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IAUC NEWSLETTER

INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

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President's Column

Colleagues, I am pleased to announce that David Pearlmutter has agreed to be the newsletter editor for the next 3 years starting January 2008. David is an Architect with research interests in desert architecture and related fields, including: Bioclimatic design, focusing on the geometry and energetic properties of building envelopes and elements; Passive and low-energy technologies for heating and cooling; Urban microclimate, energy balance and thermal comfort in open spaces and; Sustainable development and appropriate planning for sparsely populated desert regions (www.bgu.ac.il/CDAUP/david.html).

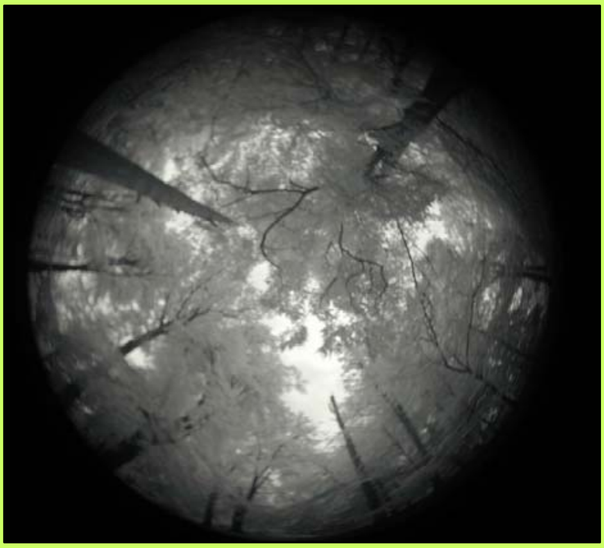
In this, the 25th edition of the Newsletter, there are reports on two urban projects. Lee Chapman (Birmingham) draws attention to the significant (and variable) role that trees have on view factors in urban environments. Robert Samuels (CEO & Director of Urban-Climate & Energy[INC]) writes on an innovative concept—an Urban Heat Harvester. The project is at an early stage but it is envisaged that it could cool cities by harvesting waste heat using the air-conditioning systems of buildings.

I would like to call your attention to two sessions planned on urban climate issues for the next annual meeting of the *Association of American Geographers* (AAG) in Boston, 15-19 April 2008. "Urban growth and its impact on the environment" is organized by Chandana Mitra (Dept. of Geography at the University of Georgia; chandana@uga.edu) and "Urban climate and planning practice" by Gerald Mills (School of Geography, Planning and Environmental Policy at the University College Dublin; Gerald.Mills@ucd.ie). If you are interested in participating please contact the session organizers directly. The deadline for all submissions is 31 October 2007. Several of our members will be interested in the 18th *International Congress of Biometeorology* in Tokyo, 22-26 September 2008. Abstract deadline is 15 November 2007. The 24th *International Conference on Passive and Low Energy Architecture* (PLEA) will take place in Singapore on 22-24 November 2007. The venue is the National University of Singapore and I hope to meet some of you during the meeting or please feel free to drop in my office which is close to the conference rooms.

Finally, I would like to encourage members to contribute articles to the Newsletter. These can take the form of conference, project or country reports or may simply be urban images of interest. Our next opportunity to meet face-to-face as an organisation will be in Yokohama in 2009. As such, the Newsletter is an important part of the IAUC, which maintains contact among the urban climate interest community.

Matthias Roth geomr@nus.edu.sg

Urban Images



A Near-infrared hemispherical image showing the spectral response of vegetation in the range 740-1000nm. (See Towards a tree-view factor, p6).

The Urban Forest Project

During Fall, 2006 The Urban Forest Project, an unprecedented outdoor exhibition, took root in New York City. One hundred eighty-five of some of the world's most celebrated designers and artists employed the idea or form of the tree to make a powerful visual statement on banners that were displayed throughout Times Square.

The adjacent banner was designed by Rodrigo Corral.
www.urbanforestproject.org./

Contents

Urban Climate News

City birds better than rural species in coping with human disruption

Birds that hang out in large urban areas seem to have a marked advantage over their rural cousins -- they are adaptable enough to survive in a much larger range of conditions.

