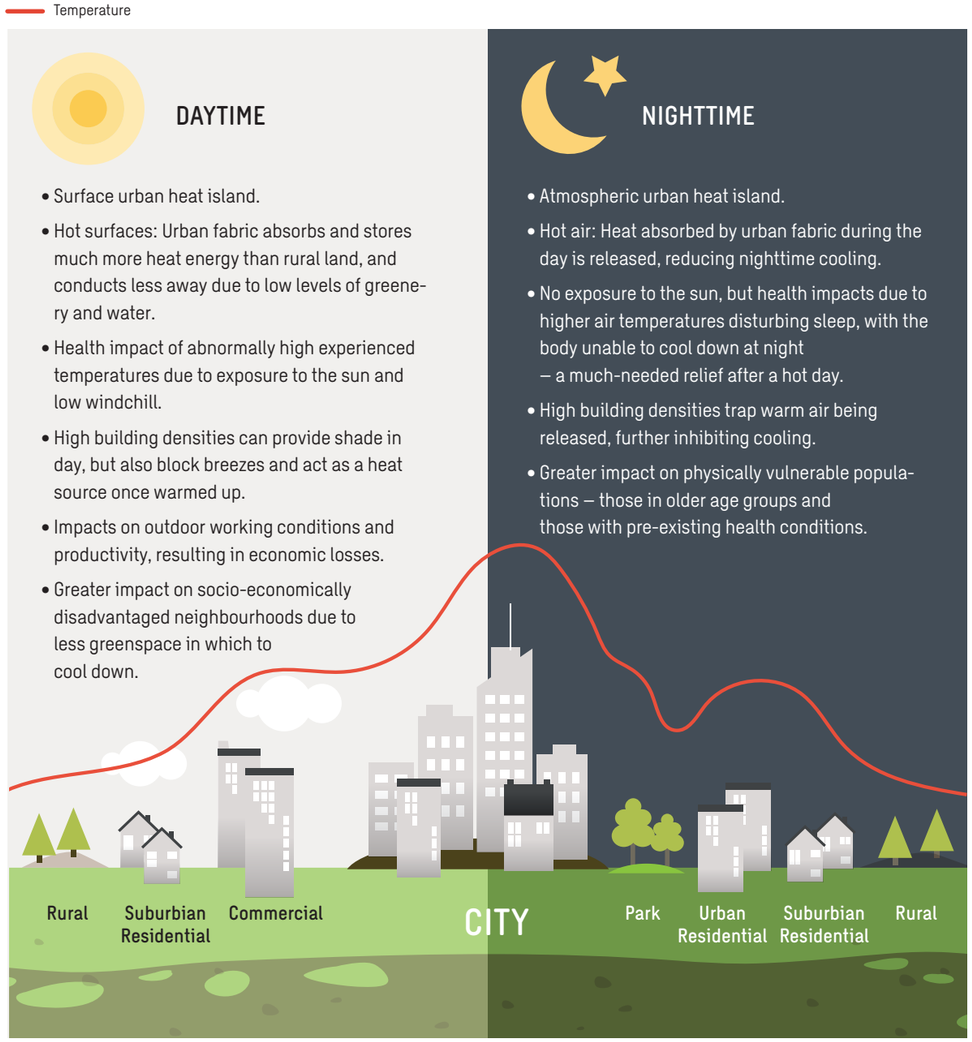
The impact of heat in cities is exacerbated by the urban heat island effect (UHI). This is a phenomenon whereby many cities are warmer than their rural surroundings due to a combination of dark surfaces, high-rise buildings, lack of green space, lack of wind and air pollution trapping heat from the sun, industry, traffic, and day-to-day activities. This effect is most pronounced at night, with extreme cases displaying differences of 5-10°C between rural and urban areas, with the average effect a difference of 2-4°C[16]. Heatwaves also make the UHI effect worse, and this effect will intensify with climate change.[5]

Climate risks such as flooding are very visual, whereas heat is invisible. It's not a tangible risk, similar to air pollution.

Anna Mavrogianni, Associate Professor of Sustainable Buildings and Urban Design at University College London

THE URBAN HEAT ISLAND EFFECT

Daytime and nighttime impacts of the UHI effect, as well as the health risks due to heat.[16, 17, 18, 19] These result in an uncomfortable urban environment – one with reduced liveability and spatial quality.




Project: Strandveien 1, Norge. Photo/illustration: HRTB Arkitekter/ Sweco Norge/ Cadman/ MIR

VISUALISING HEAT

Many European cities in cooler and more temperate climates were built for staying warm, not for staying cool. Many are full of older buildings, difficult to alter and adapt. Any number of other historical and cultural reasons may mean that we are ill-prepared to manage the impacts of heat.

