

## From the IAUC President

Dear colleagues in the IAUC community.

When I last wrote my column three months ago, countries around the globe were at various stages of COVID-19 shutdown. Now, three months on, countries are at various stages of re-opening, but with different degrees of success. It has been a difficult time for all of us, mostly of course for those who have been ill or lost loved ones. Those of us teaching in the university sector have been stunned by the impact. Australian universities have been especially hard hit by COVID-19, partly because they are so dependent on international students for funding and partly because travel restrictions began while so many of these students were overseas during the (austral) summer break. Currently the university sector in Australia is going through massive budget cuts along with academic redundancies. As teaching was moved online earlier in the year, workloads for staff increased dramatically. This will worsen in the second part of the year as online and face-to-face teaching proceeds in tandem, accommodating students who are still overseas as well as local students. I sincerely hope that you are all managing.

There are some small areas of silver-lining in this overarching cloud of gloom. Urban researchers of all persuasions (including sociologists, transport engineers, retail analysts as well as air quality and climate specialists) have found rich research opportunities in the shutdown and subsequent reopening of cities. My own Monash University in Melbourne has launched the 'Melbourne Experiment', a multi-disciplinary study to document the impacts of shutdown and implications for the future city. In our own field, I know of at least two large international research programs to document urban atmospheric impacts of COVID-19. One that I have recently become involved in is sponsored by WMO/GAW and involves observation, modelling and satellite remote-sensing of urban and regional air quality for more than 45 cities around the world as they shut down and reopened.

Also on a very positive note, we have 11 candidates for the two vacant positions on the IAUC

### Inside the June issue...

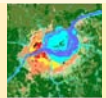
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Board. The Board is especially delighted by the gender and geographical diversity of the candidates. I encourage all members to take the opportunity to vote for their preferred candidates. Details of the voting procedure will be circulated in the coming days.

Issue No. 76 of the Quarterly Newsletter of the IAUC provides its usual excellent offering of contributions from our members, as well as an opportunity to focus on the post-pandemic future and activities for our community. I hope that there will soon be opportunities for us to meet face-to-face at IAUC-related workshops and conferences, but realistically this might not occur until mid-2021. Until then video conferences will have to suffice.

With best wishes.

– Nigel Tapper,  
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## 'A summer unlike any other': Heatwaves and Covid-19 are a deadly combination

*As underserved populations face hotter neighborhoods and limited access to air conditioning, the pandemic threatens the malls and libraries where they typically find relief*

May 2020 — Temperatures in some California cities this week broke decades-old records. The heatwave that cooked Las Vegas over the past few days brought temperatures over 100F. And in Phoenix, highs this weekend are expected to approach or exceed 110F.

This year is on track to be one of the hottest on record, and public health officials worry that in cities across the US, summer heatwaves will collide with the coronavirus pandemic, with deadly consequences for poor, minority and older populations.

Even before the pandemic hit, heat was killing more Americans than all other natural disasters combined. People who live in cities are especially vulnerable to heatwaves because of a phenomenon called the "urban heat island effect" – cities with populations of 1 million or more can be up to 5F hotter than surrounding areas due to high population density, a lack of greenery and shade, and because materials like steel, concrete and asphalt tend to absorb more heat.

Analyses have also found that cities' poorest neighborhoods tend to be hotter, and that many low-income families have been struggling to cope for years. In some neighborhoods of Los Angeles, New York and Chicago, up to a third or more of households lack air conditioning. Due to the economic fallout of the coronavirus pandemic, many more are unable to pay to run their ACs. And even as cities begin reopening after lockdown, many of the malls, public libraries and recreation centers where overheated Americans traditionally went to cool down remain risky, especially for older people and others with a heightened risk of dying from Covid-19.

Throughout the country, public health officials told the Guardian they were scrambling to find ways to protect the most vulnerable from the dual threats of heat and coronavirus. "This summer is definitely not going to be like any other summer," said Deanne Criswell, the commissioner of New York City Emergency Management. "We're not going to have the same level of facilities open that New Yorkers typically go to all the time to stay cool. It's a big concern."

New York is in the process of installing 74,000 air conditioners in the homes of low-income seniors, according to Criswell. The city is also seeking to help more people pay for electricity this summer, as the unemployment crisis leaves thousands of New Yorkers without the means to make rent and utilities. Other cities across the US have



**Some California cities broke decades-old temperature records, heightening fears amid the coronavirus pandemic.** Source: [www.theguardian.com](http://www.theguardian.com)

asked utility companies not to shut off service this summer, even if customers can't pay bills, so that they have access to water, cooling and refrigeration through the hottest days.

"Every summer we worry about the heat when it ramps up – especially in April and May before people have a chance to acclimatize," said Carolyn Levering, the emergency management administrator for Las Vegas. "I think it just gives us extra concern this year because of the pandemic."

In Las Vegas, Phoenix and Los Angeles, officials are keeping some cooling centers – designated public buildings where residents come for cold water and a respite from the heat – open, at a reduced capacity so people can maintain social distancing while seeking relief from the heat. At five cooling centers in LA, anyone who enters has their temperature checked and is required to wear a mask and remain 6ft away from other people. In Nevada's Clark county, which includes Las Vegas, four cooling centers stayed open during the most recent heatwave.

But none of these solutions are broad enough to catch everyone at risk of dying from heatstroke, advocates say. "Hell no, it isn't enough," said Jonathan Parfrey, the executive director of the LA-based non-profit Climate Resolve. "This is just a staggering problem."

In South LA, where 64% of residents fall below the poverty line, more than 40% of households lack air conditioning, according to a study published this month by researchers at the University of Southern California who analyzed data from the electrical meters of nearly 180,500 households. "Poverty was a better predictor of whether or not people

had AC than even how hot or cool it was in a neighborhood,” said Kelly Sanders, one of the study’s authors.

The vast majority of these heat-related deaths in cities occur inside homes that aren’t air-conditioned, said New York’s Criswell. “That ain’t going to be me this year,” said Collette McCoy-Douglas, 67, a retired nurse who lives in a public housing facility for seniors in Chicago. McCoy-Douglas said her building turned on the central air conditioning a day early, after residents complained during the heatwave over Memorial Day weekend. But the system, which only cools each apartment’s living room, “felt warm when I touched it,” she said. Her thermostat read 100F. “So I’ve poured ice on my head twice today – it messed up my hair, but it helped,” she laughed.

A spokesperson for Chicago Housing Authority said it was not aware of any air conditioning issues at senior housing facilities.

Although McCoy-Douglas considered looking for someplace cool she could go, she decided against it. “I’ve got an autoimmune disease, I have asthma, I have stents,” she said. “I’m more skeptical against the coronavirus.” Unable to cool down, she eventually picked up a neighbor, an older woman with cerebral palsy, and they drove around for a bit in McCoy-Douglas’s air-conditioned car.



People sit inside social distancing markers at Domino Park in Brooklyn. Source: [www.theguardian.com](http://www.theguardian.com)

Chicago’s infamous 1995 heatwave, which killed more than 700 people, was on the minds of both women.

“You know, in my apartment, we have people with mental illness and disabilities. They can’t even leave the building,” said McCoy-Douglas, who also knew of two neighbors who had died of Covid-19. “It just breaks my heart. It’s just inhuman.” Source: <https://www.theguardian.com/us-news/2020/may/30/coronavirus-heat-waves-health-summer-us-cities>

## Coronavirus and Extreme Heat Are ‘on a Collision Course’ as NYC Summer Begins

*Among the initiatives to combat extreme heat, the de Blasio administration launched a program to provide free air conditioners to vulnerable New Yorkers.*

June 2020 — It was a hot summer morning in the Bronx on Tuesday, June 23, with temperatures climbing into the high 80s. Jose Batista, an 81-year-old tenant in the New York City Housing Authority’s (NYCHA) Mitchell Houses, was getting ready to head outside for some fresh air and to cool down.

“I can’t deal with this in the apartment,” Batista says in Spanish. “Now, at least outside with the trees and my mask on, I could put up with it a little more, because with this humidity, I can’t. I can’t.”

His window-unit air conditioner was old and not working properly, so someone had recently uninstalled it, he says. Now, he’s requested a new one from NYCHA management, but that was 11 days ago, and he hasn’t heard back from anyone.

Batista – who suffers from high blood pressure, is diabetic, and just finished radiation treatment for prostate cancer – lives in a studio apartment in the Lincoln Avenue development, located in the Bronx’s Mott Haven

section. The apartment, which faces the street, bakes in the heat. “I’ve had to use a fan, but it’s not working well because the heat has increased a lot over the past three days ... and the fan is not helping a lot,” Batista says.

Extreme heat is an increasingly dangerous facet of summers in New York City, and is especially so this year for populations that are at higher risk of COVID-19 and would be safer cooling down indoors rather than at a cooling center, pool, or beach. The communities that are mostly affected by extreme heat during the summer are now the same ones that have been disproportionately affected by the coronavirus pandemic: lower-income communities of color and the elderly.

One of the programs the mayor’s office has begun to implement this year to combat extreme heat in the summer is providing free air conditioners to low-income New Yorkers so they can stay cool while remaining inside.

“Essentially, COVID-19 and climate change – in particular, extreme heat ... are on a collision course, and it’s going to be low-income families, older adults, our communities of color that are most impacted,” says Jainey Bavishi, director of the Mayor’s Office of Resiliency. “And extreme heat is the deadliest weather event that we face, and so this is really a matter of life and death, so it’s extremely



critical that we are taking steps to prepare for this very unique heat season that we are about to enter.”

The program is among several initiatives the city carries out every year to help cool down New Yorkers. This year, there will also be “misting oases” and spray showers in NYC parks, and the Fire Department will install spray caps on hydrants in neighborhoods that are most at risk of heat waves.

Cities around the world experience extreme heat as an effect of climate change, and New York City is not an exception. Like many other places, NYC faces the urban-heat-island effect. This is caused when infrastructure, buildings, and roads replace moist green areas, creating impermeable, dry surfaces that prevent heat from being absorbed properly. Despite efforts to mitigate heat waves, summer weather results in an average of 115 excess deaths from natural causes “exacerbated by extreme heat” and 13 heatstroke deaths every year in NYC, according to a 2017 report from the de Blasio administration.

In an interview with Curbed back in December – in pre-pandemic times – about what the next decade would look like for New York City in terms of climate-change mitigation, Dr. Timon McPhearson, professor of urban ecology and director of the Urban Systems Lab at the New School, emphasized the importance of addressing extreme heat, especially because it disproportionately affects already vulnerable populations.

“Low-income minority neighborhoods that have low amounts of green space, they don’t have as many trees, they don’t have many parks, and so they’re hotter – but they’re not just hotter, they’re hotter in areas where people have less income, less ability to afford air-conditioning, less resources to deal with heat, and therefore are more at risk,” McPhearson said.

There is an evident overlap when it comes to the neighborhoods affected by COVID-19 and those hit hardest by heat waves. According to the Heat Vulnerability Index, which measures heat-related illness or death in different neighborhoods, it was found that several areas in the Bronx, including Mott Haven, Melrose, and University Heights, are at highest risk, along with Bed-Stuy and East New York in Brooklyn, plus Jamaica in Queens. Risk factors for an area, according to the index, include hotter surface temperatures, less green space, and more low-income residents. And some of those same neighborhoods have been largely affected by the coronavirus pandemic as well. Research has also shown that African-American New Yorkers are at a higher risk of mortality as a result of heat, and they have experienced a high mortality rate because of COVID-19, too.

The \$65 million free-air-conditioners program aims to provide over 74,000 ACs to New Yorkers who are 60 or older, who don’t already have an AC at home, and who have an income below 60 percent of the state’s median



income. As of June 24, 18,000 ACs have been installed, and 37,000 senior households, many of them located within NYCHA developments, have registered to get them.

Meanwhile, in order to help the New Yorkers receiving ACs pay for their higher utility bills, the state’s Public Service Commission also agreed to double the amount of its Con Edison utility-bill discount. Through that low-income program, Con Edison customers receive a discount of \$13 a month, and now, the “emergency summer cooling credit” will add up to \$40 a month between June and September.

And though it is an innovative program, it is definitely not the best long-term solution to extreme heat, McPhearson says in a recent interview: “Long-term, we have to decrease the urban-heat-island [effect], and that’s going to mean increasing in blue and green infrastructure at a much larger scale to provide evaporative and shade-based cooling in the city.” McPhearson adds that running ACs will require more energy and become a larger source of CO<sub>2</sub> emissions.

The city is also working to prevent power outages – like the one last year that left more than 50,000 New Yorkers without power during a heat wave – from increased use of air-conditioning during the summer.

Extreme heat is only expected to get worse in the years to come. The New York City Panel on Climate Change, a group of climate and social scientists that aims to develop climate-change projections, first assembled by former mayor Michael Bloomberg in 2008, predicts that the number of days above 90 degrees annually in NYC could be doubled by the 2050s.

For now, Batista, the elderly resident of Mitchel Houses in the Bronx, is hoping to get his AC installed soon. “I went to the NYCHA office with my nephew who speaks English well, and they took my information and they said they would call me, but they haven’t. I haven’t received any answer,” he says. “It’s very tough because the AC could help with the pollen [entering my apartment] a little bit, but [right now] I have to keep the window open, you see?”

Source: <https://ny.curbed.com/2020/6/29/21302060/nyc-coronavirus-heat-waves-summer-climate-change>

## Covid-19 demonstrates urgent need for cities to prepare for pandemics

*Cities and towns need to deepen understanding of their risks from disease outbreaks, as for other more visible threats like extreme weather.*

June 2020 — Some 95% of Covid-19 cases have come from urban areas. Pandemic preparedness in cities and towns is more urgent than ever for reducing disaster risk, particularly in challenging situations where disease outbreaks could coincide with an extreme weather event. The eastern Indian city of Kolkata has been devastated by Cyclone Amphan, which caused many deaths and left millions without electric power. Fear of contracting the virus made it impossible to use cyclone shelters to their maximum capacity. Covid-19 restrictions made evacuations more difficult. Countries around the world were caught by surprise by the Covid-19 pandemic despite many warnings and recent experience of epidemics such as Severe Acute Respiratory Syndrome (SARS), which spread through urban centres including Hong Kong and Toronto.

It is now an urgent requirement for cities and towns to develop a deep understanding of their risks from future pandemics, just as they would for other more visible hazards like extreme weather events. These recent experiences and others, such as the Ebola outbreak, have led some countries to be better prepared. But generally, there is a lack of planning for hazards and disasters at all levels. The frustrating shortages of personal protective equipment, ethanol for disinfectant and other emergency supplies could have been avoided if there had been adequate scenario-planning at the national level, supported by the allocation of required resources to local governments. The Covid-19 crisis exposes systemic vulnerabilities in healthcare systems that cannot handle surging caseloads. Likewise, cities have been forced to confront the fact that unplanned urbanisation creates conditions where many of their residents lack adequate water and sanitation facilities, while living in overcrowded places where physical distancing is challenging. It is now an urgent requirement for cities and towns to develop a deep understanding of their risks from future pandemics, just as they would for other more visible hazards like extreme weather events.

**New metrics** – Governments, especially at the local level, need to plan and strategise to deal with all hazards, including biological ones, and to address gaps in their preparedness and develop response capacity. This will prevent them being taken by surprise, and then overwhelmed. Better data collection will allow city leaders to prepare for future episodes where once unthinkable metrics become normal, such as whether a park can accommodate neighbourhood residents if they must keep two metres apart.

There is an existing framework to manage disaster risk. Over 200 cities and towns around the world already use the United Nations Disaster Risk Reduction (UNDRR) Disaster Resilience Scorecard to develop evidence-based approaches to managing their disaster risk. The Scorecard has been augmented by the development of a Public Health Addendum which provides guidance to local governments on the wider issues of management and recovery in case of biological hazards, including a pandemic. The Addendum to the Scorecard is designed to help



Kathmandu city.  
Source: [eco-business.com](https://www.eco-business.com)

cities establish their public-health system resilience baseline and to frame an action plan. It will soon be available as an online course. In cities like Lisbon, Kampala and Greater Manchester, the Disaster Resilience Scorecard has proved to be a useful tool helping cities to establish their public-health system resilience baseline and to frame an action plan. Likewise, UN-Habitat's City Resilience Global Programme provides hands-on support to local governments in urban planning and building resilience to all types of hazards.

