

From the IAUC President

Welcome to our third IAUC Newsletter for 2021. I think you will find much of interest in this issue. As ever, the Newsletter richly demonstrates the range of excellent and relevant work undertaken by our community. Its quality is a testament to the considerable efforts of David Pearlmutter and his section editors, Dragan Milosevic, Helen Ward, Joe McFadden and Chenhao Wang. I am always very proud to share our Newsletter with folk from outside of the IAUC.

In this issue of the IAUC Newsletter, we are delighted to announce the winners of the 2021 Luke Howard Award for outstanding research from an individual member of our community, and the 2021 Timothy Oke Awards for excellent contributions from our early- to mid-career researchers. **Gerald Mills** is the well-deserved winner of the Luke Howard Award, and **Leena Järvi, Iain Stewart** and **Benjamin Bechtel** are the winners of the Timothy Oke Award. Each of these people have contributed in many ways to the work of the IAUC, often well beyond their research efforts. Read on in the Newsletter for [further details](#).

While on the topic of the contributions of our community, IPCC AR6 Working Group 2 submitted its 18 chapters on September 3, for adoption at the 55th Session of the IPCC in February 2022. Many among our community were involved in the preparation of the chapters and many more of our community have important work that is reviewed within those chapters. Through all of this work the urban climate community are making critical contributions to the development of global climate policy.

In the last Newsletter, we reported on the postponement of the Sydney ICUC-11 until August 2023, as a result of various uncertainties related to the COVID-19 pandemic. The good news is that as a result of global and Australian travel opening up over the next 6-12 months, that conference date is now secure. Further excellent news is that planning for a IAUC Virtual Poster Conference (for late August 2022) focused on our graduate and early career researchers is proceeding apace. The conference will feature daily keynotes and a multiple time-zone friendly format along with various other innovations that will provide significant points of difference from other virtual conferences. Sponsorships have been sought that will keep the registration costs very low and we have a very energetic and diverse or-

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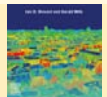
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ganising committee – thanks to those of you who took up the offer to join.

Finally, a couple of IAUC Board-related matters. First, as a result of the recent election, we welcome and congratulate our two new IAUC Board members, **Natalie Theeuwes** from the Royal Netherlands Meteorological Institute, and **Vincent Luo** from the University of Reading. Many thanks to those members of our community who put their names forward for election. Second, a reminder that the IAUC Board is very keen to receive proposals from the IAUC community for small regional meetings and summer schools, especially for calendar year 2022. Please see the IAUC website for details on how to apply for financial support for such activities.

With very best wishes

– Nigel Tapper,
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Children set for more climate disasters than their grandparents, research shows

Climate crisis brings stark intergenerational injustice but rapid emission cuts can limit damage

September 2021 — People born today will suffer many times more extreme heatwaves and other climate disasters over their lifetimes than their grandparents, research has shown.

The study is the first to assess the contrasting experience of climate extremes by different age groups and starkly highlights the intergenerational injustice posed by the climate crisis.

The analysis showed that a child born in 2020 will endure an average of 30 extreme heatwaves in their lifetime, even if countries fulfil their current pledges to cut future carbon emissions. That is seven times more heatwaves than someone born in 1960. Today's babies will also grow up to experience twice as many droughts and wildfires and three times more river floods and crop failures than someone who is 60 years old today.

However, rapidly cutting global emissions to keep global heating to 1.5C would almost halve the heatwaves today's children will experience, while keeping under 2C would reduce the number by a quarter. A vital task of the [UN's Cop26 climate summit](#) in Glasgow in November is to deliver pledges of bigger emissions cuts from the most polluting countries and climate justice will be an important element of the negotiations. Developing countries, and the youth strike protesters who have taken to the streets around the world, point out that those who did least to cause the climate crisis are suffering the most.

"Our results highlight a severe threat to the safety of young generations and call for drastic emission reductions to safeguard their future," said Prof Wim Thiery, at Vrije Universiteit Brussel in Belgium and who led the research. He said people under 40 today were set to live "unprecedented" lives, i.e. suffering heatwaves, droughts, floods and crop failures that would have been virtually impossible (0.01% chance) without global heating.

Dr Katja Frieler, at the Potsdam Institute for Climate Impact Research in Germany and part of the study team, said: "The good news is we can take much of the climate burden from our children's shoulders if we limit warming to 1.5C by phasing out fossil fuel use. This is a huge opportunity."

Leo Hickman, editor of Carbon Brief, said: "These new findings reinforce our 2019 analysis which showed that [today's children will need to emit eight times less CO₂](#)



Boy walks through a dried up agricultural field in the Saadiya area, north of Diyala in eastern Iraq. Source: www.theguardian.com

over the course of their lifetime than their grandparents, if global warming is to be kept below 1.5C. Climate change is already exacerbating many injustices, but the intergenerational injustice of climate change is particularly stark."

The research, [published in the journal Science](#), combined extreme event projections from sophisticated computer climate models, detailed population and life expectancy data, and global temperature trajectories from the Intergovernmental Panel on Climate Change. The scientists said the increases in climate impacts calculated for today's young people were likely to be underestimated, as multiple extremes within a year had to be grouped together and the greater intensity of events was not accounted for.

There was significant regional variation in the results. For example, the 53 million children born in Europe and central Asia between 2016 and 2020 will experience about four times more extreme events in their lifetimes under current emissions pledges, but the 172 million children of the same age in sub-Saharan Africa face 5.7 times more extreme events. "This highlights a disproportionate climate change burden for young generations in the global south," the researchers said.

Dohyeon Kim, an activist from South Korea who took part in the global climate strike on Friday, said: "Countries of the global north need to push governments to put justice and equity at the heart of climate action, both in terms of climate [aid] and setting more ambitious pledges that take into consideration historical responsibilities." The analysis found that only those aged under 40 years today will live to see the consequences of the choices made on emissions cuts. Those who are older will have died before the impacts of those choices become apparent in the world. Source: www.theguardian.com

Cop26 climate talks will not fulfil aims of Paris agreement, key players warn

Major figures privately admit summit will fail to result in pledges that could limit global heating to 1.5C

September 2021 — Vital United Nations climate talks, billed as one of the last chances to stave off climate breakdown, will not produce the breakthrough needed to fulfil the aspiration of the Paris agreement, key players in the talks have conceded.

The UN, the UK hosts and other major figures involved in the talks have privately admitted that the original aim of the Cop26 summit will be missed, as the pledges on greenhouse gas emissions cuts from major economies will fall short of the halving of global emissions this decade needed to limit global heating to 1.5C.

Senior observers of the two-week summit due to take place in Glasgow this November with 30,000 attendees, said campaigners and some countries would be disappointed that the hoped-for outcome will fall short.

However, the UN, UK and US insisted that the broader goal of the conference – that of “keeping 1.5C alive” – was still in sight, and that world leaders meeting in Glasgow could still set a pathway for the future that would avoid the worst ravages of climate chaos.

That pathway, in the form of a “Glasgow pact”, would allow for future updates to emissions pledges in the next few years that could be sufficient for the world to stay within scientific advice on carbon levels.

A senior UN official said: “We are not going to get to a 45% reduction, but there must be some level of contributions on the table to show the downward trend of emissions.”

A UK official said: “Cop26 will not deliver all that we want [on emissions].” But the UK, charged as host with delivering a successful outcome, is hoping that progress will be made on other issues, including phasing out coal, providing climate finance to poor countries, and improving the protection of forests.

A US official told the Guardian countries must still aim as high as possible on emissions cuts: “We are going to try to achieve [the emissions cuts necessary]. No one in the administration wants to admit defeat before we have made the maximum effort. You should set an ambitious agenda and may have to, in the end, take baby steps but you should plan for long strides. We are taking long strides.”

Lord Nicholas Stern, the climate economist, said falling short on emissions plans should not be equated with failure. “I agree with [the UN] and most observers that



Protesters take part in a climate protest in Glasgow as part of the Global Youth Strike For Climate in the lead up to COP26 climate summit in the city. Source: [the-guardian.com](https://www.theguardian.com)

we will not close that gap [between emissions pledges and scientific advice] completely,” he said. “But we should hope for good progress in closing that gap and we should hope for mechanisms and ways forward on how we close that gap further between now and 2025. That’s the way we should think about what is a good, or better, or worse result – a language of success or failure doesn’t seem to me to be very helpful.”

At the Paris climate summit in December 2015, 196 nations agreed to hold global temperature rises to “well below 2C” with an aspiration to limit rises to 1.5C above pre-industrial levels. But the pledges on emissions – known as nationally determined contributions, or NDCs – they brought to the French capital were not enough to fulfil either goal, and would have led to catastrophic heating of at least 3C.

For that reason, the French hosts wrote into the agreement a “ratchet mechanism” that would require countries to return to the negotiating table every five years with fresh targets to meet the temperature goals. Cop26, which was postponed by a year because of Covid, is the fifth Cop – conference of the parties – since Paris.

Some people would be disappointed by the admission that the high hopes for an outcome that would fulfil the Paris aspiration would not be met, said Mary Robinson, chair of the Elders Group, former UN climate envoy and former president of Ireland. “The NDCs will be disappointing, given the urgency and given the climate impacts. It is disappointing that leaders have not been able to step up enough. But the momentum will be there, and that’s very important. I am determined to be hopeful.”

She said the original conception of the Paris agree-

ment, of returning every five years, should be revised so that countries would be asked to return every year with their plans.

The UN takes a similar view. "The Paris agreement built this five-year cycle of ambition, but there is nothing preventing a country from reviewing and updating its NDC next year," said the senior UN official.

"Cop26 is a very important milestone but it should not be seen as the end of the game, where we give up on 1.5C," he added. "[It] will signal that 1.5C remains in reach [through] a combination of NDCs, negotiated outcomes and signals in the real economy."

While the UK, the US and the EU have submitted NDCs requiring much stiffer cuts than those proposed at Paris, the world's biggest emitter – China – has yet to submit an NDC, and has only indicated that it will cause emissions to peak by 2030, which experts said was not enough to hold the world to 1.5C.

Alok Sharma, the UK cabinet minister who is Cop26 president-designate, said: "Cop26 has always been about delivering urgent action to ensure we keep the path to a 1.5C world alive. Those nations which have submitted new and ambitious climate plans are already bending the curve of emissions downwards by 2030. But we con-

tinue to push for increased ambition from the G20 to urgently close the emissions gap. The clock is ticking, and Cop26 must be the turning point where we change the course of history for the better."

China has still not said whether president Xi Jinping will attend Cop26, causing consternation among climate diplomats who fear China will make no major move at the summit. Relations with China and the US and the UK have been strained by the announcement of the Aukus defence pact with Australia, and by trade differences.

Other countries have also failed to come up with improved NDCs, including Australia, Brazil, Mexico, Indonesia, Russia and Saudi Arabia. India is also the subject of intense diplomacy, as the world's fourth-biggest emitter after the EU.

Campaigners said the focus should be on the biggest emitters. Mitzi Jonelle Tan, an activist for Fridays for Future in the Philippines, who joined the youth climate strike last Friday, said: "We have seen how big polluters, like the US and China, have promised and pledged less than what is needed from them in the past, yet have fallen short on those every time. Unlike the so-called leaders who like to cheer themselves on for subpar speeches [at the UN], the youth aren't impressed." Source: theguardian.com

Killer Heat Forces Cities to Adapt Now or Suffer

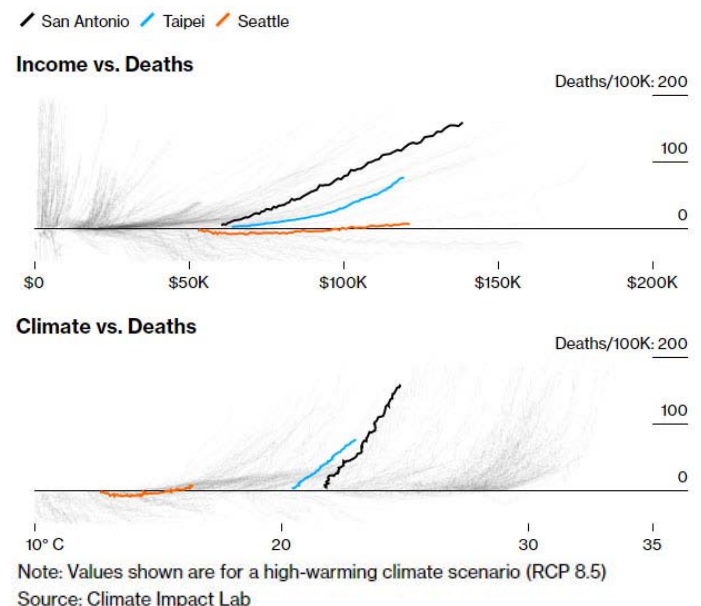
September 2021 — Climate change abruptly gripped North America's Pacific Coast at the start of summer, setting new heat records by staggering margins across the region's cities and towns. Hundreds of people died.

The sudden and extreme heat disaster — matched by other recent heat waves in the Southeastern U.S., Northern Africa, Western Asia, Japan, and Europe — means many temperate cities are in for significantly warmer conditions. At the same time, cities built to withstand 20th-century heat will now face far worse.

The question of which cities and regions will be able to adapt to new extreme heat is part of the hard math of climate change. Heat researchers see this process defined by two drivers: income and climate. It's wealth that determines which cities have the resources to defend themselves, and future heat mortality that determines if those efforts succeed.

Compare Seattle, San Antonio and Taipei, wealthy cities with vastly different climates. Each is home to professional sports teams and global corporate headquarters. These cities also now have recent severe heat waves in common. Yet heat-related deaths are projected to diverge sharply.

This is one of the major insights about the relationship between temperature, income and mortality from a study that Climate Impact Lab [published last summer](#).



Cities like San Antonio, Taipei and Seattle are projected to see similar increases in income in the next 80 years, but income can't equalize mortality outcomes. Due to hotter climates, San Antonio and Taipei are projected to see much higher death rates. Source: bloomberg.com

The research group found that preparation is central to staving off heat-related deaths, with future income growth making adaptation possible.

