Urban Climate News

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From the IAUC President

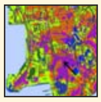
Colleagues — Welcome to the 55th edition of the *Urban Climate News*. Thanks to David Pearlmutter for his work as editor and to all the contributors in this issue. In this edition I would like to bring to your attention two items of IAUC business.

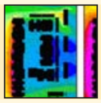
First, the call for proposals to host the next International Conference on Urban Climate – ICUC-10, is now open. In a change from past practice, we are now first soliciting expressions of interest (EOI) from those who wish to host ICUC-10. The EOI is a short description of the who, where and when of a proposed ICUC-10. All EOI received will be shared with all submitters and with the IAUC Board. We hope this will better allow discussion and potential collaboration among groups interested in hosting ICUC-10 from the outset. We would like to receive expressions of interest by **April 15, 2015** and for those who wish to continue with full proposals, submissions are due by **June 15, 2015**. Presentations of proposals in person to the Board are scheduled for the afternoon of **July 19, 2015** (the Sunday before the start of ICUC-9 in Toulouse). Full details of the call are available in this edition of the *Urban Climate News* (see page 27), posted on the website (http://www.urban-climate.org/) and have been circulated by email to the membership. If anyone has questions on the process please feel free to contact me.

Second, a call for nominations to the IAUC Board will be coming out shortly. This year we will be seeking to fill one spot on the Board. We seek a Board that broadly represents the diversity of our membership in terms of geographical locations, fields of interest and gender; to this end the Board would particularly encourage the nomination of women this year. The nomination process is described on our website (http://www.urban-climate.org/organisation/iauc-procedures-and-administrative-matters/). A list of current and past Board members is also available from the website.

Service to the IAUC can take many forms beyond membership on the Board; there are a number of

Inside the Spring issue... DOUBLE-FEATURE





committees on which members may serve. For the upcoming ICUC-9 in Toulouse, I am actively soliciting members for an Awards sub-committee who can help judge the student paper competition. If you are willing to serve, please contact me.

Also in this edition, you will find two featured articles – on temperature projection in Hong Kong, and on heat mitigation in Phoenix – and a report on recent meetings in Barcelona adressing urban green infrastructure.

– James Voogt,
IAUC President

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Hidden benefits of electric vehicles revealed: they are cool

March 2015 — Electric vehicles are cool, research shows. Literally.

A study in this week's *Scientific Reports* by researchers at Michigan State University (MSU) and in China add more fuel to the already hot debate about whether electric vehicles are more environmentally friendly than conventional vehicles by uncovering two hidden benefits.

They show that the cool factor is real – in that electric vehicles emit significantly less heat. That difference could mitigate the urban heat island effect, the phenomenon that helps turn big cities like Beijing into pressure cookers in warm months.

Moreover, the cooling resulting from replacing all gas-powered vehicles with electric vehicles could mean city dwellers need less air conditioning, another environmental win.

"It's easy not to see the big picture on issues like electric cars and global warming, but when we look with a holistic approach, we find these unexpected connections," said co-author Jianguo 'Jack' Liu, who holds the Rachel Carson Chair in Sustainability at MSU and is director of the Center for Systems Integration and Sustainability (CSIS). "Heat waves kill, and in terms of climate change, even one degree can make a difference."

The research was led by Professor Canbing Li of Hunan University in Changsha, China, who was a visiting scholar at CSIS. The electric vehicles' benefits of reduced greenhouse gas emissions are countered by the expense and pollution from producing the vehicles, leading to debate on whether they are the best replacement for conventional vehicles.

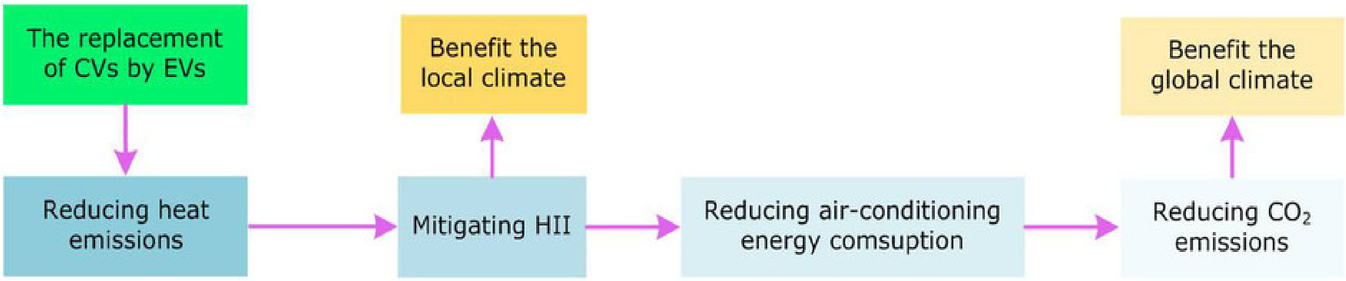
In the paper, Li and his colleagues take a wider view to find new positives for plug-ins. Conventional vehicles and air conditioners are the two biggest contributors to the heat island intensity – the difference between urban temperatures and the cooler temperatures of rural areas. In that arena, electric vehicles are cooler – giving off only about 20 percent of the heat a gas vehicle emits.

Electric vehicles emit less heat than gasoline-burners. ***Source:*** **www.greenoptimistic.com**

The researchers used Beijing in summer of 2012 to calculate that switching vehicles from gas to electricity could reduce the heat island intensity by nearly 1 degree Celsius. That would have saved Beijing 14.4 million kilowatt hours and slashed carbon dioxide emissions by 11,779 tons per day, according to the paper "Hidden Benefits of Electric Vehicles for Addressing Climate Change."[1]

The authors caution that several factors can influence the urban heat island effect, not all of which were addressed in the study. For example, there are conflicting reports regarding the impact of reduced aerosol pollution on heat island intensity. These factors may need to be considered when weighing the benefits and disadvantages of replacing conventional vehicles with electric vehicles. *Source*: www.sciencedaily.com/releases/2015/03/150319105313.htm

[1] Canbing Li, Yijia Cao, Mi Zhang, Jianhui Wang, Jianguo Liu, Haiqing Shi & Yinghui Geng (2015). Hidden Benefits of Electric Vehicles for Addressing Climate Change. *Scientific Reports*. DOI: 10.1038/srep09213



EVs emit much less heat than CVs within the same mileage. Replacing CVs with EVs would mitigate heat island intensity and CO_2 emissions to benefit local and global climates. (from Canbing Li et al., 2015)

Heat waves becoming more prominent in urban areas, research reveals

January 2015 — The world's urban areas have experienced significant increases in heat waves over the past 40 years, according to newly published research study.

These prolonged periods of extreme hot days have significantly increased in over 200 urban areas across the globe between 1973 and 2012, and have been most prominent in the most recent years on record.

The results, published the journal *Environmental Research Letters*,[1] show that over the same time period, more than half of the studied areas showed a significant increase in the number of individual extreme hot days, whilst almost two-thirds showed significant increases in the number of individual extreme hot nights.

The study, undertaken by researchers at the Indian Institute of Technology (IIT) Gandhinagar, Northeastern University, University of California, Los Angeles, and the University of Washington, is one of the first to focus solely on the extent of extreme weather on a global scale, as well as examining disparities between urban and non-urban areas.

In their study, the researchers obtained daily observations for rain, air temperature and wind speed from the Global Summary of the Day (GSOD) data set produced by the National Climatic Data Center (NCDC).

They identified all urban areas globally with a population greater than 250,000 (around 650 areas) and then refined the list based on the area's proximity to a GSOD station and the availability of complete weather records. They were left with 217 stations with complete records for the period 1973-2012, most of which were located at airports close to urban areas.

Once the data were obtained for the 217 urban areas, the researchers identified extremes for temperature, precipitation and wind and calculated heat waves, cold waves as well as individual extreme hot days and nights.

Heat waves were defined as periods where the daily maximum temperature was hotter than 99 per cent of days for the period 1973-2012, for a consecutive period of six or more days.

The results showed that there were statistically significant increases in the number of heat waves per urban area during the last four decades. Of the five years with the largest number of heat waves, four were the most recent years on record (2009, 2010, 2011 and 2012).

Results also showed a general decline in cold waves, and around 60 per cent of urban areas experiencing a significant decline in extreme windy days. Around 17 per cent of urban areas experienced a significant increase in daily precipitation extremes, and around 10 per cent experienced a significant increase in annual maximum precipitation.

Lead author of the research Professor Vimal Mishra from IIT Gandhinagar said: "Our results show significant increases in heat waves and the number of hot days and warm nights, and at the same time declines in cold waves and extreme windy days in many urban areas over the last 40 years. We also find that the number of changes in precipitation extremes was modest, which is somewhat surprising as our previous work showed a predominance of increases in precipitation extremes in major U.S. urban areas.

"Over half of the world's population now live in urban areas; hence, it is particularly important to understand how the climate and climate extremes, in particular, are changing in these areas.

"Urban areas make up a relatively small part of the global land area; however, they are the centre of wealth, so damage to urban infrastructure could result in potentially large economic losses. Surprisingly, there have been few studies that have focused on changes in climatic extremes in these areas."

Using a separate data set in which 142 pairs of urban and non-urban areas were selected, the researchers found disparate changes for temperature and wind-related extremes, with generally more increases in temperature-related extremes, and more decreases in wind-related extremes in urban areas compared to non-urban areas.

The team is now examining the impacts of climate and weather extremes in urban regions on critical lifeline infrastructures, as well as on urban and coastal ecosystems and marine life. *Source:* http://www.sciencedaily.com/releases/2015/01/150130102543.htm

The world's urban areas have experienced significant increases in heat waves over the past 40 years. ***Source:*** **http://www.sciencedaily.com**

[1] Vimal Mishra, Auroop R Ganguly, Bart Nijssen, Dennis P Lettenmaier (2015). Changes in observed climate extremes in global urban areas. *Environmental Research Letters*,10 (2): 024005 DOI: 10.1088/1748-9326/10/2/024005

Study aims at mitigating human impacts on the Central Valley, California

March 2015 — As more people move to different regions of the country, planners will be required to use as many tools as they can to develop urban areas that satisfy population demands and do not overburden the environment.

A new study from Arizona State University (ASU) details some of the dynamics at play as one region of the country, the Central Valley of California, braces for substantial population growth and all it entails. The study, based on computer simulations of rural to urban land conversion using the ASU Advanced Computing Center, shows that as areas of California grow and develop, the resulting built environment could generate additional heat (i.e., the urban heat island).