In fact, new research from the University of Washington suggests that the adaptability of many urban bird species means they don't just survive but actually thrive in what might be considered to be a very challenging environment.

"The urban habitat is usually more severe than the habitats these birds historically occupied. Urban habitats aren't easy, so the birds have to have developed coping mechanisms," said John Wingfield, a UW biology professor involved in the research.

The study was led by Frances Bonier, a postdoctoral researcher in biology at Virginia Polytechnic Institute, who did the work as a UW doctoral student before moving to Virginia Tech. Co-author Paul Martin, now an assistant professor of biology at Queens University in Kingston, Ontario, also took part in the research as a UW doctoral student.

Ornithologists, biologists and birdwatchers around the world were sent questionnaires that asked them to list 10 common native breeding birds found in their cities. The responses produced data on 217 urban bird species from 73 of the world's largest cities and 247 rural species. To be considered "rural," a species could not be described as breeding in human-disturbed habitats such as towns and cities, and its natural breeding distribution must overlap at least one of the large cities, implying that at one time the species occupied the area where the city is now.

Some birds on the urban list -- starlings, parrots, crows, sparrows, pigeons and doves -- would be expected to be found in cities, Bonier said. However the researchers only looked at species native to a particular area, so starlings and sparrows native to Europe but found in North American cities, for example, did not count. Less-common species found in cities included the black-tailed trainbearer, a tiny hummingbird in Quito, Ecuador; the green bee-eater found in Giza, Egypt; and a small bird called the broad-billed tody that lives in Santo Domingo, Dominican Republic, and is part of a group of birds found only in the Caribbean.

The researchers learned that urban birds worldwide can endure a far broader range of environments than rural species. Urban species had elevation ranges more than 1,600 feet broader and their distribution covered about 10 degrees more of latitude, or about 700 miles.

"This sounds very intuitive, but there's never been any research confirming urban birds' adaptability," Wingfield said. "Fran's idea to send out the questionnaires provided the information that we lacked. This now gives us a hypothesis to work from for further research."

A white stork peers out from a nest atop a street light standard in the small city of Faro in southern Portugal. (Photo: John Wingfield)

The work, supported in part by the National Science Foundation, is detailed in a paper that has been published online and will appear later this year in the print edition of the Royal Society journal Biology Letters. The Royal Society is the United Kingdom's national science academy.

While it is not exactly clear what allows some species to flourish in urban settings, the research supports previous findings that suggested the most specialized birds will have the hardest time adapting in an ever-changing world.

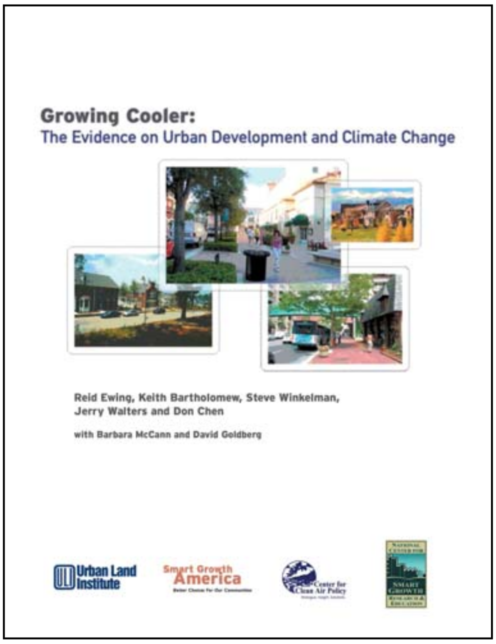
"In the face of global climate change and human disturbances, such as increased urbanization and deforestation, we may be able to identify species that can cope with such changes," Wingfield said. "Then we may be able to identify the species that cannot cope with these changes, or might even go extinct in the face of increased disruption."

The information could be used to fine-tune conservation efforts to save those challenged species, he said.

"Land managers can use the information to determine where trails should go, how many people should be on those trails and similar issues," he said.

Source: University of Washington (www.uwnews.org)

Urban Climate News



Less Auto-Dependent Development Is Key to Mitigating Climate Change,

WASHINGTON, D.C. – Meeting the growing demand for conveniently located homes in walkable neighborhoods could significantly reduce the growth in the number of miles Americans drive, shrinking the nation's carbon footprint while giving people more housing choices, according to a team of leading urban planning researchers.