As of this summer, the heat records measured in Seattle, San Antonio and Taipei stand at 108°F (42°C), 111°F (44°C) and 103°F (39°C), respectively. The difference is that San Antonio has invested for decades in infrastructure such as air-conditioning, cooling centers and warning systems. Taipei has likewise followed an urban-cooling plan for at least a decade, and just this week sent out an alert on the city's color-coded heat alert system.

Seattle, accustomed to temperate weather, was blindsided by the climate change-induced heat wave. As Seattle heads toward a Texas- or Taiwan-like climate, the U.S. city has a lot of catching up to do — and a high per-capita income should help.

Research into the hotter future ended up anticipating the present day. When Climate Impact Lab published its heat study in August 2020, the researchers mentioned in passing the obvious economic reasons that Seattle hasn't already adapted itself to Texas-style heat. Investing in defensive measures such as cooling infrastructure made little sense, despite Seattle's wealth, since it had little experience of severe heat. Then came the heat wave, after which Seattle and Houston suddenly had nearly matching records.

The extreme heat of 2021 adds a layer of urgency to Climate Impact Lab's intricate analysis, which warned that the annual mortality rate at the end of this century could rise by 73 deaths per 100,000 people solely from excess heat. The recent research paper "is all about the difference—when you're prepared and when you're not prepared," said Tamma Carleton, an environmental economist at University of California, Santa Barbara, and a co-author of the study. The June heat wave "was a natural experiment of climate change happening overnight, with Seattle not being prepared." If higher income equals more potential for adaptation and fewer future deaths, the opposite is also true. Compare cities with similar climates but very different incomes: Seattle, Kyoto and Istanbul. With far lower per-capita income, Istanbul faces the most severe obstacles of this group.

Local and regional governments trying to understand who is vulnerable and how to protect them increasingly need specific research into heat effects. This is true whether cities, rich or poor, are cool places facing triple-digit heat for the first time or hot places experiencing new heat records. Until recently, much economic research was limited to simple global analyses. "Only in the last few years have we had the local-level information on climate risk that we now do," Carleton said. "It opens the door to really important local-level policy action."

Heat is the most intimate and universal threat. It kills more people in the U.S. than any other weather. No one is immune, but everyone can be protected. It's an axiom repeated among emergency managers that nobody should die in a heat wave.



A temporary misting station set up by the fire department during a heat wave in Vancouver on June 28, 2021. Source: [bloomberg.com](https://www.bloomberg.com)

And yet they do, sometimes in overwhelming numbers. More than 70,000 Europeans died in the summer of 2003, the first weather disaster that scientists attributed, in part, to climate change. France alone lost 15,000 people. Some 55,000 died in Russia in 2010. Three weeks of heat left more than 1,800 dead in Argentina at the end of 2013, with daily deaths 43% above average in Buenos Aires at the time. The final death toll from the Pacific North American heat wave could exceed 1,000, the New York Times has [reported](#).

After Ahmedabad in India lost more than 1,344 people to a heatwave in 2010 when temperatures hit 116°F (47°C), the city became the first in South Asia to issue a heat-action plan and early warning system. The plan saves an estimated 1,200 heat-related deaths a year, and has been published as a 50-page City Resilience Toolkit for other cities to adopt.

With more mass-casualty heat waves, cities around the world are investing in infrastructure and adopting practices to defend against an unfamiliar climate. Planning and preparation really save lives: France activated a heat plan in 2019 just before temperatures spiked to 115°F (46°C). The country recorded fewer than 1,500 deaths — a tenth of its losses in 2003.

After an extended heat wave combined with inadequate infrastructure and poor communication to kill 739 in Chicago in 1995, city planners established multiple generations of preparedness plans. The result can be seen in reformed emergency services and improved communication. Chicago's ongoing response is noteworthy for its continual evolution and includes crucial community partnerships. Many victims in 1995 were low-income, elderly and lived in neglected neighborhoods, and a disproportionate number were Black.

"If people don't know you, they won't feel comfortable answering their phone, telling you where they live," said Ernesto Gonzalez, marketing manager for My Block My Hood My City. "It's crucial to start working years before."

You need to make a plan.”

It doesn't take catastrophe to motivate a city. Miami-Dade County in Florida is already hot and so far not prone to heat spikes, plus there's nearly universal access to air-conditioning, according to Jane Gilbert, the region's first chief heat officer. But air-conditioning can break, power can fail and high electricity bills can inhibit usage. After public surveys showed that people were especially worried about heat, Gilbert said officials moved to create a statewide agreement with the local utility not to shut off power for a failure to pay when the temperature is above 95°F (35°C).

“We do have a whole series of evacuation shelters that do have backup power that are designed for hurricane response,” Gilbert said. “It's just we want to create more capacity that isn't in the format of a shelter, it's more sort of a neighborhood resource.”

Heat-management strategies tend to recommend common tactics and tools, whether they're crafted in New York, Paris, Buenos Aires, Ahmedabad or Victoria. A 2017 report called [Strategies for Cooling Singapore](#), for instance, offers a readable and comprehensive overview of more than 80 steps cities can take, from green parking lots to artificial ponds, shaded walkways, lighter car-colors and “urban geometry,” or the physical layout of streets and buildings.

A heat wave “is something else in London than it is in Capetown or Sao Paulo,” said Regina Vetter, senior manager of climate adaptation at C40 Cities, one of several groups that help governments manage heat risk. But the necessary steps to prevent harm are similar, which means the “interchange really works out well across the regions. “Some of the most important actions are the least expensive, Vetter said, especially those that target the vulnerable, such as public education and early communication. The differences between rich and poor cities' tactics are more stark when heat-protection involves infrastructure and planning more than emergency-management, community organizing and communication.

A chronic problem everywhere is called the “urban heat-island effect,” the phenomenon of city infrastructure absorbing and retaining heat, lifting temperatures above rural areas. It's not a problem that governments may prioritize when they're busy looking for every poverty-eradicating development opportunity they can find.

Rapidly urbanizing Cairo, for example, saw hard surfaces grow from 23% to 35% of its land between 2000 and 2019. Green areas fell by three percentage points, and bare land by nine. The heat-island effect consequently worsened. At the same time Cairo was growing the old-fashioned way, richer cities have had the luxury and presence of mind to attend to heat-island cooling strategies. Los Angeles wants to lower the city-rural temperature difference by at least 3°F by 2035 and Melbourne wants to be more than 7°F cooler.



Workers remove the body of a person who died during a heatwave in Paris on 16 Aug 2003. Source: [bloomberg.com](#)

There are many ways to accomplish this. Phoenix's Maricopa County saw a record 145 days in 2020 that reached above 100°F (37.8°C) and suffered 323 heat-related deaths. The city in June approved the new position of tree and shade administrator, a role meant to help a push for 25% of the city to fall under a shade canopy by 2030. A cost-benefit analysis found that the city earns a return of \$2.23 on every tree planted, with total annual benefits of more than \$40 million.

Materials and design also figure into many cities' heat plans. Just as glaciers reflect solar energy and cool the planet, white roofs reflect 80% of light, compared with 5% for standard dark roofs. A comparison of white and red roofs in Auckland found the lighter roof was 18°F cooler.

Roofs of grass and other vegetation similarly prevent heat absorption in buildings, a feature prominent in mar-quee “sustainable” buildings, such as Singapore's Park-Royal hotel or Chicago's City Hall. City dwellers have found that green roofs can muffle noise, too.

“Actually changing our urban environment to mitigate urban heat island impacts can take more time,” said Gilbert of Miami-Dade County. “Getting people knowing what to do when they start to feel heat stress is something we can address more short-term.”

There's an irony to the Climate Impact Lab heat-mortality work, with its granular focus on the power of adaptation to avoid deaths in places that can afford it. That, ultimately, is not the motivation for their research. The team instead set out to estimate, in dollars, how much damage every metric ton of emitted carbon-dioxide inflicts on the global economy. When the cost of carbon-dioxide is known, the thinking goes, governments can use it to write policy that prevents global heating.

Scientists have for decades pointed to only three possible responses to climate change: prevention of rising temperatures, adaptation to a much warmer world, and human suffering in the heat. The deadly extreme heat of 2021 has put the focus on the suffering that comes to cities that aren't ready or able to adapt. Source: [bloomberg.com](#)

How Ida dodged NYC's flood defenses

Despite spending billions on adaptation, cities aren't keeping up with climate change

September 2021 — Floods killed at least two dozen people as Hurricane Ida swept through New York, New Jersey, and Pennsylvania on the night of September 1. This devastation is on top of the 13 who died and the million who lost power when the storm hit Louisiana, Mississippi, and Alabama last weekend.

As the storm moved up the East Coast, New York City was hit particularly hard. Over three inches of rain fell in Central Park within an hour, breaking a record set just over a week before. Floodwaters turned parkways into canals and subway steps into waterfalls, leaving residents stranded or trapped. This despite billions of dollars the city has spent to improve its flood defenses since Hurricane Sandy in 2012.

Extreme storms are now becoming more common as climate change makes rainfall more severe, and storms will get worse with further warming. There's still a lot that cities need to figure out to prepare for the resulting threats, which can range from flash floods to storm surges. Adapting will take time and money—decades in some cases, and hundreds of billions of dollars. But climate change and adaptation efforts are running at different speeds. Stormwater pipes, pumps, and other infrastructure aren't built for intense storms fueled by climate change. "The problem is, we're seeing these impacts and these changing storms faster, and adaptations are just not keeping pace," says Lauren McPhillips, a hydrologist at Penn State University who studies urban flooding.

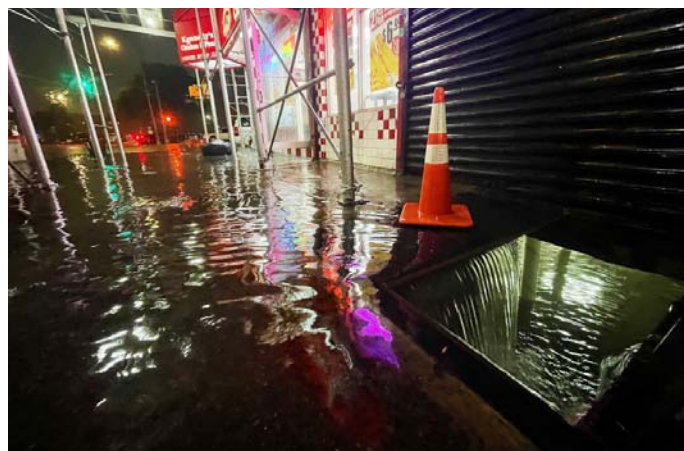
New York City has been relatively forward-thinking when it comes to preparing for floods, McPhillips says. For years, the city put in more permeable architecture, like green roofs and rain gardens, and upgraded pumps and drainage pipes. These improvements intensified after Sandy. "We learned a lot of lessons from Sandy," said New York governor Kathy Hochul in a press conference the morning after the storms. "We built back resiliency; our coastal shorelines are in much better shape than they had been. But where we have a vulnerability is in our streets."

Sandy looms large in any discussion about flooding in New York City. But the difference between the 2012 hurricane and Ida illustrates the complex flood threat the city faces from climate change. Sandy caused an intense storm surge, where the ocean rushed into the city. Ida dumped inches of water all over the city in a short time—a problem that sea barriers and other coastal protections can't solve.

While New York City and other coastal areas are more vulnerable to sea-level rise, any urban area can experience what's called pluvial flooding, the kind caused by rainfall. "The way we've developed New York City has caused the flood problem," says Timon McPhearson, a researcher in urban climate resiliency at the New School and a member of the New York City Panel on Climate Change.

Impervious surfaces like concrete cause water to rush downhill rather than sink into the ground as it might in grasslands or forests. And if enough water runs together, the consequences can be deadly.

With the input of researchers like McPhearson, New York City has developed plans to improve its defenses against storm-caused flooding. A forward-looking stormwater resiliency plan



Rain from Hurricane Ida floods the basement of a fast food restaurant in the Bronx. Source: [technologyreview.com](https://www.technologyreview.com)

released in May 2021 included an assessment of flood risk across the city and proposed solutions ranging from social strategies, like educating local city councils on flood risks, to engineering techniques such as more green roofs and rain gardens.

And the city's Department of Environmental Protection is considering plans for areas that are hit especially hard during the most intense storms. The Cloudburst Resiliency study, completed in 2018, examined strategies to deal with extreme rain events. Pilot plans in a frequently flooded area in Queens included green infrastructure like floodable park walkways, as well as a basketball court designed to hold water during major flooding.

But carrying out these or any other stormwater management solutions would require major funding, and some would require a decade to engineer. "We need to literally redesign the city to solve the problem," McPhearson says. And he expects the price tag to be hefty—likely hundreds of billions of dollars. In some cases, he says, the research already suggests how to protect the city against flooding, but getting together the money and political will to act is still a hurdle.

In the meantime, floods will continue to kill. More people die in floodwaters than from any other effect of a hurricane, says Anne Jefferson, a hydrologist at Kent State University. And vulnerable people are the most likely to be harmed or killed by flood damage. At least eight people who died in the storm in New York City were living in basement apartments, some of them illegal, which tend to be less expensive than those above ground. Engineering solutions can help decrease some of the harm caused by some flooding in cities. But right now, those solutions are moving slowly, and millions will remain in harm's way as climate change races ahead.

Ultimately, if warming continues, future storms will likely get even worse. And limiting future damage will require a range of solutions: ecological, social, legal, and engineered. But Ida, along with the plethora of other climate disasters this year, from wildfires to extreme heat, has made it exceedingly clear: climate change is no longer a future problem to avoid. It's happening now, and we're just trying to keep up. Source: [technologyreview.com](https://www.technologyreview.com)

How much do urban green spaces cool cities at night?



By Hirofumi Sugawara (hiros@nda.ac.jp)

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Several observation projects were carried out in Tokyo to understand the benefits of green spaces for human thermal environment in cities. Results spanning a total of 16 years give us suggestions for how to adapt urban areas to better cope with future climate.

