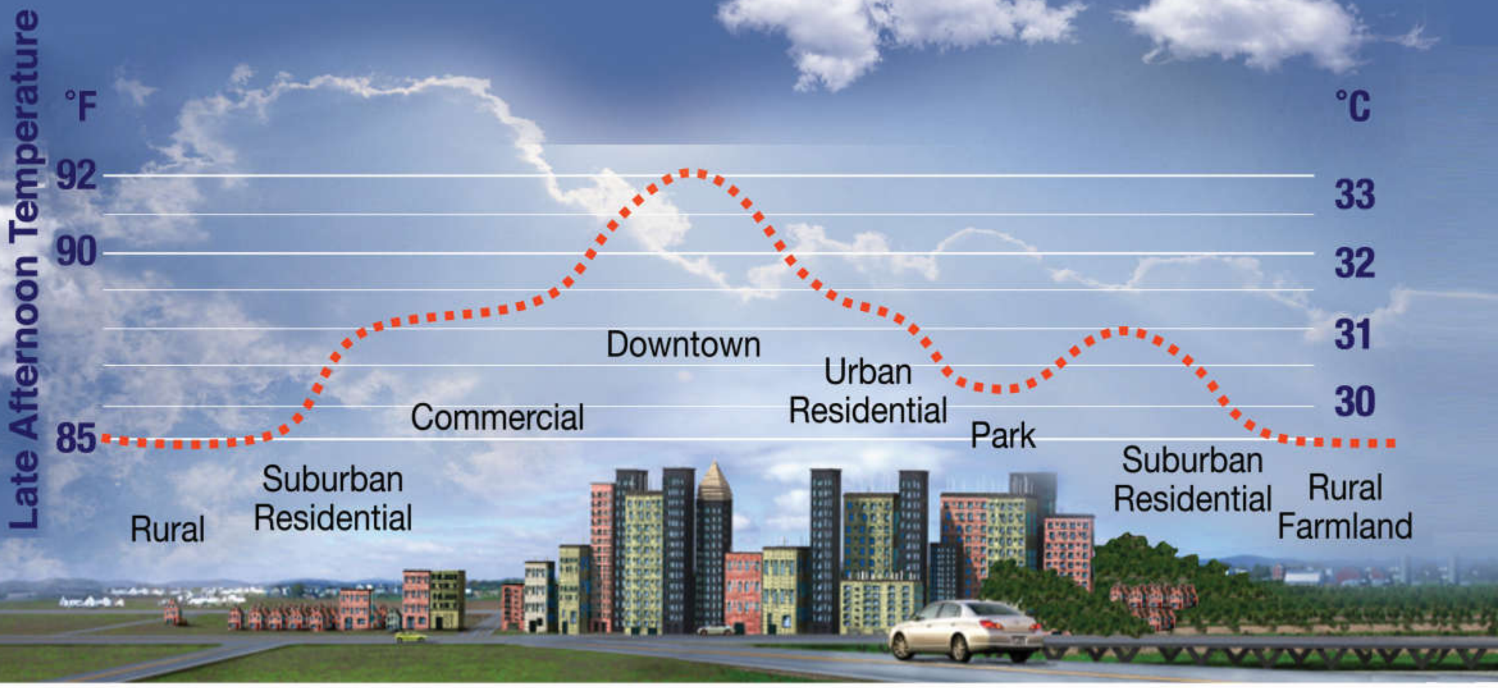
5th International Conference on

Countermeasures to Urban Heat Islands

02-04 December 2019

Book of Abstracts



IC2UHI 2019

International Institute of Information Technology Hyderabad

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IC2UHI-2019 Conference Agenda

Time	Particulars	Location
Day - 0 (December 1, 2019)		
18:00 - 20:30	Registration and Welcome Party	Hyatt Hyderabad Gachibowli
Day - 1 (December 2, 2019)		
09:00 - 10:00	Registration & Networking Tea	Reception Area - Himalaya
10:00 - 10:45	Inaugural Session	KRB Room
10:45 - 11:30	Keynote Address by Prof. David Sailor, Arizona State University	KRB Room
11:30 - 12:00	Tea Break	Reception Area - KRB Room
12:00 - 12:45	Plenary Talk by Prof. Hashem Akbari, Concordia University, Canada	KRB Room
12:45 - 13:00	Sponsors talk	KRB Room
13:00 - 14:00	Lunch	Reception Area - Himalaya
14:00 - 15:30	Technical Paper Parallel Sessions	Himalaya - 101 to Himalaya - 104
15:30 - 16:00	Tea Break	Reception Area - Himalaya
16:00 - 17:30	Technical Paper Parallel Sessions	Himalaya - 101 to Himalaya - 104
Day - 2 (December 3, 2019)		
09:30 - 10:00	Registration	Reception Area - Himalaya
10:00 - 10:15	Announcements	KRB Room
10:15 - 11:00	Keynote Address by Dr. Ronnen Levinson, LBNL, USA	KRB Room
11:00 - 11:30	Tea Break	Reception Area - Himalaya
11:30 - 13:00	Technical Paper Parallel Sessions	Himalaya - 101 to Himalaya - 104
13:00 - 14:00	Lunch	Reception Area - Himalaya
14:00 - 15:30	Technical Paper Parallel Sessions	Himalaya - 101 to Himalaya - 104
15:30 - 16:00	Tea Break	Reception Area - Himalaya
16:00 - 16:45	Plenary: Panel Discussion-1	KRB Room
16:45 - 17:30	QUIZ on UHI	KRB Room
19:00 - 22:00	Cultural Event & Gala Dinner	Hyatt Hyderabad Gachibowli
Day - 3 (December 4, 2019)		
09:30 - 10:15	Keynote Address by Mr. Tanmay Tathagat, Environmental Design Solutions, India	KRB Room
10:15 - 11:00	Plenary: Panel Discussion-2	KRB Room
11:00 - 11:30	Tea Break	Reception Area - Himalaya
11:30 - 13:00	Technical Paper Parallel Sessions	Himalaya - 101 to Himalaya - 104
13:00 - 14:00	Lunch	Reception Area - Himalaya
14:00 - 14:30	Inaugural of Open Session	Himalaya - 105
14:30 - 15:00	Case Study on "*Cool Streets LA: Los Angeles' Cool Pavement Pilot*"	Himalaya - 105
15:00 - 15:30	UHI Mitigation Initiatives in India	Himalaya - 105
15:30- 16:00	Panel Discussion	Himalaya - 105
16:00 - 16:15	Sponsors Talk	Himalaya - 105
16:15 - 16:20	Summary of the Conference	Himalaya - 105
16:20 - 16:50	Conference Takeaways	Himalaya - 105
16:50 - 17:00	Awards and Closing Remarks	Himalaya - 105
17:00 - 18:00	High Tea & Networking	Reception Area - Himalaya

Overview of Parallel Technical Sessions

02 December	Room: Himalaya -101	Room: Himalaya -102	Room: Himalaya -103	Room: Himalaya -104
Parallel Session – 1				
02:00pm to 03:30pm	Analysis of UHI and its Effect across Scales-1	Urban Vegetation and Greenery-1	Remote Sensing of Cities and Urban Climates-1	Cool Materials Development & Characteristics-1
Parallel Session – 2				
04:00pm to 05:30pm	Outdoor Comfort and Health in the Urban Environment-1	Policies, Rating & Labeling Programs with UHI mitigation strategies	Urban Economy-1	Analysis of UHI and its Effect across Scales-2

03 December	Room: Himalaya -101	Room: Himalaya -102	Room: Himalaya -103	Room: Himalaya -104
Parallel Session – 3				
11.30am to 01.00pm	Analysis of UHI and its Effect across Scales-3	Resilient Design of Buildings in Response to Changing Climates	Measurement Techniques and Standards-1	Modeling and Forecasting Urban Climate and Weather-1
Parallel Session – 4				
02:00pm to 03:30pm	Urban Vegetation and Greenery-2	Outdoor Comfort and Health in the Urban Environment-2	Implementation of Urban Heat Mitigation Strategies-1	Case Study Presentations

04 December	Room: Himalaya -101	Room: Himalaya -102	Room: Himalaya -103	Room: Himalaya -104
Parallel Session – 5				
11.30am to 01.00pm	Cool Materials Development & Characteristics-2	Implementation of Urban Heat Mitigation Strategies-2	Outdoor Comfort and Health in the Urban Environment-3	Analysis of UHI and its Effect across Scales-4

Schedule of Parallel Technical Sessions

Day-1 (December 2, 2019)

Parallel Session – 1 Time: 02:00 pm to 03:30 pm

Analysis of UHI and its effect across scales – 1	Room: Himalaya-101	
Paper ID	**Paper Title**	**Presenting Author**
32	Effects of Heat Island Mitigation on Heat-Related Mortality in Montreal during Heat Wave Periods of 2005, 2011 and 2018	Hashem Akbari
63	Evaluation of momentum fluxes in developing internal boundary layers over an urban canopy	Afshin Afshari
161	Monitoring the urban heat island effect and the efficacy of future countermeasures in the Los Angeles Basin	Ronnen Levinson
238	Heat Vulnerability Index for Urban Heat wave Risk Adaptation for Indian Cities: A Case Study of Akola	Rajashree Kotharkar
256	Extent vs Impact: A modelling study of Targeted Heat Mitigation Strategies	David Sailor
Urban Vegetation and Greenery-1	**Room: Himalaya-102**	
Paper ID	**Paper Title**	**Presenting Author**
47	Influence of urban green on human thermal bio climate – Application of thermal indices and micro scale models	Andreas Matzarakis
89	The seasonal thermal environment in urban park and surrounding urban spaces: A case study in Xi'an, China	Yupeng Wang
111	Study of the thermal behaviour of unplanted extensive green roof sample according to the nature of the substrate	Maxime Chaumont
128	Surface Temperature Reduction by Tree Shade: Influence of Tree Characteristics	Andrew Speak
165	Sustainable Landscaping Initiatives in Three Educational Institutions in India	Mohan Kotamrazu
Remote Sensing of Cities and Urban Climates-1	**Room: Himalaya-103**	
Paper ID	**Paper Title**	**Presenting Author**
66	Downscale Land Surface Temperature based on Three Models to Analyze Urban Heat Island: A Case Study of Hangzhou	Rui Wang
170	Urban surfaces identification and characterization with remote sensing data and evaluation of possible mitigation alternatives	Giulia Santunione
189	Relationship Between Urban Land Use Dynamics and Land Surface Temperature: Current and Future Scenario Modelling	Nimish Gupta
220	Land surface temperature responses to land use dynamics across the agro-climatic zones of Karnataka	Madhumita Dey
241	Spatial and Temporal Nature of Urban Heat Island in Roorkee	Siva Ram Edupuganti
Cool Materials Development & Characteristics-1	**Room: Himalaya-104**	
Paper ID	**Paper Title**	**Presenting Author**
35	Quantum Dots: A New Generation of Fluorescent Materials for UHI Mitigation	Samira Garshasbi
102	Development of heterogeneous directionally reflective materials for building facades and measurements of their reflective properties	Riccardo Paolini
223	In Situ Assessment of the Cooling Effects of Pavement-Watering: Application to Cool & Low Noise Asphalt Roads	Sophie Parison
290	Cool Roof initiatives in India: An evaluation of the existing conditions and lessons to be learnt from global best practices	Hema Sree Rallapalli
295	Development of an online calculator for cool roof and green roof	Shanmukh Dontu

Schedule of Parallel Technical Sessions

Day-1 (December 2, 2019)

Parallel Session – 2 — Time: 04:00 pm to 05:30 pm

Outdoor Comfort and Health in the Urban Environment-1		**Room: Himalaya-101**
Paper ID	**Paper Title**	**Presenting Author**
51	Thermal Sensation and Thermal Load of Human Body in Irradiated Hot Environment	Atsumasa Yoshida
90	Quantitative Outdoor Thermal Comfort Assessment of Street: A case in warm and humid climate	Naga Brinda Deevi
107	Urban Micro-climate and Spatial Promotion for Creating the Historical Streets' Sustainability	Man Li
182	Local scale climate change assessment for preservation of cultural heritage sites and their resilience, the case study of Gubbio medieval city in Italy	Anna Laura Pisello
294	Summertime Thermal Comfort Assessment for Compact Local Climate Zone	Shweta Deshmukh
Policies, Rating & Labeling Program with UHI Mitigation Strategies		**Room: Himalaya-102**
Paper ID	**Paper Title**	**Presenting Author**
162	Solar-reflective "cool" walls: benefits, technologies, and implementation	Ronnen Levinson
237	Review of heat wave studies & related urban policies: Case of South Asia	Rajashree Kotharkar
261	A Big Picture of Urban Heat Island Mitigation Strategies and Recommendation	Vaibhav Rai Khare
14	Effect and Development of Cool Roofs: A Review	Meng Zhen
15	Outdoor Thermal Sensation and Thermal Comfort in Xi'an	Meng Zhen
Urban Economy-1		**Room: Himalaya-103**
Paper ID	**Paper Title**	**Presenting Author**
13	Health and energy benefits of urban overheating mitigation counteracting climate change	Riccardo Paolini
57	Use Urban Green as a Mitigation Strategy to Combat Urban Heat Island Effect: A Case of Puri-Cuttack Road, Bhubaneswar, Odisha	Sukanya Dasgupta
94	Spatiotemporal Characteristics of Anthropogenic Heat and Its Impact on Outdoor Thermal Environment in a University in Chongqing	Zhongyu Hao
198	Climate-Informed Decision-Making for Urban Design: Assessing the Impact of Urban Morphology on Urban Heat Island	Gloria Pignatta
248	Assessing the benefits of UHI mitigation for indoor heat exposure during concurrent heat wave and blackout events in Phoenix, Arizona	Brian Stone Jr.
Analysis of UHI and its Effect across Scales-2		**Room: Himalaya-104**
Paper ID	**Paper Title**	**Presenting Author**
68	Assessment of surface urban heat island and urban cooling effect based on downscaling LST, a case study of Fukuoka prefecture, Japan	Wangchongyu Peng
110	Urban features at neighbourhood scale to assess and mitigate the heat island in arid Mendoza, Argentina	Michele Zinzi
132	Development and Application of "Shadow Ratio" for Evaluating Urban Thermal and Wind Environment - Take a Site of Xi 'an West Street as an Example	Dian Zhou
187	Impact Analysis of Deep Static Blue space on Urban Heat Island: Case of Chandigarh	Aditya Rahul
291	Satellite based observations for Surface level Urban Heat Island over Bhubaneswar: A case study	Dudam Bharath Kumar

Schedule of Parallel Technical Sessions

Day-2 (December 3, 2019)

Parallel Session – 3 Time: 11:30 am to 01:00 pm

Analysis of UHI and its Effect across Scales-3	Room: Himalaya-101	
Paper ID	**Paper Title**	**Presenting Author**
48	Evaluation Urban heat island and bio climate studies in Freiburg, Germany	Andreas Matzarakis
284	Characteristics of micro weather stations distributions for urban heat island monitoring and corresponding thermal mapping	Tzu-Ping Lin
152	Thermal Studies of Mid-latitude Urban Environment	Roger Clay
270	Conceptual Framework for Environmental City Planning Tool with an Intelligent System based on BIM and GIS Technology	Shinji Yamamura
287	Assessment of variation in Intra Canopy Layer Urban Heat Island Intensity in Residential areas --- A case study of Nagpur City	Sujata Godbole
Resilient Design of Buildings in Response to Changing Climates	**Room: Himalaya-102**	
Paper ID	**Paper Title**	**Presenting Author**
23	Study of Adaptive City by Osaka Heat Island Countermeasure Technology Consortium	Hideki Takebayashi
99	"Cradle to Gate" Assessment Of Material Related Embodied Carbon: A Design Stage Stratagem For Sustainable Housing	Ashan Jayawardana
130	The resilient design for traditional residential building in Northern Shaanxi of China	Yupeng Wang
131	The Resilient Design for Small Commercial Building – A Case in City Center of Gifu, Japan of micro weather stations distributions for urban heat island monitoring and corresponding thermal mapping	Dian Zhou
239	Assessing resilience to summertime overheating in modern low energy flats in UK	Rajat Gupta
Measurement Techniques and Standards-1	**Room: Himalaya-103**	
Paper ID	**Paper Title**	**Presenting Author**
77	Impact Zonation and Mitigation of UHI (through remote sensing & development of Blue-Green Infrastructure Network)	Atul Kumar
183	Microclimate analysis of UHI affected areas through wearable monitoring systems: the case study of New York City	Ilaria Pigliautile
232	Local Climate Zone Classification and Seasonal Variation by using Land Surface Temperature: A case of National Capital Territory, Delhi, India	Manoj Panwar
278	“Inverted” Surface UHI: An artefact of relying solely on Satellite Remote Sensing data for measuring the Urban Heat Island Phenomenon	Prasad Pathak
180	Green Infrastructure Strategies as Countermeasures to Urban Heat Islands with particular reference to the Bangalore Metropolitan Region	Reshmi MK
CS-1	Evaluation of countermeasures for thermal environment in Delhi by urban canopy-building energy coupled simulation	Takaharu Ota
Modelling and Forecasting Urban Climate and Weather-1	**Room: Himalaya-104**	
Paper ID	**Paper Title**	**Presenting Author**
64	Improving the Accuracy of Simplified Urban Models Using Actual Radiation Parameters	Afshin Afshari
121	Urban Heat Island Minimisation, Local Climate Zones and Parametric Optimisation: A “Grasshopper” Based Model	Dilushan M. Kodikara
153	Modelling potential air temperature reductions yielded by cool roofs and urban irrigation in the Kansas City Metropolitan Area	Ronnen Levinson
208	Envelope heat load characteristics of the building cluster considering radiate heat exchange process in an urban district	Yasunobu Ashie
245	Minimizing the inconsistencies of urban building energy simulations through strong microclimate coupling	Georgios-E Kryakodis

Schedule of Parallel Technical Sessions

Day-2 (December 3, 2019)

Parallel Session – 4

Time: 02:00 pm to 03:30 pm

Urban Vegetation and Greenery-2	Room: Himalaya-101	
Paper ID	**Paper Title**	**Presenting Author**
50	Assessment of Terrace Gardens as Modifiers of Building Microclimate	Pranjali Varshney
114	Study of Urban Morphology and Its Impact on Microclimate of Surrounding Area Case Study – SB Road, Pune	Sujata Karve
125	A study on Park Cooling Island Effect on Surrounding Urban Area, in Urban Design Perspective	Shuowen Chi
214	High albedo plant selection for mitigation of the urban heat island	Giulia Santunione
279	A Comparative empirical assessment of native deciduous and evergreen trees on carbon stock potential for regulating ecosystem services in tropical dry evergreen forest, Coromandel coast, Tamil Nadu, India	Parisutha Rajan
Outdoor Comfort and Health in the Urban Environment-2	**Room: Himalaya-102**	
Paper ID	**Paper Title**	**Presenting Author**
54	Comprehensive evaluation of the influence of outdoor temperature change on health around the urban area	Daisuke Narumi
92	Outdoor Thermal Comfort Implications of Planning and Building Regulation Induced Canyon Geometry	Jeny Hepsheba Jeyakumar
147	Analysis of urban parameters to improve outdoor thermal comfort in Singapore new high rise developments	Juan A. Acero
185	Effectiveness of UHI mitigation strategies for outdoor thermal comfort enhancement	Ilaria Pigliautile
297	Effect of urban morphology on urban microclimate: A case of Vijayawada	Madhavan G R Yadav
Implementation of Urban Heat Mitigation Strategies-1	**Room: Himalaya-103**	
Paper ID	**Paper Title**	**Presenting Author**
33	Effects of Albedo Enhancement on Air Temperature and Ozone Concentration in Four Cities over North America: Sacramento, Houston, Chicago and Montreal during the 2011 Heat Wave Period	Hashem Akbari
43	Urban and peri-urban agriculture in Goiânia: searching for solutions for mitigation and urban adaptation in a context of global climate change	Karla Emmanuela R. Hora
171	Materials for outdoor curtains and awnings as a solution for improving thermal comfort and mitigating urban heat island	Andrea Nicolini
224	Physical and geographic analysis of the urban cooling potential	Maxime Chaumont
226	Linkages between built form and open spaces and its impact on thermal comfort: A case of Mumbai, India	Surabhi Mehrotra
Case Study Presentations	**Room: Himalaya-104**	
Paper ID	**Paper Title**	**Presenting Author**
CS-2	Vulnerability to Heat Stress A Case Study of Yavatmal, Maharashtra	Premsagar Tasgaonkar
CS-3	Evaluation of the surface urban heat island intensity with respect to the different local climatic zones	Judit Bartholy
CS-4	Development of Education Materials for Awareness of Junior Generation on Urban Heat Island Counteraction	Toshiaki Ichinose
CS-5	Truth in Architecture	Tushar Parikh
CS-6	Urban Climate Adaptation Strategy for Tropical Megacities Utilizing Energy Efficient Technologies	Kazuki Yamaguchi