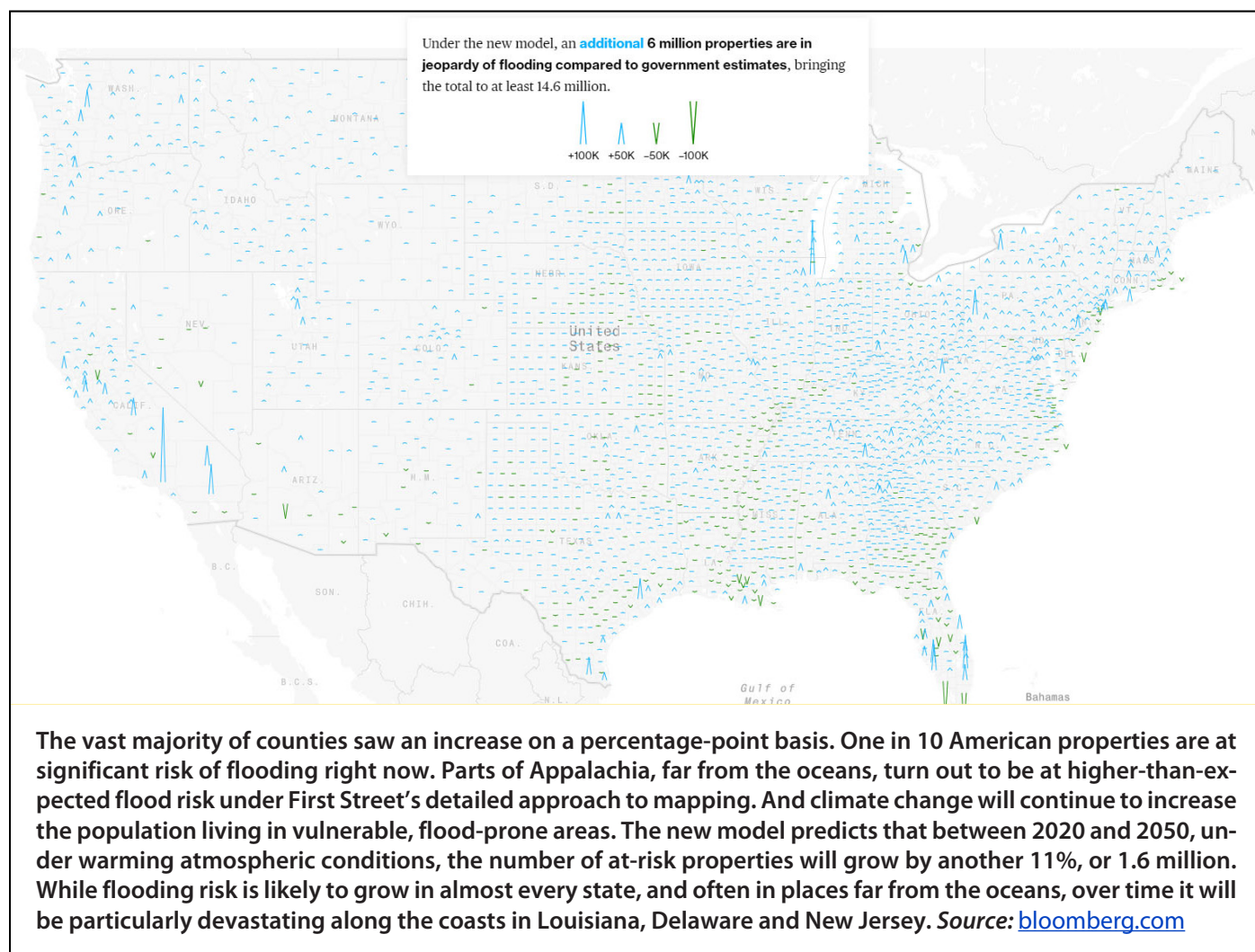
**Global campaign** – These UN agencies and other partners like the World Bank Group saw the need to prepare for risks like climate change, disease outbreaks, pollution, waste management, land use and building codes when they launched the Making Cities Resilient (MCR) campaign 10 years ago. The campaign has since attracted 4,300 cities and towns to sign up, creating a global network of local governments keenly aware of the need to reduce disaster risk. Now, UNDRR, UN-Habitat, the World Bank Group and other partners are joining forces to elevate the campaign's focus from advocacy to implementation over the next decade. New partners willing to work together for urban resilience are invited to join. The successor campaign, MCR2030, will launch towards the end of this year and pandemic preparedness will be a priority area of focus for all participants, including local governments and municipalities, over the next decade.

The focus is on cities because, while they can be disease vectors, it is also clear that sustainable urbanisation creates social, economic and environmental prosperity – which can be an important bulwark against the spread of disease. It is a hopeful sign that some of the world's most urbanised countries are responding with relative success to the Covid-19 pandemic. South Korea, where over 80% of citizens live in cities and towns, applied lessons learned from its experience with Middle East Respiratory Syndrome (MERS) in 2015. It has managed to fight the outbreak using technology, open communication, rigorous testing and tracing, and excellent hospital care.

Covid-19, like most epidemics, is largely an urban problem. Local strategies for disaster risk reduction must include pandemic preparedness as a priority, and this needs to be part of the process of better recovery and building resilience to future disease outbreaks. — MAMI MIZUTORI & MAIMUNAH MOHD SHARIF  
Source: <https://www.eco-business.com/opinion/covid-19-demonstrates-urgent-need-for-cities-to-prepare-for-pandemics/>



## Mapping America's Underwater Real Estate: What happens to home prices if flood maps start measuring climate change?



*June 2020* — Millions of Americans just woke up in a flood zone that had never before been listed on U.S. government maps.

The first-ever public evaluation of flood risk for every property in the 48 contiguous states has found that federal maps underestimate the number of homes and businesses in significant danger by 67%. The [new flood-risk data](#), released Monday by the research and technology nonprofit First Street Foundation, is a virtually unprecedented disclosure of how much damage climate change can be expected to inflict at the level of individual homes.

First Street's model gives homeowners access to risk-analysis techniques that had previously been available to insurers and financiers. (Look up your address [here](#).) Until now public information on flood vulnerability in the U.S. relied heavily on maps produced by the Federal Emergency Management Agency, which are often out of date, incomplete, and difficult to understand. First Street aims to change this by eventually making its flood information available on

Realtor.com, the second largest listing website – a risk-disclosure event that could have profound repercussions on property values, bank loans and municipal bonds.

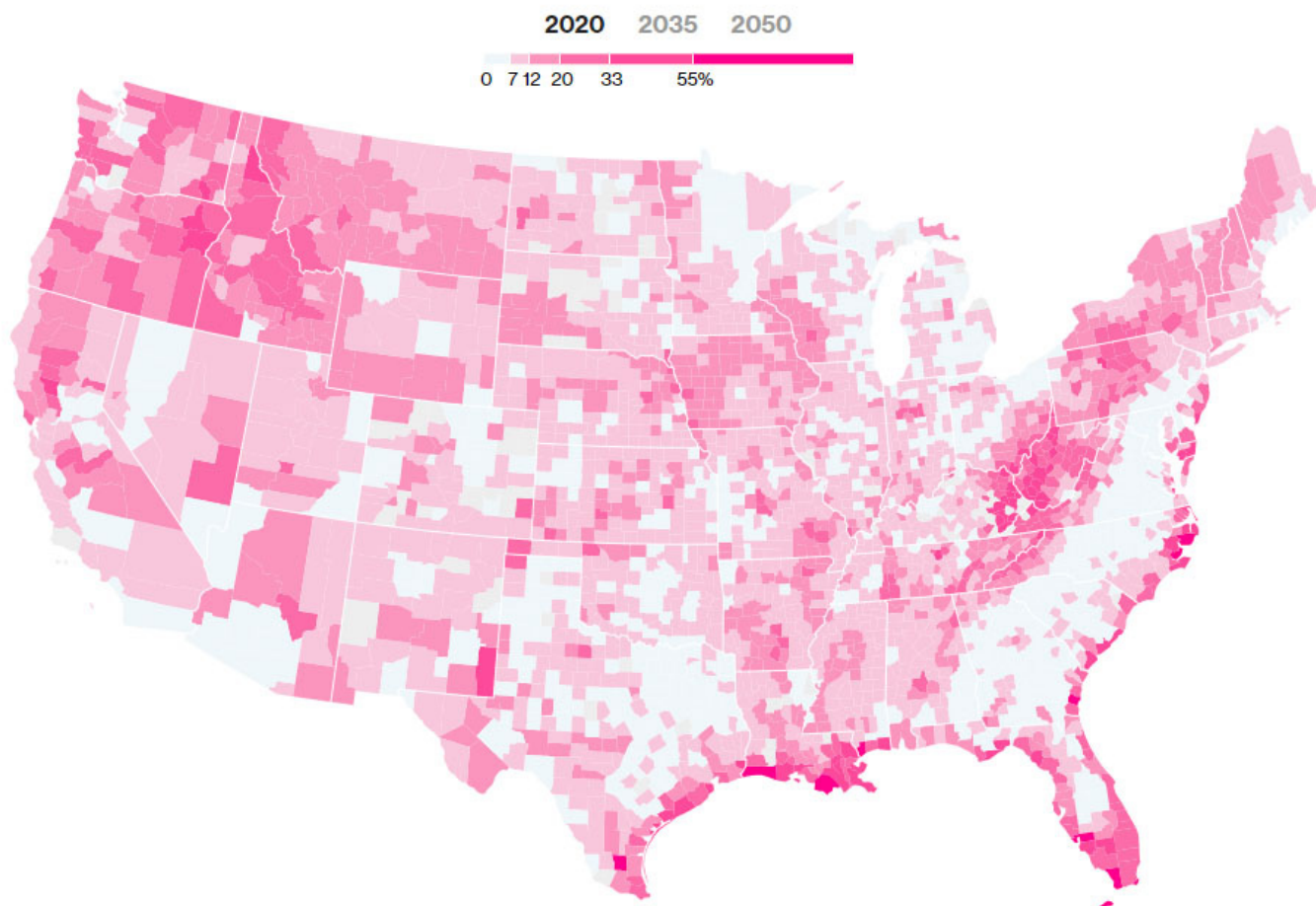
There are 142 million properties in First Street's public database, and each one is scored on a 10-point scale based on the likelihood of flooding over a typical 30-year mortgage. The score, called Flood Factor, rates the likelihood of flooding in simple terms. (A Realtor.com spokeswoman said the new flood-risk scores, which had been slated to be introduced on the website already, would be added to listings after a technical issue is resolved.)

First Street and FEMA use the same definition of "significant risk": at least a 1% chance or greater each year that a property will experience a once-in-a-century flood. Over the course of a 30-year mortgage, if the risk remains at 1% annually, a property would have a greater than 26% chance of facing that 100-year flood. Several million more properties face moderate risk of flooding.

It's anyone's guess how this new transparency will affect

## Flood Risk Projections

Percentage of properties at 1% risk of significant flooding each year



Source: First Street Foundation

Source: [bloomberg.com](https://www.bloomberg.com)

real-estate prices. When FEMA marks an area at significant risk of flooding, residents with mortgages are forced to buy flood insurance. First Street’s maps come with none of that regulatory weight, leaving buyers and sellers free to ignore them.

Academics and regulators think clear signals about expanded flood risk could be transformational. “We are already seeing real-estate values go down in some of the Southeastern coastal communities where flooding is a common nuisance. And First Street’s work is likely to accelerate that,” says Jesse Keenan, a professor of real estate at Tulane University who tracks the impact of climate change. “I think it could be a self-fulfilling prophecy.”

The bureaucrat who ran FEMA’s National Flood Insurance Program until 2018 agrees: “If they can pull it off and they really have the goods on every property, it could be a game changer,” says Roy E. Wright, now president and chief executive of the Insurance Institute for Business and Home Safety.

In the last decade, U.S. floods have caused over \$155 billion in property damage and account for the majority of federally declared disasters. Ninety-eight percent of counties across the U.S. have experienced a flooding event, and FEMA rates floodwaters above all other natural disasters in

damage potential.

Yet the primary purpose of FEMA’s flood maps isn’t to inform individual homeowners. The agency’s mission is to outline zones of significant risk of once-in-a-century floods for community management and insurance purposes. “FEMA’s maps are notably different in their intended use and design,” an agency spokesperson said in a statement about First Street’s project. Data needed to make decisions about “floodplain management or life and safety during a flooding event” is different from what’s needed to “inform someone’s decision to acquire [private] flood insurance or take an action to reduce their individual flood risk.”

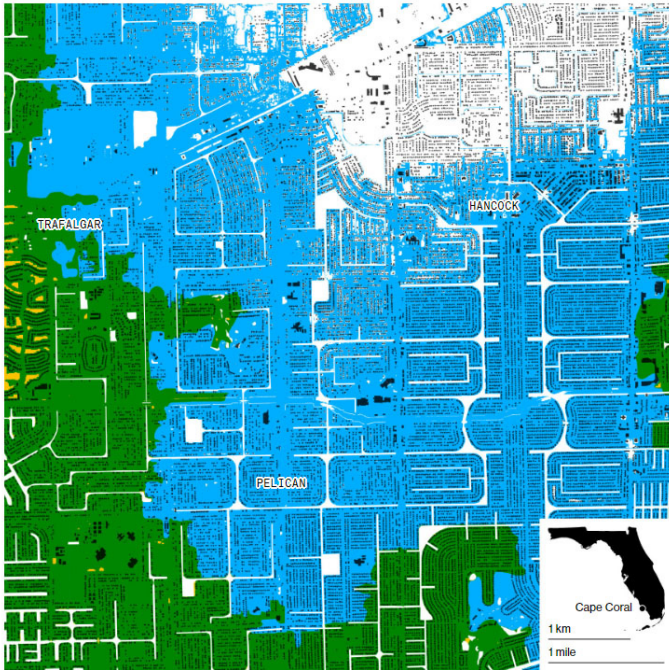
Since First Street’s definition of significant risk is the same 100-year flood used by FEMA, the big difference in outlook comes down to a few important factors. The climate nonprofit mapped 99% of all properties in the lower 48 states, a completist approach FEMA doesn’t take. In addition, the new maps use data to recreate property flooding caused by 55 past major hurricanes, tropical storms and nor’easters. Many states lack flooding-disclosure laws, so this information would otherwise be nearly impossible to find.

First Street’s model takes into account 55 previous major storm events but there are significant gaps. It doesn’t yet include Hurricane Harvey in 2017, which prompted FEMA



**Cape Coral, Florida**  
New data finds 46% of Lee County's properties are now at risk, compared to 33% under FEMA

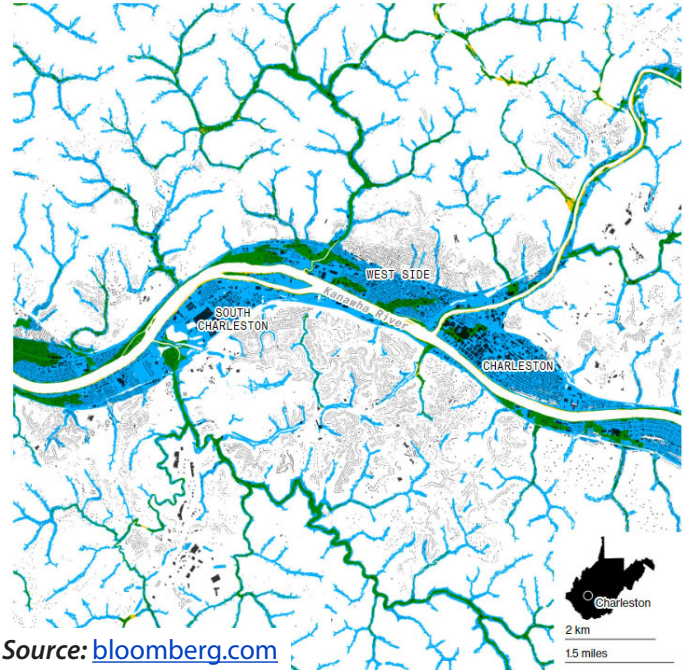
■ FEMA 1% annual risk ■ First Street 1% annual risk ■ Both ■ Buildings



Source: First Street Foundation, Federal Emergency Management Agency, Microsoft

**Charleston, West Virginia**  
New data finds 44% of Kanawha County's properties are now at risk, compared to only 14% under FEMA

■ FEMA 1% annual risk ■ First Street 1% annual risk ■ Both ■ Buildings



Source: [bloomberg.com](http://bloomberg.com)

Source: First Street Foundation, Federal Emergency Management Agency, Microsoft

insurance payouts to 92,000 Texans.

The new maps also include projections for sudden, heavy precipitation events and data on millions of miles of streams and creeks that aren't measured by FEMA. And, of course, the first purpose of FEMA's flood maps is to designate zones for insurance that's sold in one-year increments – which means the process wasn't set up to account for climate change over decades. Yet homeowners often make decisions about where to live that can last 30 years or more.

The heightened risk detected in First Street's data can be mapped across the country in unexpected places. Washington, D.C. sees a 438% increase in properties identified as vulnerable to floods, Utah is adjusted upwards by 419% and Wyoming's real-estate risk rises by 325%. The new maps also point to a huge spike in flood threat along the spine of the Appalachian Mountains in states like West Virginia, Kentucky and Virginia—none of which spring to mind when imagining the looming threat of rising waters.

In fact, First Street's analysis found nearly one in four properties in West Virginia is at risk from flooding, the highest percentage of real estate in any state. That's higher than famously flood-prone Florida, where 20.5% of homes are in flood zones.

The new model is also much more sensitive to how major rain storms might overwhelm county drainage systems, a fact that had a big impact on risk mapping in urban areas. In Los Angeles County, for example, First Street found nearly 204,000 properties have a substantial risk from floods – or seven times FEMA's estimate of 29,000. In Cook County, which includes Chicago, an estimated 11% of 1.4 million properties are at risk, as opposed to the current federal maps which list 2%.

In areas where FEMA's maps are up to date, the flood-risk assessments by FEMA and First Street are closely aligned. First Street's maps of Louisiana, a state that faces extensive coastal erosion from sea rise, show 477,000 houses in the high-risk zone right now – 84,000 fewer than FEMA's current map. Mike Amodeo, director of data science for First Street, says his analysis took into account the recent construction of levees or flood walls that made certain properties less likely to flood than before.

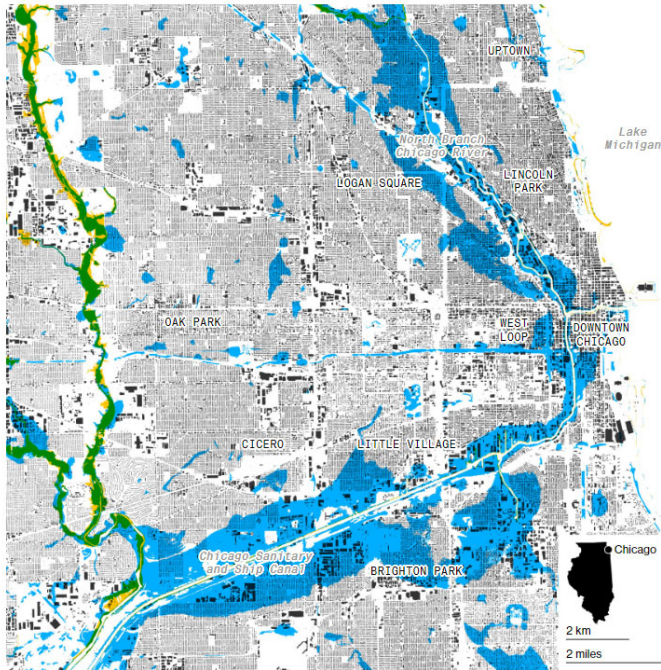
While the new flood-risk maps reflect the power of adaptations like seawalls in the short run, they also reveal limitations over time. By 2050, according to First Street's projections, another 332,000 houses in Louisiana will be at substantial risk of flooding because of inexorable sea rise. The model doesn't anticipate that current defenses will save the coastline for long.

The risk maps will also help highlight newly installed protections such as marsh and wetland restorations that can fend off waters. Boston is building a series of sea walls, berms and other structures around it that will act as a barricade against Mother Nature. The new 1,000-acre Seaport District filled with restaurants, bars and gleaming office and residential towers is particularly vulnerable. While all of Los Angeles is currently protected by flood adaptations, areas like Gardena remain vulnerable because its levee was not designed for 1% annual flood risk.