And despite the facts and figures, the problem remains: The threat to the health of vulnerable people has not had much of an impact on policy-making or public awareness. The impacts are still difficult to visualise. What might an increase in summer temperatures or more frequent heatwaves in the future actually feel like for me, my children, my elderly parents and my city?

One way to visualise the changes that we will experience in the future is to use climate analogues as a tool.[20] These demonstrate the supposed geographic shift cities will experience in the coming years. The Crowther Lab has done this for 520 major cities across the world, showing the cities (i.e. the analogues) that current cities will most likely resemble by 2050.[21] Some of these shifts for European cities are shown in the figure below.

CLIMATE ANALOGUES

What the climate of European cities will feel like in 2050 under an optimistic scenario, where we stabilise CO_2 emissions by the middle of the century. (RCP 4.5).[20, 21]

Using this tool allows us to understand what the 2050 temperature equivalent of our city will feel like as well as how to visualise our hotter future and potentially change the way we build our infrastructure and institutions.

	Current average max. temperature of warmest month	Likely change in average max. temperature of warmest month by 2050	What current city represents what this change will feel like?
ROTTERDAM	20.3°C	+3.5°C	Paris
LONDON	21°C	+5.9°C	Barcelona
BARCELONA	27.5°C	+3.4°C	Lisbon
STOCKHOLM	19.8°C	+5.9°C	Budapest
WARSAW	21.8°C	+6.6°C	Tbilisi
ATHENS	30.6°C	+5.7°C	Fez

Experiencing extreme heat

– the old and the young

We know that both the old and the young are more physiologically sensitive. People over the age of 65 are more vulnerable to heat, and this vulnerability increases with age. Infants younger than one are particularly impacted by heat-related mortality due to the weakness of their thermoregulatory systems[22].

The young and the old also experience hot weather in a particular way, depending on their own vulnerabilities and routines and the routines of the people who care for them. It is important to understand the experiences of the most vulnerable to ensure that we build resilience in a way that adequately caters to their needs.

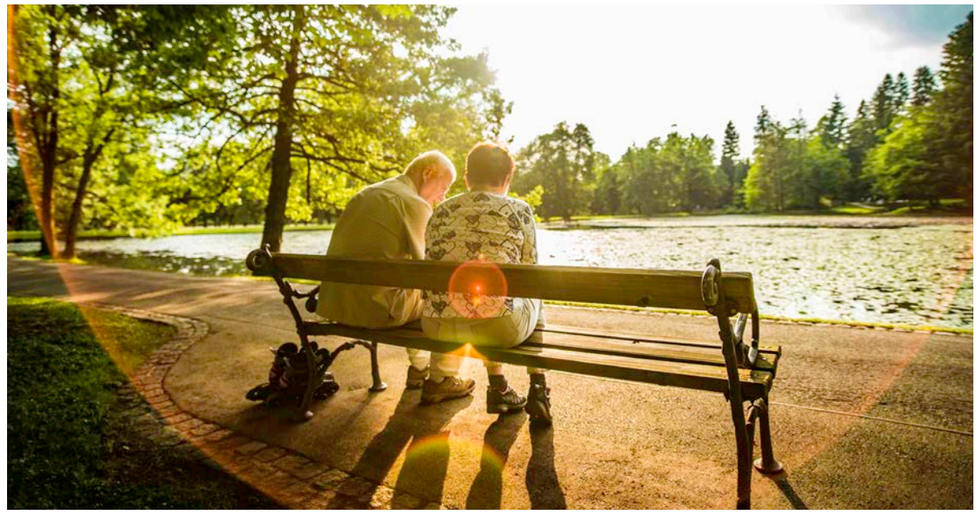
Older people increasingly live alone, which raises questions about their accessibility to nearby facilities and social integration.[23, 24] They might also rely on caregivers in nursing homes or hospitals, highlighting the importance of health-care quality and management. Children's caregivers shoulder a huge responsibility for their well-being since children are unable to care for themselves. Spaces where children spend their time – nurseries, schools and playgrounds – all add to their experience of heat. The next page helps us to visualise the experience of the old and young in more detail.

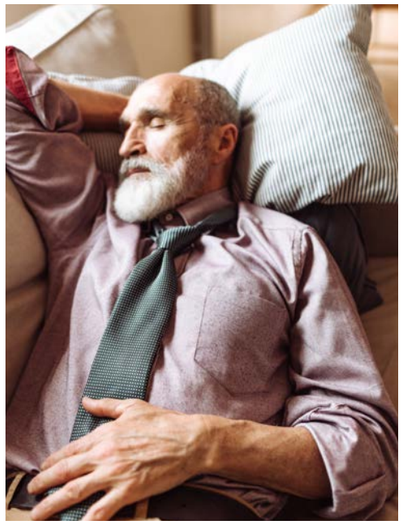
I felt uncomfortable walking on the open, heated sidewalk. I feel the heat now, as if it were worse, as if I were allergic – not like before when I was young, when it meant I could sunbathe. My age matters.