But the UHI can be mitigated using new technologies and the latest in sustainable design techniques, said Matei Georgescu, the author of "Challenges associated with adaptation to future urban expansion,"[1] which appears in the April 1, 2015 issue of the *Journal of Climate*. Finding the right combinations of technologies and techniques will be key.

"This research examines, for the first time, climate impacts for rapidly expanding urban areas within California exclusively due to anticipated conversion of existing landforms to the built environment, such as variable density residential dwellings and commercial infrastructure," said Georgescu, an assistant professor in ASU's School of Geographical Sciences and Urban Planning and author of the study.

"In addition, commonly proposed urban climate adaptation strategies are examined to assess their efficacy in mitigating urban induced warmth," he explained. "Given that decisions about future land use change in this potentially heavily populated area have yet to be made, it is critical to understand environmental consequences of such development pathways prior to their taking place."

Georgescu focused his study on the Central Valley area of California, a large inland area that ranges from Redding to the north to past Bakersfield to the south. The region encompasses some 22,500 square miles and currently is the country's richest agricultural area. It also is the fastest growing region of California, and is expected to add 5 million people by the year 2060 and millions more by 2100.

Georgescu used ensemble-based simulations employing EPA projections of urban growth to assess urban expansion climate effects by the year 2100 in the Central Valley. He first assessed the resulting rise in regional temperatures (expected to be 1 to 2 degrees C) and then explored several temperature mitigating strategies (cool roofs, green roofs and hybrid approaches) for buildings. He then assessed the environmental impact of the different strategies.

"The focus of the study was on those regions of California projected to undergo the greatest conversion to urban land use and covers," said Georgescu, who also is a senior sustainability scientist at ASU's Julie Ann Wrigley Global Institute of Sustainability. "Modification of large swaths of existing California landscapes to urban areas raises regional climate concerns for future residents."

California's Central Valley. *Source:* visitcentralvalley.com

What Georgescu found was that as the state deploys temperature-mitigating technologies, there are secondary effects that appear to take place – less daytime air turbulence – which could lead to higher concentrations of pollutants.

"This finding shows that as temperature-mitigating technologies of the sort investigated in this research are deployed, they considerably reduce daytime air turbulence, and therefore identical future emissions of pollutants [e.g., particulate matter (PM)] will be confined to a smaller volume, decreasing perceivable air quality," added Georgescu.

The research shows that future environmentally sensitive development will need to rely on incorporating clean energy technologies that limit emissions, Georgescu said.

For example, the impact of more efficient transit and transportation systems with decreased PM emissions are likely to play important roles in terms of actual air quality impacts. He added that a principal take-home message of this work is the significance of such urban adaptation strategies extending beyond just near-surface temperature impacts, since humans must breathe this modified air.

In addition, targeting the UHI itself, primarily a nighttime rather than daytime phenomenon, is a research area requiring further consideration.

"The bulk of the UHI effect occurs due to reduced loss of energy from the urban infrastructure during nighttime hours," Georgescu said. "The strategies explored in this work and those that are widely considered today as reasonable and practical choices illustrate much greater capability to reduce daytime temperatures, but exhibit little effects during the nighttime hours, when reduction of the UHI is required most. Consequently, common urban adaptation approaches do not directly tackle the effects of the UHI."

"So, orientation of buildings and preferred landscape configurations that permit long-wave radiation loss during nighttime hours and directly target impacts associated with urban expansion are critical to examine further," he added. *Source:* http://www.sciencedaily.com/releases/2015/03/150327132234.htm

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[1] M. Georgescu (2014). Challenges associated with adaptation to future urban expansion. *Journal of Climate*, 141210105735004 DOI: 10.1175/JCLI-D-14-00290.1

Paris briefly tops world charts for air pollution

March 2015 — Air pollution in Paris was worse than in any city in the world for a brief moment – putting it above regular offenders such as Delhi and Beijing, according to pollution-monitoring mobile app-maker Plume Labs.

According to Plume (which monitors 60 cities worldwide), an air quality index number above 150 is considered "critical", while anything above 100 is considered "harmful". Paris hit 125 on the app's index on March 18th.

The smog, which continued to envelop the city as well as much of north-western France, quickly dissipated enough to knock Paris off the top polluter's spot.

City Hall, which told FRANCE 24 that it recognized the gravity of the situation, put some short-term measures into place. On Saturday March 21, public transport was to be free in the greater Paris region in an effort to reduce pollution from cars, while parking in the city would be free.

In the long term, the city is looking to progressively ban the most polluting cars and lorries from the streets while working to extend and upgrade the public transport system in a bid to wean the public off private vehicles.

Despite the recent high numbers, French experts say any claim that Paris is one of the most polluted cities in the world is far-fetched.

"We have pollution issues, but lots of other cities do too," said Karine Leger, assistant director of Airparif in Paris, which monitors air quality for the Environment Ministry and supplies its data to Plume Labs.

"Air quality in the French capital is generally better than a decade ago," she said, adding that the spike was not indicative of Parisian pollution levels in general. "It's the wrong idea to compare a city at a certain moment when you have meteorological conditions that could make the pollution worse at that point."

The weather is indeed partly to blame. March was a dry month and as the spring weather warmed up, more dangerous fine particles filled the air. But blaming the weather is no excuse, according to the French Association of Transport Users (FNAUT), which condemned "uninspired politicians" for failing to tackle the problem head-on.

"We need long-term solutions including extra charges on heavy goods vehicles which the government backtracked from implementing last year," FNAUT spokesman Fabrice Michel told FRANCE 24, in reference to the proposed "Ecotax" that had truckers up in arms in 2014.

"Paris also needs a congestion charge inside the city," he added. "This would reduce circulation and raise revenue. But all our politicians seem to do is wait for the rain and when it doesn't come, they blame the weather for their failings."

City Hall rejected this criticism, and insisted it was doing everything possible to find long-term solutions to the pollution problem.

This file photo, dated March 11, 2014 shows the Eiffel tower and Paris' roofs through a haze of pollution. Paris experienced a periodic pollution spike on March 18, 2015. *Source:* www.france24.com

"We're already investing heavily in improving public transport and the most polluting cars [diesel cars made before 2001] will be banned starting in July," said Christophe Najdovski, spokesman for the Paris's transport commissioner. Najdovski added that a London-style congestion charge levied on motorists in central Paris was off the cards – "the mayor believes it is unjust" – but insisted everything was being done to encourage people to go clean.

"A big problem is the périphérique [city ring road] which is just about the busiest urban motorway in Europe," he added. "It's used by a million cars a day, and we can't just stop people from using it."

The Plume Labs index which gave Paris the worrying score of 125 includes various pollutants, but the main offenders are the fine particles emitted by diesel vehicles, according to Patrick Kinney, an air pollution epidemiologist and professor at Columbia University's Mailman School of Public Health.

The dangerous particulate matter floating in the air above Paris comes in two sizes, PM10 (from smoke and dirt) to the much smaller PM2.5 which contains toxic organic compounds and heavy metals and brings serious long-term health implications, from wheezing and asthma and even lung cancer.

According to Kinney, pollution in Paris is more noticeable than in big cities in the US because of the much larger number of diesel vehicles on French roads.

"Riding a bike in Paris, versus riding a bike in New York, you can really notice the difference," said Kinney. "That's probably because of the amount of diesel cars."

Source: http://www.france24.com/en/20150320-paris-city-smog-pollution-plume-labs-hidalgo-public-transport-diesel/

This Texas town will get all of its energy from solar and wind

Source: Mike Blyth

March 2015 — News that a Texas city is to be powered by 100-percent renewable energy sparked surprise in an oil-obsessed, Republican-dominated state where fossil fuels are king and climate change activists were described as "the equivalent of the flat-earthers" by U.S. Senator and GOP presidential hopeful Ted Cruz.

"I was called an Al Gore clone, a tree hugger," says Jim Briggs, interim city manager of Georgetown, a community of about 50,000 people some 25 miles north of Austin.

Briggs, who was a key player in Georgetown's decision to become the first city in the Lone Star State to be powered by 100-percent renewable energy, has worked for the city for 30 years. He wears a belt with shiny, silver decorations and a gold ring with a lone star motif, and is keen to point out that he is not some kind of California-style eco-warrior with a liberal agenda. In fact, he is a staunchly Texan pragmatist.

"I'm probably the furthest thing from an Al Gore clone you could find," he says. "We didn't do this to save the world — we did this to get a competitive rate and reduce the risk for our consumers."

In many Texas cities, the electricity market is deregulated, meaning that customers choose from a dizzying variety of providers and plans. In Houston, for example, there are more than 70 plans that offer energy from entirely renewable sources.

That makes it easy to switch, so in a dynamic marketplace, providers tend to focus on the immediate future. This discourages the creation of renewable energy facilities, which require long-term investment to be viable. But in Georgetown, the city utility company has a monopoly.

When its staff examined their options last year, they discovered something that seemed remarkable, especially in Texas: Renewable energy was cheaper than non-renewable. And so last month, city officials finalized a deal with SunEdison, a giant multinational solar energy company. It means that by January 2017, all electricity within the city's service area will come from wind and solar power.

In 2014, the city signed a 20-year agreement with EDF for wind power from a forthcoming project near Amarillo. Taking the renewable elements up to 100 percent, SunEdison will build plants in West Texas that will provide Georgetown with 150 megawatts of solar power in a deal running from 2016 or 2017 to 2041. With consistent and reliable production the goal, the combination takes into account that wind farms generate most of their energy in the evenings, after the sun has set.

Despite its proximity to the left-leaning Austin, Georgetown is not instinctively progressive. Its main selling point is the old-school charm of its historic core, which credibly bills itself as the Most Beautiful Town Square In Texas. It is not a natural political companion to Burlington, a similar-sized city in liberal Vermont that last year reportedly became the first city in the U.S. to use 100-percent renewable energy.

Though Georgetown is home to Southwestern University, a liberal arts college, Briggs said that more than 40 percent of residents are over 50. The area is conservative and much of the positive reaction to the announcement has come less because the citizens are desperate to help the planet than because they are getting the security of a fixed rate plan that will be similar to the current cost of about 9.6 cents per kilowatt-hour and will protect them against the impact of fluctuations in the price of fossil fuels.