These new and vastly expanded flood maps are likely to be controversial. After all, what homeowner wants an unaccountable, unelected entity publicly ranking their property as a high risk of damage or destruction? While some owners won't appreciate this transparency, others will see newly installed protections to fend off waters as selling

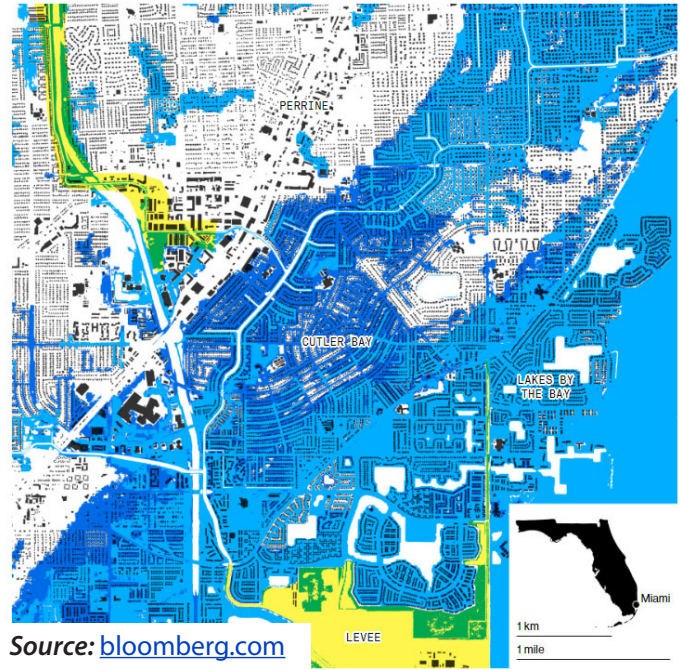


**Chicago, Illinois**  
 FEMA's flood maps put only 2% of Chicago-area properties at risk. The new maps found about 11% face significant flood danger.



Source: First Street Foundation, Federal Emergency Management Agency, Microsoft

**Miami-Dade County, Florida**  
 Properties in 1% risk zone may increase 25% by 2050



Source: [bloomberg.com](https://www.bloomberg.com)

Source: First Street Foundation, Microsoft

points, says Danielle Hale, chief economist for Realtor.com.

“Market forces work fast when there are informed participants making the buying and selling decisions,” says Hale. “It’s not surprising that the home next to a beach has flood risk. But this broadens it.”

It took some effort previously for home shoppers to find out if a property was within a flood zone defined by FEMA. If flood scores spread soon from First Street’s website to Realtor.com as planned, risk information will be discoverable far more easily. Hale acknowledges that visibility could change buying decisions and factor into home prices. Realtor.com plans to provide information on the validity of the data, and concerns will be directed to a customer-service team.

Insurance companies, banks and businesses often pay for private research that affords access to more accurate data than FEMA’s maps. These powerful interests have already been making decisions accordingly. Almost all flood insurance policies for homes in the U.S. – about 95% – are part of the National Flood Insurance Program run by FEMA because private insurers find it too risky. That leaves taxpayers picking up the tab when devastating floods occur.

Recent academic papers have found banks are using flood information to “blue-line” neighborhoods, offering homeowners fewer or more expensive mortgage services due to more detailed understanding of risk. After big storms, research shows that banks sell off an increased percentage of mortgages in riskier areas to government-backed Fannie Mae and Freddie Mac. Banks are also increasingly asking for modified terms on mortgages in flood zones, such as demanding much more than 20% down at closing.

Even places known to be vulnerable today might see prices shift if flood risk becomes more visible to real-estate shoppers. The median home in Miami is worth about \$370,000 and, according to the real-estate website Zillow, that price has increased slightly in the past year. First Street’s data already assigns 30% of properties in Miami-Dade County to the significant risk category and projects the designation will apply to 38% of the county by 2050.

Matthew Eby, executive director of First Street, says it’s only fair to bring transparency into a rigged market. “Sophisticated investors have privately purchased flood risk information from for-profit firms for years,” he says. First Street is “correcting an asymmetry of information by providing free access to everyday Americans.”

Others worry that flood mapping down to the level of individual homes requires a granularity of information that First Street can’t muster, with homeowners in the newly identified flood zones left facing harsh financial losses from publicly posted but essentially unverifiable projections of risk. Rachel Cleetus, the policy director for climate and energy program at the Union of Concerned Scientists, believes publishing this information would place a “bullseye” on unsuspecting owners or, in some cases, entire marginalized communities.

“Having detailed risk information is important,” she says, “but it is insufficient without public-policy supports. These people didn’t create the problem and the market alone can be a harsh and inequitable way to deal with the results.”

Source: <https://www.bloomberg.com/graphics/2020-flood-risk-zone-us-map/>

[Look up the Flood Factor score for your home and any other property in the database.](#)

# Magnitude and seasonality of global surface urban heat islands: A coarse-grained approach



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*This article summarizes two recently published manuscripts illustrating their connection (Manoli et al. 2019; 2020)*

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## Introduction

Cities are generally warmer than the surrounding rural land, a phenomenon called the Urban Heat Island (UHI). Given their implications for energy consumption (e.g. Santamouris et al. 2015), climate change adaptation plans (e.g. Estrada et al. 2017), and public health (e.g. Mora et al. 2017), UHIs have been widely studied over the past decades, considering both air and surface temperature measurements (e.g. Oke 1973, Oke 1982, Grimmond and Oke 1999, Imhoff et al. 2010, Clinton and Gong 2013, Zhao et al. 2014, Gu and Li 2018). Air UHIs are most intense during night-time, while the intensity of surface UHIs, hereafter referred to as SUHIs, generally peak during daytime (e.g. Oke et al. 2017). The physical drivers of urban warming and its canonical diurnal patterns are reasonably well known, both in terms of air and surface temperatures. More recently however, remote sensing observations have revealed global and seasonal trends of SUHIs that lack a complete explanation (e.g. Zhou et al. 2013, Zhao et al. 2014).

**Scaling laws impacting SUHIs.** A first link between urbanization-induced warming and city size (as measured by urban population) was proposed by Oke (1973) based on night-time air temperature measurements. With the proliferation of remote sensing products, similar relations between urban population and SUHI intensity have been observed at the global scale (Clinton and Gong 2013). Local hy-

droclimate also contributes to the intensity of SUHIs (Zhao et al. 2014, Li et al. 2019), with rising mean annual precipitation causing an increase in urban to rural surface temperature differences ( $\Delta T_s$ ). However, given the complexity of urban systems, the factors contributing to these variations in  $\Delta T_s$  across background climatic conditions and city size continue to be a subject of inquiry and debate (Clinton and Gong 2013, Zhao et al. 2014, Gu and Li 2018, Li et al. 2019).

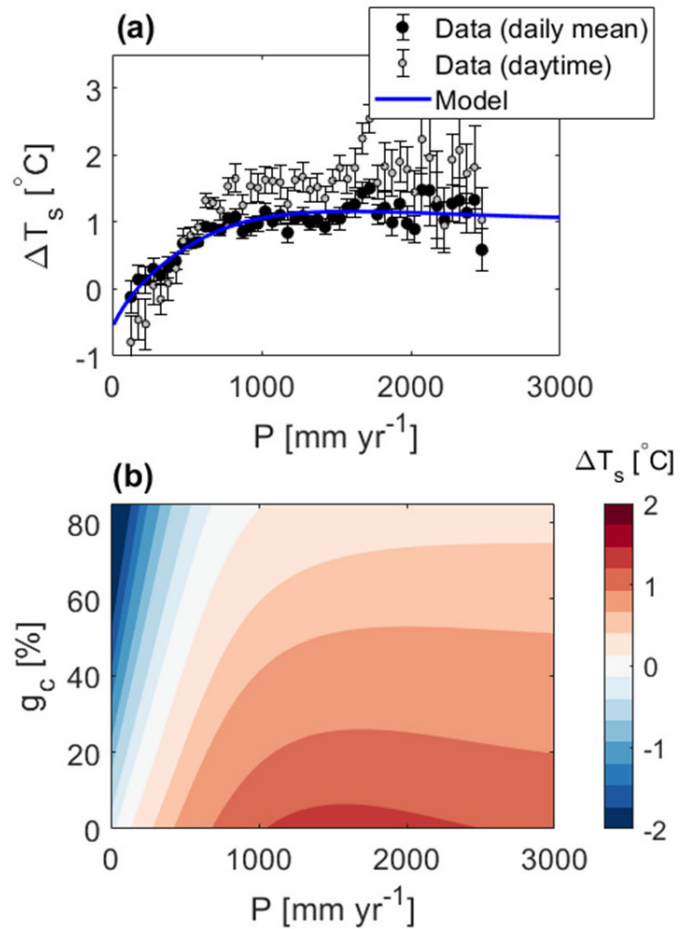
While Oke's later work suggested that population density (or actual measures of urban form such as building density) is a more direct and reliable driver of the nocturnal air UHI (e.g. Oke 1981), recent remote sensing studies detect better correlation between SUHI and total city population (Clinton and Gong 2013). On the hydroclimatic side, both changes in convection efficiency (Zhao et al. 2014) and partition of net radiation in latent/sensible heat fluxes (Zhou et al. 2016b, Gu and Li 2018, Li et al. 2019) have been proposed as the main drivers of daytime SUHIs. Some studies suggested that  $\Delta T_s$  increases linearly with regional precipitation due to changes in rural aerodynamic resistance (Zhao et al. 2014), but remote sensing observations from China point to the existence of a precipitation threshold above which  $\Delta T_s$  becomes insensitive to precipitation changes (Zhou et al. 2016b). Numerical simulations have confirmed possible nonlinear responses of  $\Delta T_s$  to precipitation (Gu and Li 2018) but, unlike previous modelling results,



the variability of  $\Delta T_s$  has been explained by changes in rural temperature rather than convection efficiency. In short, the causal links between  $\Delta T_s$ , population, city texture, and background climate remain unclear and, as a consequence, a fundamental knowledge gap persists in understanding the cooling effects obtainable with urban vegetation (e.g. Gunawardena et al. 2017) and albedo management (e.g. Zhao et al. 2014) across cities and climatic conditions.

**Seasonality of SUHIs.** Another ubiquitous feature of SUHIs is their seasonality. On seasonal timescales, urban areas exhibit distinctive hysteretic patterns between  $\Delta T_s$  and background land surface temperature  $T_s$  (Manoli et al. 2020). This seasonal hysteresis has been demonstrated by remote sensing observation from Europe (Zhou et al. 2013) and the Southwest United States (Bechtel et al. 2019), as well as in numerical simulations for the Greater London area (Zhou et al. 2016a). The directionality of hysteresis is always clockwise, but  $\Delta T_s$  either increases or decreases with  $T_s$  depending on the local hydroclimate (i.e. wet versus seasonally-dry). Such hysteretic behaviour was postulated to result from time lags between the energy/water fluxes of urban and rural areas (Zhou et al. 2013, Zhou et al. 2016a) but previous attempts to verify this hypothesis have been unsuccessful (Zhou et al. 2013). These recalcitrant challenges and questions highlight the complexity of the coupled urban-biosphere system, with the emergence of hysteresis as one of its signatures (Ashkenazy et al. 2008, Morris 2011).

**Objectives.** Here, the aforementioned knowledge gaps are addressed by combining concepts from statistical physics, urban climate, and complexity science. Despite the diversity and complexity of cities, universal scaling laws linking urban population  $N$  to infrastructure and socio-economic metrics have been confirmed for cities across the world (e.g. Bettencourt et al. 2007). We show that such scaling laws, when coupled to energy budget and radiative transfer principles, provide the logical basis for coarse-grained representations of SUHIs. The objective is not to provide a detailed simulation of urban microclimate, which is a prerogative of urban climate models (e.g. Grimmond et al. 2010) and detailed urban energy and water budget schemes (e.g. Meili et al. 2020). Rather, we aim to describe emergent behaviours of urban-biosphere interactions so as to disentangle the key drivers of SUHIs across numerous cities and diverse climatic regions. To be clear,



**Figure 1.** (a) Observed (symbols) and modelled (solid line)  $\Delta T_s - P$  relation. The same trend is observed for daytime and mean daily data. (b) Impact of different green cover on the simulated SUHI intensity  $\Delta T_s$  as a function of mean annual precipitation  $P$ .

the scale of applicability of such an approach is governed by the applicability of scaling laws linking city properties (e.g. size, population) to urban form and function.

## Methods

**Data.** Global estimates of summertime SUHIs are obtained from the Global Urban Heat Island Data Set 2013 (CIESIN 2016). A SUHI is defined as the land surface temperature difference between the urban area and a 10 km buffer in the surrounding rural region. The dataset provides daytime and nighttime UHI intensities ( $\Delta T_{s,d}$  and  $\Delta T_{s,n}$ , respectively) for more than 30000 cities. When focusing on climatic patterns and long-term averages (Manoli et al. 2019), the intensity of summertime SUHIs ( $\Delta T_s$ ) is estimated as the average of daytime and nighttime observations. At the seasonal scale (Manoli et al. 2020), we use the seasonal trends of SUHIs digitized from Zhou et al. 2013

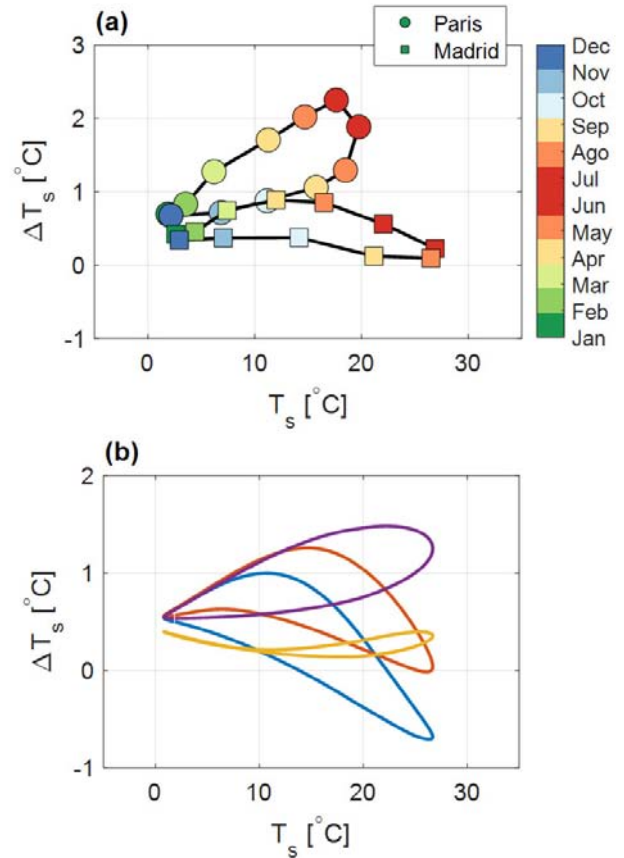
and Zhou et al. 2016a for five European cities (Paris, London, Milan, Madrid, and Nicosia). The selected cities are characterized by different background climates and exhibit the main hysteretic behaviours observed in Europe (Zhou et al. 2013, Zhou et al. 2016a). Monthly meteorological data (i.e. precipitation  $P$ , two-meter air temperature  $T_a$ , surface temperature  $T_s$ , incoming shortwave radiation  $R_{sw}$ , wind speed  $W_s$ , and atmospheric pressure  $p_{atm}$ ) and land surface diagnostics (i.e. albedo, leaf area index, and evapotranspiration) have been retrieved from the Modern Era Retrospective-Analysis for Research and Applications (MERRA) and used to define background climatic conditions and assess model accuracy.

**Coarse-grained SUHI model.** A first order approximation for the intensity of SUHIs can be derived from the surface energy balance considering urbanization as a perturbation to the rural base state. Specifically, urban-rural surface temperature differences  $\Delta T_s$  can then be expressed as a function of annual precipitation  $P$  and city population  $N$  only (Manoli et al. 2019):

$$\Delta T_s(P, N) = \frac{1}{f_s(P) - \frac{\eta}{a_T} f_a(P)} \Delta S(P, N) \quad [1]$$

where  $f_s$  and  $f_a$  [ $W\ m^{-2}\ K^{-1}$ ] are energy redistribution factors associated with surface and air temperature, respectively (Zeng et al. 2017),  $\eta$  and  $a_T$  are parameters accounting for the coupling between  $T_s$  and  $T_a$ , while  $\Delta S$  [ $W\ m^{-2}$ ] is the differential energy forcing due to urban-induced changes in surface albedo ( $\Delta\alpha$ ), emissivity ( $\Delta\varepsilon_s$ ), evapotranspiration ( $\Delta ET$ ), convection efficiency ( $\Delta r_a$ ), and anthropogenic heat ( $\Delta Q_{ah}$ ). Note that urban  $ET$  is calculated considering the urban green cover fractions ( $g_{c,u}$ ) and irrigation (as defined by an irrigation index  $I_{r,u}$ ).

Given the objective of exploring the sensitivity of SUHIs to as few “summary variables” as possible (i.e.  $P$  and  $N$ ), a set of climate relations linking background meteorological variables (e.g.  $T_s$ ,  $T_a$ ,  $R_{sw}$ ) to  $P$  has been derived from fitting the MERRA data. Similarly, changes in urban characteristics (e.g. area, mean sky view factor, mean building height, anthropogenic heat) are linked to city size by urban scaling laws. The resulting model in Eq. 1 then postulates that  $\Delta T_s$  can be coarsely-modelled as a function of only  $N$  and  $P$ , where  $N$  is an aggregate measure for urban infrastructure size and  $P$  is a proxy for time-integrated surface-atmosphere exchanges and climatic patterns.



**Figure 2. (a) Observed seasonality of SUHIs in Paris and Madrid; (b) simulated hysteresis of  $\Delta T_s$  for different rainfall-radiation phase shifts  $\Delta\Phi_{\lambda R}$  and mean rainfall frequencies  $\mu_{\lambda R}$ .**

The proposed approach is deemed “coarse-grained” because “fine-grained” properties of climate, cities and rural areas are smoothed over in space and time to focus on collective phenomena and global patterns rather than microscopic (i.e., building to block scale) or specific city-climate processes.