Schedule of Parallel Technical Sessions

Day-3 (December 4, 2019)

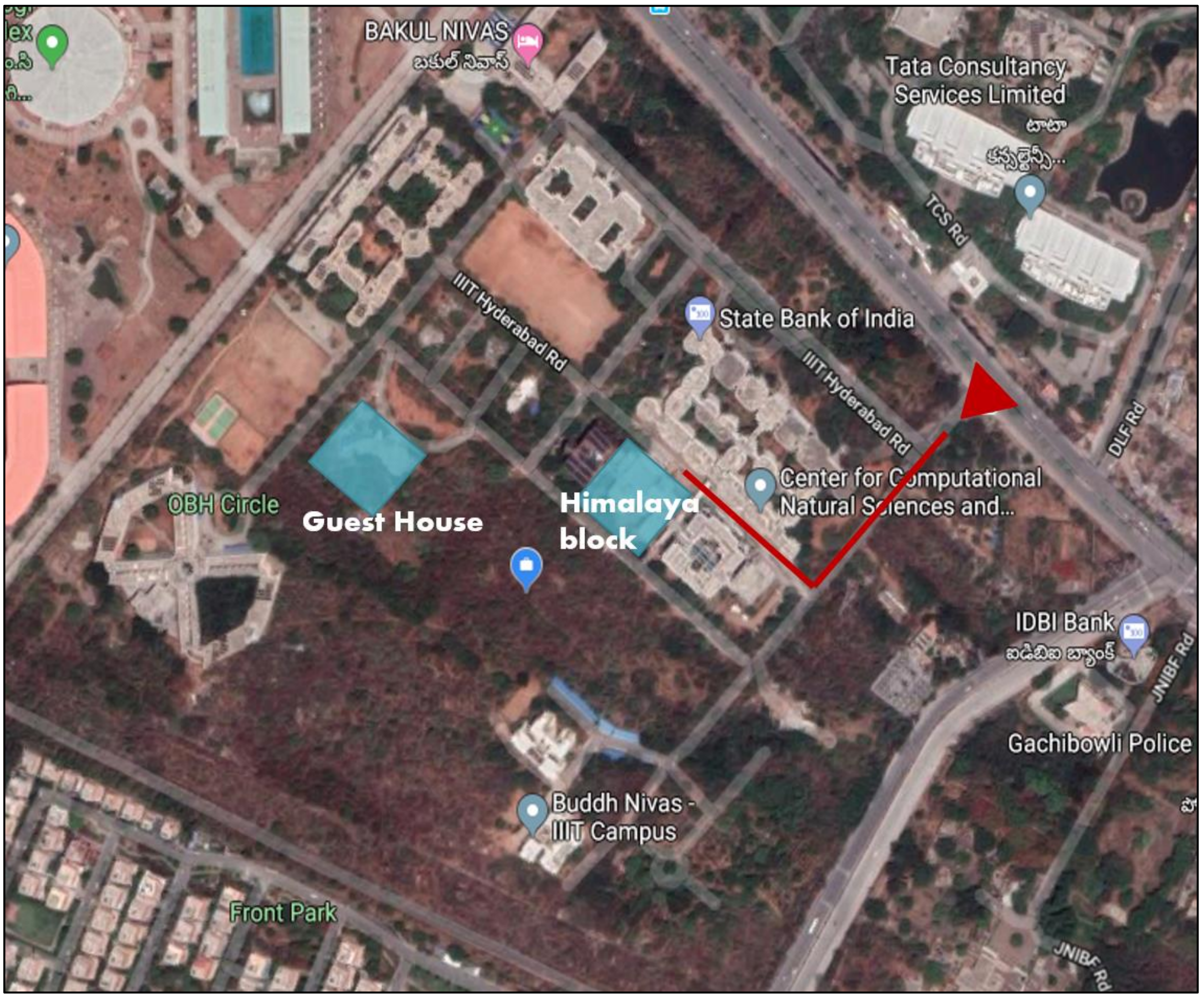
Parallel Session – 5 Time: 11:30 am to 01:00 pm

Cool Materials Development & Characteristics-2		Room: Himalaya-101
Paper ID	**Paper Title**	**Presenting Author**
76	The evaporative cooling and its impact on the urban climate: study of the influence of road covering materials	Sophie Parison
138	Potential of switching cool materials to optimize the thermal response of residential buildings in the Mediterranean region	Michele Zinzi
173	Black Titanium Dioxide: An Innovative Material to minimize the Urban Heat Island Effects in Walled city of Jaipur	Prasanna Bhangdia
253	Numerical Analysis of Human Thermal Load Affected by Solar Reflection Characteristics of Vertical Wall in Street Space	Shinichi Kinoshita
274	Harnessing Benefits of Pervious Concrete Pavements: A Novel UHI Mitigation Strategy	Poornachandra Vaddy
Implementation of Urban Heat Mitigation Strategies-2		**Room: Himalaya-102**
Paper ID	**Paper Title**	**Presenting Author**
44	A pavement-watering thermal model validation for SOLENE-microclimate: application to the Buirestreet	Auline Rodler
126	The Oasis Project: UHI mitigation strategies applied to Parisian schoolyards	Ghid Karam
129	Impact of Urban Heat Island formation on electricity consumption over Delhi region	Priyanka Kumari
293	Effect of UHI and Building Geometry on Pollution Dispersion in an Urban Street Canyon	Udayraj
299	Controlled experiment for estimating the energy-saving potential and indoor thermal comfort improvement by the use of high albedo surfaces on pitched concrete roofs	Aviruch Bhatia
Outdoor Comfort and Health in the Urban Environment-3		**Room: Himalaya-103**
Paper ID	**Paper Title**	**Presenting Author**
46	Heat Health Warning System in Germany – Implementation of city issues	Andreas Matzarakis
81	The effects of commuter travel behaviour on transportation heat and pollution emissions	Man Li
96	Study on the Microclimate Effect of Water Body Form in Urban Square	Ziyu Tong
172	Experimental evaluation of thermal comfort improvement due to innovative solutions for tensile structures	Federico Rossi
207	Effects of the Green Façade on Thermal Comfort in the Transitional Spaces: Field Measurements in Munich, Germany	Hankun Lin
Analysis of UHI and its Effect across Scales-3		**Room: Himalaya-104**
Paper ID	**Paper Title**	**Presenting Author**
191	Evaluating urban heat island due to built morphology in Pune city	Sujata Karve
302	Evaluation of sleep disorder caused by urban heat island based on the Pittsburgh Sleep Quality Index	Tomohiko Ihara
303	Evaluation of the Daily Cycle of UHI using Multi-site Measurements in a Central European Capital City	Rita Pongracz
49	Study on Appropriate Ground Cover Configuration of Open Spaces to Mitigate Urban Heat Island Effect	Yuvraj Mesharam
300	Land surface temperature variations: Case study Bhopal (MP)	Arka Kanungo

Conference Venue and Map

The 5[th] International Conference on Countermeasures to Urban Heat Islands (IC2UHI) will be held in the International Institute of Information Technology (IIIT) Hyderabad campus.

- The **plenary and the parallel sessions** will be held at the **Himalaya block**.
- **Lunch** will be served at the **Guest house**
- **Welcome Party** and the **Banquet dinner** will be at the **Hyatt, Gachibowli**



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Hosted by:
IIIT Hyderabad, India
Venue: IIIT Hyderabad, Gachibowli, India

Keynote Addresses

December 2, 2019
10:45 am to 11:30 am

Prof. David Sailor

David Sailor received his PhD from the University of California at Berkeley in 1993. He conducted his doctoral research in the Urban Heat Island Group at the Lawrence Berkeley National Laboratory under the direction of Hashem Akbari and Art Rosenfeld. His first academic appointments were at Tulane University (1993-2003) and Portland State University (2003-2015). In 2016 he joined Arizona State University (ASU) as Professor in the School of Geographical Sciences and Urban Planning. He also serves as Director of the Urban Climate Research Center—a center that leverages the diverse expertise of more than 36 faculty affiliates across 7 schools at ASU to develop and implement large-scale highly-interdisciplinary projects addressing crucial atmospheric environment challenges for cities. Professor Sailor's scholarly agenda focuses on the intersection of climate with the built environment. This includes investigation of feedback mechanisms between the built environment and climate with a focus on building energy consumption and renewable energy resources as well as both indoor and outdoor thermal comfort and air quality. He has worked extensively on quantifying the causes and prospects for mitigating the urban heat island effect, including investigation of innovative materials and technologies integrated into building designs and urban infrastructure. Dr. Sailor has also been quite active in several societies that focus on urban climate systems. This includes serving as chair of the American Meteorological Society's Board on the Urban Environment (2008-2011) and as secretary of the board of the International Association for Urban Climate (2014-2018).

December 3, 2019
10:15 am to 11:00 am

Dr. Ronnen Levinson

Dr. Ronnen Levinson is a Staff Scientist and Leader of the Heat Island Group at Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. Within his research portfolio he develops cool roof, wall, and pavement materials; improves methods for the measurement of solar reflectance; and quantifies the energy and environmental benefits of cool surfaces. He serves on the boards and technical committees of the Cool Roof Rating Council and the Global Cool Cities Alliance; represents the United States in International Energy Agency Annex 80 (Resilient Cooling); and advises policymakers, code officials, utilities, and building rating programs about cool surfaces. He holds a B.S. in engineering physics from Cornell University and an M.S. and a Ph.D. in mechanical engineering from the University of California at Berkeley. He has authored or co-authored over 100 publications and serves on the editorial boards of Energy & Buildings and Solar Energy. He received the 2016 Marty Hastings Award for outstanding contributions to the Cool Roof Rating Council, and a 2016 R&D 100 Award for invention of the Cool Roof Time Machine.

December 4, 2019
09:30 am to 10:15 am

Mr. Tanmay Tathagat

Mr. Tanmay Tathagat has a background of architecture and engineering. He works on projects dealing with sustainable development, building energy efficiency, green buildings, and energy efficiency standards and labeling in Asia, Africa and the US. Tanmay leads the Environmental Design Solutions [EDS] team of consultants working on climate change policies, energy efficient building design, building code development, energy efficiency policy development, energy simulation and green building certification process. His work over the last 25 years includes, the development of Energy Conservation Building Code (ECBC 2007 and ECBC 2017) and Eco-Housing program in India and is currently leading the Market Transformation and Integration for Energy Efficiency (MAITREE) program as part of the US-India Bilateral initiative. Since 2003 EDS has worked on hundreds of green buildings, energy efficiency, and policy research projects worldwide.

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PAPERS TO BE PRESENTED IN PARALLEL SESSIONS

Day-1: Parallel Session – 1 (02:00 pm to 03:30 pm)

Analysis of UHI and its Effect across Scales-1

Urban Vegetation and Greenery-1

Remote Sensing of Cities and Urban Climates-1

Cool Materials Development & Characteristics-1

Day-1: Parallel Session – 2 (04:00 pm to 05:30 pm)

Outdoor Comfort and Health in the Urban Environment-1

Policies, Rating & Labeling Program with UHI Mitigation Strategies

Urban Economy-1

Analysis of UHI and its Effect across Scales-2

Day-2: Parallel Session – 3 (11:30 am to 01:00 pm)

Analysis of UHI and its Effect across Scales-3

Resilient Design of Buildings in Response to Changing Climates

Measurement Techniques and Standards-1

Modelling and Forecasting Urban Climate and Weather-1

Day-2: Parallel Session – 4 (02:00 pm to 03:30 pm)

Urban Vegetation and Greenery-2

Outdoor Comfort and Health in the Urban Environment-2

Implementation of Urban Heat Mitigation Strategies-1

Case Study Presentations

Day-3: Parallel Session – 5 (11:30 am to 01:00 pm)

Cool Materials Development & Characteristics-2

Implementation of Urban Heat Mitigation Strategies-2

Outdoor Comfort and Health in the Urban Environment-3

Analysis of UHI and its Effect across Scales-3

Day-3: Plenary Session (02:30 pm to 03:00 pm)

Case Study Presentation

Analysis of UHI and its Effects Across Scales – 1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 32

Effects of Heat Island Mitigation on Heat-Related Mortality in Montreal during Heat Wave Periods of 2005, 2011 and 2018

Zahra Jandaghian[1], Hashem Akbari[2]
[1]Research Assistant at Ryerson University, [2]Professor at Concordia University (Canada)

Abstract:

Heat-related mortality (HRM) is increasing as a result of climate change leading to extreme heat events. Increasing surface reflectivity is applied to mitigate the effects of heat island and high temperature in urban areas. The Weather Research and Forecasting model (WRF) is coupled with a multi-layer of the Urban Canopy Model (ML-UCM) to investigate the effects of heat island mitigation strategy during the 2005, 2011 and 2018 heat wave periods in the Greater Montreal Area (GMA). Three indicators are applied to translate the effects of extreme heat events and the potential of albedo enhancement on HRM rates: air mass type, air temperature and apparent temperature changes for each day of simulations. Using the Spatial Synoptic Classification (SSC) indicates that the moist tropical plus and dry tropical weather have the highest rank in HRM. The non-accidental mortality data during summer period are employed. The heat-induced mortality correlations are defined on daily basis based on consecutive days of the heat wave events, the day in summer season and apparent temperature in ^{o}C. The albedo of roofs, walls and ground increased from 0.2 by 45%, 40% and 25%, respectively. The beneficial contributions of albedo enhancement are a decrease in daily averaged temperature by nearly 1^{o}C and an increase in daily averaged dew point temperature by 0.4^{o}C. Heat island strategy shift days into less oppressive air masses by 50%. The heat-related death will decrease by at least 3 to 5%, meaning that seven to twelve lives could be saved during these heat wave events.

Paper ID: 63

Evaluation of momentum fluxes in developing internal boundary layers over an urban canopy

Nicolas Ramirez[1], Afshin Afshari[2]
[1]Smart4Power, United Arab Emirates,
[2]Fraunhofer Institute of Building Physics, Germany

Abstract:

The evolution of the atmospheric boundary layer (ABL) overstep changes in roughness has been extensively investigated and the layers that appear are well defined. However, the effect of heterogeneous surfaces on the Urban Boundary Layer (UBL) structure has seldom been studied in a quantitative way for un-developed flows due to different constraints. We conduct an extensive visual and analytical analysis of the developing UBL over a large portion of the city of Abu Dhabi using a steady-state RANS simulation. For the first time, we attempt to analyse and identify the different boundary regions that appear above a real city, introducing an innovative layer herein called the combined boundary layer (CBL), which is the height above which the flow has fully adapted to the combined effects of the upstream and local roughness. It is found that it behaves in much the same way as the equilibrium layer found over constant-roughness surfaces. Furthermore, the roughness sub layer (RSL) grows out of the CBL as it adjusts to the underlying surface. Across the RSL depth, layers that are in local equilibrium (LEL) with the underlying roughness appear such that the LELs of upstream patches become plumes that flow over the LELs of downstream patches. Moreover, these plumes seem to fade with fetch for our simulation. We further propose an original methodology to define and characterize the depth of these layers for any developing UBL using the derivative of the velocity field with respect to the span wise direction and height, $\partial u/\partial y$ and $\partial u/\partial z$, respectively.

Analysis of UHI and its Effects Across Scales – 1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 161

Monitoring the urban heat island effect and the efficacy of future countermeasures in the Los Angeles Basin

Ronnen Levinson[1], George Ban-Weiss[2], Sharon Chen[1], Haley Gilbert[1], Howdy Goudey[1], Joseph Ko[2],
Yun Li[2], Arash Mohegh[2], Angie Rodriguez[3], Jonathan Slack[1], Haider Taha[4],Tianbo Tang[2], Jiachen Zhang[2]
[1]Lawrence Berkeley National Laboratory (USA),
[2]University of Southern California (USA)
[3]National Autonomous University of Mexico, Mexico City (Mexico),
[4]Altostatus Inc. (USA)

Abstract:

To understand spatial air-temperature variations in local urban heat islands (UHIs) and urban cool islands (UCIs), and their relationship to land-use and land-cover (LULC) properties in the Los Angeles Basin, we sought to (a) use fine-resolution climate models to identify UHI / UCI areas, (b) relate observed intra-urban temperature variations (from mobile transects and stationary monitors) to LULC and surface physical properties, and (c) calibrate/validate the fine-resolution meso-urban climate models that were used in identifying the UHI / UCI. We conducted a multi-dimensional assessment of urban temperature variations based on numerical modelling and several types of observations, including mobile transects dense networks of personal weather stations, and sparse but more accurate research-grade stationary weather monitors. To identify the causative factors of the UHI / UCI at the neighbourhood scale, we collected detailed LULC datasets, such as 1-m resolution roof albedo and tree canopy cover, as inputs for the meteorological modelling and analysis. The fine-scale meteorological model was used to design mobile-transect routes and to site the stationary monitors based on the definition of UHI / UCI areas. This study provides the first observational evidence from analysis of high spatial density weather stations that increases in roof albedo at neighbourhood scale are associated with reductions in near-surface air temperature. This was corroborated with the analysis from mobile transect measurements and correlation of observed air temperature with neighbourhood-scale albedo and vegetation canopy cover, which revealed a cooling effect from area-wide increase in albedo and/or canopy cover.

Analysis of UHI and its Effects Across Scales – 1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 238

Heat Vulnerability Index for Urban Heat wave Risk Adaptation for Indian Cities: A Case Study of Akola

Rajashree Kotharkar[1], Sahil Aneja[2], Aveek Ghosh[3]
[1]Professor, Visvesvaraya National Institute of Technology (India)
[2]M. Tech Student, Visvesvaraya National Institute of Technology (India)
[3]PhD Scholar, Visvesvaraya National Institute of Technology (India)

Abstract:

According to IPCC report 2012, the intensity, duration, and frequency of heat wave are going to increase in the upcoming future (IPCC 2012)and from past experience shows that heatwave has a strong relation to human health. (Meteorological Bulletins 2003)(NDMA 2016)(ClimateCouncil 2016). However, in India to tackle heat wave, Heat Action Plan (HAP) was prepared involving do's and don'ts strategy in which spatial pattern of vulnerability have not been addressed and excludes the role of an urban planner (Anjali Jaiswal, 2013). A Heat Vulnerability Index (HVI) was proposed using the GIS-based spatial information system which presents an overall vulnerability considering three more indices based on sensitivity, exposure, and adaptive capacity. This study entails a comprehensive method for preparing HVI which is constructed based on data extracted from census tract and remote sensing data accessed via Principal Component Analysis (PCA). The study also describes the criteria for selecting the indicators for constructing three indices and overall HVI taking weightage factor by variance in the context of Indian cities. The objective of the study is to perform a comparative analysis of vulnerability considering the indices and their interrelationship study at a local scale in India. These indices will further help in resource distribution, urban planning measures and also for proposing the specific policies which can help in risk adaptation of heat hazards in the dynamic nature of urban areas in a more accurate way.

Paper ID: 256

Extent vs. Impact: A modelling study of Targeted Heat Mitigation Strategies

David J. Sailor[1], Peter J. Crank[1],Jannik Heusinger[2],Masayuki Hara[3],
[1]Arizona State University (USA), [2]TU Braunschweig (GERMANY)
[3]Center for Environmental Science in Saitama (JAPAN)

Abstract:

The strength of any downwind cooling effect of high-albedo surface modifications on near-surface air temperature depends upon the location of the mitigation strategy (roof vs ground level), local turbulent mixing, and the spatial extents of the modified surface and the downwind region of interest. A vexing question in the urban climate community and local government decision-makers is: how far downwind are the effects of any mitigation strategy felt? To address this question, we conduct an idealized modelling study to explore downwind effects of urban heat mitigation. The simulations, while idealized, are focused on the city of Phoenix Arizona, USA. We explore the question across scales by using both micro scale and musicale atmospheric models—ENVI-met and WRF, respectively. Each model is centered on the same residential neighbourhood near the center of a city comprising a uniform array of residential neighbourhood blocks. A base case (control) simulation is conducted for each simulation set, followed by high albedo roof and high albedo ground cases. The hybrid modelling approach allows investigation of mitigation scales ranging from hundreds of meters to tens of kilometres. We present results from these suites of simulations demonstrating the relationship between the spatial extent of the ground-level and roof-level mitigation action and the local and downwind footprint of the resulting air temperature perturbations.

