

CITIES AND CLIMATE CHANGE

PROGRAMME

International Conference
Lisbon – Portugal

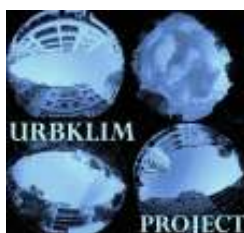
15 - 16 May 2008

Centre of Geographical Studies
University of Lisbon

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Translation and revision of abstracts:
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PROGRAMME

1st day - 15 May 2008

09h Reception of participants

09h30 Opening session – Professor Doutor Álvaro Pina, President of Conselho Directivo of the Faculdade de Letras of Lisbon; Professor Doutor Diogo de Abreu, Director of the Centre of Geographical Studies; Professora Doutora Maria João Alcoforado, Organization Committee.

Maria João Alcoforado (CEG, UL) – The Urbklim Project. Climate and urban sustainability: perception of comfort and climatic risks in Lisbon.

10h 15 Session I – Determining thresholds of mechanical comfort applied to Portugal

Moderator: Henrique Andrade (CEG)

Sandra Oliveira (CEG, UL) – Methodology for the evaluation of the thermal and mechanical comfort thresholds from tests in wind tunnels

António Lopes (CEG, UL) – Comfort thresholds obtained from wind-tunnel experiments. First results.

11h Coffee-break and poster session

11h30 Session II – Perception of bioclimatic comfort in outdoor public spaces of Lisbon

Moderator: Jorge Saraiva (LNEC)

Henrique Andrade (CEG, UL) - Weather perception and bioclimatic comfort in the use of outdoor public spaces, in Lisbon - methods and main results

Sandra Oliveira (CEG, UL) – Microclimatic conditions of two green spaces in Lisbon and preferences of usage

Margarida Queirós (CEG, UL) - Qualifying public space in urban environment, a profile of the users and improvement in the quality of life

Sílvia Pelham (FA-UTL) – Climate and Urban Design

Henrique Andrade (CEG, UL) - The comparison of thermal sensation and preference for outdoor occupants in Lisbon and Central Taiwan

13h15 Lunch-break

14h30 Session III – Risks associated with strong winds and pollution in Lisbon

Moderator: Carlos Neto (CEG, UL)

Jorge Saraiva (LNEC) - Urban pollution: road tunnels

Ana Luísa Soares (ISA, UTL) - Urban tree value assessment

Sandra Oliveira (CEG, UL) - Strong wind and falls of trees, boughs and branches in Lisbon: proposal for an evaluation method

António Lopes (CEG, UL) - Strong wind and fall of trees in Lisbon. Risk assessment and first results

Marcelo Fragoso (CEG, UL) – The atmospheric environment associated with the occurrence of windstorms in Lisbon: Using the radiosondes and the evaluation of instability conditions (2000-2005)

16h15 Coffee-break and poster session

16h45 - Conference

Andreas Matzarakis (Meteorological Institute of the University of Freiburg): Climate and Tourism – Implications and Perspectives.

2nd day - 16 May 2008

9h30 Session IV – Regional and Local Climate Change

Moderator: João Corte-Real (University of Évora).

Ricardo Trigo (IGDL, UL) – The impact of extreme temperature events in Portugal:
learning from observations and climate change scenarios

Andreas Matzarakis (M.I, Universidade de Freiburg, Alemanha) –Future perspectives of
urban climate – A challenge for urban planning

10h30 Coffee-break and poster session

11h Session V - Climate change and environment in urban areas

Moderator: Luísa Schmidt (ICS, UL)

M. João Alcoforado (CEG, UL) – Urban climate and climate change

Magda Lombardo (UNESP, Brasil) - The use of geotechnologies for climate change
analysis in S. Paulo metropolitan Area (Brazil)

Cecília Sérgio (Botanical Garden, National Museum of Natural History, University of
Lisbon, CBA - Centre of Environmental Biology) - Is it possible to evaluate local and
temporal climate change in Europe, based on bryophytes?

Helena Nogueira (FL, UC) - Urbanity, sustainability, health: an evident and persistent
relation

12h30 Lunch-break

**14h30 Session VI – Mitigation and adaptation to climatic variations – the role of urban
planning**

Moderator: Margarida Queirós (CEG, UL)

Vitor Campos – Director of DGOTDU

Paula Cadima (FAUTL) - Urban Design and Bioclimatic Strategies

Maria da Graça Saraiva (FAUTL, CESUT/UTL) – Flood risks and management in urban
areas in urban areas

Marta J. N. Oliveira Panão (EnerOne) - Thermal performance of the buildings in the city:
physics of buildings and urban climate

16h00 Coffee-break and poster session

16h30 Conference

Jorge Gaspar (CEG, UL) – Cities and global changes

ABSTRACTS

- Papers -

The URBKLIM Project
Climate and Urban Sustainability: Perception of comfort and climatic risks in Lisbon
(Portugal)

Maria João Alcoforado ¹

In a world where urban population is increasing exponentially, the way to sustainability implies the application of solutions to ameliorate the urban environment, either indoors or outdoors. The project "UrbKlim: Climate and Urban Sustainability. Perception of comfort and climatic risks in Lisbon" is presented as an example of interdisciplinary research, putting together the knowledge, methodologies and skills of climatologists, architects, engineers, biologists, sociologists, as well as members of the "Civil Protection Services", in order to contribute to a better urban environment.

The main objectives of this project are the following:

(i) to define wind speed thresholds applied to mechanical comfort ranges, as most of them date back to the 1970s and are not adapted to the Mediterranean climate; this task is based on wind tunnel experiments, which are still ongoing.

(ii) to assess the perception of outdoor thermal comfort in different city districts, mainly open areas and green spaces, and to verify how people's behaviour vary accordingly. Field work is now completed (circa 1000 enquiries combined with simultaneous meteorological measurements), about the relations between microclimatic conditions, personal parameters (as age, gender and motivation), the bioclimatic comfort and the patterns of use of the space.

(iii) to assess wind and pollution risks in Lisbon. Although the increase of urban density to the windward side of the city will decrease mean prevailing N and NW winds, strong winds, mostly from the W and SW still constitute an important hazard, causing accidents to the inhabitants and different types of damages. Current work is centred in the study of the risk of tree falls due to strong winds (analysis of data from 1990 to 2006).

The main achievements expected from the project are the definition of guidelines to the planning and design of healthier, safer and more comfortable urban outdoor open and transitional spaces, thus helping to reduce the energy consumption and the environmental impacts in the city.

Keywords: urban sustainability; bioclimatic comfort; mechanical comfort; strong wind risks; urban planning; outdoor open spaces.

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Session I - Determining thresholds of mechanical comfort applied to Portugal

Methodology for the evaluation of the thermal and mechanical comfort thresholds from tests in wind tunnels

Sandra Oliveira¹, António Lopes¹, Fernando Marques da Silva², Jorge Saraiva²

Wind influences thermal comfort as well as the individual's capacity for movement (mechanical comfort). Comfort thresholds may vary from individual to individual even when they are subjected to the same environmental conditions. This is due to each person's different characteristics, such as age and clothing, amongst other factors.

In order to evaluate the influence that wind has on each of these parameters, a methodology was defined for tests to be held at the wind tunnel of the National Civil Engineering Laboratory (LNEC). The methodology was tested during the first experiment session that was held in November, 2006.

This paper presents the adopted methodology that was used to evaluate the influence that wind has on the thermal and mechanical comfort of the tested individuals. In this way the comfort limits could be defined and then used in all manner of different applications.