Rajmund, 81, Warsaw

Living in the city before, I remember considering buying an airconditoning unit, because the baby's room was on the top floor, under a flat roof. The hot room made it difficult for the children to sleep.

Martijn, 38, Utrecht





Citizen experience

How do young children, and older people like Rajmund, Barbara, Maria, Robin, Eileen and Roman experience heat? These insights are based on interviews and literature.[25-31]

A lack of thermal insulation in buildings, and sleeping in a room directly below the roof of the building, are particularly risky for older people.

High air temperatures can contribute to air pollution. Both are associated with child asthma, obesity, and behavioural and cognitive development.

A lack of effective heat management in care homes can heighten vulnerability.

There is a lack of standardised data on thresholds for risks and criteria for overheating for young children and older people, preventing the development and implementation of long-term strategies.

Older people change their behaviours and routines in response to heat. They shift their routines earlier, buy fans and darker blinds, drink more water and using cooling techniques like taking more showers and using misting sprays.

Some children spend more time outdoors involved in vigorous activity than adults, thus increasing their vulnerability to heat.

Older people often do not perceive themselves as either old, or vulnerable. Additionally, some older people view interventions that approach them directly as patronizing and patriarchal.

Social contacts are important: being a widow or widower is an important vulnerability factor, as is depression.

"I live in a block of flats and these rooms are not big, so when it's hot it's not easy. The concrete heats up quickly. I have slight asthma and need to take medication when it's like this".

Maria, 81, Poznan

"You have to drink a lot in the summer but then it can be difficult to find a toilet when you are out. This is a problem for women when they are older and it can be stressful".

Barbara, 66, Warsaw

"Not having a garden or any shade would really prevent me from being able to cope".

Roman, 72, Poznan

"Rarely any apartment is adapted to the heat. During heat waves it is better at my son's home. Nights in my own apartment are unpleasant in the heat, you cannot sleep".

Rajmund, 81, Warsaw

"It must be very difficult for elderly people living in flats or alone. The community network is very important".

Eileen, 75, London

"There should be more greenery in the city. Where there are large open spaces, concrete and the biggest hustle and bustle, fountains and squares should appear instead".

Rajmund, 81, Warsaw

"Smog, hot pavements, hot walls, hot roads – all these are challenges to living in the city."

Rajmund, 81, Warsaw

"We started having a siesta in the afternoon. It was a good way to recharge and also a good use of the time when it was unbearably hot outside".

Robin, 78, London

"Public transport was even hotter than usual. I didn't even dare to take the tube because it is always too hot, even when it is cool outside. But I wanted to keep doing my normal tasks...Staying sociable is important for me, even if it is very hot on the bus!"

Eileen, 75, London

Building resilience in cities

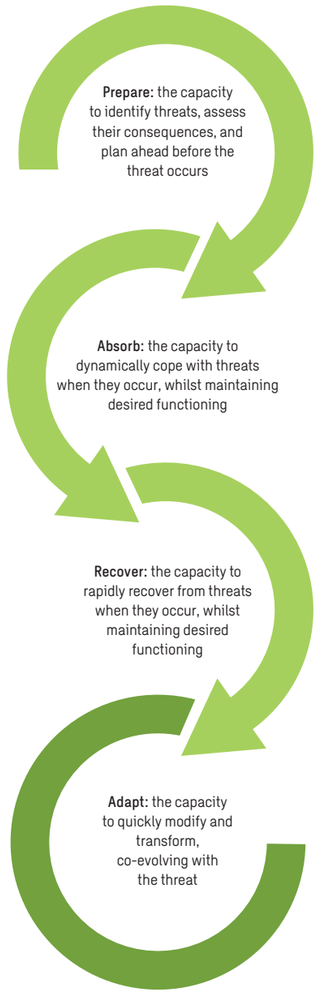
We understand the facts and figures around the problem of heat in cities and can visualise how it impacts our most vulnerable. But beyond heat, cities face a myriad of other potential threats that disrupt their functioning. These include shocks and stresses like natural disasters, financial crises, terrorist attacks and biodiversity loss[32], not to mention the spread of infectious disease as experienced during the coronavirus pandemic. Because of the global nature of our world, these threats intersect and interact, making their nature, magnitude and impact difficult to predict.

