Issue No. 19
October, 2006.

IAUC NEWSLETTER

INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

www.urban-climate.org

President's Column

I am very pleased to welcome you to the beginning of the fourth year of the IAUC newsletters. Once again Gerald Mills, the Editor, has done an excellent job of compiling a very interesting array of articles on urban climate projects, country reports, book reviews etc. I strongly encourage you to send short articles for inclusion in the next newsletter: deadline November 30th.

The deadline for the Luke Howard Award has been extended to November 1 2006. I strongly encourage you to nominate colleagues worthy of this recognition (full details are presented at the end of this newsletter) Shortly, the IAUC Board will be bringing to you a series of proposals for the next International Conference in Urban Climate to be held in 2009 and asking you to vote on the next venue.

Sue Grimmond
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Newsletter Contributions

The next edition will appear in early December. Items to be considered for the next edition should be received by **November 30, 2006.**

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@bham.ac.uk
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.

The Luke Howard Award

The Luke Howard Award 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 2004 and 2005 winners were Prof. Tim Oke and Prof. Ernesto Jauregui, respectively.

Nomination materials for the 2006 Award will be collected and coordinated by the Manabu Kanda (kanda@ide.titech.ac.jp) Chair of the IAUC Awards Committee. 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 November 2006: 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.

Manabu Kanda (Chair, Japan)
Bob Bornstein (USA)
Tony Brazel (USA)
Ingegard Eliasson (Sweden)
Jenny Salmond (UK)
Ernesto Jauregui (Mexico)

Urban Climate News

Designing Arizona Architects turn back to Wright

On Arizona.com Steve Friess (Sept. 06) writes on how Arizona architects are revisiting ideas for design with nature advocated by Frank Lloyd Wright:

A new generation of Wright disciples wants to go back to basics, to adapt a variety of elements that typified Southwestern-style architecture and update those elements to the age of air-conditioning.

"Architects are rediscovering the early notions of working with climate and sun," said architect Vernon Swaback, a Wright apprentice whose firm created the Univision structure and planned the 1,000 acres surrounding the Arizona Biltmore Resort and Spa. "What you want to do is shield Western exposure, let light in on the north side but also try to shield the sun from direct contact with glass with the shape of the buildings and landscaping, And we're using exposed concrete walls and floors that act like insulators, just as the earlier people did."

There is no one definition of Southwestern architecture, but scholars and practitioners asked to describe it offered consistent basic principles: rectangular forms, small windows, minimal exposure to western sunlight, buildings that use the complexion, and often the materials, of their environs, often ones with trellis-covered courtyards to provide light and shelter.

Those seemingly sensible principles started first with early Native American and Spanish settlers who carved homes into rock or the ground throughout the region. The practice of using the sturdy packed-earth concoction of adobe, usually from the building's dig site, began. Early settlers figured out that adobe not only blended aesthetically with the surroundings but had the insular ability to hold in some heat during cold nights in the desert's winter, and to hold in cool air in the summer.

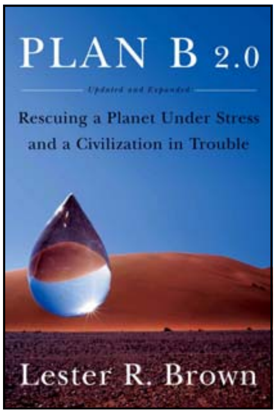
With a *postwar population influx, the modernist style of the 1950s and the advent of air-conditioning prompted builders to abandon concerns over what building materials to use or what position to point the houses. Courtyards gave way to picture windows overlooking front yards, said Arnold Roy, a Wright acolyte who teaches architecture at his former master's school, Taliesin West in Scottsdale: "Take a drive down Central Avenue (in Phoenix) and you can pick out the buildings and when they were built by their orientation," Roy said. "In the '50s and '60s, you see some homes with orientations that go directly toward the west. By the late 1980s and 1990s, they got a little smarter and started putting them at 45-degree angles so you don't ever get the full effect of the setting sun."*

Several old concepts are making their returns in modern form, most notably the notion of a multipurpose, or great room, said James Abell, the architect designing the in-fill project near Fillmore and 10th streets. Abell notes that all a great room is, is a return to homes that aren't sectioned off with so many walls, a good idea that helps circulate air more efficiently. Still, other no-nos are practiced anyway. Abell said he is surprised that many builders ignore basic notions learned over centuries of desert living, most notably using wood for housing frames because it dries out and warps easily. Another shocker to him is that people park hot cars in enclosed or attached garages, adding heat to the home.

"To truly be Southwestern architecture today, you at least need to pay a great deal of attention to where you place the openings on the buildings and how you use the space to be energy efficient," Abell said. "In many cases, (builders) ignore the reality of the climate."

Plan B 2.0

Lester R. Brown



The Earth Policy Institute has published Plan B 2.0 on its website (www.earth-policy.org/Books/PB2/). The book covers a host of environmental issues, including the design of sustainable cities. The book is available entirely online. Below is an excerpt taken from Chapter 11 of the book, Designing sustainable cities, which was published on the Earth Policy website.

THE ECOLOGY OF CITIES

Urbanization is one of the dominant demographic trends of our time. In 1900, 150 million people lived in cities. By 2000, it was 2.9 billion people, a 19-fold increase. By 2007 more than half of us will live in cities—making us, for the first time, an urban species.

Cities require a concentration of food, water, energy, and materials that nature cannot provide. Concentrating these masses of materials and then dispersing them in the form of garbage, sewage, and as pollutants in air and water is challenging city managers everywhere.

Most of today's cities are not healthy places to live. Urban air everywhere is polluted. Typically centered on the automobile and no longer bicycle- or pedestrian-friendly, cities deprive people of needed exercise, creating an imbalance between caloric intake and caloric expenditures. As a result, obesity is reaching epidemic proportions in cities in developing as well as industrial countries. With more than 1 billion people overweight worldwide, epidemiologists now see this as a public health threat of historic proportions—a growing source of heart disease, high blood pressure, diabetes, and a higher incidence of several forms of cancer.

The evolution of modern cities is tied to advances in transport, initially for ships and trains, but it was the internal combustion engine combined with cheap oil that provided the mobility of people and freight that fueled the phenomenal urban growth of the twentieth century. As the world urbanized, energy use climbed.

Early cities relied on food and water from the surrounding countryside, but today cities often depend on distant sources even for such basic amenities. Los Angeles, for example, draws much of its water supply from the Colorado River, some 970 kilometers (600 miles) away. Mexico City's burgeoning population, living at 3,000 meters, must now depend on the costly pumping of water from 150 kilometers away and must lift it a kilometer or more to augment its inadequate water supplies. Beijing is planning to draw water from the Yangtze River basin nearly 1,500 kilometers away.

In the years ahead, urbanization could slow or even be reversed. In a world of land, water, and energy scarcity, the value of each resource may increase substantially, shifting the terms of trade between the countryside and cities. Ever since the beginning of the Industrial Revolution, the terms of trade have favored cities because they control capital and technology, the scarce resources. But if land and water become the scarcest resources, then those in rural areas who control them may sometimes have the upper hand. With a new economy based on renewable energy, a disproportionate share of that energy, particularly wind energy and biofuels, will come from nearby rural areas.

Urban Project

Change in urban heat island intensity: Beijing Climatic Station 1961-2000

Introduction

Beijing is a mega city with a population of more than ten million. In the past 50 years, and especially since the 1980's, the city has experienced rapid urbanization, both in terms of population and city area. Presently, Beijing City has a built-up area of almost 500km^2. Such rapid urbanization has resulted in large modification of the landscape within the built-up area and the nearby suburbs, and has undoubtedly enhanced the urban heat island effect.