Three different tests with specific goals were defined. The participating individuals were subjected to the 3 tests simultaneously.

i) The first test aimed at establishing the limits of thermal comfort. The participants, divided into groups of 5, dressed in 2 layers of clothing on their upper bodies and jeans, stood without moving in the wind tunnel. They were subjected to a 5 minute period of acclimatisation for each different wind speed after which time they would fill-in a questionnaire indicating the comfort levels felt regarding temperature, wind and in general terms. The wind speed was increased from 1.6 m/s to 9.1 m/s in 6 stages.

ii) The second test aimed at determining the level of thermal response. The participants stood without moving in the wind tunnel, dressed only in a light layer of clothing and were subjected to an acclimatisation period of 3 minutes for the same wind speed levels defined in the previous test. When the participants felt that they had reached their comfort limit and needed an extra layer of clothing, they would leave the wind tunnel and record the wind speed at which they had to leave.

iii) The third test was aimed at establishing the individual's ability to move at medium to strong wind speeds (between 7.5 and 18 m/s, divided into 6 increasing steps). The participants were divided into groups of 2 and 3 people and walked along the wind tunnel at each of the set wind speeds. They then recorded in the questionnaire provided the levels of difficulty felt whilst walking.

Keywords: Wind tunnel; Methodology; Thermal comfort; Mechanical comfort.

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Comfort thresholds obtained from wind-tunnel experiments. First results.

António Lopes¹, Sandra Oliveira¹, Fernando Marques da Silva², Jorge Saraiva²

Wind tunnel experiments have been carried out since November, 2006, at the wind tunnel of the National Civil Engineering Laboratory (LNEC) as part of the URBKLIM project. The aim was to define the comfort thresholds at specified temperature and wind speed values. The adopted methodology was tested and adjusted during the test-sessions. The Autumn and Winter test-sessions were carried out with 36 participants, 18 women and 18 men, between the ages of 20 and 59. The clothing, health condition, weight and height of the individuals were the variables considered. These factors were registered in the questionnaires filled-out by each person along with their tested perceptions of comfort and the difficulty felt in moving.

Three different tests were performed and the preliminary results are presented here.

i) The thermal comfort limit was found to be situated between 3 and 4.5 m/s. For these wind speeds only 39% of the participants stated that they were not cold. For wind speeds above 6 m/s all participants stated that they were cold or very cold. As for wind speed perception, 86% of the individuals tested declared that they found it to be windy at the threshold of 3 m/s. At wind speeds of 6 m/s, 50% of the participants stated the conditions as very windy. When asked about the general comfort, 47% of the people tested declared to be uncomfortable at 3 m/s and 80% were uncomfortable or very uncomfortable at wind speeds of 6 m/s.

ii) Thermal resistance tests revealed that at 4.5 m/s, 50% of the participants had already left the tunnel and at 6 m/s only 8% of the participants still remained inside the tunnel.

iii) As for the difficulty felt in moving, which was tested for wind speeds between 7.5 and 18 m/s, the results showed that for wind speeds of 7.5 m/s all participants felt no difficulty in moving, at 9.4 m/s 50% felt some difficulty in moving, at 15 m/s 60% considered that it was difficult and 7% found it very difficult to move, and at 18 m/s 70% of the tested individuals found it very difficult to move.

These tests contribute towards a more precise definition of the thermal and mechanical comfort thresholds, which may be applied to a variety of different situations.

Keywords: wind tunnel, thermal comfort thresholds; mechanical comfort thresholds

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Session II – Perception of bioclimatic comfort on outdoor public spaces of Lisbon

Weather perception and bioclimatic comfort in the use of outdoor public spaces, in Lisbon - methods and main results

Henrique Andrade¹, Maria João Alcoforado¹, Sandra Oliveira¹

The main aims of the Task II of the UrbKlim project were:

1. To analyse the perception of the atmospheric conditions by users of open public spaces in Lisbon and to define thresholds of bioclimatic comfort in relation to the atmospheric and personal conditions;
2. To analyse the usage of green areas in Lisbon, in relation to the weather types and the microclimatic conditions inside these green areas.

The perception of the bioclimatic comfort by users of the different outdoor public spaces was studied in two different riverside leisure areas (Alcântara and Parque das Nações). Questionnaire surveys and measurements of weather parameters (air temperature, relative humidity, solar and long wave radiation and wind speed) were carried out in every season in both places during the years 2006 and 2007, in order to assess the relationships between these parameters, the individual characteristics of people (such as age, origin, clothing, activity and motivation, among others), their perception of the weather variables and their level of comfort. Nearly 1000 questionnaires were made. The analysis was carried out considering the preference votes of the interviewees, based on their answers concerning the desire to decrease, maintain or increase the values of the measured variables, in order to improve their level of comfort. Multiple logistic regression was used to model the relations between preference votes and the environmental and personal parameters.

Concerning the green areas, questionnaires and measurements of weather conditions were made in two small neighbourhood green spaces (Gardens from Campo de Ourique and Campo de Santana). The results of this work will be presented in other papers during this conference.

The thermal preferences depend largely on the season and are strongly associated with wind speed. Besides, a general decrease of discomfort with increasing age was also found, possibly due to higher clothing insulation and lower climatic sensitivity of older people. On the other hand, most people declared preference for lower wind speed in all seasons; the perception of wind shows significant differences depending on gender, with women declaring a lower level of comfort with higher wind speed than men. It was also found that the acceptability of warmer conditions is higher than for cooler conditions and that adaptive strategies are undertaken by people to improve their level of comfort outdoors, such as adjustments in clothing and the selection of shaded or sunny places.

This study provides a framework to assess the influence of the atmospheric parameters and the subjective factors in the perception of the bioclimatic comfort, besides being a potential contribution to the design of more satisfying leisure areas in cities.

Keywords: outdoor public spaces; microclimate; bioclimatic comfort; Lisbon

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Microclimatic conditions of two green spaces in Lisbon and preferences of usage

Sandra Oliveira¹, Henrique Andrade¹, Maria João Alcoforado¹

Green spaces have an important role in the improvement of living conditions in urban areas: they help regulate the city's climate, they minimise the heat island effect, they reduce the energy consumption for temperature control, they contribute towards reducing noise and the concentrations of atmospheric pollutants and they also contribute positively on an ecological and social level.

For this study two green spaces of the city of Lisbon were selected: The Teófilo de Braga Park in Campo de Ourique and the Braancamp Freire Park in Campo Mártires da Pátria. Both are located in areas of high urban density but have different characteristics. The aim is to determine the influence of these green spaces on the microclimatic conditions of the surrounding area and to relate the park's characteristics to the frequency and type of use of its frequent visitors.

The climatic conditions of green spaces and those of the surrounding area were analysed using measurements from thermohygrometers set around and inside the parks at approximately 3 meters above the ground during the summer periods of 2006 and 2007. The usage of these parks was analysed from questionnaires that were filled out by the park visitors at the same time that temperature, relative humidity, wind speed and solar and infra-red radiation data were being collected through itinerant measurements.

In both green spaces the registered temperature inside the parks was lower (between 3 and 8 °C) than the surrounding areas, whilst relative humidity levels were higher (10 to 20%). Within the parks the microclimatic conditions varied considerably. This was due to the surrounding urban network, the park's equipment (benches, game-tables, play-parks, lakes) and structure and type of vegetation. These factors influence park activities and the preferences of its users, which also depend on the time of year and on daily weather conditions.

The influence of the Campo de Ourique Park on the microclimatic conditions of the surrounding area was monitored using measurements taken between the park and its surrounding streets. Temperature differences higher than 6°C between the park (shaded) and some of its surrounding streets (in the sun) were recorded, in very hot and dry days.

Keywords: Urban green spaces; Microclimatic conditions; Questionnaires; User's preferences.

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Qualifying public space in urban environment, a profile of the users and improvement in the quality of life

Margarida Queirós¹

Although outdoor public space is, in most cases, simply urban space, it should be understood as a concept that is beyond streets, as a social-spatial dimension of urban life fundamentally characterised by actions that attribute a meaning to certain urban areas that are also influenced by those actions.

This paper analyses the uses of outdoor public spaces in the urban experience and characterises its users. As an empirical reference, two public pedestrian areas were used in the two riverside fronts of Alcântara/Belém and Parque das Nações, in Lisbon.

The hypothesis of this work refers to the possibility that the daily or even occasional use of these areas can contribute towards the qualification of public life in urban environments, towards the improvement of the quality of life of its users and towards revitalising civic life. The main argument is that the activities of the users in public outdoor spaces are related to the configuration of those spaces, their functional and formal qualities, valorisation, location, accessibility and management.

Keywords: Outdoor public space; quality of life; Alcântara/Belém; Parque das Nações.

