SYMPOSIUM ON CHALLENGES IN APPLIED HUMAN BIOMETEOROLOGY

Monday, 2.3.2020 – Tuesday, 3.3.2020

Plenary session A, Location: Haus zur Lieben Hand

The long way from one parameter indices to complex and universal thermal models of the human body

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There is a long history in trying to assess the thermal effects of the environment on comfort and strain of humans. While at the beginning of such endeavours specific climate situations had been in the focus for which some very simple indices seemed to be sufficient, in recent years universally applicable tools have become state of the art. It has been accepted for a long time now that such tools have to consider all relevant meteorological as well as behavioural parameters like the kind of clothing and activity. This leads to the necessity to base such tools on modelling all heat flows from and to the human body. From such complex heat balance models, however, some easy to understand heat indices like PET or UTCI can be derived, which now in contrast to the old simple indices consider all relevant factors and are applicable universally.

The recent summers in Germany - heat waves and their impact on human health

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Recently, Germany has experienced a series of hot summers after the record breaking summer of 2003.
As a consequence of the severe health impacts of the summer 2003, Germany has implemented a heat heath warning system with the aim to inform the health sector and the public about upcoming heat waves.
In this talk a review of the recent heat waves in terms of their meteorological and biometeorological conditions, their health impact and a comparison to the summer 2003 is presented.

A Masterplan for the Implementation of Heat Health Action Plans in Germany

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On the basis of the WHO heat health guidance document (2008) the “Recommendations for Action: Heat Action Plans to protect human health’” (https://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/hap_handlungsempfehlungen_en_bf.pdf) had been developed by a joint Federal/Länder Working Group on Adaptation to the Impacts of Climate Change in the Health Sector, which was published by the Ministry for the Environment (BMU) in 2017. It serves as a master plan to ensure better protection of public health in Germany during long periods of extreme high summertime temperatures. As contribution to the National Adaptation Strategy to Climate Change for the health sector, this compilation aims to implement adaptation measures and prevent health consequences associated with extreme heat at the regional and local level.

Its goal is to decrease morbidity and mortality connected with heat waves through issuing heat and health warnings, to encourage planning in the relevant sectors, to mainstream health in all policies, and to raise the public and health sector workers’ awareness, as well as to mobilize the resources for managing the heat effects. Since its publication and promotion at the federal, regional and local level in 2017/2018, currently first heat health actions plans are under preparation for the implementation.

The health care system in Germany has an important role in establishing adaptation, health prevention and response measures to address the health risks related to climate change such as:
- Strengthening existing public health capacities for early detection and adequate response
- Anticipating the consequences of emerging diseases possibly related to climate change
- Raising awareness among the population about the possible links between climate change and health.

Climate services for future bioclimatic assessment in Portugal

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Climate services and urban climate maps are essential tools to cope with local climate change. The use of climate projections by local authorities can be challenging, because grid data format is difficult to interpret in territories with complex landscapes and topography. Besides that, scenarios and future projection models have a limitation in spatial resolution and, does not properly reproduce the variability and topoclimates diversity of a territory.

The creation of a local climate assessment system through cartography for urban planning was first proposed by Knoch (Uber das Wesen einer Landesklima-aufnahme) in the 1950s (Ren et al. 2010). This methodology was developed later (in the 1970s) in regions where the atmosphere was heavily polluted by the metallurgical industry, particularly in the Rhine and Ruhr (Ruhrgebiet) valleys. In Portugal, this methodology was adopted and implemented in the municipalities of Lisbon and Cascais at the beginning of this century (Alcoforado et al. 2005; Alcoforado et al. 2009; CMC 2014). More recently, the proposed method was applied in 9 municipalities and metropolitan areas in Portugal, in the frame of the adap.local network (www.adapt-local.pt/.

Homogeneous Climate Response Units - HCRU are local areas that interact with the boundary layer and are defined and delimited according to climatic factors (i.e. altitude, aspect, urban geometry and land cover) and functions (sea breezes, regional winds, and others) and not only defined by the spatial variation of climatic elements (i.e. temperature, humidity, solar radiation, etc).

In the urban scale, LCZ (Local Climate Zones – WUDAPT project) can provide even more detailed information that can be very useful to relate urban densities and extreme thermal patterns like heat waves that can affect human thermal comfort and even mortality patterns.

Within this research, HCRU, complemented with LCZ methodology was used as local landscape features to extract data from regional circulation models (EUROCORDEX) for three periods (the last 40 years; 2041-2017 and; 2071-2100) in two RCP scenarios (4.5 and 8.5).

By expressing recent trends and future climate projections into territorial units that are easily understandable by local authorities, we have effectively translated climate information into the territorial planning sector. Furthermore our results were presented in several technical workshops with municipalities and local stakeholders in order to integrate climate information into local climate change adaptation plans in Portugal.

Pollen information services for general public

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Pollen measurement and provision of pollen information including the forecast of pollen burden in the air is a well established routine in Slovenia. The measurements and forecast compilation are performed by the National Laboratory of Health, Environment and Food. Slovenian Environment Agency is assisting with weather data and is instrumental in conveying the information to the general public on the daily, monthly and annual time frame. Also information about the pollutants in the air that can cause illness of respiratory system and worsens perceived allergic symptoms is based on the network of measurement stations operated by Slovenian Environment Agency.

Being aware that timely information can help allergy sufferers, both organizations recently joined the EUMETNET AutoPollen Programme. Technological developments offer the possibility of providing automatic real-time pollen observations that could reshape the availability of information and vastly improve the treatment and lives of allergy sufferers, as well as the forecasts provided.

Our main goal is to provide pollen information in the fastest and most accurate and ready to use way to end-users. Interaction with stakeholders, collaboration and communication helps to increase visibility of the activity. Active involvement of users/stakeholders will help to develop the most effective way of products presentation and to ensure that they will be tailored to the needs of users. A general standard which defined threshold levels for different pollen types is not available. The connection with users will give regionally dependent pollen load values that might trigger allergic response.

The EUMETNET Autopollen Programme is bringing together very different communities: from National hydrometeorological services to public health authorities, numerical modellers, developers and producers of measuring equipment, academia and medical practitioners, but also general interested public and media. We hope that taking part in the programme will help us to improve our services to the large spectrum of end-users in our country.

Combined ground-level ozone and temperature events relevant for human health

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Ground-level ozone concentrations and air temperature are jointly analysed, due to the relationships between air temperature and ozone formation, single and combined effects of these variables on human health and their large anticipated changes in the scope of climate change. The European area builds the regional focus.
Ground-level ozone is a secondary air substance, which is primarily built by photochemical reactions under solar radiation with the involvement of precursor gases including nitrogen oxides, carbon monoxide, methane, and non-methane volatile organic compounds. It has to be distinguished from stratospheric ozone, which acts to protect against harmful UV radiation.
Temperature extremes like heat waves as well as high ground-level ozone concentrations can have negative impacts on human health. They range from temporary events, like heat exhaustion and ozone-related irritations of the eyes and air passages, to major adverse health effects within the scope of cardiovascular and respiratory diseases as well as to increased mortality.
Anthropogenic-induced global climate change involves the rise of mean temperature, but it is also associated with an increase of temperature extremes and with changes of ground-level ozone concentrations, via changes of the synoptic circulation and the chemical environment.
The current contribution addresses relationships between air temperature and ground-level ozone, taking into account different settings of air substances concentrations (inner-city, outer conurbation area, rural regions). Meteorological mechanisms for the occurrence of combined ozone-temperature events are analysed and regional to local projections of combined temperature-ozone events under the constraints of ongoing climate change until the end of the 21st century are shown. Moreover, a special focus is given to the discussion of current thresholds related to human health.
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Session A: Health, Location: Haus zur Lieben Hand

Detailed analysis of extreme heat waves in Serbia

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The detailed analysis of extreme heat wave events in Serbia from the biometeorological point of view is presented in this study. For this purpose, newly developed Heat Wave Magnitude Index daily (HWMId), was used on Physiologically equivalent temperature (PET) for Serbia. A series of daily maximum air temperature, relative humidity, wind, and cloud cover was used to calculate PET for the investigated period 1975–2018. HWMId is defined as the maximum magnitude of the heatwaves in a year. Here, the heat wave is characterized as 3 consecutive days with maximum PET above the daily threshold for the reference period 1981–2010. The analysis revealed that during the investigated period the most intensive heat waves occurred in 2007, 2012 and 2015. HWMId values for 2007 were in the range of 8 to 23 indicating extreme heat stress, while for the other two events the values were not as high. Hourly temperatures revealed that the PET values during the day were as high as 55°C. Thus, the mitigation and adaptation to extreme temperature events is of vital importance for humans and their everyday activities. Future investigation should be oriented towards a way to deal with the oppressive heat. Additionally, more research is needed in order to explain and predict these catastrophic events. Main focus of the future activities will be on determining the physical causes which lead to occurrence of extreme heat waves.
Key words: Heat Wave Magnitude Index daily, Physiologically equivalent temperature, Serbia, heat waves.

Assessment of impacts of extreme heat on global health using human thermoregulation models and indices

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Climate change has been identified as the biggest global health threat of the twenty-first century. This leads to multiple direct and indirect health risks through changing patterns of extreme weather events, population distribution, and supply of food and water. Compared to other extreme weather events, extreme heat events caused the biggest increase in associated deaths during the last decades and are very likely to increase in frequency, intensity, and duration in the future. The human thermoregulatory system can, within limits, compensate changing environmental conditions, but these limits vary depending on individual characteristics and impairments.
Here we give an overview on the human thermoregulatory system and discuss potentials and limitations of different scientific assessment approaches. These comprise thermoregulation models such as the "Klima-Michel" and the Universal Thermal Climate Index which quantitatively assess impacts of environmental factors on health. However, they are limited to an average individual's response disregarding particularly vulnerable groups and possible memory effects related to the duration, frequency, and variability of extreme heat. The combination of future projections of climate change with currently established thresholds for deadly heat conditions indicates alarming scenarios especially for these vulnerable groups. Based on extended but preliminary research, exact deadly thresholds of extreme heat events' duration as well as the impacts of temperature variability are at present not adequately covered by the models and thus warrant further investigation.

Evaluation of the ERA5-based UTCI on mortality data in Europe

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Various thermal comfort indices based on the heat exchange between the human body and its thermal environment have been developed to improve the assessment of heat stress and its impacts on human health. However, their use in biometeorological and epidemiological studies has been limited due to the lack of proper station data. ERA5 is a novel climate reanalysis product from the ECMWF (European Centre for Medium-Range Weather Forecasts). It provides estimates of surface and atmospheric parameters at much higher resolution (31 x 31 km) than any previous climate reanalyses. From ERA5 parameters the Universal Thermal Climate Index (UTCI) can be computed as a gridded parameter at the ERA5 resolution for the whole European continent. Using daily mortality data from European members of the MCC Collaborative Research Network, we explored the potential of the ERA5-based UTCI as a health-related tool by evaluating UTCI-mortality relationships in 20 cities across 10 European countries. Distributed Lag Nonlinear Models (DLNM) were used to analyse exposure-response relationships between mortality and UTCI in selected cities calculated from (i) the ERA5 reanalysis and (ii) station-based data. Meta-analysis was used to pool the results for each city to bigger groups according to climate zones. The results suggest that ERA5-based UTCI is a comparable predictor of heat-related mortality to station-based data, and the ERA-5 reanalysis could be a useful tool for the development of a pan-European health-hazard warning system that would be able to assess thermal conditions in locations where high-quality station data are not available.

Residents' Perceptions and Attitudes Towards Winter in Cold Climate City Erzurum, Turkey

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In winter cities, cold weather has increasingly forced residents to live under certain conditions in limited ways. In those cities, people are experiencing stressful climatic conditions in each day such as snow, ice, wind and darkness. Residents have to struggle with cold stress and urban planners and policy makers have try to increase outdoor thermal comfort. Those conditions of winter and their lenght cannot be changed, but changing people's adaptation to winter can reduce the extension of winter in their mind. In this process, it is required to understand residents' adaptation to winter for implementing sustainable winter communities and creating climate sensitive places which provide residents' adaptation to winter cities resolving their stressful climatic conditions. Thermal sensation of users has to be understood and explored in outdoor environments for those types of cities especially in Turkey due to the lack of research on this topic. In this context, the focus of this research is defined as the perceptions and attitudes of people towards winter in the case of Erzurum. In order to implement sustainable winter city and community strategies, understanding residents' perceptions, attitudes and adaptation to winter is critical need.

In this framework, the main objective of this paper is defined as to explore perceptions and attitudes of residents towards winter in the city of Erzurum. This study is made through questionnaire study with residents in different age groups. Thus this study will test the assumption indicating that the negativity of the perception of residents' to cold climate conditions increase as they get older. Erzurum is selected as a case study area due to its harsh climate conditions. It is the city located at 1800-meter altitude in the north east part of Turkey and has a mean annual temperature of 5,6 0C. However, its urbanization process and social and economic issues are not consistent with the winter city characteristics. This study mainly questions whether the attitudes and perceptions of residents in Erzurum are focused on the positive aspects of winter. It also questions the changing pattern of attitudes in different age groups and try to demonstrate the relationship between the perceptions and attitudes of residents to winter and adaptation capability of city's physical and economic issues. Attitudes of residents are the main points of analysis contributing the sustainability and livability. The findings show that attitudes and perceptions of residents are in the tendency of enduring and tolerating winter which is related with insensitivity of urban physical environment to climate conditions (affected by variables such as the distance between buildings, street orientation, sky view factor, etc). For sustainable development and being resilient against the global warming, adaptation to winter or cultivation of positive attitude towards winter should be integrated into the existing education and urban policies. Also, climate sensitive urban design strategies must be developed in those types of cities. Consequently, it can be said for Erzurum through attitudes and perceptions of residents that it is not a winter city yet but the change is seeming possible with the use of creative solutions.

Keywords: Winter, Perceptions, Attitudes, Spatial Structure, Erzurum

Impact of biometeorological and aerosanitary conditions on influenza-like ilnesses incidence in Warsaw

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Incidence of influenza-like illness (ILI) rises during the cold season in temperate climatic zone. Accumulating evidence demonstrates that there is strong relationship between weather factors and influenza seasonality. In some epidemiological studies occurred also suggestions, that exposure to air pollutants may increase the morbidity due to influenza virus. Accordingly, we examined the association between particular meteorological factors, biothermal conditions defined by Universal Thermal Climate Index (UTCI), air pollutants of particular matters < 10 µm (PM10) and influenza occurrences in Warsaw, Poland, between 2013 and 2018. We found that nearly all weather parameters, especially mean air temperature (t) and vapour pressure (e), correlate at least moderately with ILI occurrence. Although, due to regression model, mean UTCI values and PM10 mean concentrations best explain influenza seasonality. The above relationship can be observed across all age groups (< 5, 5–14, 15–64, and > 64 years).

Vulnerability to heat-related mortality during the summer of 2015: evidence for an urban population in Central European city (Novi Sad, Serbia)

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Hot summers with several intensive heat waves (e.g. summer of 2015) lead to strong heat-related mortality in Central and Southeast European cities. Therefore, the aim of the study was to evaluate association between maximum temaprature and mortality, during the summer 2015 in urban population of Novi Sad and to contribute to the future long-term assessment of heat-related mortality in cities. Novi Sad (with 380,000 inhabitants in 2015, according to the population register) is the second largest city in Serbia and it is located in the northern part of the country. In this research was covered urban area of city with approximately 300,000 inhabitants.
In analysis were used the daily number of deaths of all causes and cause-specific mortality, as well as hourly air temperature data from the Novi Sad urban network (NSUNET) system, covering 25 measurement stations. As a measure for heat waves was used Kysely methods, while different statistical methods were applied to detect the association between the maximum temperature and the mortality. Summer 2015 was recognized as one of the hottest in th past several decades with the maximum temperatures reached almost 38 ºC during the heat wave days. Furthermore, in July and August, 45% of days had a maximum temperature above 30 ºC, and more than 70% of days had a maximum temperature above 25 ºC. Four heat waves were detected using the Kysely methods. Three heat wave periods lasted longer than ten days. The average number of deaths was higher during the heat wave days. Significant association was found between Tmax and all-cause, cardiorespiratory, non-cardiorespiratory in total population, all-cause and cardiorespiratory mortality in the age group 65 and over. No association was found between temperature and non-cardiorespiratory mortality in the old population.