The hot environment in cities is becoming a significant threat to human health. More than 90,000 people affected by heat strokes needed medication in the summer of 2018 in Japan, many of which experienced a heat stroke even at night (Japanese Ministry of Environment, 2018). Urban green spaces could be a countermeasure for this urban thermal environment because green parks in towns and cities have lower air temperatures than the surrounding built-up areas, especially in summer (e.g., Shashua-Bar and Hoffman, 2000). This phenomenon is known as the green 'cool island' effect. The cooler air in the park flows out to the surrounding built-up area by the 'park breeze' (Elisson and Upmanis, 2000) and cools the city.

We carried out several observational projects to understand the cool island effect in large parks during

summer nights in Tokyo. This article introduces these projects and adds perspectives for urban planning based on the observation results. Most of this article discusses the nocturnal cool island.

The projects were carried out in two urban parks in the central part of Tokyo (Fig. 1). One was Shinjyuku Gyoen (0.6 km²), which was presented in Sugawara et al. (2021, hereafter S21) and another was Shirogane (0.2 km², officially the park of Institute of Nature Study) in Sugawara et al. (2015, S15). These parks have different features. Gyoen is located on the flat terrain, and has large grass fields and some wooded areas where average tree height is 15 m. Shirogane is on a slope and covered with trees (14 m high).

1. Cold air flows out from the park to the surrounding city

A park's cold air flows out into the surrounding city, and its travel distance in the urban area should be considered when evaluating the benefits of cool islands in urban planning. The travel distance expresses

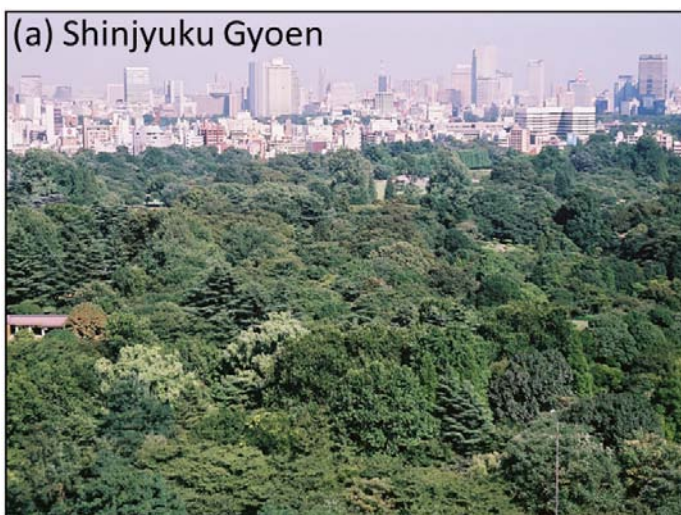


Figure 1. Photos of two parks where the projects were undertaken: a) Shinjyuku Gyoen and b) Shirogane.

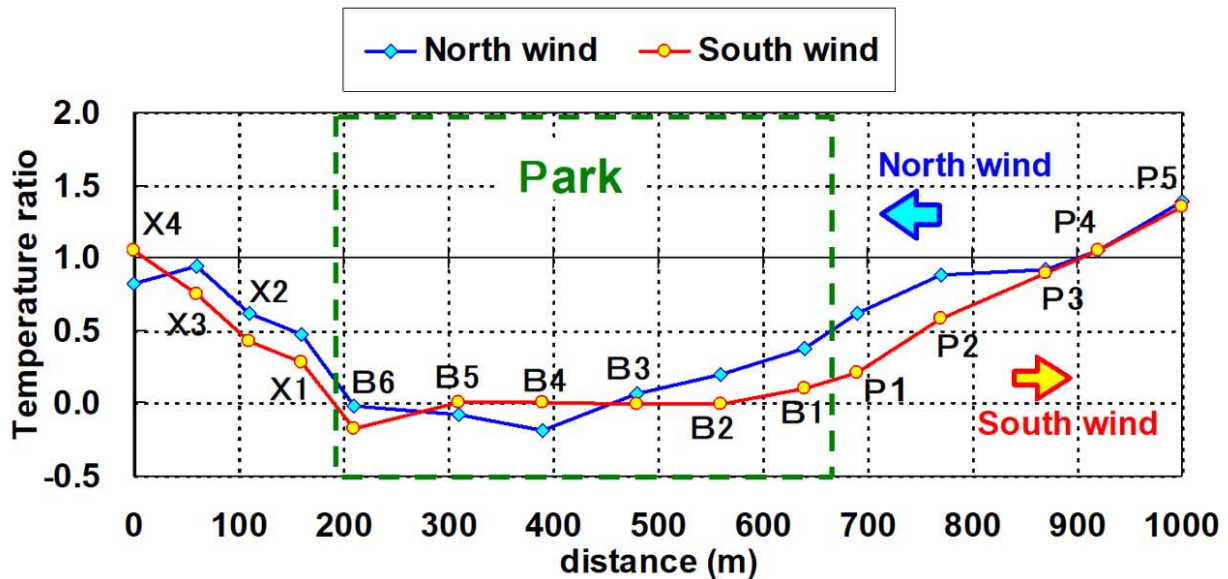


Figure 2. Air temperature distribution along the transect line across Shinjyuku Gyoen park (between P5 and X4 in Fig. 3). Y axis is the temperature difference between the park and the town normalized by the difference in spatial average between the park and the town. Note that this figure includes data from both day and night (N04).

the area of influence of the park and relates it to the number of people benefitting from the park cold air. The maximum distance reached was 200 m at Gyoen (Fig 2, Narita et al., 2004, hereafter N04). In the urban area north of the park (X = 700–800 m in Fig. 2), the cooling effect was greater when the location was on the leeward side of the park (southerly winds) than on the upwind-side (northerly winds), indicating that this temperature distribution is formed by the flow out of the park. Observations in Shirogane showed that the travel distance of cold air increased on the lower side of the slope, with the maximum distance being 450 m (S15).

Wind transports the park's cold air into the city. However, even in calm conditions cold air flows out from the park towards the surrounding city by itself on a local scale. This is called a 'park breeze'. The park breeze has a divergent flow pattern in which cool air flows out in all directions (Fig. 3). The physical mechanism behind this flow is the gravity current (Simpson, 2007), in which the cooler park air goes under the warmer town air by the density gradient (S21). Figure 4 shows an example of the air temperature distribution during a calm night. Although the travel distance is smaller than the advection cases in Fig. 2, there is a very sharp change in the air temperature.

2. How much does the park cool the city?

Public understanding of the cooling phenomena by urban green spaces is necessary in urban planning to promote urban greening and/or preservation of existing green areas. During opinion-exchange meetings with the local citizens, we (scientists) are often asked; "How much does the park cool the town?" and "How many room-air-conditioners are comparable to the green cooling?" To answer these questions, it is necessary to evaluate the cooling phenomena in terms of units of heat (Watt or Joule).

Based on our observations, we obtained two answers. The first pertains to the cold (heat) stored in the park. The air temperature difference between the park and the surrounding city (cool island intensity; CII) is related to this stored heat, although the results shown in Fig. 2 are only at the pedestrian level. The stored heat amount can be calculated as the vertical integration of the horizontal temperature difference, and the depth of the cold air in the park is required in this calculation. Our tethered balloon measurements in Gyoen showed that the park cold air reached 50 m above the ground (Fig 5). The stored heat was calculated as $49,903 \text{ J m}^{-2}$ at a specific night, which corresponds to 10% of the net radiative loss (cooling) in the park. This amount of cold heat can cool the town

by 4°C if the cold air spreads to 200 m at a depth of 10 m in the town area (see S21 for details of this calculation). This 4°C decrease is significant as compared to the typical heat island intensity, showing great potential for further town cooling by the park. Therefore, urban planning should consider better use of this cool air stored in the park, for example in street design, to facilitate outward cold air flow towards town.

The second answer to these questions is the amount of cold (heat) that the park actually provides to the city. This answer does not include the stored heat in the park, which is the previous evaluation, but includes the advected heat to the city. We evaluated this cooling amount using heat budget analysis in Shirogane. The resulting heat amount was correlated to the radiative net loss in the park, with the ratio of 0.83. This means that the park used 83% of cold air generated by radiative cooling to cool the city, and the remaining 17% was used to cool the park itself. The average cooling amount was 7.8 MW for the entire park area. To achieve the same amount of cold air (S15), 2600 room air conditioning units would be required.

These two evaluations suggest that CII may not always be an adequate index to assess the value of urban green spaces. The cool island intensity does not represent the full function of the park cooling as this intensity is the temperature difference which does not account for the air mixing around the park boundary. For example, the cold air flowing out from the park cools the city air by mixing, and most of the instruments, such as normal-response thermometers, are unable to identify this cooling and they measure

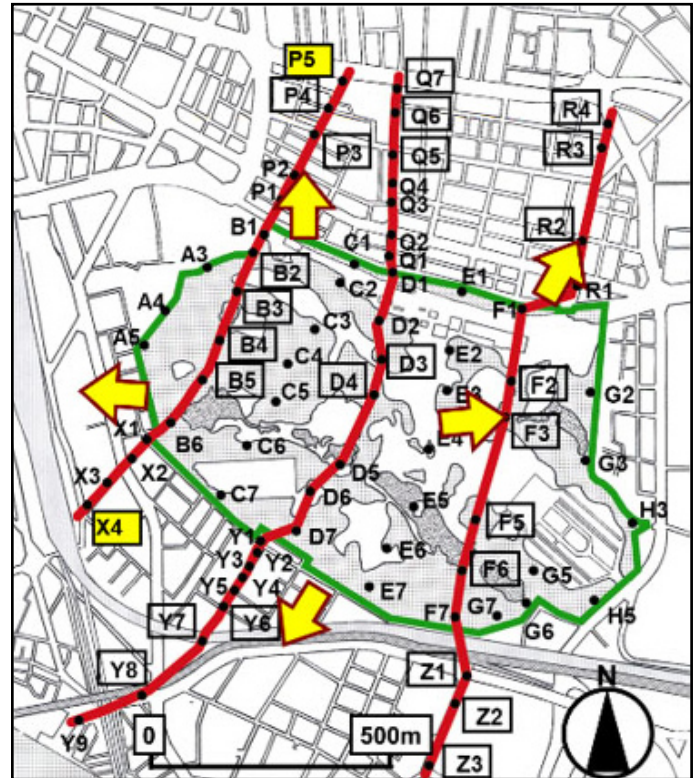


Figure 3. Map of Shinjuku Gyoen and measurement points in N04. Yellow arrows indicate wind direction measured by sonic anemometers at 05:00 on 5 August 2000.

the balanced state of the air after mixing. Similar phenomena must occur for the advected air in the park. The cool island intensity does not include this heat exchange. Therefore, even in a park with a small CII, there is a possibility that cold air generated in the park flows out almost completely towards the town and significantly benefits city cooling (see S15 for details).

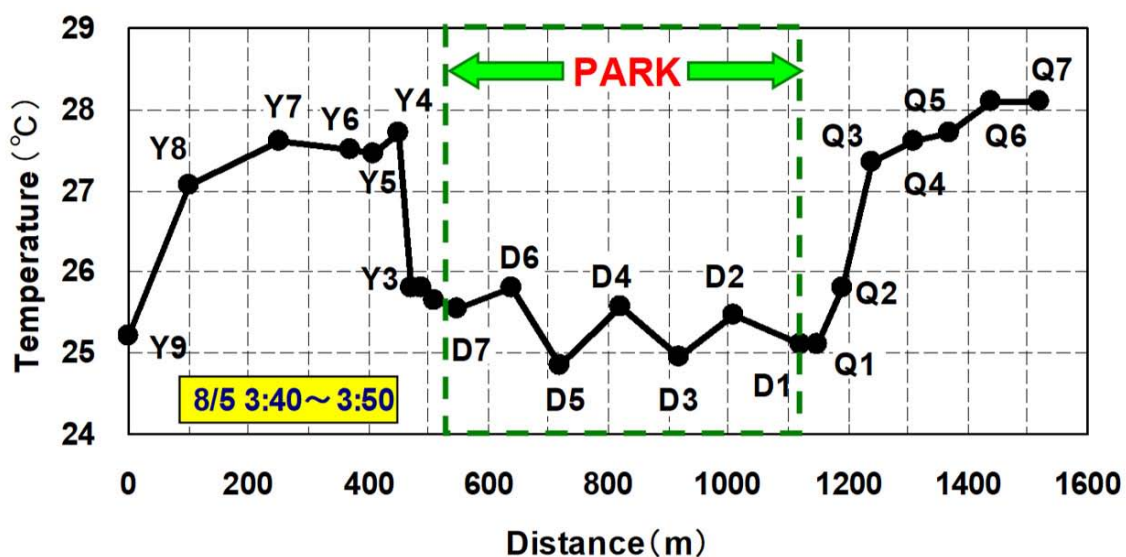


Figure 4. Air temperature distribution at Shinjuku Gyoen on a calm night (N04).

3. How about in winter? Is the park also cooler?

Mitigation of the urban thermal environment in summer is clear; however, how about in winter? If the green park is still cooler in winter, it should be considered as a negative factor for the human thermal environment in urban planning. The benefits and costs of urban green areas should be evaluated throughout the year, and there is a possibility that urban green areas do not give us a net benefit over a whole year.

Our long-term measurements showed that CII decreased in winter (Fig. 6). In some cases, a negative CII in which the park was warmer than the surrounding city can be seen, although the negative CII was not statistically significant compared to the spatial variation of air temperature in the city. The physical mechanism of this seasonal variation in CII has not been fully understood, which is a topic for future research.

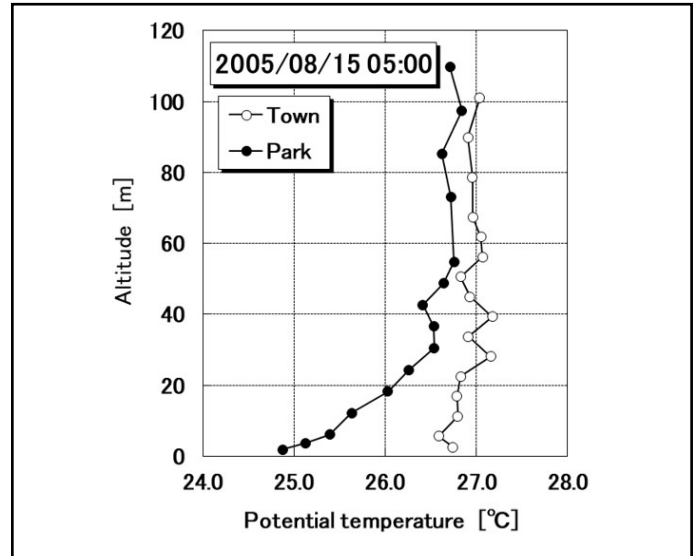


Figure 5. Air temperature profile measured in the park (Gyoen) and surrounding town (S21).

