

IAUC NEWSLETTER

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President's Column

Country Reports: I have received a number of very positive comments about the country reports that have been appearing in the newsletter and I wish to convey those compliments and my appreciation to the authors. Two more excellent reports, for Malaysia and Sri Lanka, appear in this newsletter. I would like to encourage those of you from countries for which reports have not been written as yet to contact me if you are interested in providing an overview of urban climate activities in your country or region. Or if there is another aspect that could be reviewed from your country please also submit an article. As is evident from those reports already published, the format can be varied and this provides an excellent opportunity to showcase work to the international community.

ICUC6: The deadline for the submission of abstracts for ICUC6 to be held in Goteborg, Sweden is approaching (November 10th, 2005). ICUC6 promises to be an excellent conference and I encourage all of you to submit abstracts and to distribute information about this meeting to interested colleagues. In the near future, the IAUC will be issuing a call for proposals to host ICUC7. For those who may be already thinking of this, I encourage you to start contacting relevant colleagues.

Membership: As noted by Janet Barlow, membership for the IAUC is now approaching 1000 urban climatologists with representation from more than 80 countries. In the northern hemisphere, as the new academic year approaches, please encour-

age your students in urban climatology to consider joining the IAUC. At the same time, those of you who have opportunities or information to share, I strongly encourage you do submit it to the newsletter or via the Urban Climate email list.

Awards: Finally, I want to draw your attention to the call for nominations for the Luke Howard Award (also distributed on the Urban Climate email list). This award is given annually to an individual who has made outstanding contributions in the realm of urban climatology. The deadline is October 1, 2005 (please see full announcement on page 22).

Sue Grimmond
IAUC President.
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Newsletter Contributions

The IAUC Newsletter is published bi-monthly. The next publication will occur in early June. Any items to be considered for the October edition should be received by **September 30, 2005**.

The following individuals compile submissions in various categories. Contributions should be sent to the relevant editor:

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<u>Bibliography:</u>	Jennifer Salmond (j.salmond@bham.ac.uk)
<u>Urban Projects:</u>	Sue Grimmond (grimmon@indiana.edu)

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 would be delighted to receive any images that you think may be of interest to the IAUC community (see p2).

Urban Climate News

We welcome submissions to the "News" section. Submission materials could include but are not limited to: upcoming papers, field experiment information, awards, data or document availability announcements, etc. You may submit your "news item" to Dr. J. Marshall Shepherd

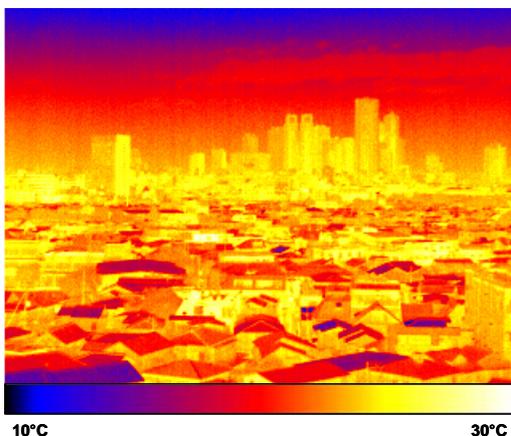


(marshall.shepherd@nasa.gov).

Images of Tokyo



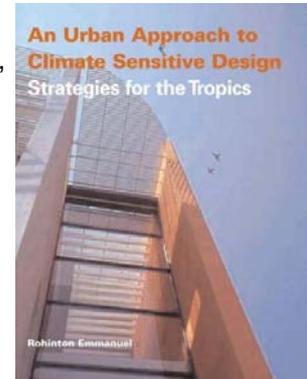
The skyline of the Shinjuku area of Tokyo. The extended tower on the right hand side was part of a project intended to make observations of the energy balance and turbulent exchange over a dense residential area of Tokyo. It involved researchers from Japan (M. Kanda, R. Moriwaki, M. Roth, S. Kubo, Y. Nakamura, Y. H. Ueda) and Canada (T.R. Oke, J.A. Voogt, M. Roth and C.A. Soux). The project involved one of the first applications of scintillometry over urban areas (Kanda et al, 2002: Area-averaged sensible heat flux and a new method to determine zero-plane displacement length over an urban surface using scintillometry, *Boundary-Layer Meteorol.*, 105, 177-193). The source area for measurements extended primarily to the left and right of the tower where the land use was primarily dense residential. Photo taken by M. Roth (now of National University of Singapore).



A thermal image of the same area was taken by an Avio Thermal Scanner during the late afternoon of Oct 9, 1998 as the urban area began to cool. The relative warmth (and coolness) of individual surfaces can be seen, including the effects of various roof materials in the foreground, as well as the warmth of Shinjuku in the background.

An Urban Approach to Climate Sensitive Design: Strategies for the Tropics

Rohinton Emmanuel,
University of Moratuwa,
Sri Lanka



Spon Press, London and New York, January 2005, 246x174mm: 172pp: illus. 57 line drawings and 26 tables. Hb: 0-415-33409-8: **£80.00**. Pb: 0-415-33410-1: **£35.00**

Rapid urbanization in the tropics has brought in its wake many hitherto unknown changes to humans, animals and plants and the physical environment. Many of these changes are well studied by researchers in diverse fields such as medicine, agriculture and engineering. However, the climatic effect of urbanization has not been understood nor the knowledge base applied by urban designers, planners, architects and engineers. In particular, the energy and bio-climatic implications of changes induced by urbanization have received very little attention in urban design and planning. This book lays out the problem of tropical urban climate anomaly and points to possibilities of mitigating these changes through design and planning options.

An Urban Approach To Climate Sensitive Design brings together the emerging literature on climate-sensitive urban design and places it in a tropical context. The physical processes behind changing urban climate are clearly illustrated. The book presents a general background to the environmental issues facing tropical building designers - energy consumption and comfort implication of buildings and an overview of microclimate changes brought about by urbanization. New ways of looking at urban design are presented from a climatic design perspective.

The focus of the book is design strategies that can mitigate the negative impacts of tropical urban climate. Three such design goals are: radiant cooling, ventilation and evaporative cooling. Simple design strategies further develop the conceptual ideas, including discussion of a "shadow umbrella" or sun avoidance scheme and demonstrates its applicability to the equatorial tropics. In order to make the discussions on urban energy use and energy efficiency complete, the book closes the discussions with a series of strategies that facilitate movement between interconnected urban activity patterns in a climatically suitable manner.

Urbanization in tropical regions is beginning to gather momentum and is likely to intensify in the near future. This book fills a crucial gap in the knowledge of climate-sensitive urban design in a tropical context. This comprehensive reference will be welcomed by student and practising architects as well as other built environment professionals engaged with the environmental effects of building in worldwide warm and humid climates.

Urban Climate in the News

GREEN MIRACLES THAT ALSO COOL BUILDINGS

by Cathy Shufro (www.emagazine.com, *The Environmental Magazine*, July-August, 2005)

"Critics praised the new Millennium Park in downtown Chicago when it opened last July, and visitors streamed in: a half million in the first week alone. Visitors exploring the 24-acre park were drawn to the shiny 110-ton abstract steel sculpture by Anish Kapoor, nicknamed "the bean," and to Frank Gehry's concert pavilion, a bandshell composed of stainless-steel ribbons surrounded by a green lawn designed to seat 7,000. One journalist called the park a "green miracle in the Windy City."