Study

Beijing Climatic Station is located in the southeastern part of the city proper (Fig 1). The site experiences a significant UHI effect due to its specific location in the city and the local prevailing northwesterly winds. In addition to this station, Beijing Municipal has other nineteen meteorological stations spread over seventeen thousand km^2 (Fig 1). Of the 20 stations, 15 have a record length of at least 40 years before 2000, and the remainder have records that commenced in the 1960's or early 1970's. With reference to the method by Easterling et al. (1995), in-homogeneity examination and adjustment have been conducted on the monthly mean temperature data. Break-points are found in the time series of Beijing and Shunyi Stations, which is the result of their relocation during their observation period. An adjustment is made to correct for these in-homogeneities (Chu and Ren, 2005).

Using population statistics, the specific description of location of stations, and and principal components analysis, six rural stations are chosen as reference sites or country stations for comparison with Beijing Station (Chu and Ren, 2005). They are Xiayunling, Zaitang, Feyeling, Tanghekou, Huairou and Shangdianzi stations respectively, which are all located in the remote areas of the municipality (Fig. 1). The statistical mean temperature for these six stations is treated as a 'rural' series, which is compared to the 'urban' series observed at Beijing Station.

Average monthly and annual mean temperature anomalies for the rural environment are calculated for each year, and linear trends of the mean temperature anomaly series are obtained by using the least square method. The period 1971-2000 is used as climate reference period for calculating temperature anomalies.

The difference between the linear trends exhibited by the urban and rural series is regarded as being caused by urban warming. The relative contribution of urban warming to the total warming for Beijing Station can be estimated this way.

Results

Figure 2 shows the annual mean air temperature anomalies for the urban and rural series for 1961-2000. Two periods, a short cooling period between 1961 and 1969 and a significant warming period after 1969, were observed for both the urban and rural annual mean temperatures in Beijing area,. Overall, there is a significant warming trend in both series and the degree of warming is greatest in winter. However, while the annual urban warming

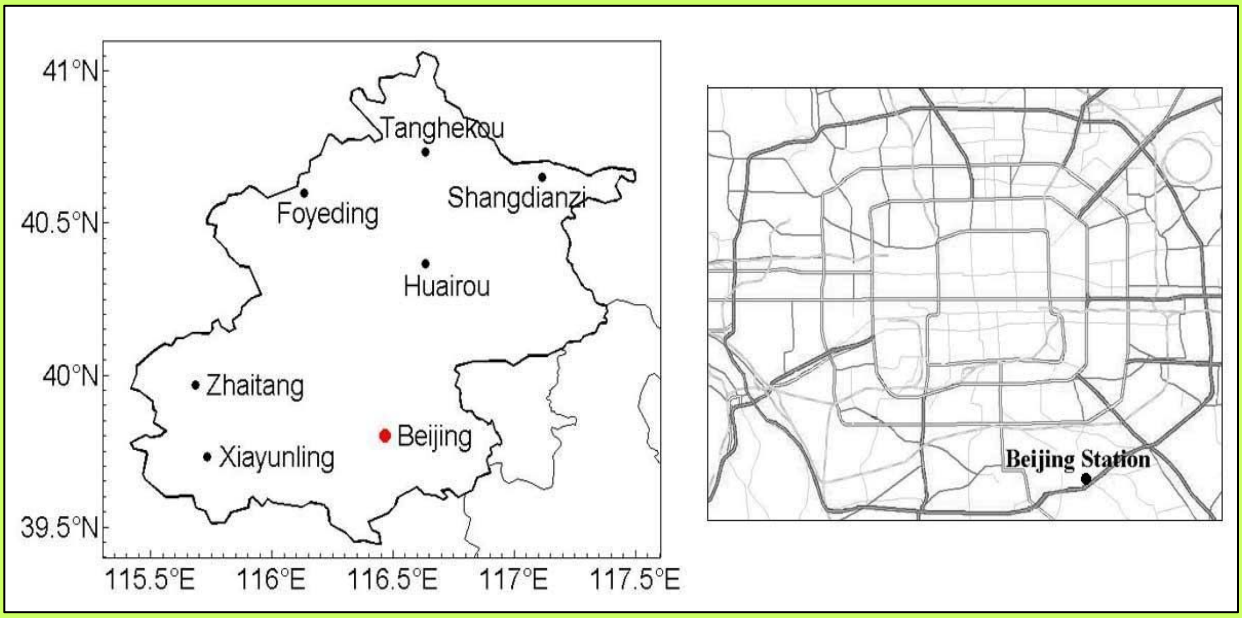


Figure 1 Location of the stations as mentioned in the text

trend is 0.32 ℃/10a, it is only 0.06℃/10a for the rural series, indicating that the temperature trend of Beijing Station is significantly impacted by urban warming.

Figure 3 shows the respective warming trends for the urban and rural series for the periods 1961-2000 and 1979-2000, respectively. Table 1 presents the urban warming trends for these two time periods.

A warming trend is obvious for Beijing Station for all the seasons and time periods. The positive tendency of temperature anomalies is much greater in winter than in any other seasons. While urban warming is generally significant in each of the four seasons for 1961-2000, and it is even stronger in summer and autumn for 1979-2000. Increase in annual mean temperature induced by urbanization for time periods of 1961-2000 and 1979-2000 is 0.26 ℃/10a and 0.44 ℃ /10a, respectively. Maximum urban warming occurs in springtime for 1961-2000 and in autumn for 1979-2000, while minimum urban warming for the two periods occurs in summertime and wintertime, respectively. Therefore, the urban warming in summer and autumn is becoming more obvious with time.

Furthermore, the relative contribution of urban warming to the total warming observed at Beijing Station has been estimated. With regard of annual mean temperature, it reaches to 81% for 1961-2000 and to 56% for 1979-2000. The contribution generally increases from winter and spring to summer and autumn. During 1961-2000, the recorded warming in summer and autumn can be entirely accounted for by the urbanization effect. The contribution of urban warming to the recorded warming can also be as high as 50-80% for the three warm seasons for period of 1979-2000.

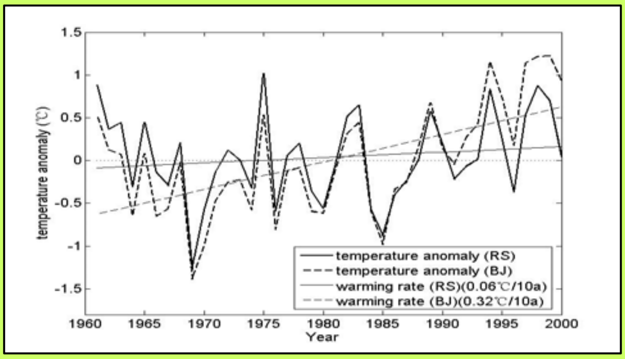


Figure 2 Annual mean air temperature anomalies of Beijing Station and six rural stations: 1961-2000

	Winter	Spring	Summer	Autumn	Annual
1961-2000	0.21	0.33	0.19	0.23	0.26
1979-2000	0.33	0.41	0.43	0.57	0.44

Table 1 Urban warming rates of Beijing Station during 1961-2000 and 1979-2000

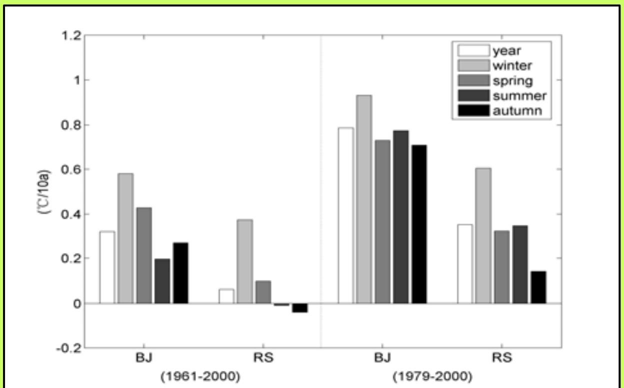


Figure 3 Warming rates of Beijing Station and six rural stations for periods of 1961-2000 and 1979-2000.