Chris Foster, Georgetown's manager of resource planning and integration, said that since the announcement he has "gotten calls from businesses as far away as California and Maryland wanting to know: What does it cost to move over here? [They say:] 'We're out here trying to be renewable; it's cheaper over there to be renewable.'"

He said that for manufacturing companies conscious of their carbon footprint, basing themselves in a place that offers 100-percent wind and solar energy would be an easy way to boost their green credentials.

In a state that loves to bash Washington, what little criticism there has been, Briggs said, has stemmed from the federal tax breaks handed out to encourage renewable energy.

"Well then, we should never have mass transit and quit farming … that argument, while it's there, is really pretty shallow," he says.

Fearing an imminent end to the government's generosity, private green energy companies have scrambled to build facilities. At the same time, in recent years a glut of Chinese-made panels has made solar power more cost-effective. And while West Texas is an oil driller's paradise, it is also sunny and gusty, making it a perfect corridor for renewable energy.

The region bordering New Mexico is one of the prime solar resource sites and the wind whistles across the plains to such an extent that, as *Scientific American* pointed out last year, the state is America's largest wind power producer — as well as leading the nation in the production of crude oil and the emission of greenhouse gases.

Renewable energy also uses much less water than traditional power generation — a bonus in a state where half the land and more than 9 million people are affected by drought conditions, though Briggs said that for Georgetown, water conservation was only a "side benefit."

Greg Abbott, formerly Texas attorney general and now governor, repeatedly sued the federal government over its attempts to regulate greenhouse gas emissions. Last year, the chair of the Texas Commission on Environmental Quality, Bryan Shaw, said there is a "lack of links between greenhouse gases and the climate." Shaw was appointed by former-Gov. Rick Perry, a notorious climate-change skeptic and a prospective Republican White House candidate for 2016.

Yet amid the rhetoric, denial and promotion of corporate interests and economic prosperity ahead of environmental concerns, over the past decade Texas lawmakers authorized the spending of $7 billion of taxpayers' money on the Competitive Renewable Energy Zone, a vast infrastructure project to connect West Texas wind power to major urban areas.

So Texas has the weather, the infrastructure, and — certainly in small places such as Georgetown — the current market conditions to be greener. But a state report last September cast a cloud over the future of renewable energy in Texas, saying it was not reliable or extensive enough to meet peak demand. "Renewables need conventional power backup," it said.

Fred Beach, assistant director for policy studies at the University of Texas at Austin's Energy Institute, said that, "At the moment, unfortunately, the legislature is pretty clueless when it comes to renewables," and is failing to get the most out of their investment.

Beach suspects that Big Oil will fret that Georgetown's pioneering move is the start of a trend, and polluting, inefficient coal power plants will be pushed out of service by more deployment of wind and solar energy. But he believes that would likely prove good news for natural gas generators, who will be relied upon in the scorching summer months when demand is highest.

Ultimately, he said, in a practical-minded place like Texas, the best way to encourage the use of green energy is to appeal to heads rather than hearts and make a strong business case, as happened in Georgetown.

Russ Dickson, co-owner of an antiques shop on the main square, said he was delighted at the move.

"This is a pretty conservative community and to see a conservative community step up [and do this] makes me feel good about the future," the 61-year-old said.

Outside, Jon Klopf, a barber, sat on a bench enjoying a splendidly sunny Thursday afternoon.

"They were just looking out for the cheapest deal. That's just business," the 50-year-old said. "I don't really think we should be relying too much on oil, even though they have to right now. That don't last forever.

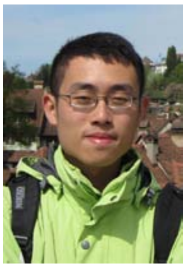
"Sun will, though. Long as the sun comes up, the wind will blow."

— By Tom Dart

This story was originally published by The Guardian *and was reproduced as part of the* *Climate Desk* *collaboration.*

Source: http://grist.org/cities/this-texas-town-will-get-all-of-its-energy-from-solar-and-wind/

Temperature projection using remote sensing: A case study of Hong Kong

By Janet E. Nichol (lsjanet@polyu.edu.hk)
and To Pui Hang

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Background

Global temperatures have increased at 0.13° per decade between 1956 and 2005 (IPCC, 2007). But individual countries report higher decadal increases, with 0.19° in USA (Knappenberger et al, 2001), 0.28° in Japan (Matsumoto et al, 2003) and 0.22° in China (Ren et al, 2004). Real comparisons remain difficult due to uncertainty over the contribution of urbanization to temperature records. As Hong Kong is the most densely built city in the world, many additional factors may contribute to the sharp increase in temperature, and great uncertainty will remain unless these can be identified. Specifically, parameters representing urbanization are difficult to quantify. The effect of greenhouse-induced warming on Hong Kong is indicated by the temperature change at Ta Kwu Ling (TKL) climate station in the northern New Territories where urban development is absent (Lam, 2006; Leung et al., 2007). Here the annual mean temperature has increased by 0.08° per decade between 1989 and 2009 (Fig. 1), but at Hong Kong Observatory's headquarters in the dense urban core an increase of 0.28° per decade between 1980 and 2009 was observed (Fig. 2). Furthermore, this is almost double the rate observed for a longer period extending back to 1948. This suggests that urbanisation is an additional factor causing temperature rise, and if current urbanization trends are continued, temperatures could increase much faster in future.

Since the urban infrastructure is known to alter the thermal environment creating an urban heat island (UHI) effect (Howard, *The Climate of London*, Vol.1, 1818), the dependence on urban features suggests greater variability of temperatures over space in urban, than in rural areas. Spatially detailed temperature mapping and future temperature projections are therefore required, which cannot be provided by current low-resolution climate models. For example IPCC's AR4 climate projections (IPCC, 2007) are at coarse spatial resolution of over 100km, and although AR5 considers urbanization effects at city-wide level, the projections do not recognize intra-urban heterogeneity. Fine spatial resolution satellite imagery from thermal infra-red sensors such as Landsat ETM+ and ASTER can provide a basis for

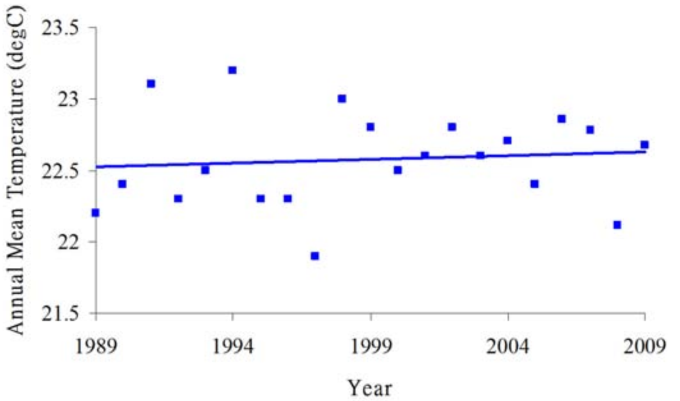

Figure 1. Trend of annual mean temperature at Ta Kwu Ling from 1989 – 2009.

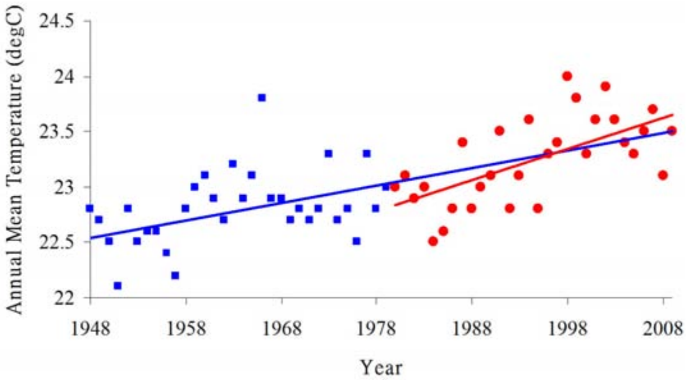

Figure 2. Trend of annual mean temperature at HKO Headquarters from 1948 – 2009 (the blue and red lines represent the trend for the entire period and only the second half, respectively).

more detailed modelling which allows urban scale effects to be considered, and many satellite-based urban climatic studies have been carried out (for a comprehensive review, see Voogt and Oke (2003) and Weng (2009)). Most previous research has only utilized satellite images for static climate modelling, but this study demonstrates the use of thermal satellite images for dynamic modeling of processes whose spatial components change through time.

Methods

Use of thermal satellite images for baseline air temperature mapping

Thermal satellite images from the ASTER satellite sensor on 22nd August 2009 daytime and 13th August 2008 nighttime, were geometrically and emissivity corrected and converted to air temperature (Nichol and To, 2012). The emissivity correction (Nichol, 2009) resulted in a pixel size of 10m. The air temperatures were derived from a regression of image surface temperatures against a series of air and surface temperature points collected in the field at the time of imaging, for which an R^2 of 0.74 and 0.82 were obtained for day and nighttime images respectively. When the image-derived air temperatures were validated against air temperatures at automatic weather stations (AWS), R^2 values of 0.75 and 0.84 were obtained for day and night (Figure 3). The two images were tested for their relevance to times and dates other than the time of imagery, and were found to be representative of spatial patterns of air temperature over Hong Kong for 4 hours during the day and 11 hours during the night (Figure 3) on the imaging dates respectively. The nighttime image was able to represent 62 out of 69 dates during the summer months and the daytime image was representative of 17 out of 76 dates (Nichol and To, 2012).

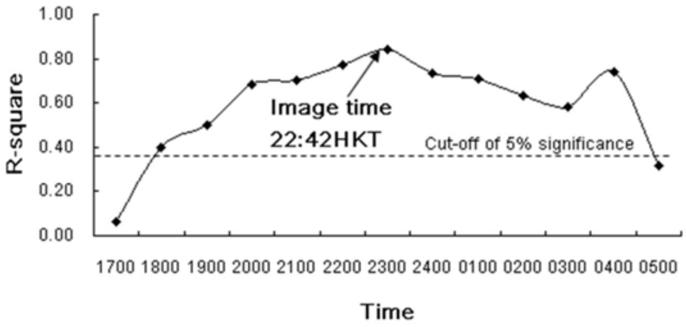

Figure 3. Hourly time series correlation analysis between image-derived and 11 AWS recorded air temperature on the nighttime image.