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Climate and Urban Design

Silvia Paula Pelham¹, Paula San Payo Cadima¹

The climate in cities varies according to the lie of the land, the prevailing winds, the nearness of large expanses of water or green spaces. It can also be changed by the built environment, planning and the choice of materials for both interiors and exteriors.

Two green spaces in Lisbon (Campo de Ourique and Campo Mártires da Pátria) were analysed for this study, the aim being to confirm whether the differences in microclimate between them were influenced by the layout of surrounding buildings and the urban fabric in the vicinity.

The basis for the results was a series of measurements covering temperature, relative humidity, wind speed, solar radiation and infra-red. The study was carried out on site from the summer of 2006 to the summer of 2007.

Microclimate conditions vary inside the two spaces not only because of the layout of the gardens and the type of vegetation but also because of the materials used for finishes in the outside spaces and on surrounding façades.

Orientation and the urban fabric both condition the views, the natural ventilation and shading, all of which has an effect on the sense of comfort felt by occupants.

This study presents proposals for improving the microclimate in the chosen sites by modifying the urban design. This will be achieved by the introduction of new elements which increase the well-being of users both in the gardens themselves and in surrounding spaces.

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The comparison of thermal sensation and preference for outdoor occupants in Lisbon and Central Taiwan

Tzu-Ping Lin^{1,*}, Henrique Andrade², Ruey-Lung Hwang³, Sandra Oliveira²

The way people feel the thermal environment is dependent not only on the physical environment (namely in terms of air temperature, humidity, wind speed and radiant temperature), but also, strongly, on the personal and cultural characteristics of the individuals. The general thermal comfort models were mainly developed for the assessment of the indoor environment, assuming very standardized conditions, and hardly considering personal and cultural differences. Outdoor thermal conditions are much more variable and thermal conditions are difficult to control; therefore, the individuals may have low expectations regarding outdoor thermal comfort. Besides when outdoors, people use a greater variety of clothing and engage in many more activities than when inside office buildings.

In this study a comparison is made between the thermal sensations and preferences of people living in Lisbon and central Taiwan, as well as an analysis of these preferences in relation to the weather conditions, the regional climate and cultural differences. Taiwan, located at 23° latitude N, has a hot-humid climate while in Lisbon, located at 39° latitude N, the climate is Mediterranean, with a hot-dry summer and a mild winter. Questionnaire surveys and simultaneous meteorological data measurements were conducted in both areas. The results of the analysis of the thermal sensation, the thermal comfort range and the occupants' thermal preferences revealed that significant differences exist between both regions, mainly in respect to the wind speed and the solar radiation preferences. These differences can be associated not only with the climate conditions, but also with cultural differences between the populations of these two areas.

Keywords: Outdoor thermal comfort; Thermal acceptable range; Urban area; Cultural preferences.

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Session III – Risks associated with strong winds and pollution in Lisbon

Urban pollution: road tunnels

Jorge Saraiva¹

The development of projects and the construction of urban road tunnels are usually faced as a possibility to improve the city's environment, since it is expected that they promote an increase of mobility in much wider areas than those directly involved in their physical implementation.

In addition, it is also expected a general improvement in air quality, due to the existence of evidences that point out to the possibility of reducing, at some point, global emissions in the areas of influence and managing the specific emissions associated with the location of these infrastructures. These two aspects allow us to think in the decrease of the risk to human health that may incur from poor air quality, since many vehicles' emissions are potentially dangerous (CO, NO_x, particles, benzene...).

It is important to mention that urban tunnels are usually built in areas where surface land is extremely valuable and that social conditions of usage and acceptance may be decisive; this second aspect has been neglected up until recently but its importance is starting to be acknowledged.

If in the generation of pollutants traffic is a basic variable, in air quality it is also necessary to consider initial and boundary conditions, the physical solutions and the management of air fluxes, both fresh and contaminated, inside the tunnel as well as its delivery outdoors. As to the delivery outdoors, the atmospheric conditions are decisive and among these, wind plays an important role in both aspects of atmospheric stability control (associated with temperature) and promotion of the processes of diffusion of gases and particles generated inside the tunnels.

In this work, some of the aspects related to gas and smoke diffusion are analysed, particularly the situations when the source is a portal; a simplified model for the estimation of the concentration field, taking into account wind action, is presented. Two applications to tunnels of Lisbon are referred, one already built and the other is under construction. Lisbon wind regimes are considered as their axis are E-W and N-S, respectively.

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Urban tree value assessment

Ana Luísa Soares¹, Francisco Castro Rego¹, Cristina Castel-Branco¹, João Santos Pereira² e Alexandra Correia²

In Europe, more than two thirds of the population lives in urban areas (Forrest et al, 1999). Although this growing urbanization has provided society with countless opportunities and challenges, it has also negative impacts on the environment and on the quality of city life.

It has been shown that spaces in the urban landscape planted with trees can minimise many of the environmental impacts of urban growth by improving the chemical and physical environment: moderating the micro-climate, in particular the air temperature; improving urban hydrology, air quality, reducing noise levels and the energy requirements of the city. In addition, planting trees in the urban context can increase the biodiversity in the city and bring numerous other benefits of an aesthetic, psychological and socio-economic nature.

However, the studies, the systematization, quantification and evaluation of these benefits are recent. The concerns of century XX strengthened by the requirements of century XXI have lead to the request of quantitative studies. The impact of the alteration of the climate is without any doubt a basic question. The future climacteric scenes for Portugal (Miranda et al. 2006) have pointed to a systematic increase of the average temperatures in the Summer in the order of the 3 to 7°C over all, with an increase of the intensity and frequency of heat waves in the interior North and Center of Portugal. It is very important therefore to assure and to improve the quality of life in the cities through the sustainable development, where applied ecological beddings in the city play a crucial role.

As a reply to these concerns the Superior Institute of Agronomy (Lisbon Technical University) has come to study this theme, as for example through the project entitled: "Tree value assessment, Lisbon urban trees" (Soares, 2006).

The deepening of the bibliographical revision and tested models to quantify the benefits of urban trees, lead to the practical application of the model STRATUM to Lisbon. The results of the value of net benefits obtained from the modelling of the Lisbon tree resources indicates large benefits of energy saving and air quality. In addition, the STRATUM model also shows that tree resources have a large impact on reduction of storm-water runoff as well as in the increase of the real estate value of the neighbouring properties.

The local adaptation of this existing model allowed the quantification of the benefits of the urban trees as well as the maintenance cost. The quantification of the maintenance costs also allows to develop a proper management plan, in order to maximize the relation costs benefit associated with the street trees and green areas in the city.

Keywords: Lisbon trees; tree value assessment; urban comfort.

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Strong wind and falls of trees, boughs and branches in Lisbon: proposal for an evaluation method

Sandra Oliveira and António Lopes¹

The existence of trees in urban areas is associated with a variety of benefits, both at an environmental level and at an economical and social level. However, trees can also be the source of damage and human injuries caused by the falling of branches, boughs and even the uprooting of the tree itself under strong wind conditions.

In the city of Lisbon, this type of events is relatively frequent. The Lisbon Fire Brigade and Rescue Service (RSBL) is responsible for the cataloguing of these occurrences that are reported via telephone and also for cleaning the area and submitting the reports to the entities responsible for tree maintenance.

This paper presents the methodology used to obtain information, to analyse the data of the damages caused to trees by wind in the city of Lisbon and to determine the potential causes for the uprooting of trees and the fall of boughs and branches. The data of these occurrences were obtained from the archives of the RSBL and are being analysed along with weather data (wind speed and direction), information on the tree species, fyto-sanitary conditions, characteristics of the area and other urban parameters (such as street orientation, sky-view factor and the H/W relationship). Information on the synoptic situation associated to the events with the greatest number of occurrences were also retrieved.

The presented methodology intends to contribute towards the mapping of risk-areas for tree uprooting (and falls of boughs and branches) events in urban areas that are caused by strong winds; the delimitation of the more vulnerable areas is being computed with the analysed parameters.

Keywords: Street trees, strong wind; fall of trees; risk evaluation.