Chicago's Millennium Park boasts a "green roof" covering a parking garage and train terminal. But few writers noticed one of the greenest things about Millennium Park: it's a living "green roof" of plants on top of a huge subterranean parking garage and commuter train terminal. With 120 living roofs built or planned citywide, including one on City Hall, Chicago is pioneering a trend that has taken off across North America. The impetus came from Mayor Richard M. Daley, a proponent of green technology who was impressed by the green roofs he saw when traveling in Europe—where they've been built for 30 years and have become commonplace.

Building green roofs "is a very important initiative for the mayor," says Chicago Green Projects Administrator Michael Berkshire, an urban planner. "He's a very popular mayor, so when he gets behind something, it really means a lot."

In a city where more than 700 people died during a July 1995 heat wave, one benefit of green roofs that was clearly important to Daley is their capacity to mitigate the "urban heat island effect" that makes cities hotter than surrounding suburbs. Higher urban temperatures derive from mile after mile of concrete and other heat-absorbing materials; in contrast, the plants on green roofs cool the air and reduce ozone formation.

Green roofs also reduce flooding and sewer overflows by absorbing rain like sponges, slowing its release and filtering out pollutants. The plants oxygenate the air, attract birds and insects and soften the urban "viewscape." In addition, the living systems insulate roofs, keeping buildings cooler in summer and cutting electricity use. (An unexpected benefit of the Millennium Park green roof is that the South Shore Terminal directly below the park stays cool, despite the heat of the trains.)

Chicago has taken its cue from German cities by requiring green roofs and other "green" strategies for certain construction projects that are built with public money, that are large enough to require special review or that sit close to Lake Michigan. For instance, a new Target store on the city's north side is getting a green roof. The Millennium Park green roof is unusual; most green roofs are not designed for everyday foot traffic. Those that are require a heavier layer of soil and stronger roofs. "

The article goes on to discuss the use of green roofs in other North American cities, including San Francisco and New York.

CHICAGO CITY HALL GREEN ROOF CHICAGO, ILLINOIS



The above figures were obtained from the American Society of Landscape Architects website (www.asla.org/meetings/awards/awds02/chicagocityhall.html) on which David Yocca (Senior Partner, Conservation Design Forum) discusses the value of green roofs.

"Under Mayor Richard M. Daley's direction, the City of Chicago's Department of Environment took the initiative to start an aggressive green roof pilot project by hiring a team of landscape architects, architects, structural engineers, and ecologists to design and implement a green roof for Chicago's City Hall. Centrally located in downtown Chicago, City Hall is one of the most visible and recognized structures in the city. The primary purpose of the City Hall Green Roof Pilot Project is to provide a green roof demonstration that serves to facilitate research and educational outreach within the context of a midwestern climate. Completed in 2001, the rooftop garden was designed to test different types of green roof systems, heating and cooling benefits, success rates of native and non-native vegetation, and reductions in rainwater runoff. The three systems integrated into the design include lightweight soils at 4, 6 and 18 inches in depth. These varying green roof systems are recognized respectively as Extensive, semi-intensive, and Intensive green roofs. Soils were fabricated using lightweight soil mixture guidelines developed in Germany over the past 20 years."

Urban Climate in the News

WHO'S BATTING NEXT IN THE GLOBAL WARMING DEBATE?

Melbourne, Australia: Wednesday, 3 August 2005. Florenz Ronn (Australian Broadcasting Company) reported on how Melbourne's changing urban climate has allowed bats to establish year-round 'camps'. (The following excerpt is taken from a longer story at www.abc.net.au/melbourne/stories/s1428897.htm)

"From cool and dry, Melbourne's climate has changed, making it more suitable for the fruit bats that now call the city home, according to research produced by Deakin University and released in May of this year. Based on long-term records, Melbourne was too cool and dry for camps or colonies of the grey-headed flying fox. However, a study by Dr Kirsten Parris of Deakin's Faculty of Science and Technology and Dr Donna Hazell of CRES at the Australian National University, shows Melbourne has become warmer and wetter, making the city's climate more appealing to the bats.



(Photo from the Dept. of Environment and Conservation NSW, Botanic Garden Trust website: www.rbgsgyd.gov.au/sydey_gardens_domain/gardens_feature/wildlife/flying_foxes)

The temperature in central Melbourne has been increasing since the 1950s, leading to warmer conditions and fewer frosts. This temperature rise is likely the result of a localised "urban heat island", plus a general warming trend seen across Australia, Dr Parris said. "The construction and continued expansion of our city, plus the huge amount of water we use on our gardens, has made Melbourne warm enough and wet enough for the bats to live here year round," she continued to say. The urban heat island effect, where a city is warmer at night than the surrounding countryside, is caused by the release of heat from buildings, asphalt and concrete, plus absorption of heat by pollution in the atmosphere. Dr Parris believes a year-round smorgasbord of the bats' favourite foods (pollen, nectar and fruit) in Melbourne, plus large-scale clearing of the forests that form their natural habitat have also contributed to their move to city. "The bats have always been seasonal visitors to Melbourne, but they did not establish a camp here until the 1980s" she said. "A few brave bats first withstood the cold and gloom of a Melbourne winter in 1986, and by autumn 2003, numbers in the camp at the Royal Botanic Gardens had swelled to 20,000." The results of the research have been published on-line in the international journal, *Biological Conservation*. So our city has attracted them, but, generally speaking, they are not welcomed. Flying foxes, as they are also known, have gained a reputation as a nuisance. They are noisy and sometimes smelly when they roost. They will raid orchards and have destroyed some important trees in the Botanic Gardens in Melbourne, and in Sydney."

GARDENS, PARKS COULD BOOST AIR QUALITY

PRATIK JOSHI of the St. Paul Pioneer Press, Minnesota reported on an urban ecology research project of Joe McFadden. The following is an excerpt from the full story.

"A lush carpet of grass can add to a home's curb appeal and a neighborhood's aesthetics, but lawns, backyard gardens and trees also may play a significant role in improving air quality.

Joe McFadden, a University of Minnesota assistant professor researching urban ecology, hopes to find out how big a role by studying vegetation in a nearly 2-by-2-mile area in Roseville, Falcon Heights, Lauderdale and a tiny corner of St. Paul. The area runs from Minnesota 280 on the west to Snelling Avenue on the east and from Minnesota 36 on the north to a southern boundary approximately at Como Avenue.

McFadden's team will gather data on how much carbon dioxide suburban vegetation absorbs and how much oxygen it releases into the atmosphere.

By analyzing vegetation cover and the quality of the surrounding air, McFadden hopes to discover if there is a link between vegetation and reduced carbon dioxide levels, both of which affect climate patterns.

McFadden said this is the first such study of a suburban community. Similar studies in Baltimore and Denver urban areas found that vegetation could absorb significant amounts of carbon dioxide.

As suburban ecosystems change, it is important for scientists to understand their "carbon exchange" to learn more about global warming and potential climate changes, he said. McFadden's study will provide new information on the Upper Midwest, which is wetter than Denver and drier and colder than Baltimore.

He chose his specific location because of the 557-foot radio tower in Falcon Heights, near residential areas. McFadden said he scouted from Rosemount to Shoreview before making his final choice.