Urban Vegetation and Greenery-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 47

Influence of urban green on human thermal bio climate – Application of thermal indices and micro scale models

Andreas Matzarakis[1], Marcel Gangwisch[1], Dominik Fröhlich[1]
[1]Research Centre Human Biometeorology, German Meteorological Service (Germany)

Abstract:

For the quantification of the atmospheric conditions and their impact on humans, methods from human biometeorology can be applied. For the thermal component air temperature, humidity, wind and radiation fluxes are the key factors, which are required. Most significant for urban areas and urban green is the quantification of heat stress, which can be estimated by thermal indices, e.g. the Physiologically Equivalent Temperature (PET), the Perceived Temperature (PT), or the Universal Thermal Climate Index (UTCI). For an overall assessment, different approaches can be applied based on measurements and models (e.g. Ray Man, ENVI-met and Sky Helios) for single points (Points of Interest) within urban areas or neighbourhoods and city quarters (Areas of Interest). The most relevant reduction of heat stress can be obtained by increasing shade with specific trees and by improving wind conditions. These two factors (radiation and wind modification) can be extremely helpful in the creation of optimized thermal comfortable urban places with green areas. The application of models, which focus on long term quantifications, can deliver valuable results and information for whole year assessment of the effect of urban green on human thermal bio climate. In addition, models deliver additional basic parameters (sun paths, sunshine duration, aerodynamic roughness), which are important in the estimation of the effects of urban green on human thermal bio climate. In particular, this information is available for future planning and construction.

Paper ID: 89

The seasonal thermal environment in urban park and surrounding urban spaces: A case study in Xi'an, China

Dixuan Ma[1], Yupeng Wang[1], Zongzhou Zhu[1]
[1]Xi'an Jiaotong University (China)

Abstract:

Urban parks are providing favourable conditions for sustainable urban planning, which is beneficial to the urban microclimate in different seasons. However, few studies have focused on the seasonal differences and comparisons between different urban spaces. In this research, air temperature, wind speed and wind direction of three seasons in the Xingqing Palace Park and its surrounding urban areas were measured in 2018. Through the analysis of air temperature, the actual seasonal thermal environment of park and surrounding urban spaces in different seasons is clarified. The temperature of high-rise building space and multi-story campus space in winter park is higher, but the temperature change of the multi-story residential building space is opposite to that of the park; the temperature difference between the inside and outside of the park is small and the fluctuation is diverse in spring; the internal temperature of park is slightly lower than the surrounding space in summer. In terms of application, surrounding urban spaces can be optimized in the future based on analysis results, so that the urban park can better exert its function by combining with the surrounding urban space, to mitigate the urban heat island (UHI) effect.

Urban Vegetation and Greenery-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 111

Study of the thermal behaviour of unplanted extensive green roof sample according to the nature of the substrate

Chaumont Maxime[1], Parison Sophie[2], Hendel Martin[1,3], Royon Laurent[1]
[1]Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS(France)
[2]Paris City Hall (France), Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS(France)
[3]Université Paris-Est, ESIEE Paris, département SEN (France)

Abstract:

In this study we are interested in the influence of substrate composition on the thermal behaviour unplanted extensive green roof structures. We also focus on the impact of on substrate water content on roof behaviour. Two kinds of substrates are studied: the first is a compost-based gardening soil, while the second is sampled taken from a Parisian park (urban soil). It appears that the sample with the compost stores much less heat than the one with the urban soil. This trend is valid whether the substrates are dry or saturated with water. It should be noted, however, that the near-surface temperature is 5°C higher in the case of compost, and that the presence of water increases the thermal conductivity of the latter.

Paper ID: 128

Surface Temperature Reduction by Tree Shade: Influence of Tree Characteristics

Andrew Speak[1], Leonardo Montagnani[1] , Camilla Wellstein[1], Stefan Zerbe[1]
[1]Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

Abstract:

The shade provided by trees in cities can help to counteract Urban Heat Islands (UHI). This study used a thermal camera to record the surface temperatures of three common urban surfaces – asphalt, porphyry, and grass – in the shade of single tree crowns, of multiple species, during the peak temperature period of summer days. By subtracting from the temperature of adjacent unshaded ground, measures of the degree of cooling were made. The cooling was related to a multitude of tree traits, of which Leaf Area Index (LAI) and crown width were the most important. Median average cooling of 16.4, 12.9 and 8.5°C was seen in the western edge of the tree shade for asphalt, porphyry and grass, respectively. Maximum temperatures were reduced by roughly 19 °C for all surface types. Strategic planning of single trees in cities can have significant impacts on the absorption of solar radiation by ground surface materials and thus the magnitude of the UHI.

Urban Vegetation and Greenery-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 165

Sustainable Landscaping Initiatives in Three Educational Institutions in India

Mohan Kotamrazu[1]
[1]*School of Architecture, GITAM (Deemed to be University), (India)*

Abstract:

Green landscaping, environmentally friendly landscaping or sustainable landscaping is a way of designing gardens and larger landscapes which reduce harm to the environment. Green landscaping lowers maintenance which results in cost reduction. By treating water (both rainwater and water used for domestic or landscaping purposes) as a valuable resource and not as a waste product it aims to conserve water by reusing it or reducing its use. Plants, shrubs, ground covers and vines are used passively for improving environmental quality, modifying microclimates, reducing temperatures in and around buildings which ultimately result in improvement in environmental quality and in energy conservation. Educational campuses can serve as a laboratory where the application of sustainable landscaping principles can be directly seen by students using the spaces in the campus. The present paper presents some of the landscaping strategies adopted by three different campuses in the country namely Piloo Mody College of Architecture, Cuttack, Kits Ramtek, Maharashtra and GITAM (Deemed to be University), Visakhapatnam.

Remote Sensing of Cities and Urban Climates-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 66

Downscale Land Surface Temperature based on Three Models to Analyze Urban Heat Island: A Case Study of Hangzhou

Rui Wang[1], Wangchongyu Peng[1], Wei Chen[2], Weijun Gao[1]
[1]The University of Kitakyushu (Japan), [2]Xi'an Jiaotong University (China)

Abstract:

Land surface temperature (LST) is a pivotal indicator in urban heat island (UHI) research. Nowadays, remote sensing technology plays an increasingly important role in LST research with the development of space technology. However, remote sensing data still has some shortcomings. In order to solve the problem of long revisit period and the data shortage caused by cloud, rain and some other weather trouble at low-scale and the problem of low resolution at high-scale in LST research, this research downscales LST based on three models from 1km to 100m to analyze UHI in day and night of four seasons, based on Modis data and Landsat-8 data. They are Random Forest Model (RF Model), Multivariate Regression Model (MR Model) and Thermal sharpens Model (TsHARP Model). This research takes an area (25*25km) of Hangzhou as the study area. R2 and RMSE are introduced to evaluate the conversion accuracy of three models. Research indicates: Among the three downscaling models, RF model has the highest accuracy to downscale LST from 1kmto 100m, followed by MR model, the accuracy of TsHARP model is the lowest. From the time dimension, the downscaling accuracy in summer and winter is obviously higher than that in spring and autumn, and the accuracy at night is generally than during day. During daytime, the LST of urban centre is lower than that of surrounding area, and at night, is higher. The LST difference during daytime in different areas in study area is generally higher than that at night.

Paper ID: 170

Urban surfaces identification and characterization with remote sensing data and evaluation of possible mitigation alternatives

Chiara Ferrari[1], Francesca Despini[1], Giulia Santunione[1], Tommaso Barbieri[1], Stefano Tommasone[1],
Alberto Muscio[1], Sergio Teggi[1],
[1]Department of Engineering Enzo Ferrari, University of Modena and Reggio Emilia (Italy)

Abstract:

Considering the new IPCC report and its recent suggestion, it is important to pay seriously attention to Urban Heat Island. In this study the surface albedo, one of the main causes of UHI, was analyzed focusing our attention on the city of Modena, a medium size municipality in the Emilia Romagna region, Italy. A satellite image, acquired by Worldview3 sensor, has been processed to classify the different kind of urban surfaces (tiles roofs, dark bituminous roofs, aluminium roofs, streets, parking's, green areas, etc…) and to compute the albedo value for each of these surfaces. Ground field measurements have been used to validate satellite values. Based on the results obtained, several UHI mitigation scenarios were analyzed varying the albedo of urban surfaces by choosing solar reflecting materials. In particular tiles roofs, grey roofs and parking have been considered as "modifiable surfaces" and their albedo values have been increased with respect to literature and data available from companies. For each proposed scenario, the reduction of intensity of Urban Heat Island (ATD), the energy saving brought by reduction of cooling system (ΔE) and the consequent money saving were calculated.

Remote Sensing of Cities and Urban Climates-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 189

Relationship Between Urban Land Use Dynamics and Land Surface Temperature: Current and Future Scenario Modeling

Nimish G.[1], Chandan M. C.[1], Bharath H. A[1]
[1]Ranbir and Chitra Gupta School of Infrastructure Design and Management, Indian Institute of Technology Kharagpur, West Bengal – 721302, India

Abstract:

Anthropogenic activities have ominously transformed landscape (unplanned urbanization) over past few decades affecting the atmospheric processes and the most perilous amongst it is heat stress and thermal discomfort. Mitigation techniques for plummeting the surface temperature as suggested by the scientific community across the world include dedicating a part of land in every locality for plantation, construction of green roof, terrace gardens, etc. This study analyses the effect of Land use changes on Land Surface Temperature and its variability with features on the surface contribute to the absorption and reflection of heat influx for Indian city of Kolkata. The historical city of Kolkata has experienced extravagant development residentially, commercially, industrially and culturally that has led to modification in its microclimate. The study examined temporal land use changes for Kolkata Metropolitan Area using supervised classification algorithm to understand the urban footprint and it was observed that the study area has experienced a growth of 203% in urban area over three decades. Also, quantification of land surface temperature using single window method was performed to assess thermal comfort ability and a rise of 7˚C was observed in the mean land surface temperature. A buffer was considered to understand the sprawl, and urban heat island. The study also tries to relate various land cover types with LST, estimates the urban heat island and further includes modelling futureland use changes. Result of the developed model based on business as usual scenario shows an increasing trend of concretization that would lead to a rise in surface temperatures. The outcome of the study will assist the decision makers, government officials, higher authorities, etc. in developing a sustainable plan and modify policies that would help in creating a balance between environment and hominids.

Paper ID: 220

Land surface temperature responses to land use dynamics across the agro-climatic zones of Karnataka

Ramachandra TV[1], Bharath Setturu[1], Madhumita Dey[1]
[1]Energy & Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

Abstract:

Landscape dynamics has a crucial role in the ecological processes and sustainability of natural resources. Understanding of landscape dynamics aids in planning and prudent management of natural resources. However, unplanned rapid urbanization during the post 1990's consequent to the globalization has driven anthropogenic activities leading to the alterations in the landscape structure, impacting the ecological process evident from the increase in land surface temperatures, alterations in the hydrologic regime, etc. Thus, land surface temperature being sensitive to land use dynamics, has become a vital factor in the regional climate change studies. The current study explores the relationship between biophysical parameters of earth to sub pixel thermal variations based on agro climatic zones of Karnataka. The general trend of temperature of the region with different land use class was established which indicates rise in temperature in the recent period. The study identifies the hotspot zones of higher temperature with the insights of land uses across the agro climatic zones of Karnataka.

Remote Sensing of Cities and Urban Climates-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 241

Spatial and Temporal Nature of Urban Heat Island in Roorkee

Siva Ram Edupuganti[1], Arjun Satheesh[1], Dr. Mahua Mukherjee[2]
[1]Research Scholar, IIT Roorkee (India), *[2]Professor, IIT Roorkee (India)*

Abstract:

Urban areas occupy less than two per cent of the Earth's land surface but house 50 per cent of the world's population. By 2030, Urban areas will hold 60% of the world's population (United Nations, 2014)Cities are point sources of pollution and are responsible for 50-70% of Greenhouse gas emissions (Oke *et al.*, 2017) Urbanization has led to a phenomenon called Urban Heat Island(UHI) resulting in microclimatic variations in the city; characterized by higher temperatures when compared to the surrounding landscape. This can have an adverse impact on the health and comfort of the people and energy efficiency of the city. It is imperative to understand the phenomena of Urban Heat Island at different scales and come up with mitigation measures to make our cities more sustainable. According to 2011 census of India, there are 468 cities with population exceeding 1 lakh. For this study, the categorization of cities done by Indian Government for House Rent allowance is adopted. As per this, cities are classified into 3 different categories;

Category X - Cities with population exceeding 50 lakhs,

Category Y - Cities with population between 5 lakh and 50 lakh,

Category Z- Cities with population between 1 lakh and 5 lakh.

Based on 2011 Census data, there are 8 category X, 88 category Y and 372 category Z cities in India. Currently, the UHI research is only focused at the scale of category X and Y cities like Nagpur, New Delhi, Kochi, Chandigarh, Noida etc. (Kotharkar and Bagade, 2018)(Thomas *et al.*, 2014)(Mathew, Khandelwal and Kaul, 2016). There are 372 cities which are at a nascent urbanization stage compared to the Category X and Y cities. There is a big gap in understanding of UHI in these smaller scale cities. By better understanding, there is great opportunity to intervene and mould these cities at this nascent urbanization stage. This paper intends to understand the Urban Heat Island phenomena in a Category Z city like Roorkee with population of 2, 38,422. The methodology involves generating LCZ maps for multiple cities using WUDAPT process in India to understand the composition of morphology in Category Z cities. This will throw light into the evolution their morphology. Further, CUHI (Canopy layer urban heat island) will also be investigated spatially through mobile traversing techniques using Roorkee as a case study. Through this process, the phenomena and trends of UHI will be established in smaller scale cities.

Cool Materials Development & Characteristics-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 35

Quantum Dots: A New Generation of Fluorescent Materials for UHI Mitigation

Samira Garshasbi[1], Shujuan Huang[2], Mat Santamouris[1]
[1]Faculty of Built Environment, University of New South Wales, Sydney, 2052(Australia)
[2]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney 2052 (Australia)

Abstract:

Quantum dots (QDs) are novel nano-scale fluorescent materials with tunable optical properties offering the great opportunity to customize their properties based on the application. In this paper, we have developed a novel algorithm to identify the optimum optical properties of QDs to achieve the highest cooling/temperature reduction potential. Based on our model, surface temperature reduction potential through photoluminescence (PL) effect can be improved by modulating band gap energy/ PL peak wavelength, PL quantum yield (PLQY). Our results also show that QDs demonstrate their highest temperature reduction potential with PL peak at 1100 nm. Furthermore, there is a linear correlation between temperature reduction and PLQY, which means higher temperature reduction, could be achieved with QDs having higher PLQY values.

Paper ID: 102

Development of heterogeneous directionally reflective materials for building facades and measurements of their reflective properties

Chiara Ferrari[1], Riccardo Paolini[2], Alberto Muscio[1], Mat Santamouris[2]
[1]Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia (Italy)
[2]Department of Built Environment, University of New South Wales, Sydney (Australia)

Abstract:

Solar reflective materials are recognized as an effective countermeasure to UHI. They show high values of albedo, so they can easily reflect toward the sky most of solar radiation hitting the low-sloped surfaces to which they are applied. Nonetheless they are not equally effective when applied to vertical surfaces in densely-built areas due to the strong absorption of solar radiation that occurs in the so-called urban canyon, caused by multiple reflection-absorption effects. Such issue has been addressed by several researchers. Directionally reflective materials that rely upon a proper surface and colour texture have also been investigated for sloped roofs, with reflective facets that face the sky, whereas facets with a desired but absorbing colour are visible from the below. During summer they can reflect sunlight, which impinges onto the reflective facets, whereas in winter sunlight impinges onto the absorbing facets. Such materials can also be exploited for facades, which is the subject of this work. Combinations of reflective and absorbing coatings are applied on shaped prototypes of 3D printed façade elements. Their behaviour is analyzed through field measurements aimed to evaluate the response to sun's height (comparing the measured performance with that predicted by theoretical models) and façade orientation, comparing the measured performance with that predicted by theoretical models and providing an accurate projection of such performance across the daytime and the season.

Cool Materials Development & Characteristics-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 223

In Situ Assessment of the Cooling Effects of Pavement-Watering: Application to Cool & Low Noise Asphalt Roads

Sophie Parison[1,2], Martin Hendel[2,3], Laurent Royon[2]
[1]Paris City Hall, Water and Sanitation & Roads and Traffic Divisions (France)
[2]Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS (France)
[3]Université Paris-Est, ESIEE Paris, département SEN, (France)

Abstract:

As part of the Life Cool & Low Noise Asphalt project, the City of Paris will test the effectiveness of three innovative pavements and the cooling effects of their watering using non-potable water as soon as the summer of 2019, in order to mitigate the effect of heat on the population during heat waves. We propose a brief presentation of the project framework and preliminary results of micro-climatic measures conducted prior to the implementation of the new pavements. Further field campaigns will be used to determine the cooling effects of the method expected to be improved by the innovative structures, designed to favour water retention.

Paper ID: 290

Cool Roof initiatives in India: An evaluation of the existing conditions and lessons to be learnt from global best practices

Hema Sree Rallapalli[1,2], Janmejoy Gupta[3]
[1]PhD Student, School of Planning and Architecture, Vijayawada (India)
[2]Assistant Professor, GITAM (Deemed to be University), Hyderabad (India)
[3]Associate Professor, School of Planning and Architecture, Vijayawada (India)

Abstract:

Cool roof is a simple yet powerful technology used for temperature control of buildings and urban areas. To understand the effectiveness of cool roof application in Indian cities and to understand the existing policies, codes and practices being carried out in India, a review of the existing conditions is done. This paper also studies various best practices from around the world and suggests the lessons India can learn from these global examples. There have been several studies done to prove the applicability and effectiveness of cool roofs in Indian conditions. In line with the country's National Cooling Policy, there are a few state and city level initiatives for the wider application of cool roof technology. Several green rating systems in India highlight cool roof as an energy saving strategy. There is a code specific to energy conservation in buildings with cool roofs requirement. However, at this point this code is not mandatory for majority of the Indian states. As learnt from the global examples, mandatory codes, policies, incentives, tax credits, and other such similar measures have a higher outreach for this technology adoption. India would benefit greatly from updating the existing policy framework to include cool roof related interventions, supporting focused research in the area and maximizing ground implementation through short and long term strategies. A consortium of scientific partners, industry partners, policy makers, along with the NGOs and volunteers working towards a common goal will make wider adoption and visible reduction in Urban Heat Island a reality.

Cool Materials Development & Characteristics-1

02:00pm – 03:30pm (December 2, 2019)

Paper ID: 295

Development of an online calculator for cool roof and green roof

Shanmukh Dontu[1], Vishal Garg[1]
[1]International Institute of Information Technology, India

Abstract:

Cool and green roofing strategies are proven to reduce the cooling load in air-conditioned spaces and improve thermal comfort in unconditioned spaces. Calculators that use simulated models to estimate cost savings are used to evaluate various roof configurations. Currently available online calculators that estimate savings provide limited possibilities for locations and roofing options. In this paper, we present a unified online calculator which can simulate both cool as well as a green roof over flat and sloped roofs for all locations for which weather data is available on the Energy Plus website. It provides an option to simulate an unconditioned building which helps the user to know monthly Fanger Predicted Mean Vote and Indoor Air Temperature. This calculator includes various cool roofing options with different Solar Reflectance Index values and green roofs with different plant and soil properties. It also supports parametric simulations and provides a graphical view of roof insulation thickness v/s energy savings, for different insulation thickness values where multiple simulations are needed to run. We use distributed tasks queues to handle requests at peak calculator usage.

Outdoor Comfort and Health in the Urban Environment-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 51

Thermal Sensation and Thermal Load of Human Body in Irradiated Hot Environment

Atsumasa Yoshida[1], Takuma Naka[1], Narihisa Chigusa[1], Shinichi Kinoshita[1]
[1]Osaka Prefecture University (Japan)

Abstract:

Subject experiment and numerical calculation were carried out to study the thermal sensation under awning and heat stress reduction effect to the human body outdoors in summer. The thermal sensation was reduced in the awning space, and the thermal load reduction effect was confirmed. There was a correlation between the change in thermal sensation and the change in mean skin temperature due to entering and leaving the awning space. The influence of weather conditions such as air temperature on the behaviour of mean skin temperature and human thermal load was clarified. The relationship between the solar radiation characteristics of the awning material, the infrared radiation characteristics and the reduction of the human thermal load was clarified. The effect of ambient weather conditions on the relationship was discussed.

Paper ID: 90

Quantitative Outdoor Thermal Comfort Assessment of Street: A case in warm and humid climate

Brinda Deevi[1], Faiz Ahmed Chundeli[2]
[1]Vaishanavi school of architecture and planning, Vijayawada, India
[2]School of architecture and planning, Vijayawada, India

Abstract:

Increasing air temperature in urban areas due to urban heat island (UHI) has been a problem of global concern since industrialization. This phenomenon of UHI is attributed to physical changes in urban environment and increased dependence on mechanically driven systems. As a result, the quality of urban life has been compromised with increased heat stress and thereby the need to mechanically condition spaces for comfort. Literature suggests that streets are major component of urban outdoor spaces for attaining comfort levels, if they are scientifically planned. In this paper, a study carried out for mapping and improving thermal comfort in Besant Road, a semi-motorized commercial street in Vijayawada, Andhra Pradesh is presented. A multi-dimensional methodology is adopted which include user-perception survey and empirical measurements taken at various locations across the street. For measuring thermal comfort established index Physiologically Equivalent Temperature (PET) is used. Calibrated Testo 480 was used to record temperature, humidity& air velocity, and Testo 870 was used to map the thermal sensitivity imageries at regular intervals. SPSS tool was used to derive the correlations between the critical parameters of study. Field measurements and simulation results suggests that Sky view factor (SVF) and Mean radiant temperature (MRT)are major influencing factors in determining thermal comfort. It was also observed that aspect ratio, which is generally given higher importance was not as significant as SVF in improving thermal comfort. On the other hand, increased vegetation improved thermal comfort as it decreased SVF.These findings suggest that while planning new layouts and development, care must be taken to achieve a desired SVF, thereby outdoor comforts can be attained. Further, study is need for developing a generalized planning guideline for achieving outdoor thermal comfort.