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Strong wind and fall of trees in Lisbon. Risk assessment and first results

António Lopes¹ and Sandra Oliveira¹

It is recognised that trees in urban areas contribute to improve the urban climate and environment and they have aesthetical effects in the city, which makes them more valuable. Furthermore, trees can be carbon sinks (tackling climate change), they filter pollutants, remove harmful nutrients that may infiltrate in the soil, reduce surface drainage and erosion and increase biodiversity. In spite of these important functions, it is necessary to consider that trees can cause damages to urban structures and its inhabitants, partly due to the fall of branches, boughs or the uprooting of trees, which have a strong and decisive contribution from strong winds. In the city of Lisbon, the fall of trees, boughs and branches happens rather frequently, especially under certain meteorological conditions. In the framework of the URBKLIM project, a methodology was defined to assess the risk of the fall of trees due to strong winds in Lisbon. Several variables, besides wind direction and speed, were included on a database with correspondence to each fall registered, namely street orientation, H/W ratio (buildings height x street width), aerodynamic roughness and affected species. A period of 17 years, between 1990 and 2006, was analysed from 1241 falls registered by the RSBL (Regimento de Sapadores Bombeiros de Lisboa). It was concluded that the highest percentage of falls occurred in the last 7 years and there are seasonal variations, in relation to the number of occurrences and the dominant wind direction. The majority of falls occur in autumn and winter, with S and SW winds, while in summertime the falls (mainly boughs and branches) are mostly due to north winds. In relation to the locations of the falls, it was verified that they concentrate in the central areas of the city, which may be dependent not only from the number and the species of existing trees and their phyto-sanitary conditions but also of the urban design of these areas. The investigation on these parameters is being developed with further detail. This study has the purpose to contribute to the definition of the areas most vulnerable to the fall of trees, boughs and branches in Lisbon, in order to establish a risk cartography, that can be the support to an alert system capable of preventing human and material damages. Further investigation on this topic is needed and is on-going.

Keywords: Urban trees; fall of trees; strong wind; risk assessment.

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**The atmospheric environment associated with the occurrence of windstorms in Lisbon:
Using the radiosondes and the evaluation of instability conditions (2000-2005)**

Marcelo Fragoso¹ and António Lopes¹

The analysis of data obtained from radiosonde stations is a common approach for the evaluation of favourable conditions for the occurrence of phenomena associated with severe weather, such as heavy rains, storms or thunderstorms. This paper presents the preliminary results of an ongoing investigation that is based on the systematic analysis of radiosonde data (during the period of 1990-2006) retrieved from the Lisbon/Airport weather station. This work aims at determining the critical values of thermodynamic parameters and indices for the occurrence of wind storms. The presented work results from an analysis of radiosonde data that were selected based on the days when tree-fall events were registered in the city of Lisbon, during the six-year period from 2000-2005. The instability conditions that were deduced from the data are evaluated by using three indices: CAPE, SWEAT and shear. In the analysed sample, the values of the SWEAT index suggest that this might be the better index to use in the prediction of strong wind events in the city. The statistical treatment of the data from the selected radiosondes has allowed for an initial evaluation of the influence, both individually and as a group, of factors such as positive buoyancy in the vertical structure of the atmosphere, of humidity in the lower layers of the atmosphere and of strong wind-shear conditions in the occurrence of extreme weather conditions in Lisbon.

Keywords: Radiosonde data; instability indices; windstorms.

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Climate and Tourism – Implications and Perspectives

Andreas Matzarakis ¹

The climate and tourism interaction are twofold. On the one hand, tourism affects climate and is responsible for five per cent of greenhouse gas emissions. On the other hand, climate and weather are the main driving factors for tourism and recreation, together with nature and landscape. Existing methods for the quantification and assessment of climate and weather in the tourism and recreation issues are limited most of the times to winter or summer tourism. The existing methods or approaches are based on single or simple parameters or factors.

Based on the *Climate-Tourism-Information-Scheme* (CTIS) and on thermal indices or precipitation several examples on the global, regional and local scale will be presented.

The issue of climate and tourism is also interconnected with microclimatological options i.e. urban climatology and urban and regional planning. In this case the microclimatological conditions can build a positive factor for creation of recreation resorts. On the other hand, dense urban environments and required cooling devices for buildings and tourism resorts not only contributes for the creation of negative microclimates, but may also have a part in the climate change issues.

Keywords: Tourism; Climate; microclimate; *Climate-Tourism-Information-Scheme* (CTIS).

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Session IV – Regional and local climate change

The impact of extreme temperature events in Portugal: learning from observations and climate change scenarios

Ricardo M. Trigo^{1,2}

The observed rise in global mean temperature over the last century, particularly in the last 30 years, has prompted the recent increase in the number of studies related with climate change scenarios. Global mean surface temperature rose approximately 0.7°C since late 19th century until the present time (IPCC, 2007), with two periods of warming being identified (1910-1945 and since the 1970s). In Europe the highest temperature increases are in agreement with the periods found at the Global level.

Portugal is particularly vulnerable to summer extreme events, such as heatwaves, with significant increments in mortality and wildfires occurrences. The summer of 2003 was characterised by exceptionally warm weather in Europe with the average temperature exceeding that of any previous summer over the last 500 years. The seasonal 2003 summer temperature for central Europe was beyond the historical distribution range and could bear a closer resemblance with climate change scenarios for late XXI century. Nevertheless, it was the heatwave that occurred between the 1st and the 15th of August 2003 that had a major impact in excessive mortality rates throughout Europe.

We present an analysis of climate change over Portugal simulated by a regional climate model of Hadley Centre (HadRM3). Maximum and minimum temperatures for both IPCC emission scenarios (A2 and B2) are discussed for the 2071-2100 period and compared with the control simulation (1961-1990). In these 2 scenarios, Portugal undergoes a substantial warming with highest values of maximum temperatures increase in summer reaching 7°C (A2) and 6°C (B2). In winter, maximum temperature increases range between 2.5°C and 5.5°C (A2) and 2°C and 4.5°C (B2). For minimum temperature, in winter there is an increase of approximately 3°C (A2) and 1.5°C (B2). Seasonal percentiles of extreme episodes (10th and 90th) for both maximum and minimum temperatures were computed for present and future periods in order to evaluate changes of extreme events for the two distinct future climate scenarios. Additionally we have also computed the number of days per season (in 2071-2100) with temperatures higher than the 90th percentile (hot events) and lower than 10th percentile (cold events) based on the 1961-1990 reference period.

Keywords: Extreme temperatures; heatwaves; climate change scenarios; IPCC; Portugal.

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Future perspectives of urban climate – A challenge for urban planning

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The specific physical and chemical properties and conditions of urban areas modify the climate. The city's influence on air temperature is a well-known phenomenon named the Urban Heat Island (UHI) or the Urban Heat Archipelago (UHA). However, other factors e.g. air pollution or wind modifications are also of importance.

Urban climate modifications are strongly related and can be changed in a positive or negative manner by urban planning. In this manner, the mitigation and adaptation possibilities at an urban climate level have an important role in the global warming discussion. However, before applying mitigation and adaptation strategies the urban climate modifications must be quantified and assessed.

The present conditions of urban climate especially in urban structures cannot be described by a single parameter e.g. air temperature. Human biometeorology aims at quantifying the effects of the atmospheric environment on humans. These effects are described in effective complexes because of their non mono causal character (e.g. thermal or air pollution complex).

The assessment of the thermal effective complex is based on thermal indices, which can define that effect in a thermo-physiological manner and allow the quantification of the effects of urban structures e.g. streets (with different orientations, heights, size) and the effect of parks and vegetation on the thermal bioclimate of humans; contribute towards mitigation and adaptation strategies against climate change in cities; modify energy demand for heating in urban areas caused by the urban heat island. The examples can be easily applied through urban planning and create better climate conditions for city dwellers.

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Session V – Climate change and environment in urban areas

Urban Climate and climate change

Maria João Alcoforado¹

The new urban utopia is the sustainable city, whose impacts upon the environment are minimized, without bringing about a reduction in the quality of life of the urban dwellers. As climate change is an up-to date and urgent topic, the relationships between global warming and urban warming will be dealt with in this paper. Is there a direct or an indirect effect of urban warming upon planetary climate change? What are the consequences of global warming to the urban heat island?