Key words: Mortality; Heat Vulnerability; Heat Waves; Urban; Serbia

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Relationship between weather and the occurrence of respiratory and ischemic heart diseases in Germany

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Daily weather affects human health in several ways and not only concerning climate change. In a previous study it was shown for Germany, that the occurrence of ischemic heart diseases is strongly linked with the thermal environment. In particular, the mortality due to ischemic heart diseases increases with higher temperatures and during heat waves. For the morbidity, however, no significant relationship to the thermal environment could be found. Besides ischemic heart diseases, respiratory diseases like asthma, bronchitis, and chronic obstructive pulmonary disease (COPD) are globally immense heath factors. In this study, we focus on the occurrence of respiratory diseases in Germany and possible effects of daily weather, climate, and climate change.
A retrospective analysis studying the relationship between weather and the occurrence of chronic lower respiratory (J40-J47) and ischemic heart (I20-I25) diseases was assessed. For this, daily or two-daily mortality and morbidity (hospitalization) data on a county level of Germany for the period 2001-2015 were used in combination with meteorological observations from the German Meteorological Service (DWD) network. To control the data of long-term trends, seasonal variations and the weekly cycle of the hospitalization data, a population-based rate and a Gaussian low-pass filter were applied. With this, an Expected value and Relative Risk (RR) was derived. RR is independent of seasonal variations and the weekly cycle and used for evaluation.
Mortality due to chronic lower respiratory diseases increases with higher temperature above approx..17 °C and during heat waves. Ischemic heart mortality increases also with heat, however the increase occurs less steep than respiratory mortality. Hospitalizations due to respiratory diseases rise during hot days too, with the exception of asthma diagnosis, which shows no relationship with heat. An effect of cold days are only minor and partly not significant. The heat waves of the summers 2003 and 2015 show, that mortality is more affected than morbidity and women more than men. The longer the heat wave last the higher the excess mortality and morbidity.

In the next project part, the change of specific parameters and weather patterns in the context of climate change is assessed using regional climate model simulations from the CORDEX project. Two different RCP scenarios (4.5 and 8.5) are selected to display the possible range of future effects. This will allow us to estimate potential changes in the occurrence of respiratory and ischemic heart diseases due to climatic changes for different periods in the future.

Saharan dust intrusions over southern Portugal: overall characterization and atmospheric synoptic patterns (2005-2015)

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Saharan dust intrusions are a phenomenon responsible for several environmental impacts over the Mediterranean regions. Regarding the Iberian Peninsula, very scarce studies have addressed this topic in Portugal contrasting to the extensive literature produced by Spanish researchers (e.g. Díaz et la, 2017; Salvador et al, 2014; Alonso Pérez et al, 2011; Escudero et al, 2005). Among the most relevant impacts associated with north African dust intrusions are its adverse effects on human health and mortality (Kotsyfakis et al, 2019). The present study pretends to be a contribution to improve the current knowledge on dust intrusions over Southern Portugal (Central Alentejo region) focusing on two main issues: firstly, the characterization of the incidence of Saharan dust intrusions over the period 2005-2015, by analyzing its interannual, seasonal and monthly distribution; secondly, this study aims to analyse the synoptic meteorological conditions that favour these intrusions.

The identification of Saharan dust intrusions in Portugal was based on a validation of the events inventoried the Portuguese Environment Agency (APA) and available within annual reports ("Identificação e avaliação da ocorrência de eventos naturais em Portugal"1). The events listed in these reports were cross-checked with three different criteria, allowing a selection of episodes with undoubtful occurrence over Southern Portugal: dust plumes detection in Terra-Aqua satellites images (MODIS sensor); simulations of airmass backward trajectories (5-day) using the HYSPLIT model; air quality observations at surface (particulate matter, PM10 and PM2.5 concentrations). After this cross-check procedures, a total of 246 validated dust events were identified. It was found a remarkable interannual variability of dust intrusions, being 2011 the year with highest frequency of events (49). The seasonal distributions revealed a clear predominance of dust intrusions occurring during the hot semester, particularly from July to August. However, the frequency (%) of bad air quality days, due to exceedances of the PM´s legal limits (2008/50/EC directive), was higher for the winter period episodes compared to summer dust intrusions.

The atmospheric synoptic circulation that promotes the Saharan dust transport to the southern Portugal regions was analyzed through an automated classification, based on the scheme developed by Jones et al (1993). The adopted method only requires the use of mean sea level pressure data and permit to determine the vorticity and direction of the geostrophic airflow, and modern ERA 5 reanalysis data was used for this purpose. This classification allowed to identify the diversity of circulation weather types (CWTs) associated with the pre-inventoried dust events. Differences between the prevailing CWTs of winter events and summer episodes were noticeable, demonstrating the influence of large-scale atmospheric circulation to the dynamics of dust intrusions.

Session B: Bioclimate in Urban Environments, Location: KG III, 3042

Seasonal microclimatic and thermal comfort conditions in various built-up and green areas of Ghent (Belgium)

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This study is the first comprehensive analysis of microclimatic and outdoor human thermal comfort (OHTC) conditions in various built-up and green areas of Ghent (Belgium). We used 1-year meteorological observations from six weather stations that represent the urban climate network in and around the city of Ghent. The stations are located in various urban environments (e.g. port, urban park, downtown, suburbs) and their local climate signals can be compared with the surrounding countryside (urban-rural comparisons) and with each other (intra-urban comparisons). Daytime and nighttime variations of air temperature (Ta), relative humidity (RH), wind speed (v), mean radiant temperature (Tmrt) and Physiologically Equivalent Temperature (PET) were accessed on seasonal and annual level, supplemented with the case studies from two summer heat wave periods.

The seasonal analysis revealed that the cold stress is more apparent in Ghent. However, citizens are better protected against cold stress since the society is adapted to this feature. This is less the case for heat stress, so measures should be taken to reduce the prevailing heat stress that will occur more frequently in the future. Furthermore, this study shows that the dangerous strong heat stress is prevailing during the daytime periods of both heat waves at all locations and the heat stress is stronger when the heat wave is more intense. During the night, slight cold stress is even still present. The urban park location creates the most comfortable area in city, so this result should be taken into account in urban planning and design in order to keep Belgian cities livable.

Acknowledgment: This research is supported with the project grant from the Research Foundation - Flanders (FWO): A network to networks to progress urban climate science, 2019-2023.

Analysing Outdoor Thermal Comfort with Proximity to Water Bodiesin Tropical Humid Climate- Case Study of Kolkata, India

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The study intends to showcase the impact of the change inurban microclimate parametersand its thermal comfort due to its proximity to water bodies. The thermal sensation and perception of outdoor thermal comfort is represented through Physiological Equivalent Temperature (PET). Readings from Globe Thermometer in combination with air temperature, wind speed and global radiation sensorsare used to calculate the Mean Radiant Temperature, an important parameter in calculation of PET . In this study, the primary data has been used to calculate the PET values of thermal comfort by using the ENVI-Metsoftware. A Questionnaire surveywas used for the study of thermal perception, thermal sensation, thermal acceptability and thermal tolerance in different case study areas. Plan Area Fraction (Oke,2017) was used to analyse the landcover of selected station at neighbourhood scale. It also helped in understanding the surface features responsible in contributing to Thermal Load (heat storage in urban areas) and Dynamic Potential (wind circulation). The two stations taken into consideration show different landcover with station 1 having higher share in built surface but also having proximity to water body. Station 2 has close proximity to water body with a lesser share in built and impermeable surface. While station 2 show comfort conditions throughout the day and the pedestrian are satisfied, station 1 shows comfort conditions only in the evening. Station 1 is a small but busy road junction characterised by large number of vehicles, pedestrians and surrounding buildings. The daytime conditions in Station 1 are hot and humid in warm season providing little relief in respect to outdoor thermal comfort. However, the evening conditions in Station 1 is very comfortable due to the incoming breeze from the Lake area. In this study, the authors have tried to draw comparison of the outdoor thermal conditions of the two stations with help of simulation results from ENVI-MET, along with questionnaire survey. Thefindings from the study highlights various outdoor thermal comfort scenarios with respect to proximity to waterbodies in Tropical humid climates.

Keywords
Outdoor Thermal Comfort, PET, Thermal Load, Dynamic Potential, Thermal Perception,Plan Area Fraction,Local Climate Zones

Modeling the urban geometry influence on outdoor thermal comfort in the case of semi aride microclimate

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Urban microclimatic conditions affect the human body energy balance and thermal comfort which in turn influences their usage of outdoor spaces. Thermal indoor conditions and the energy use of buildings depend also on the thermal outdoor conditions.
It is therefore important that a great interest should be paid to them in the urban design.
This study aims to define various configurations of urban open spaces by analysing the influence of geometrical parameters on outdoor comfort levels. To achieve it, open spaces are simulated for typical hot and cold days in the semi-arid climate of Ali Mendjeli, Algeria. The sun exposure is estimated using TownScope 3.1, and assorted models are evaluated according to the geometrical indicators aspect ratio (H/W), sky view factor (SVF) and orientation . ENVI-met 3.1 is used to simulate such factors as the outdoor air temperature, mean radiant temperature (Tmrt), wind speed and relative humidity, while RayMan pro 3.1 is used for converting these data into physiological equivalent temperatures (PET) and mPET.
The results show that duration of direct sunlight, mean radiant temperature and wind speed are influenced by the urban form and play an important role in attaining optimal thermal comfort levels.

Keywords: urban geometry; public place; sun exposure; thermal comfort; envi-met, PET, mPET.

Influence of Thermal Comfort provided by Tree Shadows on sidewalks in Downtown São Paulo

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Environmental quality of sidewalks influenced physical activity practices in public areas to prevent diseases related of sedentary lifestyle. Tree and its air thermoregulation capacity can modify microclimate conditions that affect people's daily behaviour. To promote the thermal comfort on streets, it is necessary to design urban areas with trees and cool materials can mitigate effects of heat islands. This work aims to evaluate the influence of thermal comfort in different urban landscapes on pedestrian walkability. Methodology: a) selection of route based on a transect that crosses different types of urban landscape: a park (dense green area) and streets with or not tree planted; b) collection of climate data (air temperature and humidity) and surface temperature by thermal pictures during 13 day in 2019 summer; c) quantification of thermal comfort in terms of Air Temperature; Physiological Equivalent Temperature (PET) and Universal Thermal Comfort Index (UTCI); d) statistical analysis of measured data and mapping of climate variables. Results show air temperature differences between shaded and sun area is until 3,1 ° C and 8,5 ° C, in terms of PET. It was observed that the features of shade od trees and planting strategies can also influence in results. In streets, clusters of trees planted in line can promoted more thermal comfort than other analyzed areas (on park and streets without trees). People preferred walking on shady places, whether shadow promoted by trees or awnings and pergolas. There is a higher frequency of people on streets that are wooded by species that filter out solar radiation and permits the wind permeability.

Latitude-dependent analysis of microclimatic conditions in ideal urban canyons

Kerstin Reusch and Andreas Matzarakis
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Heat stress in cities is an increasing burden and danger to urban dwellers in the face of urbanization and climate change. Many studies on thermal stress in differently configured street canyons are available for individual cities. A latitudinal-dependent comparison of microclimate in urban canyons has not been used and further developed since Arnfield (1990). The aim of the present study is to show latitudinal dependence of annual sunshine duration and global radiation, as essential components of the microclimate, within differently configured street canyons. For this purpose, microclimatic simulations were performed with RayMan for 0° to 65° N in 5° steps. The canyons are configured using urban aspect ratio (height/width) (0.25, 0.5, 1, 2, 3, 4) and orientation (N-S, NE-SW, E-W, NW-SE). Knowledge of the global distribution of radiation fluxes and the urban influence on radiation flux densities is fundamental to this study.
The analysis of the simulation data deals with annual data of the parameters and their course of the year. In general, a decrease in the values can be observed poleward as well as with an increasing aspect ratio. E-W street canyons clearly differ from the N-S streets both in their latitudinal behaviour and in the course of the year. In numerous latitudinal ranges the E-W orientation is associated with a high solar access and uncomfortable thermal conditions. The outer tropics and subtropics are particularly affected with high radiation influence during summer and low values during winter which contradict the local requirement for thermal comfort. In contrast, N-S street canyons are characterized by uni-formity in latitudinal behaviour and variation during the year.
With the help of a regression analysis, an algorithm was developed that allows calculation of sunshine duration and global radiation in the centre of a street canyon based on their orientation, aspect ratio and latitude.

Detailed investigation of microclimate by means of computational fluid dynamics (CFD) in a tropical urban environment

Omer Muhammad Mughal, Aytac Kubilay, Paolo Burlando, Simone Fatichi, Naika Meili and Jan Carmeliet
Singapore ETH Center

In light of globally increasing temperatures and urban heat island effects, urban planners and designers are looking for innovative and quantitative methods to effectively assess urban design performance in terms of services they provide to urban dwellers. Among those services, improved microclimate conditions and associated impacts on human thermal comfort are very valuable. An urban scene of the tropical city of Singapore is numerically investigated in this study with a fully-integrated urban microclimate model implemented in OpenFOAM. Transport in air and storage effect in urban environment are coupled so that the steady-state Reynolds-averaged Navier-Stokes (RANS) is solved iteratively with the unsteady heat and moisture transfer in urban surfaces. Vegetation is modeled as a porous medium for flow of moist air and a leaf energy balance model is used to determine the heat fluxes and evapotranspiration at leaf surfaces. Results in terms of air temperature, air humidity, and wind speed are analyzed for a number of configurations where tree height, number of tree rows and evapotranspiration capacity of trees is modified. Finally, simulation results are compared with an Urban Ecohydrological model that cannot solve all the spatial details of the OpenFOAM simulation but allows exploring longer periods and a larger number of scenarios. A good agreement is observed in the air and surface temperatures between the two models.

Cool spots as strategy for urban heat

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Most cities aim for climate resilient (re)development. For water management the regulations are already formulated in governance. However, formulations of regulation for urban heat remain rather vague. With a formulation such as “more green to mitigate urban heat” the aim is not quantified. In order to set a measurable strategy for urban heat a research is started to study cool spots.
The hypothesis is: an urban area is livable during hot weather extremes when every house has a cool spot within 300 meters. In the summer of 2019 measurements and questionnaires are done in several cool spots in one neighbourhood in Amsetrdam. Based on these measurements and questionnaires we can make a definition of a cool spot that provides enough cooling and is attractive for people to visit. In addition the necessary distance to a cool spot is redefined.

Bioclimate, Urban heat Island and Urban development

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The most pronounced effect of urbanization on the climate is observed in the formation of a stable positive temperature anomaly that is known as "urban heat Island" (UHI). Its intensity depends on the size and density of the buildings, their heat content, population, natural climatic conditions, etc. The main microclimatic parameters affecting the bioclimate of the urban environment include the intensity of solar radiation and thermal radiation of buildings and area around (radiation balance); temperature and humidity, wind direction and speed. To improve the microclimatic characteristics of urban space it is necessary to clarify the impact of urban geometry, green and water spaces, surface properties of buildings and roads, etc.
Human thermal sensation can vary significantly depending on the temperature of the surrounding surfaces, which is largely dependent on different orientation and exposure to sunlight, as well as differences in their thermal properties, such as absorbing and reflecting ability. In order to reduce the effect of the urban heat island and optimize the radiation balance, five different strategies for environmental adaptation using modern technologies are proposed. 1. The urban architectural complex with the geometry of urban canyons, which can be used at the stage of urban planning. 2. Vegetation, mainly configuration of trees. 3. The location of the water bodies. 4. Modification of surfaces (roads, pavements, walls and roofs). 5. Application of shelters to protect against direct solar radiation. Control and improvement of bioclimatic outdoor conditions using geometry of urban canyons, quality of covering materials, vegetation and water bodies, can play an important role in indoor thermal environment, reducing energy consumption. To assess the impact of UHI on human body, general bioclimatic indices as a combination of climatic parameters are applied, adapted to the conditions of open urban spaces; most commonly used are Physiologically equivalent temperature and Universal thermal climate index.