Table 1. Regression models used for downscaling, and the R^2 values, Standard deviation (SD) of TKL observations for July to September, from 2000 to 2009, and the mean discrepancy between the predicted and observed temperatures for each model in the same period. The n values denote the number of months available for each climate model.

Model	Regression Model[1]	R^2	n	Mean Discrepancy	Accept?
BCM2	$y = 0.9859x - 3.0664$	0.91	120	-0.14	Yes
CM3	$y = 0.9449x - 0.9997$	0.87	120	-0.32	No
MK3.0	$y = 1.2679x - 9.0459$	0.86	108	-0.36	No
*CM2.0	$y = 1.0848x - 4.0971$	0.85	108	-0.01	No
E20/Russell	$y = 0.8504x + 5.0524$	0.93	72	-0.12	Yes
CCSM3.0	$y = 1.2336x - 6.8555$	0.92	120	-0.20	Yes
PCM (V1)	$y = 1.1649x - 5.7879$	0.93	120	-0.14	Yes
HADCM3	$y = 1.2357x - 6.2108$	0.82	120	0.02	Yes
CGCM2.3.2a	$y = 1.0691x - 3.0463$	0.90	108	0.38	No
ECHO-G	$y = 1.1619x - 6.6416$	0.85	108	0.12	Yes
CM3.0	$y = 1.2961x - 10.74$	0.82	108	-0.41	No
ECHAM5	$y = 0.9362x + 0.7609$	0.80	108	-0.43	No
CM4 (V1)	$y = 1.757x - 21.04$	0.88	120	-0.10	Yes
*CGCM3.1	$y = 1.3493x - 11.095$	0.85	108	-0.28	No
MIROC (V3.2)	$y = 1.0233x - 0.8576$	0.89	108	-0.17	Yes

[1] y = model data, x = TKL station data

Projection for greenhouse-induced warming

Temperature was projected up to 2039 using a multi-model approach, whereby the simulation outputs of 15 global climate models, with the A2 emission scenario specified, were extracted from the Program for Climate Model Diagnosis and Inter-comparison (PCMDI) website, for the grid cell corresponding to Hong Kong. For this study the A2 emission scenario was selected for the modelling as it lies between the highest and lowest scenarios for the study period up to 2040. Timeframes beyond this are deemed unsuitable as urban parameters used in the modelling are unavailable. For downscaling of temperature predictions from regional to local level, the monthly temperature outputs from 2010 to 2039 of the eight selected GCMs were fitted into regression models obtained by regression of GCM outputs from the earliest year available for the GCMs against Hong Kong's 'rural climate station at Ta Kwu Ling (Table 1). The decadal summer temperatures predicted by each model were averaged to obtain an ensemble mean, and the upper and lower limits provided the maximum and minimum temperatures at the end of each decade.

Projection of temperature due to urbanisation

Since the UHI is an effect of urbanization, not a causative factor, it cannot be used to parameterize a future prediction model. This study used the plot ratio as the parameter defining the degree of urbanization, as it considers the density and height of buildings at a site, is a widely accepted parameter in city planning and future plot ratios for sites were available from government sources. Plot ratio is defined as the gross floor area (GFA) of buildings divided by the site area, of each project site (Eq. 1):

$$PR = \frac{\sum a \times f}{A} \quad (1)$$

where PR is plot ratio, a is the footprint area of a building, f is the number of floors and A is the corresponding site area.

The rates of temperature change at different urban locations would depend on the surrounding built environment since building materials create higher thermal load. The wide spatial spread of Hong Kong's AWS (Hong Kong Observatory, 2013) provides a good opportunity to study temperature changes with respect to the surrounding environment. The hourly temperature data of eight AWS which have been established for at least 10 years and with continuous records since their establishment were obtained. Since no change in plot ratios had taken place at any of the sites since establishment, any temperature increases at these AWS should be attributed to territory-wide developments, which cause more heat to be retained by existing urban structures anywhere within the territory.

The hourly summertime (July to September) temperatures were grouped into daytime (10am-1pm) and nighttime (6pm-4am) temperatures respectively, periods during which temperature patterns remain constant (Nichol and To, 2012) since temperature trends are expected to be different owing to different thermal processes during day and night (Voogt and Oke, 2003). The TKL weather station shows an increase of 0.08° and 0.07° per decade for day and night respectively, which is very similar to the overall background warming of 0.08° per decade as observed from the long term data for Hong Kong (Fig. 1). The temperature change solely due to urbanisation was obtained by subtracting background temperature increase at TKL from the total increases of the other stations.

Estimating urbanization effects using using plot ratios

The plot ratios of the street blocks where the eight selected AWS are situated were extracted and correlated with temperature changes at the corresponding site. A logarithmic function was best able to explain the relationship between the degree of urbanization (plot ratio) and temperature (Eqs. 2 and 3), because air temperature is more closely related to horizontal surfaces (r = 0.7) than vertical surfaces (r = 0.49) (Nichol, 1996). This implies that air temperature is more sensitive to density rather than height of buildings, though the latter cannot be fully neglected. It can be assumed that the rate of temperature increase can be similar in areas with different plot ratios if there is no significant difference in the built densities, meaning that the plot ratio difference is a result of building height variations. In Hong Kong, most areas of high plot ratio are occupied by high rise buildings. It can be expected that the rate of temperature increase will slow down when the plot ratio has reached a certain level since the temperature is less sensitive to the height of buildings. A logarithmic function can best model this relationship as it gives a slowing trend when the independent variable (i.e. plot ratio) increases.

Daytime: $y = 0.13\ln x + 0.44$ (2)

Nighttime: $y = 0.11\ln x + 0.02$ (3)

where x = plot ratio, and y = net temperature increase per decade.

Modeling future urban temperatures

In this project, high resolution satellite imagery allows fine resolution urban environment modeling, and with the aid of dynamic modelling software (e.g. PCRaster: Utrecht University, 2009), temporal data can be integrated with satellite imagery at different spatial resolutions. Once temporal parameters such as rate of change have been specified for each pixel according to its degree of urbanisation, an image at every time step can be generated using different input parameters until the end of the study period (Van Beek and Van Asch, 2004).

The plot ratios of all street blocks over Hong Kong, including future plot ratios, were input into the logarithmic equations (Eqs. 2 and 3) in order to calculate the net temperature increase per decade. Pixels were assumed to have the same increase as the street block to which they belonged. These pixel-based incremental values were then added to the original temperatures of the pixel by decadal increments for the next 3 decades. The actual temperature increase was then obtained by adding the background warming rate to the net temperature increase. Therefore, in total 3 daytime and 3 nighttime future temperature maps were produced by dynamic modeling on a per-pixel basis, with the model parameters varied at each time step (i.e. decade).

Findings

By downscaling of IPCC models (Table 1), the summer temperature at TKL rural station is expected to increase by 0.24° in 2010 – 2019; 0.11° in 2020 – 2029 and 0.32° in 2030 – 2039. The relatively small increase of 0.11° in the third decade (2020 – 2029) may be explained by the influence of the emission reduction agreements later in the second decade (Copenhagen Accord, 2009), which has been factored into the models. The total temperature increase in these three decades is estimated to be between 0.10° and 1.29°, with an ensemble mean of 0.67°.

Although urban development is frozen after the first decade due to lack of planning data beyond 2020, this relationship assumes that even if the plot ratio does not change, air temperature would still increase. This phenomenon can be explained by regional rather than local scale developments. In the past few decades, the whole Pearl River Delta (PRD) region has experienced rapid urbanization, with massive increase in population and buildings. The new developments would increase the heat storage capacity, with more long-wave radiation trapped by artificial materials (Oke and Maxwell,1975). As temperatures have been rising, more energy consumed by air conditioning, in turn releases more heat. This would create a large urban boundary layer (UBL) (Oke, 1976), covering the whole PRD region including Hong Kong. The heat trapped in the UBL will diffuse across the UBL, and feed back into the UCL where urban structures in any area will reabsorb the heat. Thus temperatures would increase further in such areas even if there is no further urban development in Hong Kong. Validation of the outputs by back-projection, observed a mean RMSE between the actual and projected change for the stations, of 0.19°C for daytime and 0.14°C for nighttime.

Mapping the temperature projections

The summer nighttime air temperature image (Fig. 4a) shows the inner urban areas as significantly warmer (29 -31°) than the surrounding non-built and vegetated areas (28.5-29°) and as in the daytime, older medium rise high density districts are the warmest (Fig. 4a and b). For example the purple areas in dense urban districts of Jordan (corresponding to the old Chinatown district) and Hung Hom (as arrowed), which are 0.7° hotter than their surroundings, can be regarded as the core of the UHI. Thus nighttime temperature hot spots are the densest built areas, whereas during the day the hottest areas are open spaces and low density built areas.

Between 2010 and 2039, nighttime temperatures in the centre of Kowloon are expected to show at least a 2° increase, reaching up to 32° (Fig. 4b, red and white areas). Open spaces should continue to be 1-2° cooler (the purple class) than the central urban area. The UHI core will develop further to include more areas along the main shopping districts of Nathan Road and Tsim Sha Tsui (white areas) in the future. The intensity of the UHI should increase further as temperatures in urban areas will rise faster than in rural areas of lower plot ratios.

Validation of the projected temperatures, with a mean RMSE of 0.19° and 0.14° for 8 climate stations for day and night respectively, suggests the models are reliable and that future increase will follow the predictions based on trends from the 1980s and 1990s to 2009, which are linked to plot ratios plus the background warming rate.