Outdoor Comfort and Health in the Urban Environment-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 107

Urban Micro-climate and Spatial Promotion for Creating the Historical Streets' Sustainability

Zheyang Fei[1], Yupeng Wang[1], Man Li[1],
[1]Xi'an Jiao tong University (China)

Abstract:

Historic districts are important parts of a city's material, cultural and economic forms, which have become an important place to undertake the characteristic urban culture, show the charm of the city and inherit the traditional culture. This paper is based on the basic principles of space syntax and related practices of the internal morphological quantification of historic districts, and the related research on microclimate environment simulation of public space systems in historical blocks. From the deficiencies of the research areas of the public system space quantification and environmental simulation, the two research perspectives are combined to quantitatively evaluate the street and square space of the public space system in Xi'an Beilin historical district to explore the best location and the best form of the streets network and squares. Starting from the point of perspective of renewal and optimization of block space and microclimate, this paper puts forward specific suggestions.

Paper ID: 182

Local scale climate change assessment for preservation of cultural heritage sites and their resilience, the case study of Gubbio medieval city in Italy

Benedetta Pioppi[1], Ilaria Pigliautile[1], Cristina Piselli[2], Anna Laura Pisello[2] , Franco Cotana[2],
[1]CIRIAF Interuniversity research centre on pollution and environment Mauro Felli, (Italy)
[2]University of Perugia, (Italy)

Abstract:

Climate change related events have demonstrated to massively compromise citizens' wellbeing in urban environments but, at the same time, they may represent too severe boundary conditions affecting cultural heritage (CH) preservation and their attractiveness for tourists. These aspects may be considered when assessing CH resilience to climate change because local overheating phenomena are responsible for CH damaging, conservation issues and, at the same time, their appeal for tourists. In this study, an extensive experimental field monitoring and CFD modelling is carried out in the area of the historical site of Gubbio (Italy), which is affected by massive overheated summer days, exacerbated by climate change related forcing. Field monitoring is carried out by means of wearable microclimate stations in order to better describe the boundary conditions of pedestrian citizens. All these data were specifically analyzed aimed at characterizing local microclimate peculiarities, CH preservation issues and to calibrate CFD models. Finally, the analysis of both experimental and simulated results was carried out demonstrating the serious threat compromising CH resilience in terms of its suitability to host tourists during summer time, as typically happens for social-cultural purpose and economic sustainability of the sites.

Outdoor Comfort and Health in the Urban Environment-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 294

Summertime Thermal Comfort Assessment for Compact Local Climate Zone

Dr. Rajashree Kotharkar[1], Shweta Deshmukh[2]
[1]Professor at Department of Architecture & Planning, Visvesvaraya National Institute of Technology, Nagpur-440010, Nagpur (India)
[2]M. Tech student at Department of Architecture & Planning Visvesvaraya National Institute of Technology, Nagpur-440010, Nagpur (India)

Abstract:

Thermal comfort studies are under research since last decade. Outdoor spaces contribute to urban liveability and vitality. People in the outside environment are directly exposed to urban climate, which cannot be totally controlled. The study of outdoor thermal comfort is critical in areas experiencing temperature and climate extremities and affecting human sustenance. Central India is identified as the critical zone due to its growth patterns and heat related vulnerabilities. Urban climate studies in central region shows varying heat intensities. Previous studies have used different approaches and techniques to analyze the physical and geometrical attributes of city however they have not considered its effect on urban population. This study evaluates social aspect (outdoor thermal comfort) by developing a systematic frame work. Physical, physiological and psychological level of assessment with the help of different parameters like building density, sky view factor aspect ratio, vegetation, micro metrological variables and thermal sensation vote (TSV) are studied. The study focuses on Compact Local Climate Zone and uses Physiological Equivalent Temperature (PET) index for outdoor thermal comfort (OTC) assessment. The study shows strong correlation with sky view factor (SVF) and building density. Different mitigation scenarios are simulated and PET index is calculated with the help of computational tool Ray-man. Vegetation shows the maximum effect followed by combination of cool roof and cool pavement. However, the findings show that cool roof is the most feasible mitigation measures for dense urban pockets with respect to the surface treated and percentage reduction in temperature. The study develops a strategy for improving outdoor thermal comfort in urban areas, which could help in developing practices and policy interventions for future sustainable cities.

Policies, Rating & Labeling Programs with UHI Mitigation Strategies

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 162

Solar-reflective "cool" walls: benefits, technologies, and implementation

Ronnen Levinson[1], George Ban-Weiss[2],Paul Berdahl[1],Sharon Chen[1], Hugo Destaillats[1], Nathalie Dumas[3], Haley Gilbert[1], Howdy Goudey[1], Sébastien Houzé de l'Aulnoit[1], Jan Kleissl[3], Benjamin Kurtz[3], Yun Li[2], Yan Long[3], Arash Mohegh[2], Negin Nazarian[3], Matteo Pizzicotti[3], Pablo Rosado[1], Marion Russell[1], Jonathan Slack[1], Xiaochen Tang[1], Jiachen Zhang[2], Weilong Zhang[3]

[1]Lawrence Berkeley National Laboratory (USA), [2]University of Southern California (USA)

[3]University of California, San Diego (USA)

Abstract:

Raising the albedo of a building's walls reduces unwanted solar heat gain in the cooling season. This saves electricity and lowers peak power demand by decreasing the need for air conditioning. It can also cool the outside air, which can mitigate the urban heat island effect and also improve air quality by slowing the reactions that produce smog. We quantified the energy savings, peak demand reduction, urban cooling, and air quality improvements attainable from solar-reflective "cool" walls in California; collaborated with industry to assess the performance of existing cool wall technologies, and to develop innovative cool wall solutions; and worked with government agencies, utilities, and industry to create a cool-wall infrastructure, including application guidelines, a product rating program, incentives, and building code credits. Simulations indicate that cool walls provide annual energy savings, peak demand reduction, annual emission reduction, and summer heat island mitigation benefits comparable to those yielded by cool roofs, and are helpful across California and in United States climate zones 1 – 4. Natural exposure trials conducted at three sites in California and another three across the United States indicate that cool wall materials tend to stay clean and reflective. Significant advances were made in novel cool wall technologies, such as fluorescent cool pigments that expand the colour palette for cool wall products. We prepared guidelines for the climate- and building-appropriate use of cool walls. Ongoing efforts seek to introduce or expand cool wall provisions in building energy standards/programs and develop a cool-wall product rating system.

Policies, Rating & Labeling Programs with UHI Mitigation Strategies

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 237

Review of heat wave studies & related urban policies : Case of South Asia

Rajashree Kotharkar[1]*, Aveek Ghosh*[2]
[1]*Professor, Visvesvaraya National Institute of Technology (India)*
[2]*PhD Scholar, Visvesvaraya National Institute of Technology (India)*

Abstract:

The Intergovernmental Panel on Climate Change (IPCC) projects that the frequency of heat waves (HWs) is likely to increase over most land areas in the twenty-first century. In 2015, heat waves were accountable for 4 of the 10 fatal natural disasters, with South Asian heat waves ranked at third and fourth by mortality (UNISDR et al. 2015). Recurrent heat waves are an emerging environmental and health concern and already a distress in rapidly growing and urbanizing South Asia. However, coordinated adaptation efforts can reduce heat's adverse health impacts. A review of original research publications of the past five decades from peer-reviewed journals and conference proceedings, covering South Asian cities, revealed that highly dense cities are in extreme danger due to subsequent impact of heat waves. The objective of the review is to assess the impact of heat waves and its associated spatial vulnerability with increasing consecutive summer days (heat waves) especially in urban areas. The review attempts to understand HWs in different contexts, geographic locations and its studies in the past. The study also tries to review the existing plans and policies in place at national/regional/city level to counter the heat wave risk and identify the issues and gaps in the existing policies and frameworks in the larger setting of urban planning measures for various adaptation and mitigation efforts. Throughout the past century, the trends in the increase of anthropogenic heat have caused a lot of problems due to change in land use/cover. Specific set of long-term tasks concentrated on cities in the form of vulnerability assessment to formulate a Heat Action Plan (HAP) towards counter-measuring and mitigation of heat waves must be developed. Policies and actions must address the issues of built environment and environmental factors in land use/planning along with a need to find and plug the existing gaps.

Policies, Rating & Labeling Programs with UHI Mitigation Strategies

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 261

A Big Picture of Urban Heat Island Mitigation Strategies and Recommendation

Vaibhav Rai Khare[1], Akash Vajpai[2], Durva Gupta[3]
[1]Environmental Design Solutions (India)
[2]PwC India (India)
[3]Indian Institute of Technology Delhi (India)

Abstract:

Climate change poses a great threat to human and ecosystem of the planet. There are many factors that trigger climate change, and there are many after-effects. One of the after-effects is Urban Heat Island (UHI), recognized as the most evident characteristic of urban climate. It occurs due to dark, non-reflective surfaces used for parking, roads, roofs, walkways. These surfaces absorb the warmth of the Sun, radiate heat, and thus increase the land surface temperature. Consequently, material flow and energy flow of urban ecological systems is influenced, employing a series of environmental effects on urban climates and human health. Additionally, heat islands increase cooling loads in the summer, which tends to increase energy consumption and produce more greenhouse gases. There are numerous strategies to mitigate the UHI effect. This study reviews various heat island mitigation strategies as well as their effectiveness in cooling the urban environment and proposes a set of recommendation based on research and analysis. Broadly, the mitigation strategies have been divided into three parts – (i) Roof strategies (high-reflectance roof, vegetation roof), (ii) non-roof strategies (shading structure with energy generation/architectural devices, high reflectance paving, plantation, and water bodies) and (iii) covered parking strategies. It has been found out that simultaneous use of several UHI mitigation measures has a more significant impact on lowering the urban temperature and it could be mitigated. The present paper highlights the importance of each mitigation strategies based on research and field-analysis and thus presents a set of recommendations which can be directed at the government level to policies to mitigate the UHI effect.

Paper ID: 14

Effect and Development of Cool Roofs: A Review

Meng ZHEN[1], Ru JIA[1], Qishu ZOU[1], Wei DING[1], Weihan ZOU[1], Ling WANG[1]
***[1]**Department of Architecture, School of Human Settlements and Civil Engineering, Xi'an Jiao tong University, China*

Abstract:

This article reviews a large number of existing studies and discusses the working principle and characteristics of cool roofs, such as utilisation of radiation reflectivity, high infrared radiation emissivity and excellent thermal insulation properties. This mechanism enables the release of additional energy back into the sky such that less heat remains in the ground or passes into rooms. The following three main functions of cool roofs are discussed:(1) saving cooling energy and extending the roof life; (2)alleviating urban heat island effect and improving urban thermal environments; (3)decelerating global warming andprot`ecting the ozone layer. The history of the cool roof development, including the three important cool roof standards (i.e. ASHRAE 90.1, EPA Energy Star label and LEED 2.0) since the 1990s and the advancement of materials used in the five generations of cool roofs, is presented. This article also introduces three shortcomings of cool roofs, namely, higher cost than ordinary roofs, light pollution and additional heating load in winter.

Policies, Rating & Labeling Programs with UHI Mitigation Strategies

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 15

Outdoor Thermal Sensation and Thermal Comfort in Xi'an

Meng ZHEN[1], Ru JIA[1], Weihan ZOU[1],Wei DING[1], Ling WANG[1]
[1]Department of Architecture, School of Human Settlements and Civil Engineering, Xi'an Jiao tong University (China)

Abstract:
To study the current situation of outdoor thermal comfort in Xi'an, this research conducted a questionnaire survey from April to May 2019. The questionnaire included basic information, thermal sensation, thermal comfort and thermal expectations of the respondents. A total of 248 valid questionnaires were returned. Survey results indicated that the thermal comfort characteristics across gender, age, educational background, height and weight were analysed and climate differences in typical cities in five climate zones were compared and evaluated. Results showed that women are more sensitive to thermal sensation and thermal comfort than men. The respondents aged 31–35 have the lowest and highest sensitivities to thermal sensation and thermal comfort, respectively. Below undergraduate respondents have the highest and highest sensitivities to thermal sensation and thermal comfort, respectively. Body mass index is positively correlated with thermal sensation. When thermal sensation increases, the respondents expect that the temperature and solar radiation are decreased but wind speed and relative humidity are increased. Xi'an has large geographical differences with cities in other climate zones, thereby indicating that outdoor thermal comfort has significant regional differences.

Urban Economy-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 13

Health and energy benefits of urban overheating mitigation counteracting climate change

Riccardo Paolini[1], Samira Garshasbi[1], Shamila Haddad[1], Mattheos Santamouris[1]
[1]UNSW (Australia)

Abstract:

In many areas of the world, the population concentrates along the coastal regions, benefitting from the sea breeze, with warmer inland areas. However, increasing population is driving the explosion of urbanization in traditionally low-density areas, enhancing the impacts of climate change. A typical case is that of Australian capital cities. Here we show that local climate mitigation can reduce the impacts of climate change, with the analysis of a new development area in Sydney, 50 km from the coast. With meso-scale climate modelling, we computed that by 2050 the peak summer temperature will increase by 0.8 °C and the daily average summer temperature by 1.6 °C. Mitigation with cool materials, greenery, and irrigation will lower the peak and average daily temperatures respectively by 2.2 °C and 1.5 °C with respect to the unmitigated condition under the future climate. Moreover, mitigation can reduce the annual building energy demand (heating and cooling) by 14% for offices and 30% for residential buildings. The heat-related mortality rate also would be reduced by 27% and still increasing from the current level of 10 to 12 deaths per 100,000 people. Our study indicates the need for improved mitigation technologies to tackle urban overheating in future climate scenarios.

Paper ID: 57

Use Urban Green as a Mitigation Strategy to Combat Urban Heat Island Effect: A Case of Puri-Cuttack Road, Bhubaneswar, Odisha

Sukanya Dasgupta[1], Nilanjana Roy[2], Dr. Dudam Bharath Kumar[3]
[1]B.Arch., MA (Urban Design), Asst. Professor, KIIT DU (India)
[2]B.Arch., Design Head, A&N Architects & Designers, (India)
[3]PhD (Atmospheric Science), Asst. Professor, KIIT DU (India)

Abstract:

Environmental issues destabilize sustainable development of cities. In urban setting today urban greenery, vegetation and plants fall prey to the perils of increased levels of pollution. Roads and pavements constitute a major portion of the urban areas and are one of the highest contributors to the development of heat island effect in its tussle against the menace of imprudent urbanization; the go-green movement is a combatant that requires further reinforcement with regards to roads and pavements. Besides being a resource for the city, the urban green is a key player in countering the heat island effect. The Puri Cuttack road in Bhubaneswar spans between two important nodes: The Rasulgarh Square and Kalpana Square. This stretch of 5.1 kms is abutted by a palette of commercial, industrial, healthcare, hospitality and residential settlements. The road also gives way to a secondary entrance to the Bhubaneswar Railway Station. The heat generated from structures, road materials and related anthropogenic activities has modified the neighbourhood's natural state of vegetation and greenery. The primary aim of this paper is to arrive at mitigation strategies for combating UHI at the Urban Design level. The paper uses the strategies of how one of the coolest cities in the world (Stuttgart, Germany) has been able to mitigate the effects of industrialization and improved the air quality issues in spite of its geographical set up. A set of recommendations to develop the urban environment of the Puri Cuttack road is prescribed based on the concepts comprehended from Stuttgart.

Urban Economy-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 94

Spatiotemporal Characteristics of Anthropogenic Heat and Its Impact on Outdoor Thermal Environment in a University in Chongqing

Zhongyu Hao[1], Yang Xu[1], Dachuan Shi[1], Yu Liu[1], Yafeng Gao[1]
[1]Chongqing University (China)

Abstract:

The research on the influence of anthropogenic heat on the outdoor micro-environment has not received enough attention, which leads to great differences in the prediction and evaluation of the outdoor thermal environment. This study is to obtain the spatiotemporal characteristics of anthropogenic heat on the campus of Chongqing University, and compare the total anthropogenic heat of the campus with solar radiation to evaluate its impact on urban energy balance and outdoor thermal environment. The results show that under winter conditions, the total amount of anthropogenic heat on working days and non-working days is 38.2% and 35.3% of solar radiation respectively. Under summer conditions, the total amount of anthropogenic heat on working days and non-working days is 15.8% and 17.1% of solar radiation respectively.

Paper ID: 198

Climate-Informed Decision-Making for Urban Design: Assessing the Impact of Urban Morphology on Urban Heat Island

Luis G. R. Santos[1], Ido Nevat[1], Gloria Pignatta[2], Leslie K. Norford[3]
[1]TUMCREATE (Singapore)
[2]UNSW Sydney (Australia)
[3]MIT (United States)

Abstract:

Urban growth is related to major environmental consequences, including the Urban Heat Island (UHI) phenomenon. This phenomenon has been studied over the past decades and affects people's liveability and economy. In order to address environmental impacts, researchers, government agencies, and stakeholders must evaluate different scenarios based on the output of different measurements and models. The complex nature of this phenomenon, added to the large output of data generated by it, often makes the comparison of scenarios subjective and unclear, limiting the process of decision making. To overcome this difficulty, we propose a framework able to cope with multiple climate models and wide sets of generated data. In this framework, a few additional parameters are defined in a Data Processing Unit, resulting in a more objective output that can encompass external trade-offs. We illustrate the framework by selecting an urban area of Singapore as a case study to analyze different building-to-site densities (30%, 40%, and 50%) and different building heights (49m, 65m, and 81m) in terms of their environmental impact on UHI and population allocation. The Urban Weather Generator was chosen as the weather model due to its capacity to generate a large output dataset with low computational expense. The final result is a matrix of scores per scenario based on different metrics that were considered relevant under the scope of this work. The scenarios with the highest building height (81m) and medium (40%) or low (30%) density area good option for a balance between environmental impact and allocation of people.

Urban Economy-1

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 248

Assessing the benefits of UHI mitigation for indoor heat exposure during concurrent heat wave and blackout events in Phoenix, Arizona

Brian Stone[1], Evan Mallen[1], Mayuri Rajput[1], Godfried Augenbroe[1], Ashley Broadbent[2],Scott Krayenhoff[3], Matei Georgescu[2]
[1]Georgia Institute of Technology (USA)
[2]Arizona State University (USA)
[3]University of Guelph (Canada)

Abstract:

Concurrent with a rapid rise in temperatures within US cities, the frequency of regional electrical grid failures is also rising in recent decades, resulting in a growing number of blackouts during periods of extreme heat. As mechanical air conditioning is a primary adaptive technology for managing rising temperatures in cities, we examine in this paper the impact of a prolonged blackout on heat exposure in residential structures during heat wave conditions, when air conditioning is most critical to human health. Results find a substantial increase in heat exposure across residential buildings in response to the loss of electrical power and mechanical cooling systems. We further find high density zones to experience marginally elevated building interior temperatures during blackouts relative to lower density zones and that buildings with cool roofs experience marginally lower building interior temperatures during blackout conditions than buildings with conventional roofing materials.

Analysis of UHI and its effect across Scales – 2

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 68

Assessment of surface urban heat island and urban cooling effect based on downscaling LST, a case study of Fukuoka prefecture, Japan

Wangchongyu Peng[1], Rui Wang[1], Wei Chen[2], Lilei Zhou[3], Weijun Gao[1], Yingjun Ruan[4]
[1]the University of Kitakyushu (Japan),[2]Xi'an Jiao tong University (China)
[3]Chongqing University (China),[4]Tongji University (China)

Abstract:

The phenomenon of urban areas becoming warmer than surrounding rural areas, known as urban heat island, is one of the biggest urban issues due to human activities. The study adopts remote sensing data from Moderate-Resolution Imaging Spectro radiometer (MODIS) sensor to assess the surface urban heat island effect for summer and winter (daytime and nighttimes) of two cities in Fukuoka Prefecture, Japan, Fukuoka and Kitakyushu, in 2005 to 2015. The land surface temperature (LST) images were first downscaled to 250 m spatial resolution based on Random Forest Regression (RFR). The study first identified the surface urban heat island intensity (SUHII) based on downscaled LST images. Then the interrelationship between SUHII and distribution of population, the distance to the sea, and land use and land cover (LULC) were studied. The results show that the SUHII in summer daytime is the biggest while in winter nighttimes is the smallest, and SUHII in Fukuoka city is bigger than that in Kitakyushu city suggesting city size has a positive impact on UHI. Through zonal statistics, population distribution was strongly correlated to SUHII in Fukuoka prefecture, and the sea has the strongest urban cooling effect (UCE).