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Session C: New methods and tools in Human Biometeorology, Location: Haus zur Lieben Hand

R language, a powerful tool for biometeorological research

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Biometeorology is a field of science that combines information from the biosphere and the Earth's atmosphere to investigate the interaction between these parts of the environment. Since we are rooted in the era of big data, the biometeorological community has new opportunities and abilities to study extensive networks of relationships between organisms and the atmosphere. So, the vast amount of data needs new tools and methodologies to wrangle, analyse, model, illustrate and finally to communicate the findings to a broad public. R- language is a potent tool that combines all the above functions from the data acquisition to the presentation of the analysis' results and it is suitable for scientists without a programming background.
The power of R is the vibrant and active community that has already produced almost 15.000 packages (thematic libraries) for all science branches, when at the same time, the nature of this language promotes open and reproducible science. This work will briefly present the R ecosystem and justify why this language could be a general-purpose tool for research and findings' dissemination.

Evaluation and application of a low-cost measurement approach for urban air temperatures during record-dry summer 2018

Moritz Gubler, Andreas Christen, Jan Remund and Stefan Brönnimann
University of Bern

The understanding of fine-scale temperature variability within the urban canopy layer is crucial for cities' adaptation to heat-related impacts of present and future anthropogenic climate change. Depending on extensive measurement networks, high-resolution air temperature measurements in urban environments are challenging due to high instrumentation and maintenance costs. Here, we present a low-cost measurement device (LCS) consisting of a simple temperature logger and a custom made, naturally ventilated radiation shield. Besides inter-comparisons with automated weather stations (AWS) at three reference sites during record-dry summer 2018, we tested its potential for the analysis of urban heat island (UHI) patterns throughout an intense heat wave based on a network of 81 sensors distributed across the city of Bern, Switzerland. We found positive mean measurement biases between LCS and AWS of 0.61 to 0.93 °C (RMSE: 0.78 to 1.17 °C) during daytime, of which up to 82.8% could be explained by radiative heating by solar radiation and insufficient ventilation by prevailing winds. During night, average measurement biases were markedly lower and eventually negative with -0.12 to 0.23 °C (RMSE: 0.19 to 0.34 °C). Our results further highlight the importance of sensor inter-comparisons being conducted at multiple locations with differing urban metabolism given that biases differed considerably between the reference sites. Data retrieved by the city-wide measurement network showed that the LCS approach is well suited for the analysis of spatiotemporal UHI-patterns with maximum UHI intensities of up to 5.6 °C. In conclusion, the here presented LCS measurement approach represents a valuable option for cost-effective analyses of urban air temperature variability across multiple scales, which may be of particular value for the development, appliance, and monitoring of adaptation strategies to climate change in cities with restricted financial resources.

Discrepancies of the radiation component between different thermal comfort models – implications and solutions

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One of the most important component when estimating thermal comfort in outdoor environments is the total radiation received by the human body. The radiation is usually divided into two main wavelengths, longwave (~4–100 µm) and shortwave (~0.3–4 µm). The shortwave part is strongly anisotropic, especially the direct part originating from the Sun beam as well as the diffuse part originating from all other parts on the sky-vault. In addition, reflected shortwave radiation is an important component in urban environments. Furthermore, the longwave radiation is also anisotropic as different surfaces surrounding the human body emits and reflects different amounts of radiation based on brightness temperature and emissivity. When observing or modelling these radiation fluxes and they need to be adjusted for the shape of a standing human.
The various observation techniques and modelling approaches available produce very large discrepancies of the radiation component resulting in large differences in thermal comfort between the various method approaches available. This paper explores these differences mainly focusing on observation techniques and discuss the implications and possible solutions to solve these differences that still exist up to this day.

On the modification of the local microclimate by clusters of trees

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Urban trees are one of the key factors that determine energy, mass, and momentum exchanges in local microclimates; yet, systematic research is sparse, especially at the micro-γ scale (~10 m). Here we examine the radiometric (spectral reflectance and transmittance, surface temperature) and microclimatic (convective energy fluxes, air temperature and relative humidity) characteristics above and below the canopy of clusters of trees in urban and non-urban, controlled microenvironments within the micro γ-scale.
In two experimental campaigns during the summers of 2018 and 2019, canopy scale spectral radiative and thermal characteristics of clusters of containerized trees (Acer platanoides), were probed with a prototype experimental approach which involved sensors being mounted on a 7.3m portable crane; net radiation and convective energy fluxes were measured above the tree canopy, and air temperature and relative humidity were measured within the tree canopy. The dependence of the radiative and microclimatic characteristics on the arrangement of the tree clusters, and characteristics of the underlying surface and general characteristics of the local microenvironments is examined.
First results show that the greatest differences in within-canopy microclimatic conditions between two adjacent local microenvironments with distinct (enclosed paved versus grassed open) characteristics, were detected between sunrise and midday. Accordingly, results indicate that convective fluxes differ between the two adjacent local microenvironments during the morning, even though the flux source area extends to several tens of meters away from the masts and therefore more research would be needed. For moderate canopy coverage (a fusion of ~65% tree canopy and 35% underlying surface), the reflectance distributions are affected by the characteristics of the underlying surface only in the near infrared band of the spectrum. For higher coverage of the canopy (a fusion of ~80% tree canopy and 20% underlying surface) changes in the underlying surface did not affect spectral reflectance patterns.

Innovative methodology for the monitoring of urban environments' risks to health

Izhak Schnell
Tel Aviv University

The problem
Common studies measure environmental conditions in few static stations and calculation of distributions based on distance from main sources. Such studies are inaccurate and under estimations of real levels of environmental risk factors.
goals
To suggest a novel methodology based on direct measurements, on the subjects bodies, while they perform their daily life and to generalize exposures and responses for selected types of environments and people in the city.
Methods
We attach portable devices to subjects' bodies to measure noise, thermal load, air pollution and environments as independent variables and heart rate variability as a dependent variable. They visit eight types of environments for half an hour each and we calculate their direct exposures as well as their HRV. We analyze the results by mixed models
Results
We present 4 studies: 1. we tested 36 young healthy subjects for 48 hour each around the city from highly crowded and stressful areas to parks. Noise and social loads were the dominant causes for risk to health.
2. We confirmed the restorative power of parks and the high risk to health posed by crowded and noisy environments like open markets. We identified 8 types of environments that significantly differ from each other in the risk they pose to human health.
3. We showed that subjects from different ethnicities (72 Muslim and Jewish women) differ in their modes of coping with environmental risk factors in town centers, residential areas and parks. However, the restorative power of parks was found affective for both ethnicities.
4. We suggest a quantitative model of measuring quality of urban environments based on exposure to noise, thermal load and air pollution.

GrüneLunge-Project - Potential of the urban green infrastructure to reduce heat stress

Marcel Gangwisch and Andreas Matzarakis
Deutscher Wetterdienst/ZMMF

Urban areas are affected by the Urban Heat Island effect (UHI), resulting in increased thermal heat strain compared to rural areas. This threat gets even more severe due to global climate change. Therefore, we need to assess human thermal and olfactorial comfort and risk in urban areas for adequate decision making. This is important for planers (mitigation and adaptation of the impacts of global climate change), health sector (warnings and information in advance for young, old, weak, fragile people), tourism, urban architects (style and aesthetic), building architects (insulation, demand of energy), energy sector (yield of energy). Human thermal comfort is accessible by thermal indizes (e.g. Physiologically Equivalent Temperature (PET), Perceived Temperature (PT) and Universal Thermal Climate Index (UTCI)), which require the fundamental input of meteorological parameters (air temperature (Ta), vapor pressure (V P), wind velocity (v), wind direction (WD), global radiation (G)). The urban green infrastructure (UGI) modify these local meteorological parameters and therefore human thermal comfort on the microscale. But the influence of UGI on the atmosphere is not fully understood. Especially, the knowledge about the influence of different tree species (different leaf types, transpiration and photosynthesis rates) and the impact of different arrangements in clusters of trees (mixed species parks vs. mono species parks) is limited. In order to improve the understanding about the effect of UGI, simulations based on computational fluid dynamics (CFD) are conducted and mobile measurements are performed during autochthonal weather conditions in Karlsruhe and Rheinstetten in Germany. The CFD simulations are conducted with the urban microscale model SkyHelios based on the discrete threedimensional lattice Boltzmann method (D3Q15), to assess the thermal, spatial effects of UGI. It is linked to a radiation and tree biophysiological module to depict the fundamental processes of UGI (transpiration and photosynthesis). The measurements are linked to stationary data (stations by DWD, KIT and LUBW), remote sensing data (Copernicus, Landsat, Sentinel), local geodata (by municipality of Karlsruhe) and open source geodata (OpenStreetMap) for further analysis. The statistical analysis encompass the relationship of land use, spatial tree density and tree species density to meteorological variables.

Session D: Communication and warnings, Location: KG III, 3042

Thermal walks for fundamental and applied research

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The thermal walk investigates the influence of urban design on the thermal experience of pedestrians moving through a certain urban area. Thermal walks are often used by scientists to understand how residents experience heat in urban areas. However, thermal walks can also be beneficial to urban professionals working at local governments that need to adapt urban areas to rising temperatures. Thermal walks can answer their questions such as: How hot is a shopping street, a residential area, a specific walking route through the city or a station area? Which adjustments are needed to create cool spaces? Which factors determine whether the outdoor space is hot or cool and which of these factors can be included in a heat-resilient design? A thermal walk reveals and lets participants experience which urban designs are hottest, coolest or most pleasant, and which factors play a role. Therefore, thermal walks can help urban professionals by:
1. giving insight into the phenomenon of urban heat and the factors that lead to a heat resilient design;
2. mapping the heat resilience of a specific area and understanding which adjustments can help to create a cool areas.

During a summer day in 2019, we used the thermal walk to investigate the heat resilience of the walking routes on a former historic naval base in the city center of Amsterdam and to give the participants insight into the phenomenon of urban heat. In groups of 10, the participants examined the thermal situation at four different locations: along water, in a shady park, under a street tree, and in a paved sunlit environment. Among the participants were policy advisers and urban designers. Their answers and comments showed that the thermal walk is a good way to explore and experience the influence of greenery, water and space on air temperature, thermal sensation and thermal experience. Eye openers among the participants were that the air temperature at the various locations did not differ greatly from each other and that shadow can greatly reduce thermal sensation. The participants were surprised that water was not measured and experienced as the coolest place. In addition, their comments showed that a thermal walk can be a useful tool to explore and discuss the subject of urban heat with colleagues and municipal administrations in the adaptation planning process towards heat-resistant cities.

Revision of the Swiss heat warning system – indices comparison and recent developments

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High temperatures can lead to heat-related human stress and discomfort. To quantify heat discomfort and the relevant dangers, heat stress indices combine different meteorological variables such as temperature, relative humidity, radiation and wind speed. Besides multivariate indices, solely temperature-based indices are commonly used to examine the risk of heat stress. In this contribution, a set of widely known heat (stress) indices is analyzed and compared with the Heat Index (currently used to issue official heat warnings in Switzerland), considering 28 Swiss weather stations for the years 1981-2017. More precisely, it is investigated how well warnings that are based on the Heat Index match warnings that are calculated from other heat indices. To identify these warnings, individual thresholds for each index and for each station are derived by using a frequency-based approach, meaning that the number of warning days (issued with the Heat Index) by definition stays the same regardless of the index used.

The percentage of alternative warnings that match the official warnings varies among indices. The Simplified Wet Bulb Globe Temperature (swbgt) resembles the official heat warnings very well and has further advantages, such as the possibility to calculate continuous climatologies. Yet, other indices (e.g. with higher dependencies on humidity or purely temperature-based) can have some added value, too. The optimal index to use thus strongly depends on the purpose of the warning.

This study is a first step towards the general desire for expanding the current heat warning system in Switzerland to a more diverse and impact-oriented system, which, by definition, cannot rely on one single threshold or index, but needs to consider a broader set of user needs. These requirements might be attained through a dual warning system containing i) official heat warnings issued for the whole of Switzerland based on a certain index and ii) target-group-specific heat predictions based on several user-tailored indices.

Indoor conditions during heat waves - Nocturnal part of the heat health warning system

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A major increase of heat-related morbidity and mortality are presumable, as an increase of frequency and intensity of heat waves are expected in the future due to climate change. Especially after the heat wave in 2003 over a large part of Europe with excessive fatal casualties, induced many countries to establish heat warning systems.

The Heat Health Warning System (HHWS) of the German Meteorological Service considers a collective of weather forecast, thermal indices and their specific alterable thresholds. In order to predict heat episodes, short time acclimatization to heat during summer months and indoor conditions are observed and analyzed. The building performance energy modeling software ESP-r is used to estimate thermal conditions of a west- and an east-oriented room, which are connected by a corridor. The indoor operative Temperature (Top) is modelled based on outdoor meteorological conditions, building stock and user behavior. The model assumes one person being present 24 hours a day, a window in each room which is only opened when the outdoor air temperature is lower than indoor air temperature and which is shaded as soon as direct solar radiation hits the surface of the window.

As it is one of the crucial factors of human recreation during the night, mean nocturnal Top (22.30 - 5.30 CET) is integrated in the HHWS. Therefore, the course of the indoor operative Temperature during selected heat waves between 1980 and 2018 is analyzed for different locations in Germany.

One of the aims of the German Meteorological Service is to warn vulnerable people, public health authorities, nursing and support staff, but also the general public about heat waves, so that protectives measures can be induced. Especially risk groups such as elderly, chronically ill or isolated people, spend a lot of time indoors, thus it is necessary to consider indoor heat loads in HHWSs.

Pollen forecast - latest developments at DWD

Christina Endler
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Allergenic diseases have become one of the major health issues. Allergenic diseases caused by pollen are for example allergic asthma, allergic rhinitis (hay fever) and atopic dermatitis. In the last decades, a strong increase in these diseases has been observed in many regions around the world. In order to minimize allergic symptoms, take the medication in time or plan outdoor activities, the public requires detailed information about the start of the pollen season and the daily pollen load.

The German Meteorological Service provides daily pollen forecasts since 1985/86. In recent years, much work has been done to develop and improve numerical pollen forecast systems.

As our latest development, we will use the ICON-ART model in a limited area mode. ART stands for Aerosols and Reactive Trace gases and is an extension to the operational ICON model. ICON-ART is able to predict atmospheric pollen concentration under consideration of the relevant atmospheric processes.

Importance of Atmosphere Related Syndroms in historical context and future possible developments

Kathrin Graw, Stefan Muthers and Andreas Matzarakis
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Atmosphere Related Syndroms (ARS) are changes in physical or mental well-being caused by atmospheric factors depending on weather conditions. The first connection between weather and human health was already recognized 3000 B.C. Since that time, it has been a long way with many milestones in human biometeorological research to the present understanding of ARS.

Meanwhile a multitude of weather effects on human health has been proven. The greatest consensus exist in weather effects on diseases such as heart attacks, apoplectic strokes, pain in the musculoskeletal system, psychological diseases and respiratory disorders like asthma. However, some contradictions between different study results and experts are not unusual and reveal that there is still a need for further research. In the first instance there is a need to understand in what way atmospheric factors do affect human body and in particular the autonomic nervous system because the causal relationships are little-known until now.

The German Meteorological Service (DWD) was encouraged by a pilot study in 1985 conducted in the area of Frankfurt in which 81% of the patients considered a Medical-Meteorological Information Service to be „helpful“ or at least „partly helpful“ and began to establish a telephone service with Medical-Meteorological Information for the public over the whole country. Nowadays the Medical-Meteorological Forecasts from DWD for up to 2 days in advance can be retrieved via www.dwd.de/biowetter for 11 different regions in Germany. The method is based on the numerical weather forecasts of the ICON model from the DWD and an objective analysis of weather conditions.

The last representative survey in Germany reconfirmed that still 50 % (42 % men, 57 % women, generally increasing with age) of the interviewed people stated that weather has a lot of or at least some effect on their health. The survey was conducted in January 2013 by the IfD Allensbach with 1653 Face-to-Face-Interviews of people older than 16.

New methods within the AI sector could be suitable to set a new milestone in human biometeorological research. They can be used to examine the relationship between atmospheric factors and human well-being. If the challenge of data aggregation and preparation as a fundamental step of these new methods succeed such methods offer an additional value for forecasting ARS. Furthermore Citizen Science can contribute to more individualized and beneficial information for the public and to improve health protection.