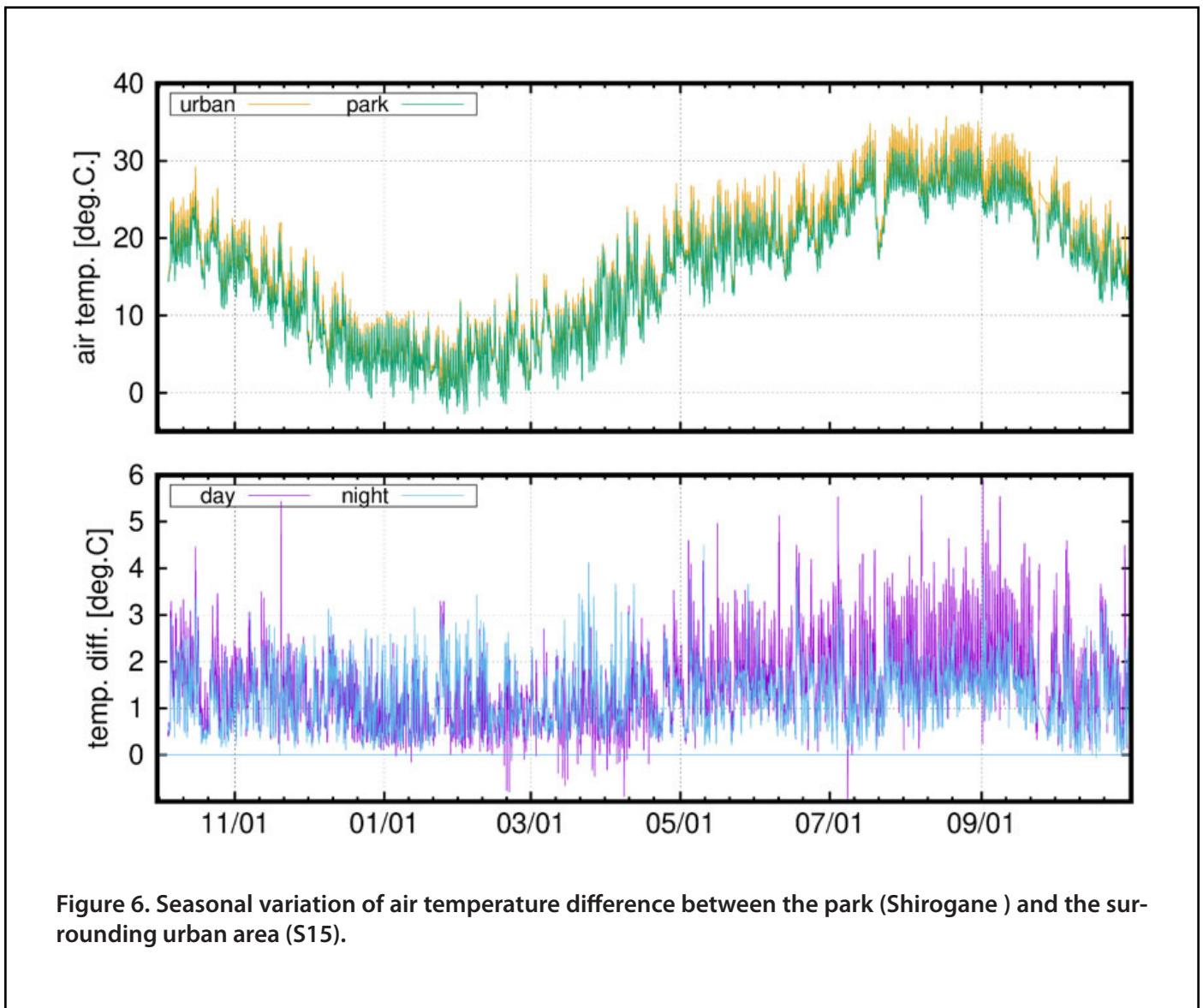


Figure 6. Seasonal variation of air temperature difference between the park (Shirogane) and the surrounding urban area (S15).

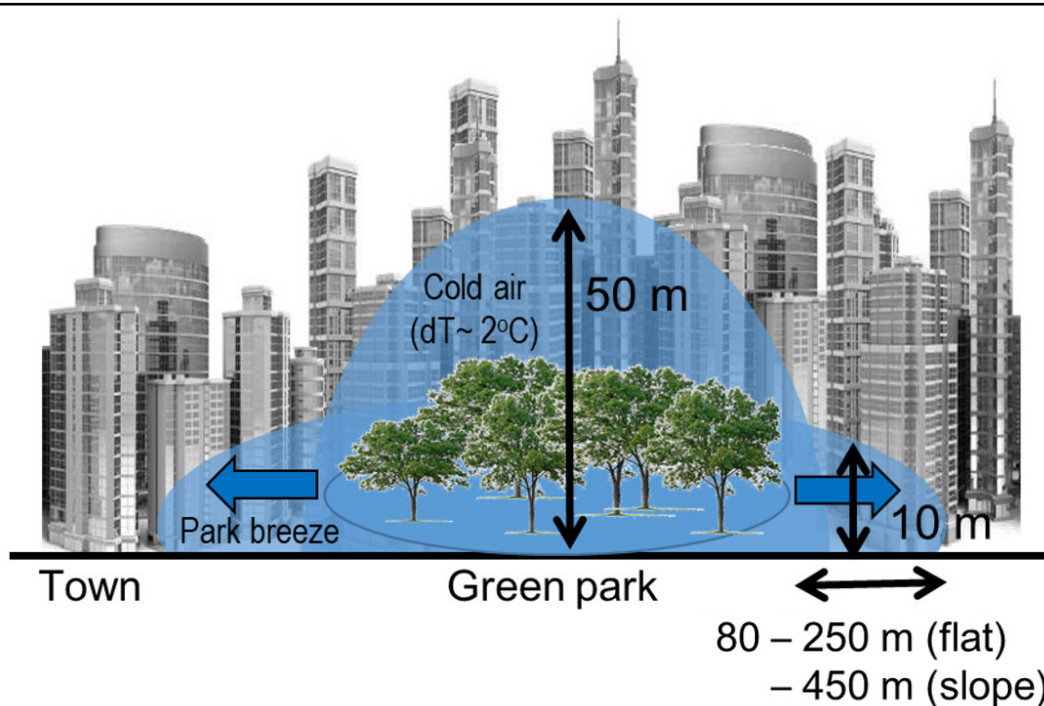


Figure 7. Schematic illustration of the green cool island and the park breeze at night. Size and temperature values are based on our observation results and are not necessarily representative for other urban parks.

4. Conclusion

Figure 7 illustrates the green cool island at night with the observed values. The travel distance and temperature difference could depend on many factors such as climate, plant species, urban morphology (e.g., street size and orientation), and so on. These relationships could be a topic for future research.

This article introduces our urban green projects and presents some perspectives for urban planning. Green areas in cities tend to decrease as a result of urbanization. However, they can provide a better thermal environment, which requires proper scientific assessment. In Tokyo, there are many green areas on sloped terrain. Some of these areas are left undeveloped because of high costs. While these areas may not show significant benefits in traditional urban planning, they are significantly beneficial for combating urban heat island phenomena, which is a significant threat to public health.

These projects were initiated by Prof. Takehiko Mikami (Tokyo Metropolitan University) who presented the cool island study at the first stage of research (Mikami, 1982), and Prof. Ken-ichi Narita (Nippon Institute of Technology), whose skill in measurement and sense of physics was essential in the projects. Prof. Tsuyoshi Honjo (Chiba University) provided valuable contributions in the plant ecology and urban landscape in these projects.

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‘Surface’, ‘Satellite’ or ‘Simulation’: Mapping Intra-urban Microclimate Variability in a Desert City

This report is based on: Zhou B., Kaplan S., Peeters A., Kloog I. and Erell E. (2020) ‘Surface’, ‘Satellite’ or ‘Simulation’: mapping intra-urban microclimate variability in a desert city. *International Journal of Climatology*, 40 (6):3099-3117.

Introduction

Cities are characterized by high heterogeneity of built form, land use and land cover, all of which contribute to diverse microclimate effects. As urban planners and city authorities seek to address the effects of historic environmental degradation and the potential consequences of global climate change, detailed mapping of the spatial and temporal variability of a wide range of indicators is becoming increasingly important. The three most common methodologies – in-situ measurements (transects or point measurements), remote sensing, and model simulations – are summarized in Table 1.

The objectives of this study were (a) to compare and contrast the three different methods for evaluating the thermal dynamics of a complex urban environment; and (b) to add to the relatively small sample of studies on the microclimate of desert cities.

Methods

The application of the three methods to describe the microclimate was demonstrated for the city of Be’er Sheva in the Negev Desert of Israel (31°15’N, 34°47’E, elevation 260m, population about 200,000). The study compared the surface skin temperature obtained from satellite thermal images with co-temporal canopy layer air dry bulb temperature (DBT) records obtained by means of vehicle traverses and with computer simulation using the Canyon Air Temperature (CAT) model.

Surface: An automobile traverse comprised two routes crossing representative landscapes and land use categories including parks, the central business district (CBD) and streets with different aspect ratios (H/W). Temperature measurements were made at 5-second intervals using thermocouples in mechanically aspirated screens approximately 50cm above the car roof. GPS was used to

Table 1: Methods of obtaining urban temperature.

	SURFACE	SATELLITE	SIMULATION
Spatial scale and resolution	Limited number of points, microscale (1–10 ⁴ m ²)	Sensor-dependent, micro- to local-scale (10 ⁵ -10 ⁷ m ²)	Model dependent
Temporal resolution	Single data point for each stop on traverse	Continuous (geostationary) or periodic (polar orbiting)	Model dependent
Level	Screen level (1.5-2 m)	Skin level (LST)	No constraint
Parameters	Most meteorological, limited by equipment	LST, reanalysis of some other met. variables	All meteorological, model dependent
Weather conditions	No restriction	Clear sky only	All weather
Surface features	Accessible (by car, bicycle or foot)	Surfaces exposed to the sky	Model dependent
Applications	Model validation	‘Backcasting’, epidemiology	Scenario testing, prognostic

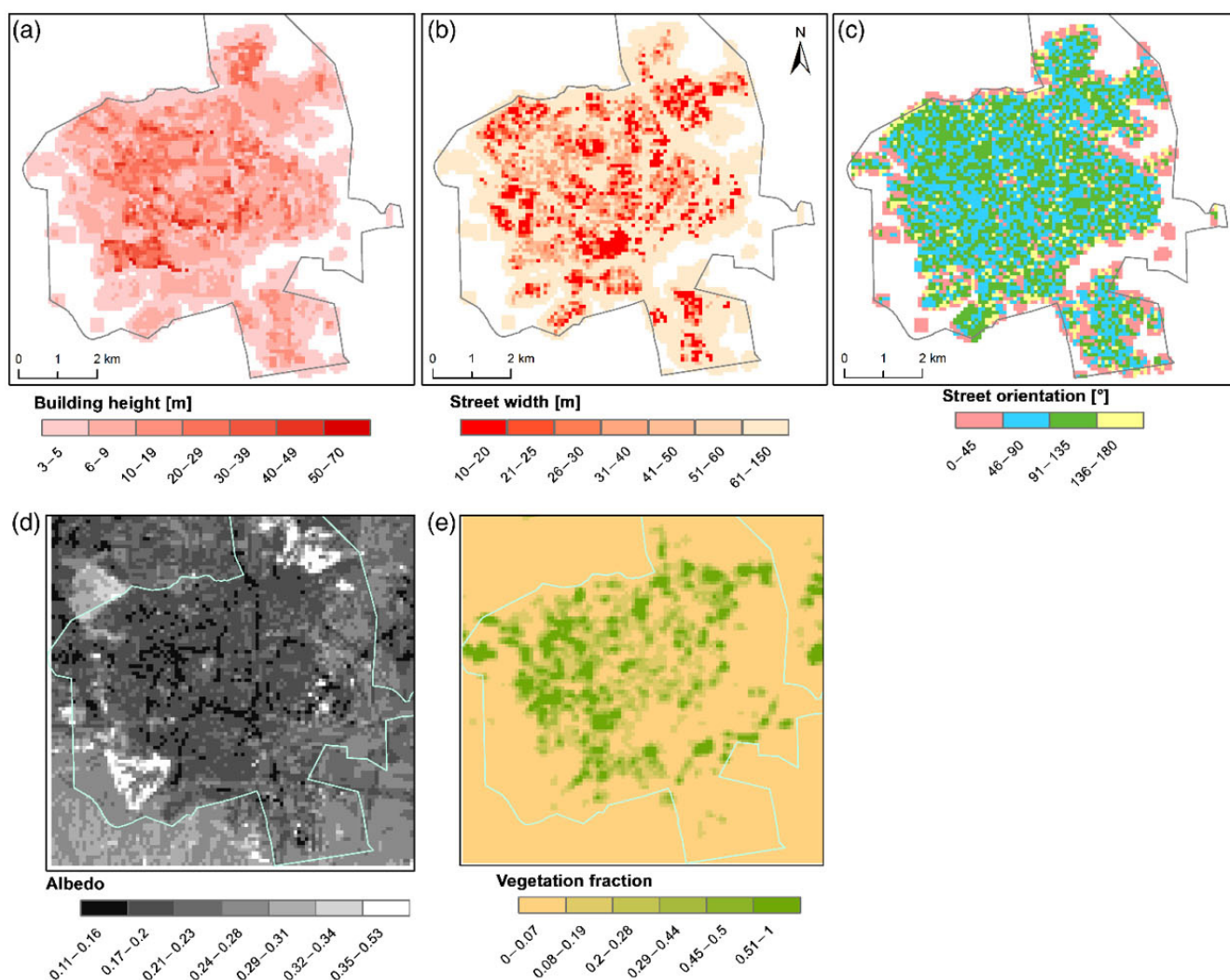


Figure 1. Spatial distributions of selected CAT input parameters: (a) building height, (b) street width, (c) street orientation, (d) albedo, and (e) vegetation fraction. The parameters in the upper panels (a)–(c) are derived from a building footprint geodatabase.

mark time and location. Intra-urban temperature differences were referenced to the Israel Meteorological Service (IMS) weather station near the center of the city.