The tower, a transmitter for the University of Minnesota Radio K station, will help him gather air quality data, which he plans to compare with ground vegetation data collected by his students.

McFadden will combine the ground and air data with satellite imagery and develop models to show the relationship between suburban land use and climate.

Although McFadden's project began last year, the ground measurements started in June after he'd secured permission from some suburban residents to take readings on their properties, which are among 400 randomly selected study points.

By extrapolating the model over a larger area, ecologists hope they can predict the workings of a managed landscape and its impact on the planet, he said.

McFadden said his study could aid land use planning to better manage growth and change."

Pratik Joshi can be reached at pjoshi@pioneerpress.com.

Country Report

Urban climate research in Malaysia

Introduction

According to Sham (1987), the first known work on urban climate in Malaysia was published in 1972 (Sham 1972a,b&c), followed by several more studies on the urban heat island and variation of sunshine and solar radiation (Sham 1973a&b; Shahrudin, 1979). Around the same time, urban climate studies became the focal point of attention among honours students in the Geography Department, National University of Malaysia and this continued through to the 1980s. One major attempt to compile research studies on the climate of Malaysia was carried out by Ooi Jin Bee and Chia Lin Sien (1974). Sham's (1980) study of the impact of urbanization on local climate with special reference to Malaysia's Federal Capital, Kuala Lumpur, was published in the form of a book. The latest book on weather and climate of Malaysia was written by Lim and Azizan (2004). The aspects of urban climate that have been studied and attracted the greatest attention are temperature variation and the urban heat island effects and urban thermal and comfort zones. This paper reviews urban climate research in Malaysia.

Temperature Variation in Malaysia

As an equatorial country, Malaysia experiences uniform temperature throughout the year, with an annual range of temperature of less than 2°C. Although the seasonal and spatial temperature variations are relatively small, there is definite variation of temperature with the monsoons, particularly in the east coast areas. April-May and July-August are the months with the highest average temperature in most places, and November-January are the months with the lowest average monthly temperature.

Sham (1987) examined annual mean minimum temperatures for Subang Airport and Petaling Jaya for the period 1969-1983 (Figure 1). The results suggests there is an overall increase of temperatures by about 0.9°C for Subang Airport and 0.7°C for Petaling Jaya for the period 1969-1983. In a similar study, Yassen (2000) assessed mean maximum, mean, and mean minimum temperature for Subang Airport and Petaling Jaya for the period 1983-1997. The results revealed that overall average temperature changes in mean maximum, mean and mean minimum were



Figure 1. Geographical location of the Klang Valley Region

small: 0.025°C y⁻¹, 0.073°C y⁻¹, and 0.081°C y⁻¹, respectively for Subang Airport. However, the values are -0.012°C y⁻¹, 0.014°C y⁻¹, and 0.184°C y⁻¹, respectively for Petaling Jaya.

Shahrudin (2003) studied the impact of urbanization on urban climate trends in Malaysia for the period between 1970 and 2000. The study of 55 climate stations located in urban areas, with population ranging from about 2,000 to 1.5 million, found that the annual air temperatures vary with the changing size of urban area. Urbanization was measured by the increase in population with time. The urban annual air temperature for the 30-year period had positive linear correlation with slope (*b*) coefficients from as low as 0.01 to as high as 0.12. This implies that the urbanization that took place within the last 30 years in most of the urban areas, to some extent, plays quite a significant role in changing the urban air temperature patterns.

Shahrudin and Teo (2004) considered climate variability in Malaysia for a short period, 1980-1995 (Figure 2). They used surface mean maximum and minimum air temperatures as indices of climate change. The twenty-one urban areas (weather stations) throughout Peninsular Malaysia used in the study were divided into two parts, namely the West Coast and the East Coast areas. The results show that the annual and seasonal trends of minimum temperature are highly correlated for urban centres in the West Coast; meanwhile, maximum temperatures are strongly correlated for urban centres in the East Coast. Furthermore, the trend in the diurnal temperature range (DTR) was highly correlated (and negative) for all seasons except for the Northeast Monsoon season for urban centres in the West Coast region but and positively correlated

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in all seasons for urban centres in the East Coast region. They then used the Mann-Kendall test to find any significant changes to the DTR trend over the study period. This revealed that the DTR was getting smaller over time in urban centres in the West, while urban centres in the East were either constant or slightly increase over the same period of time.

Urban Heat Island Studies in Malaysia

The urban heat island (UHI) in Malaysia was first studied by Sham (1972b, 1973a) who was then followed by Jamaluddin Jahi (1974). In the earlier research, Sham (1972b) used temperature traverse technique to study the urban microclimate in Kuala Lumpur and he found that temperatures were normally higher in the central district than in the rural areas around the city and the intensity of heat island was normally greatest during calm and clear sky at nights as compared to the intensity of heat island during the day. By using the same technique, Jamaluddin (1974) found the existence of urban heat island in Kuala Lumpur of the intensity range between 2° to 3°C during mid-day. In a much later study, Sham (1979) noted that the maximum heat island intensity for Kuala Lumpur-Petaling Jaya twin cities was between 6° and 7°C. Sham (1989) also found that in the urban area of Bangi, a much smaller town, the maximum heat island intensity was only 2°C (see Figure 1).

Shaharuddin (1992) studied some effects of urban parks on air temperature variations in Kuala Lumpur. Among important aspects he studied was UHI in Kuala Lumpur. He employed the technique of temperature traverse across the study area during clear and cloudy skies. In general, he found that the maximum UHI intensities of from 3° to 5°C were mostly established under partly cloudy skies and clear conditions. On the other hand, the lowest UHI intensity of about 1°C was mostly associated with rain condition prior to data collections.

Sin & Chan (2004) used sling psychrometer to observe temperatures at 65 stations on Penang Island at three different times a day, viz. at 0900-1000 hours, 1400-1500 hours and 2100-2200 hours (see Figure. 2). They found that most of the major urban areas such as the city of Georgetown, Air Itam, Bandar Bayan Baru and Bayan Lepas experience the urban heat island both during the day and at night. Furthermore, they found that the intensity of UHI varied from 2° to 6°C, depending on size of urban areas. In general, there are other studies of UHI in various urban centres in Malaysia (Table 1).

Researcher year	Location (urban areas)	UHI intensity
Lim, 1980	Georgetown, Penang	4°C
Zainab, 1980	Johor Bahru, Johor	3°C
Sham, 1983	Kota Kinabalu, Sabah	3°C
Sham, 1984	Kuala Lumpur-Petaling Jaya	7°C
Sham, 1986	Several urban centres in the Kelang Valley	2°-5°C

Table 1. Urban Heat Island studies in various urban areas in Malaysia.

Urban Rainfall Variation in Malaysia

Sham (1972) studied rainfall patterns in and around Kuala Lumpur for the 11 year period (1954 – 1964). He found that the heaviest falls tended to be located in two areas: one centred around Bangsar Estate in the southwest of Kuala Lumpur and the other in and around Ampang waterworks in the east of Kuala Lumpur (Figure 1). In addition, he observed that January and February were dry months with similar rainfall distribution patterns. Rainfall increased to a maximum in April when areas around Ampang Waterworks received more than 12.0 inches. He also found that June, July and August were about as dry as the beginning of the year. Thereafter, total rainfalls increased to a maximum in October

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while November and December were also very wet. April and October heavy rainfall was coincided with the passage of the Inter-tropical Convergence Zone over the area. He concluded that, even within a relatively small area like Kuala Lumpur, rainfall amount varied both in terms of space and time.