Plenary session B, Location: Haus zur Lieben Hand

Supporting sun protection: UV index forecasts of the Deutscher Wetterdienst

Gudrun Laschewski and Andreas Matzarakis
Deutscher Wetterdienst/ZMMF

Introduction

The relevance of sun exposure on human health is ambivalent: depending on the dose of radiation affecting the organism, the ultraviolet part of solar radiation (UV) can have positive or negative impacts. Aimed at the prevention of skin cancer and other negative implications of UV exposure, the worldwide consistently used UV index serves as an information medium.

Material and Methods

Based on satellite measurements, calculations of the further development of the measured data as well as the results of numerical weather prediction models, the Deutscher Wetterdienst (DWD, German Meteorological Service) calculates the UV index for all effective atmospheric conditions with a global coverage and with a high resolution European coverage. The UV Index on a global scale is forecasted in post-processing to DWD's global weather prediction model ICON in a horizontal resolution of currently 1/6° (approximately 13 km). The forecast is based on column ozone forecasts that are provided by the Royal Dutch Meteorological Institute (as part of the Copernicus Atmosphere Monitoring Service) in an hourly resolution and interpolated to the ICON grid. A chemistry-transport model is used to extrapolate the satellite measurements of total column ozone. The DWD large-scale UV Index is calculated first, depending on solar zenith angle and the column ozone forecast. Subsequently the large scale UV Index is adjusted by factors to variable aerosol amount and type, altitude, surface albedo of predicted snow cover and cloud optical thickness of predicted cloudiness. The DWD UV Index forecast on a high resolution European scale is done in post-processing to ICON_EU that provides the detailed forecasts for the above mentioned adjustments of the large scale UV Index in a horizontal resolution of currently 0.0625° (approximately 7 km). The European and German UV index all sky forecasts are compared with ground based measurements

Results

DWD operationally provides year-round forecasts of the UV index for 3 days. The daily update of the UV index forecasts comprises all sky as well as clear sky in order to rate the maximal expectable values. The UV index is presented WHO-conform in the web in form of maps and additionally site specific forecasts. UV warnings for German counties are issued in case of exceptionally high values of the predicted UV index or seasonally high values due to low total column ozone. The UV warnings are disseminated in the web, via newsletter and smartphone app. The UV index forecasts are available free of charge for all users such as the general public, service providers or other weather services. The verifications show that about 95 percent of the UV index all sky forecasts and measurements match within the range of ± 1 UV index for German sites and about 87 percent for other European sites.

Conclusion

In order to support the sun protection of the population reliable information is available in form of the DWD UV index forecasts in combination with the corresponding sun protection messages of the World Health Organization. In view of the serious threat caused by UV radiation, research and action are still needed with respect to the dissemination and the acceptance of UV index as well as its application for behavioral and structural prevention.

Urban Climate, Air Quality and Human Comfort in the South-Eastern Europe: Advancements and Challenges within the Climate Change Context

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This paper presents an overview of the most relevant achievements in the SEE countries in urban climatology, air quality and biometeorology, and proposes possible directions of developments in the climate change context. Urban areas are rapidly increasing in population, size and complexity triggering unique societal and environmental arrangements. Urban dwellers face twin challenges derived from the climate change and associated risks, on one side, and anthropogenic pressures, on the other side. The cities of the South-Eastern Europe (SEE) have many similarities due to a comparable historical, economical and cultural background. Last, but not least, the cities from the area have similar expectations related to climate variability and changes in the next decades. As a consequence, the research focused on the climate, air quality and human comfort in urban areas can report analogous progress during the last decades and may consider joint efforts in the perspective of the societal and environmental future. This overview covers the whole SEE area and tackles issues like the current and future challenges, monitoring, modelling and assessment of urban climate and its impact on air quality and human comfort, relationships between air quality and health, or local administration.

Modelling of continuous Sky View Factor based on ultra-high resolution natural color images taken by Remotely Piloted Airborne Systems. The case study of a complex building environment in the campus of National and Kapodistrian University of Athens

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The thermal comfort conditions in a complex urban area is influenced by the surrounding structures and obstacles which modify the incoming radiation fluxes. A measure of this modification is the Sky View Factor (SVF), which could be estimated in each point of a selected area if a high-resolution Digital Elevation Model (DEM), or other urban morphological data including the manmade infrastructure, are available. The accurate assessment of the continuous SVF over an urban complex area, is of utmost importance to quantify human thermal indices such as Physiologically Equivalent Temperature (PET), Universal Thermal Climate Index (UTCI) and Perceived Temperature (PT), which are based on human energy balance.

The goal of this study is to model the continuous SVF for a complex building environment in the campus of National and Kapodistrian University of Athens (NKUA), based on a high-resolution DEM (0.09 m). For this purpose, a novel remote sensing approach, the Structure-from-Motion technique (SfM), which takes advantage of the interpretation of ultra-high resolution color images acquired by Remotely Piloted Airborne Systems (RPAS), also known as drones or Unmanned Aerial Vehicles (UAVs). The proposed methodology could be applied for human-biometeorology research in micro scale complex urban environments.

The quantitative analysis, based on statistical metrics such as MAE, MBE, RMSE, R2 and IA, showed that the modelled SVF values are very reliable (statistically significant at $p = 0.01$ level) against observed SVF calculated from fisheye images captured at 30 specific locations of the NKUA campus. Further, the building and green atriums within NKUA campus, presenting small SVF values, could mitigate the heat stress in summer period. This is very encouraging for people to use these open spaces with comfortable environmental conditions.

Urban thermal stress map based on human perception in urban areas

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Urbanization has been the main factor of urban heat island, which results in the high temperature and thermal stress in down town area. In hot-humid regions as Taiwan, people have specific thermal perception, they prefer stronger wind speed and better shading area to prevent potential thermal stress in urban area. Furthermore, the microclimate condition is an important factor for local people decide the route and activity area based on the attendance of people in different season and shading level in an outdoor space. In order to apply human perception on the microclimate information, this study introduce several temperature observation network approaches which installed in three different cities including Tainan (HiSAN), Kaohsiung (STONK), Chiayi (LATiC), and Taipei (MAST), to demonstrate the long-term air temperature distribution in different time and seasons. Furthermore, the characteristics of local people preference on the climate, and the potential thermal risk of people, will also be included in the map for future application.

Advocating a Human Thermal Perception Protocol for Bio-Meteorological Research

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Since the early 2000's, urban outdoor thermal conditions for city inhabitants have received increased attention and become a new field of research, aiming to provide a better understanding of human thermal adaption in different climatic zones. In this field of research, the examination of thermal indices by subjective perception has become a methodical tool. The study comprised two stages: (1) a literature review of articles which combined micrometeorological measurements and subjective thermal questionnaires, for identifying data collection techniques, field survey strategies, methods for neutral temperature range determination and indices scale modification methods and (2) a comparison between the outcome of different methods and techniques for human thermal perception assessment.
From 2001 to 2019, over 130 studies have assessed human thermal perception by investigating in-situ thermal conditions as compared to subjective thermal perception. A brief review of these studies shows a variety of data collection techniques (differences in tool set up, place, time and duration of measurements), field survey strategies (a diversity of questionnaire designs, different ASHRAE scales and sampling methods), the use of an assortment of indices (over 160), different methods for neutral temperature range determination (probit analysis, ordinal logistic regression, $-0.5 \leq TSV \leq +0.5$ in the adjusted PPD curve, 0 in regression fit between MTSV and chosen index, etc.) and differences in indices scale calibration methods (ordinal regression, linear regression, probit analysis, frequency analysis, thermal acceptable range, and discriminant analysis). Hence, deducing consistent conclusions about human thermal perception in different climatic environments has become challenging. The aims of this study are to review the different techniques, strategies and methods for human bio-meteorological research, to examine the accuracy of the different techniques and methods and to suggest a general human thermal perception assessment protocol for bio-meteorological research.
A comparison between the outcome of different methods and techniques show that different methods of data analysis for the same raw human bioclimatic data demonstrate different perception thresholds. It also shows that greater accuracy can be obtained by: using 24-hour consecutive data collection, measuring extremes of thermal conditions within the research unit, and preferring TSV data collected by convenience sampling and measuring thermal perception in all seasons.
On the basis of these findings, we suggest a unified framework for bio-meteorological research and advocate the most accurate techniques and methods for human thermal perception assessment.

Strengthening interdisciplinary bridges between human biometeorology with that of bottom-up urban thermal sensitive design in an era of climate change

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To date, there has thus far been a large amount of disseminated research pertaining to human biometeorological studies that can also be arguably associated to the consolidating international climate change adaptation agenda. For this reason, and as climate change impacts continue to aggravate already existing human thermo-physiological conditions in urban environments, there still remains a fertile opportunity for further scientific investigation.

Subsequently, the disclosed presentation shall discuss the importance of such scientific advancement being synonymously concomitant with that of interdisciplinarity. Respectively, while the deepening of knowledge pertaining to human-biometeorology shall remain quintessential, the same can be said for its 'interdisciplinary bridging' with different disciplines that are ultimately, set to face similar challenges while ensuring human wellbeing and safety throughout the twenty-first century. As a result, this delicate emerging equilibrium between human biometeorological assessments and its respective easy-to-understand communication with non-climatic experts must be enforced. Such an interdisciplinary bridging ultimately shall further enable the collaboration with other professionals, with liaising skillsets, that are adjacently able to modify the thermal responsiveness of indoor and outdoor environments through local bottom-up creative adaptation processes.

Session E1: Thermal indices, Location: Haus zur Lieben Hand

Anisotropic longwave sky radiation

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Downwelling longwave radiation from the sky is an important part of the heat load of humans. In measurements longwave radiation is obtained as the integrated flux over the upper hemisphere received on a horizontal surface and such values are also used in models to calculate mean radiant temperature. However, sky longwave radiation is not homogenously distributed over the sky since the path through the lower part of the atmosphere is short in zenith and increases towards the horizon. Accordingly, the flux along the path increases with increasing zenith angle. The elongated shape of a standing human implies that the increased fluxes closer to the horizon increases the impact of longwave radiation in estimations of the heat load of humans. In this study we introduce a method how to include anisotropic sky radiation in calculations of mean radiant temperature.

UTCI calibration for a tropical Brazilian city and the influence of the sample size upon the calibration process

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Thermal sensations of comfort and discomfort are related to microclimatic, individual and subjective variables. The integrated effect of these variables can be evaluated through thermal comfort indices. For the validation of the results of these indices, it is necessary to calibrate them to local conditions, considering characteristics of the specific population (STEANE; STEEMERS, 2004; NIKOLOPOULOU et al. (2004) The number of studies in which thermal comfort indices are calibrated are continuously increasing. (HIRASHIMA et al., 2016; ROSSI et al., 2017; KRÜGER et al., 2018; SILVA; HIRASHIMA, 2018; HIRASHIMA et al., 2018; SILVA, 2019) However, there is a lack of standardization on index calibration procedures (POTCHER et al., 2018). In addition, studies about the significance of the sample size for the results of calibration processes are scarce. Therefore, the objective of this work is to present the calibration of the UTCI for Belo Horizonte, Minas Gerais, Brazil and to evaluate the relevance of the database size for the calibration process. UTCI is frequently adopted for the evaluation of thermal comfort in open spaces and was developed in 2000 by the ISI Commission 6 managed by the International Society of Biometeorology (ISB). According to the Köppen-Geiger classification, the climate of Belo Horizonte is classified as tropical climate with dry winter (Aw). The city presents an annual average air temperature of 21.8°C, relative humidity of 67.2% and wind intensity of 1.7m/s. In the present study, two samples containing subjective data regarding thermal sensations and objective data, represented by the values of the UTCI, were analysed. The sample collected by Silva (2019), n=755, was collected between August 2018 and February 2019, during winters, spring and summer, in four different squares. The other database, Hirashima (2014), n=1693, was collected during winter and summer of 2013, in two squares. The microclimatic data collected were: air temperature (Ta), relative humidity (RH), wind velocity (W) and globe temperature (Tg). The mean radiant temperature (Mrt) was calculated according to ISO 7726 (1998) forced convection equation. The 10m high wind velocity parameter (W10m), required for the calculation of the UTCI, was calculated using the logarithmic equation developed by Bröde et al. (2012). Thermal perception of the users was collected by means of interviews conducted simultaneously to the monitoring of the microclimatic data. The questionnaire elaboration considered ISO 10551(2015). The UTCI values were calculated using the software BioKlima 2.6. Ordinal Logistic Regression (OLR) was used for the calibration of the UTCI. As a result, for the Silva (2019) sample, when the UTCI is below 15.9°C, the subject is classified as "cold" (discomfort for cold), if the UTCI value is between 15.9°C and 26.9°C the subject is classified as "comfort" and above 26.9°C as "hot" (discomfort for heat). For the Hirashima sample (2014) the categories are: “cold” when UTCI<19.3°C; “comfort” when 19.3°C≤ UTCI ≤26.7°C; and “hot” when UTCI>26.7°C (SILVA; HIRASHIMA, 2018). Comparing the calibrated UTCI ranges for the different samples, it is possible to note a divergent lower limit, respectively 15.9°C and 19.3°C. For the upper limit, the difference is small, 0.2°C. The difference between the lower limit values for the two calibrated UTCI bands can be attributed to the number of people who declare cold votes ("very cold", "cold" and "cold"). For the smallest sample, only 45 people, approximately 5% of the total, declared cold votes; for the largest sample, 271 respondents reported cold votes, corresponding to an approximate percentage of 16%. For the sample of Silva (2019), n=755, the calibration of the UTCI was able to explain only 9.85% of the occurrence of the evaluation of subjective thermal sensation with prediction of 25.93% of correct answers. For Hirashima’s sample n=1693 it was able to explain 43,2% of the occurrence of the subjective evaluation of thermal sensation, predicting 67,3% of correct answers. The latter results are the most reliable ones. It can be inferred from the comparison of the results that, under the conditions evaluated, the larger the sample size, the greater was the prediction of correct responses, although other aspects can also influence this significance. It is concluded that the sample size plays an important role for the calibration of the UTCI. Future studies shall be able to discuss the minimum adequate size to be considered in order to calibrate the indices for the local populations. It is expected that they could guide a necessary future international normalization on the subject.

Thermal Comfort Index Calibration: review and analysis of statistical methods used

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Calibration of thermal comfort indices for urban environments is performed by using statistical methods, which correlate the numerical value of the index with the response of people's perception of thermal sensation, in order to determine the representative ranges of thermal comfort and discomfort for cold and hot conditions. Studies aimed at calibrating the Universal Thermal Comfort Index (UTCI) and the Equivalent Physiological Temperature Index (PET) for local populations are increasing in many countries. However, there is currently no standardization of the procedures to be adopted in the calibration process, notably regarding statistical treatments. In this context, the present study seeks to analyze the statistical methods most used in the calibration of these two indices in order to verify which of the methods most used by the scientific community has the greatest statistical adequacy. The methodology used in this research encompasses 1) the survey of previous studies, in the international scenario, to identify the most used statistical methods used on the calibration of the PET and the UTCI thermal indices for urban environments; 2) PET calibration, for a sample of 2,448 subjective responses in the city of Belo Horizonte - MG, region of tropical climate, using the three most used statistical methods; 3) comparison of the obtained results; 4) analysis of the statistical methods; and 5) formulation of considerations about the calibration process of these indices. This research covers the comparative computational inductive method, a qualitative and quantitative approach, an exploratory-descriptive objective and an applied nature. It is expected at the end of the research, to identify the method with greater statistical adequacy, justifying the parameters adopted. This will be a contribution to the necessary and urgent standardization of procedures used to calibrate these indices, enabling the comparison of study results for different locations and also their practical application in urban planning projects.

Key- words: PET; UTCI; Calibration; Statistical methods.

The influence of warm weather and outdoor-environment design on preschoolers' physical activities and thermal comfort

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The summer of 2018 was one of the warmest experienced in Sweden. The heat wave led to forest fires and water supply problems, but also to heat stress among the population. Preschool children spend a large amount of their time outdoors and the effects of weather and outdoor environment design on children's thermal comfort are not clear. Methods for estimating thermal comfort and physiological stress outdoors are not developed or adjusted for children. By better understanding how weather affects children's thermal comfort, measures can be taken to reduce heat stress and increase children's health and well-being.