In a comprehensive review of dozens of studies, published by the Urban Land Institute, the researchers conclude that urban development is both a key contributor to climate change and an essential factor in combating it.

They warn that if sprawling development continues to fuel growth in driving, the projected 59 percent increase in the total miles driven between 2005 and 2030 will overwhelm expected gains from vehicle efficiency and low-carbon fuels. Even if the most stringent fuel-efficiency proposals under consideration are enacted, notes co-author Steve Winkelman, "vehicle emissions still would be 40 percent above 1990 levels in 2030 – entirely off-track from reductions of 60-80 percent below 1990 levels by 2050 required for climate protection."

"Curbing emissions from cars depends on a three-legged stool: improved vehicle efficiency, cleaner fuels, and a reduction in driving," said lead author Reid Ewing,

Research Professor at the National Center for Smart Growth, University of Maryland. "The research shows that one of the best ways to reduce vehicle travel is to build places where people can accomplish more with less driving." Depending on several factors, from mix of land uses to pedestrian-friendly design, compact development reduces driving from 20 to 40 percent, and more in some instances, according to the forthcoming book, Growing Cooler: The Evidence on Urban Development and Climate Change. Typically, Americans living in compact urban neighborhoods where cars are not the only transportation option drive a third fewer miles than those in automobile-oriented suburbs, the researchers found.
At the same time, the book documents market research showing a majority of future housing demand lies in smaller homes and lots, townhouses, and condominiums in neighborhoods where jobs and activities are close at hand. The researchers note that demographic changes, shrinking households, rising gas prices, lengthening commutes and cultural shifts all play a role in that demand.

The report cites real estate projections showing that two-thirds of development expected to be on the ground in 2050 is not yet built, meaning that the potential for change is profound. The authors calculate that shifting 60 percent of new growth to compact patterns would save 85 million metric tons of CO_2 annually by 2030. The savings over that period equate to a 28 percent increase in federal vehicle efficiency standards by 2020 (to 32 mpg), comparable to proposals now being debated in Congress.

"Clearly, the development industry has a key role in the search for solutions to offset the impact of climate change," said ULI Senior Resident Fellow William H. Hudnut, III, former mayor of Indianapolis. "Whether close-in or in suburbs, well planned communities give residents the option to walk, bike or take transit to nearby shopping, retail and entertainment. Being able to spend less time behind the wheel will benefit our health, our pocketbooks and the environment."

Implementing the policies recommended in the report would reverse a decades long trend. Since 1980, the number of miles Americans drive has grown three times faster than population, and almost twice as fast as vehicle registrations. Spread-out development is the key factor in that rate of growth, the research team found. The findings show that people who move into compact, "green neighborhoods" are making as big a contribution to fighting global warming as those who buy the most efficient hybrid vehicles, but remain in car-dependent areas.

While demand for such smart-growth development is growing, government regulations, government spending, and transportation policies still favour sprawling, automobile-dependent development. The book recommends changes in all three areas to make green neighborhoods more available and more affordable. It also calls for including smart-growth strategies as a fundamental tenet in upcoming climate change legislation.

The study represents a collaboration among leading urban planning researchers, including Ewing, Steve Winkelman of the Center for Clean Air Policy, Keith Bartholomew of the University of Utah, and Jerry Walters of Fehr & Peers Associates. Smart Growth America coordinated the multi-disciplinary team that developed the recommended policy actions and is leading a broad coalition to develop those strategies further. The U.S. Environmental Protection Agency and the Hewlett Foundation provided funding for the underlying research.

The executive summary and full book are available at www.uli.org, or at www.smartgrowthamerica.org.

Urban Project
Towards a tree-view factor

Why do urban climatologists dislike trees?