**Stochastic soil moisture balance.** To test the hypothesis that hysteresis is the result of time lags between urban and rural dynamics, Eq. 1 has been modified to account for the seasonality of background climate (see Manoli et al. 2020). Specifically, changes in background meteorological forcings with time  $\tau$ , have been modelled with sine functions  $\Gamma = \Gamma(\tau)$  characterized by mean  $\mu_r$ , amplitude  $A_r$ , and phase  $\Phi_r$ . A well-established stochastic soil moisture balance (Porporato et al. 2004, Feng et al. 2015) is then employed to compute the seasonality of relative soil moisture, evapotranspiration ( $ET$ ), and surface albedo ( $\alpha$ ) in the rural areas. This probabilistic approach integrates information on rainfall daily stochasticity and seasonality to describe the “average” seasonal cycle of surface water fluxes. Note that the selected



sine functions represent prototypical examples of intra-annual variability rather than precise site-specific conditions. Also, the analysis here focuses on two contrasting climatic conditions defined as “wet” (i.e. continental/temperate regions with summer rainfall and well-watered vegetation throughout the year) and “seasonally-dry” (i.e. Mediterranean climates with dry summers and prolonged water-stress) even though more complex seasonal dynamics may occur on continental scales (Zhou et al. 2013).

Further details on data sources, analysis, and model development can be found elsewhere (Manoli et al. 2019; 2020).

## Results and Discussion

**Global patterns of summertime SUHIs.** Consistent with prior results (Zhou et al. 2016b, Gu and Li 2018), a nonlinear relation between  $\Delta T_s$  and mean annual precipitation is found (Fig. 1a). The intensity of SUHIs modelled by Eq. 1 increases linearly at low precipitation regimes (Zhao et al. 2014) but it saturates at precipitation values exceeding around  $P=1200$  mm yr<sup>-1</sup>, in agreement with the observations. Model inferences suggest that the shape of the  $P-\Delta T_s$  relation is largely controlled by changes in evapotranspiration. In wet climates, energy limitations control the upper bound on  $ET$  differences between urban and rural environments, thus creating the observed plateau of  $\Delta T_s$ . In arid regions, water limitations reduce the magnitude of rural  $ET$ , thus limiting the contribution of  $\Delta ET$  to  $\Delta T_s$  and, when urban vegetation is irrigated,  $\Delta T_s$  becomes neutral or even negative creating an “oasis” effect.

A sensitivity analysis of Eq. 1 to changes in urban green cover fraction elucidates this interplay among multiple mechanisms and highlights the fundamental role of background climate in regulating the ability of urban green spaces to reduce the SUHI effect (Fig. 1b). In arid regions, rural land surfaces can be warmer than urban areas due to lower albedo, lower convection efficiency, and water-limited rural evapotranspiration. As a consequence, urban vegetation and irrigation reduce urban temperatures efficiently, and control the magnitude of the “oasis” effect (e.g. Oke 1982, Gunawardena et al. 2017). In wet climates, vegetation is not water limited and  $ET$  is a dominant component of the rural surface energy balance so that, to reduce  $\Delta T_s$  by a fixed value, an increasing green cover is needed for increasing  $P$  (Fig. 1b).

**Seasonal hysteresis of SUHIs.** The seasonality of

SUHIs is illustrated in Fig. 2. Cities in relatively wet climates (represented by the example of Paris here) show a concave up hysteresis characterized by peak SUHIs in summer and  $\Delta T_s$  always positive, while cities in seasonally dry regions (e.g., Madrid in Fig 2a) exhibit a concave down curve with peak SUHI in spring and  $\Delta T_s \leq 0$  during summer/autumn. These trends are consistent for both daytime and mean-daily observations (not shown here) and in line with observations reported elsewhere (Bechtel et al. 2019). Despite its simplicity, the model captures the major features of the observed seasonality of water and energy fluxes at the land surface as well as the hysteretic behaviour of  $\Delta T_s$  (Fig. 2b). Model results suggest that, in wet climates, the SUHI intensity is largely determined by  $\Delta ET$  because rural  $ET$  is in-phase with radiation; it approaches potential evapotranspiration ( $ET_{max}$ ) and maximizes  $\Delta T_s$  during summertime by cooling the rural environment. Conversely, in seasonally dry climates, rainfall is out-of-phase with radiation causing water stress and a summertime decrease in rural  $ET$  that reduces  $\Delta ET$  to potentially negative values and, consequently,  $\Delta T_s$ . Under dry conditions, soil moisture influences not only latent heat fluxes but also surface albedo by modulating the dynamics of leaf area index ( $LAI$ ) in rural areas (see results in Manoli et al. 2020). In addition, for such water limited ecosystems, rural vegetation is generally of low stature so that differences in convection efficiency can contribute to enhance the cooling of urban surfaces (Zhao et al. 2014). This effect, however, depends on the three-dimensional structure of urban areas, the density of buildings, their mean height, and how all these parameters influence surface heat flux efficiency (e.g. Grimmond and Oke 1999, Li et al 2020). These attributes vary significantly among and within cities.

These results demonstrate that the shape of the observed hysteretic cycles is fingerprinted in the time lags between incoming shortwave radiation, temperature and rainfall. In wet climates,  $ET$  is not water limited and the concave up hysteretic loop is mainly due to temperature-radiation lags. In seasonally dry regions, the shape of hysteresis is modified by the radiation-rainfall lag, and the induced water stress in the rural areas that generates a concave down loop. This confirms the conjecture of a phase shift mechanism (Zhou et al. 2013, Zhou et al. 2016a) regulated by energy and water availability.

**Limitations and perspectives.** While the proposed coarse-grained approach provides a new per-

spective on emergent urban-rural dynamics, it focuses on remotely-sensed surface temperatures only and considers city-scale values, averaged in space and time over monthly timescale. Clearly, this is not sufficient to quantify local microclimatic effects, pedestrian thermal comfort, and guide site-specific urban planning solutions as the characteristics of single cities and their spatial heterogeneities can significantly deviate from the emergent behaviours discussed here (by definition, emergence occurs when a system exhibits macroscopic properties that are not necessarily observed at the microscopic level of an individual city). Climate sensitive urban planning requires a quantification of the overall climatic conditions experienced by residents (i.e. local air temperature, radiative loading, air humidity, and wind speed at the block/building scale from sub-hourly to interannual timescales), as well as their exposure and vulnerability to heat. Hence, the intensity of SUHIs is a useful but not sufficient metric to characterize heat stress and guide heat mitigation strategies. Nevertheless, SUHI remains an important indicator for urban climate research as the study of bulk urban properties, and their interwoven relations with climate and population growth can provide useful insights to identify global trends and general guidelines. Similar coarse-grained analyses have been critically important in many other fields (e.g. the Budyko curve in hydrology as illustrated, for example, by Berghuijs et al. 2014), and yet they remain lacking in urban climatology where they can assist in framing the increasing number of global modelling and observational studies of cities.

### Conclusions

This study reveals that urban-rural systems exhibit emergent large-scale behaviors that can be described by a coarse-grained representation of the underlying biogeophysical and socio-economic processes. The intensity of SUHIs is shown to be non-linearly modulated by mean annual precipitation and population size, which are sufficient to encode the associated changes in heat release, albedo, convection efficiency, and evapotranspiration explaining the observed global patterns of urban-rural surface temperature anomalies. Strategies aimed at reducing city-scale warming should account for these inherent system nonlinearities as local climate-vegetation characteristics influence the efficiency of different cooling solutions. On seasonal timescales, SUHIs are char-

acterized by distinctive hysteretic cycles associated with urban-rural phase shift mechanisms generated by radiation, temperature, and rainfall seasonality. The coarse-grained approach presented is intended to complement, potentially at the preliminarily design stage, more detailed city-specific studies, which remain fundamental to capture the high spatio-temporal variability of urban characteristics and design local-scale heat mitigation strategies. Yet, as the science of cities continues to grow, general results begin to emerge at a “macroscopic” level. Such macroscopic results can generate hypotheses about connections between mitigation strategies (derived empirically or from detailed simulations), climatic regimes and city attributes, which is one of the outcomes to be explored in future works.

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## Mapping African cities in Local Climate Zones: Reporting on a mapathon experience

### Background and context

The WUDAPT effort and framework (Ching et al., 2018) based on the Local Climate Zones (LCZ) scheme by Stewart and Oke (2012) has been heavily used by the urban climate and earth observation communities in recent years. The number of global cities being mapped into LCZs is steadily growing, and is an important prerequisite for others to map vast areas such as Europe and the Continental United States into LCZs (Demuzere et al., 2019; 2020). This demonstrates that the community-based effort that is the philosophy underlying WUDAPT can lead to great achievements. However, very few cities in Africa have yet been mapped, something that is rather interesting to see since these cities would benefit the most from the WUDAPT efforts. Indeed, building resilient cities in Africa will depend on the accessibility to inexpensive and user-friendly data gathering methods (Acuto et al. 2016). And resilience doesn't have to be constrained to climate resilience. In fact, LCZs offer a detailed land use land cover (LULC) classification of cities that is primarily of use for climate studies but that can also be extended to other types of studies that are sensitive to the ways we build our cities. For example, urban health issues such as the risk of heat stress (eg. Aminarini et al. 2019) – a concern which most of the IAUC community is already familiar with – or to vector-borne diseases, as suggested in Brousse et al. (2019). Indeed, morphological heterogeneities within the urban environment may affect the presence of the vector (e.g. the mosquito), while certain LCZs (e.g., LCZ 7, lightweight lowrise or often referred to as informal settlements) may explain the vulnerability of certain populations because of their socio-economical dimensions. Still, this must be demonstrated.

We therefore decided to address the characteristic (climate and meta-) data scarcity in this part of the world by: i) studying the link between LULC characteristics given by the LCZ and the urban malaria prevalence of a set of African cities; and ii) complementing the existing set of LCZ maps in Africa so that a continental mapping may be foreseen. To do this, we organized a one-day mapathon event at the Université Libre de Bruxelles (ULB) on the 29th of October 2019 with the objective of mapping as many African cities as possible from the Remote sensing for Epidemiology in sub-saharan African CiTies (REACT, <http://react.ulb.be/>) project that aims at improving our understanding of malaria epidemiology within and across different African cities. Eighteen participants responded, most of whom were African residents doing a GIS-training at the ULB (Figure 1).

### Teaching LCZ and WUDAPT to beginners in a short amount of time

Before the mapathon was held, we provided the participants with the reference literature concerning LCZs and



Figure 1. Participants to the mapathon at ULB digitizing training areas over African cities.

we asked them to train themselves via the *driver test*, as the HUMINEX 2.0 project (Verdonck et al. 2019) revealed that students who took part in this test had significantly higher overall accuracies (OA) for their maps compared to those who did not. All participants were also given a one-hour presentation at the start of the mapathon to sum up all that had been sent to them previously. Two persons were also present to supervise them during the day if they had any questions.

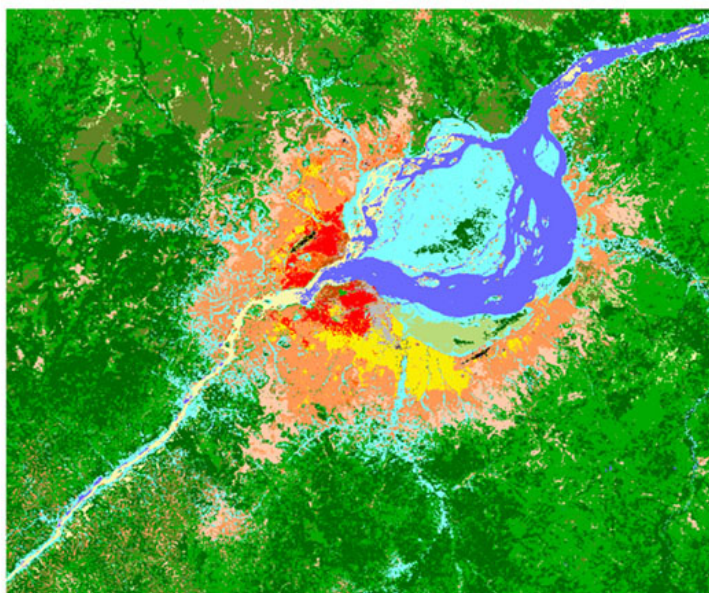
In the end, all participants were responsible for one city where they had to digitize as many LCZ training areas (TA; in the form of polygons) as possible. To gain time, as the mapathon lasted only one day, participants were not asked to map their cities in the SAGA GIS program as proposed by Bechtel et al. (2015; 2017). This could impact their sampling accuracy, as WUDAPT's standard LCZ classification workflow (Bechtel et al., 2015) outlines that the development of TA and the application of the classifier should be performed iteratively until there is a good match between the classification output and the underlying urban landscape (Bechtel et al., 2019).

### Mapping African cities in the form of LCZ

Before feeding the random forest classifier with the newly gathered training dataset, a preliminary manual revision of the TA was done by three experts to make sure that all students properly understood the LCZ classification. It was found that all the training dataset required some adjustments. The first verification procedure took about half a day for 6 cities to be properly verified. In particular, this step made sure that no unrealistic LCZ TA were fed to the model. For example, it was not accepted that a polygon sampled over a compact urban setting (e.g., compact low-rise, LCZ 3) was assigned to an open class (e.g., open low-rise, LCZ 6). Also, we made sure that all polygons fit the WUDAPT map-



Kinshasa Brazzaville



Lagos

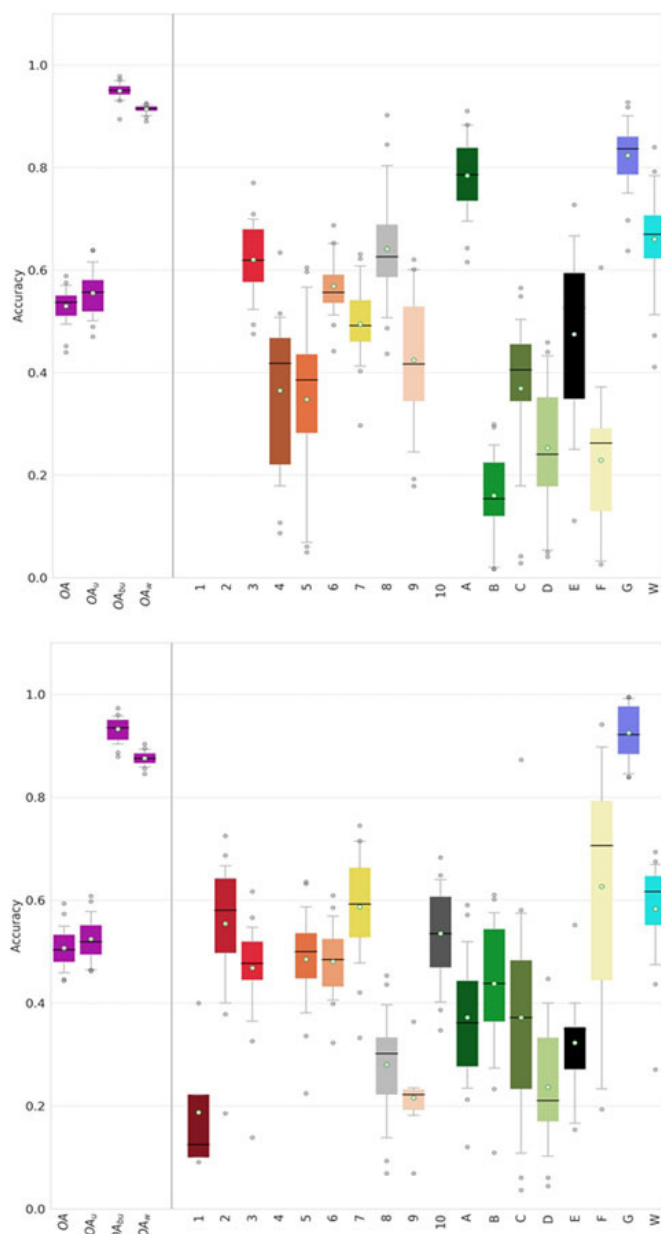
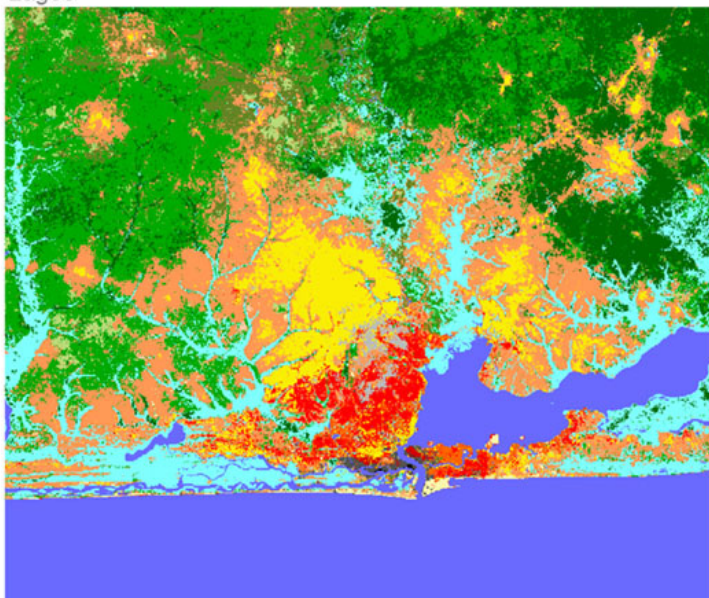


Figure 2. Examples of LCZ maps obtained out of the mapathon for Kinshasa Brazzaville and Lagos. Right panels show the overall accuracy (OA), the urban only overall accuracy (OA<sub>urb</sub>), the built-up overall accuracy (OA<sub>bu</sub>) and the weighted accuracy (OA<sub>w</sub>). The cross-wise LCZ F1 accuracies are also given.

ping guidelines proposed by Bechtel et al. (2015).

Our first verification round made us aware that participants potentially misunderstood the WUDAPT TA's sampling method and/or the LCZ scheme. Indeed recurrent mistakes were found: i) the set of TA for some LCZ classes that were well spread in the cities of interest was not consequent enough or even null; ii) some polygons were too small – way below the recommended 1 km<sup>2</sup> area; iii) TA of the same LCZ class were clustered in space instead of being spread across space to capture as many spectral signatures as possible from the same LCZ; and iv) unrealistic LCZ classes were sampled – the latter being potentially explained by the desire of some participants to find as many LCZs as

possible, even if not present. Certainly, most of these issues would have been avoided if more time was provided to map these cities. In fact, this probably affected the ability of participants to learn the LCZ scheme and its mapping framework, as well as the capacity of the teaching staff to make sure that everything was properly understood by the participants. Nevertheless, albeit these undesirable outcomes, we gathered a consistent number of training polygons over 18 cities in a very short amount of time and with a – although subjective – decent quality. Therefore, once the first verification step was done, we tested the efficacy of this training dataset to map the cities of interest. We fed it into the random forest classifier available in Google's Earth





Figure 3. Examples of different urban LCZ locations in Dar Es Salaam (Tanzania), Ouagadougou (Burkina Faso) and Kampala (Uganda): compact low-rise (LCZ 3) in red, open low-rise (LCZ 6) in orange and lightweight lowrise (LCZ 7) in yellow.