Conclusions

These results indicate strong warming induced by urbanization around Beijing Station during the time periods investigated. As Beijing Station is not located in the central area the city, the findings reported here are not necessarily representative of the downtown area where maximum urban heat island effect should usually be felt. The present analysis of urban warming trend is unable to reveal the annual and decadal variations of urban heat island intensity of the area around the urban station. It would be interesting to further look into the detailed temporal and spatial structure of the urban warming in the fast growing mega city in combination with other dataset and analysis tools in the future.

References

1.Chu, Z. Y., Ren, G. Y., 2005, Effect of enhanced urban heat island magnitude on average surface air temperature series in Beijing region, Acta Meteorologica Sinica, 63 (4), 534-540.

2.Easterling, D.R. and Peterson T.C., 1995, A new method for detecting and adjusting for undocumented discontinuities in climatological time series, Int. J. Climatol., 15, 369-377.

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Urban Project

URBAN HEAT ISLAND EFFECT IN TIANJIN CITY, CHINA

Urbanization leads to a modification in the urban climate. Of all features, the Urban Heat Island (UHI) is the most commonly studied. Tianjin is a large city in North China, with a population of about 9 million. In the past two decades, the city has experienced rapid growth. Climate of the city is characterized by strong seasonal variation of temperature and precipitation. We use the following sources of data to analyze the urban heat island effect and its variation with time in the city: (1) The monthly and annual mean temperature series of the Tianjin Meteorological Station (an urban station) from 1951 to 2003; (2) The monthly mean maximum and minimum temperature series of Tianjin, Wuqing, Ninghe and Hangu (the last three are located in suburban area) stations from 1964 to 2003; (3) Landsat Thematic Mapper (TM) from June 15, 1993 to May 12, 2001.

Figure 1 shows the time series of temperature departure at Tianjin station. The annual temperature departure shows a significant upward trend. Notable warming began from the mid 1980s. It remains unclear how much of this trend can be attributed to the urban effect and how much to regional warming.

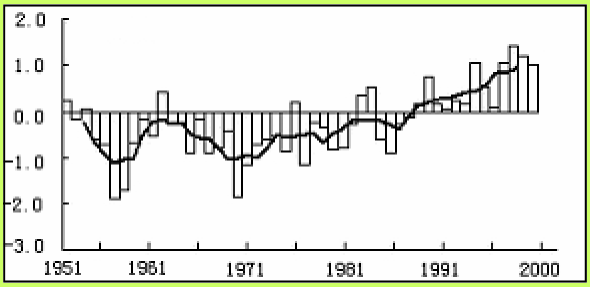

Figure1 The annual temperature departure in Tianjin station（column）and 5-years moving average（solid line）.

By comparing urban and rural stations with similar topographic features, it is possible to separate the urban heat island effect from the temperature series of Tianjin Station. We choose Wuqing, Ninghe and Hangu stations as the rural sites, and compare the average temperature of the stations with that of the Tianjin Station to obtain the temporal change in urban heat island intensity at the urban station (Figure 2). The UHI intensity is defined as the temperature differenceΔTu-r between the city station and the three rural stations. The time series of annual ΔTu-r are shown in Figure 2.It is notable that a more evident UHI effect at this site occurs after 1980s, and the maximum UHI effect occurs during the last decade.

Table 1 shows the trends of temperature change for year and seasons. During the last four decades, the trends of the city and rural stations' annual mean temperature are 0.45℃/10a and 0.56℃/10a, respectively. The trend of UHI intensity is 0.11℃/10a. For seasons, the trend of UHI intensity is the largest in autumn (0.16℃/10a) and the smallest in spring (0.06℃/10a). The trends in UHI intensity as measured for maximum temperatures are generally smaller than those for minimum temperatures.

The Landsat Thematic Mapper (TM) has three visible bands and three infrared bands with a spatial resolution of 30m. The thermal band (band 6) has a resolution of 120m (60m with ETM). Two computer compatible images for 15 June, 1993 and 12 May, 2001 were obtained to indicate the thermal environmental change in Tianjin City. The TM data of 3th, 4th and 6th channels were chosen for mapping land use in Tianjin city and 6th channels for the study of thermal characteristics, through calibration, positioning, and by bi-linear interpolation magnification. The Planck function is used for the brightness temperature calculation.

In Figure 3 the UHI intensities for these selected days are presented. It is apparent that built-up areas have a relatively high temperature. Some 'hot spots' (the highest temperature class) can be clearly identified. In 1993, there exist an extensive hot spot in the old urban areas due to their high

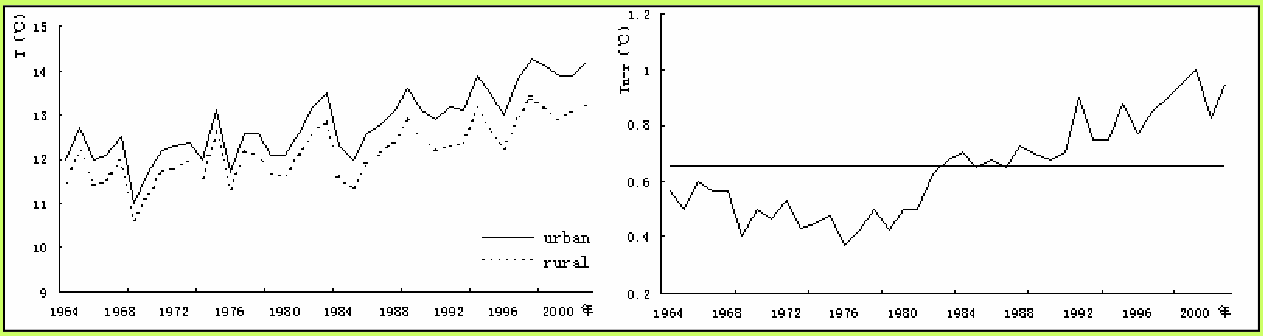

Figure 2 Annual mean air temperature (left) and urban heat island intensity (right, ΔTu-r) at Tianjin Station, 1964~2003.

	Mean temperature			Maximum temperature			Minimum temperature		
	city	rural	ΔTu-r	city	rural	ΔTu-r	city	rural	ΔTu-r
Winter	0.80	0.70	0.10	0.57	0.49	0.08	0.97	0.85	0.12
Spring	0.63	0.57	0.06	0.51	0.46	0.05	0.74	0.72	0.02
Summer	0.41	0.30	0.11	0.33	0.26*	0.07	0.45	0.41	0.04
Autumn	0.34	0.18*	0.16	0.16	0.10*	0.06	0.41	0.25*	0.16
Annual	0.56	0.45	0.11	0.41	0.35	0.06	0.67	0.57	0.10

Table1: Temporal trends of temperature variation during 1964~2003 (℃/10a). Note: All are significant at 0.01 level except for those marked with *

construction density. The spatial pattern of the UHI intensity on 12 May 2001 is markedly different from that of 13 June 1993. Comparing these two images shows that the area of high UHI intensity has expanded southeast from Beichen District to Hexi District along the Haihe River.