Shaharuddin (1994) examined the diurnal variation of rainfall and its relation to urban development in Kuala Lumpur. Diurnal rainfall were divided into three intensity categories, namely light, moderate and heavy rainfall. These categories corresponded to intensity levels of less than or equal to 2.5 mm per hour, between 2.5 and 7.7 mm per hour; and greater than 7.7 mm per hour, respectively. In general, he concluded that, regardless of season, the three categories of diurnal intensity of rainfall displayed their maximum values in the early morning and late evening and/or night. This finding is associated with the occurrences of squall-lines, known locally as *Sumatras*. This type of squalls lines normally lie wholly within a single airstream, commonly strike the coast between Port Klang and Singapore, and consist of a practically continuous line of towering cumulus or cumulonimbus.

Solar Radiation and Sunshine Variations in Malaysia

As a maritime country close to the equator, naturally Malaysia has abundant sunshine and thus solar radiation. However, it is extremely rare to have a full day with completely clear skies even in periods of severe drought. The cloud cover limits sunshine substantially and thus solar radiation. Hu and Lim (1983), investigated solar radiation and sunshine duration for a total of 14 stations in Peninsular Malaysia. They found that the pattern of global solar radiation follows somewhat in accordance with that of rainfall pattern. Yassen and Jamaluddin Md. Jahi (2003b), examined variations and trends in the global solar radiation in the Klang Valley Region, Malaysia. The overall average rate of change in global solar radiation during 1975-2002 and 1977-2000 as represented by the slope of the linear regression was small (of the order of -0.126 and -0.314 MJ m⁻² per year for Subang Airport and Petaling Jaya, respectively). Moreover, Yassen and Jamaluddin Md. Jahi (2004), investigated the variations and trends in monthly, seasonal and annual sunshine in three urban areas in the Klang Valley, namely Subang, Petaling Jaya and Bangi (Universiti Kebangsaan Malaysia) for the period 1975-2002. The sunshine results revealed that there is a maximum in May

of 7.0 hours at Subang and a minimum in November with a value of 4.5 hours at Universiti Kebangsaan Malaysia. The statistically fitted linear trend at Subang Airport and Petaling Jaya over the period 1970-1999 were -4.30 and 0.22 hour per year, neither relationship was statistically significant. At Universiti Kebangsaan Malaysia the linear trend over the shorter period of measurement available, 1979-2000 was -13.57 hour per year, and was significant at 0.05 level.

Climate - Air Pollution Relations

Sham's (1979) study, in Kuala Lumpur-Petaling Jaya, showed that there was a weak negative relation between dust particulates and precipitation; and a weak relation between respirable dust particulates and wind speed ($R=0.127$ correlation coefficient). A similar study was carried out by Yassen (2003a) for Kuala Lumpur-Petaling Jaya. He used four different sites to measure morning and evening dust particulates concentrations and wind speed. He found that the correlation between dust concentrations and wind speed, ranged between 0.06 in the morning to -0.51 in the evening. Sham (1985), when conducting field survey in Sandakan town (in Sabah, Malaysia), observed that despite the cleansing capability of the rainfall, there were still the redelivery of particulate and other pollutants into the atmosphere, both during and after the rain, thus negating any meaningful cleansing effect. Indeed, the atmosphere tends to be relatively more stable and calm soon after rain, thus inhibiting dispersion while the injection process of pollutants continues. Furthermore, Sham (1988) noted that earlier studies showed that the effectiveness of precipitation scavenging in cleansing the atmosphere in the Klang Valley is inconclusive.

Correlations between TSP and mean daily rainfall (1985-86) in Bangi were -0.14 (Sham 1987a), -0.043 to -0.567 in Kuala Lumpur-Petaling Jaya during 1983-1997 (Yassen 2000) and -0.36 in the Klang Valley during 1984-1999 (Soleiman 1997). Sham (1993) suggests that the low correlation values between TSP and rainfall might be expected because of the scavenging effect of precipitation upon particulates is not normally linear. Japan International Cooperation Agency (JICA 1993), in the Klang Valley, showed Suspended Particulate Matter (SPM) concentrations decreased with increasing in rainfall amount. The wash out effect on particulate matter seems to be larger. However, gaseous pollutants such as SO₂ do not show any clear association with rainfall. Soleiman (1997) investigated the relations between the relative humidity and TSP

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concentrations based on weekly averages for the years 1990-1994 in the Klang Valley Region ($R=0.58$). Yassen (2000) found a correlation between daily mean TSP concentrations and relative humidity in Kuala Lumpur and Petaling Jaya, for the period 1983-1997, which ranged from -0.041 to -0.373. The analysis of the average daily concentrations of TSP, PM_{10} and wind speed showed a significant negative correlation for many years. This observation gives prominence to the efficiency of the atmospheric horizontal mixing as a dilution mechanism. A negative correlation was found between wind speed and TSP concentrations in the Klang Valley Region (Solieman 1997, Yassen 2000). Dilution can be considered a principal mechanism for decreasing TSP and PM_{10} concentrations with increasing wind speed.

Yassen (2000), used regression and multiple regression techniques to find relations between daily TSP, SO_2 and O_3 and meteorological parameters (rainfall, relative humidity, temperature and wind speed) in Kuala Lumpur and Petaling Jaya. The results revealed a negative correlation between TSP and rainfall. The relation between SO_2 and meteorological parameters was found to be quite small, ranged between -0.049 to 0.271 and 0.01 to 0.051 for temperature and wind speed, respectively. The amount of variance explained by the multiple regression equations averaged 15% for TSP concentrations, 14% SO_2 for concentrations and 35% for ozone.

The effect of such variations in meteorological parameters has been investigated previously for ozone concentrations. JICA (1993) working in the Klang Valley showed that ozone concentrations peak around 2:00 p.m., when incoming solar radiation is strong and temperatures are high. The results of correlation between ozone concentrations and temperature are consistent with most other studies; temperature was found to have positive relation with ozone. Yassen (2002a) in Kuala Lumpur and Petaling Jaya found the correlation coefficient between daily ozone concentration and temperature ranged from 0.281 to 0.454. The implication of these relationships is that the ozone concentrations tend to increase with increasing temperature and solar radiation.

CONCLUSIONS

Starting from 1972 studies on the spatial and trend of urban climate have focused on annual and seasonal variations of air temperature and rainfall, but little work has been done on other

climatic parameters. However, a few studies have also focussed on the diurnal pattern of several climatic variables such as rainfall and temperature.

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Urban climate research in Sri Lanka: Efforts towards mitigation.

Tropical urban climate studies are relatively new. One of the earliest tropical urban micro-climate studies was conducted by Nieuwolt in Singapore less than forty years ago (Nieuwolt, 1966). Since then, urban climate studies in the tropics have quickly multiplied, covering the entire tropical region from Kuala Lumpur (Sani, 1973), Ibadan (Adebayo, 1987), Mexico City (Jauregui, 1993), Darwin (Aynsley & Gulson, 1999) and Dar es Salaam and Ouagadougou (Jonsson, 2005). However, the situation in Sri Lanka is in its early infancy. The first ever comprehensive historical survey of the Urban Heat Island phenomenon in the Colombo Metropolitan Region (CMR) was completed only in 1999 (Emmanuel, 1999).