In certain cities, temperature has already risen to values, predicted for 2100 for the mean temperature of the planet and urban areas are particularly vulnerable to climate change. Furthermore there exists in cities the potential (in terms of critical mass and technology) to present innovative solutions that are easily reproducible on a greater scale. So the question is: are not the cities a privileged place to test different types of adaptation to climate change? We are still at an initial stage in the development of a global answer to the threat of climate change. However, in some cities there is a great concentration of resources that may lead, in certain cases, towards improving our capacity to take the right action. In cities there are potentially less barriers to implement measures and to make decisions than at a national and global level. Some examples of adaptation measures to climate change in urban areas will be presented; these adaptation measures contribute, at the same time, to an improved urban environment.

Keywords: climate change; global warming; urban climate; urban heat island; adaptation.

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The use of geotechnologies for climate change analysis in S. Paulo metropolitan Area (Brazil)

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The growing anthropic actions on the planet's natural resources have made it necessary to increase studies of the consequences on environmental quality and climate change. Fast demographic growth has also negative consequences in areas that are not prepared for sudden increases of the existing infra-structure, which is nearly always not sufficient.

In the context of metropolitan urban areas, climate changes are more intense and reflect not only local but also regional scale changes. The urban area of the city of São Paulo, with a population of almost 20 million, presents significant climate changes that affect the quality of life of its inhabitants.

In an intensely urban area that was occupied without proper planning, of all sorts of problems abound that deeply affect environmental quality and the population's quality of life. In addition to these problems is the lack of proper urban planning that result in the occupation of areas that are at environmental risk. The result is an increase in deforestation, the degradation of water resources and increased atmospheric pollution. These problems reflect the vulnerability of the natural and social systems. The São Paulo Urban Metropolitan Area was analysed based on inter-disciplinary knowledge of geoprocessing and remote sensing. The economical, social and environmental impacts present scenarios for the future climate of the São Paulo urban area and indicate a more appropriate policy that can contribute towards improving the quality of life.

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Is it possible to evaluate local and temporal climate change in Europe, based on bryophytes?

Sérgio, C. ¹, Figueira, R. ², & Sousa, A.J. ²

The development of methodologies capable of selecting and proposing possible indicators that are, for each moment, able to validate the results of climate change simulations, might help to minimise problems in this area of study.

In this context, it is important to monitor the impacts that might occur, and that can help warn about the potential positive or negative consequences of the expected changes, both on cities, with the increase of temperatures, and rural areas, with their desertification. In addition to other limitations, the simulation of the predicted climate changes, especially those concerning temperature and precipitation, have yet to be confirmed.

From among the biological indicators that are advantageous to these studies, the bryophytes stand-out. The expansion or reduction of this species in different areas is independent of direct human action and their existence is conditioned only by the presence of substrates for their proliferation. The study of the influence of atmospheric pollutants on their existence is therefore, of importance.

In the case of the epiphytic bryophytes, the simple presence of a group of trees that fulfil some criteria is enough for this species to either develop or be eliminated. In the case of the tested species (*Sematophyllum substrumulosum*), the presence of a small wooded area of *Pinus*, or other resinous trees, is enough for them to be able to develop. In a second phase, the presented cartography may be validated with further field studies. The generalised increase in temperature and desertification are processes that can be monitored with biodiversity models and the knowledge of invasion strategies allows the monitoring the disappearance of species that are indicative of new conditions.

Keywords: Global and regional climate change; biological indicators.

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Urbanity, sustainability, health: an evident and persistent relation

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The opportunity and pertinence of the questions related to the environment, health, quality of life and sustainability result from the acknowledgment, even if late, of the negative impacts of some anthropic actions (or their absence) on the environment and the consequent decrease in the levels of health of the populations. The progressive concentration of people and activities in cities has put into evidence the complexity and fragility of the territory, considered as support, consequence and essence of human communities. The problem seems paradoxal: if, historically, the areas with denser urbanisation have played a vital role in the creation of richness and in the improvement of life conditions and health of the populations, nowadays they accumulate and expose their inhabitants to an additional range of health risks. In addition, urban space is not a uniform *continuum* which provides the same opportunities to all to promote their health and to live in a healthy way. There are scientific evidences that point out consistently to a lower level of health of those who live in poorer and more segregated places and are more deprived of a set of opportunities that allow a *pro-health* daily life. In the continental part of Portugal, the study of the geographic variation of the mortality, due to specific causes, shows a set of pathologies with greater expression in areas more densely urbanised, especially for the area of Greater Lisbon. By assessing the environmental determinants of health in the Metropolitan Area of Lisbon, considered as a set of features of the local physical and social environmental, it was concluded that some of the analysed determinants are more relevant than others, emerging clearly the strong connections between a poor and unqualified environment, and the loss of health and quality of life of the populations.

Keywords: Mortality; Health variations; Environmental health determinants.

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Session VI – Mitigation and adaptation to climatic variations. The role of urban planning

Urban Design and Bioclimatic Strategies

Paula San Payo Cadima¹

The environmental quality of urban spaces, the pleasantness and the potential of urban microclimates to improve the environmental performance of surrounding buildings, depends of its design and detailing. Several examples of human settlements illustrate for ages different strategies for microclimatic control in order to mitigate climatic conditions and to improve comfort. The integration of water elements and vegetation, for instance, has been use for decades for shading or cooling outdoor spaces. Orientation and the spacing between shelters have been applied to control or take advantage of the effects of the sun and wind movements. Moreover, construction materials and outdoor pavements have been cleverly used to reflect or absorb solar radiation.

With urban growth and traffic increase, the integration of efficient and sustainable transport and mobility systems, as well as the use of renewable energies for heating, cooling and lighting the buildings and outdoor spaces, are becoming more and more relevant in sustainable urban design and the development of cities more adapted to climate change. However, today street geometry, building form, finishing and orientation, landscaping, additional shading systems, urban materials and outdoor surface detailing still influence the environmental quality of our cities. This presentation shows examples of urban design bioclimatic strategies for the environmental control of outdoor spaces and examines the principles and physical processes of these for the environmental performance of urban microclimates.

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Flood risks and management in urban areas in urban areas

Maria da Graça Amaral Neto Saraiva¹

The increase in the asymmetry of seasonal precipitation is among the predicted climate change impacts, for the geo-spatial context in which we find ourselves. These impacts have the potential to increase the risk of floods, including those resulting from flash floods events, which increase their vulnerability and hazard.

Flood risks are higher in urban areas and this is caused by changes in the natural drainage conditions, due to different urban land uses and the extent of the flood damages. Impervious extensive areas and the construction of drainage systems modify the natural runoff conditions. Other factors, such as insufficiency and overloading of the drainage systems, obstruction and culverting of natural watercourses, occupation of riverbeds, margins and floodplains by urban development, among other factors, contribute towards the aggravation of these risks.

In order to reduce flood risks, it is common to adopt two types of measures – the structural measures, which involve different structures that reduce one or more parameters that cause inundations, such as the flooded area, the river flow or the height of the floods, and the non-structural measures, which involve preventive or adjustment measures that aim to reduce risk through changing the area's social and economical liability that might be damaged by the inundations.

The non-structural measures encompass a wide range of alternatives, such as zoning and regulations of the hazard areas, construction guidelines and building and infra-structure maintenance, soil acquisitions policies and management, insurances, prediction and early-warning measures, the promotion of public awareness, emergency systems and post-recovery measures. These measures face mostly prevention and mitigation aims, implemented through regulations and institutional tools, that are essential for land use management in flood-prone areas.

Small catchments are more vulnerable to flood risk intensification due to anthropic actions, such as those promoted by a deficient urban management. Flood risks in urban areas and their relationship with urban land use planning and management should be an important factor in the prevention of future events.