Satellite: Thermal images at night (ASTER, 90m spatial resolution, about 22:00 local time) and daytime (LANDSAT-8, 30m resolution, at about 10:00) were processed using ENVI and ArcGIS (10.4). The procedure included re-projecting, clipping data to the defined study area and converting Digital Numbers (DN) to brightness temperature in Kelvin. A 20m resolution SENTINEL image was used to classify the area into 4 Land-Use/Land-Cover classes: Roads, buildings, vegetation and bare soil. The brightness temperature was then converted to land surface temperature (LST) using a classification-based emissivity method. To highlight the intra-urban surface temperature variability, the Surface Urban Heat Island (SUHI) was estimated by subtracting the average LST of the desert from each urban pixel in the scene.

Simulation: The Canyon Air Temperature (CAT) model (Erell and Williamson, 2006) calculates a representative air temperature in an urban canyon from measured meteorological parameters at a reference station exposed to the same meso-scale conditions. Model inputs are limited to meteorological parameters monitored routinely at standard weather stations, and a rudimentary description of the geometry and materials of the two sites. The present version of CAT, extended from Kaplan et al. (2016), employs automated procedures to link inputs from a GIS database and remote sensing products to 90x90m² grid cells covering the whole city (Fig. 1). Moisture advection is modeled using a simplified source-area model that assigns a wedge-shaped source area upwind of each grid point and is updated at each time step. A surface energy balance is then solved for both the reference site and each of the urban locations. Variable ground moisture is modeled following Leaf and Erell (2018). Anthropogenic

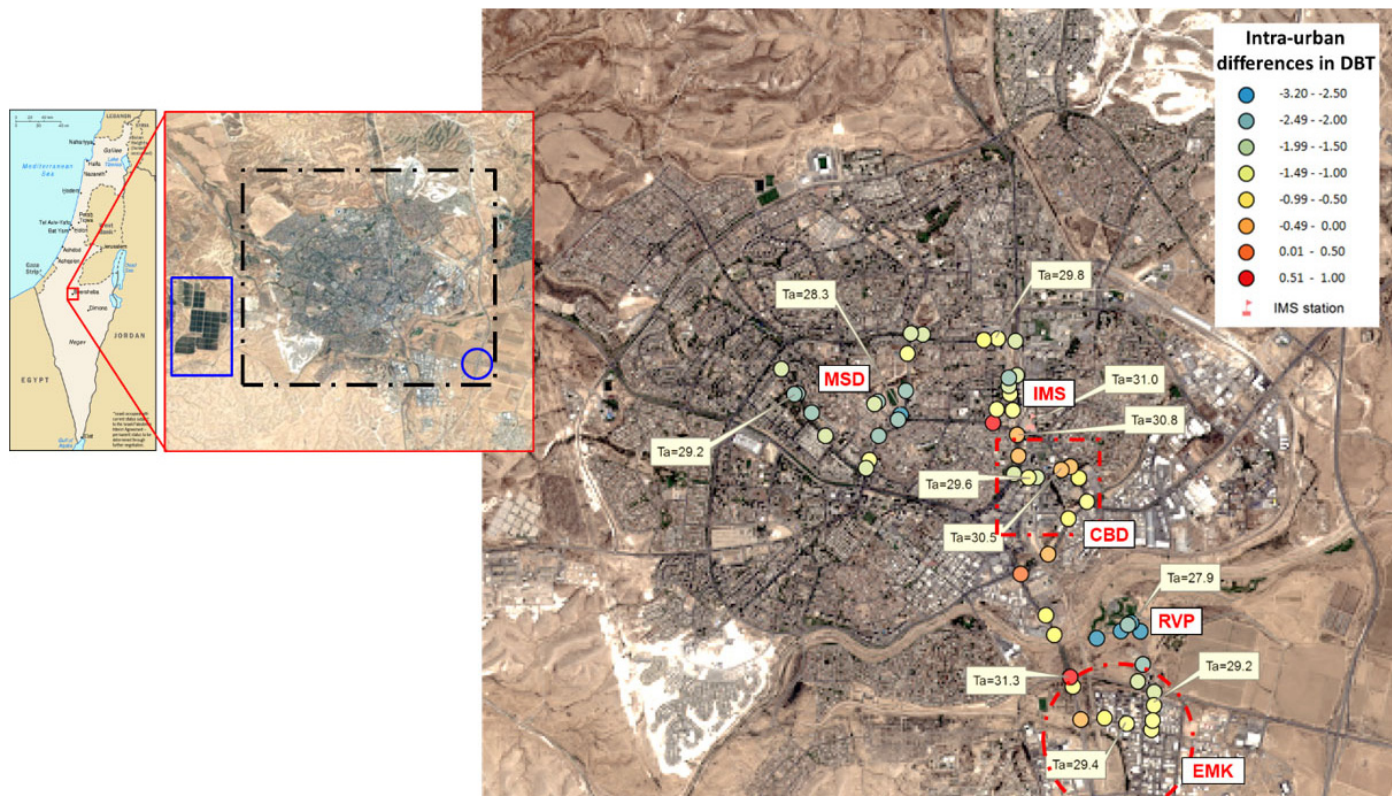


Figure 2. Route taken by one of two vehicle traverses in Be'er Sheva. Colour coding refers to the differences in air temperature relative to the IMS weather station located near the middle of the city. The blue rectangle (surrounding irrigated crops) and circle (highlighting major road interchange) in the inset indicate features visible on thermal images in Figure 3.

heat input for each grid cell accounts for building-related emissions using hourly air temperature to estimate heat loss by conduction and convection, as well as heat ejected by air-conditioners, and traffic-related emissions assigned according to street dimensions following a typical diurnal profile at hourly intervals. Regional weather data to drive the model were obtained from the IMS station at Nevatim, about 7 km southeast of the city center.

Results

The city of Be'er Sheva and its vicinity were divided into a total of 10,400 (100 × 104) grid cells of 90m × 90m. The linear spaces ('streets') identified automatically by means of a procedure developed for the purpose (see [full paper and Supplementary Material](#)) were aggregated to derive a representative street width and orientation for each grid cell.

Surface

Figure 2 shows the route taken by one of the vehicle traverses between 10:00-10:30. Intra-urban differences in DBT were ~3°C. The warmest area was the CBD, while a residential area to northwest (MSD) was cooler. A light industrial zone with low-rise buildings (EMK) was clearly warmer than the park adjacent to it to the north (RVP). The park, featuring extensive lawn and numerous trees, was the coolest point along the traverse.

Satellite

Figure 3 demonstrates the variability of surface skin temperature (LST) in the city and its vicinity by means of nighttime ASTER (a) and daytime Landsat-8 (b) images, respectively.

Night-time surface skin temperature shows a SUHI of 4–5°C, in contrast to a cool island of similar magnitude in mid-morning. The bare desert soil (loess) in the suburbs and urban periphery has a low thermal capacity and consequently exhibits large changes in temperature – cooling down rapidly after sunset but also heating up very rapidly after sunrise.

Simulation

The CAT model was used to generate urbanized weather for 90 x 90m² grid cells covering the whole city of Be'er Sheva for the entire year of 2016 at hourly intervals. The simulations were validated using Nevatim as the reference station and the IMS station in the city as the objective: simulated DBT (hourly for the entire year) had a mean error of -0.02°C with MSE = 0.76°C.

The (modelled) nocturnal urban heat island of Be'er Sheva is often followed by weak daytime cool island as exposed desert surfaces heat more rapidly than higher thermal mass urban surfaces. The nocturnal heat island is well developed in winter, but more modest in summer.

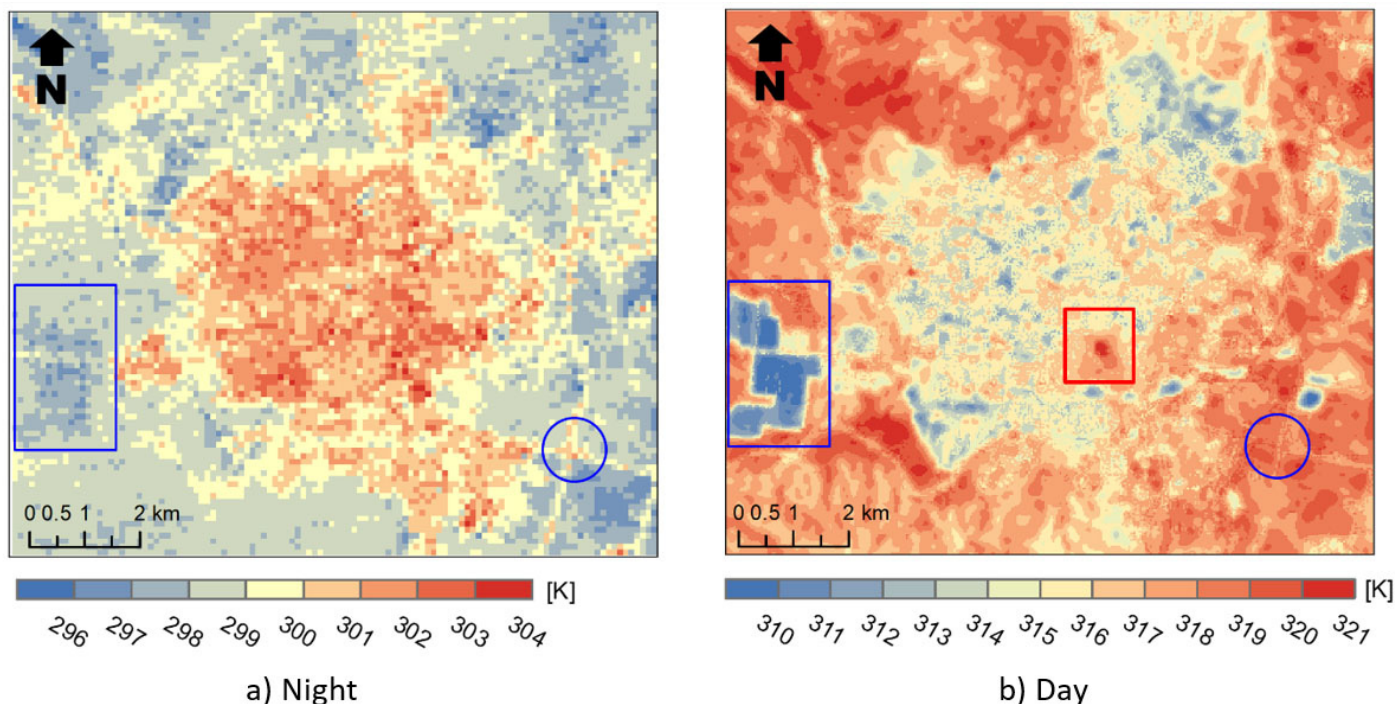


Figure 3. Surface kinetic temperature captured by (a) the ASTER sensor at 90m resolution for night-time at about 22:00 local time July 30, 2012; and (b) the Landsat-8 satellite at 30m resolution (resampled) for daytime at about 10:00 local standard time July 28, 2016. The dashed rectangle, solid rectangle, and dashed circle mark an irrigated jojoba farm; a cemetery, which is bare and devoid of vegetation, and thus behaves rather like open desert; and a road junction, respectively, which exhibit abnormal temperature patterns contrasting with their surroundings.

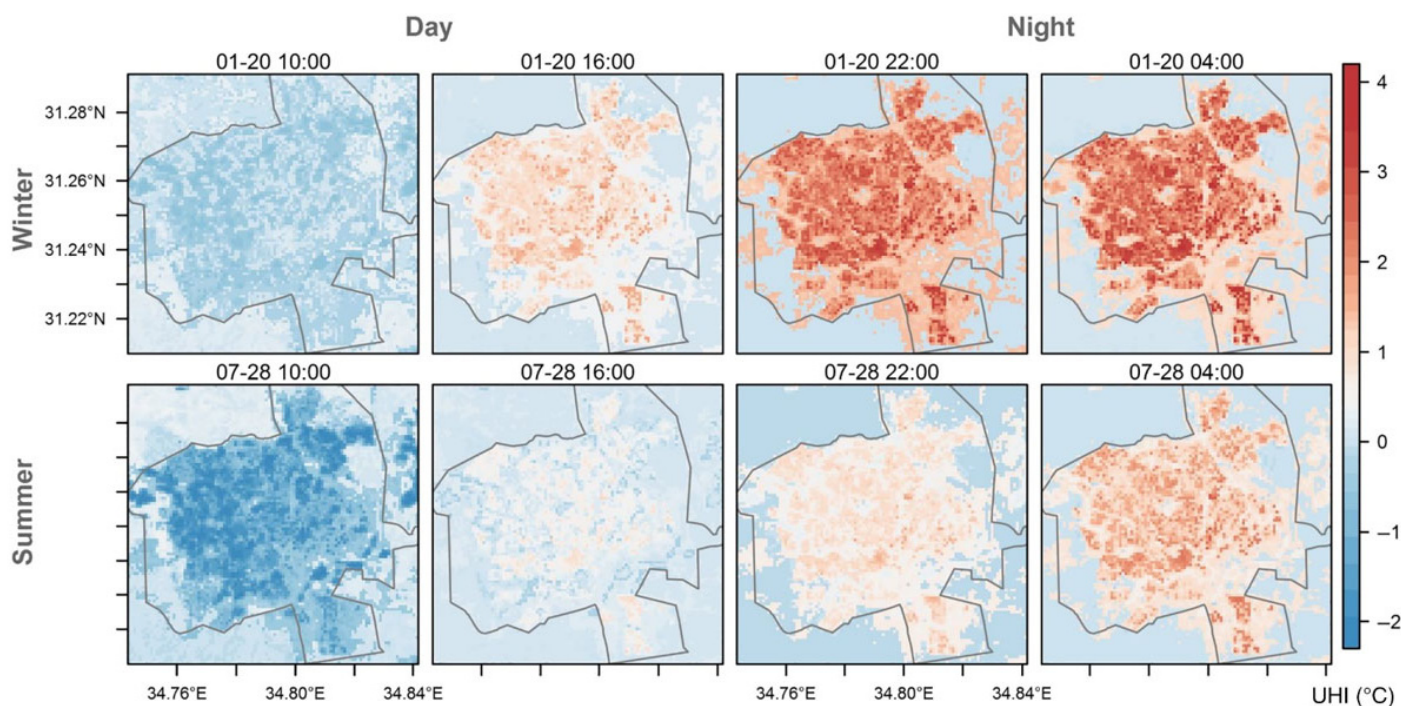


Figure 4. Spatio-temporal pattern of modelled surface air temperature at 6-hour intervals on a typical winter day (January 20, 2016) and summer day (July 28, 2016), grouped in daytime (LT1000 and 1600) and night-time (LT2200 and 0400). The UHI intensity is defined as the temperature difference relative to the rural reference measurement.