In summary, long temperature series at Tianjin Station has been significantly affected by urbanization. The growth of the city has resulted in a large increase in mean surface air temperature. The average temperature of the city is always warmer than its outskirts. The urbanization-induced trends of annual mean temperature, annual maximum temperature and annual minimum temperature are estimated to be 0.11ºC/10a, 0.06ºC/10a and 0.06℃/10a respectively during last four decades. In addition, the different periods of TM pictures show that the urban built-up areas have a relatively high temperature, and the high UHI intensity area has markedly extended since 1993.

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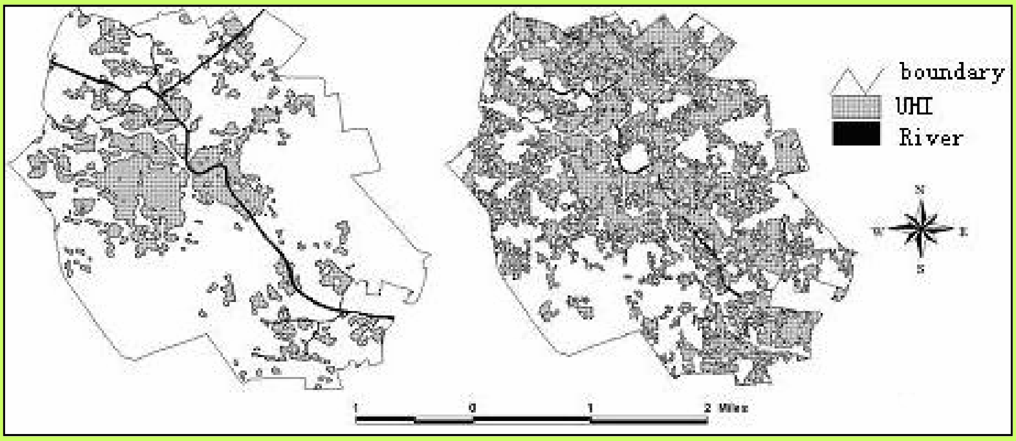
Figure 3 The urban heat island of Tianjin City as detected by Landsat Thematic Mapper in 1993 (left) and 2001 (right).



Country Report
Urban Climate Research in Australia

INTRODUCTION

Research into urban climatology in Australia has lacked a critical mass compared to other continents across the world but is undergoing strong growth in interest at present. While Australian cities are relatively young (~200 years), development has been rapid but adhoc, leading to many of the environmental problems and climate quality seen in other cities. Most Australian cities consist of single detached dwellings on 500m2 block which results in significant urban sprawl. More than 85% of the population of Australia live in urban areas, mostly in the capital cities and along the coastal fringe. Most of the work done in urban climatology in Australian cities at present is based on urban climate modelling. These projects are aimed at achieving improved regional climate simulations to better predict urban air quality for urban areas on a range of timescales. Other modelling projects are focused on the impact of global warming on urban climates. While modelling projects are the dominant focus by those interested in urban climates, observational studies have been lacking in Australia, but are slowly becoming a greater focus of specialist research and will be discussed in this country report. This report will focus on the observational aspects in particular with an emphasis on Melbourne where much of the current research is being undertaken.

Weather monitoring is conducted comprehensively by the Australian Bureau of Meteorology and its network of automatic weather stations. In all the major cities in Australia, government agencies such as the Environment Protection Authority (EPA) in Sydney (Figure 1), have wide-scale air pollution monitoring sites established across the city. These networks provide valuable information for validation of air quality models. This data is readily available for researchers and organisations. Data is used to determine the day to day air quality in Australian cities and air quality indexes (Figure 1). The Government's Department of Environment and Heritage produces a "State of the Environment" report every four years which gives a good summary on air quality observations with the next report due this year (2006) and brings together expertise from across the private and public sectors (http://www.deh.gov.au/soe/).

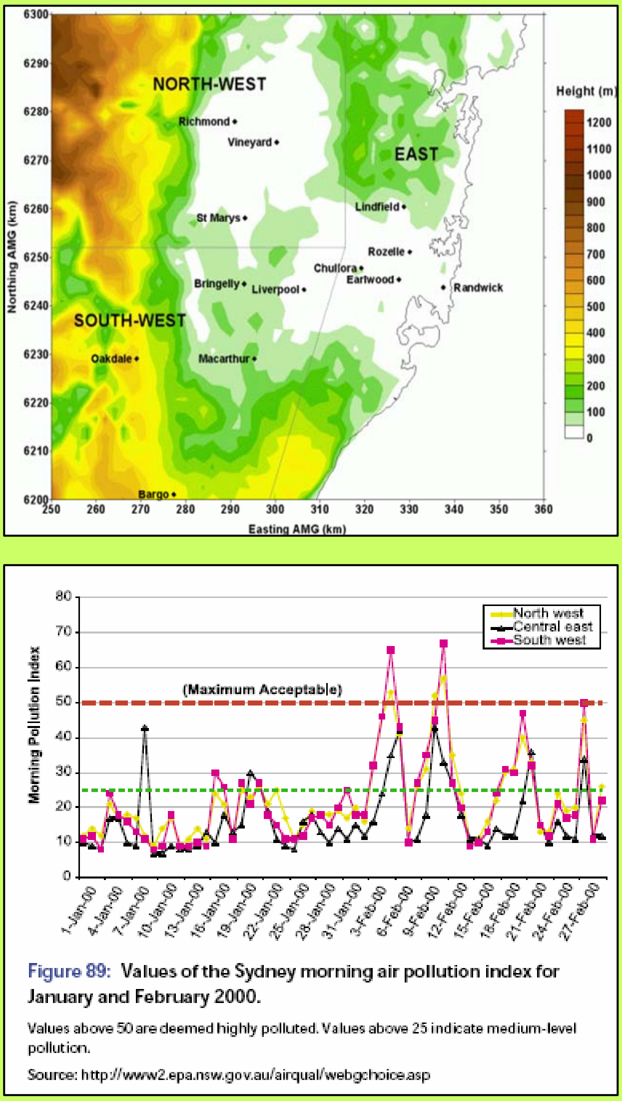


Figure 1. Location of air quality monitoring station in the Sydney region, Australia (left panel) and the Sydney air quality index in 2000 (DEH 2001)

SURFACE ENERGY BALANCE STUDIES

The first surface energy balance measurements in Australia were conducted in Adelaide, Australia in 1979, and included measurements of sensible and latent heat fluxes (Coppin 1979). This study identified many of the features of urban energy balances including highly variable evapotranspiration rates and an extended tail of positive sensible heating into the night from significant heat release from heat stored in urban surfaces. Bowen ratios during the day ranged from 1 to 7. Since this study, no surface energy balance studies have been conducted in urban areas until 2003 when an observational site was established in the suburb of Preston in Melbourne, Australia (Figure 2) by Monash University. This site became one of three sites in Melbourne which operated for various time periods, but were operating simultaneously for 3 months using eddy covariance (March 2004-May 2004). This was in order to investigate the influence of urban housing density and form on the surface energy balance. A rural site was also established during this time as a control site using the Bowen ratio approach (Coutts et al., 2006a).

The study produced a comprehensive dataset of urban fluxes that provided valuable information on urban energetics for urban climate modelling and for urban planners. Results obtained from the study illustrate large differences in partitioning between the urban and rural sites (Figure 3). Increasing density led to greater heat storage from the trapping of energy within urban canyons from greater impervious surface cover (including walls). Summertime Bowen ratios were high across all three urban sites (mean monthly values >2) irrespective of density due to low water availability (Coutts et al., 2006a).

