

From the IAUC President

Colleagues:

Welcome to the 56th edition of the *Urban Climate News*. This is the last edition before the upcoming [ICUC-9 in Toulouse](#) and includes a special feature article, two project reviews and a special review by our editor David Pearlmutter that covers the past 18 months.

I am very pleased to announce that the 2014 winner of the Luke Howard Award is **Manabu Kanda** of the Tokyo Institute of Technology. The Luke Howard Award recognizes outstanding contributions to the field of urban climatology in a combination of research, teaching, and/or service to the international community of urban climatologists. Prof. Kanda's citation reads: "For his innovative and important experimental urban field studies, measurement techniques and efforts that have provided fundamental insights linking complex fluid flows between physical elements representing morphology structures and numerical scale-dependent model simulations including LES and urban canopy parameterizations, and for his active leadership and service to the urban community." A full description of [Prof. Kanda's achievements](#) is contained in this edition of the newsletter. On behalf of all IAUC members, I would like to congratulate Prof. Kanda on this well-deserved award.

Over the past couple of years, the IAUC has been working to develop a better website, an initiative launched by Gerald Mills when he was President. We have recently completed a migration of the web functions to a new server; thanks are due to Dale Cunningham, Julia Hidalgo and David Podeur for their help in providing a smooth transition. The new server will better support the urban bibliography, our archive of newsletters, ICUC proceedings, and our teaching materials. It also provides an opportunity for us to expand our content and include more types of content that can benefit our members. The web site affords members the opportunity to join discussion groups based upon areas of interest identified during the registration process. Going forward, we plan to consolidate the membership

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and email list functions through our webpage. So I would like to take this opportunity to encourage all IAUC members to create an account via our website at www.urban-climate.org. If you encounter difficulties in this process please let me know.

As I write this column, final preparations are underway for the joint [ICUC-9/UE12 in Toulouse](#). There are 520 registered participants scheduled to give 371 oral and 327 poster presentations, reflecting sustained strong interest in our field. The WMO, an

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– James Voogt,
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Pope Francis to Urban Planners: Build Better Cities

June 2015 — Pope Francis called for an extraordinary global response to climate change this week in his [much-anticipated encyclical](#). But the first pope from the developing world also has a message for urban planners: Build better neighborhoods for the poor. And while you're at it, find a way to integrate the natural world in city design. "We were not meant to be inundated by cement, asphalt, glass and metal, and deprived of physical contact with nature," he [writes](#) in *Laudato Si*. It's subtitled "Our Care for Our Common Home."

Cities have become unhealthy places for human beings — not only because of toxic emissions, but also because of poor transportation, visual pollution, congestion, social exclusion, violence, noise and even "the loss of identity." And inequality looms over it all.

"In some places, rural and urban alike, the privatization of certain spaces has restricted people's access to places of particular beauty," Francis writes. "In others, 'ecological' neighbourhoods have been created which are closed to outsiders in order to ensure an artificial tranquillity. Frequently, we find beautiful and carefully manicured green spaces in so-called 'safer' areas of cities, but not in the more hidden areas where the disposable of society live."

Call this the B-side of the groundbreaking treatise that has aligned the leader of the Roman Catholic Church with mainstream science. The pope's urban planning analysis is a thoughtful take on the interconnectedness of the natural and built environments. His theme? The choices we make in cultivating the places we live in have consequences for human behavior. Francis specifically urges "those who design buildings, neighbourhoods, public spaces and cities" to go beyond their planning niches and "draw on the various disciplines which help us to understand people's thought processes, symbolic language and ways of acting. It is not enough to seek the beauty of design."

That is, our plans and projects must also serve the quality of life of others, contributing to a culture of encounter and mutual assistance. At every step, it's crucial that "urban planning always take into consideration the views of those who will live in these areas."

Historic preservation is also on Francis' radar. The man whose residence is adjacent to St. Peter's Basilica, which opened in 1626, recognizes the need to protect the "common areas, visual landmarks and urban landscapes" that increase "our sense of belonging, of rootedness, of 'feeling at home' within a city which includes us and brings us together." That sense of community is essential. Preservation of structures and spaces for their own sake is irrelevant; rather, preservation efforts should be tailored to the public good, and should be accessible to all. When



Activists celebrate Pope Francis' encyclical on climate change in Manila, Philippines. Source: [NextCity.org](#)

they are well integrated into the landscape, residents of the city will feel a deepened sense of the whole. When they are not well integrated, they contribute to isolation and separateness.

"Interventions which affect the urban or rural landscape should take into account how various elements combine to form a whole which is perceived by its inhabitants as a coherent and meaningful framework for their lives," Francis writes. "Others will then no longer be seen as strangers, but as part of a 'we' which all of us are working to create. For this same reason, in both urban and rural settings, it is helpful to set aside some places which can be preserved and protected from constant changes brought by human intervention."

Housing, too, is a concern for Francis. He notes that state budgets cover only a tiny portion of the demand for housing across social classes, which cuts right at the heart of the human dignity that he champions throughout the encyclical.

"In some places, where makeshift shanty towns have sprung up, this will mean developing those neighbourhoods rather than razing or displacing them," he writes. "When the poor live in unsanitary slums or in dangerous tenements, 'in cases where it is necessary to relocate them, in order not to heap suffering upon suffering, adequate information needs to be given beforehand, with choices of decent housing offered, and the people directly involved must be part of the process.'" (He's quoting from the 2004 Compendium of the Social Doctrine of the Church.)

When Francis turns his attention to transit, there is perhaps unintentional humor in his understatement. "The quality of life in cities has much to do with systems of transport, which are often a source of much suffering

for those who use them.” Driving culture is a major polluter, and the building of roads and parking lots spoils the urban landscape. But directing everyone to get on the buses and trains is no easy solution either. Public transit, he writes, needs to be make marked improvements if they are going to win over the majority. Crowding, inconvenience, infrequent service, and lack of safety are the particular gripes of Francis, who has been seen numerous times taking public transit.

Collectively, the encyclical affirms how important it is to make the *moral case* for city design. Whether he is discussing the need for improved utilities in rural areas or the value of beauty in architecture, Pope Francis connects it all back to the web of life. “Our insistence that each human being is an image of God should not make us overlook the fact that each creature has its own purpose. None is superfluous,” he writes.

Our civic spaces are intensely personal, shaping the terrain of our lives and our memories. They influence how we think, feel, act and express our identity. “We make

every effort to adapt to our environment, but when it is disorderly, chaotic or saturated with noise and ugliness, such overstimulation makes it difficult to find ourselves integrated and happy,” he writes. On the other hand, if our built environments are well designed – equitable, serviceable, historic, coherent and integrated with the natural world – they make it possible to “recover something of our true selves.”

Too often, developers, urban planners and city leaders seem to think that it is obvious or implied why the decisions they make are in the best interest of the public. But there is no shortcut to articulating why our planning choices speak to the fundamental *human dignity* of the communities we’re working in. Indeed, *Laudato Si* is a powerful template for how to do just that. And if, even with that model on hand, we can’t articulate the moral case for what we are doing – consider that a major red flag. — Anna Clark

Source: <http://nextcity.org/daily/entry/pope-message-urban-planners-cities-encyclical>

Heat Wave Picking Off Pakistan’s Urban Poor

June 2015 — Over 950 people have perished in just five days. The morgues, already filled to capacity, are piling up with bodies, and in over-crowded hospitals the threat of further deaths hangs in the air.

Pakistan’s port city of Karachi, home to over 23 million people, is gasping in the grip of a dreadful heat wave, the worst the country has experienced since the 1950s, according to the Meteorology Department.

Temperatures rose to 44.8 degrees Celsius on Saturday, Jun. 20, dropped slightly the following day and then shot back up to 45 degrees on Tuesday, Jun. 23 putting millions in this mega-city at risk of heat stroke.

Though the entire southern Sindh Province is affected – recording 1,100 deaths in total – its capital city, Karachi, has been worst hit – particularly due to the ‘urban heat island’ phenomenon, which climatologists say make 45-degree temperatures feel like 50-degree heat.

In this scenario, heat becomes trapped, turning the city into a kind of slow-cooking oven. Every single resident is feeling the heat, but the majority of those who have succumbed to it come from Karachi’s army of poor, twice cursed by a lack of access to electricity and condemned to live in crowded, informal settlements that offer little respite from the scorching sun.

Already crushed by dismal health indicators, the poor have scant means of avoiding sun exposure, which intensifies their vulnerability. Anwar Kazmi, spokesperson for the Edhi Foundation, Pakistan’s biggest charity, tells IPS that 50 percent of the dead were picked up from the streets, and likely included beggars, drug users and daily

wage labourers with no choice but to defy government advisories to stay indoors until the blaze has passed.

Two days into the crisis, with every free space occupied and corpses arriving by the hundreds, the city’s largest morgue, run by the same charity, began burying bodies that had not been claimed. “In all my 25 years of service, I’ve never seen so many dead bodies arriving in such a short time,” Mohammad Bilal, who heads the Edhi Foundation’s mortuary, tells IPS.

The government has come under fire for neglecting to sound the alarm in advance. Prime Minister Nawaz Sharif and Sindh Chief Minister Syed Qaim Ali Shah issued belated warnings by ordering the closure of schools and government offices. Hospitals, meanwhile, are groaning under the strain of attempting to treat some 40,000 people across the province suffering from heat exhaustion and dehydration.

Saeed Quraishy, medical superintendent at Karachi’s largest government-run Civil Hospital, says they have stopped all elective admissions in order to focus solely on emergencies cases. Experts say this highlights, yet again, the country’s utter lack of preparedness for climate-related tragedies. And as always – as with droughts, floods or any other extreme weather events – the poor are the first to die off in droves.

The crisis is shedding light on several converging issues with which Pakistan has been grappling: energy shortages, the disproportionate impact of climate change on the poor and the fallout from rapid urbanisation. In Karachi, the country’s most populous metropolis, these problems

are magnified manifold.

Though a census has not been carried out since 1998, NGOs say there are hundreds of millions who live and work on the streets, including beggars, hawkers and manual labourers.

More than 62 percent of the population here lives in informal settlements, with a density of nearly 6,000 people per square kilometre. Many of them have no access to basic services like water and electricity, both crucial during times of extreme weather. The 'kunda' system, in which power is illegally tapped from the electrical mains, is a popular way around the 'energy apartheid'.

Just this month, the city's power utility company pulled down 1,500 such illicit 'connections'. But even the 46 percent of households across the country that are connected to the national electric grid are not guaranteed an uninterrupted supply. With Pakistan facing a daily energy shortage of close to 4,000 mega watts, power outages of up to 20 hours a day are not unusual.

At such moments, wealthier families can fall back on generators. But for the estimated 91 million people in the country who live on less than two dollars a day, there is no 'Plan B' – there is only a battle for survival, which too many in the last week have fought and lost.

For the bottom half of Pakistani society, official notifications on how to beat the heat are simply in one ear and out the other. Taking lukewarm showers, using rehydration salts or staying indoors are not options for families eking out a living on 1.25 dollars or those who live in informal settlements where hundreds of households must share a single tap.

Lashing out at the government's indifference and belated response to the crisis, Dr. Tasneem Ahsan, former executive director of the Jinnah Postgraduate Medical Centre (JPMC), tells IPS that preventive action could have saved countless lives.

"The government should have taken up large spaces like marriage halls and schools and turned them into shelters, supplying electricity and water for people to come and cool down there."