Discussion and conclusions

The presence of a daytime surface (LST) heat island accompanied by a weak canopy layer cool island, while not entirely surprising, underline the need for further study of desert cities, which often behave differently to cities in temperate or tropical locations.

We find that the results obtained by different methods used for evaluating the urban climate might not always be entirely consistent with each other. Consequently, while we do not necessarily rule out conclusions and suggestions drawn from studies based exclusively on a single method, we suggest that such studies should be interpreted much more carefully. As our study has demonstrated, urban-rural differences in LST obtained by remote sensing may be substantially larger than concurrent differences in canopy layer air temperature, at night as well as in daytime. In particular, differences in vegetation cover among urban neighborhoods that are clearly visible in images of LST may generate only moderate differences in air temperature.

Computer simulation at appropriate scale may be able to bridge the spatial gap between surface based in-situ

measurements, which are inherently local, and remote sensing data, which cannot resolve all thermal fluxes. The study demonstrates an innovative GIS-based, bottom-up approach to generating the required inputs for high-resolution modeling. The method to derive urban geometric parameters relies on several input layers of moderate resolution, such as land cover, albedo, and building footprints, which are all available from publicly accessible sources.

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Rethinking urban heat – risk and adaptation options across socioeconomic groups in Bonn, Germany

Insights from a household survey under the “Future-oriented Vulnerability and Risk Analysis as Instrument to Support Urban Infrastructure Resilience – ZURES” project

Although scenarios for changes in the climate signal are standard in assessing climate change and corresponding adaptation strategies, future changes of societal vulnerability are hardly taken into account. In addition, people and their socio-economic conditions have so far played at best a subordinate role in the design and implementation of risk assessments and respective adaptation options. In this respect, the ZURES project aimed to innovate risk assessments by linking societal vulnerability to climate change impacts embedded in the broader socio-economic change processes of urban areas. As part of a project consortium and comprising other actors from academia, the private sector, and policy, UNU-EHS led the development of conceptual analysis and evaluation schemes for urban vulnerability scenarios as well as a large household survey to assess risk and adaptation options in Bonn.

Notably, numerous studies analysing urban heat risk have been conducted. However, most of them either have a strong focus on the hazard component, e.g. assessing magnitude and frequency of (future) extreme heat events or diving into specific aspects of vulnerability, such as heat susceptibility related to health conditions (Estoque et al., 2020). Comparably little research focuses on assessments that consider, compare, or weight a broad range of heat risk factors such as health, behaviour, age, economic or housing conditions.

Accordingly, there is little research on the development of analytical risk assessment frameworks for urban or sub-urban scales. Even in well-researched areas like European cities, where impacts of heat are projected to increase in the future, no such analytical risk assessment framework exists. This is even despite the record hot summers of 2018 and 2019, which triggered research into possible adaptation measures (Beckmann and Hiete, 2020). Consequently, the household survey and the underlying analytical framework presented here are seen as a step to close this gap.

Household survey

The survey sought to understand how contextual factors such as housing characteristics and climatic factors interact with individual factors such as attitudes and awareness of urban dwellers. In line with recent evolutions in risk debates, our study adopted an integrated perspec-

The ZURES project was financed by the German Ministry of Research and Education under its initiative on sustainable transformation of urban regions from 2016-2019. The consortium, led by the University of Stuttgart, consisted of the Technical University of Dortmund, the cities of Bonn and Ludwigsburg, a private sector partner from urban planning and climate modelling and the United Nations University - Institute for Environment and Human Security (UNU-EHS).

The project aimed at developing new methods and instruments for a future-oriented urban vulnerability and risk assessment regarding heat stress. Besides concentrating on future shifts in natural hazard patterns around heat stress, it especially focused on shifts in socio-economic vulnerability, resulting from societal transformation processes.

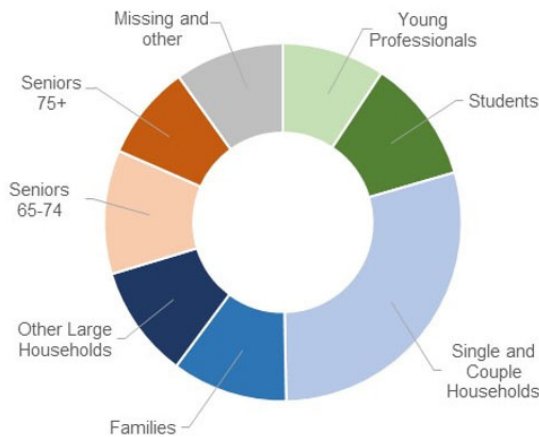
Among others, UNU-EHS led the development of conceptual analysis and evaluation schemes for urban vulnerability scenarios as well as the vulnerability assessment in the city of Bonn.

This article summarizes the recently published paper ‘Rethinking urban heat stress: Assessing risk and adaptation options across socioeconomic groups in Bonn, Germany’, available at: <https://doi.org/10.1016/j.uclim.2021.100857>.

tive that considers risk to be driven by the interplay of various political, environmental, economic and social factors (Turner et al., 2003; Birkmann et al., 2013; IPCC, 2014). Specifically, we followed the conceptualization proposed by IPCC (2014), in which risk results from the interaction of hazard, exposure and vulnerability (drawing on earlier work by Wisner et al. (2004) and others).

The survey was conducted in the city of Bonn, which increasingly faces climatic and socio-demographic pressures contributing to growing heat stress. It was designed to learn more about residents’ experiences with heat stress and efforts to cope and adapt, and was conducted May-September 2018 in three city districts that already face high exposure to heat and that are characterised by comparatively dense development in their cores. The selection of the districts was based on the results of the climate analysis carried out by GEO-NET in the ZURES project, which was able to forecast comparatively high and

Socioeconomic groups



Group		Criteria	n	%
Age <30 years old			141	20.5%
Young Professionals	YP	>1500€ per month	64	9.3%
Students	STU	<1500€ per month, A-level+ education	77	11.2%
Age 30-64 years old			343	49.9%
Single and Couple Households	S&C	1-2 people	201	29.2%
Families	FAM	3+ people, including 1+ child <6 years	72	10.5%
Other Large Households	OLH	3+ people, no child <6 years	70	10.2%
Age >64 years old			136	19.8%
Seniors (65-74)	65-74	65-74 years	77	11.2%
Seniors (75+)	75+	75+ years	59	8.6%
Missing and other			68	9.9%
Total			688	

Figure 1. Overview of socioeconomic groups and respective categorization criteria and distribution.

future increasing heat loads in both areas (Bundesstadt Bonn, 2020d). Overall, 688 responses were collected. Results were analysed along seven socio-economic groups (Figure 1).

Key findings

Non-surprisingly, results indicate that all socioeconomic groups are at risk of urban heat stress, though to differing extents and for different reasons. Therefore, the study demonstrates the need to take a deeper look at the different risk components, as they vary greatly across groups.

Exposure was lowest in older age groups (see Figure 2), which are usually considered to be at highest risk from urban heat. This results from comparatively better housing conditions and a high potential to adapt their behaviour to heat, as they are usually no longer part of the working population and thus not restricted by fixed working hours. In contrast, exposure of younger population groups is highest, as they frequently use public transport which is considered very uncomfortable during hot periods, and often live in poorly heat-adapted housing. As a result, Students and Young Professionals

Exposure

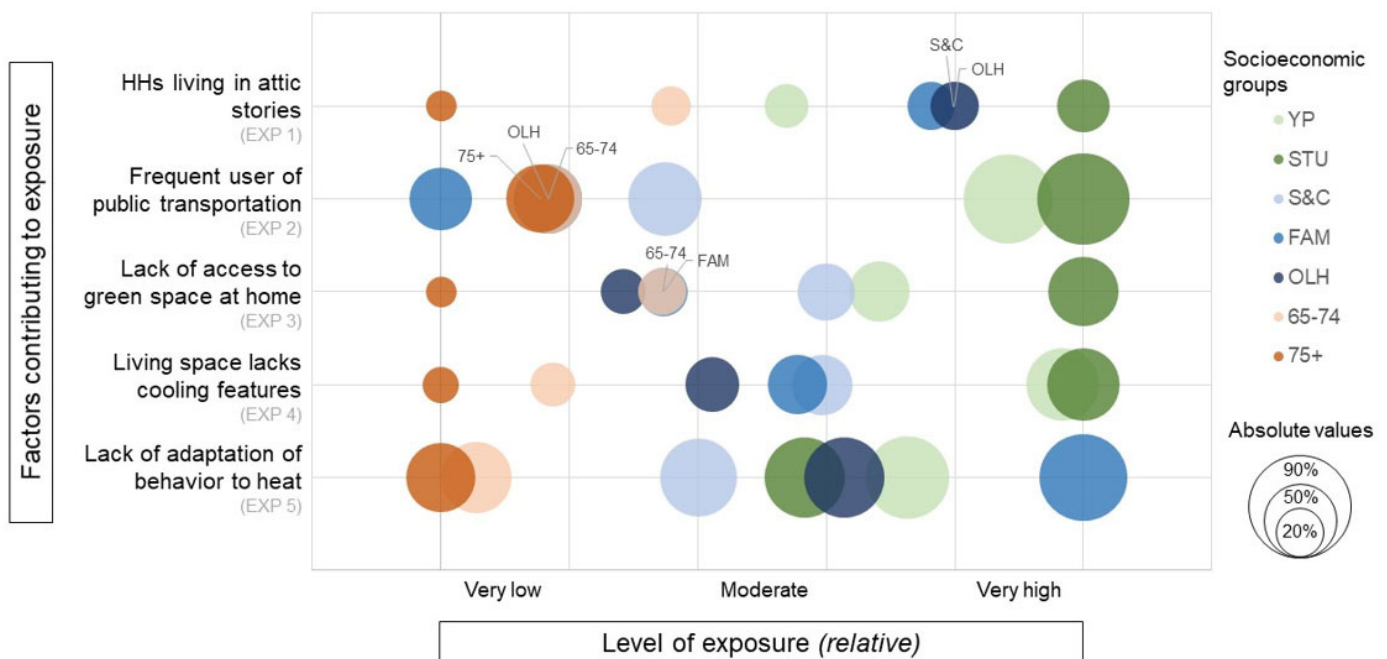


Figure 2. Exposure across socioeconomic groups (abbreviations and colour schemes as introduced in Figure 1). Absolute values (%) represented through size of the bubbles, while relative, normalized values are portrayed through the position of the bubbles on the x-axis.

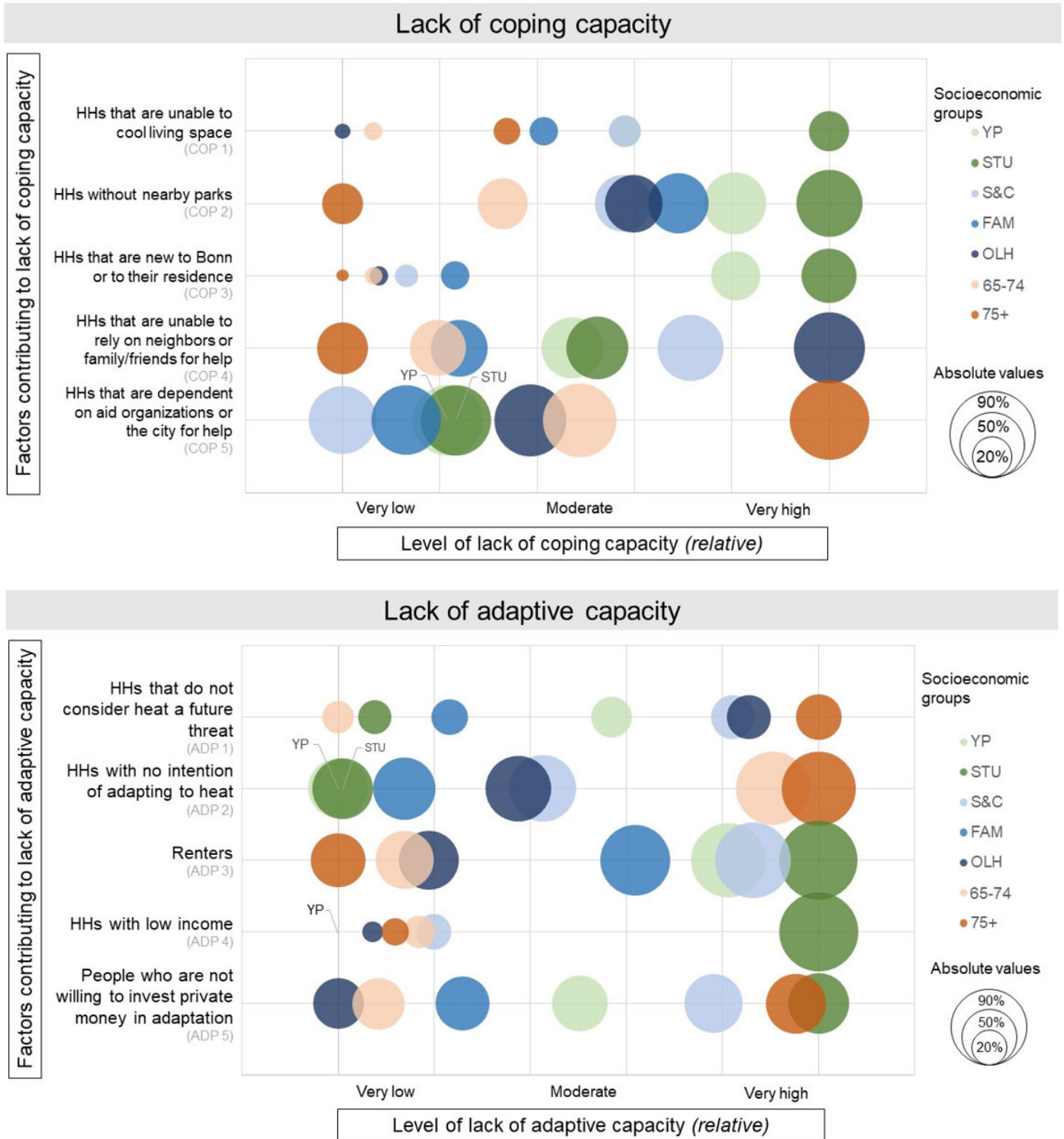


Figure 3. Lack of coping capacity (top) and adaptive capacity (bottom) across socioeconomic groups. Absolute values (%) represented through size of the bubbles, while relative, normalized values are portrayed through the position of the bubbles on the x-axis.

are more exposed due to their climate-friendly behavioural practices. However, these groups are not necessarily on the radar of urban decision-makers. Although usually lower exposed, families with young children indicated a lack of adaptation of behaviour to heat stress, likely resulting from fixed schedules, which significantly increases their exposure.