While studies on tropical urban climate anomaly continue to focus on understanding the physical processes underlining the phenomenon, a second and important thread has been the emphasis on efforts to mitigate the negative consequences of the UHI. This assumes greater importance in Sri Lanka on account of two reasons. On the one hand, an unprecedented acceleration of urbanization is currently underway in Sri Lanka. Historically, Sri Lanka had a steady rate of urbanization (approximately 22% of the national population lived in cities ever since independence in 1948 – see, Statistical Abstracts, 1995). However, the introduction of market-friendly economic policies and opening of the national economy in 1977 has seen the share of urban population rise: slowly in the first two decades, but gathering momentum since late 1990s. By 2010 urban population is expected to top 50% of the national population (CMRSP, 1998). As such, Sri Lankan cities offer a unique opportunity to study the changing urban climate even as the changes occur. On the other hand, the naturally oppressive warm, humid climate of the region is being negatively influenced by tropical cities and this influence is readily recognized by the urban population. Therefore conditions are ripe for mitigatory action via urban planning/design controls (see, Emmanuel, 1993). The relatively lower rates of urban growth offer opportunities to mitigate the negative climate/thermal comfort consequences of urban growth before the situation worsens. This may have lessons for other equatorial tropical cities as well.

Most of Sri Lanka's rapid urbanization is centered on the CMR (Figure 1). Being the only metropolitan region in the country, the CMR enjoys the status of a primate city. In 1996, with a population of about 4.5 million, the CMR accounted for over 80% of all industrial establishments in Sri Lanka, provided jobs to a third of the Sri Lankan workforce and generated over 44% of the national GDP. Due to its economic and administrative importance, the CMR is expected to grow rapidly in the coming years. By 2010, an expected 6.5 million people will be living in the CMR (CMRSP, 1998).

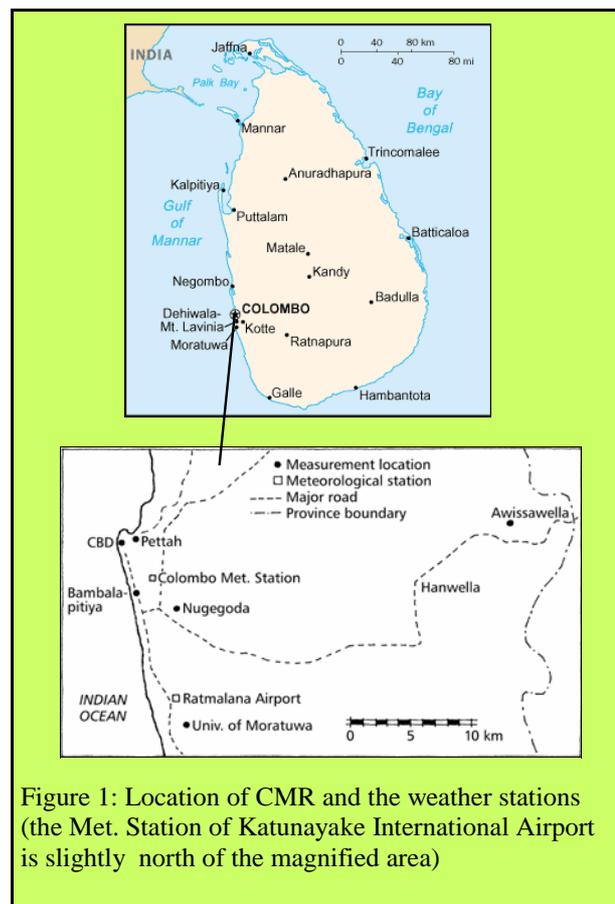


Figure 1: Location of CMR and the weather stations (the Met. Station of Katunayake International Airport is slightly north of the magnified area)

Urban Climate of the Colombo Metropolitan Region (CMR)

The study of historic trends in climate of the CMR is greatly facilitated by the long-term climate records available at the three first-order weather stations in the region (Figure 1 – the International Airport at Katunayake is slightly north of the mag-

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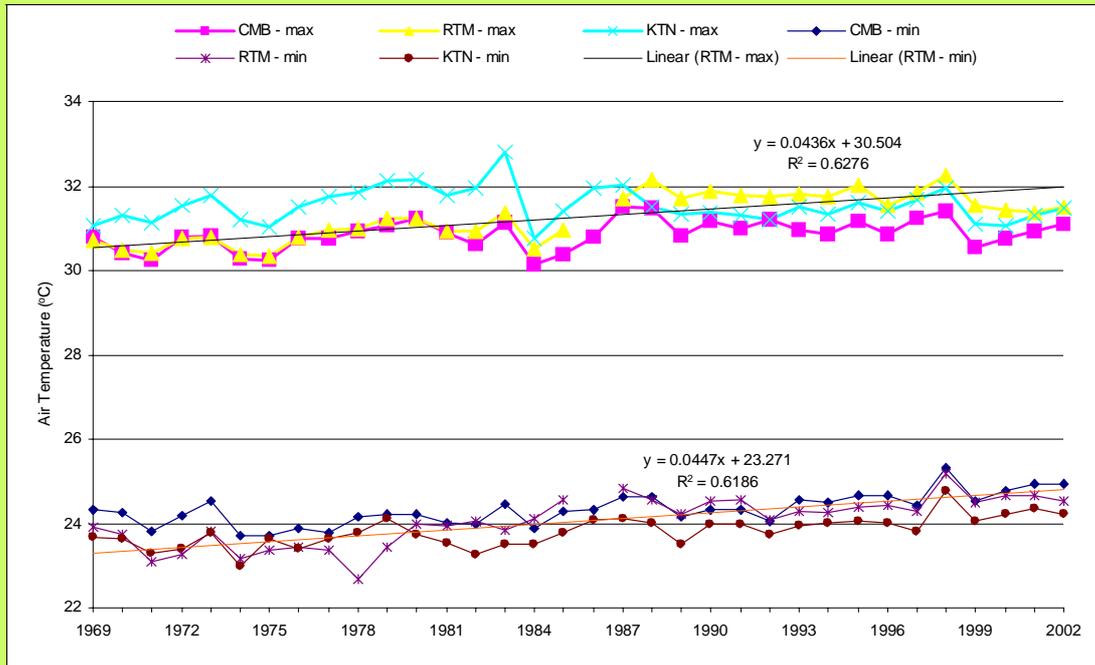


Figure 2: Historic temperature trends in the CMR CMB – Colombo Met. Station; RTM – Ratmalana Airport; KTN – International Airport at Katunayake

nified area). The land cover characteristics are such that the “city station” (Colombo Met Station) has more green cover with lower building density than the other stations (“Rural” Station at the International Airport, Katunayake and the “suburban” station at the Domestic Airport, Ratmalana). This has led to uneven microclimate variations across the CMR with several “cool islands” being created within the city.

Figure 2 shows temperature trends during a thirty-five year period starting 1969 (see Emmanuel, 2005a). A clear warming trend can be seen, both at day and night. The “typical climate” (i.e. prior to rapid urbanization, up to about early 1980s) which was barely tolerable has been made worse by rapid urbanization in the 1990s. This is demonstrated in Figure 3, which shows the deterioration of thermal comfort (expressed as the Temperature-Humidity Index) during the last decade.