Actually, the aim to develop preventive measures has become more common, through the mitigation of the flood effects, as well as those of pollution, by integrating these measures into urban management and planning, usually referred as Best Management Practices (BMP). BMPs promote stormwater management using a source control concept, increasing infiltration, detention and retention, and influence the retrofitting of stormwater drainage systems that, together with pollution control and the implementation of simplified treatment systems, will have important environmental and economic benefits.

This presentation aims to discuss the benefits of implementing some of the non-structural measures for the management and zoning of flood-prone urban areas, as well as the integration of BMP measures for stormwater management, when integrated with land use planning and urban space design. An efficient management of these measures might contribute towards flood risks mitigation, improving the environmental conditions, the citizen's quality of life and sustainability of the urban landscape.

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**Thermal performance of the buildings in the city:
physics of buildings and urban climate**

Marta J. N. Oliveira Panão¹

The thermal performance of a building depends on how it is built and used, that is, of its *first envelope* and the climate where it is located: the *third envelope*. The *second envelope*, thus, will correspond to all the interactions existing between the urban space and the climate, because climate in a city is strongly associated with the characteristics of the urban space and, besides, buildings interact with each other and influence the thermal performance of the other buildings. To assess the thermal performance of urban buildings it is necessary to consider the relation between urban climate and physics of buildings.

In this study, the phenomena of transference that occur in the Urban Canopy Layer (UCL) are considered and an attempt is made to establish the parameters that allow the assessment of the thermal performance of a set of buildings when these are influenced by the microclimatic specificities of their surrounding outdoor space.

Initially, the fluxes of the radiation absorbed and emitted by the building are quantified, by using the dimensionless parameters of effective absorptance and emittance of a building block, in order to evaluate the natural ability of a building to warm up or cool down when it is integrated in an urban structure (Oliveira Panão *et al.*, 2008). In the calculation of these fluxes it is taken into account the effect of multiple reflexions between buildings, in a three-dimensional structure, according to the urban matrix method (Oliveira Panão *et al.*, 2007a). Additionally, it is also studied the effect of thermal gradients in air flow inside urban cavities with different geometries, considered as bidimensional, with the purpose to quantify thermal conductance of an urban cavity (Oliveira Panão *et al.*, 2007b), an indicative parameter of temperature increase in the area adjacent to buildings due to weak ventilation conditions of the cavity.

The integration of the various parameters allows the definition of a set of rules on the structure of urban morphology, in order to promote a better thermal performance of urban constructions.

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Cities and Global Changes

Jorge Gaspar¹

Urbanisation represents Mankind's greatest state of evolution in terms of territorial organisation, as it achieves a balance between the economical, social and environmental facets of life. The city, in the sense we know it and have known since Ancient times, epitomises the most robust form of urbanisation as it balances the aforementioned facets of human life with a cultural dimension.

There is a great sensitivity in the manner in which cities react to the solicitations of global changes, whether they might be of physical, economical, social or cultural origin.

It is for these reasons that, throughout history, periods of increased exchange are also periods during which cities and urban areas have achieved their greatest splendour. However, not all cities prospered, as some were losers, in absolute terms or relative terms.

The progressive assertion of the globalisation period in which we have been living since the 1980's is an entirely new era in the History of cities. Although some thought that cities might disappear entirely (some articles were written on the concept of *counter-urbanisation*, a concept that became rapidly defunct), cities quickly obtained a new splendour in the context of a new urban culture that has also become global.

In the face of the climate changes that the more credible research papers predict, there are several opinions on how they might affect cities. Are cities areas in which the climate changes will most rapidly be felt or, given that they are a planet friendly form of human organisation, do they offer a unique potential for the application of measures that might mitigate those changes?

In the same manner in which the city has reacted through time to human changes (ageing of the population), social changes (global migration, hunger, disease) and cultural changes (bringing cultures together and creating an appreciation for differences), can it not be that it is the city that will provide the best answers in how to mitigate impacts and even eliminate and control some of the more undesirable changes.

The cities, like the rest of the planet, are now faced with several possible futures. There are several credible studies that present some scenarios of those futures. Humanity still has enough freedom to choose which of those futures they desire. It is important to make choices and prepare appropriately so that we might achieve our desired reality.

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POSTERS

Bioclimatology

Daily Mortality and winter climate in Lisbon

Henrique Andrade¹, Jorge Marques²

In studies of the influence of climatic conditions on mortality, much greater attention has been given to the relationship between mortality and high temperatures than with mortality and lower temperature values. In spite of this, mid latitude countries have higher mortality rates during the winter than during the summer. The aim of this research was to study the relationship between winter daily mortality (all causes) in the District of Lisbon and the atmospheric conditions. Relationships were sought between mortality and the values of different climatic elements at different time lags, and were tested using a cross correlation function. A significant negative relationship was found between mortality and air temperature (maximum, average and minimum). The higher correlation coefficients with temperature were observed with a time lag of 4 and 7 days before the obit registration. The stronger relationship was observed using the thermophysiological index Physiological Equivalent Temperature (PET), also with a time lag of 4 to 7 days. These results show that, in the analysis of the variations in winter daily mortality, wind speed and radiation fluxes, combined with air temperature, must also be considered. The air temperature and PET values corresponding to minimum daily mortality and the increment of mortality as a consequence of the cooling were estimated. Periods of particularly high and low mortality were analysed and compared, with the aim to identify synoptic situations associated with the increment of mortality.

Keywords: winter; daily mortality; PET; air temperature; Lisbon.

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Meteorology and health
The weather conditions as risk- factors for respiratory diseases

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The objective of this study was to relate weather conditions in Lisbon with hospital emergency respiratory disease admissions in the Santa Maria Hospital paediatric ward. Data were collected for eleven winter months (the months from November to February) for the period of January 2000 to February 2003. The methodology used was based on the construction of weather types, determined from four daily meteorological observations (00, 06, 12, 18 UTC) measured at the Lisbon/Gago Coutinho weather station. A principal component analysis was applied to these variables followed by Cluster Analysis which produced eight groups (clusters) that were meteorologically similar – the Weather Types. The relationship between the weather types and the daily respiratory admissions cases was assessed based on a daily respiratory admission index (IDR). This index is the ratio of the number of daily admissions due to respiratory disease and the average of the total admissions due to respiratory disease for the period considered, expressed as a percentage. The weather type A-QE(F) was found to be associated with the highest number of emergency respiratory diseases admissions.

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Studies of Thermal Comfort in Green Spaces in the City of Bragança

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The study of thermal comfort in outdoor spaces is an important source of information allowing a greater understanding of the reasons for choosing outdoors spaces for diverse activities, including recreation and leisure (Thorsson et al., 2004). Studies developed in areas with different local conditions allow an evaluation of the impacts of urban characteristics on human comfort, thus allowing for the definition of recommendations that aim at increasing the social use of outdoor urban spaces. The thermal conditions of urban spaces are influenced by their different characteristics, both urban and architectural, as the urban climate is recognisably different from the climatic conditions in rural areas (Hough, 1998). It has also been registered the presence of microclimatic phenomena in the wide range of urban occupations and the existence of particular thermal conditions in green spaces has been acknowledged, by comparison to the conditions of the paved and built areas that exist in the same urban setting (Givoni, 1991).

The present research, which is being developed in the city of Bragança, is part of the GreenUrbe project– Impact of Green Spaces on the Quality of Urban Environment (POCI/AMB/59174/2004), and aims at evaluating the influence of these green spaces in the urban thermal comfort, seeking to identify principles that guide their conception and design so as to create a thermal environment that is best suited for social use.

Studies of mesoclimate characterisation and comfort in green spaces, with the purpose of understanding the factors that influence thermal comfort, at both urban and local scales, have been carried out to date. The localised studies were divided into two approaches: structured experiments under controlled conditions in a single location; and surveys of occasional users in different green spaces. In both cases the prevailing climatic conditions were evaluated and comparisons with the tested individual's perceptions of comfort were made.

The results obtained to date have allowed an identification of the particular characteristics of outdoor spaces and an establishment of some of the relationships that exist between the characteristics of green spaces and their influence on the perception of comfort. The presented project is still on-going and further studies will be held.

Keywords: Green Spaces; Cities; Thermal Comfort.