We also need to be able to look ahead. What do we want our future and the future of our children to look like? We must be equipped to face whatever the future holds, while ensuring that cities remain liveable, healthy, attractive and functional.

So, how can we prepare for not only a future of higher temperatures, but one that holds a host of other challenges, particularly for our most vulnerable?

The answer lies in building resilience into our cities and society at large. Being resilient helps us – and our communities and cities – to manage the interconnectedness of all these challenges. It enables us to prepare and quickly cope with and recover from challenges without being impacted too negatively. But it's not just about quickly returning to business as usual: it's about learning and positively adapting to a new normal, and even transforming our systems and their ingrained societal inequities that affect the way people are impacted in the first place.

Building resilience can focus on strengthening four capacities: the capacity to **prepare** for threats, to **absorb** them and quickly **recover** when they occur and to **adapt** and transform the way we cope in the future. This conception of resilience is based upon academic literature that synthesizes the vast array of research on the topic.[33]



The four capacities or approaches, to building resilience.

SOCIAL STRUCTURES
Behaviours, communication systems, governance systems, institutions

PHYSICAL STRUCTURES
Infrastructure, environment, urban metabolism (flow of resources and data)

WHERE CAN RESILIENCE BE BUILT? [34, 35]

Strength in all four capacities would be optimal. But in reality, the physical and social structures in each urban environment are different. Resource availability, the types of other challenges faced, particular vulnerabilities, and political and socio-economic factors all result in different priorities at the local level. This means different approaches are required to build resilience.[33]

The four capacities can therefore translate into four approaches to building resilience, with each more or less relevant or desirable in different settings. This allows a focus on what is needed and what is possible in the local context.[33, 34]

The capacity for resilience needs to be built in both the social and physical structures of our urban systems. It should be tailored to the needs of the most vulnerable people like the young and the elderly. Physical and social structures are not separate but interrelated: you cannot build optimal infrastructure without considering the needs of the community who will use it.

Policy-makers, building managers, developers, consultants, architects, urban planners, teachers, social workers, communities, families and individuals: all these people are stakeholders, with their own role to play.

Building resilience is relevant for a range of shocks and stresses. But let's apply resilience to the threat of heat. What might a city resilient to this threat in both its social and physical structures look like for the very young and old?

Approaches to building resilience

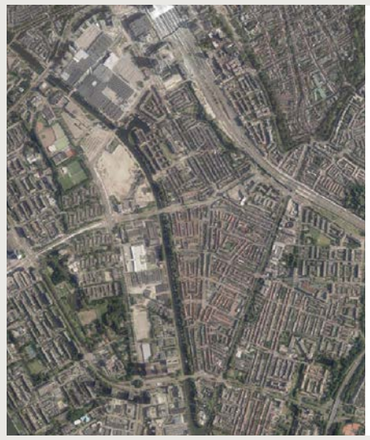
What might a city resilient to extreme heat look like for a 2-year-old and an 80-year-old?

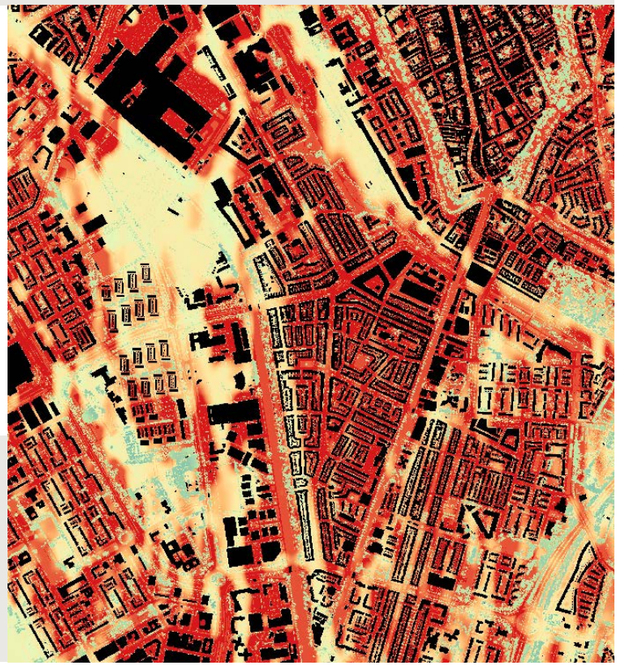
PREPARE

The first approach to building resilience is: be prepared. Data is crucial for increasing the capacity to prepare for challenges. In a city with a strong capacity to prepare, the municipality has conducted research on important thresholds and criteria particularly for vulnerable groups. Risk and vulnerability assessments pinpoint the particular threat to our 2-year-old and 80-year-old.