Paper ID: 110

Urban features at neighbourhood scale to assess and mitigate the heat island in arid Mendoza, Argentina

María Belén Sosa[1], Erica Correa[1], Michele Zinzi[2]
[1]Instituto de ambiente, hábitat y energía - CONICET (Argentina),[2]ENEA (Italy)

Abstract:

In arid and hot climate cities, urban heat island (UHI) phenomenon reductions represent a major challenge. Nowadays, climate-sensitive urban planning strategies are useful in order to reduce the UHI in arid cities. The presented study was carried out in the arid Metropolitan Mendoza Area (MMA), Argentina. The study measures the thermal improvement of apply high-albedo's roof materials and analyses its effectiveness in different neighbourhood´s layouts forms. To carry out the study, three low-density neighbourhoods that have analogous urban features but different layouts forms (multi-azimuthal, rectangular and Cul-de-Sac) were selected. Also, the downtown and four MMA´s boundaries points were assessed. The study cases were micro-climate monitored, and the three neighbourhoods were modelled and adjusted with ENVI-met software. The results show that reductions in diurnal air temperatures could be achieved by using cool roofs strategy. These findings validate the researches that indicate that this UHI mitigation strategy has a higher diurnal cooling impact. Regarding the neighbourhood form, the rectangular and multi-azimuthal layouts forms remain cooler. This highlights that suitable urban planning decisions in arid cities could helps reduce the UHI phenomenon and improves the liveability of outdoor and indoor spaces.

Analysis of UHI and its effect across Scales – 2

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 132

Development and Application of "Shadow Ratio" for Evaluating Urban Thermal and Wind Environment - Take a Site of Xi 'an West Street as an Example

Yuheng Lyu[1], Dian Zhou [1], Yupeng Wang [1]
[1]Department of Architecture Xi'an Jiao Tong University (China)

Abstract:

The development of urban economy and society, especially the advancement of urbanization greatly facilitates human life, and also deteriorates the living environment of cities to a certain extent. The urban environment is closely related to citizens' well-being. Therefore, the continuous improvement of living standards, creating a liveable city space environment is particularly important. Urban wind environment and thermal environment are elements of urban microclimate and are playing an important role in optimizing urban living environment. Shadow from the buildings has an important influence on urban microclimate, because it affects the heat and wind environment to a great extent. This paper proposed the concept of "Shadow Ratio" and its derivative concept of "Continuous Shadow Ratio", which could be used to indicate the spatial morphology of urban thermal environment and wind environment. The importance of using sunlight shadow to prevent heat in buildings in cold region is analyzed, and the relationship between sunlight shadow and building thermal environment and wind environment is indicated. ENVI-met software is used to simulate and evaluate the urban environment in a 300m×300m scale in the central area of Xi 'an city, calculated the shadow ratio of the site at 7 time points in the day and compares the calculated results with the environmental simulation data, and carried out coupling analysis. This paper developed and demonstrated the application value of "Shadow Ratio" for urban building environment evaluation.

Paper ID: 187

Impact Analysis of Deep Static Bluespace on Urban Heat Island: Case of Chandigarh

Aditya Rahul[1], Mahua Mukherjee[1]
[1]Indian Institute of Technology Roorkee (India)

Abstract:

Urbanisation has picked up rapid pace since dawn of the industrial revolution. This unprecedented and unplanned urbanization is leading to Urban Heat Island effect. Urban Heat Island effect is a rise in temperature of the urban area in comparison to nearby rural areas, which in turn have a multidimensional impact on human health. Urban water body can act as a viable solution to attenuate this phenomenon. This research investigates the impact of Sukhna Lake (deep static water body) on heat stress in Chandigarh, India using remotely sensed data (LANDSAT-8 TIRS). It also examines the influence of urban form in the vicinity of the water body in propagating or reducing the impact. The results show that in Subtropical Humid climate of Chandigarh, water body provides a cooling effect in both summer and winter, with the cooling impact being greater in summer. Impact amplitude can go as high as 6.1 °C in summer in an area of sparsely built and low plant. The maximum impact range was observed to be 1080m in winter in the area of dense trees, whereas maximum impact gradient of 0.1383 °C/m is achieved in the compactly built low-rise area during summer. This result will assist urban planners and designers to plan suitable built environment around water body and vice versa for better heat stress attenuation as well as optimal urban landscape designs for a more ecologically sound and pleasant living environment.

Analysis of UHI and its effect across Scales – 2

04:00pm – 05:30pm (December 2, 2019)

Paper ID: 291

Satellite based observations for Surface level Urban Heat Island over Bhubaneswar: A case study

Dudam Bharath Kumar[1]
[1]*Assistant Professor, School of Civil Engineering, KIIT-Deemed to be University KIIT-DU, Bhubaneswar-751024 (India)*

Abstract:

We present a case study on identification of surface level urban heat island (SUHI) based on a land surface temperature (LST) of satellite observational data. Further, relevance of air pollution on dynamics of the LST is explained. Ground based observation at KIIT-DU station for air pollution was carried out to assess the climatology of air pollution in Bhubaneswar. Results show that the LST over Khandagiri region exhibits SUHI compared to that over adjoining regions of the city. Analysis of present study suggests that heavy built-up area followed by land-use or land-cover change over Khandagiri made a region consisting of SUHI on its own region. On the other hand, the Chandaka a forest region shows contrasting results being a region full of vegetation. The normalized deviation of vegetative index (NDVI) from Moderate Resolution Imaging Spectrophotometer (MODIS) -Aqua algorithm-based data also supports the vegetation information over study region. Efforts to relate pollution and other geographical information are required to infer heat island not only at surface level but also at canopy and at boundary layer level are essential.

Analysis of UHI and its Effects Across Scales – 3

11:30am – 13:00pm (December 3, 2019)

Paper ID: 48

Evaluation Urban heat island and bio climate studies in Freiburg, Germany

Andreas Matzarakis[1]
[1]*Research Centre Human Biometeorology, German Meteorological Service (Germany)*

Abstract:

The city of Freiburg has a long tradition in urban climate issues because of the specific perception of the population on climate by the local wind system developed by the complex surrounding topography. The first comprehensive climate analysis were performed in the beginning of the seventies of the 20th century, where car traverses have been implemented in the analysis and the beginning of the development of climate function maps. In the following decades only specific modifications the area of the city have been analyzed like the development of new residential areas or the increase of the site of the football stadium or the new railway station. In the beginning of the 21st century the Freiburg city council begun to update the city's master plan and to adjust it for the year 2020. Local climate and air pollution were considered in this scheme through the application of a spatial urban climate analysis of the entire area. The analysis has built the basis for future analyses of individual areas in the context of building applications in the meantime. After 2015 the city of Freiburg decided to implement the issue of climate change for a vulnerability analysis.

Paper ID: 284

Characteristics of micro weather stations distributions for urban heat island monitoring and corresponding thermal mapping

Tzu-Ping Lin[1], *Yu-Cheng Chen*[1]
[1]*Department of Architecture, National Cheng Kung University, Taiwan*

Abstract:

Urbanization has been one of the most efficient factors for urban heat island. City planning from the government is a crucial role of the urbanization. Planning strategies are always based on the observation data collected by the weather bureau. However, the lack of integration environment assessment would be leading to an irreversible result to the land and nature. A small number of meteorological stations are insufficient for representing the atmospheric changes and understanding the microclimate, thermal conditions, and built environment in large complex urban areas. The urban heat island effect indicates that the temperature differences between various environments are affected not only by natural climatic conditions, but also by different built environments. Therefore, a suitable number of meteorological stations is required in urban areas to accurately understand how different land covers, land uses, and other factors such as impermeable surface area and total floor area affect thermal conditions. This study aims to compare the three meteorological data, a temperature observation network approaches which installed in three different cities including Chiayi (LATiC), Tainan (HiSAN) and Kaohsiung (STONK) to comprehend the air temperature distribution in different purpose of setting and different number of standard weather station, to realize the advantages and disadvantage of each method. and compare the land pattern differences with the local micro thermal condition.

Analysis of UHI and its Effects Across Scales – 3

11:30am – 13:00pm (December 3, 2019)

Paper ID: 152

Thermal Studies of Mid-latitude Urban Environment

Roger Clay[1], Huade Guan[2.]
[1]School of Physical Sciences, University of Adelaide (Australia)
[2]National Centre from Groundwater Research and Training, College of Science & Engineering, Flinders University (Australia)

Abstract:

Urban Heat Island (UHI) studies have been carried out over a number of years in the City of Adelaide. Adelaide is a coastal city with a Mediterranean climate and is noteworthy in having a central business district (CBD) which is surrounded by substantial parklands. Studies have been made of the Adelaide UHI both with a fixed system of temperature and humidity sensors, and through night-time traverses monitoring temperature, humidity, and infra-red sky temperatures. A summary of the measured UHI properties of Adelaide will be presented to discuss relevant urban distance scales, the effect of varying sky view factors, and the effects of incorporating small open spaces in an urban environment.

Paper ID: 270

Conceptual Framework for Environmental City Planning Tool with an Intelligent System based on BIM and GIS Technology

Shinji Yamamura[1], Liyang Fan[1], Yupwng Wang[2], Dian Zhou[2]
[1] Nikken Sekkei Research Institute (Japan), [2] Xi'an Jiaotong University (China)

Abstract:

Recently, the rising of the maximum temperature in summertime and air pollution in the winter time have been common issues in the cities of China, especially the large cities. The heat island phenomenon, triggered by urbanization based on the global warming, is caused by different factors. The high density of building development which change the urban typology, leading to the change of traffic volume, vegetation coverage and the urban micro-climate are considered as the important factors. Most of the existing studies to mitigate heat island phenomenon usually weight on introduction of low surface temperature material, reduction of the heat exhaust or vegetation from building-scale viewpoint, or strategies as instruction of large parks, shifting to public transportation systems from district-scale viewpoint. However, the community-scale environmental friendly planning method are merely to be discussed, such as making effective network of cool spots and the wind path in the community. It is an optimal approach, with synergies among various elements and solutions interactively consider existing community structures, energy systems for different building types, traffic strategies, greenery renovation possibility and city typologies. In this paper, we propose a system for environmental urban planning tool with Geographic information system (GIS) and Information and Communication Technology (ICT). We firstly introduce the concept and architecture of the tool. The applicability of the resulting model is then examined by applying it to the city of Xi'an, China. Finally, thermal environmental simulation are adopted to figure out the opportunities and challenges for environmental urban development in these target area

Analysis of UHI and its Effects Across Scales – 1

11:30am – 13:00pm (December 3, 2019)

Paper ID: 287

Assessment of variation in Intra Canopy Layer Urban Heat Island Intensity in Residential areas --- A case study of Nagpur City

Sujata Godbole [1], Dr. Ravi Kumar Bhargava[2]
[1]M.M.College of Architecture, Nagpur (India), [2] T.G.P. College Of Architecture, Nagpur (India)

Abstract:

Urbanization of recent times has brought many climatologically changes in cities around the world, a major one being rise in temperature. Central Indian city of Nagpur is no exception to this phenomenon. Outdoor thermal discomfort is a major outcome of urban heat island effect. Present study focuses on urban canopy level heat island in city of Nagpur, and aims to understand the temperature distribution in urban canyons, as most of life occurs in this layer and is directly affected by the rise in temperature. This paper reports spatial and temporal variation of air temperature within selected residential areas of Nagpur. Field surveys were carried out, wherein actual physical measurements of outdoor air temperature & humidity were done using fixed station method. Data regarding urban morphology such as H/W ratio, vegetation, building material & built-up density was recorded by visual observation and mapping. The study shows intra-urban variation in air temperature at canopy level in all seasons and existence of daytime as well as nocturnal urban heat island in city of Nagpur.

Resilient Design of Buildings in Response to Changing Climates

11:30am – 13:00pm (December 3, 2019)

Paper ID: 23

Study of Adaptive City by Osaka Heat Island Countermeasure Technology Consortium

Hideki Takebayashi[1], Masakazu Moriyama[2]
[1]Kobe University (Japan)
[2]Osaka Heat Island Countermeasure Technology Consortium (Japan)

Abstract:

Osaka Heat Island Countermeasure Technology Consortium (Osaka HITEC) established in 2006, started the certification system of heat island measures technology in 2011, which contains 9 categories and has already certified 13 heat island measures technologies. A retro reflective high solar reflectance window film was first certified in 2018. Osaka HITEC is currently working on evaluation and implementation of adaptation measures against extreme heat. Several adaptation technologies have been developed by various companies and their evaluation methods were discussed so that they may be properly implemented in society. Adaptation measures for urban heat islands and their effects and associated evaluation indices are organized in a table. The cool spots and cool roads that exist in Osaka Prefecture area are aggregated to the web. The effect of shading by trees is dominant, and it combines the effects of evaporation and ventilation. The effects of adaptation measures obtained by demonstrative experiments are evaluated by SET*. Shielding of solar radiation to pedestrians is a more effective method of lowering MRT and SET*.

Paper ID: 99

"Cradle to Gate" Assessment Of Material Related Embodied Carbon: A Design Stage Stratagem For Sustainable Housing

Ashan S Jayawardana[1], Narein G R Perera[1.], L S Ranjith Perera[2]
[1]University of Moratuwa (Sri Lanka), [2]Sri Lanka Institute of Information Technology (Sri Lanka)

Abstract:

The building sector is the largest single consumer, resulting one third of global carbon emission. Achieving low carbon buildings is seen as a key concept in order to reduce carbon emission and mitigate climate change. It is estimated that 70% of all extracted materials eventually end up in the built environment. In contrast to operational emission, material related embodied carbon in the built environment plays a pivotal role when reducing CO_2 emission with the continuous consumption of high carbon emitting materials. This research was based on the 'Cradle to Gate' system boundary, concentrated on minimising the environmental effect of building design. A hybrid analysis approach was adopted, which was a bottom up process with several steps encompassing mass analysis, embodied carbon calculation, highlighting carbon hotspots and ultimately the identification of critical building components. Study revealed low embodied carbon building components and strategies which can be implemented primarily by designers during early design stages understanding the composite behaviour of the building components. Further, the research has generated a process to recognise low carbon materials and their alternatives. Multi-story residential buildings were selected as the critical building typology which is constructed with conventional building materials in Sri Lanka. The findings discuss the importance of Mass Materials, High Carbon Materials when selecting building materials and a process to assess low carbon masonry walls in the early design stages. Thus, generate directions for material selection in future housing projects to mitigate high carbon emission.

Resilient Design of Buildings in Response to Changing Climates

11:30am – 13:00pm (December 3, 2019)

Paper ID: 130

The resilient design for traditional residential building in Northern Shaanxi of China

Sunwei Liu[1], Yupeng Wang[2], Yitong Kang[1]

[1]Master Student, Department of Architecture, Xi'an JiaoTong University
[2]Professor, Department of Architecture, Xi'an JiaoTong University

Abstract:

The indoor lighting environment and energy consumption is a big issue for traditional residents of Yaodong in Yan'an city in China. In order to promote the living environment of Yaodong, the retrofitted scheme uses passive ecological measures such as natural lighting and attached sunspace to make full use of solar energy during the winter. In summer, facing to the problem of high indoor air temperature, the building uses a wall with thermal insulation and a roof that draws on the traditional residence of Yaodong. In addition, the added windows can improve indoor ventilation and reduce the excessive indoor temperature and humidity in summer. Besides, this design is entirely using renewable energy. In this research, simulation software BEST energy, Ecotect and RET Screen are used to evaluate the effects of the comprehensive design method for improving indoor lighting, thermal comfort, and annual energy consumption. All of the additional building resilient design will be based on the adaptation to traditional building design and living style of the local people. From the overall analysis of the whole year, these retrofit measures will be conducive to the improvement of indoor lighting and thermal comfort and reduce the energy consumption. It's demonstrated that the resilient house has better adaptability to UHI, compare to local ordinary urban dwellings.

Paper ID: 131

The Resilient Design for Small Commercial Building – A Case in City Center of Gifu, Japan

Yitong Kang[1], Dian Zhou[2], Yupeng Wang[2], Sunwei Liu[1]
[1]Master Student, Department of Architecture, Xi'an JiaoTong University
[2]Professor, Department of Architecture, Xi'an JiaoTong University

Abstract:

In recent years, the urban heat island (UHI) effects have caused many environmental problems, which is attracting attention from scientists and governments. As one of Japan's major cities, Gifu's UHI is becoming serious. Building energy consumption is greatly effected by UHI. It is important to design resilient buildings to reduce their energy consumption to alleviate UHI effects. In addition, in order to face to the UHI effects in the future, it is also important to reduce the growth rate of building energy consumption when the temperature rises. This research takes the resilient design of a small commercial building in Gifu City, Japan as an example. By using BEST energy software, the four design parameters of building volume, window-wall ratio, and window shade ratio and envelope material were evaluated. Three evaluation criteria, the annual energy consumption, the annual cooling energy consumption and the daily increase of cooling energy consumption during the UHI phenomenon, evaluate the building design, and the optimal solution of each impact factor is obtained, so that the building design can reduce the building energy consumption and adapt to the extreme weather. This research supports new policies and design strategies for resilient building design.

Resilient Design of Buildings in Response to Changing Climates

11:30am – 13:00pm (December 3, 2019)

Paper ID: 239

Assessing resilience to summertime overheating in modern low energy flats in UK

Rajat Gupta [1], Matt Gregg[1]

[1]Low Carbon Building Research Group, Oxford Institute for Sustainable Development, Oxford Brookes University, Oxford, UK

Abstract:

This paper investigates the influence of physical and occupancy factors on the prevalence of summertime overheating in four new-built flats located in the same housing block in Southeast England. The dwellings were built to the same construction standards (building fabric thermal performance) and occupied by residents with similar economic status (high income). In-situ monitoring of indoor environment was carried out in the four flats using Hobo data loggers. Data on occupant behaviour were gathered using questionnaire surveys along with physical monitoring of opening-closing of windows. The paper focuses on the month of July as representative of the summer season. The indoor temperature measurements in the summer revealed potential issues with overheating in the flats, especially those on the top floor. The maximum temperature in the southern exposed top-floor flats reached over 30°C, higher than the maximum outdoor temperature recorded over the same period. The lower level flats had more stable temperature and less overheating. Data on window opening showed that windows were regularly opened during the summer across the four flats, implying that occurrence of overheating could be due to lack of shading devices, as well as the high levels of insulation that prevented indoors to cool down in the night. Given the prevalence of summertime overheating found across the flats, it is necessary to carefully consider this risk during the design of homes, to avoid the growth of energy intensive and localized heat producing domestic air-conditioning in the future especially in a warming climate

Measurement Techniques and Standards-1

11:30am – 13:00pm (December 3, 2019)

Paper ID: 77

Impact Zonation and Mitigation of UHI (through remote sensing & development of Blue-Green Infrastructure Network)

Atul Kumar[1], Jagrati Sehgal[2], Mahua Mukherjee[1], Ajanta Goswami[1]
[1]Indian Institute of Technology Roorkee (India), [2]MIT School of Architecture Loni Pune (India)

Abstract:

The world is moving towards urban transition–rural areas losing their identity and amalgamates into near urban sectors forming huge urban centers. The paper is concerned about the notorious effect of urbanization, where rapid and unplanned urbanization of cities and concomitant reduction in vegetation result in raised temperature compared to non-urban areas, creating a phenomenon known as the 'Urban Heat Island' (UHI). The study focused on the surface UHI (SUHI), SUHI is the effect generated by heating of infrastructure and land surface. SUHI thermal trend can be identified in daytime as well as in nighttimes. An image analysis procedure based on a two-dimensional Gaussian fitting to describe the surface urban heat island (SUHI) is developed using MODIS LST night-time data. This fitting provides a spatial extent, critical location, and magnitude of SUHI. SUHI parameters extracted for the Area of Interest (AOI) by exploring Temperature difference of the cells of the LST night band of MODIS. Lands at data used to extract LULC change pattern, the data processed in ArcGIS using maximum likelihood classification techniques. The study result shows that urban-rural temperature differences between the urban center and its surrounding areas show a maximum of 5°C for the year 2016 at night whereas it was 4°C for the year 2000 and 2008. This implies increase in heat island intensity. Ultimately, blue-green infrastructure is proposed for the critical zone of UHI.

Measurement Techniques and Standards-1

11:30am – 13:00pm (December 3, 2019)

Paper ID: 183

Microclimate analysis of UHI affected areas through wearable monitoring systems: the case study of New York City

Ilaria Pigliautile[1], Benedetta Pioppi[1.],Franco Cotana[2],Anna Laura Pisello[2],
[1]CIRIAF, Interuniversity Research Center on Pollution and Environment Mauro Felli (Italy),
[2]University of Perugia (Italy).