The CMR is still very green. Over half of its land cover could be classified as “green” (Emmanuel, 2003). However, this is rapidly changing and the consequences are clearly reflected in the region’s climate (Emmanuel, 2005b).

Over the last five years, researchers from the Universities of Moratuwa (Sri Lanka) and Lund (Sweden) have collaborated in studying the urban climate phenomenon in the CMR (Johansson, et

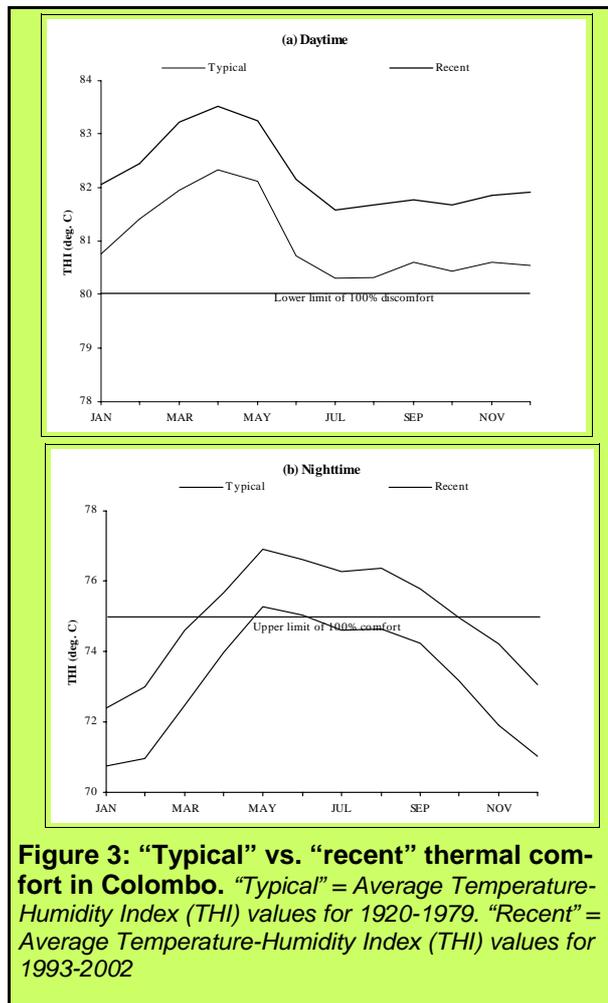


Figure 3: “Typical” vs. “recent” thermal comfort in Colombo. “Typical” = Average Temperature-Humidity Index (THI) values for 1920-1979. “Recent” = Average Temperature-Humidity Index (THI) values for 1993-2002

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Figure 4: Difference in urban morphology; the medium rise, high density Pettah district (left) and the low rise, low density Nugegoda district (right)

al., 2004). The urban climate was measured at sites with different urban morphology (Figures 1 and 4). The results (Figure 5) showed larger intra-urban differences by day than by night. The day-time variations are believed to mainly be a result of differences in morphology and proximity to the sea.

The primary focus of these efforts has been devising of urban design/planning strategies to mitigate the negative thermal comfort consequences of un-planned urban growth. The results of our work have implications for urban design and climate-conscious urban planning in the equatorial tropical cities. Possible strategies to improve outdoor thermal comfort in the city of Colombo include:

- Allowing a more compact urban form with deeper street canyons to provide shade at pedestrian level. Care has to be taken, however, especially in residential areas, because the possibility of natural ventilation and night-time cooling of buildings decreases with an increased H/W ratio. Deep canyons are also a disadvantage in polluted areas since dispersion is less than in shallow canyons.
- Providing shade within the street canyons during the hours around noon by utilising large tree canopies, covered walkways, pedestrian arcades, awnings or other types of shading.
- Encouraging airflow, which is moderate in the case of Colombo, by using irregular positioning of buildings and creating variations in building height. Tower buildings, if positioned a sufficient distance apart, also stimulate air movement.

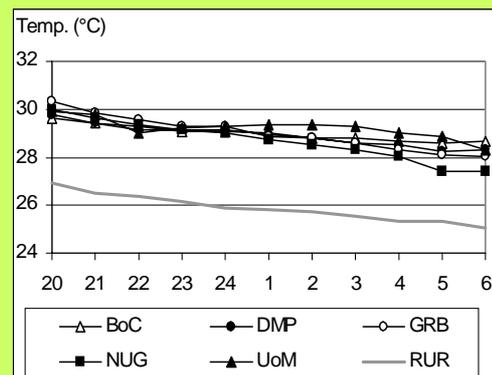
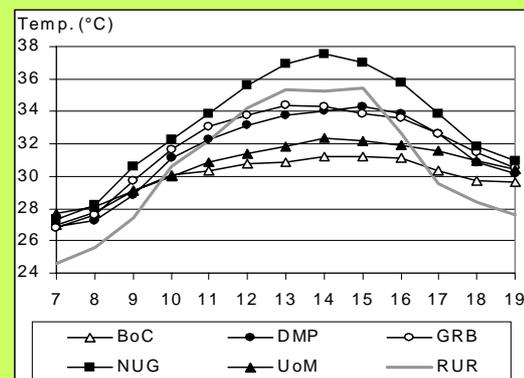


Figure 5: Microclimate variations in CMR – day (top) and night (bottom). “BoC” – Central Business District (high-rise buildings and towers); DMP – Pettah (medium rise, high density); GRB – Bambalapitiya (medium rise, medium density); NUG – Nugegoda (low rise, low density); UoM – University of Moratuwa (medium rise, green cover); RUR – Rural (Awissawella) (See Figure 1 for locations)

Country Report

- Opening up the coastal strip of the city by widening the roads, which run perpendicular to the coast so that they can act as channels. This will permit the sea breeze to penetrate further into the city and is especially important because of the weak macro-level winds in Colombo (Johansson and Emmanuel, unpub.).

Future studies should include simulations to examine the effect of different configurations of urban morphology on outdoor thermal comfort. There is also a need to explore people's subjective perception of the thermal environment – through the use of questionnaires and interviews – and relate it to calculated comfort indices in order to determine acceptable comfort limits. Further field studies are needed to evaluate the effect of different types of overhead shading devices on outdoor thermal comfort.

The issue of daytime “cool islands” (See, Figure 5) created by variations in H/W ratio and land cover opens up interesting urban design implications that could be manipulated by sensitive control of the city's fabric. Urban design/planning implications of these too, need to be studied.

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Conference Report

Urban Climatology and its Applications

A two-day meeting on Urban Climatology took place at Pembroke College in Cambridge on July 7th and 8th. The meeting was organised by Jenny Salmond (Birmingham University) and Rex Britter (University of Cambridge) and brought together over twenty speakers. The purpose of the meeting was to gauge interest in the UK research community in urban topics and it drew together those interested in modelling, air quality, urban design and applications. An objective of the meeting was to identify those among a spectrum of interests (including government at all scales, industry, business and utilities) that would be interested in supporting urban research.