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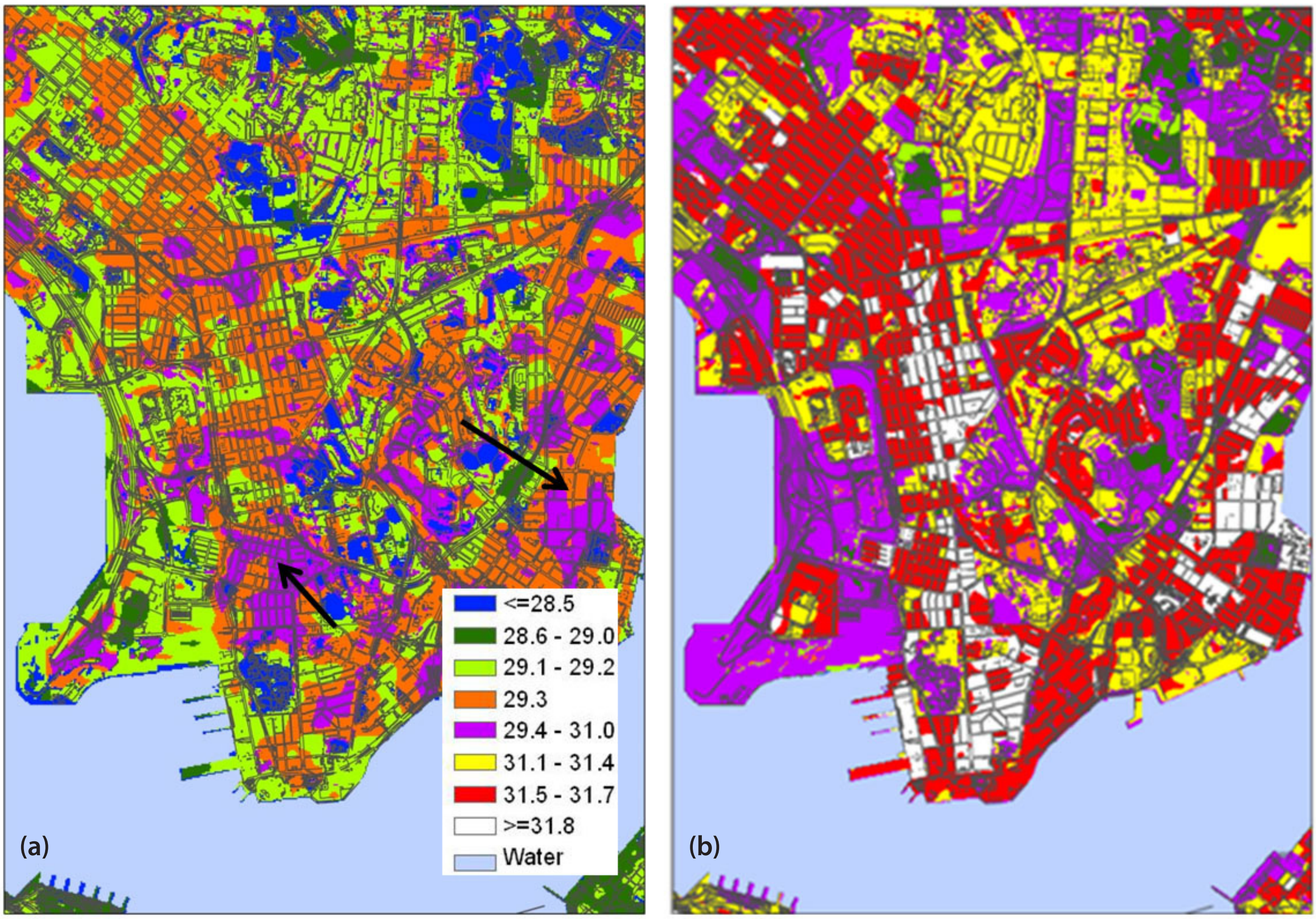

Figure 4. (a) Nighttime temperature map of Kowloon in 2008, (b) Projected nighttime temperature map of Kowloon in 2039.

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Heat mitigation through urban form and design – A case study of Phoenix, AZ


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In this study, we investigated the effect of urban form, design, and landscaping on mid-afternoon temperatures in semi-arid Phoenix, Arizona, USA, through field observations and microclimate simulations. To find effective strategies for daytime heat mitigation, we designed five urban form scenarios that represent a realistic cross-section of typical residential neighborhoods in the Phoenix metropolitan area, each corresponding to a distinct Local Climate Zone (LCZ). We then combined the urban form scenarios with three landscape designs and simulated microclimate conditions for these neighborhoods in ENVI-met for June 23, 2011, a typical pre-monsoon summer day. Model outputs were validated using the North Desert Village (NDV) landscape experiment at Arizona State University's Polytechnic campus. Results show that dense urban forms can create local cool islands in mid-afternoon. Our study showcases the utility of the LCZ concept for urban planning and design purposes. This article is a synopsis of our study that was recently published in Landscape and Urban Planning (Middel et al., 2014).

Introduction

During the hot summer season in desert cities, high solar intensity, excessive daytime heat, and elevated nighttime temperatures due to the urban heat island (UHI) effect adversely affect the urban ecosystem. Increased temperatures have implications for outdoor water use, energy use for air conditioning, air quality, and impact human health and well-being (Harlan et al., 2006; Golden, 2004; Guhathakurta & Gober, 2007). Increasing the amount of vegetation in urban areas is a key strategy outlined by the US Environmental Protection Agency (EPA) to mitigate heat, but in desert cities, where water resources are scarce, this approach creates a cooling – water use tradeoff that needs to be optimized to find a sustainable balance (Shashua-Bar et al., 2009; Gober et al., 2012; Middel et al., 2012). Recent studies explored the impact of land use, density, type and arrangement of vegetation, and residential parcel design on UHIs and urban climate (Stone & Norman, 2006; Hart & Sailor, 2009; Guhathakurta & Gober, 2010). Pearlmutter et al. (2007) found that desert environments have great potential for heat mitigation through urban form and design, because they are usually characterized by large diurnal temperature differences, low humidity, and strong winds. In this study, we systematically analyze the heat mitigation potential of various neighborhood types in the Phoenix metropolitan area, classified into Local Climate Zones (LCZs) (Stewart & Oke, 2012), in order to evaluate their cooling and warming potential related to landscaping and the built form.

Methodology

To investigate the impact of urban form and landscaping on mid-afternoon temperatures in Phoenix LCZs, we used ENVI-met 3.1 (Bruse, 2013). We parameterized and evaluated the model by comparing microclimate simulations to field observations in the North Desert Village (NDV) landscape experiment at Arizona State University's Polytechnic campus. NDV is a residential community that contains three 120-m x 120-m mini-neighborhoods with six homes, each neighborhood designed to represent a typical landscape style in the Phoenix metropolitan area: mesic, oasis, and xeric (Figure 1). The mesic neighborhood features sprinkler-irrigated non-native, high water-use plants and grass; oasis landscaping includes drip-irrigated high and low water-use plants, the ground covered with gravel and sprin-

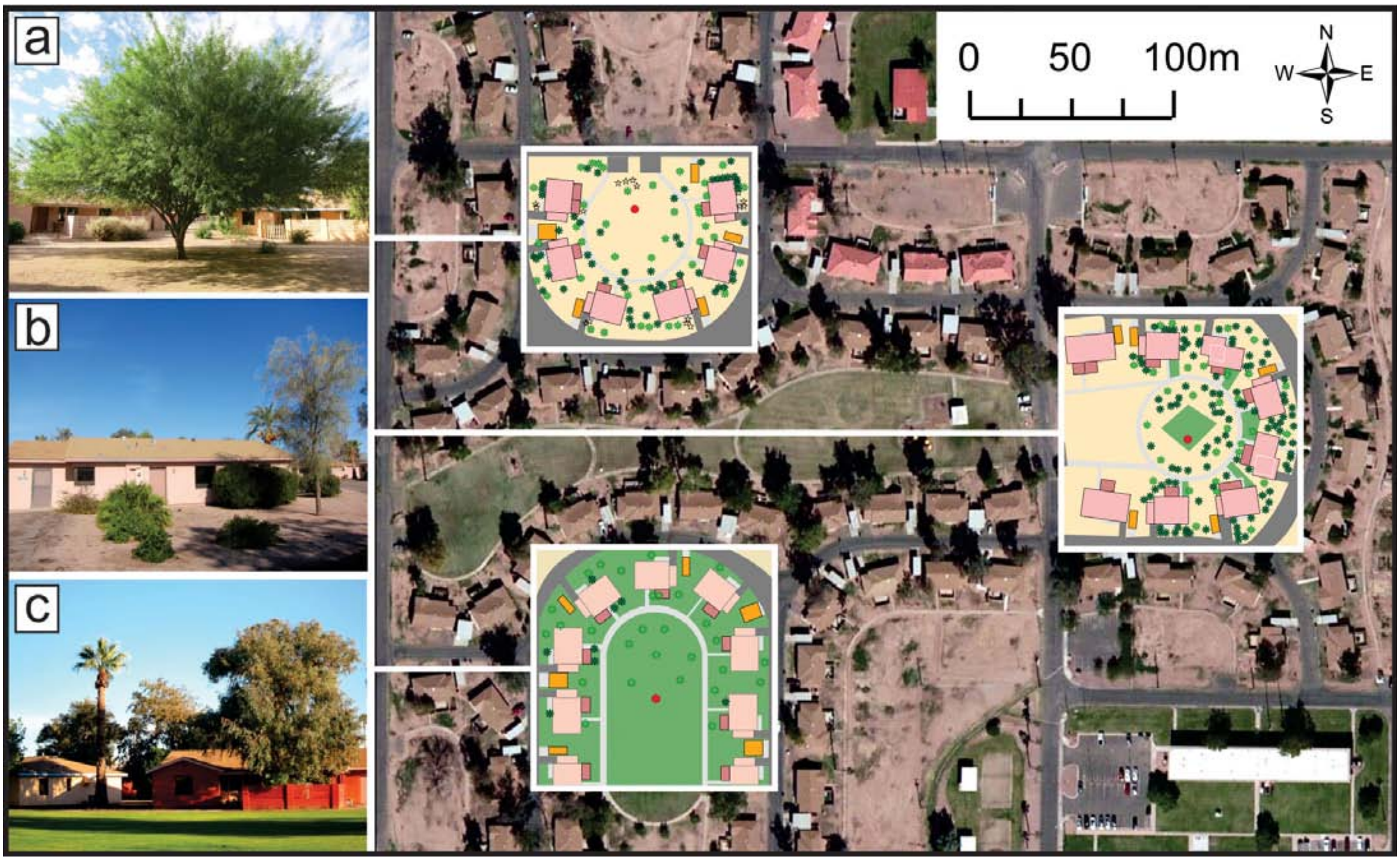

Figure 1. The North Desert Village (NDV) landscape experiment at Arizona State University's Polytechnic campus comprises three mini-neighborhoods with controlled landscape types: (a) xeric; (b) oasis; (c) mesic.

kler-irrigated grass patches; the xeric neighborhood is landscaped with drip-irrigated, water-conserving drought-tolerant plants and gravel.