She also says officials could have parked water bowsers in poorer localities for people to douse themselves, advised the population on appropriate clothing and distributed leaflets on simple ways to keep cool.

The media, too, are at fault, she contends, for reporting the death count like sports scores instead of spreading the word on cost-effective, life-saving tips "like putting a wet towel on the head".

Intermittent protests against power outages, aimed largely at the city's main power company, K-Electric, served as a prelude to the present tragedy.

Though the country has an installed electricity capacity of 22,797 MW, production stands at a dismal 16,000 MW. In recent years, electricity demand has risen to



Children from informal settlements in Karachi are often sent with large containers to fetch water donated by wealthier residents. Source: www.ipsnews.net

19,000 MW, meaning scores of people are either sharing a single power line or going without energy.

Meanwhile, civil society has been stepping in to fill the void left by the government, with far better results than some official attempts to provide emergency relief.

With most hospitals paralyzed by the number of patients, volunteers like Dr. Tasneem Butt, working the JPMC, have taken matters into their own hands. Using social media as a platform, she has circulated a list of necessary items including 100-200 bed sheets, 500 towels, bottled water, 15-20 slabs of ice and – perhaps most importantly – more volunteers.

"I got them immediately," she tells IPS. "Now I've asked people to hold on to their pledges while I arrange for chillers and air-conditioners.

"The emergency ward is suffocating," she adds. "It's not just the patients who need to be kept cool, even the overworked doctors need this basic environment to be able to work optimally."

Last week, the government of the Sindh Province cancelled leave for medical personnel and brought in additional staff to cope with the deluge of patients, which is expected to increase as devout observers of the Holy Ramadan fast succumb to fatigue and hunger.

The monsoon rains are still some days away, and until they arrive there is no telling how many more people will be moved from the streets into graves.

Interestingly, while other parts of the province have recorded higher temperatures, the deaths have occurred largely in Karachi due to urban congestion and overcrowding, experts say, with the majority of deaths reported in poor localities like Lyari, Malir and Korangi.

The end may be in sight for now, but as climate change becomes more extreme, incidents like these are only going to increase in magnitude and frequency, according to climatologists like Dr. Qamar-Uz-Zaman Chaudhry.

Source: <http://www.ipsnews.net/2015/06/heat-wave-picking-off-pakistans-urban-poor/>

Asia's Booming Cities Most At Risk from Climate Change

May 2015 — Bangkok, Dhaka, Guangzhou, Ho Chi Minh City, Kolkata, Manila, Mumbai, Shanghai, and Yangon have one thing in common. These low-lying or coastal cities are all highly vulnerable to rising sea levels, floods, and other impacts of climate change. Major urban areas in the Pacific are at higher risk still. However, even inland cities in the region could be suddenly devastated by sudden extreme weather events like typhoons, or suffer rising temperatures and increasingly uncertain weather that damages infrastructure and livelihoods.

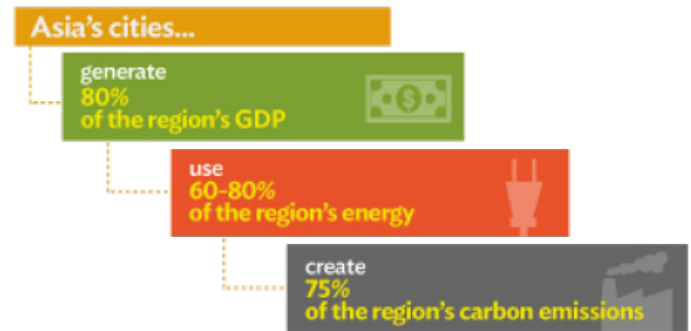
Cities are the centers of economic growth in Asia and the Pacific, generating 80% of gross domestic product in most countries. Approximately 1.2 billion Asians will move to cities over the next 35 years requiring the construction of swathes of new homes, roads, and water and electricity networks. City leaders need to make sure existing and future infrastructure can cope with increasingly frequent disasters like Typhoon Ketsana, which killed hundreds and caused an estimated \$100 million in damage in the Philippines in 2009, or Cyclone Pam in March 2015, which flattened 90% of houses and destroyed critical water and food supplies in Vanuatu's capital Port Vila and beyond.

Cities also need to be prepared for the sustained year in, year out, stress from climate change. This means installing sanitation infrastructure that is able to cope with higher-than-anticipated rainfall, water systems that work even during droughts, electricity pylons that can withstand high winds, and roads that don't crack during heatwaves.

"Climate proofing is crucial. All of the Asian Development Bank's projects are assessed for climate risk, and ADB is also working toward integrating management of disaster risks while building bridges, power plants, or other infrastructure," said Preety Bhandari, who heads ADB's Climate Change and Disaster Risk Management Unit.

In 2014, ADB approved \$1.97 billion in financing for 22 urban development projects, taking total urban lending to just over \$24 billion. But city planners must also consider how all these systems interact so one vulnerability won't undermine the rest of the urban network. For example, climate-proofing a school is pointless if roads to it are impassable. This is a key goal for ADB in Bangladesh, for example, where a 1.5-degree Celsius increase in temperature and 4% increase in precipitation are forecast to cause the sea level in the Bay of Bengal to rise by 27 centimeters or more by 2050.

The \$52 million Coastal Towns Environmental Infrastructure Project is financing climate-resilient municipal infrastructure, such as drainage, water supply and sanitation systems in eight vulnerable coastal secondary



The battle against climate change is likely to be won or lost in Asia's expanding megacities. Asian cities are poised to contribute more than half the rise in global greenhouse gas emissions over the next 20 years if no action is taken. Source: [Asian Development Bank](#)

cities. The project ensures local urban planning authorities take into account the impacts of climate change and natural disasters.

At the same time, cities need to become part of the climate change solution. Asia's cities already consume 80% of the region's energy and create 75% of its carbon emissions. Asian cities are poised to contribute more than half the rise in global greenhouse gas emissions over the next 20 years if no action is taken. Making cities resilient also means making them less energy-intensive through more and better public transport, energy-efficient buildings, and greater use of renewable energy.

Lanzhou, the capital of Gansu Province in the People's Republic of China, opted to build a bus rapid transit system rather than more roads, slashing the city's carbon dioxide emissions. ADB is also helping support a similar system in Peshawar and Karachi in Pakistan, and a mass rail transit system in Viet Nam's increasingly congested and polluted Ho Chi Minh City.

ADB's Urban Operational Plan for 2012-2020 underlines the critical need to ensure that cities are inclusive economic powerhouses while mitigating and adapting to the effects of climate change. More than half of the world's slum dwellers - an estimated 522.6 million people in mid-2012 - live in Asia, and if nothing is done that figure may rise to 1 billion by 2050.

"The poorest communities in cities often live in the most vulnerable, least safe neighborhoods in low-lying areas on coasts or riverbanks so homes, services, and livelihoods of those families are hit hardest by climate change-related events," said Vijay Padmanabhan, technical advisor on water and urban issues at ADB. Making cities more resilient to climate change benefits everyone: those living in the cities, businesses, and - given Asia's growing economic clout - the rest of the world too. Source: <http://www.adb.org/news/features/asias-booming-cities-most-risk-climate-change>

Climate change threatens to undermine the last half century of health gains

June 2015 — The threat to human health from climate change is so great that it could undermine the last fifty years of gains in development and global health, according to a major new Commission, published in *The Lancet*.

However, the report provides comprehensive new evidence showing that because responses to mitigate and adapt to climate change have direct and indirect health benefits -- from reducing air pollution to improving diet -- concerted global efforts to tackle climate change actually represent one of the greatest opportunities to improve global health this century.

The potentially catastrophic risk to human health posed by climate change has been underestimated, say the authors, and while the technologies and finance required to address the problem can be made available, global political will to implement them is lacking.

According to Commission co-Chair Professor Anthony Costello, Director of the University College London (UCL) Institute for Global Health, UK, "Climate change has the potential to reverse the health gains from economic development that have been made in recent decades -- not just through the direct effects on health from a changing and more unstable climate, but through indirect means such as increased migration and reduced social stability. However, our analysis clearly shows that by tackling climate change, we can also benefit health, and tackling climate change in fact represents one of the greatest opportunities to benefit human health for generations to come."

The report shows that the direct health impacts of climate change come from the increasing frequency and intensity of extreme weather events, especially heat waves, floods, droughts and storms. Indirect impacts come from changes in infectious disease patterns, air pollution, food insecurity and malnutrition, involuntary migration, displacement and conflicts.

"Climate Change is a medical emergency," says Commission co-Chair Professor Hugh Montgomery, director of the UCL Institute for Human Health and Performance. "It thus demands an emergency response, using the technologies available right now. Under such circumstances, no doctor would consider a series of annual case discussions and aspirations adequate, yet this is exactly how the global response to climate change is proceeding."

There are numerous ways in which action on climate change brings immediate health gains -- burning less fossil fuel reduces respiratory diseases, and active transport (walking and cycling) cut pollution and road traffic accidents, and reduces rates of obesity, diabetes, coronary heart disease and stroke. There are also health benefits from changes to diet which might arise from a concerted effort to tackle climate change, like eating less red meat.



Climate change is a medical emergency, according to medical experts. Source: [ScienceDaily](http://www.sciencedaily.com)

The commission concludes that a strong international consensus is essential to move the world to a global low-carbon economy, harnessing a crucial opportunity to protect human health, particularly of the poorest and most vulnerable populations, who stand to be hardest hit by the effects of climate change.

Commission co-Chair Professor Peng Gong, from Tsinghua University, Beijing, China, says "The health community has responded to many grave threats to health in the past. It took on entrenched interests such as the tobacco industry, and led the fight against HIV/AIDS. Now is the time for us to lead the way in responding to another great threat to human and environmental health of our generation."

In addition to presenting a detailed analysis of the impact of climate change on human health and wider social and economic structures, the report also provides a clear set of recommendations for policy makers to enable an effective response to climate change that protects and promote human health.

The Commission represents a major new collaboration between European and Chinese climate scientists and geographers, social and environmental scientists, biodiversity experts, engineers and energy policy experts, economists, political scientists and public policy experts, and health professionals.

As a result of the Commission's work, the authors propose the formation of a new global independent body on climate change and health ('Countdown to 2030: Climate Change and Health Action'). This global coalition will monitor and report every two years on the health impacts of climate change, progress in mitigation policies and their interaction with health, and progress with broader actions to reduce population vulnerability, to build climate resilience, and to implement low carbon, sustainable health systems. Source: <http://www.sciencedaily.com/releases/2015/06/150623072912.htm>

Climate Hope City: how Minecraft can tell the story of climate change

June 2015 — On the rooftops, there are endless lush gardens, so that the skyline of the city looks almost like the tree tops of a vast rain forest. Beneath them, lining the roads, are multi-storey farms, producing fruit and vegetables for the local populace. There are strange sail-shaped constructions that suck CO₂ out of the air, and along the canals, hydrogen powered boats glide silently through crystal clear waters. This is Climate Hope City – and for now, it exists only in [Minecraft](#).

When the Guardian launched its [Keep it in the Ground](#) campaign in March, editor-in-chief Alan Rusbridger, and other senior staff, spoke about the challenge of finding new ways to discuss and report on climate change – to break out of traditional journalism and explore fresh ideas. “We carry on flogging a load of dead horses, in exactly the same way, with exactly the same whip,” wrote columnist and environmentalist George Monbiot. “We have to constantly be reinventing our storytelling capacity.”