A number of the speakers present current fieldwork in the UK. These included Alan Robins (Surrey Univ.) who spoke on current wind tunnel work and on the DAPPLE project (see issue *). Similarly, Alison Tomlin (Leeds Univ.) presented some results from fieldwork in Leeds. This research examines the detailed air pollution meteorology of a selected street and is assessing the 'personal exposure' of street-users to transport derived pollutants. An assessment of the emission profile of vehicles shows these to be concentrated in short bursts, associated with rapid movement after a stoppage. Thus pollutant input is closely tied to traffic lights. Stephen Belcher (Reading) and Janet Barlow (Reading) each presented wind tunnel work examining common urban configurations and the transfer of momentum and scalars into and out of the urban canopy. Martin Best (Meteorological Office) presented ongoing work that is 'urbanizing' the UK Met. Office forecasting model.

Other speakers presented work that has a current application. Lee Chapman (Birmingham Univ.) showed some examples of work completed by Entice Ltd. for a number of clients interested in predicting surface temperatures. Thus far their clients have been Local Authorities concerned with predicting the location of surface freezing on road networks. However, the approach has a relevance to railroads, which can buckle at high temperatures. Jay Golden (Arizona State Univ.) demonstrated the potential for applied urban climatology in the context of Phoenix, Arizona. He presented a number of engineering approaches and demonstrated the potential of academic-industry-government partnerships. John Mardaljevic (DeMontford Univ) illustrated the potential of an irradiance model when coupled with a detailed description of the urban surface. The approach

would allow a building manager to obtain a detailed distribution of available energy at the outside surface of buildings and determine the blocking effect of neighbouring structures. Rob Kinnerley (Environment Agency) gave an overview of urban air pollution from a regulatory perspective. Rex Britter presented the current state of knowledge on our ability to simulate the transport of hazardous plumes within city environments. Glenn McGregor discussed human thermal comfort in London and the potential for forecasting models to identify potentially stressful climatic conditions.

An important objective of the conference was to bring together those working at different scales of urban enquiry and those concerned with indoor and outdoor spaces. Koen Steemers (Cambridge Univ.) outlined a research project that combined measurements made in outdoor climate with a detailed questionnaire survey of users of that space. The research was carried out in a number of different places (representing different climates) in Europe. While the analysis has not been completed, Koen suggested that design should provide for a variety of outdoor microclimates rather than attempt an 'optimal' solution. Gavin Davies (ARUP) also spoke of the need for design to ensure the 'usability' of outdoor public spaces and the need to raise the public's 'expectation' of outdoor environment. As such spaces would be commercially valuable this provides an incentive for including climate considerations in design. A paper was presented on behalf of Jake Hacker (ARUP) on the potential impact of climate change on building design in the future. Finally, Peter Guthrie discussed sustainable development and urban climatology. Although he expressed the view that SD terminology is overused (often inappropriately), he still thought that its widespread acceptance provided an opportunity for raising the profile of urban climatology/meteorology.

In addition to these speakers, four plenary speakers presented overviews of aspects of urban climatology. Sue Grimmond spoke on urban field measurements and their results, Gerald Mills on the current state of applied urban climatology and Jamie Voogt on remote sensing of the urban thermal environment. A list of the speakers and their abstracts is available at: <http://www.gees.bham.ac.uk/people/lecturer.asp?ID=366#UWERN>

Conferences

Workshop on Transformation of Traffic Emissions From Source to Large Scale for Evaluation of Their Effects on Climate

Dear colleagues, on 26-28 September, 2005 we (Department of Meteorology and Environment Protection, Faculty of Mathematics and Physics, Charles University, Prague in the framework of EC project MAGMA - see: <http://geo.mff.cuni.cz/magma/index.html>) are organizing the . The main part of the meeting will be the QUANTIFY Workshop on effective emission indices and QUANTIFY Activity 2 meeting. Main topics covered by the workshop are the concept of effective emission indices for evaluation of the impact of traffic emission on climate change, microscale modelling of chemistry and transport of emissions from the exhaust, mesoscale modelling of chemistry and transport of pollutants from the sources to large scale and effects of emissions from transportation on climate change. The scope of the QUANTIFY 6FP EC Project covers all main types of transportation, both cars, aircrafts and ships. There is a web page for the meeting on <http://meop0.troja.mff.cuni.cz/quantify/>

The participation on the workshop is supposed to be free, except lunches and other social and cultural events, for accommodation the block of quite cheap rooms in hotel Krystal is booked. Those interested are supposed to preregister on the web: <http://meop0.troja.mff.cuni.cz/quantify> , where you are expected to provide us necessary information for further communication and for planning the meeting. Here you can find enclosed registration and payment form as well, it should be filled in and sent to the address mentioned there. Please, follow the instruction in this form, the deadline for final registration and payment is August, 20, and 25, 2005, respectively.

There are some funds to support selected participants (100 EUR/day plus travelling up to 350 EUR against the ticket), it is supposed for participants from EC or associated countries, unfortunately no overseas. Generally, those participants receiving support are kindly asked to pay their expenses in advance, they will be reimbursed after registration for the meeting in Prague.

Tomas Halenka, Josef Brechler

Climate Analysis for Urban Planning

The 4th German-Japanese Meeting on
Urban Climatology,
Tsukuba, Japan
30th Nov.—2 Dec., 2005.

The Conference will be held in Tsukuba at the National Institute for Environmental Studies and includes an excursion to Nagano and a Klimaatlas Workshop with citizens and planners. The scope of the conference includes any topic on Urban Climatology.

Abstract Information

- Submission Deadline: 5th Sept.
- Submit an abstract to Prof. Dr. WATANABE (hwatanab@tohtech.ac.jp), by e-mail.
- Format: 500 words, 1page of A4 format, including figures and tables, if necessary
- The TITLE, Author(s) and their Affiliation(s) on the top of page.
- Please use 10 point Century or similar font for text and 30mm for all page-margins.
File format will be limited to MS-Word or PDF.

Note : If so many abstracts will be submitted, there will be not only oral presentations but also poster presentations.

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Conferences



ICLEI World Congress 2006 27 February – 3 March 2006 Cape Town, South Africa

The ICLEI's 2006 World Congress will take place in Cape Town, South Africa from 27 February – 3 March 2006. For the first time ever, the World Congress will take place in the Southern Hemisphere. With this location we look forward to a truly global exchange among our colleagues and partners from all continents.

The 2006 Congress will be a dynamic event with keynote presentations, reports, debates, workshops, networking events, site visits and an interactive exhibition. We will review progress with Local Action 21 and learn about best practice experiences with local governance; building resilient, peaceful and secure communities; alleviating poverty; protecting global environmental goods such as biodiversity, water and the global climate; sustainable procurement and sustainability management instruments.

Further information can be found at <http://www.iclei-europe.org/1343.html>

"Urban Remote Sensing: Challenges & Solutions", 2-3 March 2006, Berlin-Adlershof, Germany



This is the First Workshop of the EARSeL Special Interest Group on Urban Remote Sensing.

contact: Prof. Dr. Patrick Hostert,
patrick.hostert@geo.hu-berlin.de

The Fall Meeting of the AGU will be held on 5–9 Dec. 2005, in San Francisco.



Among the sessions are many that may be of interest to urban climatologists.