Canyon geometry acts as a significant control on urban surface temperatures. Instead of longwave radiation being released into the cold sky hemisphere, it becomes trapped in the canyon where it heats the urban surfaces. This effect is a major cause of the urban heat island phenomenon with canyon geometry alone accounting for increased nocturnal urban temperatures in the region of 5-7° C (Oke *et al*, 1991). A widely used measurement of canyon geometry is the sky-view factor (ψ_s). Particularly useful for modelling nocturnal longwave losses, ψ_s is a dimensionless ratio of visible sky 'seen' at a point to that potentially available. However, the calculation of ψ_s has proven to be a recurring challenge facing urban climatologists. As a result, a variety of techniques have been developed, ranging from the early geometrical modeling of height / width ratios (e.g. Johnson & Watson, 1984) to more recent advanced image based approaches (e.g. Grimmond *et al*, 2001; Chapman *et al*, 2001). Imaging techniques use a digital camera equipped with a fisheye lens and produce imagery that shows the local horizon throughout 360° (Figure 1). A threshold is then applied to the image that delineates sky pixels from non-sky pixels, before a value for ψ_s is calculated via a simple algorithm. Fisheye images also have the added advantage that they can be used to infer local shade by

Figure 1 *Fisheye image showing a typical urban canyon complete with solar-track.*

plotting the path of the solar beam (solar-track) which can be readily calculated by considering the latitude of a location along with the Julian Day. More recent techniques have focused on the use of Global Positioning Systems (GPS) to estimate ψ_s via neural networks (e.g. Chapman & Thornes, 2004). However, there has also been a recent resurgence in geometrical modelling techniques developed on the back of the recent proliferation of

Figure 2 *3D scene of Birmingham CBD showing extruded polygons from which ψ_s can be calculated (adapted from Studden, 2007)*

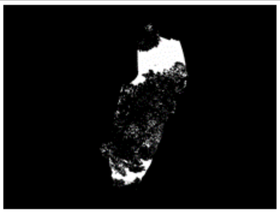
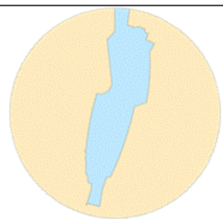
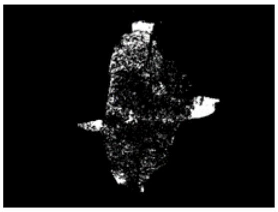
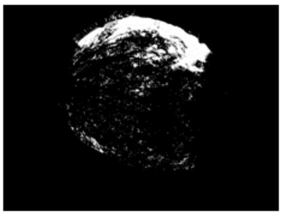
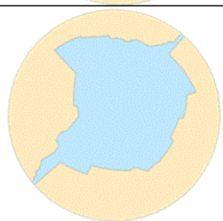
Observer Point	Original Fish-Eye Image	Processed Fish-Eye (Grimmond *et al*, 2001)	Ψ_s *(a)*	GIS calculated Ψ_s (Souza *et al*, 2003)	Ψ_s *(b)*	Ψ_s Difference *(b - a)*
1			0.0955		0.4384	0.3429
2			0.1001		0.52101	0.421
3			0.0829		0.70628	0.62338

Figure 3 *The difference between calculated ψ_s from fisheye images compared to a GIS based technique which ignores trees (adapted from Studden, 2007).*

geographical information technology. By developing a 3D GIS model of the area under study (Figure 2), ψ_s can be readily derived by using ray tracing algorithms (e.g. Souza *et al*, 2003).

Each technique has its own advantages and disadvantages, but all have one thing in common; they assume a static urban scene. Whilst this may be true for the more densely populated cities, in most urban areas the canyon will vary depending on the time of year as a direct result of deciduous trees. A fisheye image is effectively a snapshot of the canyon at a particular time and the ψ_s will vary greatly depending on the time of year in which the image is taken. 3D GIS methods will often ignore trees in the analysis, as data is typically derived from building datasets. This introduces a large source of error in measurements which will propagate through future modeling (Figure 3). To some extent, this problem can be overcome by the use of 'generic' trees which are inserted into the modelled canyons at known points, but at best this will only provide an approximation of the true canyon. Future techniques, currently under development at the University of Birmingham will see the derivation of ψ_s from high resolution LIDAR in an attempt to rapidly assess ψ_s on a broad scale whilst taking into account other structures (including trees) not included in building datasets. However, compromises will still have to be made as the techniques will be limited by the resolution of the LIDAR data and also by the fact that LIDAR is taken above the tree canopy. As a result it will be very difficult to assess the true crown closure of the tree in an urban canopy.