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Microclimatic conditions of the Teófilo de Braga garden (Lisbon) and its influence in the surrounding area

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Green spaces contribute to increase the quality of life in cities, by playing an important role in the improvement of the urban environment. Green areas can also be a major way of adaptation to climate change, due to their contribution for the improvement of the microclimatic conditions of the surrounding area and for mitigating the urban heat island, by providing cool areas for the population, during heat waves, and by their potential role on carbon and other atmospheric pollutants uptake.

The influence of green spaces in urban areas depends of several factors, such as dimension, structure of the green space and the prevailing local and regional atmospheric conditions, among others. In densely urbanised areas, green spaces are mostly “neighbourhood green spaces”, which are small but have an intense use. In Lisbon, these small green spaces are the public areas most frequently used. Previous studies showed that these areas contribute to increase the human bioclimatic comfort. The influence of the green spaces in the microclimatic conditions is particularly important in extreme hot events and mainly for elderly people, who are more susceptible to these conditions.

For this study, a small green area was selected, the Garden Teófilo de Braga (2400 m²), which is located in a densely urbanised area in the city of Lisbon (Campo de Ourique).

Measurements (permanent and itinerant) of meteorological parameters (air temperature, relative humidity, solar and long-wave radiation and wind speed) were made, with the purpose of analysing the microclimatic differences between the green space and the surrounding area and also the way the garden influences the adjacent urbanised space. The measurements were carried out inside the green area and alongside a previously defined path between the garden and some of the surrounding streets, in order to establish the differences resulting from the distance to the garden and street orientation, in sunny, hot and cloudless weather conditions, during the summers of 2006 and 2007. It was found that there are significant differences, particularly concerning temperature and radiation values, between the garden and some of the nearby streets, especially in the hottest days.

This study will contribute to improve the understanding of the climatic influence of small green spaces, on the human comfort of their users and on the quality of life of urban areas.

Keywords: Green space; microclimatic conditions; adaptation; climate change; urban areas

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Urban Climatology

Urban and regional morphologies Bioclimatic strategies for the design of a city in Portugal

Maria Rosália Guerreiro ⁽¹⁾

The work to be presented is a result of an ongoing ISCTE doctorate investigation, which is a part of the study of Portuguese urban morphologies. It seeks to give the general panorama on the regional differences that the morphologies present, which are due to climate influences. In this manner, and using an Atlantic-Mediterranean, Maritime-Continental dichotomy and based on the country's climatic regions (including that of the Azores), this work seeks to systematically characterise the behaviour of traditional urban developments of spontaneous or planned origin in relation to the climate of each region. The site selection, solar and wind orientation, urban structure and density, buildings association, shape and orientation of the façades, the more common traditional colours, as well as the usage of indigenous materials for construction shall be analysed.

The objective of this research is to set out the strategies of our traditional cities that were able to evolve in a symbiotic manner with nature. These formulas, which have been successfully adjusted throughout generations, are optimised solutions for each geographical region. The greater understanding of these strategies will help to not only preserve the character of our land, and consequentially our cultural identity, but might also prove to be an inspiration for future urbanisations and therefore help in the finding of environmentally-friendly solutions that are sustainable in the face of climate change and the fore coming energy crisis that is bound to happen with the depletion of fossil fuels.

Keywords: Urban and regional morphologies; architecture and regional urbanism; indigenous construction; environmental comfort; bioclimatic strategies.

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Influence of the urban morphology on the rainfall distribution in Greater Manchester

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The human activities and the alteration of the nature and morphology of the land surface perturb the land surface-atmosphere balances of energy, mass (atmospheric constituents) and momentum, leading to the modification of the atmospheric boundary layer and affecting the weather processes. Urban areas have been documented to affect temperature distributions, wind patterns and air quality. Furthermore, urban areas can also impact the development of clouds and precipitation in and around cities, in particular the enhancement of convective precipitation downwind urban areas has been broadly observed.

Among the causes ascribed to the modification of convective precipitation induced by urbanisation, most studies suggest that the atmospheric destabilisation associated with the heat island and surface roughness is the most significant, more so than microphysical or moisture enhancement. However the relative importance of these mechanisms remains unclear.

Major urban development and regeneration have been planned in several regions of the UK and elsewhere. The modification of the morphology of the cities expected in the future poses new challenges in various knowledge fields, from building design and city planning to meteorology.

The present work reports an investigation of the effects of urban surface heterogeneity on the distribution of sensible heat flux and its impact on convective precipitation, in Greater Manchester. A simple numerical scheme is formulated to derive fields of surface sensible heat flux for a range of wind and temperature values over the urban area. This involves the derivation and mapping of urban surface characteristics in terms of some morphologic aspects such as the height of buildings and the frontal area index. Comparisons are made of the sensible heat flux field with the rainfall field measured using a C-band radar. The possible influence of the urban morphology on the rainfall distribution, and the eventual initiation of convective cells by the sensible heat flux input generated by the high-rise buildings in Manchester city centre, are discussed.

Keywords: urbanisation, urban boundary layer; buildings; convective precipitation; radar.

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**Predictive analysis of urban climate variables in a region of Belo Horizonte, MG, Brazil,
for application on urban planning**

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The aim of this project was to study the impact on urban climate variables generated by the application of a settling model predicted by the local legislation on land use. An empirical relationship was established between climate parameters (temperature and relative humidity) and urban parameters (construction mass and sky-view factor) in an urban area located between the municipalities of Belo Horizonte and Nova Lima, MG. In order to establish a comparison between the behaviour of the variables involved, *scenario techniques* were applied, generating two scenarios: one of the occupation that existed in 2006 and the second of the projected occupation in 2016, based on the possibility for occupation allowed by the laws of the municipalities involved. Some changes in the climate variables were accounted which were related to new conditions generated by the region's simulated increase in density. The results point towards changes that are more significant in areas with greater vertical construction and density. The developed procedure was capable of simulating changes in the climate variables as a function of the changes in the urban variables, thereby integrating the study of urban climate in the planning of cities, and thus contributing towards an improvement in the analysis and prediction of the impacts of urbanisation on local climate.

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On-line Climate Information for Urban Planning in Lisbon

Ezequiel Correia¹, António Lopes¹

This research was carried-out as part of the CLIMLIS (*Prescription of climatic principles in urban planning. Application to Lisbon*, (POCTI/34683/GEO/2000) and the “Climate guidelines for the planning and management in Lisbon” projects, coordinated by the Geo-Ecology group of the Geographical Centre of the University of Lisbon, the last in collaboration with the town municipality. It was possible to obtain more in-depth information of the factors conditioning urban climate and to formulate in a descriptive and spatial manner a set of climate guidelines for the management of the city of Lisbon that were made known to the public in several presentations and via the publication of a paper (Alcoforado et al., 2005).Resorting to systems used by Geographical Information Systems, a new solution for public release of the findings of the project is currently being constructed. This will include the release of information through the Internet. Based on the use of analysis, synthesis and climate evaluation maps, the new solution will aggregate information by levels of information, the relevant characteristics of each geographical entity and other graphic and documentary elements that are essential in order to provide a proper understanding. Different functions, such as visualisation, navigation, research and analysis techniques will also be available, which will allow the user to select the appropriate contents and level of detail; some of the city’s climate characteristics and the proposed measures for its improvement in the different areas as well as the reasons behind them will also be available for consultation.

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Summer winds in Funchal and their influence on thermal patterns

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Funchal is a small island city, located near the coast and limited in the north by an arch-shaped mountainous system. In this research an attempt was made to analyse the factors and characteristics of its climate during summertime, using meteorological data obtained from the Meteorology Institute network and the Madeira Civil Engineering Laboratory (air temperature and wind). Satellite Landsat images were also used to generate heat flux models. The urban climate was studied using data registered at the top of buildings and in urban canyons. Thermal characteristics of land and sea surfaces were also observed.

The comparison of the wind between the base and the top of the southern slope, in the Funchal region, revealed that in some anticyclonic circulation situations, which are typical in the summer, the city is sheltered from the northeast gradient wind due to the presence of the mountain, topped by the two peaks (*Areeiro and Ruivo*), which enables the activation of the local circulation systems in the lower sector of the slope, where the city is located.