Abstract:

Urban heat island is the most acknowledged climate change related phenomenon in the scientific literature. Several consequences are also demonstrated as its effect on population health conditions in dense urban areas, even exacerbated by heat wave phenomena during summer seasons all around the world. The heterogeneity of the urban environment causes an intra-urban microclimate diversification under-the-canopy and thus directly affecting pedestrians' comfort and buildings energy consumption. Most of field monitoring studies and applications in urban areas are carried out by means of permanent weather stations frequently located over building roofs or, even worse, in not accessible areas for pedestrians, with relatively minor representability of the monitored conditions affecting pedestrians' comfort. In this view, this study presents a new equipment for wearable microclimate monitoring aimed at characterizing microclimate peculiarities of pedestrians' paths in urban areas. The study is implemented in New York City where several mitigation techniques are already operating, such as urban parks, water bodies, permeable surfaces. These strategies are specifically analyzed from the perspective of pedestrians, who may enter even parks and walk over sidewalk at realistic height above the ground for better studying their boundary conditions affecting their thermal comfort perception and whole wellbeing. A novel cluster analysis is also carried out with the purpose to perform data-driven identification of mitigation strategies and urban configuration peculiarities (e.g. urban canyons etc.). Dataset partition into 2 subgroups is mainly driven by solar radiation during day-time identifying streets with different orientation or aspect ratio. Partition into 5 subgroups shows a more detailed description of intra-urban microclimate diversification assuming CO_2 concentration as driving environmental parameter. Finally, higher number of subgroups seems to produce too fragmented end not significant partition of the dataset.

Measurement Techniques and Standards-1

11:30am – 13:00pm (December 3, 2019)

Paper ID: 232

Local Climate Zone Classification and Seasonal Variation by using Land Surface Temperature: A case of National Capital Territory, Delhi, India

Manoj Panwar[1] , Avlokita Agarwal[2], Varuvel Devadas[2]
[1]D.C.R University of Science and Technology Murthal (India)
[2]Indian Institute of Technology Roorkee, Roorkee(India)

Abstract:

Local Climate Zones (LCZ) are a well-established concept in cities of the developed world and is beneficial for quantification of both spread and backwash effects in the system, forecasting the future under different scenarios and simulating the mitigation strategies for climate change adaptation. Temperature differentiation in LCZ classification (ΔT_{LCZ}) is considered a more appropriate, reliable and robust measure to analyze the magnitude of spatial temperature variations than temperature differentiation of urban and rural (ΔT_{u-r}). The seasonal behaviour of ΔT_{LCZ} is still to be established. Urban morphology of Indian cities is quite different from European and American cities due to non-uniform geometric and surface cover properties. The present work investigates the ΔT_{LCZ} based on the LCZ classification system and the seasonal behaviour of Land surface temperature (LST) for the National Capital Territory (NCT) Delhi, India. The Landsat 8 imageries of NCT Delhi are analyzed for the year 2016 and 2017, downloaded from USGS earth explorer, for the purpose of LST retrieval by using well-established single-window LST algorithm. A sample of 91 subsets, nearly uniform shape and size of 1 km^2 are classified by considering built-up, vegetation, water, and other classes, and are further categorized based on land-cover, built-up density, average building height and their closely matching LCZ. The spatial distribution of sample subsets is kept uniform for all classes to represent the entire study area. Variations of ΔT_{LCZ} and LST in the same LCZs ($\Delta T_{LCZ-LST}$) for all the subsets are quantified and comparative analysis is done a season-wise comparison between ΔT_{LCZ} and $\Delta T_{LCZ-LST}$ for all present climates in the study area. A seasonal variation of intensity ranging from 1.15^{o}C (airport site) to 4.78^{o}C (agricultural sample sites) with an average variation of 2.14^{o}C is observed in $\Delta T_{LCZ-LST}$. The paper concludes with the significance of seasonal $\Delta T_{LCZ-LST}$ in urban planning.

Measurement Techniques and Standards-1

11:30am – 13:00pm (December 3, 2019)

Paper ID: 278

"Inverted" Surface UHI: An artefact of relying solely on Satellite Remote Sensing data for measuring the Urban Heat Island Phenomenon

Prasad Pathak[1], Raja Sengupta[2], Bakul Budhiraja[3]
[1]Centre for Earth and Environment, FLAME University, Lavale, Pune, India
[2]Dept. of Geography, McGill University, Montreal, CA
[3]Dept. of Civil Engineering, Shiv Nadar University, Greater Noida, India

Abstract:

Traditional definitions of the Urban Heat Island (UHI) effect focus on the observed increase in night time canopy layer air temperatures in an urban core (as measured by ground based weather stations), in comparison to a surrounding rural (usually agricultural or forest) reference. The maximum difference in temperature between rural and urban areas (usually measured in degrees Celsius) is also referred to as the "UHI Intensity". Remotely sensed measurements of "skin" or Land Surface Temperatures (LST) from satellite-borne thermal sensors such as MODIS Terra, MODIS Aqua and Landsat 8, can be used to derive Surface UHI (SUHI). However, solely relying on SUHI for UHI measurements have recently led to observations of "Inverted" UHI phenomenon in Deserts and Semi-Arid conditions (in countries such as UAE and India), where the rural reference is seen to be warmer than the urban core. Such claims of "observing" inverted surface UHI in remotely sensed data should be treated with caution, as they are predominantly the artefact of satellite sensor readings taking during certain periods of the day at specific seasons.

Paper ID: 180

Green Infrastructure Strategies as Countermeasures to Urban Heat Islands with particular reference to the Bangalore Metropolitan Region

Reshmi Manikoth Kollarath[1], Vasseem Anjum Sheriff[1]
[1]BMS College of Architecture (India)

Abstract:

Bangalore the capital of the state of Karnataka is one of the fastest growing metropolises in India. Traditionally it enjoyed a salubrious climate and was referred to as Garden city for its numerous private gardens and parks and Pensioners paradise for its lifestyle. More recently it has emerged as the IT capital and has witnessed a sudden surge in the population seeking economic opportunity. Bangalore, in recent times, is experiencing unprecedented urbanisation and sprawl due to concentrated developmental activities with impetus on industrialization and development of grey infrastructure for the economic development of the region. This concentrated growth and increase in population and consequent pressure on infrastructure, natural resources and ultimately giving rise to a plethora of serious challenges such as climate change, enhanced green-house gas emissions, lack of appropriate infrastructure, traffic congestion, and lack of basic amenities, in many localities leading to change in different land use types. Recent research indicates that Greater Bangalore is an emerging Urban Heat Island. Factors contributing to the Urban Heat Island Effect include Urban Structure, Urban Surface Cover, Urban fabric, Urban Metabolism and distinct lacunae in urban planning. The alarming decline in the vegetation cover and water bodies has contributed significantly to discomforting rise in temperature. This paper seeks to examine green infrastructure strategies at varying urban scales in order to mitigate the impact of the Urban Heat Island Effect.

Measurement Techniques and Standards-1

11:30am – 13:00pm (December 3, 2019)

Case Study-1

Evaluation of countermeasures for thermal environment in Delhi by urban canopy-building energy coupled simulation

Takaharu Ota[1], Yukihiro Kikegawa[1], Kazuki Yamaguchi[1], Yuya Takane[1], Manabu Kanda[1], Alvin Christopher Galangc Varquez[1], Tomohiko Ihara[1]
[1]The University of Tokyo, Japan

Abstract:

With the rapid population growth and economic development, urban heat island (UHI) is occurring in Delhi, the capital of India. It is necessary to reproduce UHI for evaluating countermeasures to UHI because Delhi is a harsh thermal environment where the annual maximum temperature reaches 40 °C and UHI will become more intense with the future growth of Delhi. This study demonstrated how to obtain parameters which are necessary for simulation by the urban weather-building energy coupled simulation (CM-BEM). Additionally, this study drew the spatial distribution of temperature of Delhi by CM-BEM and compared the simulated and observed meteorological elements in order to confirm the validity of the simulation. Upper-end boundary condition was created by the GIS4WRF, which is a plug-in tool of QGIS. The WRF version of the GIS4WRF is ver. 4.0. The grid shape data was extracted from the satellite image by the NASA Ames Stereo Pipeline (ASP). The type of the grid was classified based on the Local Climate Zone (LCZ). Traffic waste heat was estimated from the road area of each grid and the annual gasoline consumption in Delhi. The thermal structure and schedule data of buildings was obtained from the Energy Conservation Building Code (ECBC). Some data were set based on the previous study in Jakarta. CM-BEM was employed for simulating the outdoor temperature. By linking the canopy model (CM) with building energy mode (BEM), the feedback process of air-conditioning energy demand of the building and outdoor temperature can be reproduced. Calculation period was 8 days from March 4th to 11th in 2010. Solar radiation and outdoor temperature had been observed by Mohan et al. These observed data were compared with our simulated data for verification. Solar radiation was compared at two locations. Both showed overestimation of 10% –20% at culmination. This seems to be due to the difficulty in reproducing the cloud cover in the WRF microphysics scheme. Outdoor temperature was compared at five locations. An overestimation of about 2 °C on average was shown. It was found that our simulated temperature is close to the temperature simulated by Bhati et al. This overestimation may be improved by increasing the simulation domain size. This study constructed the parameters necessary for the simulation. Additionally, this study reproduced UHI in Delhi by urban meteorological simulation and verified the simulation. At this moment, both of solar radiation and outdoor temperature are overestimated and need to be corrected. After successful reproduction, UHI countermeasure technologies will be evaluated. We will explore the best countermeasure in Delhi by conducting cost-benefit analysis of various countermeasures with full-year simulation.

Modeling and Forecasting Urban Climate and Weather– 1

11:30am – 01:00pm (December 3, 2019)

Paper ID: 64

Improving the Accuracy of Simplified Urban Models Using Actual Radiation Parameters

Afshin Afshari[1], Nicolas Ramirez[2], [1]Institute of Building Physics (Germany), [2]Smart4Power (United Arab Emirates)

Abstract:

While detailed modeling of urban momentum/energy exchanges can be attempted via Computational Fluid Dynamics (CFD), developing and simulating a comprehensive CFD model of a realistic urban domain is a monumental task. In fact, a comprehensive model implementing the dynamic coupling of urban microclimate to building heat transfer is currently out of reach. Not to mention that an overly complex model would not be of much practical use in a decision support setting where multiple parametric simulations are often necessary. Simplified Urban Canopy Models (SUCM) are mainly contingent on the assumption of an idealized form for the urban roughness elements. They are often a component of larger mesoscale climate models but could also be used in stand-alone mode—provided that certain boundary condition simplifications are made. Some of the most notable SUCMs are: Town Energy Balance (TEB), Square Prism Urban Canopy (SPUC), Urban Weather Generator (UWG) and variants. The complexity and computational speed of these models is significantly reduced thanks to the implementation a simplified representation of momentum transfers. Concurrently, the spatial organization of the surfaces (slopes, orientations, shape factors), and their physical characteristics (albedo, emissivity, thermal conductivity) need to be simplified as well. In particular, the models often rely on very rough estimations of short-wave (solar) and long-wave (infrared) radiation heat transfer. In this study, we assess the comparative validity of the radiation heat transfer approximations proposed by the different simplified modelling approaches in comparison to exact solutions calculated for an actual urban district. The main contribution is the assessment of the impact of the improvement of an existing SUCM by replacing the default radiation transfer calculations with much more accurate ones determined in consideration of the detailed geometry of a real urban district. We show that the implementation of a more accurate radiation estimation can result in significantly different results in some cases. In particular, under a Cool Surfaces scenario, the average urban heat island intensity can be underestimated by TEB, by as much as 13%.

Paper ID: 121

Urban Heat Island Minimisation, Local Climate Zones and Parametric Optimisation: A “Grasshopper” Based Model

Madhuranga K.K.K.D.R.[1], Perera, N.G.R.[1], [1]Department of Architecture, University of Moratuwa (Sri Lanka)

Abstract:

Many cities have undergone severe transformation, creating unliveable environments, polluted and stagnant air and effected by Urban Heat Island (UHI). With the prevailing rapid development in Sri Lanka in general, and Colombo in particular, the impact of the phenomena is evident. Thus, it needs to become a key consideration in the urban design process to optimise building morphology for minimum UHI impact, especially in the Tropics. The main objective of the study is to build a parametric model to analyse the behaviour of the Urban Heat Island (UHI) effect with the changing land cover and geometric properties, based on the Local Climatic Zone (LCZ) classification. A parametric model is developed using Grasshopper VPL to match the corresponding geometric and land cover properties and thereafter, used with a derivative free optimisation algorithm to find the respective forms that generate maximum and minimum UHI values. Findings show a direct association of the building height to the UHI intensity. Higher impervious land cover percentages contribute to the increase of the UHI value. As an outcome of the research, a protocol model process is presented, which allows the input of multiple variables and generates real-time adaptive results, dramatically reducing the time of the optimising process, for UHI minimisation. Thus, allowing planners and urban designers to explore different morphologies through real-time analysis.

Modelling and Forecasting Urban Climate and Weather– 1

11:30am – 01:00pm (December 3, 2019)

Paper ID: 153

Modelling potential air temperature reductions yielded by cool roofs and urban irrigation in the Kansas City Metropolitan Area

Seongeun Jeong[1], Dev Millstein[1], Ronnen Levinson[1]
[1]Lawrence Berkeley National Laboratory (USA)

Abstract:

We evaluate two mitigation strategies for urban heat island in the Kansas City Metropolitan Area (KCMA). Using the Weather Research and Forecasting (WRF) model, we assess the potential benefits of highly reflective cool roofs and urban irrigation on urban air temperature in typical summer conditions between 2011 and 2015, and also during six of the strongest historical heat wave events over the past 12 years (2005 – 2016). Under the typical summer conditions, we simulate near-surface (2-m) air temperature for 10 summer weeks, finding average daytime (07:00 – 19:00 local standard time) temperature reductions of 0.08 and 0.28 °C for cool roofs and urban irrigation, respectively. During the six heat-wave episodes, we also find similar daytime temperature reductions of 0.02 and 0.26 °C for the two scenarios compared to those of the typical summer conditions. Our results suggest that urban irrigation can be more efficient than cool roofs in mitigating the urban heat island in metropolitan regions where the majority of the urban land cover is comprised of areas with low urban (i.e., non-vegetated) fractions. Though urban irrigation decreases temperature, it increases humidity, removing some of the thermal comfort benefits. Finally, we find the alteration of land surface conditions due to enhanced roof albedos impacts local meteorology and precipitation patterns within the WRF simulation, in particular during the heat wave periods. Further research would be necessary to determine the robustness of this last finding.

Paper ID: 208

Envelope heat load characteristics of the building cluster considering radiate heat exchange process in an urban district

Yasunobu Ashie[1],
[1]Building Research Institute, Japan

Abstract:

We developed a numerical model to calculate the annual envelope thermal load of several buildings in the urban area taking a radiative impact of neighbouring buildings into consideration. We conducted benchmark tests on air-conditioning thermal load simulation targeting single building to verify this development model and confirmed that we can obtain results appropriate compared to those obtained with existing air-conditioning thermal load calculation tools. Moreover, we conducted case studies targeting building clusters. Their results proved for the first time that a change in the aspect ratio between building height and pitch significantly affects envelope thermal load and quantitatively proved an effect of higher reflection of the urban surface on cooling and heating load.

Modelling and Forecasting Urban Climate and Weather-1

11:30am – 01:00pm (December 3, 2019)

Paper ID: 245

Minimizing the inconsistencies of urban building energy simulations through strong microclimate coupling

Georgios-Evrystheas [1,2], Emmanuel Bozonet[1], Peter Riederer[2]
[1]University of La Rochelle, [2]CSTB (France)

Abstract:

The impact of microclimate conditions on energy demand is investigated through various coupling schemes between a zonal microclimatic tool and an urban building energy simulation software for a canyon settlement. Additionally, the impact of split air condition units on ambient air temperatures is examined for an annual period. The numerical calculations for a mild oceanic climate confirm the necessity of integrating the microclimate conditions in building energy performance simulations. Air conditioning units, have a significant impact on air temperature both for cooling and heating period. Furthermore, discrepancies emerging from online and offline coupling schemes are highlighted.

Urban Vegetation & Greenery-2

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 50

Assessment of Terrace Gardens as Modifiers of Building Microclimate

Chitra Chidambaram[1], Pranjali Varshney[1], Sakshi Kumar[1], Surabhi S. Nath[2]
[1]Sharda University (India),[2] IIIT Delhi (India)

Abstract:

With rampant urbanization, permeable and soft grounds with vegetation are being replaced by impervious hard concrete surfaces that cause heat islands and floods, adversely impacting the quality of urban living. Terrace garden, reducing heat gain from the roofs and promoting greening at higher levels of built structures is seen as one of the key mitigating strategies for modifying building microclimate and improving urban health. We have undertaken a research project to quantitatively assess the value of a terrace garden to a building microclimate and explore its potential for organic farming. For the experimental research, a garden patch of about 15 m^2 in area, a typical size available in most urban terraces is developed on the terrace of an eight floored building. As conduction is the principal mode of heat gain in top floors, surface temperatures are measured on and below the roof, with and without a terrace garden, using thermocouples connected to a data logger. The data of surface temperature and the vegetable harvest is collected for one year from July 2018 to June 2019 and the paper presents the analysis. The results show that the terrace garden does stabilize and reduce the ceiling temperature of a concrete roof from 2^{o}C in February to 7^{o}C in the hottest month of June and provide nearly 400 grams of fresh monthly harvest per m^2 of garden. The study quantitatively demonstrates the benefits of a terrace garden in enhancing building microclimate and mitigating urban heat islands otherwise caused by bare concrete building roofs.

Paper ID: 114

Study of Urban Morphology and Its Impact on Microclimate of Surrounding Area Case Study – S.B. Road, Pune

Ar. Prathama Jhaveri[1], Ar. Namrata Dhamankar[2], Dr.Sujata Karve[2]
[1]D.Y.Patil School of Architecture, Lohegaon, Pune (India),
[2]Dr.Bhanuben Nanavati College of Architecture, Pune (India)

Abstract:

The aim of this paper is to study the impact of the urban morphology for its effectiveness to climate response through the analysis of its microclimate. To this end, the context of urban morphology is studied for streets, buildings, open spaces and vegetation. The rapidly growing population combined with rapid urbanization has led to unplanned and uncontrolled expansion of Pune leading to changes in land use, urban form and settlement. This study takes a simulation approach to analyze the impact in an urban settlement in Pune, India of mixed use through Envi-met -3.1software. Three environmental factors of mean temperature, wind speed and relative humidity have been selected to quantify the outdoor micro-climate with a single constant indoor temperature.

Urban Vegetation & Greenery-2

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 125

A study on Park Cooling Island Effect on Surrounding Urban Area, in Urban Design Perspective

Tong Wu[1], Shuowen Chi[1], Youpei Hu[1]
[1]Department of Urban Planning and Design, Nanjing University, No. 22, Hankou Road, Nanjing 210093, (China)

Abstract:

Previous studies have shown that urban green space has a cooling island effect, which is beneficial to mitigate urban heat island, especially in the hot-summer region. However, Researchers' interest is mostly concentrated on the green space itself, and there are a few researches on the phenomenon of the spread of cooling island to surrounding urban areas under the influence of urban wind, which could have a more positive and broad meaning for mitigating UHI. This study focuses on the latter, and aims to identify the key factors which are manipulatable in urban design perspective among various factors influencing the diffusion of green cooling island. The city of Nanjing is selected as the background city, because of its long-time and high-temperature summer. Two green spaces with different characters are chosen to conduct field measurement, from which the first-hand meteorological data are obtained, and then used to adjust the micro-climate simulation platform, ENVI-met, to ensure the reliability of simulation. Various factors, including green space own factors, meteorological factors, and surrounding urban fabric are parametric analyzed own to simulation method, from which, qualitative conclusions are drawn on the co-relation between factors and the diffusion distance of cooling islands. In the third part, we applied the knowledge obtained in this research to optimize the downwind urban fabrics of a test case. The result shows that with the knowledge, feasible urban design strategies could be applied to maintain and enlarge cooling island effect on surrounding urban area.

Urban Vegetation & Greenery-2

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 214

High albedo plant selection for mitigation of the urban heat island

Giulia Santunione[1], Chiara Ferrari[1] , Alberto Muscio[1]
[1] University of Modena and Reggio Emilia, Department of Engineering "Enzo Ferrari, Italy

Abstract:

The use of greenery as countermeasure to Urban Heat Island phenomenon is one of the more efficient answers to urban warming since it provides significant benefits in terms of thermal comfort and air quality and, therefore, human health. The civil and environmental engineering research is rising the attention to the design of greenery in urban and surrounding areas in order to find out innovative strategies and technologies that can improve the urban climate. Different types of greenery usually exist in the city areas such as parks, green roofs, vertical gardens. The physical and physiological features of plant species involved in greenery systems lead to their effectiveness in terms of thermal mitigation. This study is aimed to investigate the surface radiative properties of green canopy with high albedo such as *Stachys bizantina*, a herbaceous plant characterized by an ashen color due to the presence of a white silky-lanate hair. Its albedo can be especially helpful during heat waves, when plants in green areas often close their stomata and thus reduce significantly evapotranspiration and, with that, their mitigation potential. The albedo of *Stachys b*. has been measured through ASTM E1918, then compared with the albedo of grass commonly used in green urban areas (*Lolium perenne*). Values obtained through field measurements have also been complemented with measurements through a WorldView-3 platform satellite image of the city of Modena, Northern Italy. Replacing partially the grass cover of green areas with high albedo plants like *Stachys b*., indeed representative of other useful species, can yield a non-negligible increase of the urban albedo on these green districts and their surroundings.