Why should urban climatologists like trees?

The ability to accurately assess urban tree canopies is becoming increasingly relevant. Urban areas are already vulnerable to decreased thermal comfort during heatwaves and projected rates of urban growth mean that vulnerability will increase at the same time as the proposed impacts of climate change begin to be realised. The 2003 heatwave, which is expected to become typical by 2040, was considered responsible for 14802 and 2045 excess deaths in France and the UK respectively. Many of these deaths occurred in urban areas and with such heatwaves predicted to become increasingly common, many more similar events may occur. As a result, heat is a fast becoming a pressing priority to be tackled by planners. One way of mitigating urban heat is by the use of trees. These both provide shade and cool the air by evapotranspiration. The lower air temperatures reduce the need for air conditioning in buildings by up to 20% (Akbari *et al*, 2001). Urban air quality is also improved by the sequestration of CO_2. Overall, trees will provide an essential tool in offsetting urban heat in a changing climate.

Urban Project

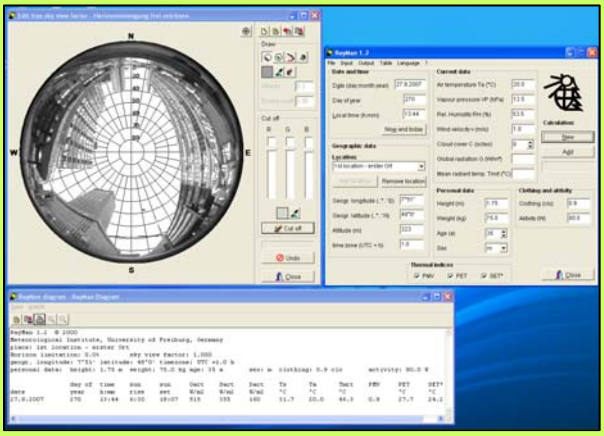


Figure 4 *Screenshot of thermal comfort indices calculated via RayMan using a fisheye image as input.*

Tools have been recently developed which can assess pedestrian thermal comfort based upon meteorological, pedestrian and building data. For example, Matzarakis *et al*, (2007) developed the RayMan model to allow for the assessment of the urban bioclimate by town planners prior to the granting of approval for new developments. A 3D scene can be quickly built up using building polygons (e.g. Figure 2) and generic trees. However, site-specific thermal comfort can also be assessed by using a fisheye image (Figure 4) – ultimately, it is the shading caused by individual facets and the thermal properties of those facets which is crucial. Such models potentially have great utility in assessing how the urban bioclimate may vary under future climates and at a variety of scales. However, to sidestep the problem of using generic trees for analysis, there is a need to incorporate a measure of the tree canopy into the model – i.e. a tree-view factor!

Recently, Chapman (2007) developed techniques to measure sky-hemisphere vegetation by using a specially adapted digital fisheye camera to take near-infrared (NIR) hemispherical images (Figure 5). Due to the spectral properties of vegetation (high reflectance in NIR), it is a simple task to determine a series of thresholds to segment tree, building and sky pixels. Once segmented, these separate facets can then be used for more accurate calculation of thermal comfort indices by models such as RayMan. Research at the University of Birmingham will seek to use this approach to identify vegetated areas of the city with the aim of modelling urban bioclimate for both current and future climates.

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Figure 5 Near-infrared hemispherical image showing the spectral response of vegetation in the range 740-1000nm.

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Urban Project
The Urban Heat Harvester

The debate surrounding global warming is currently focused on CO_2 emissions and considerable effort is being put into reducing fossil-fuel greenhouse gases by developing renewable energy sources and reducing carbon concentrations in the atmosphere. However global warming and the climate changes it produces is the result of the heat trapped by these greenhouse gases, and dealing with this heat pollution is generally overlooked in the debate.

Current levels of the heat-trapping gases in the atmosphere, and their longevity, means that even reducing emissions to zero now is unlikely to stop the temperature rising for at least the next 100 years. Only by reducing the amount of heat pollution emitted into the atmosphere can we have sufficient impact to moderate climate change extremes. Many human activities are heat producing, from industrial processes to household activities and urban lifestyles in general including all forms of transportation, and of course any use of energy irrespective of its source which deposits waste heat in the environment.