Engine (Gorelick et al. 2017) following the same method and the same earth observation input features developed by Demuzere et al. (2019a; 2019b). We evaluate the model performance by bootstrapping the random forest model 25 times using 70% of the data for training and 30% for evaluation. Also, the new LCZ W (wetlands) proposed by Brousse et al. (2019) was added, as this variable may be of importance for explaining malaria prevalence in urban environments.

#### Preliminary results of the mapathon effort

While the first LCZ maps look promising (Fig. 2), systematic confusions were found across similar LCZs for these African cities. More particularly, informal settlements (LCZ7 – lightweight lowrise) were often confused with compact low-rise (LCZ 3). Also, as some cities do not yet have Google Street View for visually interpreting the height of the buildings it may be that some of the confusion that happened between low-, mid- and high-rise classes is the result of a human induced error in the sampling. Notwithstanding, the weighted accuracy as proposed by Bechtel et al. (2017; 2020), taking into account similarities between different LCZ classes, was often higher than 0.7, suggesting an acceptable mapping accuracy.

However, by learning from previous studies (Bechtel et al. 2017; Verdonck et al. 2019; Demuzere et al. 2019), we considered that further improvement in the mapping could be obtained if we would: i) feed the model with more TA, ii) increase the quality of the TA, iii) define a protocol for visually differentiating compact low-rise (LCZ 3) from lightweight lowrise (LCZ 7) in Google Earth, and iv) test additional earth observation features in order to help the model differentiate between some LCZ classes in Africa. Since this investigation could have been labour-intensive, we focused on specific cities of interest that we considered most relevant for the REACT project. We chose these based on the availability of accurately geolocalized malaria surveys in the cities from the mapathon, so that only cities where we could conduct a proper evaluation of the links between LCZ and the malaria prevalence were retained.

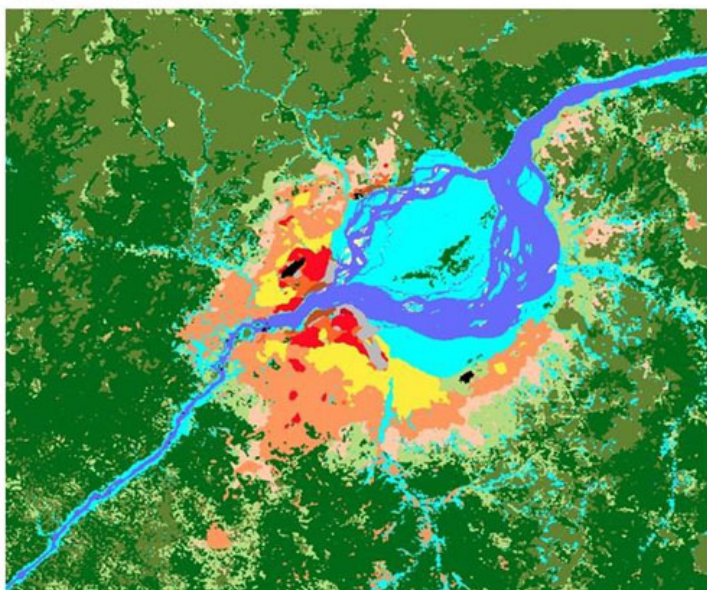
#### Investigating strategies for improved LCZ mapping in Africa

Our final selection consisted of nine cities that were not on the WUDAPT portal (Ching et al. 2018): Abidjan (Ivory Coast), Accra (Ghana), Dakar (Senegal), Dar Es Salaam (Tanzania), Freetown (Sierra Leone), Kampala (Uganda), Kinshasa (Democratic Republic of Congo), Lagos (Nigeria) and Mombasa (Kenya). First, we defined criteria for accurately digitizing LCZ 3 and LCZ 7's TA. We found that building materials that are observed from above cannot suffice to discretize one LCZ from another. Indeed, most of the houses use iron roofs and even clay for the walls. Still, completely different neighborhood typologies are found in LCZ 7. We thus considered that LCZ 7 are depicted by their unplanned forms and their very high building densities in comparison to LCZ 3, where more quadrilateral and open roads networks are found (Figure 3). In particular, height-to-width ratios are much higher and building widths are smaller in LCZ 7. Second, we added Sentinel 1 Gray Level Co-occurrence Matrix (GLCM) textures with an 11 by 11 window size to better capture the heterogeneities of built up surfaces (Forget et al. 2018) as well as Sentinel 2 red edge bands to improve the mapping of LCZ wetlands (Forkuor et al. 2018; Kaplan et al. 2018). Third, we used the same mapping strategy as previously detailed and we iteratively changed the original sets of TA after each evaluation step up until a satisfactory OA of 0.6 was obtained for each city – Bechtel et al. (2019) fixed this value to 0.5.

We found that Sentinel 1 GLCM textures could help reduce the confusion between some similar urban classes while Sentinel 2 red edge bands may help discretizing wetlands (LCZ W) that were often confused as dense trees (LCZ A) or water (LCZ W). Nevertheless, these conclusions will have to be studied in detail before further recommendations be given to the IAUC community in terms of choice of the earth observation dataset for mapping LCZ. Additionally, four iterative steps were necessary before reaching the minimum OA of 0.6 (Figure 4). This means that one person



Kinshasa Brazzaville



Lagos

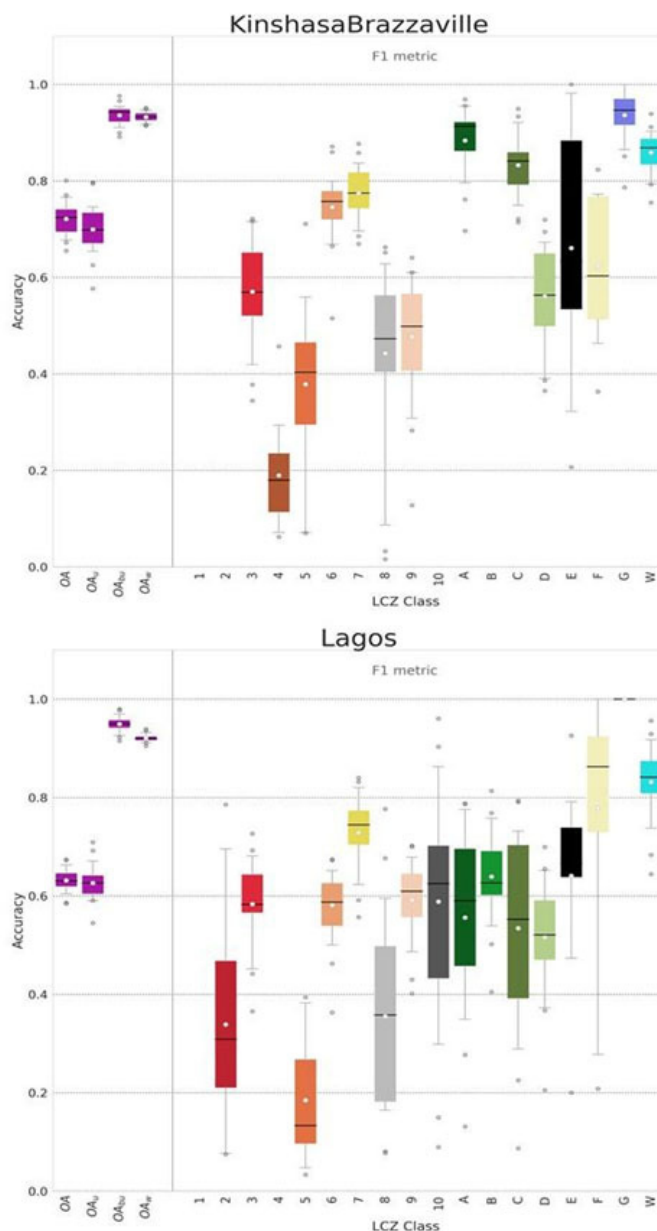
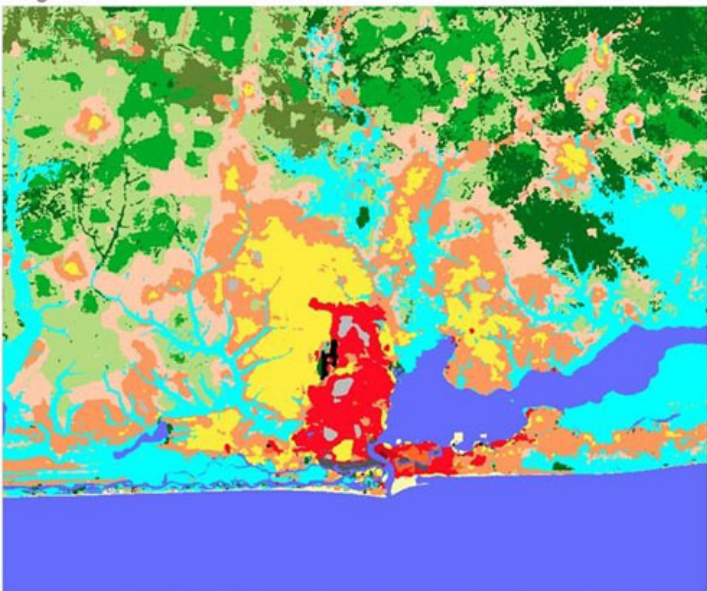


Figure 4. Examples of LCZ maps obtained after reworking the data gathered during the mapathon for Kinshasa, Brazzaville and Lagos. Right panels show the overall accuracy (OA), the urban only overall accuracy (OA<sub>u</sub>), the built-up overall accuracy (OA<sub>bu</sub>) and the weighted accuracy (OA<sub>w</sub>). The cross-wise LCZ F1 accuracies are also given.

had to work full time on the digitizing of the TAs for 10 full working days for accurately mapping nine cities, giving an idea of the time that is normally required to obtain an accurate map.

### Lessons learned and future perspectives

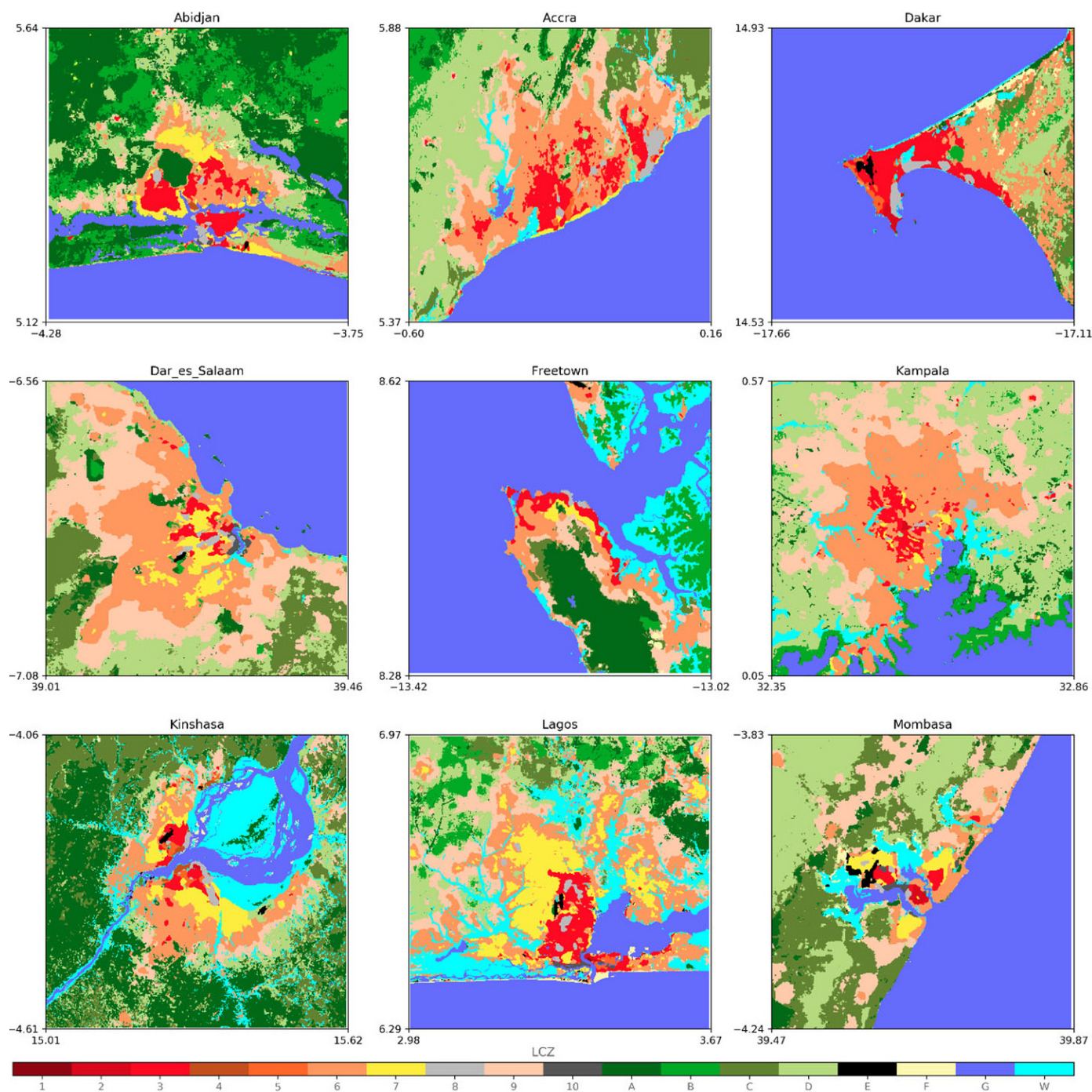
Although the mapathon effort provided us with a substantial amount of TA per city, which had the merit to be sampled by African citizens, the quality of the product was not yet sufficient to foresee a continental mapping of Africa. A substantial amount of additional work was thus required by experts familiar with the LCZ digitization process and mapping procedure. Lessons learned from this mapathon are in line with the conclusions from the HUMINEX experi-

ments (Bechtel et al. 2017; Verdonck 2019):

1) An iterative learning is required to obtain LCZ maps of good quality. Indeed, our mapathon asked participants to sample a huge quantity of TA in a very short period, without checking if the model was accurately responding to their TA sampling. This offered less chance to the participants to learn from their previous mistakes, even if the teaching staff was monitoring every participant throughout the whole day.

2) The 'wisdom of the crowd' is of added value. Each participant had a different city to map, which might have prevented some exchanges from happening between them. Still, some participants helped each other but these exchanges were rather limited. Probably, improved TAs could





**Figure 5. Final LCZ maps obtained for the REACT project that will be made publicly available on the WUDAPT portal.**

have been obtained if participants could have worked more collectively.

3) The driving test helps participants. All participants took the time to do the driving test and ended up feeling confident about their understanding of the LCZ. Nonetheless, as they were not given a second chance to learn from their mistakes some learning biases crystalized through the whole mapathon.

4) Major confusions are found between compact low-rise (LCZ 3) and lightweight lowrise (LCZ 7) despite our effort to define criteria for accurately digitizing their TA. We also found confusions between open low-rise (LCZ 6) and sparsely built (LCZ 9).

In the end, we managed to produce nine maps of major African cities that will be made public on the WUDAPT portal (Figure 5). Across these nine cities, we observed a spatial clustering of the LCZ that can be summed up as follows: an old planned and dense urbanization in the city center (LCZ 3), surrounded by more recent, densified and uncontrolled urbanization (LCZ 7) that opens towards the suburban areas (LCZ 6 and LCZ 9). Of course, we found other urban LCZ – e.g. compact and open mid-rise (LCZ 2 and 5) in business districts, or large lowrise (LCZ 8) in industrial areas and heavy industry (LCZ 10) in chemical harbors – but their spatial clustering is not as easily drawn up.

Further, we would like to encourage the members from



the IAUC community to get involved in the mapping of African cities to pursue a continental mapping that would complement some other recently made LULC maps over the continent (e.g., ESA Sentinel Africa map (Lesiv et al., 2017)). In fact, these LCZ maps can already serve urban climate studies and modelling to be done in these regions, as Brousse et al. (2020) demonstrated over Kampala (Uganda).

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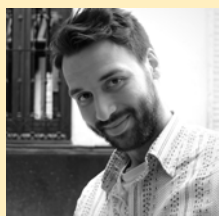
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# How time-limited events such as Oktoberfest contribute to the global CH<sub>4</sub> budget

Scientists at the Technical University of Munich figured out that the methane (CH<sub>4</sub>) concentrations in Munich are significantly increasing during the time of the annual Oktoberfest. With the help of a greenhouse gas (GHG) observation network using stationary FTIR instruments they found for the first time in 2017 that Oktoberfest is an unknown emission source of methane. Since then they have been studying the CH<sub>4</sub> emissions of the festival for three years. With the help of in situ measurements combined with a Gaussian plume dispersion model, they determined the emission flux of Oktoberfest as  $(6.7 \pm 0.6) \mu\text{g}(\text{m}^2\text{s})^{-1}$ . Additional analysis such as isotopic composition, correlations to the visitor number and the daily emission cycle show that the emissions are mainly not biogenic but anthropogenic. The most likely source of the unwanted loss of CH<sub>4</sub> to the atmosphere are incomplete combustions of natural gas from the grills and heaters that are widely used at Oktoberfest. The study shows that time-limited events, which use natural gas as a major energy source, can have a significant contribution to the global CH<sub>4</sub> budget and, therefore, should be considered in future emission inventories and mitigation policies.