HEAT MAP OF UTRECHT, THE NETHERLANDS

The Netherlands has a standardised method for heat maps, making them comparable among different municipalities. This method is based on calculating the Physical Equivalent Temperature (PET), which includes weather parameters like wind, air temperature, humidity and radiation from nearby meteorological stations but also local characteristics like buildings and trees, land use, and topography. This means that many of the different factors that contribute to the experience of heat can be mapped.





Many cities struggle with a lack of data on heat impacts, which is one of the reasons why it hasn't been much of an issue before. If there is insufficient data, municipalities cannot signal heat as an important climate adaptation theme.

Lina Hansson, Climate Adaptation Strategist, Sweco. Stockholm, Sweden

Indicators for thresholds at which extreme heat is dangerous for our vulnerable groups are proactively monitored. The municipality knows the location of neighbourhoods that lack green space, and areas where buildings are particularly at-risk.

Heatwave response and management plans have also been created by the municipality, as well as by schools, nurseries, and elderly care and residential homes. Everyone has a responsibility: the general public (including parents, caregivers, and the elderly themselves) receive targeted information about the threat through prior communications and early warning systems, describing how to prepare themselves and the people around them.

Building regulations and guidelines are updated to counter the threat of heat in building design and upkeep. All at-risk buildings, such as schools and care homes, are regularly maintained and monitored for building safety. They are adequately equipped to house their vulnerable groups during a heatwave. The same holds true for climate shelters. Climate shelters are facilities with good thermal comfort where people can take shelter and cool off from hot weather, often located in community spaces like schools.

The municipality subsidises efforts to reduce the risk of extreme heat when it occurs. Our 80-year-olds can therefore be aware of and afford the retrofit measures offered that will help them insulate their homes against heat, among other measures. Such measures also result in co-benefits, like reduced heating bills.

EDUCATE AND EMPOWER:

In cities with a strong capacity to prepare, institutional practices and behaviours of vulnerable groups are understood and accounted for.

For example, the UK has a documented 'culture of warmth' around care for older people, whereby warmth is associated with the provision of good care.[26] This means that care homes and hospitals are often kept warm in summer, with care workers continuing to provide blankets and hot drinks to older people and keep the heating on, despite finding these conditions uncomfortable. This creates a hazard for the older people themselves, as well as for the carers in their working environment. When sources of warmth are removed, older people may perceive they are no longer being adequately cared for. In preparing for heat events, policy-makers and care managers need to ensure that carers are empowered to deal with this difficult situation, through adequate training and support to tackle these ingrained practices and behaviours.

ABSORB

The second approach to building resilience is: absorb the challenges. A city with a strong capacity to absorb can dynamically cope with an extreme heat event, while maintaining public functions and avoiding negative impacts. Our 80-year-olds and 2-year-olds change their behaviour in response to a heatwave, for example by drinking more water, taking midday naps and shifting routines to earlier in the day. Families and communities check on each other.

Green and blue infrastructure is key to the ability of our 80-year-olds and 2-year-olds to find relief from the heat. Staying mobile and maintaining social contacts are vital to the physical and mental well-being of older people; but despite wearing hats and drinking plenty of cold water when out and about, they still struggle with hot, unshaded pavements in warmer weather. Young children also struggle when running around outside on school playgrounds and parks. In a city with a strong capactiy to absorb, cool spots and climate shelters are situated throughout the city for them to take a break and cool off as they go about their day.

Our resilient city focuses on green and blue infrastructure – parks, tree-lined streets, fountains and open water – that all play an important role in absorbing the impact of heat and urban heat islands (UHIs). Such areas are strategically located, or example by landscaping around a care home, hospital or school, or providing accessible greenery near transport stops and local amenities.

Barbara, a 66-year-old from Warsaw, has a strong individual capacity to prepare and absorb:

We try to keep track of the weather forecast. Last year there were warning text messages. I also try to call my mother and tell her to drink on such days. When it is very hot I plan to stay in - I organise activities at home with my family. We have fans at home and we use them to circulate the air.

Cities across Europe are building their capacity to absorb the threat of extreme heat.

GREEN INFRASTRUCTURE FOR ALL

In Warsaw, new and innovative measures are being taken. These measures provide universal access to 'cold oases', particularly in areas where children and the elderly spend their time. These include green areas, shaded areas with benches, and shading and greenery at public transport stops.[36]