One answer to that challenge is to envisage a future zero carbon city in Minecraft. The hugely successful block-building game allows players to construct complex and fascinating models of everything from medieval castles to giant space cruisers. Climate Hope City is not a fantasy world but a vision of a green urban environment which uses technologies that either already exist around the world or are at the prototype stage.

The project was overseen by expert Minecraft modeller Adam Clarke, who makes his own YouTube videos about the game, as Wizard Keen. Clarke recently worked with the Tate Modern gallery to produce the Tate Worlds project, a series of Minecraft maps based around art works such as André Derain’s *The Pool of London*. Recently, he has started *Wonder Quest*, a new educational series of YouTube videos co-written with Minecraft superstar Stampy Cat.

Together with James Delaney and his BlockworksMC team of builders, as well as experienced map maker and designer Dragnoz, Clarke took various real-life urban climate technologies and spent a week constructing them into a Minecraft environment. Features include vertical farms, kinetic pavements that convert footsteps into electricity, driverless cars and green roofs.

“James and his team had recently built a Minecraft map called [Tomorrowland](#),” says Clarke. “We wanted Climate Hope City to feel positive and futuristic yet at the same time rooted in what is going on in architecture and climate change science today. Our research led us to the very latest in building design, featuring radical shapes and forms.

“We also wanted to see some older buildings so that the city felt realistic and built upon. We added the spiral walkway to help players explore the various features as quickly as possible, but its also became a very beautiful design motif too.”

Delaney and his team of five builders, started out by sketching a rough layout, based on emerging technologies and architectural models, before spending over 100



Climate Hope City – a vision of a clean and sustainable urban environment, built in Minecraft and ready to explore. Source: [The Guardian](#)

hours building the model itself. “We needed to use existing green technologies and prototypes to create a positive image for sustainable living, which also seemed achievable and not too far off reality,” says Delaney.

“We decided to form the city around natural looking curves and spirals rather than the grid layout of many of the world’s modern cities: Zaha Hadid’s architecture was one inspiration, the new biodome concept for Amazon’s new Seattle headquarters was another. We then proceeded to lay it out in Minecraft and slowly build upwards, adapting and accommodating that plan to the city as it developed.”

The result is a rather beautiful and elegant Minecraft city, filled with intriguing buildings, and criss-crossed with canals and kinetic walkways. Guardian readers will also be able to spot the newspaper’s own office.

The map is now ready to download and is available for free to anyone who has the PC, Linux or Mac version of Minecraft installed on their computer. It can be found at the [Climate Hope City Planet Minecraft](#) page. You can freely explore the city, read signposts and listen to audio recordings that tell you more about what each building and feature represents.

“Despite climate change being the biggest story of our age, journalism has largely failed to get to grips with it,” says the Guardian’s assistant national news editor, James Randerson. “In our mission to tell this story differently and reach new audiences, we have enlisted the help of artists, poets, comedians and composers to name a few. Now we’re harnessing the creativity of some talented Minecraft designers to imagine a future low carbon city – and crucially one that is not far out of reach.”

The Guardian’s [Keep it in the Ground](#) campaign is highlighting the global fossil fuel divestment movement. In particular it is calling on the world’s two largest health charities – the Bill and Melinda Gates Foundation and the Wellcome Trust – to move their endowments out of those firms. Source: <http://www.theguardian.com/environment/keep-it-in-the-ground-blog/2015/jun/12/climate-hope-city-how-minecraft-can-tell-the-story-of-climate-change>

A Review of Urban Climate Research in Curitiba, Brazil



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This review presents a summary of research in urban climate over the past decade and since the first reported studies in the field for Curitiba, Brazil. The city is located just south of the Tropic of Capricorn and has a long tradition in Brazilian urban planning. Due to an increasing urban expansion in the last decades, quality of life within the urban area has been decaying; among other aspects, also in terms of the thermodynamic subsystem, which includes the development of Urban Heat Islands (UHIs). The integration of research outcomes and the development of the urban climate field in a more cohesive way could allow researchers to provide guidance for climate-responsive urban design, with consequential life-quality improvements in this location.

Introduction

Curitiba (25.5°S, 49°W, 910 a.m.s.l.) is located in a tropical climate zone in a relatively high-altitude region of Brazil, and is classified as a Cfb climatic type according to Koeppen-Geiger's climate classification. For Brazilian standards its climate is quite peculiar, and as the capital of the state of Paraná, it is the coldest capital city in Brazil – with frequent night-frost episodes in winter and more clearly defined seasons than in most parts of the country. Other relevant features of this location include its

long history of urban planning, and an increasing urban expansion in the last decades, which brought several consequences for quality-of-life within the urban area. Figures 1a and 1b show aerial images of the urban area in the time frames of 1984 and 2002, respectively, with a noticeable growth occurring within this relatively short period.

Urban growth in Brazil (past and present trends) has been suggested to be directly responsible for a decrease in life-quality in cities, which within a few



Figure 1. Landsat satellite imagery: urban area of Curitiba in (a) 1984 and (b) 2012.

Source: <https://earthengine.google.org> (accessed May 2015)

decades have seen their population increase three- or four-fold – and Curitiba is no exception. With its process of rapid urbanization starting in the 1950s, Curitiba has seen its population triple over the last four decades (1970-2010). Figure 2 shows the historical timeline of the local population growth between 1900 and 2010, in 20-year time increments.

Such urbanization was mostly due to migratory movements; as the economy of the state Paraná was traditionally based on agriculture, migration took place towards the state's capital with the mechanization of agricultural processes and with the expansion of the industrial sector in the city alongside the creation of the sector called "Cidade Industrial de Curitiba". In the 1990s, as a result of successful urban planning projects along with equally successful city marketing campaigns, many newcomers came seeking a higher quality of life, many of them leaving behind Brazilian megacities such as Rio de Janeiro and São Paulo, which had also experienced the negative consequences of unplanned urbanization.

In the metropolitan area, densification occurs vertically as well as horizontally (by reducing spacing between buildings and by increasing 'compactness', according to different definitions of urban density; Steemers 2003), with widespread construction of gated condominiums. In some parts of the city, the spatial configuration is characterized by urban canyons along the so-called "Structural

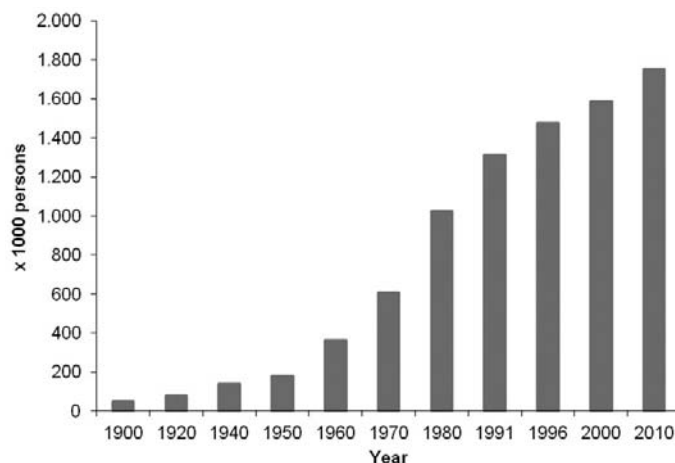


Figure 2. Growth of local population in Curitiba, Brazil
Source: Adapted from IPPUC (2015a)

Sectors" (as shown in Figure 3), which have a pronounced impact on the urban landscape: in such axes, dwellers are faced with challenges including thermal discomfort, lack of daylight, and changes in ventilation patterns leading to possible effects on air quality (Danni-Oliveira 1999; Danni-Oliveira 2002; Krüger and Suga 2009; Krüger, Minella and Rasia 2011; Guimarães 2011).

This review has the purpose of summarizing the climate-related research that has been done in Curitiba over the years, and offering future perspectives for actions and continuing investigations in the fields of climate-responsive urban design, urban climate and outdoor thermal comfort. Although local climatic conditions are not representative of the

larger Brazilian territory – less than 1% of the country is classified as belonging to the same bioclimatic zone (ABNT, 2005) – the lessons from Curitiba can be applicable to similar latitude and altitude ranges, affecting thus a number of cities in developing countries with akin climatic challenges.

Method

A search for research output as Master's and Doctoral theses was performed in freely available databases (Scopus, Google Scholar, Banco de Teses CAPES <http://bancodeteses.capes.gov.br/>, Biblioteca Digital de Teses e Dissertações - SiBi/UFPR www.portal.ufpr.br/teses_acervo.html, Repositório Digital da UTFPR <http://repositorio.utfpr.edu.br/>).



Figure 3: Densification along the Structural Axis. Source: IPPUC (2015b)

Urban climate research in Curitiba

A great part of the studies on urban climate conducted in Brazil are based on the systematization of the field by the Brazilian geographer C. A. F. Monteiro (1976) with his SCU (*Sistema Clima Urbano*) approach for guiding research on urban climate. Based on Monteiro's method, Urban Climate Systems can be subdivided into three subsystems: thermodynamic, hydro-meteorological and physiochemical. Each of these subsystems will have an impact on urban environmental quality and should therefore be handled in a systemic way by means of appropriate and climate-responsive urban planning strategies. The focus of this paper is on the thermal impacts (thermodynamic subsystem) of urbanization in a subtropical location, although one must also recognize the severe consequences for the local economy and quality of life arising from disturbances in the hydro-meteorological subsystem, e.g. increases in flooding episodes. The thermodynamic subsystem, according to Monteiro (1976), is linked to the perceptual channel "thermal comfort", which includes the determination and mapping of Urban Heat Islands (UHIs).

Search results yielded a total of 8 Master's theses and 7 Doctoral theses presented on the subject from 2004 onwards, all related to Monteiro's thermodynamic subsystem. A primary focus of these efforts is to quantify the inter- and intra-urban temperature variations in Greater Curitiba.

Rossi (2004) quantified intra-urban air temperature differences by means of simultaneous monitoring with data loggers. The study started out by updating Curitiba's test reference year (TRY), since the [TRY available](#) at that time was based on a climate database from the 1960s. Results of this update showed a small increase in air temperatures over the period, with a corresponding reduction of cold thermal stress throughout the year. For the field study, measuring instruments were positioned at a common reference height adjacent to a standard building (public library) located in each of a number of different neighborhoods across the city, and monitoring took place simultaneously at the different locations during winter. By determining land use attributes of the 14 different monitoring sites from aerial photographs, which were classified according to pervious and impervious, vegetated areas, water bodies and built up areas from aerial images, correlations were drawn with local air temperatures and their differences relative to those measured at an official meteorological station. Results showed that in some instances observed patterns conformed to what would

be expected from the literature review, but that the correlations between land use and local air temperature were generally weak (Krüger and Givoni 2007).

A follow-up study by Lima (2005) had the purpose of analyzing the relationship between energy demand for air-conditioning and urban form. Height and albedo parameters were added to the database gathered during Rossi's study and the analysis was thus expanded. In addition, computer simulations as well as predictive formulas were used for assessing energy consumption in three low-cost houses for the different sites across the urban area. The simulations were calibrated using actual monitored data gathered in a previous field study (Dumke 2002). The three low-cost houses evaluated in Lima's study presented different building attributes in terms of U-value and thermal mass, as follows: 1) a wood-based building; 2) a conventional building with unplastered walls, built with ceramic bricks; and 3) a dwelling built with an alternative building material based on soil-cement blocks. Special care was given to the overall atmospheric conditions considered for such estimations, from synoptic reports. From predictions of the indoor conditions in the low-cost houses for the various sites, percent changes in heating energy demand due to a virtual relocation of the building ranged considerably. More detailed computer simulations performed for the wood-based building system, which had exhibited the greatest variation in heating demand due to relocation, showed a 40% change rate in heating alone as a result of urban morphology.