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This article summarizes a recently published paper and related work: Chen, J., Dietrich, F., Maazallahi, H., Forstmaier, A., Winkler, D., Hofmann, M. E. G., Denier van der Gon, H., and Röckmann, T. (2020) Methane emissions from the Munich Oktoberfest, *Atmos. Chem. Phys.*, 20, 3683–3696 (<https://doi.org/10.5194/acp-20-3683-2020>)

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## Introduction

CH<sub>4</sub> is the second-most prevalent GHG emitted by human activities (Allen et al., 2018; Etminan et al., 2016; Myhre et al., 2013). It is estimated to have a global warming potential (GWP) that is 28 to 34 times larger than that of CO<sub>2</sub> over the 100-year horizon (IPCC, 2013). After experiencing a nearly constant CH<sub>4</sub> concentration (total amount of CH<sub>4</sub> in the atmosphere) from 1999 to 2006, CH<sub>4</sub> concentrations have started to increase again (Nisbet et al., 2019; Saunio et al., 2016). The reasons for the renewed growth are not fully understood; fossil fuel CH<sub>4</sub> emissions are largely underestimated (Schwietzke et al., 2016) and could play a major role in the increase (Hausmann et al., 2016; Worden et al., 2017). Natural gas is a growing source of energy, but its unwanted release into the atmosphere is a significant component of anthropogenic CH<sub>4</sub> emissions (McKain et al., 2015; Schwietzke et al., 2014), and its reduction may be essential for attaining the goal of the Paris agreement.

So far, large festivals are just considered as emission sources for air pollutants such as nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), particulate matter (PM<sub>2.5</sub>, PM<sub>10</sub>) sulfur dioxide (SO<sub>2</sub>), etc. (Huang et al., 2012; Nishanth et al., 2012; Shi et al., 2014). However, up to now, festivals have not been considered a significant source of CH<sub>4</sub> emissions and accordingly, CH<sub>4</sub> emissions from large festivals have not yet been studied.

That is why we investigated the CH<sub>4</sub> emission of Oktoberfest, the world's largest folk festival with over 6 million visitors annually that is held in Munich. In 2018, during the 16 days of Oktoberfest, approximately 8 million liters of beer was consumed. For cleaning, dish washing, toilet flushing, etc., 107 million liters of water was needed. The use of energy added up to 2.9 million kWh of electricity and

200,937 m<sup>3</sup> of natural gas, 79% of which was used for cooking and 21% for heating (Stadt München, 2018).

During our measurement campaign in 2017, we figured out for the first time that the Munich Oktoberfest could be a significant source of CH<sub>4</sub>. For a better source attribution and a quantitative emission assessment, we have investigated the CH<sub>4</sub> emissions from Oktoberfest 2018 and 2019 by carrying out mobile in situ measurements and incorporating a Gaussian plume dispersion model. The methods used as well as the results are summarized in this article.

## Methods

The measurements during our 2017 Munich city campaign indicated Oktoberfest as a possible source for CH<sub>4</sub> for the first time using our ground-based GHG sensor network that is based on the principle of differential column measurements (Chen et al., 2016). With the help of 5 stations that are distributed in and around Munich (Dietrich et al., 2020; 2019; Dietrich and Chen, 2018; Heinle and Chen, 2018) we observed higher CH<sub>4</sub> enhancements in the whole city during the Oktoberfest time in comparison to before and after. With the help of a Bayesian inversion model that is driven by STILT we were able to show that most of the CH<sub>4</sub> emissions came from the Oktoberfest site itself and are not only caused by the high number of visitors who are present in Munich at that time (Chen et al., 2018).

In order to quantify the emissions of the Oktoberfest premises more in detail, we went closer to the festival premises in 2018. There, we conducted a mobile survey around the perimeter of Oktoberfest to obtain the CH<sub>4</sub> concentration values around the festival area (Theresienwiese) and incorporated a Gaussian plume model consisting of 16 different point sources to determine the CH<sub>4</sub> emission strength.



We conducted mobile in situ measurements using two portable Picarro GasScouter G4302 instruments for measuring CH<sub>4</sub> and ethane (C<sub>2</sub>H<sub>6</sub>). Since we were not allowed to enter the festival area due to safety concerns, the measurements were carried out by walking and biking in total 94 times around the perimeter of Oktoberfest next to the security fences, wearing the analyzer as a backpack. The measurements were taken on several days during and after the time of the festival to compare the differences in emission strength and distribution. Additionally, to observe the hourly dependency of the emissions, the measurements were distributed over the course of the day. In the end, we covered the period between 08:00 and 19:00 (local time) hourly.

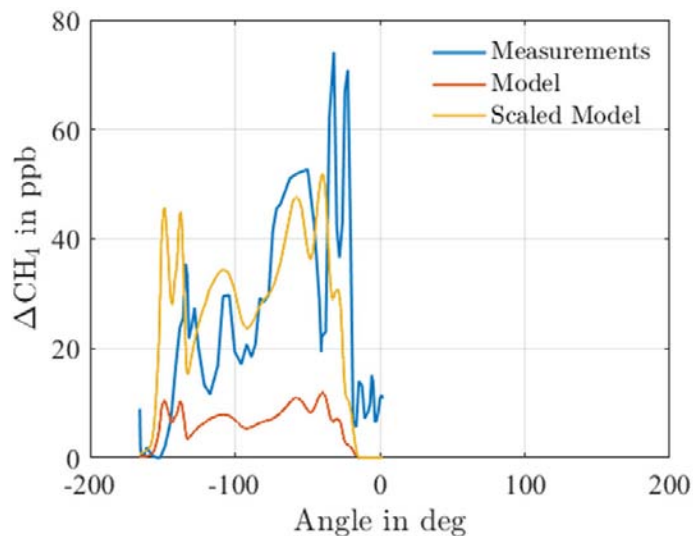
The framework of our modeling approach is based on a Gaussian plume model described in (Hanna et al., 1982; Sutton Oliver Graham and Simpson George Clarke, 1932) and widely used to assess local source emissions (Chen et al., 2017; Kiemle et al., 2017; Nassar et al., 2017; Yacovitch et al., 2018). As the concentration measurements using the backpack instrument were performed close to the festival area (<500 m), the emissions of Oktoberfest cannot be seen as a single point source. Accordingly, multiple point sources were used, which were modeled as Gaussian plumes before they were superimposed. To determine an emission number of Oktoberfest, we fitted these superimposed modelled plumes to the actual measurement signal by scaling a prior emission number so that the areas underneath both plumes are identical (see Figure 1).

In 2019, the mobile in situ measurements were repeated. This time, we focused more on the source attribution as we were allowed to enter the festival premises with our instruments, which made it possible for us to search for emission hotspots. Furthermore, a CFD (Computational Fluid Dynamics) model (Toja-Silva et al., 2018; 2017) was developed to simulate the gas dispersion within and around the terrain.

## Results

The measured CH<sub>4</sub> concentrations were plotted for each round on a map of the Oktoberfest premises to show that there is a clear correlation between the wind directions and the enhancements. These plots do not show the absolute concentration values but the enhancements above the determined background concentrations, because the enhancements are not influenced by the variation of the boundary layer height during the course of the day. Two such plots for two different wind directions are shown in Figure 2. In addition to the concentration enhancements and the wind direction, the 16 emission sources are shown as black dots on top of each tent. The Gaussian plumes themselves are also represented as orange plumes. These two plots reveal that the highest concentration enhancements can be observed downwind of the Oktoberfest premises.

In order to determine an averaged emission number, we averaged the emission numbers of all plumes that we ob-



**Figure 1.** Measurement curve (blue) with the a priori forward model (orange) and the scaled forward model (yellow).

tained by scaling the prior emission number until the area underneath the measured and modelled plume was identical. It results in an overall number of  $(6.7 \pm 0.6) \mu\text{g (m}^2\text{s)}^{-1}$ . The uncertainty is calculated by varying the input parameters such as instrument, wind and baseline uncertainty.

To verify whether the ongoing festival caused those emissions, Figure 3 also shows the emissions determined for the time after Oktoberfest (from 8 October through 25 October). This number  $(1.1 \pm 0.3) \mu\text{g (m}^2\text{s)}^{-1}$  is significantly smaller than the one during Oktoberfest.

Figure 3 (bottom) also shows a clear difference in the weekend and weekday emissions. The average emission for the weekend  $(8.5 \pm 0.7) \mu\text{g (m}^2\text{s)}^{-1}$  is higher than the averaged emission for the weekdays  $(4.6 \pm 0.9) \mu\text{g (m}^2\text{s)}^{-1}$ , almost by a factor of 2. This correlates very well with the twice as high number of visitors on weekends compared to weekdays (muenchen.de, 2018). Such a correlation indicates that the CH<sub>4</sub> emissions are anthropogenic.

Further analysis including calculations about biogenic human emissions and sewage emissions results in the conclusion that the majority of CH<sub>4</sub> emissions at Oktoberfest are caused by fossil fuel emissions such as small leakages and incomplete combustion in the gas appliances used.

In order to verify these assumptions, in 2019 we went closer to the sources and additionally measured the isotopic composition ( $\delta^{13}\text{C}$  and  $\delta\text{D}$ ) as well as the methane/ethane ratio of the exhaust gas using air-sampling bags (Chen et al., 2020). The results of this campaign are still in progress and will be published in a follow-up study soon. The preliminary results suggests that our assumption was correct; the high enhancements of CH<sub>4</sub> are caused by unwanted loss of natural gas into the atmosphere.

## Conclusion

Our study is the first one that deals with the CH<sub>4</sub> emissions of a big festival. We investigated Oktoberfest as it is

the world's largest folk festival and a CH<sub>4</sub> source that had not yet been taken into account in the state-of-the-art emission inventories.

The emissions are directly correlated to the number of visitors and are very likely caused by fossil fuel based emissions such as incomplete combustion or loss in the gas appliances. This assumption is supported by isotopic analyses of the gas that is exhausted at the festival premises.

Our approach is comparatively straightforward and can be applied widely to several emission sources such as small cow barns, uncovered heaps in landfills, or wetlands made of groups of ponds and swamps, etc.

In summary, this study uses Oktoberfest as an exemplary event to show, for the first time, that large festivals can be significant CH<sub>4</sub> emitters. Therefore, these events should be included in future emission inventories. Furthermore, our results provide the foundation to develop reduction policies for such events and a new pathway to mitigate fossil fuel CH<sub>4</sub> emissions.

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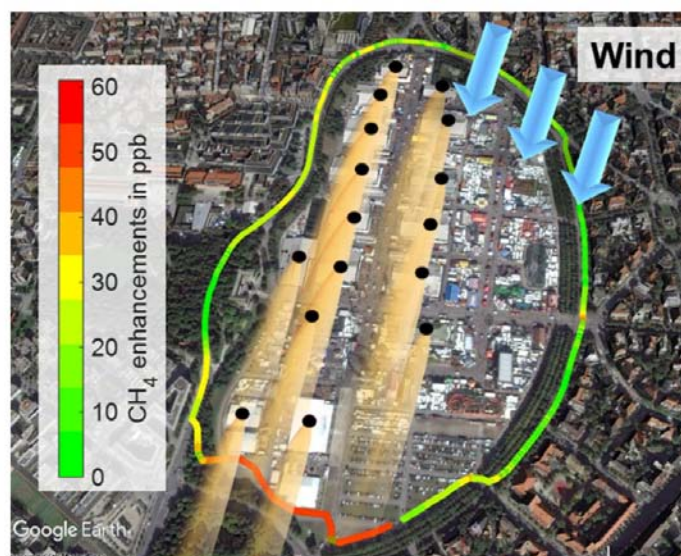
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**Figure 2:** CH<sub>4</sub> enhancements around the Oktoberfest premises for two different wind directions (top: 20°, bottom: -110°). The highest enhancements can be observed downwind of the festival (Chen et al. 2020).

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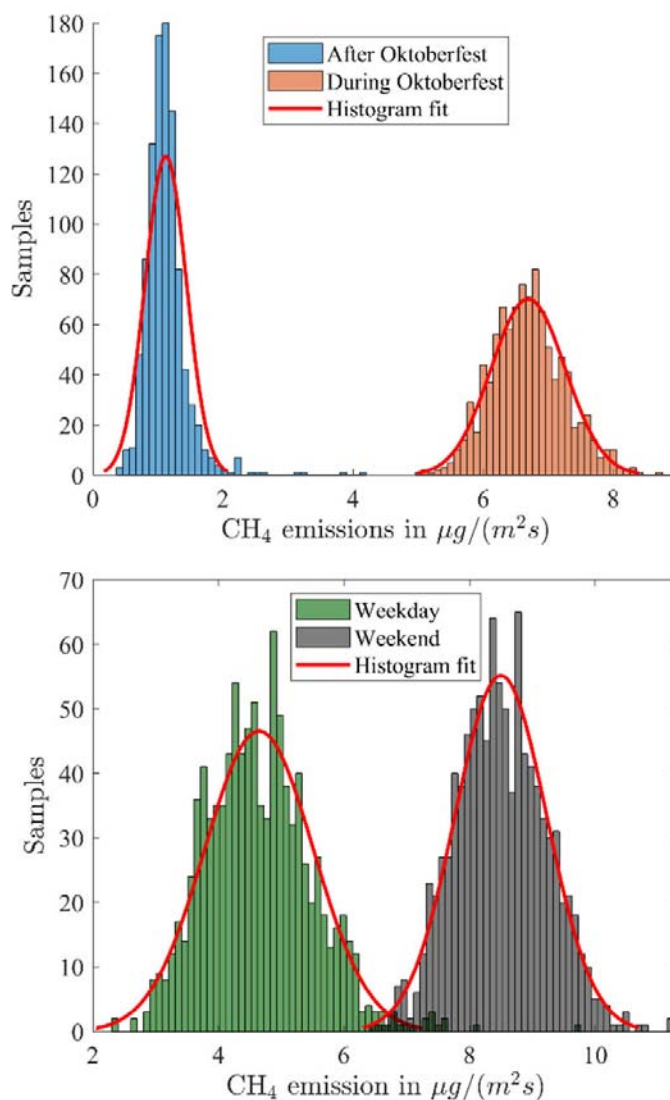
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**Figure 3: CH<sub>4</sub> emissions of the Oktoberfest 2018. On the top, a clear difference between the time during and after the festival can be seen. On the bottom, the results show that the weekend emissions are about twice as high as the weekday emissions.**

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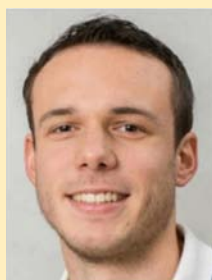
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Figure 4: Our team of the investigations 2019 including people from TUM and LI-COR Inc. standing in front of the Oktoberfest main entrance.

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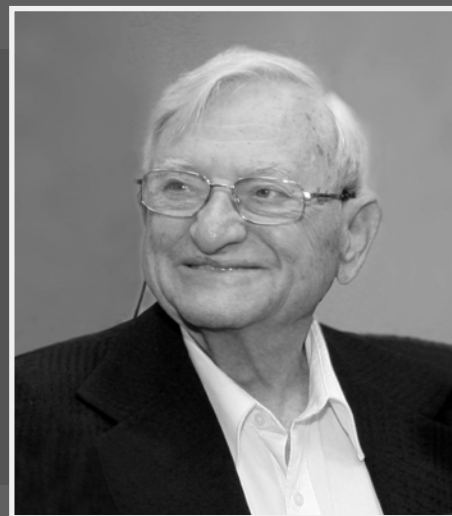


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# Man Climate & Architecture



Remembering the life and times of Baruch Givoni (1920-2019)

Baruch Givoni was born one hundred years ago in Jerusalem. At a young age he moved with his family to the coastal town of Haifa, home of the Technion – where he would later receive a professional degree from the lone faculty of architecture in the newly formed state of Israel. His career would not be conventional, however, and fifty years ago he published a book that would usher in a new field of scientific endeavor – the rigorous study of the relationship between man, climate and architecture. This year, he passed on the legacy of a man whose name is synonymous with that field.

While data points such as these tell us little on their own, it is *data* that drove Baruch Givoni. His hunger for precise information and his ability to turn empirical data into a fuller story are what led him to carry out pioneering experiments in environmental physiology, to develop universally recognized models describing human thermal stress and adaptive comfort, and to provide the bioclimatic design tools necessary for making buildings more efficient and cities more habitable.

## “Born for research”

Aside from his insatiable curiosity and lifelong persistence, Givoni’s career trajectory was guided to a large extent by circumstance and sheer luck. Initially he had no intention of studying architecture – but due to his self-professed love for plants and flowers, he was drawn to the field of garden design, having worked in his youth as a gardener and even co-founding an agricultural community (*kibbutz*). Since at the time there was no suitable program in landscape design, he decided to pursue a degree in architecture – which in turn would lead to a career at the Technion-Israel Institute of Technology that

would last for over 20 years.

Shortly after his graduation in 1953, Givoni became inspired by David Ben-Gurion, Israel’s first prime minister, to head southward and settle the Negev desert. He went to work for the Ministry of Housing in the dusty city of Beer-Sheva – but through a chance encounter was invited back to Haifa by his former professor Rahel Shalon, who informed him that she had just become the founding director of the new Building Research Station (BRS) and needed an assistant. While Givoni’s boss in Beer-Sheva was sorry to lose his talented young architect, he sent Baruch off with some parting words that would influence him for the next half century: “You were born for research.”

Indeed Givoni thrived in his new role as a researcher, and in 1958 Prof. Shalon asked him to head a new laboratory that she was establishing for “Building Climatology.” Belying a sense of modesty that never left him, Baruch accepted the offer because he was fascinated by the topic – but admitted that he knew virtually nothing about it. In order to remedy this problem he was sent for training in the US, where he joined the national research laboratory of the American Society of Heating and Ventilating Engineers (ASHVE, later merged into ASHRAE). The lab could not offer him work on building climatology, but did have ongoing research on human physiology – except that the physiologist was temporarily absent and he would have to work alone. It was thus a confluence of circumstances that led Givoni to embark on a period of self-training and independent experimentation into the effects of temperature, humidity, wind and radiation on human thermal comfort under hot conditions.

*Photo above courtesy of Wolfgang Motzafi-Haller, BGU*

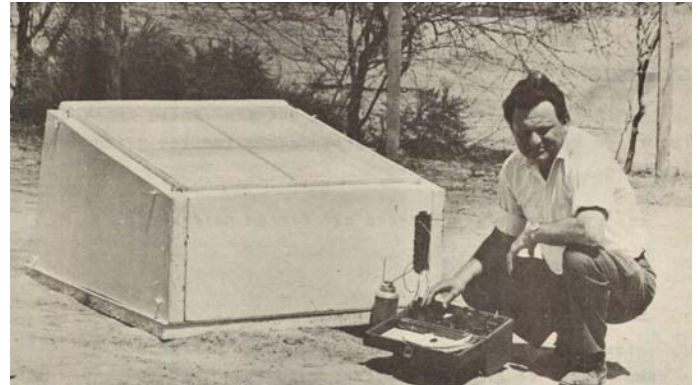
## Between environmental physiology and building climatology

These experiments proved successful, and sparked Givoni's fascination with "environmental physiology" – a field that was entirely outside the realm of architectural education and practice, but in his opinion the perfect complement to building design adapted to human needs. Based on this success, he was accepted for a master's degree in public health under the supervision of Harwood S. Belding, a noted professor at the University of Pittsburgh who had dealt previously with problems of physical work in adverse environments at the Harvard Fatigue Laboratory and as director of the US Army Climate Research Lab.