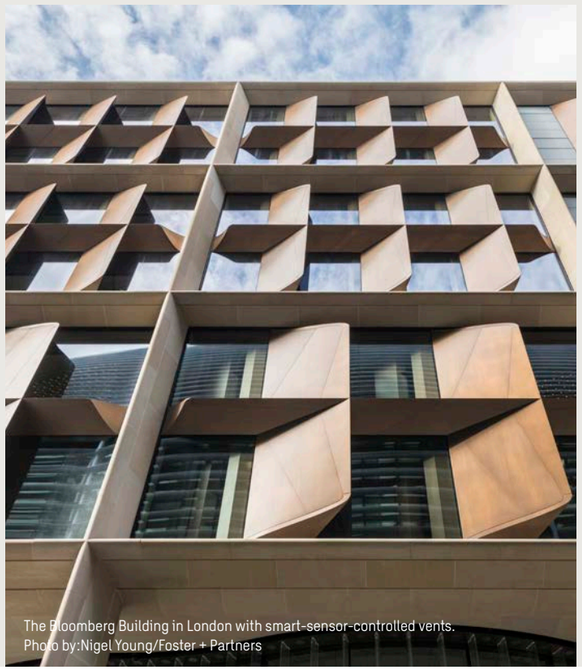
CLIMATE RESILIENT SCHOOLS AND SHELTERS

Barcelona is undertaking projects to adapt schools to heat and absorb its impact when it occurs.[37] These include installing passive cooling solutions, better insulation and solar protections within the buildings as well renovating playgrounds with more greenery and water. The aim of these solutions is to improve thermal comfort without increasing energy consumption and to designate many of the schools as climate shelters. The facilities provide good thermal comfort where people sensitive to extreme heat can take shelter.

INTERNAL BUILDING DESIGN

The Bloomberg Building in London is a good example of innovative building design. The building has a within-building power generation system, with the excess heat created used to heat the building in winter, and cool it in summer via a chilled water circulation system. The building is also naturally ventilated through external fins that can be opened or closed according to the weather, with smart-sensor-controlled vents that pull air in.

Kindergarten "Dalvägens Förskola" in Skövde, Sweden By Sweco Architects.



The Bloomberg Building in London with smart-sensor-controlled vents.
Photo by:Nigel Young/Foster + Partners

Sarphati park, Amsterdam city.

RECOVER

The third approach to building resilience is: enable a quick recovery. The availability and accessibility of resources that allow quick recovery is essential. For example, emergency financial support is made available to schools and care homes. Information is freely available and effectively communicated to caregivers and vulnerable groups during a heatwave.

Our 80-year-olds and 2-year-olds themselves need to be able to physically recover. They have access to enough water when they are out and about during the day, and green areas and climate shelters are accessible. They are also able to get a good night's sleep in a thermally comfortable building, in a city where measures have been taken to reduce the intensity of the nighttime UHI - sleep is vital for physical recovery.

Networks and knowledge-sharing platforms are vital for linking communities, industry, academia, practitioners and policy-makers. Networks can foster broad participation across these stakeholder groups, as well as the exchange of resources like information and data. Information and best practice can also be exchanged between cities and their 2050 analogues. This enables connectivity among the groups, encouraging flexibility, resourcefulness and quick recovery when faced with threats.

Many cities in Europe engage in international networks that focus on extreme heat. Examples include the C40 Cool Cities network and networks that are more broadly focused on building resilience, such as ICLEI and the UN Habitat Urban Resilience Hub. Another example is the Rotterdam Centre for Resilient Delta Cities (RDC), a triple-helix network of public, private and knowledge institutes. More local groups are also vital for connecting stakeholders locally.

ADAPT

The fourth and final capacity is: to adapt. In cities that have a strong capacity to adapt, reflective learning is key. This relies on adequate data collection during a heatwave event. Stakeholders at all levels, including in schools, hospitals and care homes, can then see what went wrong, what was done right, and how to improve the experience of our 2-year-olds and 80-year-olds the next time around. This new knowledge is then actively incorporated into policies, practices, education, and training.

The capacity to adapt also involves discovering new solutions and more inclusive practices, through creative and diverse spaces for innovation, experimentation and participation.

Rotterdam's water square

INNOVATIVE DESIGN

Innovation and experimentation is important to building the capacity to adapt. In Rotterdam, innovation and experimentation have long focused on the threat of flooding, a primary concern for a low-lying country. Heat is a newly identified threat for the city, and it is working on incorporating many of the green and blue innovations aimed at flooding into heat initiatives and heat-related issues like drought. This includes promoting private initiatives like gardens and green roofs, as well as public ones like more parks and water features.[38]

Good design solutions are relevant for all institutional settings:

If there's thoughtful design from the start when you design a care home, not just about how you're going to keep it warm but also how you're going to keep it cool... if the building is cool enough in summer, a lot of other preventative measures don't have to be taken. That would be a huge help to care workers. They're not spending all their energy and time keeping people cool because the building does it for them.