The vegetation parameters required by ENVI-met were collected on-site, yielding an inventory of 233 shrubs and 126 trees for the three study areas. As initial meteorological conditions for the simulation, we used hourly observations from the MesoWest Phoenix-Mesa Gateway weather station (MesoWest, 2012), located 2.5 km east of the NDV. We ran ENVI-met for June 23, 2011, a typical Phoenix pre-monsoon summer day with a daily maximum temperature of 43°C, a minimum of 26 °C, and clear skies. We assessed the accuracy of the ENVI-met simulations by comparing hourly observations of 2-m air temperatures from a weather station in the center of each NDV neighborhood to modeled temperatures.

After model validation, we designed five urban form scenarios that represent a cross-section of typical residential neighborhoods in Phoenix. The scenarios correspond to distinct Local Climate Zones (LCZs), a classification system developed by Stewart and Oke (2012) to report urban climate findings in a standardized fashion. From the hierarchy of 17 LCZs defined in the urban-rural transect, our scenarios represent the following zones (Table 1):

Table 1. Local Climate Zone characteristics. White columns show average values (Stewart & Oke, 2012), and gray columns show properties of corresponding Phoenix neighborhoods selected for this study.

	Open Lowrise		Open Midrise		Compact Lowrise		Compact Midrise		Compact Highrise	
Sky view factor	0.6-0.9	0.6	0.5-0.8	0.5	0.2-0.6	0.6	0.3-0.6	0.5	0.2-0.4	0.4
Building height	3-10 m	7 m	10-25 m	23 m	3-10 m	7 m	10-25 m	10 m	>25 m	25 m
Building fraction	20-40%	30%	20-40%	26%	40-70%	40%	40-70%	39%	40-60%	47%
Impervious area	20-50%	29%	30-50%	12%	20-50%	27%	30-50%	52%	40-60%	48%
Surface albedo	0.12-0.25	0.16	0.12-0.25	0.13	0.12-0.25	0.16	0.10-0.20	0.17	0.10-0.20	0.20

Open Lowrise (open set detached 2-story homes in a Mesa neighborhood), *Open Midrise* (7-story condominiums in Scottsdale), *Compact Lowrise*, (high density detached 2-story single-family homes in Mesa) *Compact Midrise* (close-set 3-story apartments near Phoenix downtown), and *Compact Highrise* (close-set highrise buildings in Phoenix downtown). We combined these neighborhoods with mesic, oasis, and xeric landscape designs to create a matrix of urban form and landscaping scenarios. ENVI-met was run for each combination using the configuration parameters determined in the validation process.

Results

Overall, ENVI-met captured the thermal hierarchy of the three NDV neighborhoods well. The xeric neighborhood was found to be the hottest site with temperatures up to 44.8°C (modeled) and 44.4°C (observed). The oasis neighborhood is slightly cooler, followed by mesic landscaping, which is coolest by 1°C or more compared to the other sites. The index of agreement between measured and simulated 2-m air temperatures is excellent for all validation runs, ranging from 0.97 (xeric) to 0.99 (mesic). For detailed model parameters and validation results, we refer to Middel et al. (2014).

To compare diurnal temperature variations among the urban form and landscaping scenarios, we calculated the hourly average and standard deviation of 2-m air temperatures over all grid cells (excluding buildings) in each scenario. Within-neighborhood temperature variability was found to increase as temperatures rise, with the highest standard deviation at 15:00h. The compact scenarios exhibit larger variability than their open equivalents. As expected, across all urban forms, the xeric scenarios are warmest, followed by oasis and mesic. A thermal hierarchy can also be established for the LCZs. On average, the *Open Midrise* scenario is the hottest neighborhood, followed by *Compact Midrise*, *Open Lowrise*, and *Compact Lowrise*. As an exception to this rule, the mesic *Compact Midrise* scenario is slightly warmer than the mesic *Open Midrise* scenario. The *Compact Highrise* LCZ has a distinct temperature profile with a smaller diurnal temperature amplitude compared to other neighborhoods. Temperatures are warmer at night and in the early morning, but lower during the day. This effect is known as a daytime cool island and has been reported by several authors (Pearlmutter et al., 1999; Chow & Roth, 2006; Erell & Williamson 2006).

For further analysis of thermal differences between the scenarios, we mapped the spatial distribution of 2-m air temperatures at 15:00h (Figure 2), a time of day when thermal stress for pedestrians in the Phoenix metropolitan area is high and heat mitigation is important. Within-scenario air temperature patterns are similar across landscaping scenarios, with a hierarchy from cool (mesic) to warm (xeric), but patterns vary across LCZs. In all simulations, the air temperature distribution follows the wind direction from west to east. Higher temperatures at the west border of the study sites are an artifact of the model's boundary conditions. Temperatures are generally lower on the lee-side of the buildings due to shading and small advective effects. For example, in the *Compact Midrise* scenarios, the apartments to the west lower air temperatures in the adjacent courtyard by about 2°C. A similar trend can be observed for the *Open Midrise* scenarios. In the *Compact Lowrise* LCZ, mean 2-m air temperatures at 15:00h are 0.2–0.3°C lower than in the *Open Lowrise* LCZ. Modeled wind speed between buildings is also lower in the compact setting, revealing a less significant advective effect and locally allowing for other processes such as shading to dominate the thermal situation. Modeling results further suggest that east-west street canyons in the lowrise LCZs have a cooling effect and function as air channels, accelerating the wind and lowering daytime temperatures at the windward-side, independent of surface materials.

We created a histogram for the relative frequency of mid-afternoon 2-m air temperature values in the model area (Figure 3). In the midrise scenarios, the temperature range is larger than in the corresponding lowrise scenarios. The *Compact Highrise* scenario has the largest temperature range and the histogram clearly shows that this LCZ is the coolest neighborhood at 15:00h. The validation scenarios (top rows in the histogram) are more sparsely built than their *Open Lowrise* scenario counterparts and have higher temperatures. Similarly, the open scenarios feature higher temperatures than the compact scenarios in nearly all cases, indicating that extensive open areas contribute to higher daytime temperatures due to a lack of shading.

Pearlmutter et al. (1999) found that compact street canyons in dense urban forms can create cool

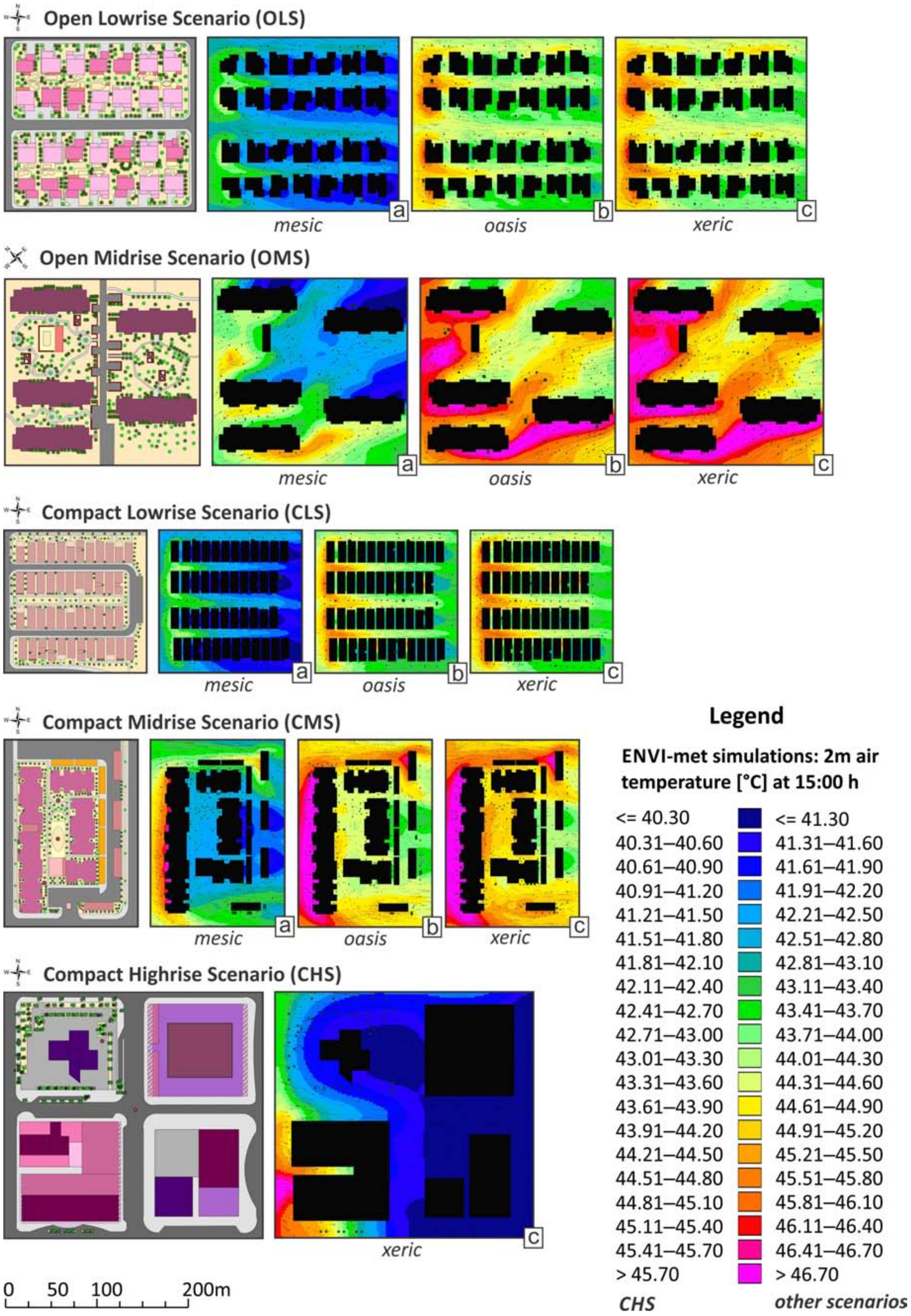

Figure 2. Urban form scenarios, classified into Local Climate Zones (LCZ); arrangement of buildings (left); snapshots of the 2-m air temperature distribution for each combined urban form and landscaping scenario for June 23, 2011, 15:00h (right).