CO_2 FLUX STUDIES

The first CO_2 flux measurements in Australia have also been conducted recently in Melbourne which began in 2004. Primarily, this study was to investigate a) the diurnal and seasonal variations in CO_2 fluxes and b) the role of vegetation in the urban landscape and its potential in offsetting emissions. CO_2 fluxes were measured in 2 suburbs in Melbourne (Preston and Surrey Hills) of differing vegetation cover for a period of 6 months (February o July 2004). Results from the study at both sites found a strong diurnal pattern in the CO_2 flux in response to anthropogenic activities, in particular vehicle emissions, which was similar to previous studies (Velasco et al. 2005). Fluxes were almost always positive, though during summer months, uptake of CO_2 by vegetation reduced the flux and also resulted in more variable diurnal course in response to variable source areas and natural gas combustion was reduced (Coutts et al. 2006b).

In relation to the influence of vegetation cover, the site of Surrey Hills, which showed a greater vegetation cover actually showed a higher CO2 flux (µmol $m^{-2}\ s^{-1}$) (Figure 5). This was likely to be due to the location of the tower, positioned next to a main road which sourced significant emissions of CO2 to the atmosphere. Analysis of wind direction confirmed this with peaks in positive CO2 flux corresponding with source areas with main roads in within.

The Preston site continued as a long term site for 17 months and allowed an estimation of the total flux over a year of approximately 93.2 t $CO_2\ h^{-1}\ yr^{-1}$. Using the population estimate for the local area surrounding the tower (29.4 persons.ha-1) the corresponding yearly CO2 source is estimated at 3.17 t $CO_2\ h^{-1}\ yr^{-1}$. Observations of CO2 fluxes will continue depending upon equipment availability (Coutts et al. 2006b). Proposed observations in the future include the measurement of VOC fluxes at the Preston tower site in conjunction with CSIRO Aspendale.

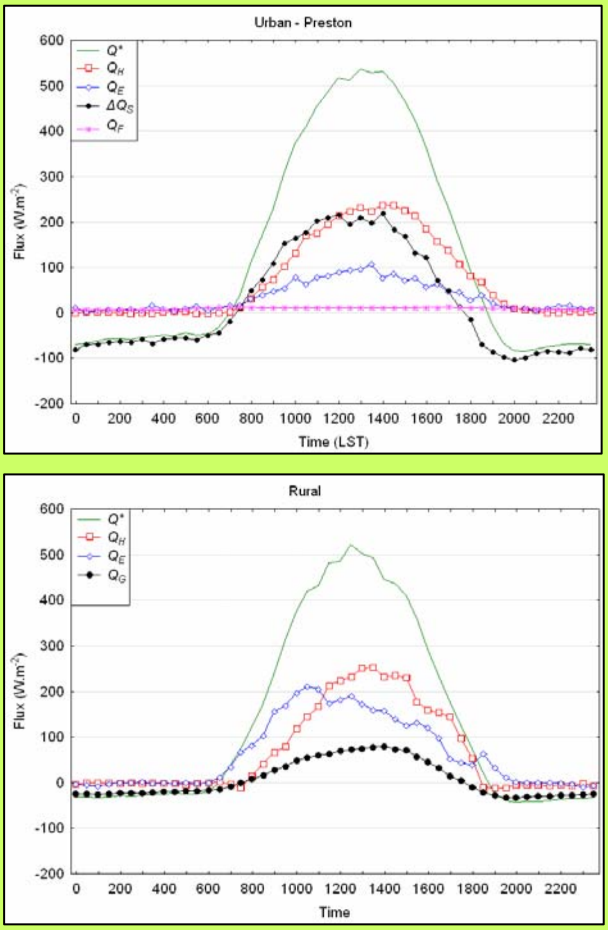


Figure 3. Comparison between urban (top) and rural (bottom) energy balance in Melbourne for the month of February 2004.

Figure 2. Eddy covariance system at the Preston site established August 2003. CO_2 fluxes were also conducted at this site in February 2004.

Figure 4. CO_2 flux site in a well vegetated suburb of Melbourne in Surrey Hills.

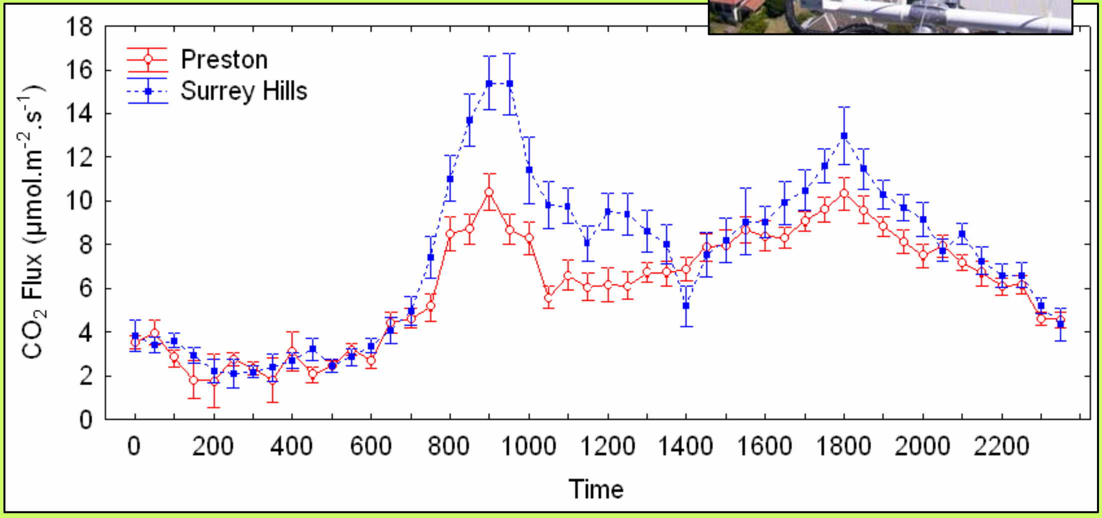


Figure 5. Mean diurnal CO_2 fluxes for a 6 month period (Feb 04-Jul 04) at Preston and Surrey Hills

URBAN HEAT ISLANDS

A number of urban heat island (UHI) studies have been conducted over the years in Australian cities with the most comprehensive observational studies of UHI's conducted in Melbourne (Morris and Simmonds 2000, Morris et al. 2001, Torok et al. 2001). As part of the Geography and Environmental Science/Atmospheric Sciences program at Monash University, 3rd year students in the subject "Earth System Interactions – From Biogeochemical Cycles to Global Change", conduct a research project on the UHI. This approach uses the concept of problem based learning through the investigation of a real world problem, in this case, the UHI (Beringer, 2006). In investigating the Melbourne UHI, students conduct both night time and daytime automobile transects across the city. This gives 6 to 8 transects being recorded from the CBD outwards in various directions into the surrounding rural areas of the city. This research approach is now in its 5th consecutive year. The transect data, combined with corresponding AWS data leads to a good spatial picture of the UHI. An example of the spatial picture that students construct is shown in Figure 6 and shows an UHI of around 3-4°C.

FUTURE DIRECTIONS

A number of projects are on the horizon in urban climate research in Australia. A project has been developed to assess the multiple benefits of vegetated roofs. Such benefits include reduced urban stormwater intensity, decreased nitrogen loading of stormwater, more amenable microclimates and reduced energy consumption of buildings. In terms of climate, the specific aims are to quantify the micro-climate benefits of vegetated roofs in Melbourne climate conditions. This will involve determining the energy partitioning (heat/evapotranspiration) over extensive green roofs from summer to winter including the thermal energy balance and potential savings in building energy. Also, the project aims to examine the potential roof scale climatic benefits and use regional climate modelling to assess any regional climate benefit of wide scale adoption of green roofs. This study also aims to quantify the stormwater flow and quality benefits of an extensive green roof, and also to compare the establishment, survival and maintenance requirements of selected native and non-native green roof vegetation.