Louis Neven, academic expert on ageing and technology

Managing resilience

What can cities actively do to manage resilience? There are many reasons to stick to the business as usual – time, money, lack of awareness and scepticism of new approaches. But urban resilience is about reaching beyond the business as usual. We need to do this in how we think about technology, and how inclusive our planning process are. This is relevant for building resilience to a range of shocks and stresses, as well as the threat of heat.

TECHNOLOGY AND INNOVATION

Technology and industry are changing fast, with more and more technologies and solutions becoming available to tackle the threat of extreme heat. A more passive design for buildings, and dynamic thermoregulation of buildings through building envelope shading, are good examples. Improved and innovative spatial planning techniques for integrating urban resilience in plans and projects are also positive examples.

Consultants, architects and urban planners need to raise awareness of the importance of new technologies and encourage their use. This will help to build trust and demonstrate the pivotal role that more innovative measures play in fostering a forward-thinking mindset around resilience preparedness. This will strengthen the capacity to absorb and recover from the threat of heat, as infrastructure is built that goes beyond business as usual and makes a better fit for the future we all face. In this way, cities can better adapt to future circumstances.

INCLUSIVE PARTICIPATION AND EQUITABLE ACCESS

Justice and equity in the design of our urban environments is vital for ensuring that building resilience truly goes beyond the norm. Take public parks and other green spaces. Along with blue infrastructure like fountains and water squares, these green spaces are key to both mitigating heat risk through lowering the UHI effect and creating more comfortable outdoor environments by providing much-needed shade and relief.[39, 40] Green spaces also enhance mental well-being and reduce stress.[41]

However, issues often arise around the distribution of and access to green and blue spaces. What about older people, or families with young children who have no garden and live far away from any green space? This is often especially true for more socio-economically disadvantaged areas.[42] To promote equitable access to parks and open water, the people most impacted must have a say in their location, planning and design. This is the same for other amenities, like climate shelters, that are used to build resilience to extreme heat. Such places need to be accessible to those most at risk and be welcoming with sufficient entertainment and opportunities for socialising.

This can best be done by ensuring participation from the whole community from the start. In this way, we can prepare in ways that are inclusive and consider the needs of our most vulnerable, enhancing the capacity to absorb, recover and adapt in all societal groups.

The city of Rotterdam has addressed resilience as an important urban capacity. That resulted in the first resilience strategy for the city, to physically and socially cope with shocks and stresses in the near future.

Arnoud Molenaar, Chief Resilience Officer, Rotterdam

Conclusions

Heat in our cities poses a serious threat that demands more attention. Extreme heat events are going to increase in intensity, frequency, and duration in the future as the impacts of climate change and urbanisation are increasingly felt in our cities, and as Europe grows older. This poses a great threat to society and city infrastructure, but especially to vulnerable groups like the very young and very old.

Many central and northern European cities are not properly prepared for extreme heat. Unlike other climate impacts, such as flooding, this threat is invisible. It has therefore been difficult to create the necessary awareness and sense of urgency to tackle the problem. To build resilience for a hotter future, it can help to look at how the 2050 equivalent of a city feels, and what it might be doing to our ability to cope with the threat of heat.

We must think about how to redesign the social and physical structures of our cities to be sustainable, liveable, and resilient. And we need to keep those most vulnerable at the forefront of our minds – a city that is resilient to heat for both the very young and very old is safer, healthier, and more resilient for everyone.

Building resilience is relevant for many other threats, as well as heat. Building resilience for one can be relevant for others. For example pandemics: in times such as these, we need almost exactly the same as what we need during periods of heat. We need spacious green and blue areas close to our homes where we can walk, play, run, cycle and play sports – places where we can maintain physical distance while supporting our mental and physical well-being. Staying at home means we need comfortable homes (not too hot and not too cold) as well as spacious gardens and parks around them that are accessible to the whole community.

It is crucial to focus on building the resilience capacities (prepare, absorb, recover, adapt) in not just our physical structures, but also our social structures: behaviour change and effective communication are just as important as cool buildings and nearby parks. The young and the old have their own particular experiences of heat, related to their own vulnerabilities – enhancing resilience requires keeping these factors in mind, something that everyone can do.

Reaching beyond the business as usual must be encouraged. As we prepare, by building our data and networks, our knowledge will grow and the threat will become more and more visible. We can then plan for heat, altering physical spaces and behaviours to strengthen our ability to absorb its impacts when the threat is upon us. Resourcefulness is key to rapid recovery, and reflective learning from our own experiences and from other cities will enable us to adapt.

From the introduction of hygiene standards paving the way for widespread sewerage systems in the 19th century, to the arrival of the automobile altering the face of our city streets in the 20th century, climate change will be the force for change in the 21st century. We have applied the concept of resilience to a climate threat: that of extreme heat. But the concept is also relevant for cities in attempting to tackle many of the other threats they may face in the future: from flooding and pandemics to natural disasters, financial crises, terrorist attacks and biodiversity loss.