Blanchet (2004) used mobile transects, consisting of air temperature and humidity sensors attached to a vehicle, to analyze the relationships between thermal fields and land use attributes in a particular neighborhood (Bairro Bigorriho) at three time steps (9am, 3pm, 9pm). Altogether 13 monitoring points were monitored in the time frame of one hour around the official WMO time stamps, along three transects in summer and in winter, and were compared to a reference station. A thermal comfort index known as the "Building Bioclimatic Chart" (Givoni, 1992) was also used for integrating measured variables. The characterization of each monitoring point according to aspects such as land use, density and vegetation was based on a combination of in situ observations, official urban planning data and aerial images, so that a quantification was made possible. Among the conclusions was that vegetation is directly linked to local air temperature changes.

Pertschi (2005) investigated the relationship between local urban design attributes and air tempera-

ture/urban heat island effects in São José dos Pinhais, a municipality which is part of the Metropolitan Region of Curitiba. This study employed fixed monitoring stations and land use classification (as in Rossi's 2004 study), but focused on a summer period in 2005. Again Monteiro's SCU approach was used, and the thermodynamic subsystem was evaluated. The mobile transect method was also employed, with air temperature measurements being sampled across different monitoring sites. Taking into account also the background atmospheric changes throughout the monitored period, correlations were drawn between urban design attributes and local air temperature. The weak correlations found were attributed to divergences between aerial images and the sites' roughness-related 3D features not captured from the overhead view, and also to limitations of the statistical analysis used.

A study by Young (2005) at the State University of Campinas in São Paulo also focused on Curitiba, with the aim of studying the relationship between vegetation and thermal changes over time, both expressed as relative indices (vegetation fraction versus local temperature). The study was carried out by means of remote sensing from Landsat satellite imagery. Three major areas of Curitiba were grouped according to vegetation profiles, and each area was evaluated at three time steps (1986, 1999 and 2002) in terms of changes in land use, population patterns and local thermal patterns. It was possible to verify the importance of the size and distribution of vegetated areas and that changes in landscape design can lead to microclimate changes.

Dumke (2007) investigated the social-spatial inequalities within Curitiba's Urban Agglomerate and their relation to local climatic features. The scope of this doctoral thesis goes beyond the analysis of physically measurable variables by also taking into account the vulnerability and quality of life of the low income population, which generally lives in the peripheral areas of the city. By means of thermal imagery and in situ monitoring of air temperature and humidity at 16 locations across the urban area, it was concluded that the population living in the outskirts of the urban center suffers from lower temperatures and higher daily swings in winter. Considering that in the southern part of Brazil low-cost houses are generally not (well) insulated, this finding suggests that such dwellers suffer from thermal discomfort in winter. Common to three studies (by Rossi, Lima and Dumke) was an emphasis on cold conditions, as Curitiba's winter season presents more challenges to building and city planners than its

relatively mild summers.

Barbosa (2008) analyzed the direct impact of vegetation on microclimate and indirect impacts on indoor conditions in low-cost dwellings situated adjacent to a green corridor in Curitiba. Mobile transects were employed for the investigation, which compared four pairs of single-family low-cost dwellings (of similar construction and building materials) either with or without adjacent trees and grass surfaces, monitored during late autumn (May-June). Interestingly, as an attribute of the urban design, the implementation or the preservation of vegetated areas was responsible for a slight reduction of the indoor daily air temperature swing, a factor responsible for indoor thermal comfort. The mobile transects carried out under different clear-sky conditions during five distinct days showed some reductions in air temperature (though not fully consistent), and improved comfort conditions due to the presence of vegetation.

With the aim of analyzing the microclimatic effect and consequences to outdoor thermal comfort of another urban design attribute, the sky view factor (SVF – Johnson and Watson, 1984), Minella (2009) carried out measurements in the main pedestrian street of Curitiba (Rua XV de Novembro) with a pair of weather stations, simultaneously positioned in locations with varying SVF. Thirteen daytime monitoring campaigns took place over the months of January through August 2009. The site's SVF was found to be only moderately correlated with measured air temperature and with the derived comfort index Physiological Equivalent Temperature (PET – Höppe 1999), though a stronger correlation was found with the mean radiant temperature.

Pertschi (2012) also looked at the implications of urban attributes for temperature changes in summer, on the basis of field data from São José dos Pinhais, the most populous municipality in the Metropolitan Region of Curitiba and the site of several industrial plants as well as the city's international airport. Thermal satellite imagery was used for the definition of 10 observation points, which were monitored in summer 2011. The study bears similarities in its method to the procedures adopted by Dumke (2007) and Pertschi (2005) for thermal monitoring in low-cost rain/radiation shields, and by Rossi (2004) for the classification of land use attributes and the subdivision of vegetated areas, water bodies, built-up and impervious areas. Furthermore, the study follows Monteiro's 1976 SCU approach. Using a more robust statistical analysis than in Pertschi's 2005 study, the author concluded that the attributes

of most monitored points showed a strong relation to local air temperature changes. An index was then suggested for guiding climate-responsive urban planning, which facilitates the analysis of implications from land use with respect to the resulting thermal effects.

In another line of research, Rossi (2012) proposed an outdoor thermal comfort model which could serve as a feasible tool for climate-responsive urban planning. This doctoral thesis was based on field monitoring campaigns in the pedestrian area of Curitiba, carried out in parallel with Minella's 2009 study using a pair of weather stations and questionnaire surveys with passersby during daytime on week days. Observed thermal sensation votes (from about 2000 respondents) were compared to calculated thermal stress expressed by the outdoor thermal comfort indices PET and UTCI (Universal Thermal Climate Index) (<http://www.utci.org/>). In addition, a thermal sensation predictive model was proposed for Curitiba, in two versions: using a Linear Discriminant Function and a Logistic Regression Model.

Silva (2012) analyzed the influence of green areas on the topoclimate in a winter month accounting for the dynamics of weather types. The values of the variables were collected at nine monitoring points locally and at three time steps and compared with each other and to data from the meteorological station INMET. The aim was to evaluate the intensity and spatial extent of the thermal benefits of a 70 ha vegetated area; results showed the importance of accounting for the atmospheric patterns over the monitored periods, which may confound thermal relationships and intensities.

Leal (2012) evaluated the influence of vegetation on microclimate by looking at the temporal and spatial variation of air temperature and relative air humidity, monitored at 44 monitoring points across the urban area. Four stationary transects in the urban area were defined, and monitoring was carried out for 22 days in each season during 2011. The study was able to identify different "microclimatic units" across the urban area, thereby corroborating previous findings regarding intra-urban thermal differences in Curitiba (Dumke 2007). The categorization of each site was not based on aerial imagery as in Rossi (2004) and Pertschi (2005, 2012), but was carried out qualitatively from in situ observations. The UHI effect vis-à-vis cool islands were found in more densified areas and in parks and vegetated areas, respectively.

Over the four seasons of 2011-2012, Martini (2013) used portable weather stations for heat stress monitoring together with questionnaire-based outdoor

comfort surveys to investigate the daytime effects of vegetation (in streets with and without trees) on local outdoor comfort. Survey data were later compared to predicted thermal sensation using the Universal Thermal Climate Index (UTCI). A categorical change in thermal comfort was observed when moving from an exposed situation to a site with trees. Though the author used the comfort/stress categories suggested by the developers of UTCI, adjustments made to this index for the specific conditions of Curitiba (Rossi, Krüger and Bröde 2012) and calibrated from Rossi's 2012 database were not included in the assessment of comfort/discomfort levels.

Silva (2014) used remote sensing (Landsat satellite imagery) as a tool for understanding the relationship between land use and surface temperatures. In this study, the Normalized Difference Vegetation Index (NDVI) which was earlier employed by Young (2005) was used, though in this case the analysis was extended for the time frame of 1985-2010. As in Young (2005), a rapid deforestation process was noticed which brought an overall increase in thermal stress over time.

In two independent doctoral theses, Schmitz (2014) and Minella (2014) used the ENVI-met (Bruse and Fleer 1998) simulation environment for the analysis of current and future scenarios of urban planning strategies in Curitiba. ENVI-met allows for transient simulations of human biometeorological parameters at selected grid points in urban areas based on meteorological input variables. The two independent studies used field measurements as a means of validating the simulation model for each urban scenario analyzed. From a validated/calibrated simulation model, alternative scenarios were tested – allowing general guidelines for climate-responsive urban planning to be designed. Both studies used meteorological variables as well as comfort indices as important evaluation parameters, and both also quantified land use patterns for understanding the relationship between thermal behavior and site attributes.

Whereas Minella (2014) proposed a preliminary index relating vegetated fraction and local air temperature variations as a feasible design tool in climate-responsive urban design, Schmitz (2014) concluded that mitigation strategies could successfully reduce thermal discomfort in Curitiba in the next 50 years despite global warming trends. It should be stressed that even though Curitiba could in general benefit from the Urban Heat Island effect (i.e. warming trends over time would reduce cold stress in winter), such benefits do not necessarily outweigh the detriments in summer.

Table 1. A summary of the cited studies carried out in Curitiba in the field of urban climate (focusing on the thermodynamic subsystem, according to Monteiro's SCU approach) over the last decade (2004-2014).

Focus	Season	Method	Source
Intra-urban air temperature differences and land use patterns	Approximately one month in two winter periods (2002-2003)	Stationary monitoring stations and land use classification	Rossi ^a 2004
Energy demand for air-conditioning and urban form	Approximately one month in two winter periods (2002-2003)	Computer simulations, predictive formulas, stationary monitoring data	Lima ^a 2005
Thermal field and land use attributes at neighborhood level	Four days in summer 2003, one day in winter 2003	Mobile transects and land use classification	Blanchet ^a 2004
Local urban design attributes and air temperature/UHI effects	Summer period in 2005	Stationary monitoring stations and land use classification	Pertschi ^a 2005
Vegetation and thermal changes over time	Year round (historic series)	Remote sensing from Landsat satellite imagery	Young ^b 2005
Social-spatial inequalities and local climatic features	Winter period in 2005	Thermal imagery and in situ air temperature and humidity monitoring	Dumke ^b 2007
Vegetation, microclimate, and indoor conditions	Autumn period in 2004	Mobile transects, reference station vs. indoor temperature	Barbosa ^a 2008
Analysis of microclimate effects of the sky view factor (SVF)	Summer, spring, winter 2009	Weather stations in pedestrian areas, locations with varying SVF	Minella ^a 2009
Urban attributes and air temperature changes	Summer period in 2011	Field monitoring, thermal satellite imagery, land use classification	Pertschi ^b 2012
Thermal comfort model for climate-responsive urban planning	Summer, spring, winter 2009	Weather stations, questionnaire-based surveys with passersby	Rossi ^b 2012
Influence of vegetation on microclimate	22-day periods in each season in 2011	Stationary monitoring stations in four stationary transects	Leal ^b 2012
Effect of vegetation on local outdoor human thermal comfort	Four seasons in 2011-2012	Weather stations, questionnaire-based surveys with passersby	Martini ^a 2013
Relationship between land use and surface temperatures	Year round (historic series)	Remote sensing from Landsat satellite imagery	Silva ^a 2014
Urban planning strategies for global warming mitigation	Summer and winter 2011	ENVI-met simulation with field validation, quantification of land use patterns	Schmitz ^b 2014
Vegetated fraction and local air temperature variations	Summer conditions in 2011-2012	ENVI-met simulation with field validation, quantification of land use patterns	Minella ^b 2014