Other future directions include a project to enhance understanding of the natural process and changes, the adaptive capacity, and the options for policies to enhance adaptation, in climate sensitive social-environmental systems in Australia. In particular, the project will conduct case studies for key urban centers and peri-urban areas across Australia to investigate the vulnerability and adaptive capacity of these areas to climate change and extremes. This project will bring together researchers across both the natural and social sciences.

Other plans also include further improvin regional scale urban climate modeling by integrating a more detailed and complex urban component into existing models used by Australian researchers and organizations. The exact details are still undetermined, but as Australian organizations are moving towards a unified climate model for Australia, it is anticipated that this also involve an added urban component.

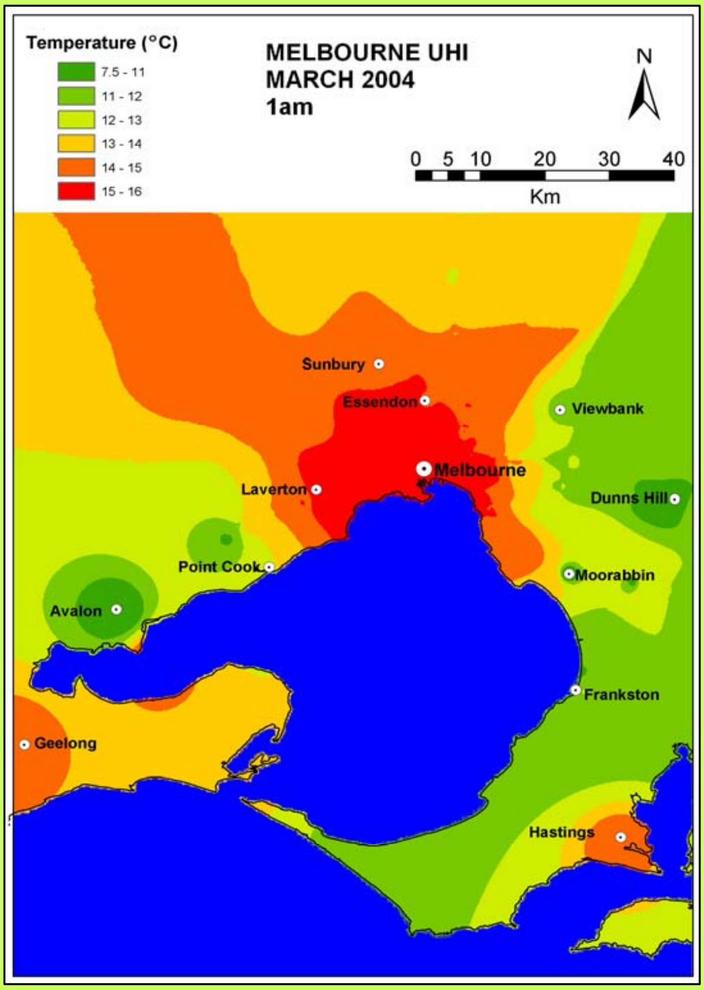


Figure 6: Undergraduate student measurements of the urban heat island for a night in March, 2004 using car transect and AWS data.

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Urban Project

Air Ventilation Assessment System for High Density Planning and Design

1. INTRODUCTION

In 2003, Hong Kong was hit by Severe Acute Respiratory Syndrome (SARS) from which about 300 people died. Following the outbreak, there has been a growing realization in Hong Kong of the urgent need for a healthy living environment (Figure 1). In respond to this concern, the Planning Department of the HKSAR Government initiated a study entitled 'Feasibility Study for Establishment of Air Ventilation Assessment System' which aimed to explore the feasibility of establishing some protocols to assess the effects of major planning and development proposals on external air movement for the achievement of enhanced macro wind environment. Unlike many countries which have their major concerns on gust and strong wind problems; the urban ventilation issue confronting Hong Kong is primarily weak wind conditions within the congested urban settings. Our distinctive high density living environment[*] makes this study original and unprecedented in the world.

In the past two and a half years, a number of studies have been conducted and eventually, a methodology for Air Ventilation Assessment (AVA) has been developed. The AVA system basically establishes a method for project developers to objectively assess their designs; it has been adopted by the HKSAR Government and now all major development projects in Hong Kong are required to undertake the assessment. This paper shares our experiences learnt from this study and reports the scientific and implementation processes leading to the AVA system.

2. STUDY METHODOLOGY

The methodology consists of 6 major tasks aimed to pinpoint the chief urban wind problems facing Hong Kong.

A. A desk top study of related works and study examples around the world – not just scientific investigations, but also policy measures.
B. A review to understand the current urban conditions of Hong Kong, and to identify issues and problems.
C. Explore the possibility to establish performance criteria needed for considering the impact of development on wind environment.
D. Define the critical issues and to explore the feasibility to develop a practical and cost effective assessment methodology.
E. Examine the practicality of an effective implementation mechanism, and to develop a methodology.
F. Establish principles and good practice for the use of professionals and practitioners in the shaping of the built environment for better wind environment.

Figure 1. Satellite image of Hong Kong. Hong Kong is a high density city with a population of 7 millions living in a piece of land of 1000 square kilometers. The population density in the densest urban area is close to 60,000 persons per square kilometer and the site development density is 3000 persons per hectare. Image source: http://geology.com/world/

3. REVIEWS

There are many scientific studies dealing with the wind environment and modeling, however most of them were concerning gust and strong wind problems, few if not any of them seems to have touched on the issue of urban air stagnation and weak city air ventilation problems. Notable exceptions are studies dealing with air pollution and dispersion. The desktop review has identified several studies conducted in Japan and Germany which were relevant to our work. [1, 2]

4. REVIEW OF EXISTING CONDITIONS

To shorten the study period, the existing conditions in Hong Kong were evaluated based on expert qualitative evaluation. Professor Baruch Givoni, Professor Lutz Katzschner, Professor Shuzo Murakami, Professor Mat Santamouris, and Dr. Wong Nyuk Hien were the five experts. For the tropical climatic conditions of Hong Kong where wind in the summer is a welcoming quantity, it was opined unanimously that "more the better" should be the guiding sprit. With minor differences in opinion, their major comments could be briefly concluded as follows; a more comprehensive presentation could be found in [3].

4.1 Breezeway / Air path: The overall permeability of the district has to be increased at the ground level, this can be achieved by creation and proper linking of open spaces and avoiding obstruction of prevailing air paths and sea breeze.

4.2 Podium / Site Coverage: The "podium" structures commonly found in Hong Kong (Figure 2) are not desirable from the viewpoint of maximizing wind

Figure 2: A typical building morphology in Hong Kong: tower blocks sitting on a podium that occupies the entire site. When podiums are very close together, they significantly reduce the air space at pedestrian levels.

Figure 3: Tall buildings too closely pack together creating an 'effective' wind block to the city behind.

available to pedestrians. The podiums with large site coverage not only block most of the wind to pedestrians, but also minimize the "air volume" near the pedestrian level, which will in turn, affect outdoor comfort and air quality.

4.3 Building Disposition: Proper orientation and layout of the buildings with adequate gaps between buildings are needed (Figure 3).

4.4 Building Heights: Vary the heights of the blocks to divert winds to the inner city; this could be done by decreasing building heights towards the direction where the prevailing wind comes from.

4.5 Building Permeability: Increase urban permeability by 1) providing voids nearer to the ground level so as to improve the ventilation for pedestrians; and 2) creating openings in the building blocks to improve the ventilation performance for mid-level occupants.