Results on vulnerability provide a less clear picture. The age groups above 65 were most susceptible and had comparatively low adaptive capacities (see Figure 3). There is a sizable lack of adaptive capacity for the two indicators of adaptation propensity, partly because adaptation is considered as the responsibility of younger generations.

Students and Young Professionals are almost opposite of older age groups for most vulnerability components. They are among the least susceptible but face a high lack of coping and partly adaptive capacity. Rental status and comparably low financial means to implement adaptation measures limit their comparably high intention to adapt (see Figure 3). Students in particular are more likely to be on low or fixed incomes, contributing to their lower capability despite high willingness to self-fund adaptation measures.

The same is true for most middle-aged households, with the exception of Families with young children which are, along with the elderly, usually considered a high-risk group in the literature. However, besides slightly higher susceptibility, overall vulnerability is at a comparable level across Single and Couple Households, Families and Other Large Households. Lack of coping and adaptive capacities are all at moderate levels, ranging between younger and older groups. As mentioned, Families state a low willingness to adapt their behaviour to heat, which also increases their lack of coping capacities.

Recommendations and outlook

Overall, each of the assessed socioeconomic groups has particular strengths and weaknesses related to their coping and adaptive behaviour. Though older population groups have heightened susceptibility, their overall risk may be at least in part offset by high coping and adaptive capacities. In contrast, younger respondents are more exposed but also displayed high risk awareness, indicating that they were more likely to alter their behaviour to adapt to a future environment in which heat waves are more of a problem. However, they might not be able to make necessary changes due to lower quality living conditions and lack of financial means, resulting in an adaptation gap in a time when rapid action is needed.

On a higher level, our results reveal that vulnerability and exposure are strongly linked to socioeconomic conditions and that, in general, lower income is associated with higher risk. Another key pattern is the link between awareness and attitude and risk. Low awareness and negative attitude towards engaging in adaptation and important impeding factors that increase risk. This indicates that offering only financial incentives may not be enough. Instead, likelihood of success needs to be bolstered by group-specific interventions.

This study has shown how important it is to more precisely capture the patterns of urban heat risk across different socioeconomic groups, which so far have rarely been analysed in a systematic way. Urban residents who do not fall into “classical risk groups” are affected by heat stress in ways that may not be accounted for in current policy measures and community outreach strategies. Key take-aways from the study are:

1) An analytical framework assessing different risk components provides a more nuanced picture of the different challenges socioeconomic groups are facing

2) All socio-economic groups perceived being impacted by heat stress, including younger age groups, and were

found to be at risk

3) It is important to look at all urban inhabitants instead of focussing on a few groups exclusively – usually young children and elderly

In a nutshell, to adapt cities to heat, it is not enough to know which parts of a city are getting hotter; policy-makers and urban planners need to know and consider which groups are most likely to experience heat stress, the underlying causal factors, and what the individual scope for action is.

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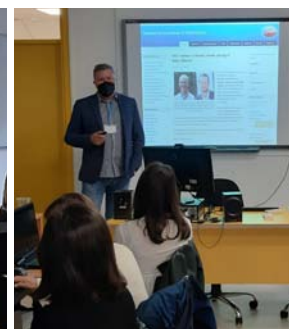
Training school on “Nature-Based Solutions and Climate-Sensitive Urban Design” held in Novi Sad, Serbia

From September 20th to 24th 2021, the **Novi Sad “Nature-Based Solutions & Climate-Sensitive Urban Design”** training school was held at the University of Novi Sad, Serbia. The school was organized by the Novi Sad Urban Climate Research Team and supported by the International Association for Urban Climate (IAUC), the COST Project “Circular City” and the Department of Geography, Tourism and Hotel Management (Faculty of Sciences, University of Novi Sad). In total, 45 participants from 20+ countries were working and networking intensively during the five days in Novi Sad.

The main topic of the school was related to Nature-based Solutions (NBS) and climate-sensitive urban design that can help to limit the impacts of climate change, enhance biodiversity, improve environmental quality and save resources while contributing to economic activities and social well-being in urban areas. These approaches have the potential to provide multiple benefits across a range of sustainability challenges facing cities.

In order to access the potential of NBS, theoretical knowledge, critical thinking and practical skills are needed for young researchers and PhD students in their future work and development. This training school provided theoretical and technical knowledge as well as hands-on skills to interested trainees in order to investigate opportunities and challenges for NBS implementation in climate-sensitive urban design and planning. The critical areas covered during the training school were:

- Assessment and application of modelling tools for NBS implementation in urban environment. For this purpose, trainees worked in modeling software ENVI-Met and RayMan with Tobi Eniolu Morakinyo and Dragan Milosevic as members of IAUC. Furthermore, trainers were introduced to PALM-4U model by Jan Geletič (IAUC member) and also worked in Rhino, ArcGis Pro and R Studio in order to enhance their skills related to climate science in urban areas.



- In addition to hands-on experience in different software, trainees learned about IAUC’s main aims, membership and activities (presented by Stevan Savic, IAUC member). Julie Fitcher and Csilla Gal (IAUC members) gave interesting presentations regarding the Urban Climate Rules. Trainees also learned about the possibilities of NBS and climate-sensitive urban design in different regions and climates as well as for different urban challenges (e.g., heat stress reduction, energy savings, air pollution mitigation, etc.)

- Organizers, trainers and trainees decided to work together in the future on research and review papers as well as to cooperate on future projects. Among the trainees, especially active were IAUC members Jelena Dunjić, Aditya Rahul, Pavel Konstantinov, Marcel Gangwisch, Matteo Migliari, Benjamin Obe, İdil Kanter Otçu and Milica Lukić.

The Novi Sad Urban Climate Research Team plans to organize the 2nd edition of the Novi Sad Nature-Based Solutions & Climate-Sensitive Urban Design training school in August 2022. We are looking forward to organizing this event together with IAUC and hope that even more IAUC members will join it.

Thank you, IAUC!

Dr. Dragan Milosevic

on behalf of the organizing team
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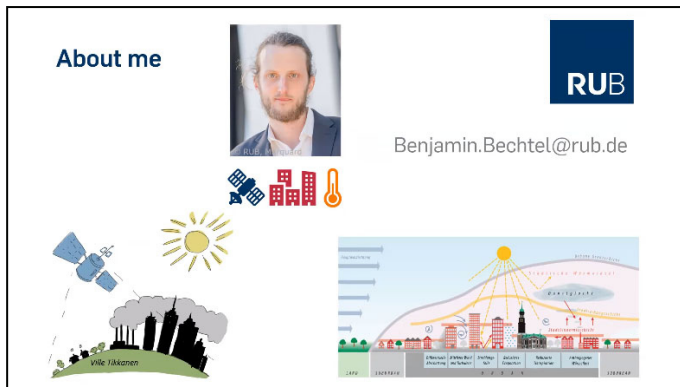


5th IAUC Webinar – Thermal remote sensing of urban climates

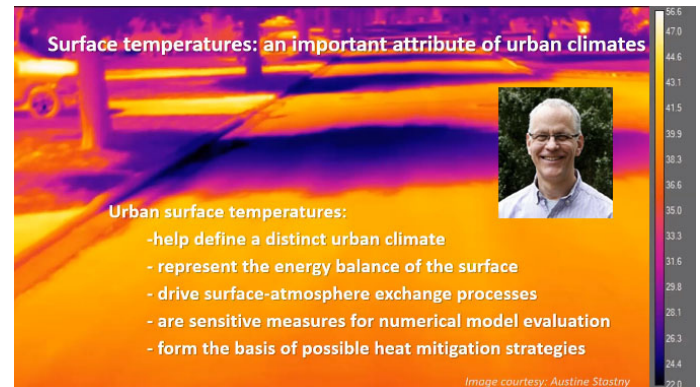
The 5th IAUC webinar was held on September 8, 2021. Its theme was thermal remote sensing of urban climates, and it explored the growing use of thermal remote sensing in urban climate research while detailing fundamental definitions and applications of this methodology.

The seminar featured two thought leaders, discussing the state-of-the-art and future directions of deploy-

ing remotely-sensed data in urban climate research. The talks were given by Professor **Benjamin Bechtel** (Ruhr-University Bochum) on “Challenges of global SUHI analysis” and by Professor **James Voogt** (University of Western Ontario) discussing “(In)complete urban surface temperatures”. The talks were followed by a lively Q&A session and discussions.



Prof. Benjamin Bechtel (Ruhr-University Bochum) addressed some of the misunderstandings between the urban climate and remote sensing communities regarding the surface urban heat island (SUHI), emphasizing that most satellite-based studies essentially see the three-dimensional urban surface as “flat.”



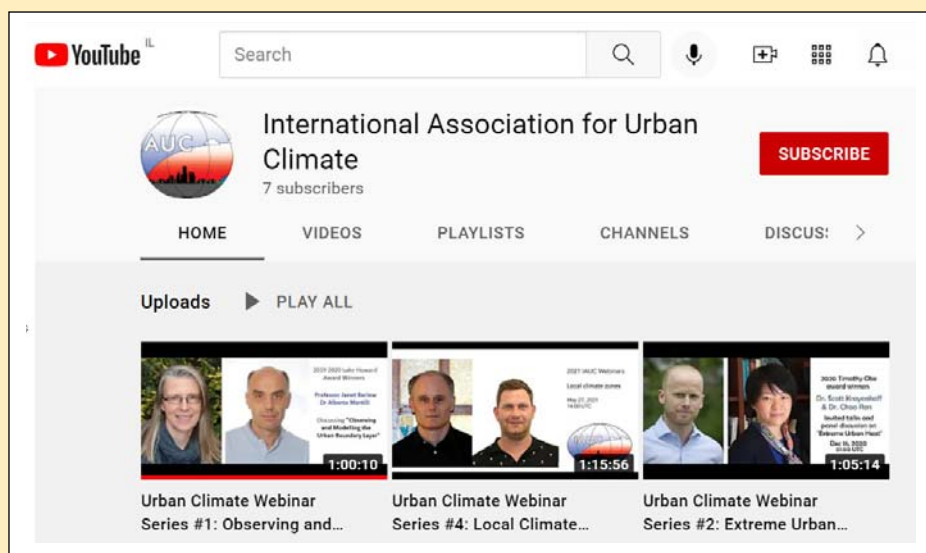
Prof. James Voogt (University of Western Ontario) discussed the importance of urban surface temperatures, and the challenge of obtaining a “complete” temperature values for three-dimensional urban terrain which are not fully captured by remotely sensed views from any single perspective.

The full video recording of the webinar is available here:

<https://bit.ly/2X2TGzv>

In addition, the full video recordings of previous IAUC webinars in the Urban Climate Webinar Series are available on the newly released IAUC YouTube channel:

<https://www.youtube.com/watch~InternationalAssociationforUrbanClimate>



Recent Urban Climate Publications

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In this edition is a list of publications that have mainly come out between **May and August 2021**. If you believe your articles are missing, please send your references to the email address below with a header "IAUC publications" and the following format: Author, Title, Journal, Year, Volume, Issue, Pages, Dates, Keywords, URL, and Abstract. Important: do so **in a .bib format**.

Note that we are always looking for (young) researchers to join and contribute to the Committee. If you are interested to join or would like to receive more information, please let me know via the email address below.

Happy reading,

Chenghao Wang

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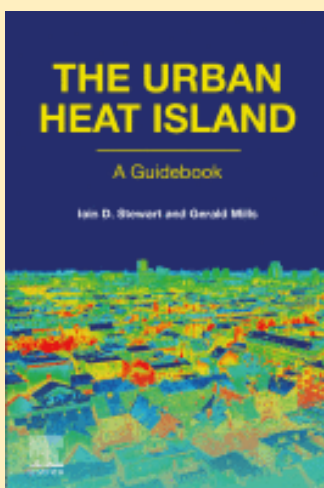
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Recently published books...