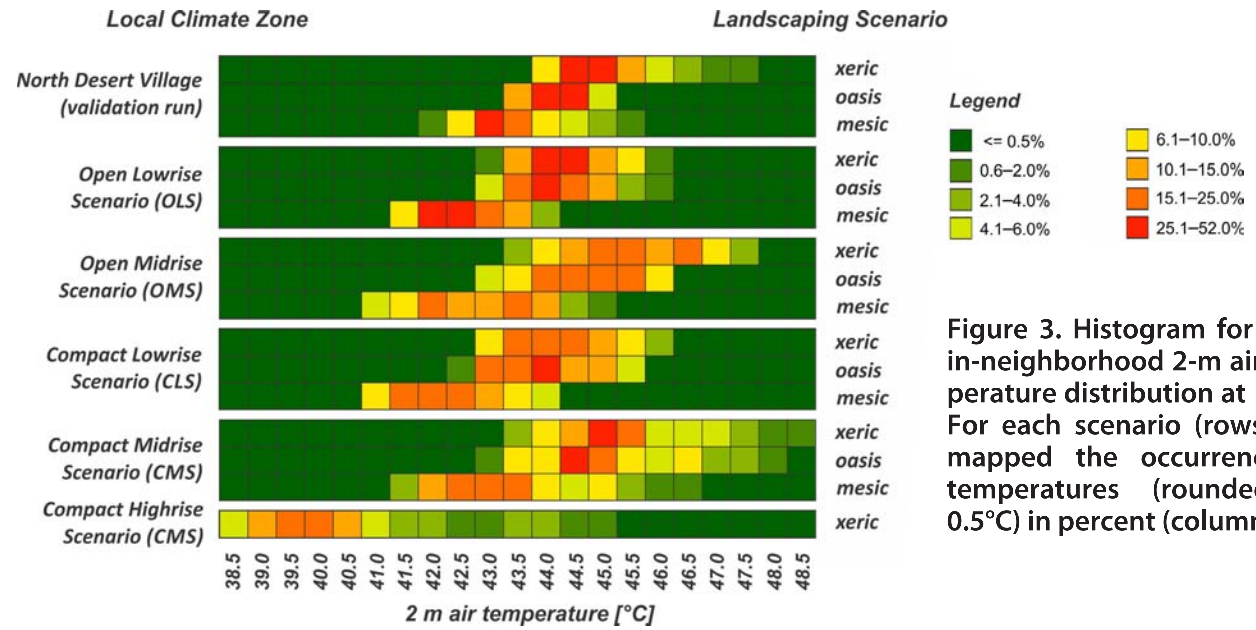

Figure 3. Histogram for within-neighborhood 2-m air temperature distribution at 15:00. For each scenario (rows), we mapped the occurrence of temperatures (rounded to 0.5°C) in percent (columns).

islands through internal shading effects. To investigate the cooling effect of local shading patterns in more detail, we ran a multiple regression analysis for n = 12934 grids in the *Compact Highrise* scenario with surface temperatures at 15:00h as dependent variable and surface materials and dichotomous shade factor as independent variables. Gravel was found to be the coolest surface (51.27 +/- 3.26°C) and asphalt the hottest (64.29 +/- 5.71°C). On average, shaded surfaces are 11°C cooler than sun-exposed surfaces. Our regression model explains more than two-thirds of the surface temperature variability (R^2 = 0.712) at 15:00h. The standardized partial regression coefficients β indicate that shade is the strongest predictor of surface temperatures and has a cooling effect (r = -.728, β = -.691), followed by gravel (r = -.359, β = -.352) and concrete (r = -.256, β = -.093). Asphalt (r = .404, β = -.145) has a warming effect due to its high volumetric heat capacity.

Discussion and Conclusion

Our findings are in line with other studies that reported air temperature cooling benefits from vegetation in semi-arid Phoenix (Guhathakurta & Gober, 2010; Gober et al., 2012; Middel et al., 2015). However, our results show that cooling is not only a function of vegetation and surface materials; daytime heat can also be mitigated through climate-smart urban form and design in the Phoenix metropolitan area. Compact scenarios were found to be most effective in reducing daytime temperatures. Our findings indicate that, at the microscale, urban form has a larger impact on mid-afternoon temperatures than landscaping. Results further suggest that small grass patches, such as in the oasis neighborhoods, do not result in significant daytime cooling compared to compact urban forms. More research is necessary to find the appropriate balance between water-intensive vegetation and energy savings from its cooling impact.

In this study, cooling is only represented through temperature differences, not by an integrated representation of microclimatic effects on a pedestrian. Such thermal comfort considerations would have to include an analysis of radiation and wind on the human body and will be part of future work.

The application of ENVI-met in our study was limited to a point in time (15:00h), because ENVI-met 3.1 does not incorporate wind direction changes, which would be critical for incorporating the thermal slope valley wind systems in Phoenix on a diurnal basis. Also, advection or shading effects between neighborhoods could not be taken into account. Despite these limitations, the model adequately captured mid-afternoon microscale dynamics in typical Phoenix neighborhoods.

Our study highlights that the LCZ classification scheme not only constitutes a comprehensive framework for UHI research; it is also a useful concept for integrating local climate knowledge into urban planning and design practices. Combined with microscale modeling, the LCZ concept is a powerful planning tool to identify and develop sustainable urban forms and landscapes that make temperatures in desert cities more tolerable.

The most significant conclusion that we can draw from our results addresses the ongoing debate about the benefits and disadvantages of compact development. While compact development has many advantages, ranging from transportation energy savings to reduced infrastructure costs and economic benefits, prior studies have also confirmed that high concentrations of buildings and impervious surfaces increase radiative heating and intensify UHI effects. While our study does not speak to the factors affecting nighttime temperatures, it does show that daytime shading capabilities of tall buildings play a significant role in reducing urban heat. The results also indicate that urban canyon effects produced by mid- to highrise buildings that are arranged along the direction of wind flow help in mitigating daytime heat. We conclude that sustainable urban development does not only entail smart growth (i.e., compact growth), but also smart design.

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A tree grows in Barcelona

Urban greening was the focus of two gatherings at the recently held Mediterranean Forest Week

The Mediterranean region is one of the most urbanized parts of the planet, and its growing population has already passed half a billion people. Its forest and tree cover is limited, and the strategic planning of green spaces in and around cities is barely a factor in national development plans. Why is this the case?

According to **Simone Borelli** of the UN Food and Agriculture Organization (FAO), there are several reasons. First of all, urban forestry has yet to be recognized as a "mature" scientific discipline. There is a lack of information on the size and potential of urban and peri-urban forests, and a lack of awareness as to the critical role played by the biotic infrastructure in cities. Also, the existing partnerships between academics and professionals from different countries are weak, and need to be better cultivated. Therefore, there is a need to exchange expertise and experience, and to promote a common language for the strategic planning of "integrated systems of trees and green spaces found in urban areas" – the urban *green infrastructure*.

Establishing this sort of collaboration is the mission underlying two European initiatives whose members met recently in Barcelona, in the framework of the IV Mediterranean Forest Week. The first was a meeting on March 16th of the *Silva Mediterranea* Working Group on Urban and Peri-urban Forestry, under the guidance of Borelli and the sponsorship of FAO. The group's participants represented over a dozen Mediterranean countries, with the largest number coming from western Europe (especially Italy and Spain), but with others traveling from Turkey, Israel and North Africa. The purpose and mandate of this group is to establish and consoli-

date a networking strategy for the Mediterranean countries, and to act as a neutral forum where representatives of these nations can meet and discuss policy related to urban and peri-urban forests and raise the issue of UPF on the political agendas in the region.

While many of the benefits of urban trees – including climatic mediation and a wide array of other ecosystem services – are well-understood theoretically, grasping the extent to which these benefits accrue in an actual city requires quantitative indicators of performance. Much of the group's work to date, as presented at the gathering, has been to define such indicators in a form that is relevant and useful for policy makers and planners. The indicators compiled fall into six different categories, spanning the physical realm (structural, biological and ecological indicators) as well as the human realm (economic, social and policy indicators).

Structural indicators include spatial measures at the urban scale (such as the total area of green space and its accessibility to residents), and at the neighborhood scale (e.g. street trees per km of road network, and vegetative cover relative to landscape area or building volume). The *Biotope Area Factor* is a structural measure of the "eco-effective" area of greenspaces, and corresponds with **Ecological** indicators related to attributes such as biodiversity and soil permeability. **Biological** indicators include the characterization of species groups, regional adaptation and water use.

In practice, realizing the benefits measured using these physical indicators depends on **Policy** – which itself has indicators related to regulation, public and private investment, maintenance and monitoring, and information dissemination to encourage public participation. Certainly some of these performance indicators are also in the realm of **Economics** – involving cost/benefit analyses and the monetary valuation of trees and green spaces, given their implications for health and well-being, property values, and even job creation. They are also undeniably in the **Social** realm, touching on the equitable distribution of parks and other amenities, and their accessibility to different sectors of society for a range of community activities.

This holistic approach to the planning and management of urban green spaces, considering aspects of society and governance as well as the environment, was also reflected in the second gathering in Barcelona. Organized by the European COST Action FP1204 - *GreenInUrbs* (see *UCN* Issue 52, page 19), this 'side event' at the Med Forest Week took place on March 17th-18th and featured a full program of invited speakers – all relating to the importance of Mediterranean urban forests for improving the environment and quality of life in cities.

The first of these speakers shared their expertise on carbon storage and air quality. **Rocio Alonso** of CIEMAT in Spain spoke about approaches for improving urban air quality in Mediterranean cities, stressing the ways in which urban vegetation can have decisive impacts. The combined influence of trees and urban form on the quality of urban air was the subject of a thought-provoking talk by **Rob Mackenzie** of the University of Birmingham in the UK, who described the mechanisms of fumigation, ventilation, dilution and deposition in urban canyons – and discussed the dynamics of urbanization which cause emissions to be directly correlated with population size only over a certain range of city scales. Another Spanish reseaercher, **Josep Peñuelas** of CREAF, looked at the ways in which urban forests interact with atmospheric changes, particularly through the lens of remote sensing. Finally, an in-depth look at the relations between climate change and ozone pollution was offered by **Elena Paoletti** of CNR-ISPS in Italy, who stressed that while concentrations may be elevated at remote sites more than they are in cities, ozone in Mediterranean urban forests is liable to have special significance as the frequency of megadroughts and wet spells increases.