5. CRITERIA

Based on the outdoor comfort studies conducted by Professor Baruch Givoni in Japan and Israel with hot humid summers and supplemented by the meteorological data of Hong Kong, a comfort outdoor temperature chart for urban Hong Kong was developed (Figure 4). The x-axis of the chart is outdoor air temperature and y-axis is the level of solar radiation. The shaded area represents the neutral comfort region which could be obtained by a proper combination of air temperature, solar radiation and wind speed. The chart provides a rough guide to the kind of wind environment that is desirable in Hong Kong. For example, a people in shade, given high summer air temperature of 28 ^{o}C, a gentle wind of 1.0-1.5 m/s is optimum.

6. AIR VENTILATION ASSESSMENT (AVA)

A key objective of the study is not scientific, but to try to find an objective protocol and methodology to guide planning practice. Planners have control of a number of design parameters. For example, site coverage, building bulk, building alignment and deposition and so on. Fundamentally, it is important to ensure that buildings and their planning do not block the ambient mechanical wind. Localized thermal wind is therefore a relatively minor consideration from a practical planning point of view.

Wind Velocity Ratio (VR_w) is used as an indicator. V_∞ is the wind velocity at the top of the wind boundary layer not affected by the ground roughness, buildings and local site features (typically assumed to be a certain height above the roof tops of the city centre and is site dependent). Vp is the wind velocity at the pedestrian level (2m above ground) after taking into account the effects of buildings. Vp / V_∞ is the Wind Velocity Ratio (VR_w) that indicates how much of the wind availability of a location could be experienced and enjoyed by pedestrians on ground taking into account the surrounding buildings. (Figure 5 and 6) As VR_w is solely affected by the buildings of the location, it is a simple indicator one might use to assess the effects of

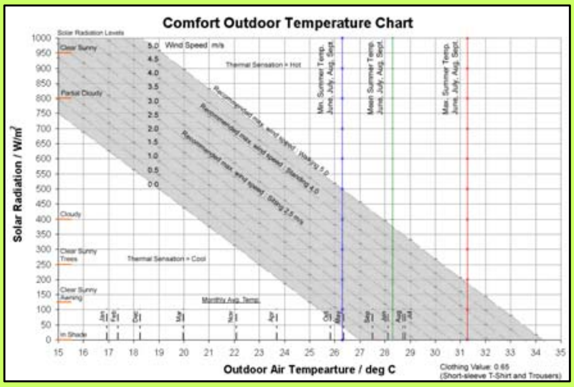

Figure 4: Comfort chart based on researches of Professor Givoni and Hong Kong meteorological data.

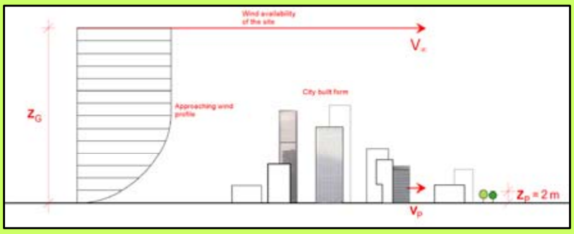

Figure 5: The concept of VR_W. Using VR_W, it is possible to factor the effects of developments to the wind environment.

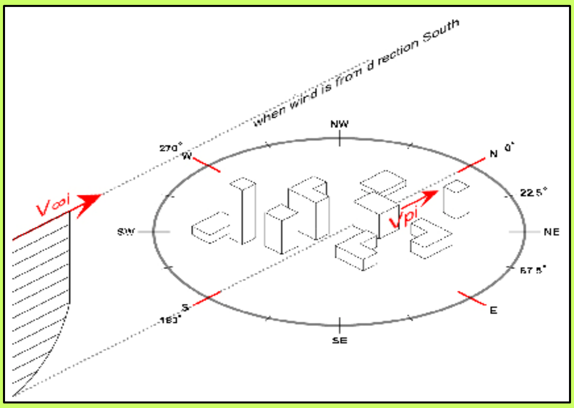

Figure 6: 16 directions are factored. The VR_W of each direction will then be factored with wind coming from that direction.

proposals. The higher the value of VR_W, the lesser the impact of buildings on ground level wind availability. Based on VR_W as an indicator, the methodology of the assessment procedures and scope needs to be identified. Although CFD could be used for some urban wind studies, this study concluded the use of wind tunnel as a more reliable tool. A more comprehensive description of the procedures could be found in [3].

7. IMPLEMENTATION

The Hong Kong Government has decided initially that all government projects of a certain characteristics to go through AVA. Some of the characteristics are:

- Preparation of new town plans and major revision of such plans.
- Development that deviates from the statutory development restriction(s) other than minor relaxations.
- Urban renewal development that involves agglomeration of sites together with closure and building over of existing streets.
- Development with shielding effect on waterfront, particularly in confined airsheds.
- Large-scale development with a high density, e.g. site area over 2 hectares and an overall plot ratio of 5 or above, development with a total GFA of 100,000 sq.m. or above.

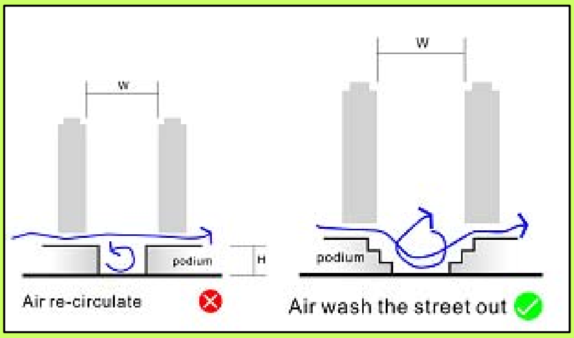

Figure 7: An example of the guideline dealing with the shape of the podium.

8. GUIDELINES AND PRINCIPLES

In addition to the assessment methodology, the government also incorporated some guidelines into the Hong Kong Planning Standard and Guidelines. The document provides some hints to designers and planners. An example is as Figure 7.

9. POLICIES AND THE WAY FORWARD

A joint government bureau level technical circular has been issued to head start AVA. The government has also required the planning development of the old Kai Tak airports site (328 hectares) to undertake AVA. It is the first piece of government land trying out the new AVA methodology.

Beyond the immediate policy implementation, the government is commissioning a number of further studies to advance the AVA methodology. An urban climatic map of Hong Kong will be generated to strategically guide design. Professor Lutz Katzschner's team at Kassel University in Germany will help. Furthermore, a series of tests will be conducted to establish a benchmark wind standard for Hong Kong that is practical, reasonable and achievable. This will further the current AVA with a standard to achieve.

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Urban Project
Representations of "Urban" and "Rural" Space in UHI Literature

Introduction

As the world's population shifts to an urban majority for the first time in history, our towns, cities, and megacities, and the spaces that surround them, have become highly interactive and complex. Driven by rapid population growth, massive rural-urban migration, and a globalizing economy, this urban "revolution" has triggered a spectacular surge in empirical UHI (urban heat island) literature of the past half-century. So heterogeneous now are the spaces we sample, the spaces that geographers call patchwork, polynucleated, and borderless cities, that urban climatologists need to rethink settlement transition and its superimposed forms in more meaningful and universally understood terms than simply "urban" and "rural."

UHI observation and the urban-rural dichotomy

Canopy-layer UHI investigations of the modern era, dating from Åke Sundborg's landmark study of Uppsala in 1951, have surveyed the heat island effect at every level of the settlement hierarchy, from agrarian village to post-industrial supercity. While swelling in number, this collection of literature remains coherent in its experimental aim and impressive in its geographic scope—we are indeed fortunate to have such diversity of place represented in our ground observations of UHI. However, in looking more critically at the foundations of this literature, we uncover a less coherent, and consequently more concerning, dimension in our representation of urban and rural space.