The breeze circulation system presents a high occurrence frequency (over 80% of the days analysed). During the night, the mountain breeze acts towards the city, reinforcing the land breeze which flows to the sea. During the day, the sea breeze, stronger in the coastal area and beyond the influence of irregular surfaces, acts in the same direction as the valley breeze, thus increasing the intensity of rising winds, in the slopes facing south.

Considering, in one hand, the shelter effect created by the mountain, and on the other hand, the breeze circulation system, which tends to cool down the atmosphere, this research seeks to verify the heat island effect in Funchal city. It was found that during the daytime period, at the top of the buildings (in the urban boundary layer) the city is warmer, than the adjacent sea atmosphere. The largest air temperature differences between land and sea (0,9°C to 1,3°C), are possibly responsible for the sea breeze circulation. In the urban canopy layer, the air temperature is higher than the periphery to the east and west part of the city. It was found that this heat island, has an average intensity of 1,5°C, irrespective of the period of the day.

Keywords: Funchal, urban climate, breeze systems, energy balance, heat island

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Climate Change

Vulnerability and Local Adaptation to Climate Change in the Algarve Region

Maria do Rosário Partidário¹, Rita Gomes²

The Portuguese Instituto Superior Técnico, as part of the Agir Programme – Environment for the Calouste Gulbenkian Foundation, has promoted three training programmes for all the municipalities in the Algarve region. These programmes focus on climate changes and their impacts on the regional vulnerability as well as the adaptations necessary on the focused regions.

In this manner it was sought to create a greater awareness of the need of local action in the adaptation to climate change aiming at a sustainability of tourism in the area, for example:

- To debate the creation of new urban intervention models – tourism adapted to climate change;
- To establish the concept of climate change not as a cost but rather as an opportunity;
- To acknowledge the need to adopt a plan of action for climate change at a municipal scale.

The local plans for climate change are made up of strategic, global and integrated plans in which the importance of the local authorities establishing policies and measures that fight climate change is recognised. Focusing on the role of the local authorities and that of other agents and sectors, the main actions to be taken are identified and measures for adaptation and short, medium and long term mitigation strategies are defined. They make up a policy for the integration of the fight against climate change into local concerns and municipal management. The instrument was presented to the municipalities of the Algarve as a way to act at a local scale against the predicted climate changes. This presentation contains the bulk message presented to the municipalities of the Algarve Region.

Keywords: Algarve region, climate change, vulnerability, adaptation.

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Energy and climate change strategy for the municipality of Cascais

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Research was carried out with the objective of identifying the areas in the Cascais municipality where the promotion of sustainable energy is a priority. This poster presents the study's main results.

The project is initiated by characterising the energy consumption within the municipality of Cascais during the year 2005. A series of important economical sectors were identified, as well as the main tendencies for the evolution of energy consumption. Also determined were the carbon dioxide emissions, the most relevant greenhouse gas (GHG). The values of energy consumption were of 200 ktep, with a value for individual consumption of 1.1 tep/cap, that is significantly lower than the national average (around 1.9 tep/cap).

A comparative analysis with other municipalities was also carried out, and two indicators were defined – individual consumption (tep/cap) and CO₂ *per capita* (tonCO₂/cap), with findings showing that, for the analysed municipalities, Cascais presented some of the best results. Evolution scenarios of energy consumption were also determined, among which were *Business As Usual scenario*, projection results and scenarios that complied with the norms imposed by European energy policies.

Also estimated was the municipality's internal energy consumption, so as to implement energy efficiency measures and renewable energy usage at this level. The total value found for energy consumption was of 2.690 tep (1.4% of the total energy used in Cascais).

Based on the municipality's energy consumption and considering the local reality, some energy efficiency measures are evaluated (the installation of regulators of the light flux in public illumination) and usage of renewable energy sources, namely the use of forest and agricultural biomass, biogas originating from wastewater treatment plants (ETAR) and waste sites, used cooking oil, the use of solar heating panels in swimming pools and gymnastics pavilions.

Keywords: Energy efficiency; renewable energy; municipalities; sustainable development.

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The evolution of the number of tropical nights in some cities of the Iberian Peninsula during the second-half of the 20th century and beginning of the 21st century (1961-2007).

Paulo Pereira¹, Bruno Simões² e Nuno Jerónimo³

One of the most apparent manifestation of the increase in the summer minimum temperatures is the increment in the number of tropical nights (>20°C), which impacts coercively on human bioclimatic comfort, on the consumption of water and energy and results in substantial economic losses. The objective of this work is to study the evolution of the number of warm nights in some cities of the Iberian Peninsula (Albacete, Alacant, Badajoz, Beja, Biarritz, Bragança, Cordoba, Lisbon, Madrid, Malaga, Perpinya, Oporto, San Sebastian, Saragossa, Torrevella, Tortosa and Valencia), during the months of June, July, August and September (JJAS), for the period between 1961-2007. The results, according to the non-parametric Mann-Kendall test, indicate that the tendency is significant at a 95% confidence level, in all stations except Braga, Bragança and Oporto. Observations show that the number of tropical nights is always higher in July and August. It is important to point out that the comparison of two sub-periods of the time-series (1961-1983 and 1984-2007) reveals a significant increase of warm nights in June and September in the cities on the Iberian Plateau and an increase in June for the cities located on the Mediterranean coast. The Skewness and Kurtosis analysis of JJAS in the two sub-periods evidence, in most stations, more negative values in the second period, with more warm tropical nights during the summers and a greater heterogeneity, than in the first period, being statistically more poignantly different in the stations of the Mediterranean cities and in the interior of the Peninsula. The application of a Factorial Analysis reveals that the dynamics of the warm nights for the entire period is that of a markedly regional pattern and is not due to the influence of the urban heat island.

Keywords: Summer low temperature, tropical nights, Iberian Peninsula

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Thermal sensation and climate change in urban areas

Gilson Campos Ferreira da Cruz¹, Magda Adelaide Lombardo²

Climate in urban areas is the result of a series of interferences that the elements that make up cities are capable of provoking. When travelling through cities it becomes apparent that in different locations that might even be close to each other, the weather conditions can be different. Thermal sensation is one of the several ways we have to understand, observe and feel climate differences within cities. Thermal sensation is partly a consequence of fluctuations in temperature and wind speed as well as changes in relative humidity. In order to identify the possible differences in thermal sensation at the centre and at the periphery of the city of Ponta Grossa-Paraná-Brazil, a research was conducted based on data collected simultaneously at three strategic points. Point 1 in the city centre, near a tree-filled square, was surrounded by buildings most of which were more than two stories high and was located on the eastern lateral street, which was paved. Point 2 was far from the urban construction conglomerate, southeast of the centre, located on a non-paved street in the Industrial District, with little construction and on Southward facing open area. Point 3 was located in a street made of stones resulting in irregular paving in the north-northeast area of the city (relative to the centre) in a heavily developed region whose construction, nevertheless, was no higher than 2 stories, with wide streets, on a Northward facing half slope. Data were collected for the winter of 2007, from the 29th of July to 1st of August, with hourly measurements between 9 a.m. and 9 p.m. The analysis of temperature and wind speed data and the observations made in relation to the surrounding construction and pavement conditions show that, in the centre of the urban area, there appears to be a smaller difference between actual temperature and thermal sensation. Throughout the 4 days the temperature evolved until reaching its maximum at 2 or 3 p.m. However thermal sensation varied a lot throughout the time period considered. In the two points located at the city's periphery, wind was always stronger than at point 1, especially during the first day when thermal sensation reached 1.8 °C in point 3. From the second day temperatures began to rise and the wind dropped, which meant that for only a few hours a day thermal sensation levels were lower than the actual temperature, with a high amount of fluctuations in thermal sensation; this scenario was repeated throughout the third day. In the fourth day of field work, the warmest of them all, thermal sensation was restricted to a few hours. The results demonstrated that the use of thermal sensation data allows for an identification of the changes or climate changes that might be occurring in urban areas, whether they might be due to interference in wind conditions or a result of interference by the elements that make up the city.

Keywords: Thermal sensation, temperature, wind and city.

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