In the same vein, building resilience in the social and physical structures for those most vulnerable to a particular threat can help create a safer and healthier city for everyone.

HOW CAN YOU BUILD RESILIENCE TO EXTREME HEAT?

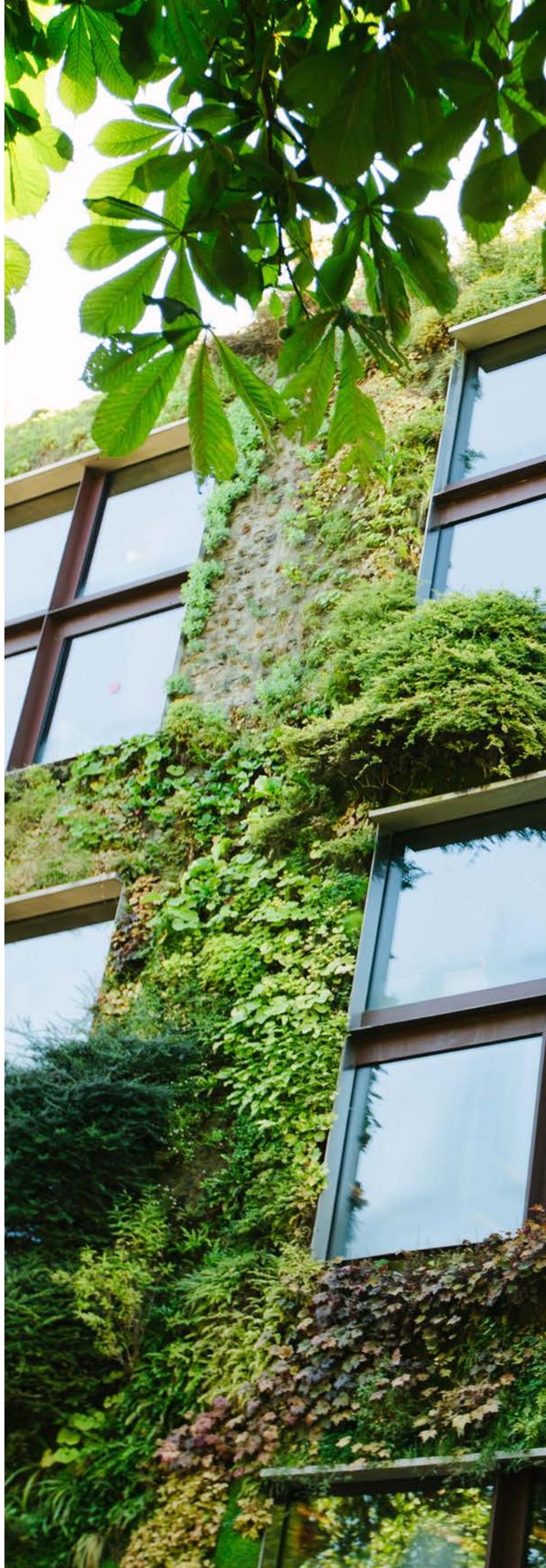
INDIVIDUALS, FAMILIES AND LOCAL COMMUNITIES:
- Prepare by reading up on extreme heat and the impacts it could have on you, your family and your life. Check on friends and neighbours, especially older people in your community who may be alone or lack social networks.
- Plant trees in your garden for shade! Private properties make up a significant amount of urban space, depending of the characteristics of the city. For example, 60% of the land in Rotterdam is private[44], pointing to the importance of action taken by residents/private owners.

BUILDING MANAGERS AND DEVELOPERS:
- Carefully consider the users of your space – are the particular needs of the users being met in the way your building is being planned and operated? How can you work with the users to better understand their needs?
- Consider more innovative design solutions like passive design and external shading with dynamic controls to minimise the impact of heat on the building and its surroundings.

ARCHITECTS AND URBAN PLANNERS:
- Evaluate your designs regarding their contribution to the UHI effect.
- Communicate with building managers and developers to build trust in more innovative solutions.
- Consider more thoughtful design solutions that minimise the impact of heat on buildings and their surroundings and better consider the needs of the building's users.

HEALTHCARE WORKERS:
- Educate and train caregivers on the risk heat poses to vulnerable groups. Empower them to know how to to prepare for the risk, absorb and recover from it when it occurs, and apply lessons learned in order to adapt to the future.

POLICY-MAKERS:
- Ensure data and methodologies are freely available.
- Promote networking between industry, academia and practitioners.
- Encourage risk preparation, absorption and recovery through subsidies and effective communication.



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