The overall purpose of this research project is to investigate how weather and the design of preschool's outdoor environment affect preschooler's outdoor activities and thermal comfort. We will use meteorological observations and model simulations to create thermal maps of selected preschools, and children's activity and thermal comfort will be observed. This particular paper presents a study on how the outdoor thermal environment differs between preschools in Gothenburg and how pre-school teacher's and staff perceive their work environment and how the children are affected during warm weather.

The result will provide knowledge of the linkage between weather and children's outdoor activities and thermal comfort as well as how to best design preschool outdoor environments in order to promote children's movement and well-being.

Modified Physiologically Equivalent Temperature (mPET) to investigate biometeorological conditions and seasonal power demand in tropic region

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Modified Physiologically Equivalent Temperature (mPET) to investigate biometeorological conditions and seasonal power demand in tropic region
Thermal indicators are widely applied to investigate the influence of thermal stress on the human beings and activities, whatever public health, urban landscape, and tourism. One of most applicable thermal indicators is Physiologically Equivalent Temperature (PET). The study will initially explain the details and difference between original PET and modified PET. PET has been modified with a multiple-segment thermoregulation model and a multiple-garments clothing model, in order to realize detailed thermo-physiological phenomena such as sweating mechanism, vasoconstriction and vasodilation, conductive heat transfer between the body tissues, and the counter current effect, and the considerable sensible and latent heat transfer over a realistic clothing model. This entire redeveloped PET has been proposed as a new thermal index called modified PET (mPET). The mPET is also based on the human energy balance as the calculating method of the equivalent temperature such as the original PET, but in a dynamic balance state not in a steady balance state. This approach is different from Universal Thermal Climate Index (UTCI), which is an effective temperature based on adjustments of the air temperature (Ta) with the effects of the wind speed, the relative humidity, and the mean radiant temperature, and it leads mPET to become a physic-based, objective, and reasonable thermal index.
Furthermore, an investigation of the biometeorology in several cities in Taiwan is proposed with a comparison between PET and mPET. The preliminary result shows that mPET is more appropriate to estimate the thermal stress events than PET in Taiwan. For instance, the assessment of the thermal conditions by the mPET delivers that less extreme cold events during winter and extreme hot events during summer than the estimation of the PET in Taipei. Finally, a further application field of the mPET is proposed in comparison of the long-term biometeorology and power demand with urban land use. The preliminary results show that the power demand and mPET have a seasonally significant correlation in different land use in Taipei.
The modified PET is overall considered as a versatile, effective and comprehensive thermal index in the study.

Keywords: physiologically equivalent temperature, thermal index, thermal conditions, power demand

Session F: Climate Change, Location: KG III, 3044

Urbanization Induced Temperature Rise over Eastern India: A Primary Appraisal to Estimate Urban Climate Change

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Specific heat capacity of the surface regulates the energy budget of the region. A slight change in the energy budget may significantly disturb the regional/local climate. Land Use Land Cover (LULC) which characterizes the surface properties can contribute immensely to the energy budget cycle through biophysical and biochemical processes like evaporation, evapo-transpiration, shortwave and long wave radiation, absorption and reflection. With the advent of urbanization and population influx to cities, the changes in LULC is inevitable thereby favouring a regional/local climate change. Ever since the Indian Economic Reforms of 1991, the urban sprawling, rise in building construction resulting to more energy consumption and thereby enhancing carbon emissions is rapidly rising in India. Using ground, satellite remote sensing and reanalysis products we have investigated the recent changes to surface air temperature over India between 1981 and 2010 and assess its relation to LULC. It is observed that the mean temperature of the state has increased by ~0.3 °C during the past three decades with the most accelerated warming (~0.9 °C) occurring during the recent decade (2001 to 2010). Our study shows that 25 to 50% of this observed overall warming is associated with LULC. Further we observe that the spatial pattern of LULC changes matches well with the independently estimated warming associated with LULC suggesting a physical association between them. Such locally induced factors may be looked upon with a more policy oriented approach as it can change the conventional definition of climate change. Changes in cropping pattern is also observed during the period. Thus, in this study we try to quantify the signatures and influences as a result of climate change over Eastern India due to urbanization. However, with the expected expansion of urban landscape and concomitant increase in anthropogenic activities along with changing cropping patterns, rise in energy demand, the relation between all these factors are much more complex in nature and necessitates additional modeling exercises.

Keywords: Urbanization, Temperature, LULC, Eastern India, Satellite data, NDVI.

Predictions and Projections of Heat Exposure on European Scales: The HEAT-SHIELD Project

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HEAT-SHIELD is a Horizon 2020-funded large scale research programme that seeks to alleviate the negative impact of increased workplace heat stress on the health and productivity of European workers. For this purpose an integrated cross-disciplinary approach is followed, involving research institutions, policy-making organizations, industrial entities and civil society organizations from across the EU. Five strategic industry sectors are considered, namely manufacturing, construction, transportation, tourism and agriculture. The primary heat stress index employed is the wet bulb globe temperature (WBGT).

An important component of HEAT-SHIELD is the provision of accurate and robust information on future meteorological conditions that define environmental heat exposure in terms of the WBGT. Two basic time horizons are considered: (1) extended range meteorological forecasts for the upcoming four weeks, and (2) multi-decadal climate projections until the end of the 21st century. For the first, the ECMWF operational forecasts are employed and are fed into a user-tailored heat warning system, while EURO-CORDEX climate scenarios for three different greenhouse gas scenario are considered for the latter. In both cases, coarse-resolved and bias-afflicted model data are downscaled and bias-corrected in order to accurately represent local scale conditions across Europe.

This contribution will present the setup and the results of both the personalized early heat warning system and the climate change analysis developed in HEAT-SHIELD. Implications for operations at MeteoSwiss and climate change impacts on the European workforce will be discussed.

Estimating the future thermal comfort in Lisbon

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Under the elaboration of the Climate Change Adaptation Plan for the Lisbon Metropolitan Area (LMA) in Portugal, the UTCI was calculated for different periods (1971-2000, 2041-2070 and 2071-2100) and for two scenarios (RCP 4.5 and RCP 8.5) based on an Ensemble model built from two Regional Models (Cordex5).
UTCI in the period of 1971-2000 was relatively moderate, with no presence of days with extreme thermal stress (both cold or heat). There was a high frequency of days with absence of stress, as well as of days with slight and moderate cold stress.
Projections until the end of the century indicated a pronounced decrease in cold discomfort as well as a widespread worsening of heat discomfort.
While in the current period slight and moderate cold stress occurred on more than 75% of winter days, it will not exceed half of the winter days at the end of the century, according to RCP 8.5.
With regard to summer discomfort, a worsening of the conditions of moderate heat stress is projected in the same scenario. In August, more than half of the days at the end of the century will be days of moderate, strong, or very strong stress.
The projections also allow to identify an extension of the period of heat discomfort throughout the year. In the current period, the heat discomfort classes were only observed from June to September and they will occur towards the end of the century between the months of April and October.
LMA is projected to reduce -65 days of cold stress per year (RCP 4.5 scenario) or -75 days (RCP 8.5 scenario) by mid-century. Towards the end of the century the annual reduction projected days of cold stress is -77 days in the scenario of lower forcing and -109 days according to RCP 8.5.

Thermal climate and case studies on urban heat island during heatwaves in coastal city of Helsinki, Finland

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Urban heat island effect increases heat stress and decreases cold stress experienced in the built environment, but the significance of the UHI effect varies seasonally according to synoptic weather patterns, and the impact of sea is important in coastal cities like Helsinki. Complexity in the variation of spatial distribution of UHI poses challenges in urban planning keeping in mind ongoing climate change and the spread and densification of the city due to natural urbanization or urban planning interventions.

Fine-resolution (500m x 500m) modelling of urban heat island in Helsinki metropolitan area was conducted by SURFEX model using TRY (Test Reference Year) data as input for calculations for present and future climate (RCP8.5, 2030's and 2050's). In our presentation we will show spatial distribution of UTCI (Universal Thermal Climate Index, operational version) in Helsinki in typical present and future climatic conditions.

The TRY data does not include representative summertime heatwave conditions. Therefore we demonstrate development of the urban heat island and related thermal conditions during heatwaves 2018 and 2019 using the operational HARMONIE model that includes also the SURFEX-model, but in sparser resolution (2.5km x 2.5km). It appears that the hottest area within the city during a heatwave depends strongly on the direction of the airflow of the prevailing synoptic situation.

We will also show modelled temperature-mortality relationships in Helsinki and in wider Helsinki-Uusimaa hospital district. These relationships indicate that increase in mortality during heatwaves is higher in the city of Helsinki than in its surrounding rural area. These outcomes emphasize a need for thorough dialogue with city planners and safety authorities responsible for preparedness during extreme situations.

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Urban air quality under climate change – overview and the role of biogenic emissions.

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The air quality will also under future climate change predominantly depend on primary anthropogenic emissions. Many cities in the world suffer from severe air pollution caused mainly by emissions from the sectors traffic, industry and residential heating. Among the air pollutants it will be especially ground-level ozone for which higher concentrations are expected due to increased temperatures. For particulate matter the overall effect of climate change is more complex to disentangle. In regions with a projected increase in precipitation amounts an increase in wet deposition is expected. Adaptation measures by employing urban trees should be aware of possible additional BVOC emissions and negative effects on ventilation
This contribution will provide an overview on possible impacts of changing meteorological and climate variables on pollutants (mainly ozone and PM2.5) and summarize related studies. Furthermore results from a study with an up-to-date urban chemistry transport model concerning BVOC emissions under heat and draught stress and their effect on ozone concentrations will be presented.

Adaptation for the impact of climate change in biometeorological field

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University of the Ryukyus

Impacts of climate change have been getting clearer and clearer recently. These impacts are categorized into two kinds, one is a long-term trend and the other is an extreme weather event. Representative long-term trend is the global warming, surface air temperature rising gradually. It is not so serious for biometeorological field, because the temperature rising ratio is too slow for human sensation. On the other hand, very heavy sudden rainfalls and strong tropical storms of strange routes are representative impacts of extreme weather events. Abrupt changes of air temperature are also thought to be an impact of climate change, though it is not clearly proved. Sudden and abrupt temperature changes that occurred frequently recently are very serious impacts on biometeorological field. For example, heatstroke, hypothermia and just common cold are sometimes caused by rapid changes of temperature. The adaptation for the such impacts of climate change is required.

Session E2: Thermal indices, Location: Haus zur Lieben Hand

Human Thermal Perception and Adaptation in a World of Population Mobility

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Since the early 2000's, bio-meteorological research has tried to assess human thermal perception aiming to expand the understanding of human thermal acclimatization and adaption in different climatic zones. In this respect, only a limited number of studies have considered indirect factors such as place of birth, ethnicity, socio - cultural background and their interaction with thermal perception in a particular climate. In a world of population mobility, these factors can affect the acclimatization and adaption of immigrants to the climate in the destination country. In an era of globalization and population mobility, mainly from hot climates to cold environments, indirect factors affect immigrants' adaptation to the climate in the destination country. Differences in thermal perception by people from diverse socio-cultural backgrounds may indicate the effect of thermal adaptation in specific thermal environments and climatic tolerance towards varied climatic conditions. Moreover, in era of climate uncertainty, it can also indicate possible human adaptation to the effects of global warming.

The aims of this study are to examine differences in thermal perception of inter and intra-ethnic groups and people from diverse cultural-climate backgrounds in Israel and to identify the behavioral adaptation of people with different climatic histories.

The findings indicate that at low temperatures people from cold regions showed higher tolerance than native Israeli residents do. From an intra-ethnic perspective, Arabs showed higher tolerance than Jews did. At hot temperatures, the differences between all groups were less pronounced and the threshold for extremely hot sensation for all populations was similar. Clothing insulation played an important role in behavioral adaption for all groups and was more significant in winter. From a gender perspective, females made better use of clothing insulation as a behavioral adaption than males.

These findings illustrate that human thermal adaptation to extreme hot climates is limited and further action is required to enable citizens to cope with global warming. Authorities cannot rely on human thermal adaptation as a coping mechanism in an era of global warming.

Define the thermal comfort range based on different generation in the same climate region

Shing-Ru Yang and Tzu-Ping Lin
National Cheng Kung University

According to the Sun moon lake thermal comfort range paper, point to the result of thermal comfort range calculated by sensation vote, define the range from very hot to very cold, seven-level. The method uses curvilinear regression, to find the satisfaction level than 80%, it means up to 80% of people feel this air-temperature or PET is comfortable.
However, even in the same climate region, in different years, ask different people, it will get different satisfaction levels, for example, we find in the National Art Museum in Taichung, 2009. Only the past year, but the satisfaction level change to 90%. We move to 2015 in Taiwan three area questionnaire, just 40%. It became difficult to define which temperature is people liked.
That we think, maybe because of the people type we chose to ask differently? Which area did we ask? What people job is. Also, different culture, generation…etc.
Our research wants to face this phenomenon. We will start to focus on finding which important reason the effect people make on the different decisions of those study cases. Next, we will find what is the best way for defining thermal comfort range, even the study background changes, still can follow up this method.

Uncertainties and errors in heat sensation inferential model and their feedbacks in climate-conscious urban planning.

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Climate responsive urban planning looks for ways to mindfully integrate climate concerns across planning stages and spatial scales. It takes on different aspects like city greening policies or natural ventilation corridor protections but there is for now only a few unique ways to assess the outcome of the implementation of such policies: scrutinizing diachronic climate maps that display air and/or surface temperatures or wind speed trajectories over cities.

With the increasing deleterious effect of urban heats on human health, some authors advocate to emphasize, in urban planning, outdoor thermal comfort (OTC) concepts and heat stress indices, like the apparent temperature AT, the Physiological Equivalent Temperature PET, or its modified version mPET. Whenever these indices are good candidates to nudge urban planning towards climate responsive designs has still to be discussed.

Our sensitivity study led on PET and mPET computation and associated subjective thermal sensation statistical inferential models over 4 central district sites in Singapore resulted in: i) PET performs better than mPET in inferring individual thermal sensations; ii) metabolic heat rate is a larger source of uncertainty in mPET than clothing insulation; iii) body mass index is insignificant in both PET and mPET; while iii) the globe temperature is no longer the most sensitive meteorological variable in mPET computation, suggesting to upgrade the quality of the air temperature and wind meteorological measurements when using mPET. Furthermore, the thermal sensation ranges issued from the inferential statistical models despite significant coefficient of determination and statistically significant population sample size showed overlapping when considering the intrinsic 5-10% errors of the inferential regression model. The overlapping can be up to the range of a full thermal comfort sensation category.

The Evaluation of the Effects of New Settlement Areas on the Thermal Comfort in a Cold Climate City: Erzurum Case

Dogan Dursun and Merve Yavas
Ataturk University

The main objective of this study is to explore the consistencies between the new planned urban development areas (Sukrupasa Residential District) and cold climate conditions in Erzurum. This area is the new settlement area in the city and conducted by the responsible municipalities. It is aimed to produce thermal comfort models of three selected housing areas in the central places of new urban development areas and determine the level of sensitivity of their urban design projects to climate conditions. It mainly questions whether the urban patterns in and around the housing areas eliminate the winter disturbances. And also, it questions the capability of these new urban developments about transforming outdoor space into a center of attraction. In this context, case study was conducted in the winter period. The analysis uses the data gathered through urban development plan related to the morphology of the site, meteorological parameters and time parameters. Thermal comfort mapping can be produced within a methodology based on these three issues and will give an idea for better urban design of housing areas for winter cities. For calculating the models, ENVI-met as a software designed to simulate the surface, plant and air interactions of an urban environment were used. In addition to ENVI-met model based on micro-climate analysis, spatial analyses were made by considering distance between buildings, street widths and orientations. The findings show that new residential areas are not compatible with cold climate conditions and creating cold stress for the environment. New urban development areas and their designs are not taking the advantage of the existing climate conditions and creating uncomfortable outdoor environments discouraging residents.