^a Master's Thesis; ^b Doctoral Thesis

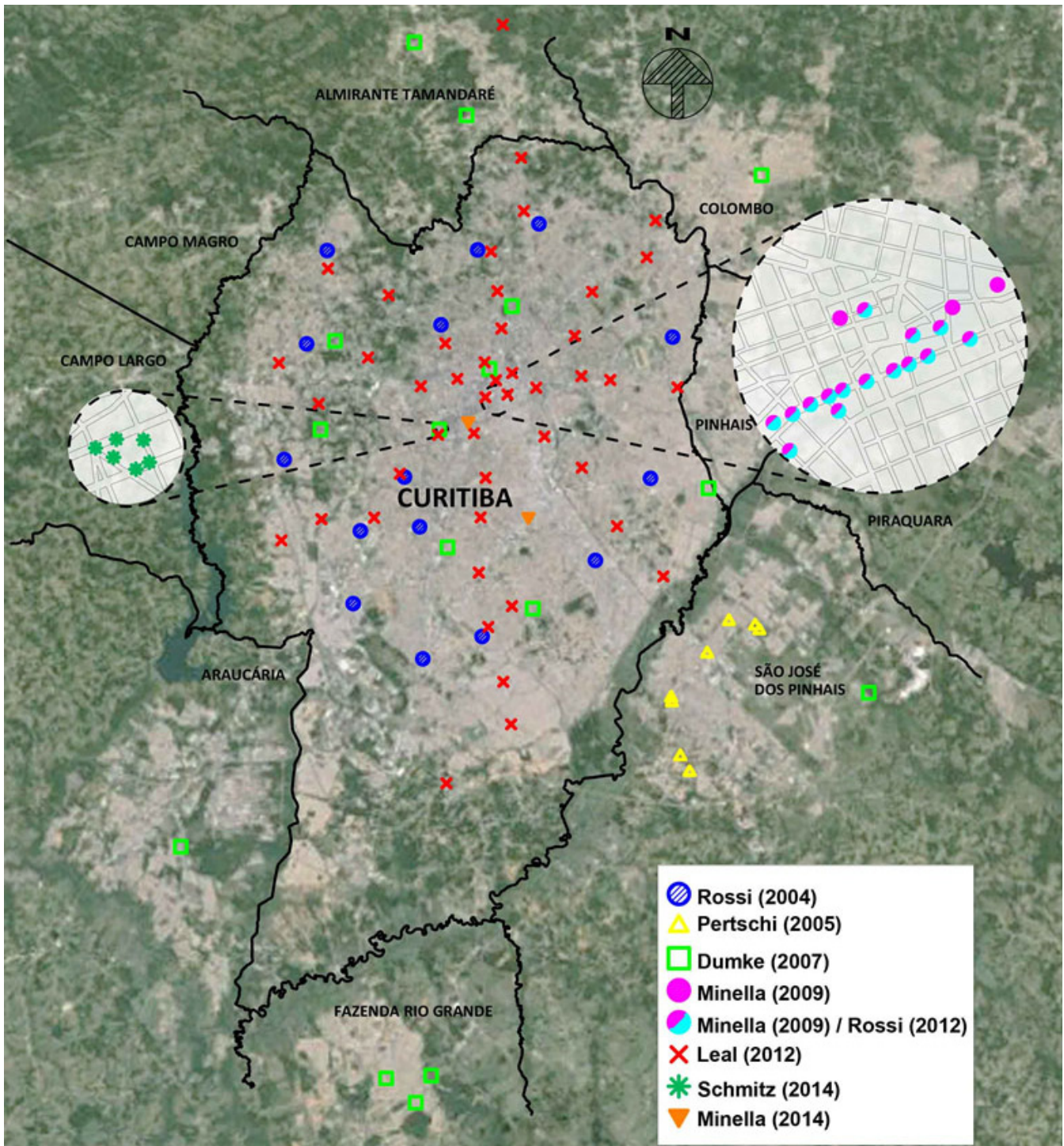


Figure 4: Spatial distribution of the points covered by fixed monitoring stations (Minella 2009 and Rossi 2012 shared 15 points). Shown over the background of satellite imagery (Google Earth) and street-layout maps from IPPUC. *Mapa de arruamento de Curitiba, Aug 2013* (<http://ippuc.org.br/geodownloads/geo.htm> – accessed June 2015).

In total, 8 studies employed fixed monitoring stations: Rossi (2004) with 15 points; Pertschi (2005) with 8 points; Dumke (2007) with 16 points; Minella (2009) with 18 points; Rossi (2012) with 15 points; Leal (2012) with 44 points; Schmitz (2014) with 6 points and Minella (2014) with 2 monitoring points, totaling 124 fixed monitoring points over an array of seasons and time periods in Curitiba and its

Metropolitan Region. Figure 4 presents the spatial distribution of all fixed monitoring points across the urban area.

Except for the points covered by Pertschi (2005), Dumke (2007) and a monitoring point studied by Leal (2012), the bulk of monitoring sites were within the city of Curitiba. Minella (2009, 2014), Rossi (2012) and Schmitz (2014) focused on the downtown area,

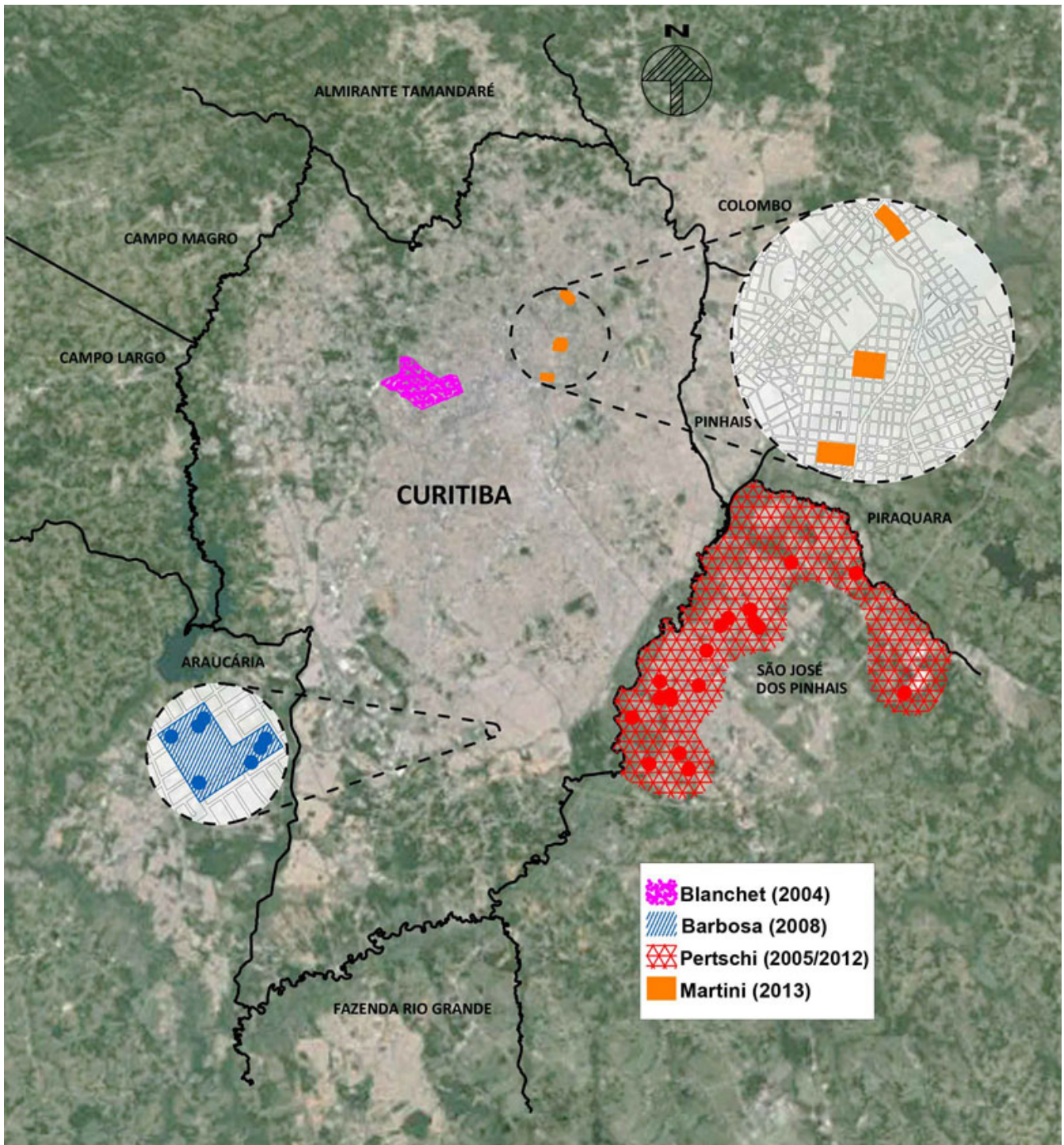


Figure 5: Spatial distribution of the mobile transect measurements over the background of satellite imagery (Google Earth) and street-layout maps from IPPUC. *Mapa de arruamento de Curitiba, Aug 2013* (<http://ippuc.org.br/geodownloads/geo.htm> – accessed June 2015)

while Rossi (2004), Dumke (2007) and Leal (2012) used more widely distributed monitoring sites, allowing for the analysis of heterogeneous situations. Except for a few points monitored by Dumke (2007) in the Metropolitan Region and by Leal (2012), the majority of sites were in consolidated urban areas. As for mobile stations, 5 studies employed such an approach for data collection: Blanchet (2004); Perts-

chi (2005 – in addition to fixed point monitoring, as cited above); Barbosa (2008); Pertschi (2012) and Martini (2013). The regions covered by transect mobile measurements and respective visiting points are highlighted in Figure 5.

Except for the regions evaluated by Pertschi (2005, 2012), other transect measurements took place in consolidated areas in Curitiba.

Critical evaluation and current perspectives

From this review, it may be seen that while several research studies used similar methods and attempted to follow a similar path, in some instances there was a lack of connection with previous work. Examples of such discontinuity can be found in:

- the disregard of the quantitative assessment of land use from aerial imagery in Leal's 2012 study, which had been pursued by Rossi (2004) and Pertschi (2005, 2012) in a consequent manner;
- the use of UTCI classes which were not locally calibrated by Martini (2013), though a calibration of the index had been carried out previously for the climatic conditions of Curitiba (Rossi, Krüger and Bröde 2012);
- Martini's (2013) study of the thermal effect of vegetated streets did not mention a similar effort by Barbosa (2008) in which two transects with similar configurations (vegetated versus bare streets) were compared, and did not replicate Rossi's (2012) use of a grey globe thermometer, as recommended for the assessment of outdoor thermal comfort (Johansson et al. 2014);
- Silva's (2014) study did not mention a previous effort by Young (2005), which was similar in its methodology and research subject.

From such examples, a duplication of efforts and a discontinuity in research methods become apparent.