Paper ID: 279

A Comparative empirical assessment of native deciduous and evergreen trees on carbon stock potential for regulating ecosystem services in tropical dry evergreen forest, Coromandel coast, Tamil Nadu, India

Parisutha Rajan Alphonse Marianadin[1], Minakshi Jain[1] , Abdul Razak Mohamad[1]
[1]School of Planning and Architecture, Vijayawada(India)

Abstract:

Vegetation, particularly trees, provides a wide spectrum of regulating ecosystem services, which include up keeping of air quality, stabilizing temperature, reduction in ultraviolet radiation, oxygen generation, and carbon sequestration. Carbon Stock, called "C-stock", is one of the most common benefits of trees in today's scenario on climate change and anthropogenic disturbance all over the world. The purpose of this technical paper is to compare empirically and assess the total C-stock (TCS) of ten dominant native deciduous trees (NDT) and native evergreen trees (NET) for 10-ha area distributed 1-ha in each of ten tropical dry evergreen forest sites of Coromandel Coast of Tamil Nadu, India. The data obtained from a recent research publication is analyzed for total c-stock potential between NDT and NET trees through the application of the statistical tool. The Chi-square, Goodness of fit between Above Ground Biomass of NDT and NET is 30733.80, The p-value is < 0.00001. The result is significant at $p < .05$ (standard level for analysis). Hence, native evergreen trees have a higher c-stock capacity, when compared to native deciduous trees. Thus, prove the higher carbon sequestration potential of native evergreen trees.

Outdoor Comfort and Health in Urban Environment – 2

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 54

Comprehensive evaluation of the influence of outdoor temperature change on health around the urban area

Daisuke Narumi[1],Tomohiko Ihara[2], Sanae Fukunda[3], Yoshiyuki Shimoda[4].
[1]Yokohama National University(Japan), [2]The University of Tokyo(Japan),
[3]Kansai University of Welfare Sciences(Japan), [4]Osaka University (Japan)

Abstract:

This paper aims to comprehensively and quantitatively evaluate the impact of urban outdoor temperature change on human health in Osaka Prefecture, based on the data accumulated by the authors and some other researches, conducted an annual evaluation from fatal severe to relatively mild impact. Specifically, based on the concept of endpoint-type life cycle impact assessment method, human health impact due to various diseases was integrally evaluated using DALY (disability-adjusted life year). The evaluated diseases were heat / cold stress and heatstroke (death) as fatal severe effect, infections such as Herpangina, sleep disturbance, fatigue and mild heatstroke (not death) as an effect that do not lead to death. The time range of the evaluation was from 1967 to 1977 (1970s) as the base period, from 1987 to 1997 (1990s), further from 2007 to 2017 (2010s) over the past 40 years. As a result, the largest increase of DALY was seen in August, especially deterioration in sleep disturbance, fatigue, death by heat stress and death by heatstroke showed large impact. On the other hands, the largest decrease was seen in February, mitigation in fatigue and cold stress showed large impact. The annual total value of DALY increased by 2,854 [DALY]. The influence of sleep disturbance and fatigue had a large impact on the change in DALY. Although the disability weight and the disease period are small for these diseases, these influences are indispensable to evaluate the entire of human health from the macro viewpoint of urban area.

Paper ID: 92

Outdoor Thermal Comfort Implications of Planning and Building Regulation Induced Canyon Geometry

Hepsheba,J.J[1], Perera,N.G.R[1.], Emmanuel. R[2]
[1]Department of Architecture, University of Moratuwa (Sri Lanka)
[2]Glasgow Caledonian University (United Kingdom)

Abstract:

The Planning and Building Regulations developed by the Urban Development Authority (UDA) of Sri Lanka are deemed to be inadequately equipped to deal with the major urban challenges of a rapidly developing Colombo, Sri Lanka - especially in terms of the climate sensitive aspects, within the overall sustainability of the City. The UDA regulations are applied for a specific plot of land. Therefore, the microclimatic impact of the regulations upon a city precinct or neighbourhood is not known. In order to understand the quality of the policy framework manifested in the Planning and Building regulations that define land use zoning and allowable building morphology imposed, we critically evaluate the outdoor thermal comfort impacts of the spaces around buildings in a typical street canyon form. The simulation based study primarily focuses on assessing the impacts of urban geometries induced by regulations. We explore low-rise, intermediate-rise and mid-rise iterations as base cases. The simulations are generated by utilising the software ENVI-met, with the Mean Radiant Temperature (MRT) as the primary variable for outdoor thermal comfort. As an initiative to improve the climate sensitive aspects of the current regulations, we model a projected, staggered street edge option and a shaded street edge option. Results and analyses map the impacts of the base canyon morphologies and the projected. Results show that, the staggered and shaded cases reduced MRT, when compared with the base case morphology. Conclusions discuss directions for the optimum street canyon geometry by regulating the spaces around buildings.

Outdoor Comfort and health in Urban Environment– 2

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 147

Analysis of urban parameters to improve outdoor thermal comfort in Singapore new high rise developments

Juan Angel Acero1, Elliot J.Y.Kohn[1], Lea A.Ruefenacht[2], Leslie k.Norford[3]
[1]CENSAM-SMART (Singapore) , [2]Singapore-ETH Centre (Singapore), [3]Dept. Architecture (MIT) (EE. UU.)

Abstract:
Tropical cities exposed to high temperatures and relative humidity throughout the year usually reach discomfort levels in the outdoor thermal perception. This can generate health, social, economic, and environmental problems to urban dwellers. Urban heat stress can be reduced with suitable urban planning. In this work, we present an evaluation of the impact of urban geometry in the outdoor thermal comfort in Singapore. The study is focused on a new mix-use high-rise development that will occur close to the actual Commercial Business District (CBD). Based on the Gross Plot Ratio (GPR) and other constrains already defined in the Master Plan, different design scenarios have been analyzed including changes in the block form, street orientation, street aspect ratio and building height profile. The study is based on modelling techniques (ENVI-met model). Each scenario was analyzed for 7 reference weather conditions during the year derived from a clustering procedure. The results are analyzed by specific metrics that take into account the spatial and temporal variation in outdoor thermal comfort levels throughout the year. Results show that the best OTC performance is for north-south oriented streets, although significant differences occur between the weather conditions. Although higher street aspect ratio (H/W) can produce shadow and reduce ground surface heat accumulation, lower street ratios can also benefit from air ventilation if they have adequate orientation with respect to prevailing winds. Finally, the building height arrangement shows a relevant influence in ventilation and air temperature at pedestrian level inside the street canyon.

Paper ID: 185

Effectiveness of UHI mitigation strategies for outdoor thermal comfort enhancement

Illaria Pigliautile[1], Anna Laura Pisello[1], Elie Bou-Zeid[2]
[1]University of Perugia (Italy), [2]Princeton University (NJ, USA)

Abstract:
Cities morphology and urban fabric characteristics modify energy balances in urban areas leading to the well-known phenomenon of the Urban Heat Island. This characteristic of the urban microclimate has several negative consequences including a worsening of citizens' well-being and life quality. Thermal comfort in outdoors is one aspect of citizens' life that is degraded by the UHI. The current work approaches thermal comfort investigation through numerical simulations. A parameterized human physiology is introduced in the Princeton Urban Canopy Model (PUCM), which captures the effect of greenery and different materials on the urban environment. Human comfort is given in terms of computed skin temperature and six different scenarios are simulated to assess the effect of common UHI mitigation techniques, i.e. application of cool materials and introduction of trees, on pedestrians' thermal perception during a hot summer week in Princeton. Results are critically analyzed and an accurate investigation of mitigation strategies' impact on each term of the simplified human energy budget is given.

Outdoor Comfort and health in Urban Environment– 2

02:00pm – 03:30pm (December 3, 2019)

Page ID: 297

Effect of urban morphology on urban microclimate: A case of Vijayawada

Ar. Madhavan Rajan[1], Dr. D. Kannamma[2],
[1]Department of Architecture, NIT Trichy, India, [2]Assistant Professor, Department of Architecture, NIT Trichy, India

Abstract:
Changes that happen in the urban surface tend to change the local climate of the particular settlement through the land surface process that influences the surface energy balance and boundary layer (Andrew M. Coutts, 2007). This study is a quantitative analysis of the urban morphology concerning the microclimate of the Vijayawada. The microclimate is simulated by using Ladybug tools. Many variables were used to accesses the microclimate of an urban area for this study chosen variables are Green Plot Ratio (GPR) and Open area (OA). These two parameters were analyzed using UTCI (Universal thermal climate index) as the thermal index for selected urban morphology in Vijayawada. This study aims to compare the High-density settlement with the low-density settlement in terms of its performance of Outdoor thermal comfort (OTC) and to accesses the microclimate respect to vegetation cover in Vijayawada.

Implementation of Urban heat Mitigation Stratergies-1

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 33

Effects of Albedo Enhancement on Air Temperature and Ozone Concentration in Four Cities over North America: Sacramento, Houston, Chicago and Montreal during the 2011 Heat Wave Period

Zahra Jandaghian[1], Hashem Akbari[2]
[1]Research Assistant at Ryerson University, [2]Professor at Concordia University (Canada)

Abstract:

The weather research and forecasting model with chemistry (WRF-Chem) is coupled with a multi-layer of the urban canopy model (ML-UCM) to illustrate the effects of albedo enhancement on urban climate and air quality over North America, focusing on Sacramento, Houston, Chicago and Montreal, during the 2011 heat wave period. Simulations are conducted in a two-way nested approach to decrease the uncertainties associated with scale separation and grid resolutions and to capture the full impacts of meteorological and photochemical reactions. The model simulated the diurnal variation of 2-m air temperature reasonably well and overpredicted ozone concentrations. The albedo of roofs, walls, and pavements increased from 0.2 to 0.65, 0.60, and 0.45, respectively. The correlations between albedo enhancement, air temperature and ozone concentrations are analyzed. The heat island mitigation strategy reduced the daily 2-m air temperature by a maximum of 2.5°C, 3°C, 2°C and 0.7°C in urban areas of Sacramento, Houston, Chicago and Montreal, respectively. In addition, the daily averaged ozone concentrations decreased by a maximum of nearly 8ppb in Sacramento and Houston and 5ppb in Chicago and Montreal during the simulation period. Based on the modeling efforts, the larger the ambient temperature reduced, the larger the impacts on urban climate and air quality. The consequences of surface modifications are episode and domain specific and may not be used in generalizing the findings to other times or locations. The results of such study can be proposed to air pollution control districts to consider the surface modification technique in a regulatory framework.

Paper ID: 43

Urban and peri-urban agriculture in Goiânia: searching for solutions for mitigation and urban adaptation in a context of global climate change.

Débora Marçal[1], Gabriel Mesquita[1], Luana Kallas[1], Karla Hora[1]
[1]Universidade Federal de Goiás (Brasil)

Abstract:

Goiânia is a city designed in the late 1930s, being one of the two planned capitals of the Brazilian savannah. The city experienced population growth from migratory processes, resulting in intense urbanization between 1950 and 1990. By 2018, the city had 1.4 million inhabitants and a population density of 2,052.17 hab / km². Due to the model of urbanization employed, resulting in waterproofing of soils, channeling of watercourses and lack of efficient strategies for water infiltration, the city coexists with periods of water scarcity and flooding. In view of this, the urban municipal policy has sought to implement land use and land use control actions to mitigate such impacts. The practices of urban and peri-urban agriculture (PUA) may be one of these strategies since, in addition to contributing to the supply of infiltration areas, it presents itself as an act of social inclusion and development. Thus, in order to contribute with actions to adapt the city to global climatic effects, this article aims to indicate areas for the practice of urban and periurban agriculture (PUA) integrated to the dynamics and territorial management of the municipality. To do so, the methodology of the study was based on the use of geographic information systems, identification and classification of urban voids and an indication of priority levels for the inclusion of the areas in PUA practices. The results pointed to three levels of use priorities of the areas, obtaining 105 hectares for the use of PUA in such a way that these areas become resilient and multifunctional for the city.

Implementation of Urban heat Mitigation Stratergies-1

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 171

Materials for outdoor curtains and awnings as a solution for improving thermal comfort and mitigating urban heat island

Federico Rossi[1], Mirko Filipponi[1], Beatrice Castellani[1], Andrea Nicolin[1], Marta Cardinali[2], Alberto Maria Gambelli[2,] Cristina Piselli[2]
[1]University of Perugia, Perugia (Italy), [2]CIRIAF Interuniversity Centre, Perugia (Italy)

Abstract:
Outdoor modular structures with curtains and awnings may be an effective solution for mitigating Urban Heat Island, in particular for Cooling Dominated Zones (CDZ). The choice of suitable materials for outdoor shadings plays a fundamental role, especially in dense urban areas, because of high solar irradiance, low ventilation and high mean radiant temperature which might reduce the thermo-hygrometric comfort in summer conditions. For that reason, outdoor textiles materials with high solar reflectance upwards and low thermal emittance downwards could represent an effective microclimate mitigation strategy: textiles with low thermal emittance downwards, in particular, contributes to reduce the infrared radiation towards the covered area, which may ensure better thermal comfort conditions. Furthermore, materials with retro-reflective (RR) capabilities could help to reduce the amount of radiation that reaches the urban surfaces, as they reflect the incoming solar radiation mostly towards the incident beam direction. In this context, the present paper is aimed at studying textile materials for outdoor curtains and awnings in terms of their solar, radiative and RR characteristics, in order to improve human thermal comfort conditions under the coverings. For this purpose, a novel, glass fibre-based material for outdoor shading applications was analysed in terms of thermal emittance, spectral reflectance and directional reflectivity. Results of the experimental characterization show that the tested samples present a good global reflectance, while a high thermal emittance value has been observed. Directional reflectivity characterization reveals that all samples present a RR trend for incident light directions near the perpendicular.

Paper ID: 224

Physical and geographic analysis of the urban cooling potential

Martin Hendel[1,3], Sophie Parison[2,1], Laurent Royon[1]
[1]Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS (France),[2]Paris City Hall, Water and Sanitation & Roads and Traffic Divisions (France), [3]Université Paris-Est, ESIEE Paris, département SEN, (France),

Abstract:
The performance of a number of urban cooling techniques has been thoroughly studied by the scientific community. However, decision-makers lack the tools to spatialize their deployment as part of their urban cooling and climate change adaptation strategies. Among other indicators, a spatial assessment of the cooling potential for a technique in a given area is lacking. To this end, we analyze the physical mechanisms on which these techniques are based and identify corresponding geographical indicators that influence their cooling performance. Solar irradiance, existing material properties and underground infrastructure stand out as essential indicators for this purpose

Implementation of Urban heat Mitigation Stratergies-1

02:00pm – 03:30pm (December 3, 2019)

Paper ID: 226

Linkages between built form and open spaces and its impact on thermal comfort: A case of Mumbai, India

Surabhi Mehrotra[1], Divya Subramanian[1], Ronita Bardhan[1], Arnab Jana[1]
[1]Indian Institute of Technology Bombay, Mumbai (India)

Abstract:

Thermal comfort in Recreational Open Spaces (ROS) is primarily a result of the surrounding built form that includes buildings and trees along with the surface treatment. For the urban Indian context of Mumbai, the impact of land surface treatment choice and urban form, on the ambient air temperature, and thus thermal comfort, was undertaken in the form of a case study assessment. To study ROS and its thermal profile, we selected three open spaces adjoining a school in Mumbai within the IIT Bombay campus exhibiting different materials and built form. Using ENVI-met based modelling, the comparative analysis of land surface treatment impact on the ambient air temperature, surface temperature, and relative thermal comfort was undertaken. The results were validated using heat stress meters and thermal infrared camera, recorded over morning, afternoon and evening, over three days. The results highlighted the significant impact of the land surface choice on the ambient air temperature of ROS. Open spaces treated with concrete paving and open mud surface showed the air temperature about 3°C and 1.5 °C higher than naturally covered surface, during day hours. During evening, concrete surface showed higher temperatures. The study shows how built areas with vegetation and suitable surface treatment can regulate thermal comfort in ROS, which reduces the formation of urban heat islands. ENVI-met can be a useful tool in generating scenarios for reducing air and surface temperatures. The study would assist in appropriate policy formation and design guidelines pertaining to building form design and land surface treatment that render thermally suitable ROS and mitigate the urban heat island effect.

Case Study Presentations

02:00pm – 03:30pm (December 3, 2019)

Case Study-2

Vulnerability to Heat Stress A Case Study of Yavatmal, Maharashtra

Premsagar Tasgaonkar[1], Dipak Zade[2]
[1]Researcher at (Social Science & Climate Change Adaptation) – WOTR, Pune
[2]PhD Scholar at Tata Institute of Social Sciences, (TISS) Mumbai

Abstract:

Rising temperature and its associated health impacts is an issue of concern globally and for the rural India. The incidences of extreme heat wave and heat related mortalities have steadily increased over the years. According to the India Meteorological Department (IMD) report in 2016, 40% of all the deaths (natural calamities) because of extreme weather conditions were due to severe heat waves. Future climatic projections indicate increase in frequency, duration and area affected by heat waves. At present, most studies and actions to manage heat stress are focused on urban areas. Understanding of rural areas has been a blind spot where a significant proportion of population resides. The study was conducted in two villages located in the Yavatmal district of Maharashtra state (India). To understand the socio-demographic characteristics, quantify heat related symptoms (HRS), heat related illnesses (HRI) and coping strategies. A sample household survey was conducted in peak summer month of 2016 which covers 70 households having 324 individuals. Indoor temperature was measured by using 20 data loggers that recorded air temperature and humidity. These were installed in houses having different roofing types and automated weather station (AWS) was installed to measure outdoor temperature and humidity. Differential vulnerability exists in terms of age, gender, occupation, roofing structure of house and economic status. Men in age group of 30 to 60 years, individuals engaged in agriculture, farm and non-farm laborers, those having the pre-existing chronic and infectious health conditions, individuals with poor economic status and those residing in tin roof (metal/galvanised sheet) houses were more vulnerable. Environmental factors that define exposure to heat, human thermal comfort and heat stress are air temperature, airflow (wind speed), humidity and radiation. In indoor environment, the factors that aggravating heat stress are building style – characterized by type and construction of the roof and walls, provision of proper ventilation and application of cooling devices. The outdoor factors that aggravating the temperature are degraded landscape, low vegetation cover, less water bodies etc. Those staying indoors especially women, elderly and children were exposed to high indoor temperatures especially during peak heat hours. The case study shows that indoor temperature measurement in houses with tin roofs was higher throughout the day as compared to reinforced cement concrete (RCC) roof houses and even exceeded the outdoor temperature. Average temperature inside tin roof houses was hottest (45.8°C) as compared to outdoor temp of 42.5°C between 12pm and 6pm.

Case Study Presentations

02:00pm – 03:30pm (December 3, 2019)

Case Study-3

Evaluation of the surface urban heat island intensity with respect to the different local climatic zones

Judit Bartholy, Rita Pongracz, Zsuzsanna Dezso, Csenge Dian
Dept. of Meteorology, Eotvos Lorand University, Budapest, Hungary

Abstract:

Artificial surface covers and buildings fundamentally determine the urban environment. Because of this complex relationship the city structure can be characterised by different local climate zones (LCZ) based on the ratio of built-in areas, general building height, and surface cover. From the internationally defined 17 different LCZ classes 7 types (i.e. compact midrise, open midrise, open low-rise, large low-rise, dense trees, low plants, water) were identified in Budapest, which is the target area of this study. Budapest is the capital and the largest city of Hungary both in terms of the total population (with about 1.7 million inhabitants from the total 9.8 million inhabitants in Hungary) and the spatial extent (about 525 km2 from the total 93,000 km2 area of the country). The city is divided by the river Danube – flowing from north to south within the city – into a hilly, greener Buda side with forests on the west, and the flat, more densely built-up Pest side on the east. The finer scale city structure is reflected in the urban heat island intensity fields with special focus on the building density and land cover types, which are also addressed by LCZ classes. To analyse the differences between LCZ classes within the city, we used the time series of surface temperature (starting in 2001) derived from the radiation data of 7 infrared channels measured by the sensor MODIS onboard satellites Terra and Aqua. The results can be used in urban planning to identify the hot spots within the city where the increase of vegetation cover might reduce the urban heat island intensity.