Like all branches of science, the study of UHI is bound by an experimental methodology of observation, measurement, analysis, and classification of the "facts" behind the "phenomenon." Beneath this generic exterior, we immediately recognise that each individual experiment offers a unique blend of geographic, topographic, and cultural controls on UHI. Scaling in further, to the actual measurement sites that give quantity to our universal heat island formula (DTu-r), we see firsthand that case observations of UHI behaviour are representative, above all else, of the micro- and local-scale instrument settings of only those cases. We can appreciate, then, that inter-city comparisons and generalisations of UHI magnitude derive, originally, from two or more corresponding temperature regimes over surfaces and surroundings of particular character. In describing these surfaces and near-surface temperatures with such overarching constructs as "urban" and "rural," we are portraying a complex world in black and white.

Table 1 lists "urban" and "rural" sampling sites appearing in modern (1950–2005) UHI literature. The problem highlighted by Table 1 relates not to the variety or number of sites, but to the classification of sites into either of two poorly defined categories. The geometry, thermal properties, and anthropogenic heat sources of a street canyon, for example, are radically different from those of a botanical garden, yet, oddly, both represent "urban" in UHI literature. There is now sufficient confusion and indiscretion surrounding the classification of UHI sites—especially peripheral sites such as airports and outlying observatories—to warrant further breakdown and reinterpretation of the very dichotomy (urban-rural) that gives meaning and method to the UHI effect.

Definitions are an important feature of scientific inquiry, yet urban climate literature fails to provide a thorough and systematic explanation, from a climate science perspective, of "rural" and "urban." While social scientists traditionally associate "rural" and "urban" with agrarian and non-agrarian modes of production, climatologists have yet to expand

URBAN	RURAL	URBAN *AND* RURAL
street canyons, city squares	agricultural academies	airports, airstrips, air bases
building rooftops	paddy fields, grain fields	university campuses
residential backyards	fruit farms, market gardens	experimental farms
ship yards, storage yards	tree nurseries	meteorological institutes
school yards	ecological preserves	pollution monitoring sites
shopping centres, hospitals	waterworks reservoirs	botanical gardens
housing estates	water treatment plants	weather observatories
sporting grounds	farming villages	astronomical observatories

Table 1. "Urban" and "rural" sites representing Tu and Tr in UHI literature, 1950–2005.

Urban Project

Figure 1. “Urban” reference sites used in observational studies of UHI. Clockwise from top left: a street canyon in Göteborg, Sweden; an airport site near downtown Phoenix, USA; a closed square in the town core of Szeged, Hungary; an open square near the central railway station in Łódź, Poland.

Figure 2. “Rural” reference sites used in observational studies of UHI. Clockwise from top left: fields of grain north of Uppsala, Sweden; an experimental farm on the eastern outskirts of Vienna, Austria; an airport site west of Regina, Canada; meadow and brushwood on the perimeter of Wrocław, Poland.

this basic interpretation into one of greater relevance to natural science. Our definition of UHI as an "urban-rural" temperature difference (DTu-r) is therefore flawed because its constituent terms have no operational basis.

The photographs in figures 1 and 2 illustrate the micro- and local-scale surroundings of typical UHI installations. Pictured in juxtaposition are data-collection sites of modern UHI studies in European and North American cities. In Figure 1 are sites classified (by the investigators themselves) as "urban"; in Figure 2 are "rural" stations. The urban photos in particular show the heterogeneity of instrument sitings found in a city environment, from a sheltered city-canyon to an open airport site. The rural photos, although less contrasting, also reveal landscapes of distinct character.

The UHI sites displayed here have been carefully selected by the investigators and are choice locations in their own right. The installations are secure, reliable, and well maintained, and the immediate surroundings are generally representative—in surface geometry and cover—of the local-scale environment. Unfortunately, conventional UHI methodology prescribes these sites, along with countless others in the literature, as broadly "urban" or "rural." Without aid of photos or other metadata, we are unable to appreciate the detailed character of these sites and instead rely on the familiar, yet inadequate, urban-rural dichotomy. In doing so, we severely limit our ablility to substantiate cross-study comparisons of UHI behaviour, especially when using city population to infer heat island magnitude.

A new scheme for UHI landscape classification

The studies depicted above have made valuable contributions to our understanding of the heat island effect. However, as a community of UHI investigators we are perhaps not communicating our findings as best we can. The urban-rural dichotomy—our long-serving paradigm for space classification—has become something of a red herring, diverting our attention away from the particular surfaces and temperature regimes that actually determine UHI magnitude. Furthermore, in the face of globalization, UHI field methodology is stumbling on surface forms and settlement patterns that reject unequivocal urban-rural classification.

UHI investigators now need a multidimensional site characterisation system to better accommodate the complexity of surface types found in and around cities. Research at the University of British Columbia is developing a new spatial framework that abandons the subjective and overly simplistic assessment of landscapes (and the stationary and mobile observations taking place within those landscapes) as "urban" or "rural," and instead embodies objective and climatologically significant measures of surface climate impact. In fulfilling a prescriptive function, the framework will anchor future observations of UHI to standardised surface climate zones; in a descriptive function, it will bring organization (via classification) to a rich, but unravelling, collection of UHI studies.

In this pursuit, climatologists have much to learn from urban theorists and cultural geographers. For decades social researchers have argued that the space economy in periurban regions of the developing world can no longer be distinguished by a clear urban-rural divide. Urban theo-

Figure 3. Left: the countryside north of Ho Chi Minh City, Vietnam, is an intensive and dynamic mixture of agricultural, industrial, and residential activity. Right: the "rural" landscape northeast of Munich, Germany, is sparsely inhabited and predominantly agricultural (image scale: 3 km by 2.5 km).

rists contend that the spatial demarcation between "urban" and "rural" is artificial, and that this relation is better described as a continuum, or a dynamic, rather than a dichotomy. Figure 3 illustrates this blurry divide—representative of rice bowl regions across Asia—on the outskirts of Ho Chi Minh City, Vietnam.

Here, on the urban periphery of the developing world, in situ population densities are extremely high; traditional (i.e., small-holder agriculture) and non-traditional land uses co-exist; and people, capital, commodities, and information flow continuously between city and countryside. Urban geographers reject these peripheral spaces as universally "urban" or "rural," and instead use regional terms like "development corridors," "growth triangles," and "extended metropolitan regions." In dramatic contrast, the outskirts of localised North American and European cities (Figure 3, right) are open, sparsely settled, and seemingly detached from the city. Far from absolute, our interpretations of rural are profoundly nuanced in culture, geography, and history.

Marginal landscapes, rightly or wrongly characterised as "urban," "rural," "extended metropolitan," or otherwise, are crucial to UHI definition and experimentation. We routinely conduct our stationary and mobile observations in these periurban spaces, ostensibly gathering unbiased data for baseline comparison with city records. The collapsing urban-rural divide described here, although chiefly an economic one, holds many lessons for UHI methodology. We should therefore give thought to the progress made by urban geographers in dismantling our shared tradition of space classification.

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"UHI literature" refers only to heat island studies of the canopy-layer type, as observed via stationary or mobile units at screen level.

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IAUC Committee Reports

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Thanks to everyone for their contributions this month. Please send any further references to papers published since January 1 2005 for inclusion in the next newsletter to j.salmond@bham.ac.uk. 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:

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We look forward to hearing from you soon! Jennifer Salmond and Evyatar Erell

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