As presented in this review and summarized in Table 1, urban climate research in Curitiba could be subdivided into three main branches: (a) analysis of intra-urban temperature distribution by means of field measurements or remote sensing; (b) applicability evaluation and/or calibration of existing outdoor thermal comfort indices, and development of novel outdoor comfort indices; and (c) urban microclimate simulation of present and future scenarios.

With regard to (a), attempts have been made in the studies surveyed to quantify land use and morphology attributes, but these efforts are still unable to provide meaningful and quantifiable indices for climate-responsive urban design. Even though earlier studies may not be complemented by new indices for the monitored sites due to changes in local urban development over time, the later studies could still come up with relevant indicators of land use and vegetation and successfully be able to generate good predictors of microclimate changes due to land use and vegetation.

The calibration and development of outdoor thermal comfort indices (b) has its importance in the context of Curitiba, as many studies are focused almost exclusively on air temperature and not on thermal indices, which encompass a set of meteorological variables relevant to thermal perception and, consequently to overall quality of life in the city. Although a robust database has been gathered over the years (e.g. by Rossi, with over 2000 respondents, and Martini, with 175 respondents), research in the field still lacks standardization (Johansson et al. 2014), which will demand renewed efforts in the future.

The use of computer simulation (c) as well as the development of rules of thumb for climate-responsive urban design are quite important and certainly suggest relevant perspectives for future studies in Curitiba.

Considering the long history of proactive urban planning in Curitiba, the integration of research outcomes obtained so far and the development of the field in a more cohesive way in future studies could allow researchers to provide guidance to urban development and redevelopment schemes for Curitiba, with a benefit to the quality of life of its citizens.

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Urban biometeorology: a thermal walk experiment in Florence

In the framework of a month-long *Arguzia della Natura* internship in Florence, a group of high school students from the “Nicola Sensale” scientific high school in Nocera Inferiore (Salerno) carried out an experiment to study the different responses and perceptions of young people to environmental stress in an urban area.

The experiment, coordinated by Marina Baldi of the Institute of Biometeorology IBIMET-CNR, was a follow-up to a project entitled “The Role of Urban Morphology and Pedestrian Movement in the Perception of Thermal Comfort in Historic City Centres: Spatial Sequences in Rome and London,” to which the staff of IBIMET-CNR in Rome had contributed, led by PhD student Carolina Vasilikou from University of Kent in the UK. [This project](#) investigated the variation of perception by individuals in a spatio/temporal sequence, based on fieldwork in urban areas.

The methodology of the project is based on the idea of “thermal walks” – during which the thermal perception of pedestrians is evaluated together with microclimatic conditions in urban areas with different morphologies. The experiment was conducted on May 11th, 2015 in early afternoon, in a peripheral area of Florence named *Peretola*, characterized mainly by narrow streets with 2 to 4-story buildings, and delimited on one side by the high-traffic Via Pistoiese (between points D and E in the map below). The walk, starting from the IBIMET-CNR premises (point A), also included a bike path (point F) with green surrounding areas and some trees and bushes, built on a former water channel now running underground.



The participants were students between 15 and 17 years old, seven male and eight female. The actual fieldwork consisted of two activities:

- handing out a questionnaire to each of the participants, which they answered at fixed points along a 1.5 hour-long walk as predetermined by the coordinator.
- meteorological and CO₂ observations at the same fixed locations, and during the whole walk.

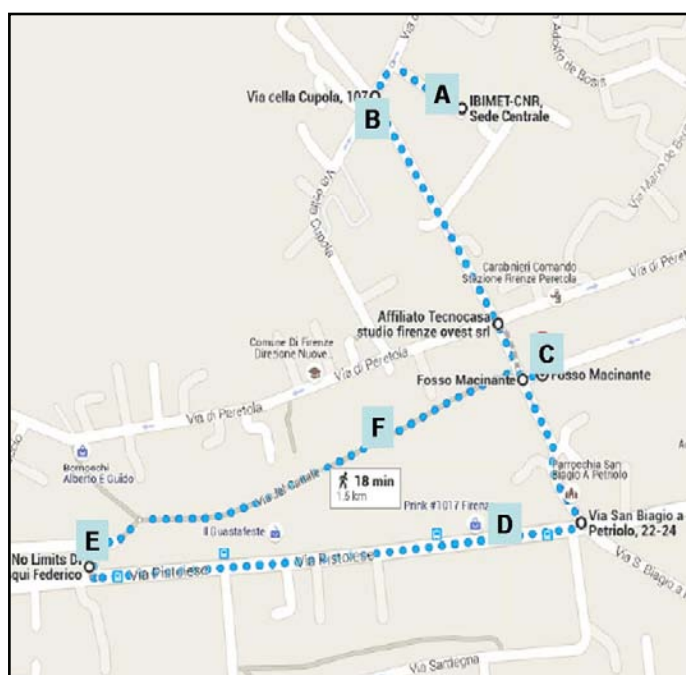
The fixed points along the path were selected on the basis of different morphological properties such as:

- paved/gravel road/path
- narrow/wide road or larger space (small square)
- road surrounded (or not) by buildings
- road with heavy/light traffic or no traffic (foot path)

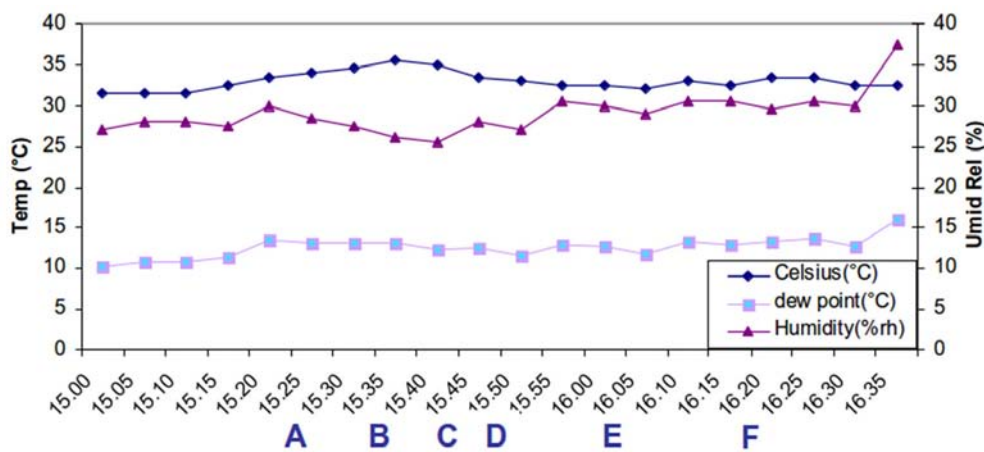
The first part of the questionnaire consisted of several questions about the participants, in order to obtain data on clothing and food/beverage consumption before the walk, and then for each location along the path, the sequence of questions was the same.

Measurements were taken with hand-held instruments measuring temperature, dew point, air pressure, relative humidity, wind direction and intensity, and with sensors mounted on a bike ([SensorWebBike](#)). In addition, CO₂ was measured using a hand-held carbon dioxide meter while an infrared thermometer detected surface temperature of soil and surrounding buildings.

Results are still under investigation, but preliminary findings already show interesting differences between the two major groupings (male and female), and quite different responses relative to different urban morphologies, as characterized by different environmental conditions in terms of temperature, relative humidity and wind. In hot and sunny conditions, wind (even a light breeze) is certainly the main factor contributing to the adaptation of the human body to environmental stress.



Map of the walking path, showing key points along the way.



Air temperature, dew point and relative humidity along the path detected using hand-held instruments. The capital letters indicate the selected locations along the walking path.



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Developing a global urban database for climate studies

At ICUC9 in Toulouse a short workshop will be held on an IAUC initiative called "World Urban Database and Access Portal Tool (WUDAPT)". This community-based project is designed to gather, store, disseminate and facilitate the use of data on cities for climatology studies. WUDAPT uses a combination of remote sensing, official sources and locally-based urban experts to derive maps of cities based on a consistent methodology (for details see www.wudapt.org). A number of papers on the project will be presented on Tuesday 21st July in Session GD2 that will outline and describe its current status and plans. On the late afternoon of July 22nd delegates are invited to a short workshop that will demonstrate our methodology and offer the opportunity for participants to participate in WUDAPT.

As atmospheric models at macro-, meso- and micro-scales improve, they have a greater need for more detailed information on landscape characteristics and their variation over space and time. This is particularly true of urbanised landscapes, which are dynamic, exhibit great spatial heterogeneity and exert considerable influence on climates at city, regional and global scales. In fact, although they are human artefacts and home to most of humanity, we know remarkably little about the physical characteristics of cities globally.

This dearth of information has been recognised in the IPCC's 5th Assessment Report (www.ipcc.ch) in which urban areas appear explicitly in "Impacts, Adaptation, and Vulnerability" (Chap. 8: Urban Areas) and in "Mitigation of Climate Change" (Chap. 12: Human Settlements, Infrastructure and Spatial Planning); for example:

*"...the limits to understanding and predicting impacts of climate change at a fine grained geographic and sectoral scale; serious limitations on geophysical, biological and socio-economic data needed for adaptation at all geographic scales, including data on nature-society links and local (fine-scale) contexts and hazards."*¹

This lack of detailed data is especially evident for urban climate research where models require details on the nature of the urban surface (building dimensions, vegetation, materials, energy use, etc.), yet acquiring values for these urban canopy parameters (UCPs) is an onerous task.

Currently, available urban data sets vary widely in (a) content, spatial coverage, level of detail, scale, features, and characteristics, (b) their type and sources of inputs, and even (c) degree of availability and accessibility. For some cities, the internal make-up of some cities may be available as maps of land-cover and/or land-use but these use varying classification systems and map scales. What we need, as a research community, is a global database that contains consistent information on cities at a detail suitable and readily accessible for a wide range of applications and for different types of models and analyses. This is the goal of WUDAPT.

WUDAPT will gather urban data in a series of steps that represent different levels of detail. The baseline data (**Level Zero**) is a basic geographic description of cities using the Local Climate Zone (LCZ) categorization scheme.² This decomposes the urban landscape into similar neighbourhood types each at a scale of about 1km². The methodology for this process was tested at a workshop held in Dublin during July 2014; it consists of three steps for each selected city:

1. Local urban experts identify training areas using GoogleEarth that represent LCZ types,
2. Landsat8 images of the entire urbanised area are classified into LCZ types using these training areas, and
3. The results are examined and the process repeated until there is a satisfactory result.

Figure 1 shows the results for São Paulo, one of 16 cities completed during the Dublin workshop. All of the software and satellite data used in the process is free to download. This is an example of **Level Zero** data and provides a useful starting point for a more rigorous exploration of cities. Even in its current form, the ranges of urban canopy parameter (UCP) values associated with LCZ types will provide some initial guidance for modeling work. Importantly these LCZ maps will provide a spatial sampling frame for further urban work, including designing urban observation projects and gathering more detailed (**Level One** and **Level Two**) urban data on building heights, energy use, etc. efficiently.

This IAUC WUDAPT initiative is exciting, it is innovative and its goals are strategically important for the development of (urban) climate research; moreover, it is

¹ Revi, A., D.E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R.B.R. Kiunsi, M. Pelling, D.C. Roberts, and W. Solecki, 2014: Urban areas. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 535-612.