Keywords: Thermal Comfort, Urban Design, Şehristan, Yeşil Yakutiye, Erzurum

Climate and Sports Events - The Tokyo 2020 Olympic Games

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Detailed climate information in an easily interpretable form is demanded by the general public, as well as by decision-makers on different planning levels. One example is the group of planners in the field of sports and tourism. A promising approach is the visualization of climate thresholds in a Climate-Tourism/Transfer-Information Scheme (CTIS) for the prevailing local climate conditions. The presented approach is adaptable to specific destinations and target activities and integrates meteorological, as well as recreational, touristic and specific activity-related parameters and thresholds. All parameters are simplified in terms of factors and combined in one individual graph, the CTIS diagram. The detailed information on local climate can be applied by non-experts like tourists intending to attend a sports event. They are able to prepare for different aspects of the local climate by, e.g., selecting appropriate clothing when planning their stay. The example of the Tokyo 2020 Olympic Games is presented and discussed. Results show that heat stress together with sultriness is likely to occur during the scheduled time of the Olympics, while cold stress will most probably not be relevant.

Session G: Bioclimate, planning and design, Location: KG III, 3044

Assessment of thermal environment and air quality in Compact Built Environment in Hot-Humid Regions

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According to the 2014 annual assessment report by Swiss Re, Taipei, Taichung, Tainan and Kaohsiung were identified to be cities at risk under the threatens of natural disasters. Moreover, over 60 days with daily Tmax greater than 35o C were recorded during June – September, 2019 in Taipei City, the extreme high temperature trend has influenced on residential health and safety gradually. Assessments and analysis reports have indicated that the correlation between O3/PM concentrations and high temperature events. There's no doubt that Taiwan is a country under threatens of multi-disasters, extreme conditions, and land scarcity.

With high population density and mix land usages among urban areas in Taiwan, we have formed various compact built types eventually. By many researches done, it's addressed that the built environment has affected the wind fields, radiation, temperature, and humidity due to the anomalies resulted in urban development; and in this research, several urban zones in Kaohsiung and Tainan will be selected as research targets, and we would like to discuss about the interaction between the microclimate and the interaction between thermal environment & air quality among various land use stereotypes. By mapping the air pollutants concentration monitored at upstream/ downstream sites and simulating the ventilation condition, we would like to find out the correlation in diffusion of pollutants. Combining with plotting out the heat risk hotspots of PET over 35 oC, we expect to better understand the essential/ main factors in leading towards the better residential requirements for thermal comfort and air quality.

Microclimate modelling to support climate change adaptation in densifying cities

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Heatwaves are severely affecting the well-being and health of urban dwellers and are expected to increase in intensity and frequency due to climate change. Green and blue spaces such as water bodies, parks and street trees are able to ameliorate high temperatures by evaporative cooling and shading and have therefore been promoted as means for climate change adaptation. However, in growing cities, supply of urban green space often conflicts with increasing housing demand, resulting in dense neighbourhoods with lack of green. Such urban growth is likely to further increase urban temperatures, exacerbating existing heat stress.
The City of Munich seeks to balance ongoing population growth and living space demand with the need to adapt to climate change. For this purpose, the project “Green City of the Future” explores how green infrastructure can be integrated into urban planning processes – from new urban developments to densification of existing neighbourhoods. As part of the research, microclimate modelling will be used to quantify and evaluate the impact of densification and the benefits of green urban elements on outdoor thermal comfort. Based on a real case study, scenarios with varying degrees of densification are studied with the microclimate model ENVI-met. Thereafter scenarios with nature based solutions are implemented to see whether they can outbalance densification impacts. Future work seeks to couple different observation levels (ventilation at neighbourhood level, thermal comfort at level of open spaces) and indoor with outdoor thermal conditions.

An exploration of a latitude based street-level density manipulation for climate sensitive urban street design

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The advancement of climate sensitive urban fabrics is currently hampered by buildings being considered in isolation, the lack of professional climate sensitive design input for the development of building stock as well as the lack of feedback between climate studies and urban planning guidelines. With the growing need for compact urban living as well as the increasing numbers of heatwaves being recorded over the past few years, it is undeniable that a thoughtful arrangement of the urban fabric would enable high density living with enhanced cooling from urban shading and wind flow. However, planners require decision support systems to make wise choices between numerous alternatives to enhance density. As a first step towards this, it is important to explore the impact of the commonly used density parameters in order to make better informed urban form controls for our growing cities.
This simulation-based study investigates the impact of urban density at 5 cities from varying latitudes on late afternoon mean radiant temperatures with the aim of identifying correlations that exist between density parameters such as land use intensity, ground coverage, open space and building heights and their influence on outdoor thermal comfort.
A hypothetical neighbourhood consisting of 5 x 5 equally spaced urban blocks were used for study conducted using the three-dimensional microclimate model ENVI-met. 9 probable cases were simulated for each city based on varying horizontal (Plan Area Ratio) and vertical (Floor area Ratio) density parameters.
Findings show the manipulation Floor Area Ratio and Plan Area Ratio can result in different thermal behaviours based on the geographic location. An initial exploration of a combination of Plan Area Ratio and FAR is presented as a tool for urban planners to aid decision-making to enhance climate sensitive urban neighbourhoods.

Planting trees in urban areas using Computer Decision Making algorithms

Nils Wallenberg and Fredrik Lindberg
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Street trees as a mitigation technique to alleviate excessive radiant load is a well-studied topic. The decrease in radiant load can mainly be attributed to the shading effect of trees, which helps blocking incoming solar irradiance. A large decrease in incoming solar irradiance will substantially lower mean radiant temperature (Tmrt) and can potentially decrease thermal dis-comfort during warm and clear weather situations.
Within urban environments excessive radiant load is generally found in front of sunlit south facing facades (northern hemisphere) with low wind speed. Not only do these areas receive a high degree of incoming shortwave radiation on clear days, but a relatively large part of the incoming shortwave radiation is also reflected from nearby surfaces. The incoming shortwave radiation also heat these surrounding surfaces which leads to large amounts of emitted longwave radiation. Thus, these so called hotspots have been proposed as beneficial locations for new trees, but the actual outcome and effect is still quite unknown. Furthermore, the effect of planting more than one tree and where to locate them is also uncharted, e.g. how they should be placed in relation to each other to provide highest possible shading effect.
Here we introduce a new model for identifying and locating areas where trees would have highest mitigating effect on excessive radiant load on multiple spatial scales (street canyon - city). The model is part of the Urban Multi-Scale Environmental Predictor (UMEP) plugin in QGIS and exploits computer decision making (CDM) techniques and machine learning approaches to facilitate urban planners and practitioners in their everyday work.

Urban Spatial Patterns and Heat Vulnerability in the City of Tel Aviv

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Future climatic change is expected to increase the duration and intensity of heat stress. Previous studies have pointed to the relationship between urban spatial patterns and urban warming. Since a city's climate is a complex phenomenon, it requires a wide range of measurement methods, in order to fully understand the effects of urban spatial patterns on heat vulnerability. This study aims to examine the effect of urban spatial patterns on heat vulnerability in selected neighborhoods in the city of Tel Aviv.

The methodology for this investigation was integrative and included several steps. In the first stage, a Local Climate Zones (LCZ) classification map of Tel Aviv was created using GIS in order to subdivide the city into different local climatic zones based on similarities in the degree of land cover, urban geometry, urban morphology and land use. The next step was to measure the urban warming of selected neighborhoods using several meteorological tools; fixed meteorological stations, mobile measurements and Remote Sensing (RS) methods (satellite images and a hand-held infrared camera). Based on the climate data, the Physiological Equivalent Temperature (PET) index was calculated for several urban spatial patterns. Landsat 8 satellite images were used in order to identify the urban heat island (UHI) of Tel Aviv, its spatial patterns and hot spots in the urban space. A hand-held infrared camera was used to analyze the effect of material thermal properties, colors, roughness, and shade on urban warming.

During the daytime the city is ~ 3 °C warmer than the rural area. At night the city is ~ 4 °C warmer than the rural area. In addition, in terms of PET, during the daytime the city is ~ 11 °C warmer than the rural area and at night, the city is 7 °C warmer than the rural area. We found that the cooling effect of parks and gardens is evident only during the hot hours of the day (9:00 – 17:00). This reduction reaches a maximum of 3.5 °C and 10 °C PET at 14:00. The use of satellite imagery (Landsat 8) allowed us to identify differences in Land Surface Temperature (LST) in different parts of the city of Tel Aviv. The northern part of the city is colder by ~ 3-4 °C compared to the southern part. Using the hand-held infrared camera, we identified the thermal properties of different surfaces in different LCZS and showed in what degrees' dark surfaces such as: basketball courts, playgrounds and unshaded grass can increase the surface temperatures and may have a negative effect on human thermal comfort. It seems that in terms of UHI mitigation in Tel Aviv, there are advantages to compact low-rise forms like LCZ 3. Whereas, compact midrise forms like LCZ 2 are not ideal from the climatological perspective. Results showed also that the southern part of the city is the warmest even in the same LCZ classes. Therefore, the LCZ method needs to be refined, in order to identify thermal properties within the various LCZS in the city.

Plenary session C, Location: Haus zur Lieben Hand

Future perspectives on micro scale modelling and communication aspects in human biometeorology

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Modelling issues in the context of human energy balance models and the derived thermal indices, as we as the generation and availability of meteorological data especially in complex topographies and urban areas is nowadays required. Meso and micro scale models, which compute not only the meteorological parameters and thermal indices, but also deliver relevant data and information for the climate conditions and can be helpful in the development of mitigation and adaptation strategies in the era of climate change. The complex or rational thermal indices follow the concept of equivalent temperature, which is easier to be understood by users. Most known indices are PMV, PET, modified PET, SET* and UTCI. All the thermal indices require the same thermophysiological and meteorological parameters. For the side of thermophysiology heat production and clothing are required. Air temperature, air humidity, wind speed, as well as short and long wave radiation fluxes in terms of the mean radiant temperature are the required meteorological parameters. The main and secondary output can be helpful for different approaches in different disciplines and issues in the context of human health and welfare.
In addition, for the development of adaptation possibilities the communication aspect has to be considered. This requires easy understandable way of presentation and communication of the results.

Poster

A new approach of generating human biometeorological information based on gridded high-resolution data (basic data of Test-Reference- Years)

Irmela Schlegel and Andreas Matzarakis
Deutscher Wetterdienst/ZMMF

The assessment of human-biometeorological information requires appropriate preparation of data and suitable visualisation of results. Human-biometeorological information can be valuable for tourists and visitors, but also for citizens looking for information about their neighbourhood or a new residence, cities or health resorts can promote their climate conditions for heath rehabilitation. To derive this human-biometeorological information in a unified, comprehensive and comprehensible form, a tool was developed. The input information contains the coordinates of a Place and/or Area of Interest and the time period of data chosen by the user. For meteorological data the basic dataset of Test-Reference-Years from the German Meteorological Service is used, containing hourly meteorological data for the time period from 1995 to 2012 covering Germany with a spatial resolution of 1 km². Based on the Perceived Temperature as thermal index, days with heat stress and cold stimulus are identified. In this process, the effect of a short-term human acclimatisation on the thermal environment is considered by using a variable threshold value based on the thermal conditions of the last 30 days. The results of the tool's application consist of several frequency diagrams, the Climate-Tourism/Transfer-Information-Scheme, diagram of heat waves and maps of the Area of Interest displaying the spatial distribution of heat stress and cold stimulus. As an example, the (bio-)meteorological conditions of the health resort Baden-Baden and the region of southern Baden around Freiburg and the Black Forest are analysed.

Implementation of human thermal comfort and air humidity in Köppen-Geiger climate classification and importance towards the achievement of Sustainable Development Goals

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Due to increasing heat-related health risks, as well as the human requirements on energy and side effects, this study attempts to figure out a methodology of quantifying the potential requirements on human thermal comfort and air humidity towards the achievements of the Sustainable Development Goals (SDGs). Based on the Köppen-Geiger climate classification and the selected 11 climate types with sample cities, the methodology has been detailed. Meanwhile, the quantified thermal and humid conditions in each city, as the primary representation of each climate type, have been presented. According to the potential application of the quantified information and based on the qualitative analysis of SDGs text, the correlation between the information of human thermal comfort and air humidity, and 12 SDGs has been summarised. Furthermore, the difference of the qualitative description between the original Köppen-Geiger climate classification and the quantified information has been discussed. For instance, obvious difference appeared in the same climate zone (e.g. climate zone C); comparing with the original climate classification, there is a different order of hot/cold conditions or wet/dry conditions. The identified differences are regarded as the enlightenments for further studies.

Variability and changes in bioclimatic parameters in Estonia – preliminary findings

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There has been a clear evidence of an increase in surface air temperature in the Baltic Sea region since the beginning of the observational period. In this study PET was used to evaluate the changes and fluctuations in bioclimate conditions in Estonia in the second half of 20th century (1960-2017). The study aims to investigate if the observed variations in PET have important impacts on human physiology in Estonia. The main purpose is to detect long-term changes of the PET index using the monthly, seasonally and annual values, as well as selected extreme indices based on the ones developed by the joint CCI/CLIVAR/JCOMM Expert Team (ET) on Climate Change Detection and Indices (ETCCDI). The observed increasing trends in warm bioclimatological extremes, especially heat waves in Estonia suggest that future bioclimate conditions will become more stressful to people which will greatly affect their health and wellbeing. But on the other hand the increasing trend in PET, that show comfortable bioclimate conditions, means that number of days with comfortable climate conditions is experiencing positive tendencies. This study is one of the first that deals with bioclimatological extremes in Estonia and it is of vital importance for mitigation and adaptation to extreme temperature events. Furthermore, future investigations should be oriented on producing a new thermal comfort scale suitable for higher latitudes. Also, the studies should focus on analysis of the extreme human bioclimatological indices that could point out necessary information, for decision makers on various levels, including health, tourism and regional planning.
Key words: PET, bioclimate conditions, extreme PET events, Estonia.

Review of outdoor thermal comfort research in urban areas of Central and South East Europe

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According to the United Nations prospects from 2018, more than half of the world's population lives in urban areas, and the future population growth is also expected to be absorbed by urban areas. Rapid urban growth along with the climate change sets challenges to the maintenance of healthy, comfortable and sustainable urban environment. That leads to the increasing interest in urban microclimatic conditions especially in outdoor environment, since outdoor spaces accommodate urban population activities. Comfortable outdoor thermal conditions contribute to the improvement in the quality of urban living.

In this paper we review the research of outdoor thermal comfort in urban areas in the 11 countries of Central and South East Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, North Macedonia, Montenegro, Romania, Serbia and Slovenia, in the past decade (from 2010 to 2019). The results show increased but uneven interest in outdoor thermal comfort by the end of the research period. Research and publication production among the countries of the study area varies significantly.

The most significant contribution to the outdoor thermal comfort research comes from Hungary and Serbia. The majority of the reviewed articles used Physiologically Equivalent Temperature (PET) index to assess thermal comfort, followed by Universal Thermal Comfort Index (UTCI). In some articles combination of questionnaire surveys and meteorological measurements was applied in order to examine subjective thermal sensations. Urban public green spaces (such as parks), streets, squares, parking lots and sidewalks were the most frequently selected locations for micrometeorological measurements and questionnaire surveys. The majority of the articles also focused on the influence of urban design on outdoor thermal comfort conditions and defining guidelines for sustainable, resilient and climate sensitive urban planning and design.

Effects of street design on outdoor thermal comfort during record-breaking heat and cold periods in Novi Sad, Serbia

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The main idea of the research is to investigate the effects of street design (height/width – H/W street ratio; street orientation) in different urbanization patterns, based on Local Climate Zone (LCZ) concept, on outdoor thermal comfort conditions. The research was applied in urban area of Novi Sad, the second largest city in Serbia with 330,000 inhabitants, and focused on heat wave (HW) and cold wave (CW) periods.
The database contains 10-minute measurements from 16 stations during 3-years period (2014-2017). Stations are located in six built-up LCZs: compact midrise (LCZ 2), compact low-rise (LCZ 3), open midrise (LCZ 5), open low-rise (LCZ 6), large low-rise (LCZ 8) and sparsely built (LCZ 9). For air temperature (Ta) and relative humidity (RH) measurements from stations we applied quality control (QC) algorithm, while other meteorological values, such as wind, vapor pressure and mean radiant temperature (Tmrt), had to be modeled for each station location, using ENVI-met software. For the calculation of Physiologically Equivalent Temperature (PET), as one of the outdoor thermal comfort indices, RayMan micro-scale model was used.
According to WMO definitions, we defined 29 heat and 21 cold waves in urban area of Novi Sad during the research period. Furthermore, the additional analysis was made for the most intensive heat wave in 2015 and cold wave in 2017, respectively. Based on hourly PET assessment for the selected extreme periods, we defined the best street design and orientation that lead to optimal outdoor thermal comfort. The different solutions were reported in different LCZs, i.e. different urban designs.