These include:

- B15: Hydrology, Ecology and Biogeochemistry of Suburbia
- B11: Changes in Land Use and Water Use and Their Effects on Climate, Including Biogeochemical Cycles
- H62: Integrated Approaches to Improve Understanding and Prediction of Hydrologic Response to Land Disturbance
- H16: Impacts of Land Use/Land Cover Change on the Water Cycle

The online submission deadline is Sept. 8. Further information can be obtained at <http://www.agu.org/meetings/fm05/>

AMS 6th Urban Environment Symposium



The announcement for this event appeared in a previous edition of the Newsletter. The Symposium will be held at the AMS Annual Meeting (29 January–2 February 2006 in Atlanta, Georgia at the Georgia World Congress Center.) The deadline for the submission of abstracts is 15th August 2005.

The Symposium has three sessions:

- Joint session A: Development of tools to assist emergency responders in the case of releases of gases and small particles within urban areas;
- Joint Session B: Mitigation of urban heat islands;
- Joint Session C: Comparison and Evaluation of Urban Land surface schemes for meso-scale models.

For further information:
<http://www.ametsoc.org/meet/annual/index.html>

Report

ICUC-6 Organization Committee

Online submission of abstracts is now available. Please visit (www.gvc.gu.se/icuc6).

Program changes:

- All **main authors** need to pay an abstract fee of 470 SEK.
- Additional abstracts submitted by the same main author will be free of charge.

Hope to see you all in June 2006
Local Organization Committee

ICUC-6

ICUC-6
Sixth International
Conference on Urban Climate
Göteborg, Sweden
June 12th - 16th, 2006



The IAUC members have selected Göteborg (Gothenburg), Sweden as the site for the sixth International Conference on Urban Climate. Further details will become available at the conference website www.gvc.gu.se/icuc6, which is also accessible via the IAUC website (www.urban-climate.org).

Call for papers

ICUC-6 welcomes papers seeking to understand the nature of the atmosphere in urban environments or to the application of such knowledge to the better design and operation of settlements. Scales of interest range from individual built elements (roofs, walls, roads) through whole buildings, streets, factories, parks, clusters of buildings and neighborhoods, to whole cities and urban regions and their impacts on weather and climate at scales up to those of global change. The focus can be original research into the physical, biological and chemical atmospheric processes operating in built areas; the weather, climates and surface hydrology experienced in built areas; the design and testing of scale, statistical and numerical models of urban climates; or reports on the application of climatic understanding in architectural design or urban planning. Papers may relate to new concepts, methods, instruments, observations, applications, forecasting operations, scenario testing, projections of future climates, etc. Sessions that focus on major field studies or other projects or topics may be proposed. For further information please visit the website or email Professor Sven Lindqvist, chair of the local organizing committee (sven@gvc.gu.se) or Prof. Sue Grimmond (grimmon@indiana.edu), President IAUC.

The deadline for submission of abstracts is 10th November, 2005. Abstracts will be submitted via the web. Appropriate topics include, but are not restricted to:

- Airflow over cities, including turbulence, urban roughness and drag, changes of wind speed and direction, urban circulation systems, and wind engineering
- Anthropogenic Heat
- Building climates (interior and exterior) and the climatic performance of built features
- Carbon exchanges in urban areas
- Cities and global change
- Climate-sensitive urban design and planning
- Climates of paved surfaces such as roads, streets, highways, runways and parking lots
- Climatic performance of urban trees, lawns, gardens, parks, green roofs, irrigation, rivers, lakes and reservoirs
- Emergency response planning
- Exchanges of heat, mass and momentum between the urban surface and its boundary layer
- Forecasting urban weather, comfort, hazards, and air quality
- Interactions between urban climate and the emission, dispersion, transport, transformation and removal of air pollutants
- Models, and their evaluation, of the urban atmosphere at all scales and urban surface-atmosphere exchanges
- Remote sensing of cities and urban climate
- Road climatology in cities, including influence from traffic and other city related-objects
- Short- and long-wave radiation in polluted air and urban visibility
- Topoclimatology of cities, including the effects of coasts, valleys and other landforms
- Urban biometeorology relevant to the functioning of plants, wildlife and humans
- Urban climates in high latitude settings
- Urban heat islands, their nature, genesis and mitigation
- Urban impacts on surface moisture, dew, evaporation, humidity, fog, cloud and precipitation



IAUC Committee Reports

Bibliography

This has been a great year for urban climate publications. We have seen a wide range of interesting papers spanning the breadth of the subject from cities around the world. Thanks to everyone who has collected and sent in references. Look out for the complete 2003 and 2004 bibliographies on the IAUC website in the near future!

Please send any further papers published since January 1 2004 for inclusion in the next newsletter to j.salmond@bham.ac.uk. As before, please mark the header of your email with 'IAUC Publications 2004'. 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
University of Birmingham
j.salmond@bham.ac.uk



Recent publications in Urban Climatology
(Languages are specified where the publication is known to be in a language other than in English.)

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IAUC Awards Committee

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Board Information

IAUC Membership

Current statistics: The IAUC is on the brink of welcoming its 1000th member! Membership of the IAUC on 31.07.05 was 991, an increase of almost 20% since the end of August last year. The male:female ratio has kept steady at 73:27%, and 24% of members are students. Congratulations to those of you who have moved on from student status after gaining your doctorates. We have members in 81 countries, from Latvia to Lesotho, and from Mongolia to Moldova!

Can you help? We are currently revamping the database and email list to streamline the signing up process – watch your inboxes for more information very shortly. If you think you can spare a few hours a year to help the IAUC membership grow, contact me for more information.

Janet Barlow
Membership Secretary
email: j.f.barlow@reading.ac.uk



IAUC Information

Non-Voting members of the Board:
Past Secretary: John Arnfield, USA.
Past President: Tim Oke, Canada.
Local Organizer ICUC5: Kazimierz Klysik Poland.
Local Organizer ICUC6: Sven Lindqvist, Sweden.

IAUC Committee Chairs

Editor IAUC Newsletter: Gerald Mills
Chair Bibliography Committee: Jennifer Salmond
Chair Membership Committee: Janet Barlow
Chair Teaching Resources: Gerald Mills
Chair Awards Committee: Bob Bornstein
WebMasters: James Voogt

Board Members & Terms

President: Sue Grimmond (USA), 2007
Secretary: Matthias Roth (Singapore), 2007
Janet Barlow (UK), 2007
Ariel Bitan (Israel), 2006
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Wilhelm Kuttler (Germany), 2008
Gerald Mills (Ireland), 2007
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AWARDS Committee

The Luke Howard Award

This is given annually to an individual who has made outstanding contributions to the field of urban climatology in a combination of research, teaching, and/or service to the international community of urban climatologists.



The inaugural (2004) winner was Prof. Tim Oke of the University of British Columbia, Canada.

Nomination materials for the 2005 Award will be collected and coordinated by the first person to notify Prof. Bob Bornstein (pblmodel@hotmail.com) Chair of the IAUC Awards Committee that a particular person is to be nominated.

Any further expressed interest in that nominee will be referred to the coordinator for that nominee. Posthumous awards will not be made, no self-nominations are permitted, and current Awards Committee members cannot be nominated.

Coordinators must collect the following documentation and submit it (in a single electronic submission) to the Chair of Awards Committee by 1 October 2005: three-page candidate-CV and two-page letters of recommendation from three IAUC members from at least two different countries.

Please contact the Chair of Awards Committee for additional information. Bob Bornstein (Chair, USA). Members - Maria Alcorado (Portugal), Tony Brazel (USA), Ingegard Eliasson (Sweden), Toshiaki Ichinose (Japan), Tim Oke (Canada), and Jenny Salmond (UK)