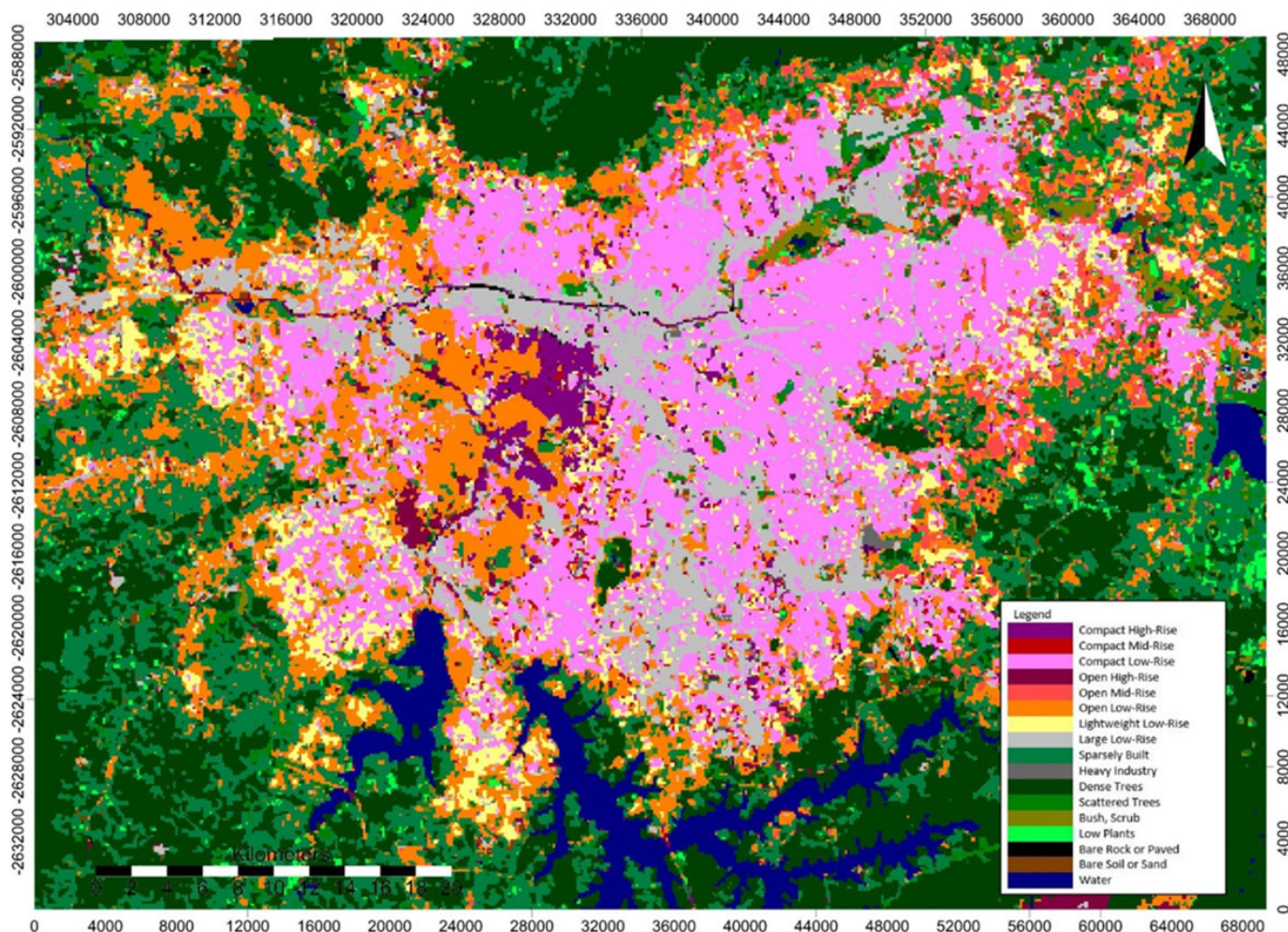


Figure 1. The Local Climate Zone classification for São Paulo, Brazil completed by Michael Foley (Geography, UCD) and Maria De Fatima Andrade (Departamento de Ciências Atmosféricas do Instituto de Astronomia, Geofísica e Ciências Atmosféricas, USP)

inclusive as it relies on the expertise and networks of the international urban climatology community. Tactically, significant progress has been made; WUDAPT is now at a point in which the IAUC (and allied) communities can now readily contribute to its development by virtue of their intellectual focus, technical expertise and global coverage. Momentum is building; at the ICUC9 Workshop, our immediate goals will be (1) to extend the number of cities that are described using **Level Zero** data and to develop approaches/tools for the acquisition of more detailed urban data globally, and (2) to identify those interested in joining our WUDAPT team. At ICUC9, we encourage you to attend the talks and participate in the workshop. The WUDAPT website (www.wudapt.org) is a useful source for more information.

It would be a significant help to the WUDAPT Work-

shop Organizers if you would indicate your interest in attending and participating in the workshop, and possibly in joining our WUDAPT team.

Please visit the WUDAPT website, and go to <http://www.wudapt.org/events/wudapt-workshop/>.



² Stewart, I. D., & Oke, T. R. (2012). Local climate zones for urban temperature studies. *Bulletin of the American Meteorological Society*, 93(12), 1879-1900.



On the doorstep of Toulouse: A look back at the last 18 months

With ICUC9 in Toulouse just around the corner, it's a good time to review the diverse contributions made by members of the urban climate community over the past eighteen months, here in *Urban Climate News* (previous 18-month reviews can be seen in the [June 2009](#), [December 2010](#), [June 2012](#), and [December 2013](#) issues).

The timing of these reviews may or may not have to do with the fact that the number 18, in Hebrew numerology, signifies "life" – but in looking over the recent activity in urban climatology, I cannot help but notice a pronounced emphasis on the living biotic systems in cities.

We see it firstly in the *problems* that are being ad-

ressed by so many researchers, such as the effects of urban climate on human health. In the stream of timely **News items** supplied by **Winston Chow**, we can see a preponderance of stories relating to the health hazards of heat stress – in sporting events, in heat waves, and in urban areas where different societal groups and sectors are especially vulnerable. Another ongoing focus is the danger to human health imposed by urban air pollution, especially in China.

These issues are also evident in many of the recent **Feature articles** (see Table below), such as a study of [heat-related mortality](#) in NYC by **Joyce Klein Rosenthal**,

Feature Articles	Author(s)	Issue
IAUC: Reflections on Whom and What we are	Tim Oke	December 2013
Thoughts on the state of urban climatology and the IAUC	Matthias Roth	December 2013
Four years as IAUC President: Summing up and looking ahead / The road to Dublin	Gerald Mills	December 2013
Modeling directional albedo with high resolution imagery	Shai Kaplan, et al.	March 2014
Combined effects of urban expansion and climate change on temperature in Sydney	Daniel Argüeso, J.P. Evans	June 2014
Heat waves in urban areas: impacts and mitigation	Dan Li, Elie Bou-Zeid	September 2014
Intra-urban vulnerability to heat-related mortality in New York City	Joyce Klein Rosenthal	December 2014
Temperature projection using remote sensing: A case study of Hong Kong	Janet E. Nichol, To Pui Hang	March 2015
Heat mitigation through urban form and design – A case study of Phoenix, AZ	Ariane Middel, Kathrin Häb	March 2015

Urban Project Reports	Author(s)	Issue
The moderating effects of urban vegetation on pedestrian thermal stress in a hot-arid environment	David Pearlmutter, Evyatar Erell, Limor Shashua-Bar, Keren Snir	March 2014
Beyond mainstreaming: Reframing governance for urban climate resilience	Richard M. Friend, Jim Jarvie	June 2014
Influences of street tree diversity on microclimate, human thermal comfort and heat wave resilience in Melbourne	Ruzana Sanusi, Stephen J. Livesley	September 2014
Evaluation and public display of urban patterns of human thermal conditions (URBAN-PATH project)	Stevan Savić, János Unger	December 2014
Developing a Global Urban Climate Database: WUDAPT	Gerald Mills, Jason Ching, Linda See	December 2014

and **Urban Project** reports (see Table above). In these studies, there is more and more attention not only to localized micro-scale and UHI effects, but to the confluence of urban heating and larger-scale climate change – and as a consequence, a focus on the drivers of global warming, such as carbon emissions from urban transport and other anthropogenic sources.

[IUFRO conference held in Nice, France](#) from June 1st to 5th, 2015. As implied by the title, the focus here was not just on the influence of urban greening upon climate, but also on the influence of climatic perturbations upon urban greenery.

The session was co-sponsored by the European [COST Action FP1204 - GreenInUrbs](#) and opened by its chairperson **Carlo Calfapietra**, who spoke about progress towards the establishment of a network of urban forest eddy covariance stations in European cities and described a case study in Naples. Also included in session were presentations by **Andrej Verlič** on the monitoring of urban and periurban forests in Milano and Ljubljana, by **Gregorio Sgrigna** and **Roeland Samson** on the deposition of particulate matter on urban tree leaves, and by **Vicent Calatayud** on the responses of urban trees to elevated ozone.

The relationship between urban vegetation and climate, then, is clearly a two-way street. Trees and green spaces are sensitive to the urban atmosphere, and they have a crucial role to play in providing ecosystem services that are essential to the city. Prime among these services is their moderating effect on the severe warming trends that many cities are experiencing, and there is no doubt that the cooling of public open spaces (see box, next page) will continue to be a vital topic in urban biometeorology.

Certainly it will be on the agenda very soon, at the IAUC's gathering in Toulouse. Hope to see you there!

— *David Pearlmutter*
Editor



We can also see an emphasis on urban organisms in the *solutions* that are being studied, proposed and implemented to address these challenges. Whether it is a news item on green roofs or a research campaign assessing the thermal effects of street trees, we see immense interest in the potential benefits of urban vegetation. This interest has been relayed in several of the **Special Reports** published in recent issues, which have chronicled the ongoing activities in Europe – most recently in a series of meetings in Barcelona – relating to [urban forests and green infrastructure](#).

Even more recent was an event dedicated to the “Impacts of air pollution and climate change on forests in the wildland-urban interface” that took place during the



EXPO2015 in Milano: Feeding the planet, energy for life . . . and some urban space cooling?

The World Exposition that opened on May 1, and will attract millions of visitors to Milan until closing on October 31, is not lacking for contrasts and contradictions.

With its theme of *"Feeding the Planet, energy for Life,"* the Expo has been promoted as a celebration of slow food, local agriculture and healthy eating, and there is plenty of all these to be found. There is also plenty of space set aside for corporate sponsors like Coca-Cola and McDonald's.

In a similar way, the planning of EXPO2015 was launched with aspirations to create a sustainable 'green' urban demonstration site. Over 200,000 of the 1.1 million square meters were planned as green space. Eco-friendly materials, high-tech innovation and renewable resources were specified wherever possible.

Conceived as an island surrounded by a 4.5 km waterway, the expo area replicates the layout of a Roman city. The *Decumanus*, or main axis running 1.5 km along the length of the site, is in the form of a shaded pedestrian mall lined on both sides with pavilions of the 148 exhibiting countries (60 self-built and the remainder in clusters representing Arid, Island and Bio-Mediterranean Zones). The *Cardo*, or perpendicular axis, terminates in the *Piazza d'Acqua*, with its artificial lake and artificial "Tree of Life" surrounded by terraced seating and concentric rings of real trees that were grown in local nurseries (see [June 2013](#) issue, p. 21). According to promoters, the lake is fed by the Villorresi Canal, one of the historic canals of the Milanese hinterland that serves to irrigate the green-space, and to "regulate

the microclimate within the exhibition area."