[Stewart ID, Mills G \(2021\) *The Urban Heat Island: A Guidebook*. Elsevier.](#)

The Urban Heat Island (UHI) is an area of growing interest for many people studying the urban environment and local/global climate change. The UHI has been scientifically studied for 200 years and, although it is an apparently simple phenomenon, there is considerable confusion around the different types of UHI and their assessment. *The Urban Heat Island: A Guidebook* provides simple instructions for measuring and analysing the phenomenon, as well as greater context for defining the UHI and the impacts it can have. Readers will be empowered to work within a set of guidelines that enable direct comparison of UHI effects across diverse settings, while informing a wide range of climate mitigation and adaptation programs to modify human behaviour and the built form. This opens the door to true global assessments of local climate change in cities.



Urban planning and design strategies can then be evaluated for their effectiveness at mitigating these changes.

Key Features:

- Covers both on-surface and near-surface, or canopy, measurements and impacts of Urban Heat Islands (UHI)

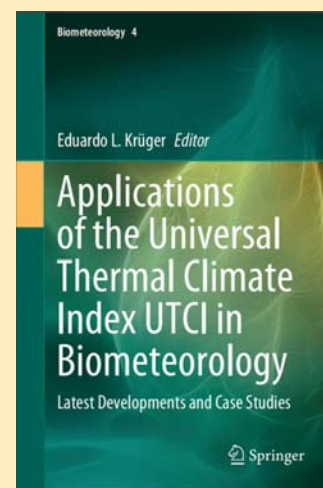
- Provides a set of best practices and guidelines for UHI observation and analysis
- Includes both conceptual overviews and practical instructions for a wide range of uses

Readership: Climatologists, meteorologists, geographers, architects, engineers, urban planners, environmental planners, policy and decisions makers, bioclimatologists, urban ecologists, public health officials

[Applications of the Universal Thermal Climate Index UTCI in Biometeorology: Latest Developments and Case Studies. Springer Biometeorology Series.](#)

Editor: Eduardo L. Krüger

This key book on the outdoor thermal comfort index: UTCI (Universal Thermal Climate Index) brings readers up-to-date with the latest applications, testing and studies of the UTCI. The book provides a comprehensive, up-to-date view on the UTCI as a heat stress metric, and its latest applications in urban planning, meteorology, public health, human physiology and sustainable architecture. Of interest to urban planners, architects, building engineers and all those interested in human wellbeing in cities.



Upcoming Conferences...

The information in this list is current as of the publication date of the newsletter, but readers should check for updated information online in the event of schedule changes due to the COVID-19 pandemic.

INNOVATE4CITIES CONFERENCE

Virtual event • October 11-15, 2021

<https://www.globalcovenantofmayors.org/research-innovation/>

AMERICAN GEOPHYSICAL UNION FALL MEETING

New Orleans, USA and Online • December 13-17, 2021

<https://www.agu.org/Fall-Meeting/>

102ND AMERICAN METEOROLOGICAL SOCIETY ANNUAL MEETING & 22ND JOINT CONFERENCE ON THE APPLICATIONS OF AIR POLLUTION METEOROLOGY, Session on "Urban Air Pollution under a Changing Climate and Changing Emission Profiles"

Houston, USA • January 23-27, 2022

<https://annual.ametsoc.org/index.cfm/2022/>

URBAN CLIMATE SESSION IN 13TH INTERNATIONAL CONFERENCE ON SOUTHERN HEMISPHERE METEOROLOGY AND OCEANOGRAPHY (ICSHMO)

Christchurch, New Zealand • February 8-12, 2022

<https://confer.eventsair.com/icshmo-2022/>

36TH PLEA CONFERENCE ON SUSTAINABLE ARCHITECTURE AND URBAN DESIGN

Santiago, Chile • November 23-25, 2022

<https://www.plea2022.org/>

INTERNATIONAL CONFERENCE ON URBAN CLIMATE (ICUC-11)

Sydney, Australia • August 2023

<https://conference.unsw.edu.au/en/icuc11>



Calls for Papers...

"WEATHER AND CLIMATE EXTREMES IN THE URBAN ENVIRONMENT: MODELING AND OBSERVATIONS"

Special Issue of Frontiers in Environmental Science

Abstract deadline: October 12, 2021; manuscript deadline: February 12, 2022.

<https://www.frontiersin.org/research-topics/24936/weather-and-climate-extremes-in-the-urban-environment-modeling-and-observations>

"URBAN MICROCLIMATE AND AIR QUALITY AS DRIVERS OF URBAN DESIGN"

Special Issue of Sustainability

Guest Editors: Luciano Massetti & David Pearlmutter

Updated Deadline: December 31, 2021

https://www.mdpi.com/journal/sustainability/special_issues/Urban_Microclimate_Air_Quality

"STATE-OF-ART IN URBAN CLIMATE PROJECTIONS"

Special Issue of Atmosphere

Abstract deadline: February 5, 2022

https://www.mdpi.com/journal/atmosphere/special_issues/Climate_Projections

"EFFECTS OF THE COVID-19 PANDEMIC ON THE USE AND PERCEPTION OF URBAN GREEN SPACE"

Special issue of Land

Guest Editors: Francesca Ugolini & David Pearlmutter

Updated deadline: April 30, 2022

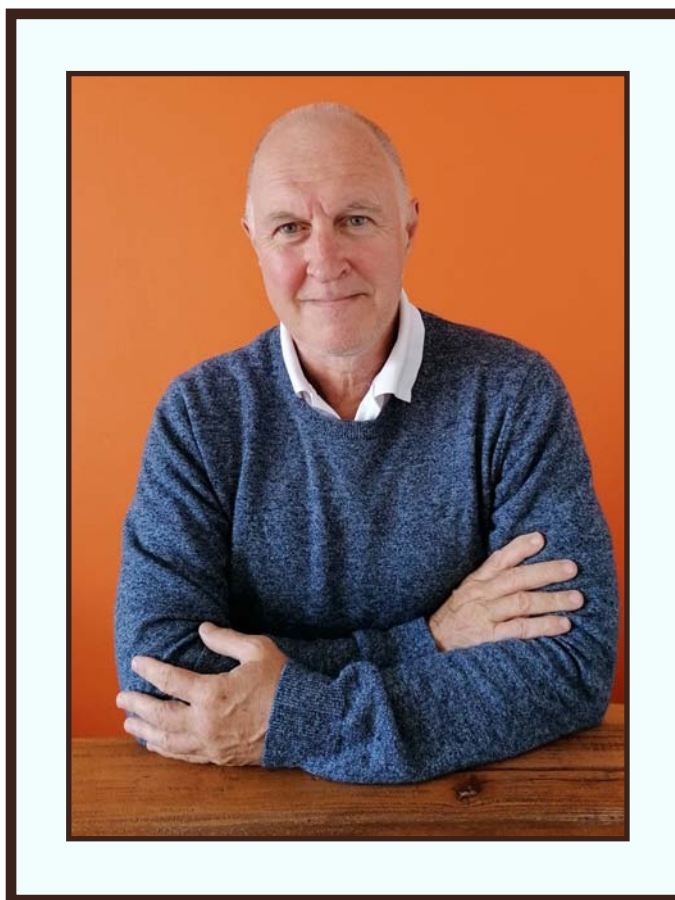
https://www.mdpi.com/journal/land/special_issues/pandemic_ugs

2021 Luke Howard Award honors Gerald Mills

We are delighted to announce Dr. **Gerald Mills** of University College Dublin, Ireland, as the winner of the 2021 Luke Howard Award for Outstanding Contributions to the Field of Urban Climatology.

Gerald is an influential urban climatologist and a remarkable researcher, widely known for his numerous scientific contributions, his genuine passion for the subject and its history, his generosity as a mentor and his exceptional dedication to the urban climate community.

Gerald's research has had substantial impact across many areas of urban climatology. These include the urban heat island, modelling the urban canopy, the surface energy balance at multiple scales, indoor and outdoor climates, the links between cities and global climate change and the importance of sustainable urban design. He has been instrumental in the WUDAPT initiative and is now perhaps even more widely known as a co-author of the *Urban Climates* textbook, which has become one of the key texts not only for urban climatologists but also for multiple disciplines interested in the urban environment. Alongside these scientific contributions, Gerald has amassed an impressive knowledge of the history of urban climate. He has brought the work of early pioneers to the



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CLIMATE OF LONDON
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attention of the present-day community with remarkable commitment and enthusiasm. He can recite long passages of Luke Howard's *The Climate of London* and has reedited this book, line by line, to make it available again for the scientific audience. For this alone, Gerald would be a worthy recipient of the Luke Howard Award.

Gerald received his PhD from The Ohio State University in 1989, then taught at Bowling Green State University, Ohio, and the University of California at Los Angeles before moving to University College Dublin in 1997.

His engagement in the community is exceptional, both nationally and internationally. Gerald has been a member of the WMO's Urban Ex-

pert team for over a decade and has remained a key part of the IAUC since it was established more than twenty years ago. His roles within the IAUC have included President, Secretary and Treasurer and he was the first editor of the IAUC newsletter (*Urban Climate News*). His open-mindedness and strong belief in international and interdisciplinary collaboration have helped to foster an inclusive and supportive global urban climate community. He is a talented researcher, an exceptional mentor and a remarkable spokesperson for urban climate – and a highly deserving recipient of the 2021 Luke Howard Award.

Meteorological Observations,
 BY LUKE HOWARD, GENT.

Three recipients named for 2021 Timothy Oke Award

In this second year of the IAUC Timothy Oke Award for Original Research in the Field of Urban Climatology, we are delighted to announce that three awards will be made: Professor **Benjamin Bechtel**, at Ruhr-University Bochum, Germany; Associate Professor **Leena Järvi**, at the University of Helsinki, Finland; and Dr **Iain D. Stewart**, Fellow at the Global Cities Institute, University of Toronto, Canada. These three exceptional early-to mid-career researchers have each made major contributions to the field of urban climate, with their high quality, high impact and highly relevant work.

Benjamin received his PhD on remote sensing of urban canopy parameters from the University of Hamburg in 2012, before working as a Research Associate for the CliSAP Cluster of Excellence and in 2019 becoming Professor for Urban Climatology at Ruhr-University Bochum. His work to characterise the morphology and behaviour of cities from satellite data has substantially advanced many areas of urban climatology, especially helping to understand the urban heat island and providing much-needed input data for urban modelling studies. Benjamin is committed to sharing data, tools and knowledge. Thanks to his efforts, software for mapping Local Climate Zones is freely available and used throughout the world. Benjamin is also a committed member of the IAUC community – and was instrumental in establishing this Timothy Oke Award.



Leena is a highly regarded researcher in the field of urban micro-meteorology who has made numerous innovative, long-lasting and diverse contributions. She consistently works at the leading edge using a range of novel and traditional measurement techniques as well as developing modelling tools to generate new insights. Her outstanding publication record is impressively varied, including significant contributions on air pollution, biogenic and anthropogenic carbon dioxide exchange, cold-climate cities, and the energy and water balance. Leena has built up her research group at the University of Helsinki and collaborates widely – she is an excellent mentor (evidenced by numerous co-authored papers with her students) and a valued member of the IAUC community.

Iain is an imaginative and creative scientist, who is internationally renowned for his work on the urban heat island from both historical and scientific perspectives. His work on Local Climate Zones has redefined urban climatology and is used by hundreds of researchers across the world. As well as providing this essential framework, Iain has developed important guidance for conducting urban heat island research to ensure high scientific standards are maintained, and his systematic review of urban heat island studies provides an important historical context for more recent studies. Iain is an excellent communicator who is highly engaged with supporting researchers around the globe. He is an exceptional scholar, highly esteemed for his exemplary approach to science: holistic, innovative and rigorous. His work has had, and will continue to have, an immense influence on the work of others.



Congratulations to two newly elected IAUC Board members

As a result of the recent election, we welcome and congratulate our two new IAUC Board members, **Natalie Theeuwes** from the Royal Netherlands Meteorological Institute, and **Vincent Luo** from the University of Reading. Many thanks to those members of our community who put their names forward for election.



Natalie Theeuwes



Vincent Luo

Would you like your work featured in *Urban Climate News*?

If you would like to write an article for the IAUC newsletter, please contact the Projects Editor **Helen Ward** (helen.ward@uibk.ac.at). Our Project articles usually provide a short summary of recent work and can be a good way to advertise a recent journal publication to a wide audience, perhaps including additional information, figures or photographs. Our Feature articles offer the opportunity to highlight results from a particular project or collection of projects, often bringing together findings from a series of complementary publications in a concise overview. We are always happy to receive suggestions for future issues of the newsletter – please get in touch!

IAUC Board Members & Terms

- **President:** Nigel Tapper (Monash University, Australia), 2018-22
- **Secretary:** Andreas Christen (Albert-Ludwigs Universität Freiburg, Germany), 2018-22
- **Treasurer:** Ariane Middel (Arizona State University, USA), 2019-22
- Alexander Baklanov (WMO, Switzerland), *WMO Representative*, 2018-22**
- Matthias Demuzere (Ruhr-University Bochum, Germany and CEO and Founder Kode), 2018-22
- Jorge Gonzalez (CUNY, USA): *ICUC10 Local Organizer*, 2016-21
- Melissa Hart (University of New South Wales, Australia), 2020-24
- Simone Kotthaus (Institut Pierre Simon Laplace, France), 2020-24
- Vincent Luo (University of Reading, UK), 2021-25
- Dev Niyogi (Purdue University, USA): *ICUC10 Local Organizer*, 2016-21
- Negin Nazarian (University of New South Wales, Australia): *ICUC-11 Local Organizer*, 2020-24
- David Pearlmutter (Ben-Gurion University, Israel), *Newsletter Editor*, 2008-*
- David Sailor (Arizona State University, USA), *Past Secretary* 2014-2018*
- Natalie Theeuwes (Royal Netherlands Meteorological Institute, the Netherlands), 2021-25
- James Voogt (University of Western Ontario, Canada), *Past President*: 2014-2018*
- Helen Ward (University of Innsbruck, Austria), 2019-22

* non-voting, ** non-voting appointed member

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The next edition of *Urban Climate News* will appear in late December. Contributions for the upcoming issue are welcome, and should be submitted by November 30, 2021 to the relevant editor.

Submissions should be concise and accessible to a wide audience. The articles in this Newsletter are unrefereed, and their appearance does not constitute formal publication; they should not be used or cited otherwise.

Bibliography: Chenghao Wang and BibCom members
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