One of the key thermal sources is the urban heat island phenomenon which traps heat in thermal mass like concrete and black roads which absorb, store and then re-emit this heat to the urban air at night. This hot city phenomenon has far-reaching environmental sustainability and human livability implications, ranging from the aggravation of health problems such as heat stress, increasing the intensity of urban air pollution, and contributing to extreme weather events - in addition to the ever-increasing use of air-conditioners, with flow-on impacts for energy supply, brownouts and greenhouse gas emissions. Because most people on earth live in cities, and each city is also substantially hotter than its natural surroundings, urban contributions to global warming are significant.

Proposed solutions to cool cities include urban greening and low-emission surfaces and cool colors on buildings, rooftops and roads. However, these have had minimal apparent affect to date, and given the rapidly developing and urbanizing nations worldwide, addressing the urban heat island phenomenon is of increasing importance. Urban greening is not a simple affair: it involves major infrastructural, management, maintenance and watering complexities.

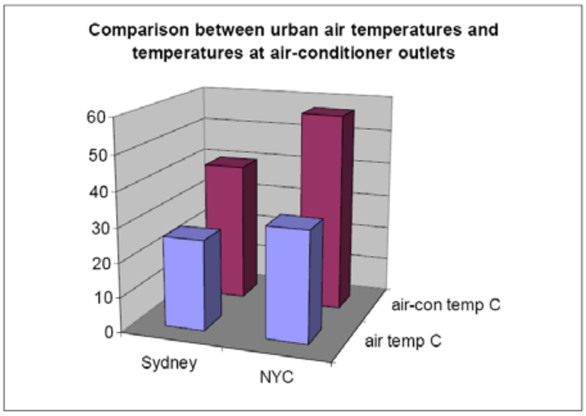
It is essential to develop strategies to capture waste heat before it is emitted into the atmosphere where it contributes to the urban and global warming effect. One strategy is to target the heat emitted at air-conditioning outlets, which essentially concentrate heat from the building, human occupants, machinery, lights, etc, and shift it outside the building -where it adds to the urban heat load (Figs 1&2).

Fig 1. Rooftop and street heat waste in New York. In a summer's day in NYC when the air temperature is 32C, the waste heat at street-level air-conditioner exhausts of CBD buildings is ±58C – substantially hotter than the ambient temperature.

International efforts to mitigate global warming now rely on Kyoto targets which are however so low and unenforceable as to be of little utility except to salve political conscience in the short term, besides earning greening corporations energy dollars from selling carbon credits. However, if capturing and sequestering heat was similarly recognized and rewarded, a rapid amelioration in urban and global climates could result.

An urgent paradigm shift is necessary, recognizing that energy-emissions and heat-emissions are both forms of pollution, which work in unison to bring about climate change - at global and urban scales. Unless the amount of heat pollution emitted into the atmosphere is reduced, it will continue to silently and invisibly change the climate, beneath the consciousness of the world energy and environmental community.

Urban Project



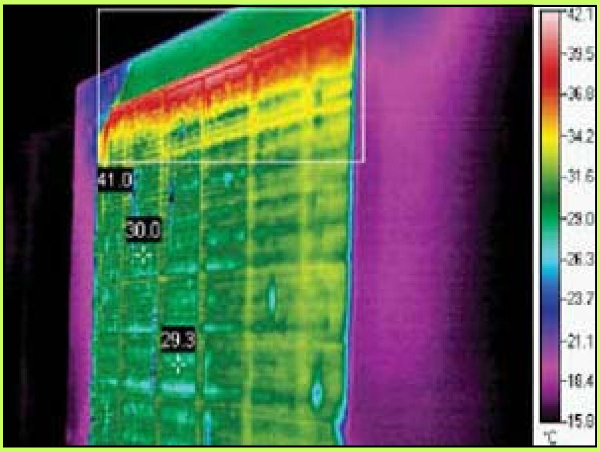


Fig. 2 Effects of air conditioning on air temperature. The lower. thermal image, is of air conditioning heat waste on mild autumn day.