However, the elaborate "canal city" idea [didn't quite turn out as planned](#). According to a recently published critique: "The Expo was to be a catalyst for reviving Milan's network of waterways, opening up canals to irrigate surrounding farms... but it was realised that the water pressure would not be strong enough to reach the fields. The revised plan met with huge environmental opposition, so instead the network was to be buried underground. With €60m already spent on the project, the fabled '[Vie d'Acqua](#)' has yet to materialise."

Despite a proliferation of green roofs, vertical gardens and near-vertical wheat fields, I couldn't help but wonder... where is the cooling? The canals are, for the most part, restricted to the site's periphery, and not much water – or evaporative cooling, for that matter – is in evidence in the main pedestrian spaces. Exceptions include the misters in Brazil's pseudo-rainforest and in the US pavilion's entrance plaza, where you can also have a refreshing shower in the digital waterfall (and with temperatures in the not-so-low '30s, I had a few).

What will remain from this urban experiment after October 31? Palazzo Italia, a "sustainable organism that uses new technology to interact and exchange energy with its surroundings," is to house government representatives and, unlike other structures built for the Expo, remain open. Without these other structures, though, one wonders what fate awaits the expanses of concrete currently covering the site – and what long-term purpose they might serve, on the distant outskirts of Milan. – DP



An early visualisation, 2009. Source: [The Guardian](#)

"The elaborate 'canal city' idea didn't quite turn out as planned..."



On the grounds, June 2015.

Recent publications in Urban Climatology

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In this edition a list of publications are presented that have come out between **March and May 2015**. As usual, papers published since this date are welcome for inclusion in the next newsletter and IAUC online database. Please send your references to the email address below with a header "IAUC publications" and the following format: Author, Title, Journal, Volume, Pages, Dates, Keywords, Language, URL, and Abstract. In order to make the lives of the Bibliography Committee members slightly more easy, please send the references in a .bib format.

Since a number of bibliography committee members have resigned, we are supporting (young) researchers to join this effort and contribute to the Committee. If you are interested to join or you want more information, please let me know via the email address below. For this edition, I would like to thank Lara Santos (TUM) for her contribution.

Regards,

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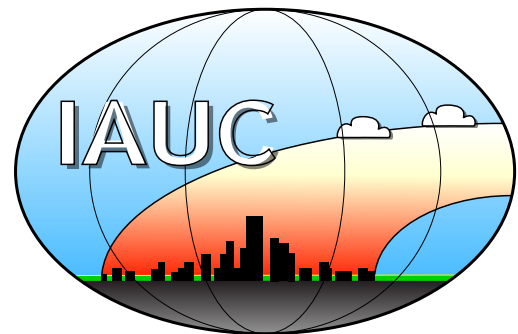
The joint 9th **International Conference on Urban Climate (ICUC)** and 12th **Symposium on the Urban Environment (SUE)**, sponsored by the International Association for Urban Climate and the American Meteorological Society, will be held in Toulouse, France, 20-24 July 2015.

In the year of the 21st session of the Conference of the Parties on Climate Change Policy & Practice, the focus of ICUC9 will be put on the recent scientific activities on climate change mitigation & adaptation in urban environments, as well as on the transfer to institutional stakeholders and urban planners to include urban climate considerations in their practices.

Traditional topics covered by ICUC and SUE and related to advances in observations, modeling, and applications will also be presented. The submission of abstracts has been concluded, and those who submitted will be notified in early February. For additional scientific information, please contact the local scientific committee (Valéry Masson and Aude Lemonsu) at : icuc9@meteo.fr



icuc9
9th International Conference on Urban Climate
12th Symposium on the Urban Environment
20th-24th July 2015
Toulouse France
www.meteo.fr/icuc9



INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

Upcoming Conferences...

INTERNATIONAL CONFERENCE ON URBAN CLIMATE (ICUC9)

Toulouse, France • July 20-24, 2015
<http://www.meteo.fr/icuc9/>

IUFRO LANDSCAPE ECOLOGY CONFERENCE: SUSTAINING ECOSYSTEM SERVICES

Tartu, Estonia • August 23-30, 2015
<http://iufrole2015.to.ee/>

PASSIVE AND LOW-ENERGY ARCHITECTURE: 31ST INTERNATIONAL PLEA CONFERENCE

Bologna, Italy • September 9-11, 2015
<http://www.plea2015.it/>

INTERNATIONAL CONFERENCE ON COUNTER-MEASURES TO URBAN HEAT ISLANDS

NUS, Singapore • May 30-June 1, 2016
<http://www.ic2uhi2016.org/>

Manabu Kanda honored with 2014 Luke Howard Award

It is a great pleasure for the IAUC to recognize Professor **Manabu Kanda** of the Tokyo Institute of Technology as the recipient of the 2014 Luke Howard Award. Professor Kanda has an enviable record of research contributions including (a) wide ranging, significant, insightful and high impact studies dealing primarily with the fundamental nature of urban climatology and climate processes, (b) exemplary science leadership, engagements in international collaborations and mentoring of students who now are highly successful and contributors to the field, and (c) his active service to the IAUC and related communities.

On climate and urban sciences, he is highly regarded for his pioneering experimental field studies and innovative measurement techniques. He established one of the first urban flux towers, the "Kugahara Project" in Tokyo, to measure meteorological and CO₂ exchanges over a city. Professor Kanda provided initiative and leadership in the consortium project called COSMOS, an ambitious and unique experimental facility comprised of multiple synthetic outdoor physical scale models that used concrete cubes to represent idealized urban morphological structures. He was one of the first to study flows and turbulence in urban environments employing scintillometry, particle image velocimetry (PIV) and thermal image velocimetry methodologies in his experimental programs, making him one of the most innovative experimental researchers in the urban climate community.

His modeling studies include using LES for detailed investigations of a range of fundamental climate processes including airflow, energetics, and turbulence over cities, providing insights into the spatial nature of turbulence over rough urban surfaces and helping to reveal large organized flow structures that are involved in controlling exchanges between urban canopy surfaces and the overlying atmosphere. Moreover, he has led in the early development of formulations for advanced urban canopy parameterizations. Particularly impressive is Professor Kanda's ability to seamlessly bridge gaps between modeling and experimental sciences, thus providing an important basis for improved urban parameterizations. His studies of momentum, heat and trace gas exchanges have provided important



insights on the applicability of similarity theory to urban surfaces. His students, Drs Moriwaki, Nakayoshi, Inagaki and Oda, among others, are also making important contributions in their own right. He has engaged in numerous collaborative investigations involving internationally renowned scientists. He has numerous, highly regarded journal publications (110) in Japanese and English (more than 40 of those in English), 1 book and 7 book chapters, and 180 Conference papers providing evidence of the high quality, productivity and wide impact of his research. Between 1991 and 2013, 37 of his articles have almost 25 citations on average per article giving him an impressive h-factor of 16. He is the recipient of several prestigious awards including the 2014 American Meteorological Society's Landsberg award, the Fujino Prize in 2008, the Tsuboi Prize in 2008, the JSHWR Academic Award in 2003 as well as four (4) best paper (for young researchers) awards over the period 1992-2002.

Professor Kanda has served the IAUC as an elected Board Member from 2006 to 2010; he chaired the 2007-2008 Awards Committee and was Chair of the organizing committee of the highly successful and stimulating 7th International Conference on Urban Climate, ICUC7 in Yokohama, Japan in 2009.

Respectfully,

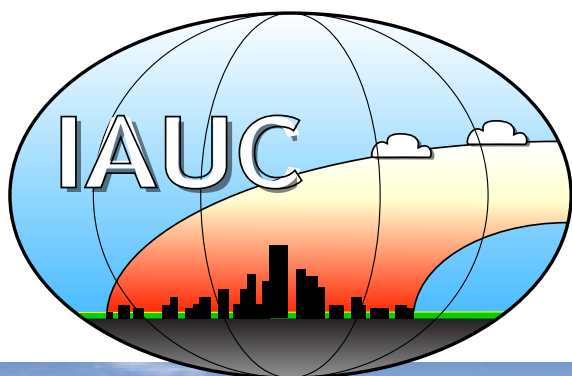
Jason Ching

Interim Chair, IAUC Awards Committee

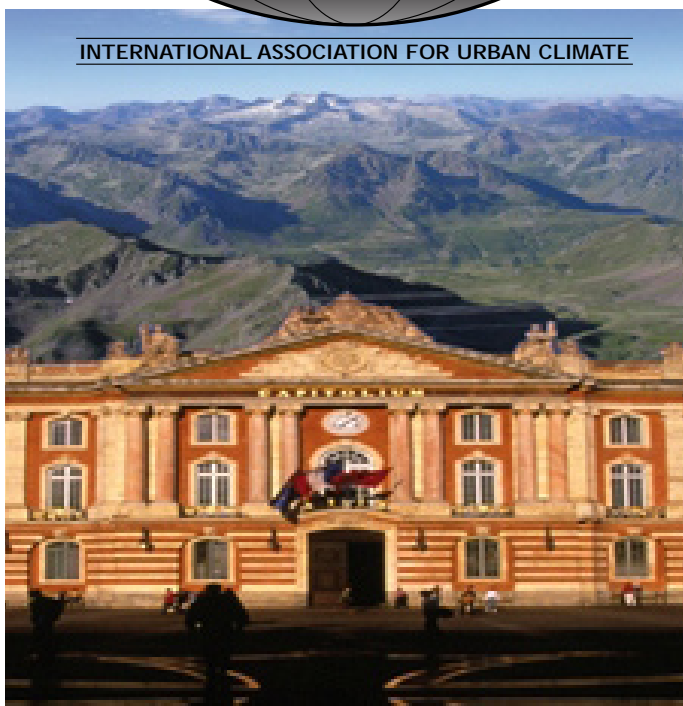
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important supporter of the ICUC meetings and of IAUC, is also signalling the importance of urban areas through a resolution at their recent Congress that seeks to establish a cross-cutting urban focus. The WMO has noted the importance of weather, climate, water and other related environmental activities that support and affect urban issues and is working to make these part of the upcoming UN HABITAT-III meeting in the fall of 2016 (see details at <http://unhabitat.org/habitat-iii/>). WMO hopes that IAUC and its members can contribute input to help focus their contribution to HABITAT-III; ICUC-9 will be an important venue for these discussions. For those wishing to learn more, there will be a presentation at ICUC-9 by Alexander Baklanov in the "Weather forecasting for city actors" session on Wed. July 22.

Finally – I would encourage anyone who is planning to participate in ICUC-9 but has not yet registered to [do so](#). I look forward to seeing you all at **ICUC-9 in Toulouse**.



INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE



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- Tim Oke (Univ. of British Columbia, Canada): President, 2000-2003; Past President, 2003-2006; Emeritus President 2007-2009*
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Newsletter Contributions

The next edition of *Urban Climate News* will appear in late September. Items to be considered for the upcoming issue should be received by **August 31, 2015** and may be sent to Editor David Pearlmutter (davidp@bgu.ac.il) or to the relevant section editor:

News: Winston Chow (winstonchow@nus.edu.sg)

Conferences: Jamie Voogt (javoogt@uwo.ca)

Bibliography: Matthias Demuzere (matthias.demuzere@ees.kuleuven.be)

Projects: Sue Grimmond (Sue.Grimmond@kcl.ac.uk)

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.