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Seasonal variations of UTCI and PET in Belgrade (Serbia)

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Over the past decade, a significant number of articles have been published considering bioclimatic extremes. Having in mind a wide spatial dimension and different geographic regions where analyzes were performed, the heat budget indices Universal Thermal Climate Index (UTCI) and Physiological Equivalent Temperature (PET) are commonly used indices. The main objective of this paper are consideration of biothermal condition in Belgrade (Serbia) during 2000-2018 for what purpose daily (hourly) data at 7h and 14h are collected. For this consideration, a seasonal variability of UTCI and PET were analyzed including summer and winter disscomfort. Based on initial study, it is observed the great summer discomforts are the most prominent in 2000, 2007, 2012, 2015 and 2017 where several long heat waves occur. Belgrade, as an urban space of 1.5 million inhabitants, is an urban heat island and in the risk for occurrence of heat waves from summer to summer. However, winter discomforts are the most prominent in 2004, 2009, 2017.

Climate sensitivity of an historical places in cold climate zone: The Case of Erzurum

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In the last decade, climate sensitive urban design has become popular research topic in most of the countries due to the changing climate pattern. But, northern cities have always been experiencing stressful climatic conditions such as snow, ice, wind and darkness and they are always needed to be ready against those conditions. From macro-scale to micro-scale, urban patterns should be consistent with cold climate conditions due to increase the quality of life in that cities. Especially, public spaces should reflect winter city characteristics in order to extend outdoor uses as one of the important factors effecting this quality of life. Residents should be encouraged to be remaining outside with the help of public space design which is maximizing the beneficial aspects of winter.

The main objective of this study is to explore the consistencies between the urban design projects and patterns of historical places (Tas Magazalar Street, Yakutiye Square, Castle and Double Minaret Madrasah Square) and cold climate conditions in Erzurum. In this process, it is aimed to produce thermal comfort models of the historical places of Erzurum and determine the level of sensitivity of those urban areas to climate conditions. It mainly questions whether urban patterns in and around those places eliminate the winter disturbances. And also, it questions the capability of public spaces about transforming this outdoor space into a center of attraction. In this context, case study was conducted in the winter period. The analysis uses the data gathered through morphology of the site, meteorological parameters and time parameters. Thermal comfort mapping can be produced within a methodology based on these three issues and will give an idea for the design of better pedestrian commercial street in winter cities. For calculating the models, ENVI-met as a software designed to simulate the surface, plant and air interactions of an urban environment were used. It is three-dimensional microclimate model in which buildings, vegetation and surfaces in the case study area are designed on a 3D grid at a typical resolution of 0.5–10m. The software calculates main wind flow, temperature, humidity and turbulence by utilizing a full 3D prognostic meteorological model. In order to make a simulation, ENVI-met needs modeling the environment, setting the configuration and evaluating the model performance. It requires to set in input several atmospheric quantities (Atmosphere temperature, Wind Speed [m/s], Wind Direction, Specific Humidity, Relative Humidity, Roughness length measurement site) and several built environment characteristics (height of the buildings; materials on building surface; pavements such as grass, water, concrete and asphalt). In addition to ENVI-met model based on micro-climate analysis, spatial analyses were made by considering distance between buildings, street widths and orientations. The findings show that urban design projects realized around historical places are not compatible with cold climate conditions and not taking the advantage of the existing climate conditions. In the conclusion part, some urban design proposals will be suggested for the case study areas.

Keywords: Outdoor Comfort, Micro-climate, Urban Design, Thermal Map, Erzurum

Human thermal comfort modeling against mobile measurements in a green-urban area of Athens, Greece. Adaptation and mitigation recommendations

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Global warming, by means of heat waves, is expected to affect the human activities in the densely populated areas. This is the case of Athens mega city, the capital of Greece, which faces the most pronounced urbanization impact related to urban morbidity and mortality, mostly during heat waves events. Thus, adaptation and mitigation measures should be scheduled towards the resilience of the Athenians.

The objective of this study is to evaluate the human thermal sensation in a green-urban area of Athens during a summer day by using a 3D microscale climate model and utilizing mobile meteorological measurements. In order to assess the biometeorological conditions over the study area, the ENVI-met (V3.1) model was applied, which is a three-dimensional, prognostic, microscale model for the calculation of meteorological conditions and distribution of air pollutants. The experimental micro-measurements of air temperature, humidity, wind speed, globe temperature and global solar radiation were conducted in two routes on July 12, 2017, from 15:00 to 17:00 and from 21:00 to 23:00 Athens local time (UTC+3:00). The meteorological parameters were recorded every 5s, using the appropriate sensors mounted on a cargo bicycle at 1.5m height. Furthermore, these densely carried out bicycle measurements were used to validate the high spatiotemporal simulations of thermal comfort (72h starting at 06:00 on July 11, 2017), derived by the model ENVI-met. Regarding the human thermal sensation, the human thermal index Physiologically Equivalent Temperature (PET) was estimated with respect to both model's simulations and experimental micro-measurements. The spatial distributions of the thermal index regarding the two bicycle routes for the study green-urban area were illustrated using ArcGIS 10.2.

The in-situ measurements along with the model's output results reveal the thermal comfort regime of the selected area and the ability of the model to evaluate the micrometeorological conditions. Last but not least, we examined different mitigation scenarios of thermal stress, taking into consideration that green spaces within urban built environments could be beneficial for human thermal comfort at the micro-scale, especially during summer period at moderate climates.

Biometeorological footprint on crime incidence over the greater Athens area, Greece

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Crime incidence is extremely high in urban areas. A lot of research has been carried out investigating this phenomenon related to traditional socio-demographic factors, such as age, sex, race, and socio-economic status. On one hand, the aforementioned factors change slowly over time or do not change at all, therefore they could not explain short term variations in crime rates. On the other hand, weather changes on seasonal or even daily scale could have a biological influence on criminal behavior or affect the rational choice-based crimes. However, the impacts of weather and climate variability on criminal behavior have not been studied enough.

To gain more insight on weather related crime within the Greater Athens Area (GAA), Greece, we performed a retrospective analysis for a 10-year period (2008 – 2018), so that to quantify the impact of weather on crime frequency, based on monthly datasets. The crime data were acquired from the Hellenic Police, Attica General Police Headquarters, and consist of five classes such as murder, robbery, rape, theft-burglary and vehicle theft. The meteorological variables of air temperature, humidity, precipitation, wind speed and solar radiation, recorded in the National Observatory of Athens were used in the analysis. Furthermore, to quantify the impact of the thermal environment on crime incidence we estimated the thermal index Physiologically Equivalent Temperature, which is based on human energy balance. The relationship between crime incidence and the aforementioned environmental parameters was estimated by the application of: a) Pearson $\chi 2$ test, the most widely used method of independence control of groups in lines and columns in a table of frequencies and b) Generalized Linear Models (GLMs) with Poisson distribution.

Our findings reveal a seasonal variation for the most crime types. Lower crime frequencies appear within summer months, which could be attributed to summer holidays; there are fewer potential victims left in the city and less opportunities for the criminals. Besides, it is noteworthy the March crimes peak. The weather begins to change during March, winter gives its place to spring and as the weather becomes more pleasant, more people prefer outside activities, being in a way more potential victims. The outputs derived from GLMs and contingency tables, indicate that the thermal environment affects to a degree the crime incidence, especially within large urban agglomerations.

Bioclimatological assessment of Camino de Santiago

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El Camino de Santiago (English St. James' Way; French Chemins de Saint-Jacques-de-Compostelle) is one of the oldest and most important pilgrimage routes of Europe. Consequently, as a growing number of people spend some of their leisure time engaged in this particular outdoor activity, weather and climate becoming relevant factors for planning the route, while the thermal comfort may determine the personal satisfaction. Both issues need to be evaluated in order to improve the quality and safety of this leisure activity.
The objectives of contribution are the evaluation of the bioclimatical conditions along the main routes of Camino de Santiago and their suitability for outdoor activities for the period 1979-2018 by means of the Physiologically Equivalent Temperature. Moreover, the Climate Information System (CTIS) is used to build a calendar of frequencies and probabilities of different bioclimatic and tourism climatic factors. This calendar is subsequently compared with the number of visitors housed pilgrims hostels along the routes. Finally, the recent decadal variability of the regional bioclimate along the routes is examined.

Deepening the knowledge of urban climate and human thermal comfort conditions: an approach based on local weather types

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Urban heat island (UHI) patters are strongly influenced by the local weather conditions. Future climate projections are showing a significant increase of air temperature and the number of really hot days and tropical nights in the city of Lisbon, which has already a hot and dry summer (average maximum temperatures rich 28,3ºC in august) and an average UHI of 2ºC in this season. These thermal conditions will jeopardize human comfort and health. Thus, a local weather types classification is presented as a new way to look further at the current climate conditions of the city and the UHI patterns. This approach was based on Hidalgo & Jougla (2018) local weather types classification applied to Toulouse (France). Several climate variables were chosen for the classification from the city's airport meteorological station and, when data was missing, the ERA 5 and ERA 5 LAND reanalysis data (Copernicus) between 2009 and 2018: daily mean air temperature, cloud cover and specific humidity, accumulated precipitation and most frequent wind direction. Also, a day and nighttime division was applied to the data based on the sunset and sunrise hours. Finally, a clusters analysis (k-means) was performed in order to group the data into sets of days with similar local weather conditions. The results will help to identify the most frequent weather types in the city and, specially in summer the most favorable conditions for the development of heat waves and strong UHI.

Study on Riparian Shading Envelope for Wetlands to Create Desirable Urban Bioclimates

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Climate change and rapid urbanization are adversely affecting the urban environment by exacerbating the widely reported Urban Heat Island effect in Dhaka, Bangladesh. Two wetland areas with variable riparian shadings in the warm-humid conditions of urban Dhaka had been investigated through field campaigns on microclimatic parameters for their cooling potential on the surrounding urban fabric. It was observed that an inversion layer of fully saturated air develops over the water surface of wetland, suppressing evaporation from the wetland water surface layer. It was observed that the inversion layer was effectively reducing the heat exchange between the water surface and the air layer above it through its action as an insulating vapor blanket. As a resultant effect wetland was unable to render as a source of coolth for the surrounding overheated urban area. This effect of the inversion layer was more pronounced in the urban wetland without riparian shading either by urban form or tree canopy. A Multiphysics simulation study conducted on the selected urban wetlands indicates the effect of differential shading pattern on the relation between fetch and inversion layer thickness. This research hypothesizes that the wetland can act as an urban adaption measure against the urban heat island effect by potentially transforming them into Urban Cooling Island (UCI) towards a favorable urban bioclimate. Based on the findings of the research an urban design matrix for urban wetlands was developed, which can contribute to design and planning thermally desirable urban bioclimate imperative in the warm-humid conditions of urban Dhaka as an adaptation measure against climate change. The effectiveness of the urban design guidelines presented in the design matrix for urban wetlands can help improve the bioclimate significantly if they form a part of the overall urban design scheme and urban development policy.

Cooling Effect of Green and Blue Spaces in Urban Requalification Project of Oued El-Harrach in Algiers

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In Algeria, a major urban redevelopment project in El-Harrach water-front is supported by the 'Algiers 2029' strategic plan, to create more comfortable green open spaces, better use of the river and resilient territories. This contribution, which is the subject of a doctoral thesis in progress, aims to focus on the role and contribution of "water and vegetation" combination for urban requalification: Firstly by presenting the results of two main phases: in-situ measurements for human thermal comfort data (temperature, relative humidity and wind speed) succeeded by simulation scenarios using ENVI-Met software.

And secondly to develop measurable criteria and indicators and to examine its interactions on all facets of the project, its immediate environment and at the scale of the territory, through a multi-criteria assessment that will study the binomial "water and vegetation" in different impacts on the urban, environmental and human aspects.

The Sustainable development goals and the new urban agenda have given new impetus to improve our cities; this assessment is at the center of the new challenges of the contemporary city as: human well-being, health, air quality, urban resilience and urban heat island.

Impact Analysis of Dynamic Bluespace on Human Biometeorology: Case of Roorkee

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Urbanisation has picked up rapid pace since dawn of the industrial revolution. This unprecedented and unplanned urbanisation has brought about an integral change in natural fabric, influencing climate at global as well as local level. Urban Heat Island reflects the impact of changing landuse patterns and anthropogenic activities at the local level. Urban heat island adversely affects human health in multidimensional ways.

Bluespace refers to all substantial surface water bodies. Owing to its integral thermal behavior, Bluespaces (rivers, lakes) have the potential to influence UHI in a localized area. This study analyses the impact of a canal on heat stress experienced by humans in the city of Roorkee. It explores the influence through measurement of PET. This aspect is evaluated with respect to stream, which in turn is defined by Stream width (SW), Stream depth (SD) and Surroundings (LCZ). The analysis is carried out through a microclimatic model (Envi-Met) to explore this interrelationship. Diurnal and seasonal variation is investigated to account for the whole spectrum of climate variability. Thus, an impact analysis matrix is generated with respect to Local Climate Zones, which denotes the optimal LCZ's to be constructed nearby to the waterbody to minimize heat stress.

This study provides directions to the urban planners by proposing the most suitable local climate zones to be developed nearby to waterbodies to attenuate heat stress and guiding efficient distribution and design of water bodies to maintain their maximum value of micro and local climate adjustment.

Keywords: Urban Heat Island; Bluespace; Local climate Zone; Microclimatic Model, PET

Indices of Outdoor Thermal Comfort: A Comparative Study in Mendoza, Argentina

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Outdoor human comfort is an essential factor to quantify the perceived quality of the urban microclimate. In order to achieve sustainable urban development, it is important to consider thermal comfort in the design phase. Specially, in arid regions, high outdoor air temperatures due to intensive solar radiation are present in hot summer seasons. Consequently, discomfort sensations and heat stress are expected. It is currently estimated that approximately one third of the world population lives in cities located in regions classified as extremely arid, arid or semi-arid.

Since the beginning of the 20th century, human thermal comfort has been discussed exhaustively in several reports. More than 100 simple thermal indices, mostly two parameter indices, have been developed in the last 150 years in order to describe the complex conditions of heat exchange between the human body and its thermal environment. However, the existing works are characterized by a certain variety of instruments and methods.

Therefore, this paper proposes the comparison of six thermal comfort indices and its contrast with subjective answers in winter, summer and annual. The goal is identifying which of them can be better used to predict thermal comfort in forested outdoor spaces of the Mendoza Metropolitan Area (MMA), an “oasis city”. It is the fifth largest city in the country, with a population of 1,055,679, and covers 168 km2. According to the Köppen–Greiger classification, the climate of the city is arid: BWh or BWk depending on the isotherm.

For this purpose, air temperature, solar radiation, relative humidity and wind speed of two meteorological stations in the downtown of MMA during winter of 2010 and summer of 2011 were selected for comparison. While the microclimatic monitoring was being carried out, people were also studied in their natural environment, through observation and structured interviews, in order to evaluate comfort levels and perception of the environment. The first part of the questionnaire consisted of items related to sex, age, clothing, and activity done before the interview and where they were coming from (to account for acclimatization). The second part addressed the perception of the thermal sensation on a 5-point scale, ranging from -2 (very cold) to +2 (very hot), going through zero (neutral), which has been defined as the Actual Sensation Vote, or ASV.

The results showed that the indices have different correlations with subjective responses in both seasons. The UTCI reported an annual percentage of correct predictions of 48.8%, higher than the PMV (38.1%), COMFA (23.8%), GOCI (13.1%) and PET (3.6%) but lower than the IZA (78.6%), the local index. The higher predictive ability of this last index is due to the fact that it was specifically meant for the MMA’s population. Finally, this type of tools is very useful in the design and evaluation of the thermal behavior of open spaces according not only to climate criteria but also to the subjective characteristics of users.