The focus of Givoni's analysis was the key issue of "sweat efficiency" – that is, the limiting effect of humidity and other environmental variables on the human body's ability to cool itself through evaporation and to maintain thermal equilibrium under warm conditions. In a more general sense, however, he internalized the important understanding that thermal comfort could not be described by a single parameter such as temperature – rather it required an understanding of the complete balance of energy exchanges between the body and its surroundings.

This collaboration with Belding, who recognized the pioneering nature of Givoni's experimental work and granted him first-author rights on their 1962 publication at the First International Congress of Bio-Meteorology, provided him a bridge to international stature in an emerging scientific community. Bringing his experience and new-found notoriety back to the BRS Building Climatology Lab in Israel, Givoni now had at his disposal a dedicated climate chamber which could serve his experimental interests in both physiology and climatology. The central question preoccupying him seemed simple: How much sweat must evaporate in order to sufficiently cool the body? But the ability to model this process, in a way that would faithfully reflect the body's internal mechanisms as well as the full range of microclimatic variables in a given location, required not only empirical data but also a deeper level of scrutiny. He took his question to the medical faculty of the Hebrew University in Jerusalem – and buoyed by a wave of interest (and funding) from the US regarding occupational health and from Israel regarding building construction, he was promptly accepted for a PhD in public health that would bridge these challenges.

The doctoral dissertation that appeared in 1963 (sponsored by UNESCO, with an English translation published by the BRS) was entitled "Estimation of the Effect of Climate on Man: Development of a New Thermal Index." What he developed was the Index of Thermal Stress (ITS), and in this work Givoni became the [first to demonstrate](#) that sweat efficiency decreases as soon as the evaporative rate required to keep the human body's heat balance



Givoni in 1968 at the meteorological station of Eilat, deploying an experimental model for studying the "cooling of houses in desert regions by utilizing outgoing radiation." Source: Building Research Station Dept. of Building Climatology and Israel Ministry of Housing, courtesy of Or Aleksandrowicz.

in a steady state reaches 20% of the maximal evaporative power. The ITS was considered to be [the most comprehensive index](#) developed for evaluating heat stress in buildings, and its use was eventually extended for outdoor urban spaces as well. More importantly, the concept of "thermal stress" came to encapsulate Givoni's efforts at connecting human beings with both their natural *and* constructed environment. "Because of this connection," he [mentioned casually fifty years later](#), "my first book was called *Man, Climate and Architecture*."

### Man, Climate and Architecture

Givoni's first book would become a worldwide best-seller, but this too was creditable in part to a convergence of circumstances that would play out over the course of the 1960s and early 70s. As head of the BRS Department of Indoor Climate – the "first permanent research body in Israel to be fully engaged in questions of building and climate" – Givoni leveraged his varied experience in architecture, physiology and climatology toward solving practical problems in the built environment. Central among these were the problem of condensation in buildings during the winter due to a lack of thermal insulation, and the overheating of these same buildings in summer. His work thus focused on design considerations such as optimal orientation for sun and wind, and the thermal and optical properties of building materials – but he easily connected these issues with the evaluation of inhabitants' biophysical comfort.

With a strong desire to see the results of his work translated into actual design practice, he also headed the national committee established to develop a national standard for building insulation. In fact throughout his career he struggled to implement what he believed to be the fundamentals of climatic design in hot-arid regions, including proper window placement and shading





*In late December 2012, I was fortunate to interview Baruch Givoni at his home in Tel Aviv as part of my doctoral research on the history of building climatology in Israel. Givoni was almost 93 years old at the time, but nevertheless he was energetic, sharp, and talkative – which made him a perfect interviewee. He told me about the almost accidental way in which he became a building scientist and an expert on thermal comfort in a manner that expressed a genuine sense of modesty. Despite being a central driving force behind the revolution in bioclimatic building research in Israel and beyond during the 1960s and 1970s, Givoni refrained from referring to his professional work in revolutionary terms and described it as a process of piecemeal expansions.*

*This was also a result of Givoni's attitude towards research: as he told me, he thought that thorough and exhaustive empirical monitoring of real-world conditions and situations is the best way of understanding the human component of climatic design. In his eyes, human beings cannot conform to deterministic and simplified models, and, therefore, a researcher must look for the physical differences and cultural preferences that shape our changing perceptions of indoor and outdoor climatic conditions.*

*As a whole, Givoni seemed to me then quite content with his life-long achievements. Nevertheless, one issue still troubled him after all these years: the almost total indifference of architects to the expanding body of knowledge that he and his colleagues had been building for decades. Here, and for the only time during our meeting, Givoni expressed deep frustration and astonishment, as if the ill-mindedness of architects towards climatic considerations is such a force of nature that nobody, not even the most clever of scientists, can make it change course.*

— Or Aleksandrowicz, Technion - Israel Institute of Technology

and the combined use of thermal mass and insulation for maximizing the effectiveness of cooling by night ventilation. At the core, however, was decision-making based on critical analysis: he believed in building theories based on experimental research, and if necessary discarding accepted dictums if the results contradicted them.

By the late 1960s his local efforts had borne fruit, generating a “reliable and accessible knowledge base for understanding the climatic implications of architectural design in Israel.”<sup>1</sup> In 1968 Givoni and his team summarized this work in a report which surveyed the crucial elements of climate, presented the concept of thermal comfort and the application of a bioclimatic chart for thermal comfort analysis, described the thermal properties of building materials, and provided specific design recommendations for the different climatic zones in Israel. Although its focus was on the formulation of simple guidelines for local designers, this practical guide to climatic building design and the years’ worth of research underlying it were about to have global implications.

In the same year the report was published, Givoni returned to the US for a sabbatical leave that would prove to be a turning point for his career and what it came to represent. He spent the first part of this period at the University of California in Berkeley, a focal point of the

turbulence stemming from heightened environmental and social awareness and particularly from the war raging in southeast Asia, and for the second part he moved to the US army’s research lab for environmental medicine and exercise physiology in Natick, Massachusetts. Performing experiments with young volunteers, who in his words “preferred suffering in a climate chamber than in Vietnam”, Givoni discovered the remarkable capacity of the human body to *adapt* to thermal stress, as its physiological mechanisms adjusted to better cope with extreme heat and humidity after each day of physical training.

In the midst of this tumultuous period, Givoni received an invitation from a British book publisher. It turned out that the model of human thermal stress which he had developed in his doctoral thesis, together with his extensive practical work on building climatology, were considered of ample importance to justify a volume that would be marketed to a general audience. The first edition of

<sup>1</sup> For a detailed account of Givoni’s early career, see: Aleksandrowicz O. (2017) Appearance and performance: Israeli building climatology and its effect on local architectural practice (1940–1977). *Architectural Science Review*, 60:5, 371–381. (DOI: [10.1080/00038628.2017.1354812](https://doi.org/10.1080/00038628.2017.1354812))

*Man, Climate and Architecture* appeared in 1969, and in June 1970 [it was reviewed](#) by Charles Senn in the *American Journal of Public Health*. Senn explained that the book was “written by an international authority on man’s thermal environment, with special reference to hot climates in regions where mechanical air conditioning is not generally available,” and emphasized how Givoni “gives a comprehensive explanation of the mechanisms of heat generation and loss from the human body [and] concludes that the most valid method for evaluating combined metabolic and environmental factors is the ‘Index of Thermal Stress’ (ITS), which enables predicting resultant physiological strain.” And in describing what the book had to offer readers at large, he concluded:

*“While a significant part of the book is of special value to architects practicing in hot climates, much of the book is of value and interest to all who are interested in man’s response to the indoor environment.”*

While endorsements like this surely helped to promote Givoni’s work, it was a set of much larger, external circumstances that would propel the book to its iconic status. In 1973 the western world experienced first-hand what energy scarcity and over-reliance on fossil fuels might look like, when the oil embargo and ensuing “energy crisis” brought concepts such as passive solar architecture into the mainstream. Givoni revised and expanded his text for a second (1976) edition, engaging a wider public in his vision of a relationship between climate and architecture that placed the human being – with all its physiological workings – at center stage. Instead of a focus on the prevailing trend towards more sophisticated air conditioning technology, this vision channeled scientific knowledge toward technological *simplification*, integrating self-cooling mechanisms into the building itself through climate-responsive design. He promoted the climatization of buildings by “natural energies,” exploiting not only incident solar radiation for passive heating but also passive cooling mechanisms such as nocturnal airflow for ventilation and rooftop evaporation for minimizing heat gain. Givoni’s book not only anticipated the urgency of energy conservation, it provided a scientific basis for energy-efficient architecture.

It was also in 1973 that Givoni became a professor at the Technion, in addition to his ongoing work as head of the Building Climatology Department at the BRS. But the publication of his landmark book had opened doors around the world, and he was promptly invited to teach for three months each year at the Architecture and Urban Design Department of the University of California in Los Angeles. After a few years, though, a set of circumstances prevented him from continuing this arrangement with UCLA from his base at the Technion – so he instead took up a position at Ben-Gurion University of the Negev, and headed back to the desert.



In the early 1980s Givoni’s experiments at the Institute for Desert Research included an earth-sheltered dome, which continues to house residents and harbor vegetation.

### Desert architecture and urban planning

Having heeded David Ben-Gurion’s call 25 years earlier to help “make the desert bloom,” this time Givoni joined in founding an entirely new kind of research endeavor – the Blaustein Institute for Desert Research at BGU’s Sede Boqer campus. The institute’s mandate was to carry out scientific research directed toward the development of arid regions, and Professor Givoni headed up a new group dedicated to solar buildings and energy conservation. The desert further sparked his interest in passive heating and cooling, and the remote site allowed for experimentation that would have been impractical within the confines of a conventional campus. He constructed experimental test buildings to systematically examine climatic design parameters and monitor the performance of low-energy systems, and he built [earth-sheltered domes](#) to analyze the short and long-term effects of dry and wet soil on a building’s thermal inertia. Most importantly, he documented a remarkable collection of ongoing experiments and ideas for future work that would inspire researchers in Desert Architecture for decades to come – leading to innovations in [evaporative down-draft cool towers](#), night sky [radiant cooling systems](#), and [hybrid rooftop systems](#) employing shade, soil and water. In fact Givoni’s later work with test cells was featured as a prime illustration of the [principles of experimental research](#) in Groat and Wang’s 2002 textbook, *Architectural Research Methods* (and its second edition in 2013).

Throughout this period he continued his part-time association with UCLA, and in 1985 it became permanent. Nearing retirement age but not nearly ready to retire, Prof. Givoni moved to southern California and launched yet another “new” career, imparting his accumulated knowledge to students in disciplines ranging from physics to architecture. It was also during this period that his attention shifted significantly from individual building systems to the larger systems of streets, neighborhoods and cities (having published in 1973 an analysis of “the influence of



When I first arrived at the Sede Boqer campus of Ben Gurion University in 1986, Givoni had already left for the greener pastures of UCLA, where he taught until his retirement. Outside my office window, however, I could see an array of test cells, which he had constructed to experiment with his ideas for passive cooling. In an adjacent room, he had constructed a bespoke piece of furniture where an Intertec 'Superbrain' computer found a place of honor – but which had by then been replaced by early model IBM PCs. As my own research developed, I found that no matter where I turned, I was walking in Givoni's footsteps: nocturnal radiant cooling, evaporative cooling, earth-sheltered buildings – he had studied them all.



I can remember vividly the day when we covered with soil an experimental dome structure he had designed, watching the tractor climb successively higher as the thin concrete shell was loaded with more and more earth, until it was perched at the very top, over three meters above the ground. It still seems hard to believe that the fragile-looking structure supported the heavy machinery, but not only was it structurally sound – the building, which we monitored in summer and winter, performed exactly as Givoni had predicted it would.

When, eventually, I started working on urban microclimate, I discovered that he had authored a WMO report published in 1989 called "Urban Design in Different Climates". Although this publication has remained relatively obscure, many of his concepts and ideas, based mainly on a keen sense of observation, are supported by research conducted by others many years, sometimes decades later.

When Givoni finally retired from UCLA and returned to Israel, he remained a sought-after speaker and guest lecturer, especially in countries with warm humid climates such as Mexico, Brazil and Hong Kong. Researchers from these countries meeting me for the first time, upon learning that I am from Israel, almost invariably ask of him. And small wonder: well into his late eighties, he would call me every once in a while to ask for new experimental data from some project, or graphs and figures he could use in yet another book he was working on. At an age when most people have long since given up academic work, he was still bubbling with ideas, travelling around the world and expounding on his research.

Once news of Baruch Givoni's passing began to circulate, I received several messages of condolence from colleagues who knew him: a tribute to the affection he generated and the high regard with which he was held by so many people.

— Evyatar Erell, Ben-Gurion University of the Negev

urban features on city climate"). While others were already studying the dynamics of the nocturnal urban heat island (UHI) effect, Givoni was mainly focused on hot conditions during the daytime – inspired by the dense urban fabric of traditional Mediterranean cities and the radiative "cool islands" created by deep shading and thermal inertia.

In 1989, the same year that the first International Conference on Urban Climate was held in Japan, the WMO entrusted Givoni with the preparation of a World Climate Programme report entitled "Urban Design in Different Climates," in which he outlined a virtual roadmap of the emerging field of urban climatology. This volume began by describing the urban climate and its distinctive characteristics, with a focus on previously neglected tropical cities, and continued with practical recommendations regarding physical planning features ranging from urban density and street width to particular housing types and green spaces. Finally, it took the "bioclimatic approach"

that had been developed for architectural design and applied it to cities as well, detailing the different urban design strategies that may be leveraged in geographic regions characterized by hot-arid, hot-humid, composite and hybrid climate regimes. In the next decade, two more books were added to Givoni's body of work: *Passive and Low Energy Cooling of Buildings* in 1994, and *Climate Considerations in Building and Urban Design* in 1998.

### The "Givoni" Bioclimatic Chart

Already in his 1969 book, Givoni had proposed a method to determine thermal comfort requirements in buildings based on the Index of Thermal Stress, and to graphically depict different design strategies for creating comfortable conditions in a particular region. Over the ensuing decades this design tool, his version of the popular "bioclimatic chart", came to be known as the "Givoni diagram."

Baruch was inspirational to me as a young researcher back in the early 2000s. He was over 80 years old when I first met him in Florianópolis, Brazil (PLEA 2001) and I was surprised to see him showing interest in a dataset with indoor and outdoor temperatures I had collected with a former MSc student on low-cost dwellings in Curitiba, Brazil. I did not hesitate in sending him the data and soon after that I got a full analysis with his predictive methods for those houses. He invited me to prepare joint papers for different conferences and journals, and I invited him over to Brazil (with limited research budget) for a course on bioclimatic architecture. He told me about the research team in Sede Boqer, and through a meeting with Isaac Meir at the PLEA Conference in Santiago, Chile I was able to arrange a visit to Israel. In this way, an important connection was made through Baruch – starting a fruitful collaboration with colleagues in Israel, particularly during my stay at Sede Boqer (pictured here) during 2005-2006 when I became close friends with David Pearlmutter and we ran field experiments together on the same grounds where Baruch had done his. Until 2010-2011 Baruch and I were still collaborating on research, and occasionally I would meet him at international conferences – though even more often other colleagues would ask me about him, as his reputation always drew interest.

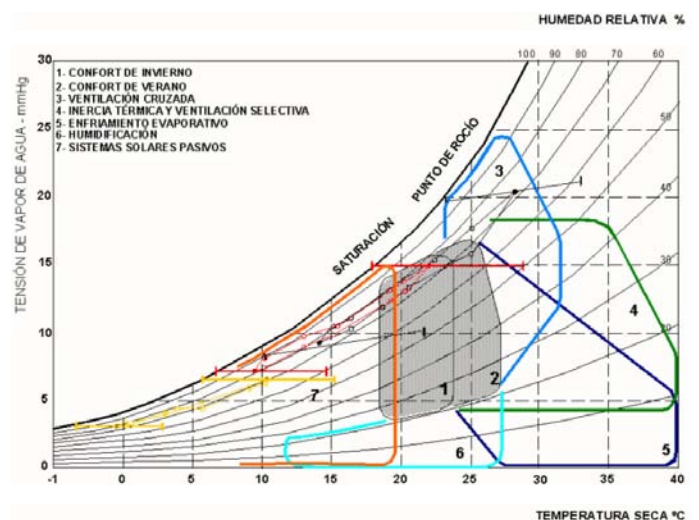


When Baruch came to Curitiba I invited him to my house and took him on a sightseeing tour, which was later reciprocated when I came to visit him in Haifa, Israel in 2015 and he showed me the Bahai gardens and the German neighborhood. I was always amazed by his friendliness and perhaps a “fatherly” attitude towards me. It puzzled me that he would show interest and curiosity in researchers and research groups in emerging economies and developing countries, so much so that he seemed to me like a missionary – working with other Latin-American colleagues such as my friend Eduardo González from the University of Zulia, Venezuela, with whom we worked together in the last few years of our collaboration. The modesty and respect he showed us, even though we were still “little fish” in research, was also part of his special gifts.

For all that, he became a role model to me, not just because of his knowledge, but for his behavior and attitude, for the way he would hug us and put on a friendly smile when meeting us, for the natural way he would describe complex phenomena, and for his curiosity and enthusiasm, which should actually be required characteristics of any researcher.

— Eduardo Krüger, Universidade Tecnológica Federal do Paraná

Givoni’s approach was based on the observation that the diurnal fluctuation of outdoor air temperature is higher when the vapor pressure is low – and that this inverse relationship is the key to “passively” reducing temperature indoors. Using average monthly temperature and humidity values, his “climogram” traces the bioclimatic characteristics of a site on a psychrometric chart and then identifies not only the zone of comfort, but ways of enlarging it through cooling techniques that incorporate natural ventilation, thermal mass, night ventilation and evaporation. Especially after his [1992 article](#) entitled “Comfort, climate analysis and building design guidelines,” Givoni’s bioclimatic chart became ubiquitous in schools of architecture and has been frequently adapted to specific climatic conditions around the world. In fact in the mid-1970s he visited Brazil and adapted his climate chart for tropical and subtropical areas, gaining a loyal following in South America and returning over the years to Argentina, Venezuela and Chile – with extended periods in Australia as well.