The second segment of the conference was particularly urban climate-related, as it was devoted to microclimate and water control in Mediterranean urban forests. The introductory speaker was **Nigel Tapper** from Monash University, who presented an overview of his group's cutting-edge research in Australia on mitigating urban heat in cities with Mediterranean-type climates, using irrigated green infrastructure. Closely related was a survey of recent work in arid cities of Israel presented by **David Pearlmutter** (yours truly), in which the effects of urban vegetation on pedestrian thermal stress and water-related cooling efficiency were evaluated by applying an energy exchange model to a series of urban case studies.

Andreas Matzarakis from the University of Freiburg, Germany, also spoke about the mitigation of thermal stress through urban greening, and its quantification using micro-scale models such as RayMan – with the enjoinder that tools like this should be used, rather than misused, by actively involving the user's brain! The session was closed by **Yusuf Serengil** of the University of Instanbul, Turkey, who spoke about riparian ecosystems under the stress of urbanization.

Improving the quality of life for urban residents was a theme addressed first by **Fabio Salbitano** from the University of Florence in Italy, who proposed a visionary strategy for Mediterranean cities that is based not just on EU initiatives, but on creativity and the active anticipation of future needs. **Payam Dadvand** of CREAL, Spain, addressed "Greenness and brain development in schoolchildren." And Barcelona's own **Teresa Pastor**, a coordinator for the FEDENATUR network of peri-urban parks, argued that green infrastructure represents a conceptual shift – from a focus on nature conservation for its own sake, to a focus on the multiple benefits *for people* which accrue from cultivating ecosystem services in cities.

*"... green infrastructure represents a conceptual shift — from a focus on nature conservation for its own sake, to a focus on the multiple benefits **for people** which accrue from cultivating ecosystem services in cities."*

Maximizing such services requires management and governance – as described by **Silvija Krajter** of the Forest Research Institute in Croatia, who defined green infrastructure as "a strategically planned network of high quality natural and semi-natural areas… designed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings."

Coming full circle, **Simone Borelli** of FAO shared his vision of the value of networking for advancing the urban forestry agenda – through the *Silva Mediterranea* working group dedicated to this task.

Finally, among the messges voiced in the discussion was a familiar suggestion: that better collaboration is needed between the bio-physical community, and architects and city planners.

— David Pearlmutter, Editor

Recent publications in Urban Climatology

In this edition a list of publications are presented that have come out between **December 2014 and February 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 Iara Santos (TUM) for her contribution.

Regards,

Matthias Demuzere

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Special Issue of *Environmental Fluid Mechanics*:

Recent Advancements in Urban Flow Research

Volume 15, Issue 2, April 2015 • Issue Editors: Silvana Di Sabatino, Marko Princevac

Articles available for download at http://link.springer.com/journal/10652/15/2?wt_mc=alerts.TOCjournals

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 commitee (Valéry Masson and Aude Lemonsu) at : icuc9@meteo.fr

Upcoming Conferences...

IUFRO INTL. CONGRESS: GLOBAL CHALLENGES OF AIR POLLUTION & CLIMATE CHANGE TO FORESTS
Nice, France • June 1-5, 2015
http://iufro-nice2015.com/

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 • 23-30 August 2015
http://iufrole2015.to.ee/

PASSIVE AND LOW-ENERGY ARCHITECTURE: 31ST INTERNATIONAL PLEA CONFERENCE
Bologna, Italy • September 9-11, 2015
http://www.plea2015.it/

Call for proposals for next ICUC meeting (ICUC-10)

The International Association for Urban Climate (IAUC) (http://www.urban-climate.org) organizes an international conference on urban climatology at regular intervals. This year the International Conference on Urban Climate, ICUC-9 will be held jointly with the 12th AMS Symposium on the Urban Environment in Toulouse, France from July 20-24, 2015 (http://www.meteo.fr/icuc9/). ICUC-9 is the continuation of a series of similar conferences starting in **Kyoto, Japan** in 1989, followed by those in **Dhaka, Bangladesh** in 1993, **Essen, Germany** in 1996, **Sydney, Australia** in 1999, **Łódź, Poland** in 2003, **Göteborg, Sweden** in 2006, **Yokohama, Japan** in 2009, and **Dublin, Ireland** in 2012. The success of this series has helped to create a cohesive international community of urban climatologists. The aims of these conferences are to provide an international forum where the world's urban climatologists can meet to showcase and discuss modern developments in research, and the application of climatic knowledge to the design and management of cities. They cater to the interests of a diverse community of meteorologists, climatologists, hydrologists, ecologists, engineers, architects, urban planners and others interested in these topics.

We would like to start the process to identify the location and host of the next ICUC meeting, which will probably be held in 2018.

As a first step we invite '**expressions of interest**' from those interested in hosting the next ICUC.

The expression of interest should be brief (~1 page) and should indicate the proposed location (city, country), organizer's name, institutional affiliation(s) and the likely time frame for the conference. This information can be submitted as an email to the Secretary of the IAUC, David Sailor (sailor@pdx.edu) by **April 15, 2015**.

We will share all the expressions of interest received with all those who make a submission and with the IAUC Board. The purpose of sharing the expressions of interest is to streamline the process and to allow collaborations/discussion around the bids from those interested in hosting ICUC-10. We will subsequently (within about 2-3 weeks) then ask submitters to confirm their intent to submit a full proposal.

For those who wish to submit a full proposal, we ask that the proposal be less than 8 pages long (single spaced, 11 pt font) and include the following sections:

1. **Location for conference**. This section should discuss the location and facilities available. Indicate why the proposed location is a good choice for an ICUC conference. Please also indicate hotels, distance between hotels and conference venue, summary details of available meeting rooms, and availability of inexpensive housing options (e.g., for students). In this section please also discuss opportunities for social activities, tours, and local attractions that might be of interest to conference participants and their guests.

2. **Proposed timing of conference**. This should be a short section discussing the likely time frame for the conference, including one or more alternatives. A brief discussion of the benefits of the proposed timing is desired.

3. **Proposed registration or other fees**. Provide an initial estimate of the proposed fees for the conference (in USD) based on current prices. Also discuss how surpluses or deficits are to be handled. Budgets should assume 350 – 500 participants (with about 1/3 of the attendees being students); please indicate what the registration fee would cover. The IAUC intends for ICUC to break even; this may require organizers to budget for a small surplus. Conference organizers are responsible for any losses.

4. **Preprints and proceedings**. Discuss whether there will be a preprint volume or conference proceedings and the mode of dissemination (e.g. electronic and/or printed).

5. **Institutional/private/government support**. Indicate whether there is institutional support for holding the conference at this location. This might include suggestions for a joint conference with another society or organization and access to suitable persons/organization to form a local organizing committee.

6. **Familiarity with IAUC and ICUC**. Please indicate whether the organizers have previously attended ICUC and/or are familiar with the objectives of IAUC.

Organizers of the last three ICUC conferences are listed below for reference:

- **M. Kanda, Japan**
(kanda.m.aa@m.titech.ac.jp)
(ICUC-7)

- **G. Mills, Ireland**
(gerald.mills@ucd.ie)
(ICUC-8)

- **A. Lemonsu and V. Masson, France**
(aude.lemonsu@meteo.fr, valery.masson@meteo.fr)
(ICUC-9)

These individuals can provide insight into the necessary financial and institutional support that is needed to run a successful conference. It must be appreciated that IAUC , as a 'dues-free' organization, has limited financial means; its main resource is the goodwill and enthusiasm of its members and the knowledge that designated ICUC meetings attract the best of the international urban climate community, and that our past success has created mutually beneficial inter-organizational linkages.

Proposals should be submitted in electronic format to David Sailor (sailor@pdx.edu) by **June 15, 2015**. We will have initial evaluations with the Board of the IAUC and then ask finalists to prepare a presentation for the Board Meeting at ICUC-9. If you have any queries or would like to see what a full previous proposal looked like, please contact David Sailor.

Applicants for ICUC-10 should be prepared to present their proposal to the IAUC Board on the afternoon of Sunday, July 19th (the day before the start of ICUC-9).

INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

Board Members & Terms

- Tim Oke (Univ. of British Columbia, Canada): President, 2000-2003; Past President, 2003-2006; Emeritus President 2007-2009*
- Sue Grimmond (King's College London, UK): 2000-2003; President, 2003-2007; Past President, 2007-2009*
- Matthias Roth (National University of Singapore, Singapore): 2000-2003; Secretary, 2003-2007; Acting-Treasurer 2006; President, 2007-2009; Past President, 2009-2011*
- Gerald Mills (UCD, Dublin, Ireland): 2007-2011; President, 2009-2013; Past President, 2014-
- Jennifer Salmond (University of Auckland, NZ): 2005-2009; Secretary, 2007-2009
- James Voogt (University of Western Ontario, Canada), 2000-2006; Webmaster 2007-2013; President, 2014-
- Manabu Kanda (Tokyo Institute of Technology, Japan): 2005-2009; ICUC-7 Local Organizer, 2007-2009.*
- Andreas Christen (University of British Columbia, Canada): 2012-2016
- Rohinton Emmanuel (Glasgow Caledonian University, UK): 2006-2010; Secretary, 2009-2013
- Jason Ching (EPA Atmospheric Modelling & Analysis Division, USA): 2009-2013
- David Pearlmutter (Ben-Gurion University of the Negev, Israel): Newsletter Editor, 2009-*
- Aude Lemonsu (CNRS, France): 2010-2014; ICUC-9 Local Organizer, 2014-2015*
- Hiroyuki Kusaka (Univ. of Tsukuba, Japan): 2011-2015
- David Sailor (Portland State University, USA): 2011-2015; Secretary, 2014-
- Alexander Baklanov (University of Copenhagen): 2013-2017
- Curtis Wood (Finnish Meteorological Inst., Finland): 2013-2017
- Valéry Masson (Météo France, France): ICUC-9 Local Organizer, 2014-2015*
- Fei Chen (NCAR, USA): 2014-2018
- Edward Ng (Chinese University of Hong Kong, Hong Kong): 2014-2018
- Nigel Tapper (Monash University, Australia): 2014-2018

* *appointed members*

IAUC Committee Chairs

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Bibliography Committee: Matthias Demuzere
Nominating Committee: Tim Oke
Chair Teaching Resources: Gerald Mills
Interim-Chair Awards Committee: Jennifer Salmond
WebMaster: James Voogt

Newsletter Contributions

The next edition of ***Urban Climate News*** will appear in late June. Items to be considered for the upcoming issue should be received by **May 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.