The **Urban Heat Harvester** is an innovative concept which aims to cool cities by harvesting waste heat, withdrawing thermal pollution from the urban atmosphere via city buildings, utilizing their air-conditioning systems. Thus, moderating urban climate extremes and heat-stress experiences, increasingly liveability, and reducing energy use for cooling; while simultaneously recycling the heat as energy equivalence (to heat water). The ultimate goal is to transform the waste heat stream to zero-emission renewable energy - and proof-of-concept research will determine this feasibility in due course.

How can heat pollution be captured and re-used?

1. Capture the heat pollution: Draw waste heat from Urban Heat Island via building air-conditioning systems and capture at rooftop outlets of: offices; high-rise residential buildings; hospitals; shopping malls; cinemas; libraries; sport arenas; train and bus stations and airports (Fig. 3).
2. Convert or transform the heat pollution: The Urban Heat Harvester technology converts and transforms waste heat into electrical energy, and captures the remaining heat to warm water. Heat extracted from inside buildings via air conditioners is not removed from the city but simply concentrated and displaced: from the inside to the outside.

If you have any comments or suggestions please contact us.

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Fig 3. Individual dwelling air conditioning units in Hong Kong (above) and rooftop building units in New York (from Google Earth). There are in NYC alone, 6000 high rise, and 10 000 medium rise (approx 10 stories) buildings that are all pumping out such concentrated heat, not to mention all the individual window air conditioners.

IAUC Committee Reports

Bibliography

Thanks to everyone for their contributions this month. Please send any further references to papers published since January 1 2007 for inclusion in the next newsletter to j.salmond@auckland.ac.nz. As before, please mark the header of your email with 'IAUC Publications 2006'. In order to facilitate entering the information into the data base please use the following format:

Author:
Title:
Journal:
Volume:
Pages:
Dates:
Keywords:
Language:

We look forward to hearing from you soon!

Jennifer Salmond
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IAUC Board & Newsletter

Board Members & Terms

- Toshiaki Ichinose (National Institute for Environmental Studies, Japan): 2007-2011.
- Benedicte Dousset (Hawai`i Institute of Geophysics and Planetology, USA): 2006-2010
- Rohinton Emmanuel (University of Moratuwa, Sri Lanka): 2006-2010
- Kevin Gallo (National Oceanic and Atmospheric Administration (NOAA), USA): 2006-2010
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- Manabu Kanda (Tokyo Institute of Technology, Japan): 2005-2009, ICUC-7 Local Organizer, 2007-2009.
- Wilhem Kuttler (University of Essen, Germany): 2004-2008
- Sven Lindqvist (Göteborg University, Sweden): ICUC-6 Local Organizer, 2004-2006*
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Newsletter Contributions

The next edition will appear in early April. Items to be considered for the next edition should be received by **July 31, 2007.** The following individuals compile submissions in various categories. Contributions should be sent to the relevant editor:

News:	Dr. J. Marshall Shepherd marshall.shepherd@nasa.gov
Conferences:	Jamie Voogt javoogt@uwo.ca
Websites:	Gerald Mills gerald.mills@ucd.ie
Bibliography:	Jennifer Salmond j.salmond@auckland.ac.nz
Urban Projects:	Sue Grimmond sue.Grimmond@kcl.ac.uk

General submissions should be relatively short (1-2 A4 pages of text), written in a manner that is accessible to a wide audience and incorporate figures and photographs where appropriate. In addition we like to receive any images that you think may be of interest to the IAUC community.

18th International Congress of Biometeorology
Date: 22-26 September, 2008

Venue: Tower-Hall Funabori
(Edogawa-ku, Tokyo)

Congress Theme: Harmony within Nature

Chair: Masami Iriki
(Prof. Emeritus, Yamanashi Univ.)

Congress Organizer: International Society of Biometeorology

Abstract Submission: September 1 ~ November 15, 2007 (Please submit from our HP)

Secretary General: Shigeki Nomoto (Tokyo Metropolitan Institute of Gerontology)

Secretariat: ICB2008 (Ms. Kikuchi, IPEC Inc.) 1-24-12 Sugamo, Toshima-ku, Tokyo 170-0002, Japan.

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