Givoni’s “Climogram” as applied to the humid climates of Argentina, with the comfort zone extended by passive bioclimatic design strategies.



*I read your book "Man, Climate & Architecture" when I was a student. I started to know you virtually.*

*In 2003, I invited you to come to Hong Kong to teach in my MSc programme. From then on, I started to know you in person. We started to collaborate on projects and publish papers together.*

*The most important lesson I have learnt from you has been that a scholar must keep the investigation simple by focusing on the most important line of thought, and solve a problem in the simplest way. For example, you always said, "Why use expensive equipment when a self-made ten-dollar device can give one the same data? And why use a complicated program and a super computer when a simple equation can achieve the same analyses?"*

*Students loved you too. They told me you were friendly, down to earth and hands on. They were surprised that you could spend hours showing them how to collate data using Excel and entering lines of data yourself; and you could stand-by under the sun supervising them on how to connect the thermocouples. They told me you loved Chinese food and always challenged other overseas visitors to taste exotic Chinese dishes like chicken legs.*

*Baruch, we will all miss you.*

*— Edward Ng, Chinese University of Hong Kong*



Traveling the world as a visiting professor, Givoni was repeatedly impressed by the capacity of local people to adapt to different levels of heat stress, and especially humidity. A climatological journey that had taken him to the arid Negev highlands of southern Israel and the mild southern pacific coast of the US also led to the humid tropical cities of southeast Asia, where he collaborated and consulted in Japan, Thailand, Singapore and Hong Kong. Leaving UCLA in 2002, he returned to Israel and began collaboration with climatologists from Tel Aviv University, and also was invited to share his knowledge with a new generation of building and urban climatologists at the School of Architecture of the Chinese University of Hong Kong (CUHK) – a recurring engagement that became yet another new career for the youthful emeritus professor.



Givoni traveling in Beijing with Isaac (Sakis) Meir of BGU.

\* \* \*

Baruch Givoni was recognized with the prestigious Passive and Low Energy Architecture (PLEA) award in 1991, and in 2008 I had the distinct honor of presenting Prof. Givoni with the first-ever [Jeffrey Cook Prize in Desert Architecture](#) from Ben-Gurion University. Until that time, we had only met occasionally and so the name Givoni was for me just that – a name. However I felt like I knew him well, because his name seemed to be attached in some way to virtually every report, article, paper or book that I encountered on the subject of climate and architecture in arid regions. He had produced literally hundreds of scientific publications and pioneered many of the most important ideas and innovations in "desert architecture": evaporative cooling, earth-integrated buildings, moderating heat stress in urban spaces, and on and on. I found myself time after time attempting to pick up and continue research that he had initiated, worked on, and then left as he moved on to something else.

As circumstance would have it though, a particular misfortune for Prof. Givoni turned out to be strangely fortunate for me. At the age of 90, on the eve of his regular trip to Hong Kong, Baruch's doctor informed him that he could no longer travel overseas. He was disappointed and dismayed that his globetrotting activity should be curtailed when he was still in full swing. But he was eager for collaboration closer to home, and hungry as ever for data – so we started a test-cell experiment comparing the thermal behavior of conventional building materials

*As an urban climatologist, I also grew up on Prof. Baruch Givoni's books and articles.*

*Upon his returning to Israel, in 2002, I asked to meet him and discuss my research. I expected to meet an elderly person who continues to be interested in the field and can certainly contribute from his vast experience and proficiency. I was totally surprised!*

*I met a young looking man, thoughtful, vigorous, and most eager to explore. He immediately asked me to take him for a walk in the park where I had done research on the effects of a new water pond on the temperature, humidity and thermal comfort. As we walked – almost ran – across the lawn on an extremely hot and dry day, he drafted a formula for predicting the temperature of irrigated grass exposed to the sun, which was based on measurements taken during different weather conditions. This work was presented at the Fifth International Conference on Urban Climate (ICUC-5) in Lodz, Poland, in September 2003.*

*From here it was only a short way until he expressed his desire to write together a review article on outdoor comfort research issues, comparing his studies in Japan and various studies done in Israel. The article was published in *Energy and Buildings* in 2003 and received hundreds of citations.*

*It was a great privilege to know and work with him, even if for a short period. He was a true scientist as well as a lively, modest man, interested in many areas beyond science – an admirable person.*

*The meaning of his name, Baruch, is "blessed". In Hebrew we eulogize by saying: "of blessed memory". Blessed Baruch has earned his just reward for a life well lived, and shall be remembered with longing.*

— Hadas Saaroni, Tel Aviv University



<https://www.youtube.com/watch?v=hIMjBw55GOQ>

with alternative low-energy materials that my students and I were developing at the time. I finally got to know the man behind the name, and discovered that Baruch's interests went far beyond the topics associated with the public Givoni. At his retirement home in Tel Aviv he had founded a weekly music appreciation group, holding weekly concerts in which he would share classical pieces from his own collection of recordings. He showed me some remarkable portraits that he had created, and I was astonished to learn that he had taken up painting only recently – having shown a certain talent for drawing in his days at architecture school, but never having been satisfied with his own abilities.

I also found that this was a person with an almost painful sense of humility, bemused that his name was known on every continent but still mainly concerned with solving problems and figuring out puzzles. When he came to visit our experimental site, he insisted on traveling independently – explaining that the train ride gave him time for his daily Sudoku. When asked what he attributed his good health to at such an advanced age, he mentioned physical exercise – but said that exercising his mind was the key.

Baruch left behind a large family, with children, grand-

children and great-grandchildren too numerous to count without a bit of effort. A few years ago he was described as an elderly father whose most obvious trait was that he was like a child, with a childlike curiosity to constantly learn new things and master new challenges – and a seeming lack of awareness as to just how successful he was.

— David Pearlmutter, Editor





## Recent Urban Climate Publications

A. Samad NS, Abdul-Rahim AS, Mohd Yusof MJ, Tanaka K (2020) Assessing the economic value of urban green spaces in Kuala Lumpur. *Environmental Science and Pollution Research* 27 10367–10390.

Abdi B, Hami A, Zarehaghi D (2020) Impact of small-scale tree planting patterns on outdoor cooling and thermal comfort. *Sustainable Cities and Society* 56

Aboelata A (2020) Vegetation in different street orientations of aspect ratio (H/W 1:1) to mitigate UHI and reduce buildings' energy in arid climate. *Building and Environment* 172 106712.

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Aguiar-Gil D, Gomez-Pelaez LM, Alvarez-Jaramillo T, Correa-Ochoa MA, Saldarriaga-Molina JC (2020) Evaluating the impact of PM2.5 atmospheric pollution on population mortality in an urbanized valley in the American tropics. *Atmospheric Environment* 224

Aklibasinda M, Ok AO (2019) Determination of the urbanization and changes in open-green spaces in Nevsehir city through remote sensing. *Environmental Monitoring and Assessment* 191

Alexander C (2020) Normalised difference spectral indices and urban land cover as indicators of land surface temperature (LST). *International Journal of Applied Earth Observation and Geoinformation* 86

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Asawa T, Fujiwara K (2020) Estimation of Sensible and Latent Heat Fluxes of an Isolated Tree in Japanese Summer. *Boundary-layer Meteorology* 175 417–440.

Askariyeh MH, Zietsman J, Autenrieth R (2020) Traffic contribution to PM2.5 increment in the near-road environment. *Atmospheric Environment* 224

In this edition is a list of publications that have generally come out between **February and May 2020**. 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,

**Matthias Demuzere**

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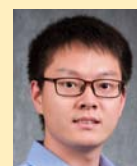
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## Upcoming Conferences...

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.

**BOCHUM URBAN CLIMATE SUMMER SCHOOL: URBAN CLIMATE INFORMATICS, RUHR UNIVERSITY Bochum, Germany** • August 17-21, 2020

<https://www.climate.ruhr-uni-bochum.de/bucss/>

**PLANNING POST CARBON CITIES: 35TH PLEA CONFERENCE ON SUSTAINABLE ARCHITECTURE AND URBAN DESIGN**

A Coruña, Spain • September 1-3, 2020

<https://www.plea2020.org>

**EMS ANNUAL MEETING 2020 SESSION ON "INTERACTIONS OF AIR POLLUTANTS, GREENHOUSE GASES, WEATHER AND CLIMATE FROM LOCAL/URBAN TO GLOBAL SCALES"**

Bratislava, Slovakia • September 7-11, 2020.

<https://meetingorganizer.copernicus.org/EMS2020/session/>

**4TH ICOS SCIENCE CONFERENCE, SESSION ON "URBAN OBSERVATIONS AND DETECTION OF HUMAN EMISSIONS"**

Utrecht, Netherlands • September 15-17, 2020

<https://www.icos-ri.eu/sc2020>

**NOVI SAD NATURE-BASED SOLUTIONS & CLIMATE-SENSITIVE URBAN DESIGN TRAINING SCHOOL**

Novi Sad, Serbia • September 21-25, 2020

<http://clihyd.com/novi-sad-nature-based-solutions-climate-sensitive-urban-design-training-school-2020/>

**AGU FALL MEETING SPECIAL SESSION ON EXTREME WEATHER AND CLIMATE IN URBAN AREAS, THEIR SOCIAL IMPACTS, AND MITIGATION**

San Francisco, USA • December 7-11, 2020

<https://agu.confex.com/agu/fm20/prelim.cgi/Session/101164> (Abstract submission by July 29, 2020)

## Calls for Papers...

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

*Special Issue of Sustainability*

Anthropogenic activities are dramatically impacting the quality of our environment, and this is especially the case in cities. Factors such as the sealing of soil, contamination of water and air, and emission of atmospheric greenhouse gases are combining to make the urban environment less livable. Efforts to better understand these problems have been intensifying within the scientific community, with research focusing on topics related to environmental quality and human health, the urban heat island, outdoor thermal comfort, and urban air quality. These phenomena have been analyzed from the microscale to the city level, using approaches such as field monitoring, remote sensing, and simulation models. Unfortunately, however, these diverse aspects of urbanization are rarely integrated in a systematic way in the actual development process. This *Special Issue* aims to collect works that improve on this knowledge, and enrich our common understanding of how urban design can positively or negatively affect the quality of the urban environment. The focus is on outdoor thermal comfort and air quality, with emphasis placed on studies showing how research can be integrated into the design process and how policies can enhance the environmental effectiveness of concrete urban interventions.

Guest Editors: Luciano Massetti, David Pearlmutter

**Deadline: January 31, 2021**

[https://www.mdpi.com/journal/sustainability/special\\_issues/Urban\\_Microclimate\\_Air\\_Quality](https://www.mdpi.com/journal/sustainability/special_issues/Urban_Microclimate_Air_Quality)

**"APPLICATION OF GIS-BASED MAPPING OF LOCAL CLIMATE ZONES IN URBAN AREAS"**

*Special Issue of ISPRS Intl Journal of Geo-Information*

The concept of local climatic zones (LCZs) has become a widely recognized standard for the description of urban climate sites, gaining substantial attention from scholars worldwide in recent years. The original concept was extended to the mapping of urban and suburban landscapes, resulting in widespread application in urban climate research and beyond. With such a radical shift in the LCZ concept, new problems were identified (e.g. the quality and level of GIS data detail, user accuracy, appropriate resolution, spatio-temporal variability, level of generalization, and standardization of classification). Most popular among authors dealing with LCZ delineation are methods based on widely available remote sensing data. The majority of such studies, however, have reported user accuracy inappropriate for recent urban climate science, demanding exact data for modeling and for application in real urban planning. We therefore have devoted this *Special Issue* to GIS-based methods of LCZ delineation and their application to the development of high-quality LCZ data. Topics of interest include, but are not limited to: Innovative GIS-based LCZ mapping methods; Analyses on producer and user accuracy for GIS-based/other methods; Studies on spatiotemporal variability of thermal exposure in LCZs; Application of LCZ concept in urban areas.

Guest Editors: Michal Lehnert, Jan Geletič, Stevan Savić

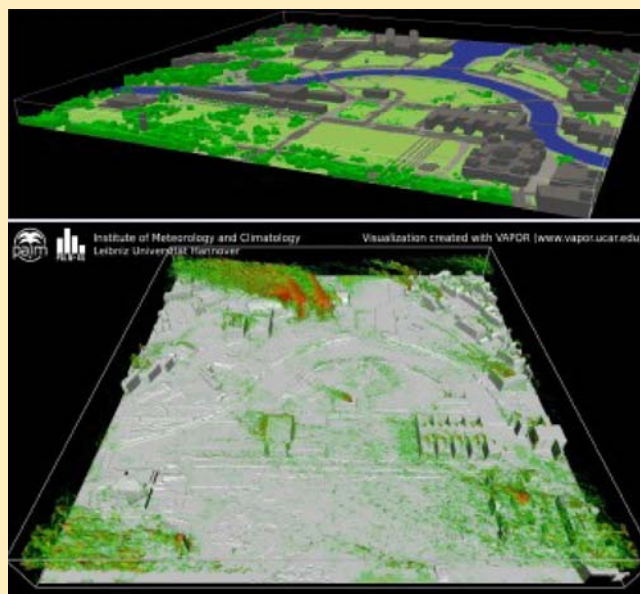
**Deadline: February 28, 2021**

[https://www.mdpi.com/journal/ijgi/special\\_issues/Climate\\_Urban](https://www.mdpi.com/journal/ijgi/special_issues/Climate_Urban)

## ONLINE SEMINAR ANNOUNCEMENT: An Introduction to the PALM model system

The PALM modelling group of the Institute of Meteorology and Climatology at the Leibniz University Hannover, Germany, is offering a 5-day webinar from 21-25 September 2020. The PALM model system has been continuously developed at the Institute of Meteorology and Climatology (IMUK), Leibniz Universität Hannover (LUH), Germany, since 1997. It is used to study micro- and meso-scale turbulent boundary layer flows in the atmosphere and the ocean. PALM includes a number of advanced features like topography, non-cyclic boundary conditions with turbulent inflow, an embedded Lagrangian particle model allowing explicit treatment of cloud droplet physics, a wind turbine model for simulating complete wind parks including wake effects, or an interface for adding user defined code. Recently, the model has been significantly extended in a collaborative effort of several research institutions for urban applications (PALM-4U), which includes explicit treatment of urban surfaces, chemistry, radiation, but also LES-nesting and nesting into larger scale models. Data input and output is in NetCDF format. PALM is optimised for high performance on all kind of state-of-the-art processor architectures and it scales on up to several tens of thousands of processors. PALM is free software and can be redistributed and/or modified under the terms of the GNU General Public License (v3). Download information and a detailed online documentation is available under <http://palm-model.org>.

**What is the seminar about?** The one week seminar gives an overview of PALM, and demonstrates how to carry out runs – on Linux computers provided by the participants. Seminar contents comprise e.g. a general introduction to large-eddy simulation, an overview of PALM's governing equations, applied numerical methods, the various PALM features and application examples. Besides a brief introduction to the PALM installation, the main focus of the seminar is on how to set up PALM simulations, how to run them using the shell scripts provided with PALM, and how to analyse the output. Setups for several standard applications will be explained in detail (e.g. convection, flow around buildings, etc.). Further attention is given to topics like how to extend PALM by user-generated code and how to debug the code. Besides the theoretical lessons which will be provided for download, there will be hands-on sessions, where participants carry out exercises under the online guidance of the lecturers.



*PALM-4U allows detailed resolution of city parts.*

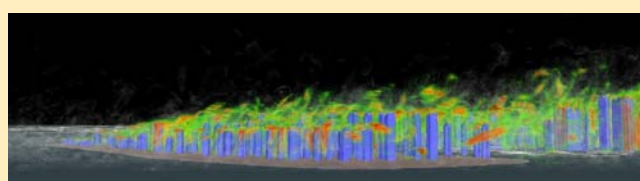
**What are the technical requirements?** The successful software installation can be verified by installing PALM via the provided automatic installer: <https://palm-model.org/trac/wiki/install>. Please check this well in advance.

**What does the seminar cost?** The fee for participants from outside the MOSAIK/UC<sup>2</sup> project will be: € 600 for commercial companies, € 300 for educational/research institutions. This includes tuition, seminar materials and support during the hands-on sessions.

**Who is this seminar meant for?** This seminar is designed for future scientific users of PALM, who have yet little to no prior experience with PALM. A solid background in modelling, particularly CFD-modelling, Fortran 2003, MPI, and Linux/Unix is of advantage.

**Where can I register?** For the registration please fill the registration form: <https://forms.gle/4tQCpHcmW2G82MBx8> at the latest by 16th August 23:59 CEST. Please note that we might close the registration earlier if we reach our maximum participant number of 50. Registered participants will receive more detailed information (method of payment, webinar tools, schedule, etc.) by the end of August 2020.

**Do you have any questions?** Feel free to contact Sebastian Hettrich: [hettrich@muk.uni-hannover.de](mailto:hettrich@muk.uni-hannover.de)



*Simulation of building generated turbulence.*



## ICUC-11 in Sydney Australia: Looking ahead to 2021



Dear IAUC community,

A special meeting of the IAUC Board was held with the conference organisers on the planning for ICUC-11, including ways of managing around COVID-19. We will be consulting with the membership regarding possible options, and will keep members updated as more information becomes available.

Key developments regarding the conference will also be included on the conference website – <https://conference.unsw.edu.au/en/icuc11>. This will be continually updated as we progress towards the conference.

### Important Dates

*Opening of Abstract Submission:* Aug 17, 2020

*Deadline for Abstract Submission:* Nov 15, 2020

*Acceptance of Abstract:* Jan 25, 2021

*Optional full paper/supplementary materials:* Mar 30, 2021

*Conference:* Aug 30 - Sep 3, 2021

**Contact for ICUC Co-chairs, Negin and Melissa:**

[n.nazarian@unsw.edu.au](mailto:n.nazarian@unsw.edu.au)

Best wishes from the IAUC Board!

### IAUC Board Members & Terms

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- **Secretary:** Andreas Christen (Albert-Ludwigs Universität Freiburg, Germany), 2018-2022.
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### Urban Climate News – The Quarterly Newsletter of the International Association for Urban Climate



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The next edition of *Urban Climate News* will appear in late September. Contributions for the upcoming issue are welcome, and should be submitted by August 31, 2020 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.

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