Influence of urban form on urban thermal comfort of in tropical cities: Case of Goiania, Brazil

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Urban form – construction's density, land uses, proportion of open spaces and buildings, vegetation and water bodies, etc.–, features of the materials used on façades, roof and pavement, topography and others can influence on urban climate changes and promote negative effects of Urban Heat Island (UHI) in the tropics. In Brazil, there are few urban studies associated climate and its application in urban planning, which may be a reflection of how the issue of climate change is approached by the institutional structures of government. This study aims to evaluate the relation between urban form and climate. The methodology involves a) study area selection b) development of a thematic map where each zone is established based on similarity patterns of topography, height of buildings, the presence of vegetation, land use and occupation; c) selection of areas for field measurements – 15 points of measurments; d) meteorological data obtained by fixed station on Campus Colemar Natal and Silva in Downtown Goiânia and measurements in different points selected in last step - air temperature and wind; d) treating data to develop urban maps; e) development of urban planning guideline. Results show that the highest temperatures, 28.7 as are found in the high-density sites in the southwest during the morning. In the southeast, there are high temperatures. It can be explained by the presence of open areas paved with asphalt, which allow greater access to the sun and an absorption of heat during the day. The results also suggest that the planting of large trees to promote shade as well as the installation of structures that support vines to promote shade for pedestrian and reduce surface temperatures.

Evaluation of Indoor thermal comfort in scholar buildings of Federal University Goiás

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Classrooms should provide adequate thermal environment for development of learning activities. In public buildings was scholar buildings of Federal University of Goiás, it is important provide indoor thermal comfort and energy efficiency. Bioclimate architecture design can indicate the adequate envelope materials and typology of classroom buildings This study aims to evaluate the indoor thermal comfort of classrooms in two different architecture typology of scholar buildings in Colemar Natal e Silva Campus, UFG - Goiânia. Building, built in the last 15 years has similar envelope materials –concrete brick in walls, glass 4mm in openings, concrete in the roof –, different of solar protection and air conditioner systems. In this study was selected 2 different typologies design of scholar buildings: Central corridor with central air conditioner systems (Centro de Aulas D); and, lateral corridor and individual air conditioning systems (Centro de Aulas E). The method consists of: a) selection of buildings and classroom (worst situation by solar orientation); b) collection climate data - temperature and humidity – in summer and winter; b) indoor thermal comfort analyses by Operative Temperature; c) simulation in software Design Builder to evaluate the thermal condition during the year; d) comparative analysis of thermal performance results and architectural design; d) development of architectural design guidelines for classroom buildings for UFG. Results of measurements and simulations show that “Centro de Aulas D” had lower temperatures than “Centro de Aulas E”. Although the glass area of classroom D was larger than from Classroom E, the solar protection used in Classroom D is more efficient than the other building. In both cases, simulation results show that it's possible to use natural ventilation instead of air conditions during the morning, reducing energy demands. Adequate shade protection can improve indoor thermal conditions and it can be observed in all scholar building design. This study can help architect and other professionals worried about health indoor conditions.

Microclimate influences on the indoor thermal comfort of scholar building on tropics: case of Cidade de Goiás- Brazil

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The well-being conditions provided by a quality school environment are fundamental to the improvement of student achievement. Promoting thermal comfort in classrooms without demanding high energy costs is a challenge in tropical regions, mainly because many buildings are adapted to receive the teaching functions. It is emphasized that microclimate and building envelopes play an important role in the thermal comfort conditions in indoor environments and the retrofit of buildings needs to consider this. This work aims to analyze the influence of microclimate on indoor thermal comfort in classrooms in two buildings of the Federal University of Goiás - Sant'Ana Unit and Areião Unit - located in the city of Goiás - GO. After analyzing the projects of the chosen buildings, two classrooms were selected in each building in the following orientations: northeast and northwest. The methods included: (a) the collection of climatic data - air temperature, relative humidity, wind speed and globe temperature - in the immediate environment and in the selected environments during the year 2017; (b) research of constructive information of the buildings under analysis; (c) application of a survey to the users of the selected rooms; (d) analysis of the immediate surroundings by the transect method and insolation analysis; (e) quantification of thermal comfort by the PMV index (AMV / PPD) and Operative Temperature and Thermal Sensations of users. In this study, 448 answers were collected among university students in the Regional City of Goiás, UFG. The data allowed concluding that the immediate environment directly influences the thermal performance of the buildings, although there were no differences in temperature within the urban area. The thermal performance of the enclosures influences the degree of satisfaction of the users, and the building that did not meet the minimum requirements of the standard presented the highest percentage of thermal discomfort. It also has been observed that many users are acclimatized to the external environment, so they are not very satisfied with the acclimatized environments. These data are very important for professionals in the area who aim to adapt educational environments to the user's thermal comfort needs.

Vulnerability of Poor Urban Populations to Temperature-Related Health Issues in Ibadan, Nigeria

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Increasing global surface temperature remains a major threat to the health status of urban populations in cities in the humid tropics. Urban populations are exposed to higher ambient thermal conditions due to the urban heat island effect and are at an increased risk to heat-related health problems under a warming climate. This paper examined the health risks and vulnerabilities of urban populations to increasing ambient apparent temperatures in six local government areas in Ibadan, Nigeria. The study adopted the use of semi-structured questionnaires, focus group discussions, interviews with inhabitants and key informants to obtain information on their individual's perception on ambient thermal condition, heat stress experience, self-reported health effects and coping strategies. It also considers factors that can amplify the effect of increasing ambient apparent temperatures on health status of inhabitants which includes the rapid and unplanned urban growth, socio-economic status, unreliable power supply, health status, number in household and type of housing facilities. The paper also examined the changes in temperature in terms of minimum, maximum and apparent temperatures in Ibadan from 1989 to 2018 which suggests that on the average, warmer conditions are being experienced in the city.

Future heat waves along latitudinal transect across Europe based on climate change indicators

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Changes in the frequency and intensity of heat waves have shown substantial negative impacts on public health. At the same time, climate change projections towards increasing air temperatures over Europe will foster such extreme events, lead to higher exposures of the population and increase societies' vulnerabilities. Based on two climate change scenarios (Representative Concentration Pathway 4.5 and 8.5) we analyzed the frequency and intensity of heat wave for three major cities in Europe representing a North-South transect (London, Luxembourg, Rome). We used indices proposed by the Expert Team on Sector-specific Climate Indices of the World Meteorological Organization to analyze the number of heatwaves, the number of days that contribute to heatwaves, the length of heatwave, as well as the mean temperature during heat waves. The threshold for the definition of heat waves is calculated based on a reference period of 30-years for each of the three cities enabling a direct comparison of the projected changes between the cities. Changes in the projected air temperature between a reference period (1971-2000) and three future periods (2001-2030, 2031-2060, 2061-2090) were statistically significant for all three cities and both emission scenarios. Considerably similarities could be identified for the different heat wave indices. This affect directly the risk of the exposed population and also might negatively influence food security and water supply.

Immediate impacts of extreme winter weather on mortality in the Czech Republic

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Extreme weather events considerably affect natural environment and various sectors of human society, including public health. While impacts of extreme temperature periods, i.e. cold spells and heat waves, on mortality and morbidity have been widely studied, the impacts of a sudden weather change per se so far received less attention. In the present study, we aim to employ a high-quality long-term mortality time series (1982–2017) to evaluate the impacts of extreme winter weather on human health in the Czech Republic (population of about 10.5 millions).
We focus on events of sudden temperature and pressure changes, heavy precipitation, snowfalls, and strong wind. They are defined using a modified extremity index which takes into account their spatial extent and severity. Since these events may occur as part of the same synoptic situation, we analyze whether their compound effect causes larger impacts on mortality than if each type of extreme is evaluated individually. We employ daily climatological data from the EOBS and ERA5 datasets over the Central European domain. Using relative deviations for the modelled mortality baseline, we estimate the mean patterns of excess mortality on days around the selected extreme events.

Exists a HHWS in the Czech Republic?

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Everybody knows that no HHWS (Heat Health Warning System) is in the Czech Republic. This information we can find in articles about HHWS in Europe or EuroHEAT Project. But – is this proposition true?
Every HHWS is composed of two basic parts: warning systém based on (bio)meteorological data and a consecutive reaction of system (rescue system, health-care systems, state, regional or municipal structures…). The poster summarizes information about actual situation in the Czech Republic.

Statistical modeling of combined ozone and temperature extremes in Central Europe

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Air pollution poses the single largest environmental risk to human health in Europe. Extreme levels of tropospheric ozone, representing one major air pollutant, cause a severe public health burden for the European population. Also, elevated temperature levels are recurrently associated with an exceptionally high mortality rate, only representing the extreme end of a wide range of possible health effects. Due to the specific characteristics of ozone formation and further underlying processes, high levels of ozone and temperature often coincide, posing an even intensified threat to human health.
The key goal of the present work is to assess the relationship between meteorological conditions and the combined occurrence of these two health stressors over Central Europe from 1993 to 2012. For the peak ozone-temperature season between April to September about 90 stations with good data coverage have been extracted for different countries in Central Europe. Maximum daily 8-hour average ozone values (MDA8O3, data source: European Environmental Agency), observed daily maximum air temperatures (TX, data source: European Climate Assessment & Data) and meteorological variables (ERA5-reanalysis, source: European Centre for Medium-range Weather Forecasts) form the data basis for model building. Extremes are defined based on high percentiles (75th and 90th) and WHO air quality guidelines (100 µg/m³). Statistical models for each station are generated and different modeling approaches are compared to identify the main drivers of the combined ozone-temperature events at each individual location.
Besides the analysis of meteorological drivers of temperature-ozone extremes in the observational period, a second major goal of this work is the impact of ongoing climate change until the end of the 21st century on the combined extreme events. Thus, ozone-temperature extremes are projected based on seven models of the Coupled Model Intercomparison Project Phase 5 (CMIP5) and potential frequency shifts of such health burden occurrences under future climate conditions are assessed.

High resolution meteorological station network in Swiss Cities: City Weather Monitoring and operational forecasts

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Today, more than half of the world's population lives in urban areas and the proportion is projected to increase further in the near future (Grimm et al., 2008). Heatwaves worldwide lead to death and increasing economic and ecologic damage, especially in urban areas where the air temperatures are typically larger than in rural areas. In many parts of the world, heatwaves kill more people than any other natural hazard (Changnon, 2003).
To monitor the large small-scale variability of the air temperature, a dense meteorological sensor network was installed in the Swiss City Zürich: 300 meteorological stations were mounted on street posts at 3 m above the ground in a horizontal resolution of 500 m, in order to cover all local climate zones (LCZs). Air temperature measurements were compared with standard WMO weather stations from MeteoSwiss in order to correct the local low-cost weather stations for a potential bias. Additionally, air temperatures from the very dense and public network Netatmo were used for a comparison of different sensor types.

Correction functions for canopy, different surfaces and distance to buildings were then applied on different sensor types, typically depending on different atmospheric conditions. Afterwards, a spatial quality control was used to exclude implausible measurements by applying a spatial regression test in combination with a Students T-Test.

A comprehensive analysis of three heat waves in the summer 2019 showed that the dense measurement network in Zürich was able to detect several urban heat islands (UHI) and cold air poolings. Nighttime UHIs were with 3-5 K higher than daytime UHIs for three heatwaves in 2019.

Based on the dense air temperature measurements, local air temperature forecasts were calculated with the operational meteoblue Learning Multmodel (mLM). This approach allows point specific temperature forecasts for the measurement locations up to 6 days ahead and produces temperatures significantly different from a city standard temperature forecast, as local (city-specific) meteorological effects are resolved in our approach.

Tension between Jews and Arabs increases risk to health: variance in Heart rate variability among Jewish and Muslim women in Afula and Nazareth

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Studies show that ethnic groups' autonomous nervous system respond to exposure to discrimination. We test responses of Muslim and Jewish women to exposure to alien ethnic environments increasing by thus risk to health.
In field experiment study, We tested 72 young and healthy Muslim and Jewish women measuring their HRV in intra and inter-ethnic park, town center and residential neighborhood in an Arab and a Jewish adjacent towns. The subjects stayed half an hour in each of the six environments contributing eight HRV measurements in each environment and measurements of exposure to thermal load, CO, and noise. Levels of HRV were higher among Jewish women in their intra-ethnic environments.
For both groups' levels of HRV increased once crossing ethnic boundaries. However, some ethnic differences emerged: Muslim experienced higher increase in LF/HF while crossing boundaries. Muslim experienced higher risk for health in residential neighborhoods than in town centers. Jewish women experienced higher levels of risk for health in town centers relative to residential neighborhoods. Muslim and Jewish women differently activated their sympathetic and parasympathetic systems in response to environmental exposures. Higher correlations between HF and LF among Muslims means that the sympathetic and the parasympathetic tones are working in more harmony among Muslim women helping them better adopt to environmental challenges. In conclusion, there are ethnic differences in response to crossing alien ethnic boundaries. A further study is needed to understand the causes of these differences, whether they are associated with differences in lifestyle, discrimination and physiology.

Co-producing climate information services for sustainable agriculture in urbanizing deltas of the world

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Water for agriculture in peri-urban areas is vital to safeguard sustainable food production. Due to the dynamics of urbanization in deltas as well as climate change, water availability (too much, not enough, too late or early) is becoming erratic and farmers cannot rely only on their own experience anymore for agricultural decision-making.

The WaterApps project develops tailor made water and weather information services with and for farmers in peri-urban areas in the urbanizing deltas of Accra, Ghana and Khulna, Bangladesh to improve water and food security and contribute towards sustainable agriculture.

The project's design framework initially focuses on the farmers that are involved and supported during its course in the study areas and assesses their needs. Based on the baseline needs assessment study and along with the farmers in a co-producing mode Climate Information Services are being developed that provide tailor-made water and weather information and are continuously monitored and evaluated to ensure their effectiveness.

WaterApps combines the latest information technology such as Apps, social media, etc. on knowledge sharing that are enhanced with the local farmers' information needs, demands and preferences to produce tailor-made Climate Information Services.

Both examined study cases indicate the importance of two-way communication and co-production with and for farmers. The co-production of water and weather information services empowers and improves livelihoods of small/medium farmers and builds capacity for enhancing sustainable food production. Finally, it lays the ground for upscaling in other urban-rural delta zones in the developing world.

Urban Morphology Aspects on Microclimate in a Hot and Humid Climate

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Bandung, the capital of West Java province, Indonesia has experienced rapid urbanization, which has affected the urban environment, including its building density, land use, and the quality of urban living. This specific urban morphology has had a significant effect on the urban microclimate. This study was aimed at describing the urban microclimate of three different overcrowded settlements, i.e., Linggawastu (overcrowded settlement), Gerlong Girang (moderately crowded), and Pasir Impun (leastcrowded). The discussion will detail aspects of the masses and buildings, the distance between buildings, the height of buildings, and the availability of green open spaces to give the perspective of urban morphology toward the microclimate. Fixed weather logger in those three locations were collected over one month, meanwhile the mobile measurements to find the micro-meteorological values of air temperature (Ta), globe temperature (Tg), humidity (RH), and wind speed (v) to define the mean radiant temperature (Tmrt). The liviThe measurements provided evidence of the trend of heat trapped in densely populated settlements shown in the diurnal temperature range from Tamax and Tamin (△Ta) as only 3.2 °C. Meanwhile in Pasirimpun, which is least populated, △Ta = 9.5°C. Linggawastu with BCR > 96% gave the contribution of low Tg=28.3° C, as there is less insolation penetration to the area. Thus, the PET for two densely populated areas, Linggawastu and Gerlong Girang, tends to be neutral to slightly cool. Nevertheless, this study points out the high humidity in the morning and afternoon, as well as the low air velocity, is a strong affecting factor.

The effect of urban green structures on thermal comfort – Comparing court yards in Potsdam

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Urban green infrastructure (UGI) is increasingly being promoted as a measure to mitigate urban heat stress caused by the heat island effect and climate change impacts. However, evidence of the effectiveness of UGI to moderate heat stress is mostly lacking. This is a serious challenge for urban planners who have the responsibility of navigating their cities towards a sustainable future while being constrained by financial and spatial factors. In this contribution, we examine the effectiveness of green structures to increase thermal comfort in four courtyards with a similar built environment but varying green structures in Potsdam, Germany. Our poster will present first results from our measurements in 2019 and an outlook to our activities in 2020. We will present significant differences in temperature with lower temperatures in court yards with more green structures and less sealed soil. Our study aims to increase the understanding of the regulating effects of urban green structures as well as their co-benefits, such as thermal comfort, biodiversity and carbon sequestration.