Case Study-4

Development of Education Materials for Awareness of Junior Generation on Urban Heat Island Counteraction

Toshiaki Ichinose,
National Institute for Environmental Studies, Japan

Abstract:

The author has promoted many practices of environmental science education as a mission of the Tsukuba Science City and developed education materials like short movies for awareness of junior generation on importance of urban heat island counteraction. One of recent products focuses on clothing color effect. Not only as a such counteraction, but also in viewpoint of climate change adaptation, this kind of knowledge has to be widely shared in junior generation. The effects of reflectance of solar radiation have been well studied in terms of the paints used on paving and on building surfaces. However, there is insufficient information on reflectance in terms of clothing color, which is important for outdoor thermal comfort. The author observed surface temperatures of polo shirts of the same material and design but different colors; the shirts were hung in unshaded outdoor open space. Brightness of color is an important determinant of solar radiation albedo, however reflection performance in the near-infrared band is also an important determinant of surface temperature. The maximum difference between green (higher) and red (lower) was almost 5 - 10 °C and was greatest when the solar radiation was strong (e.g. Lin and Ichinose, 2014). As an effect of these actions, not a few students of elementary schools have changed their choices of clothing color in summer.

Case Study Presentations

02:00pm – 03:30pm (December 3, 2019)

Case Study-5

Truth in Architecture

Tushar Parikh,
Tushar Parikh and Associates, Gujarat, India

Abstract:

As architecture professionals, we always wonder what our idiom should be! From early introduction to form, function and spatial organisation at architecture school, somehow somewhere we all picked up the materials, the opening, and the look 'n' feel so to say of the western world. Please note that those where the days of no-internet and knowledge was gained from books and teachers. Then after year of professional practice at local and regional level it was a lot of unlearning and retrospection. In a hot and dry climate, the heat gain through roof is paramount. From years of learning the Fundamentals of design like shading glass and vertical surfaces from direct sun rays, letting wind flow across the premises, use of natural and local material, getting the services right and incorporating local art and craft are strongly established in the way we execute. Not only catering to the client's brief in simple form of a requirement but persevering to take the project to a level of client's aspiration, develops into an architectural consultancy. The case study here presented has a multi layered roof with no concrete for better insulation. Use of handmade roof tile instead of factory make terracotta tiles make it to the top layer. A hollow MS structure is proposed to span the roof over a set of load bearing walls. Reclaimed teak wood and local flooring material is used. With defined seasons and weather conditions in Indian subcontinent at large, the indoor-outdoor connect or the use of courtyard and/or veranda as the integral living space is all that a designer needs to weave in. Vegetation plays and important roll to the sense of sound, touch, taste and smell to a profession which is largely considered as a visual field. In a different case-study the requirement is a functional building, efficient in terms of design and running cost with very less or no maintenance cost. For a R&D centre of a security and communication company the workspace needed to be clean and well light. Protect the roof with solar panels, west with utility block, east with circulation, taking maximum defused light form the north with 2/3 opening in the north side, same becoming solid in the south side with 2/3 wall and 1/3 opening, achieved with a staggered column grid. Here for a given rectangular urban plot the design weaves the program in such a way that all the heat gain issues are addressed to bring down the power load and in turn the carbon footprint of the building to a great extent. Results in either of the case study are very promising with the inside ambient temperature and surface temperature not gaining heat and in turn not heating up the interiors. Attention to design at micro and macro level adds up very quickly to meet and exceed the larger goals. Maybe it is not an idiom we seek but the truth we seek in being architects.

Case Study Presentations

02:00pm – 03:30pm (December 3, 2019)

Case Study-6

Urban Climate Adaptation Strategy for Tropical Megacities Utilizing Energy Efficient Technologies

Kazuki Yamaguchi[1], Tadahiro Kuwayama[2], Tomohiko Ihara[2], Yukihiro Kikegawa[3], Kazuki Okada[3], Manabu Kanda[4], Alvin Christopher Galangc Varquez[4], Nisrina Setyo Darmanto[4], Prihadi Setyo Darmanto[5]
[1]Tokyo Electric Power Company Holdings, Inc., Japan
[2]Graduate School of Frontier Sciences, the University of Tokyo, Japan
[3]School of Science and Engineering, Meisei University, Japan
[4]School of Environment and Society, Tokyo Institute of Technology, Japan
[5]Faculty of Mechanical and Aerospace Engineering, Institut Teknologi Bandung, Indonesia

Abstract:

Tokyo is known as the megacity suffering harsh hot environment attributable to the UHI. Long term trends of temperatures in the megacities indicate that nights are getting warmer faster than days. As of today, nights in tropical megacities are much cooler than nights in Tokyo during summer, which means nights have greater room for UHI progress in future tropical megacities. Human health risk induced by climate change is calculated as a product of magnitude of the influence of the change and exposure population. In terms of magnitude of the influence, night-time warming would contribute more than daytime warming in tropical megacities. In terms of exposure, it is important to consider population varies in time and place. In particular, office areas have larger outdoor population in the morning and evening commute, while residential areas have larger indoor population in the night-time. Therefore, measures to lower the temperatures in the morning and evening are desirable for office areas, while measures to lower the temperatures in the night-time are desirable for residential areas. Anthropogenic heat in urban areas is one of major factors contributing to the UHI. Hence highly efficient technology with little heat generation can mitigate UHI. If widely distributed existing technology can be replaced by highly efficient technology, it works both ways in terms of climate mitigation and adaptation. Electric vehicles (EVs) and air source heat pump water heaters (HPWHs) are expected as such energy efficient technologies. In order to quantitatively evaluate the influence on urban temperatures in the case that EVs and HPWHs were to spread throughout Jakarta in the future 2050s we carried out numerical simulations using a coupled model of urban canopy model and building energy model (CM-BEM). We also carried out a simulation that assumed the wide-area introduction of ground greening as a typical UHI countermeasure and found the following by comparing their effects. The cooling potential of ground greening is relatively low in the built-up downtown office areas, mainly because there is little space for greening. In terms of diurnal variation, the cooling potential of ground greening peaks at early afternoon. These feature does not meet the desirable condition for the future tropical megacities. On the other hand, the potential of EV is large in the downtown office areas which is natural because there is a particularly high traffic volume in the downtown. The diurnal variation pattern of the cooling potential peaks at morning and evening in accordance with the temporal variation of traffic heat. The potential of HP water heater is large in the uptown residential areas which is because heat demand is large in residences. The diurnal variation pattern of cooling potential peaks at early morning because HPWHs are programmed to operate during night. These results suggest that EV is effective to mitigate a hot environment in downtown office areas during morning and evening, and HPWH is effective to mitigate a hot environment in residential areas during nighttime. These unique features meet the desirable conditions of UHI measures for the future tropical megacities.

Cool Materials Development & Characteristics-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 76

The evaporative cooling and its impact on the urban climate: study of the influence of road covering materials

Sophie Parison[1,2], Martin Hendel[2,3], Arnaud Grados[4], Laurent Royon[2],
[1]Paris City Hall, Water and Sanitation & Roads and Traffic Divisions (France)
[2]Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS (France)
[3]Université Paris-Est, ESIEE Paris, département SEN, (France)
[4]Univ Paris Diderot, Sorbonne Paris Cité, MSC, UMR 7057 (France)

Abstract:
The thermal behaviour of different pavement structures and their evaporative cooling has been tested in the laboratory under conditions similar to those observed during a heat wave in Paris. Different surface watering rates are thus tested in order to optimize the process according to the structure that will then be implemented on Parisian sites. Using a surface heat budget, it is possible to estimate the evaporative cooling flux depending on the chosen watering rate. Two linear cooling regimes are observed, allowing the maximizing the effects of watering while minimizing water consumption. The effects for each structure are quantified and compared.

Paper ID: 138

Potential of switching cool materials to optimize the thermal response of residential buildings in the Mediterranean region

Michele Zinzi[1], Stefano Agnoli[1], [1]ENEA (Italy)

Abstract:
Cool materials are a well established solution to mitigate urban and built environment climates, but not always suitable to reduce energy and cost performances, because of energy penalties during the heating season. Thermo chromic materials able to switch from a prevalent absorbing behaviour to prevalent reflective have the potential to overcome this problem. Several studies at the material level show advantages and limits of the technology, however no marketable solutions exists yet. This study aims at quantifying the potentialities of the technology for building applications in the Mediterranean region. The task performed by simulation analyses in transient regime with hourly time-step, thus calculating the status of the thermo chromic layer as a function of the surface temperature in dynamic conditions and not by simplified by seasonal calculations. The analysis is carried out in three main cities: Barcelona, Palermo and Cairo, representative of respectively: north, centre and south of the area. Several roof configurations are selected, also the building envelope is analysed with and without thermal insulation. Assuming 30°C as switching temperature, the thermal and energy analyses are carried out assigning the material three hysteresis magnitudes (0°, 2°, 10°C) during the colouration/decolouration transition. Thermo chromic materials exhibit potential energy savings between 2 and 20% respect to conventional roofs. High reflective thermo chromic materials have better performance than static ones in all conditions; low reflective thermo chromic materials provide benefit only when heating demand is predominant. More modelling efforts are needed to predict the colouration cycles in a given time period, critical parameter for life time prediction of the product.

Cool Materials Development & Characteristics-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 173

Black Titanium Dioxide: An Innovative Material to minimize the Urban Heat Island Effects in Walled city of Jaipur

Prasanna Bhangdia[1], Dr. Tarush Chandra[2], Dr. Pooja Nigam[3]
[1]PG Student, Dept. of Architecture & Planning, MNIT Jaipur (India)
[2]Professor, Dept. of Architecture & Planning, MNIT Jaipur
[3]Assistant Professor, Dept. of Architecture & Planning, MNIT Jaipur

Abstract:

The walled city of Jaipur is one of the notable examples of medieval Indian Town planning and architecture. The city rich in its cultural and heritage value is now urbanizing exponentially, facing the problems of population growth, lack of space, minimal green area, traffic congestion and so on. This results in an increase of Urban Heat Island effect leading to several secondary issues. Time has come to address this issue in a way that does not disturb existing settlement and at the same time generate the desired output. Technology has widened the canvas of our future by contributing in the form of various innovations. One of them is Black Titanium Dioxide- a photo catalyst having a property to remove the polluting agents from the air which contributes to UHI. This research attempts to use Black Titanium Dioxide nameplates, already existing feature of architecture in the walled city of Jaipur to reduce the number of pollutants emitted by vehicles and other activities. Based on the traffic survey of this area approximate quantity of pollutants emitted in the area and the colour coating area available is figured out, and the relationship between both of them has been established. This study will help to understand that the effects of UHI can be minimized by the application of innovative material within the strong historical context of the walled city.

Paper ID: 253

Numerical Analysis of Human Thermal Load Affected by Solar Reflection Characteristics of Vertical Wall in Street Space

Shinichi Kinoshita[1], Atsumasa Yoshida[1]
[1]Osaka Prefecture University (Japan)

Abstract:

Recently, heat island phenomenon becomes remarkable with expansion of the urban area. So far it is refrained because the adaptation to the wall surface of highly reflective materials leads to aggravation of the thermal comfort of the street space. In order to decrease the heat load from a wall surface to the atmosphere and mitigate the effect of solar reflection to street space, it is necessary not only to raise the reflectance on the wall surface but also to apply the materials with retro-reflection property that can reflect the sunlight in the incidence direction. In this study, it is assumed that retro reflective wall materials is constructed for a wall surface, and the thermal influence to human body near the wall surface affected by solar reflection characteristics, especially reflection directivity is numerically evaluated.

Cool Materials Development & Characteristics-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 274

Harnessing Benefits of Pervious Concrete Pavements: A Novel UHI Mitigation Strategy

Poornachandra Vaddy[1], Avishreshth Singh[2], Prasanna Venkatesh Sampath[3], Krishna Prapoorna Biligiri[4]
[1]Postgraduate Student, Indian Institute of Technology Tirupati (India)
[2]Doctoral Research Scholar, Indian Institute of Technology Tirupati (India)
[3]Asst. Professor, Indian Institute of Technology Tirupati (India)
[4]Assoc. Professor, Indian Institute of Technology Tirupati (India)

Abstract:

With growing urbanization and associated development of infrastructure, urban heat islands (UHI) have emerged as major challenges, which need to be addressed, in order to endure sustainable urban conglomerates. In this study, pervious concrete pavement (PCP) sections were constructed to assess their suitability in mitigating UHI through actual field implementation and testing. Temperature profiles of PCP and Portland cement concrete pavement (PCCP) were measured, recorded and compared under both dry and wet conditions by embedding thermocouples across their depth. The pavement temperature was recorded at 15-minute intervals under dry conditions, while under wet conditions the pavement temperature was examined after every three hours. Wet conditions were simulated by pouring water over the pavements, which was quantified when the pavement temperature decreased by 1 °C across its depth. Under dry conditions, it was found that PCP system was warmer compared to PCCP, irrespective of the time in one day. The quantity of water required was about 0.54 L/m^{2}to reduce the surface temperature of PCP by 1 °C. Further, in order to achieve similar reduction in temperature throughout the thickness of PCP, the quantity of water required ranged from 37.07-89.83L/m^2. Owing to its impervious nature, no change in temperature was observed in PCCP system even with inundation of water, except at the surface that exhibited very minute reduction. The experimental findings showed that negative impacts of UHI can be countered by using PCP systems as a potential for harnessing evaporative cooling effects that is remarkably higher than conventional pavements.

Implementation of Urban Heat Mitigation Strategies-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 44

A pavement-watering thermal model validation for SOLENE-microclimate: application to the Buirestreet

Marie-Hélène Azam[1], Auline Rodler[2], Marjorie Musy[2], Benjamin Morille[3], Sihem Guernouti[2]
[1]Univ. Nantes, CNRS UMR 6183, GeM, Nantes, France,[2]Cerema, Equipe- Projet BPE, F-44000, Nantes, France
[3]Soleneos, France

Abstract:

Pavement watering is considered as a solution to mitigate the Urban Heat Island, particularly for compact urban areas. This technique has been mainly studied through experimental works and its impact on urban energy balance at the micro scale has rarely been addressed by modelling. A thermal soil model dedicated to pavement watering has been developed within the urban climate model SOLENE-Microclimate. Watering events are modelled through a runoff convective heat flux and a latent heat flux. This watering model is presented here and applied to the Buire street, in the city center of Lyon (France). The model performances are assessed on two hot, clear and sunny days. Simulated and measured *in-situ* surface temperatures as well as radiation measurements are compared. A RMSE of 2.99°C is observed. Modelling such a complex environment requires multiple input data which are not always available. The influence of using non-local data and thus neglecting the UHI effect on the soil temperature is studied. It leads to an underestimation of the surface temperature by 0.93°C. Finally, the effect of pavement watering on soil temperature is evaluated. Evening watering scenario (17h to 22h GMT) decreases the surface temperature by 4.09 °C.

Paper ID: 126

The Oasis Project: UHI mitigation strategies applied to Parisian schoolyards

Ghid Karam[1,2] ,Martin Hendel[1,2], Cécilia Bobée[1], Alexandre Berthe[1], Patricia Bordin[1], Laurent Royon[1]
[1]Univ Paris Diderot, Sorbonne Paris Cité, LIED, UMR 8236, CNRS, F-75013, Paris, (France)
[2]Université Paris-Est, ESIEE Paris, département SEN, F-93162, Noisy-le-Grand, France

Abstract:

Paris is experimenting and implementing strategies to increase the capital's resilience and promote climate change adaptation. Major heat waves have been hitting the French Capital lately(Bador et al., 2017) and have thus focused attention onUHI countermeasures, such as pavement-watering solutions and urban greening. The Oasis Project is one such strategy aiming to transform schoolyards into urban cool islands that would benefit surrounding neighbourhoods and their inhabitants during heat waves. The work presented here focuses on identifying high-priority schoolyards among the 670city-owned schools. This is conducted using a GIS tool used to identify areas with high cooling potential, which would benefit most from UHI countermeasures. After extracting bare schoolyard from the facilities, we built a cooling indicator based on the ratio of high solar irradiance surface to the whole schoolyard area. We were thus able to identify 38 schoolyards with high cooling potential, 157 with medium cooling potential and 286 facilities with moderate cooling potential, out of the 670 facilities. The methodology can be applied to other cities, and therefore helps set up GIS tools that can provide municipalities with meaningful insight into their urban cooling strategy.

Implementation of Urban Heat Mitigation Strategies-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 129

Impact of Urban Heat Island formation on electricity consumption over Delhi region

Priyanka Kumari[1], Vishal Garg[2], Krishan Kumar[1]
[1]School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India
[2]International Institute of Information Technology, Hyderabad, India

Abstract:

Urban heat island (UHI) effect is a common phenomenon found in urban areas which is associated with the increased ambient temperature resulting from man-made alteration of the land. Urban structures with complex geometry, increased concretized surfaces and reduced natural land cover cause reduction in the rate of heat loss leading to increased temperature over urban areas and creating urban heat island (UHI). This study explores the temporal and spatial pattern of urban heat island (UHI) formation over Delhi. It is observed that the night-time surface temperature of central Delhi is higher in all months as compared to its surrounding rural areas. Thus, a nocturnal heat island forms over Delhi in all the seasons. The dense built-up area and impervious surfaces of Delhi are responsible for trapping heat which causes discomfort to humans, resulting in increased use of cooling devices with higher electricity consumption. Polynomial regression model based calculations show cooling load may be reduced up to 21-23% in summer months, 10 to 14 % in monsoon season, and 8 to 17 % in post-monsoon season if urban heat island effect is removed.

Paper ID: 293

Effect of UHI and Building Geometry on Pollution Dispersion in an Urban Street Canyon

Udayraj[1]
[1]Department of Mechanical Engineering, Indian Institute of Technology Bhilai, Raipur, Chhattisgarh, India

Abstract:

Air pollution caused by vehicle traffic inside a street canyon is one of the major sources of pollution and air quality degradation. It represents a significant health risk to the inhabitants in urban areas. Migration from rural to urban areas and growing economic activities are leading to many high rise buildings in the urban areas to accommodate large population. Rapid urbanization and urban heat island (UHI) effect are also cause of concern apart from rising urban pollution level. In the present work, a numerical model is developed to analyze and understand effect of UHI and building geometry on pollutant dispersion behaviour in a typical urban street canyon scenario. Detailed validation study is carried out to ensure reliability of the developed numerical model. Higher pollution dispersion in vertical direction was observed at higher temperatures, especially on the leeward side. It is observed that building geometry plays an important role on pollutant dispersion. Pollution level for gable roof buildings is found to be significantly lower compared to similar buildings with mono-pitched roof and flat roof.

Implementation of Urban Heat Mitigation Strategies-2

11:30am – 01:00pm (December 4, 2019)

Paper ID: 299

Controlled experiment for estimating the energy-saving potential and indoor thermal comfort improvement by the use of high albedo surfaces on pitched concrete roofs

Vishal Garg[1], Sraavani Gundepudi[1], Aviruch Bhatia[1], Rathish Arumugam[2], Sasank Bethapudi[2]
[1]International Institute of Information Technology, Hyderabad, India
[2]Saint-Gobain Research India, India

Abstract:

Reflecting the solar radiation incident on the roof surface helps in reducing the surface temperatures. Cool roof help in reducing the cooling energy requirement of a building. There have been many studies conducted to estimate the potential of energy savings and comfort improvement using cool roof on a flat surface. However, results from these studies are not directly applicable for a sloped surface. This paper presents an experiment that was performed to identify the energy-saving potential and thermal comfort improvement for pitched/sloped cool roofs in India. Four test rooms in two locations Chennai (Warm and Humid) and Bhiwadi (Composite) were installed with Shingle-1 (initial albedo of 0.15) and Shingle-2 (initial albedo of 0.30). The difference in roof albedo between both the shingles is 0.15. The Chennai site was used for comfort monitoring and the Bhiwadi site was used for energy studies. To assess the indoor comfort, a frequency graph has been plotted with the occurrence of indoor air temperatures. The histogram plot of temperatures recorded for Chennai displays a shift in the peak temperatures towards the comfort range in case of high albedo roof compared to roof with low albedo. There was 26% increase in overall thermal comfort by using cool roof. The experimental results for Bhiwadi show that minimum and maximum electrical energy savings from the air conditioners are 27.1 Wh/m2-day and 60.8 Wh/m2-day respectively.

Outdoor Comfort and Health in the Urban Environment-3

11:30am – 01:00pm (December 4, 2019)

Paper ID: 46

Heat Health Warning System in Germany – Implementation of city issues

Andreas Matzarakis[1], Stefan Muthers[1]
[1]Research Centre Human Biometeorology, German Meteorological Service (Germany)

Abstract:

After the heat waves in the year 2003 and the statements of IPCC about the increase and the related consequences several countries in Europe decided to develop or implement a Heat Health Warning System (HHWS) and provide information for general public and public health. In Germany, weather Forecast is used to predict heat episodes, which are associated with negative health impacts. Therefore, a heat balance model of the human body and an extracted equivalent temperature (Perceived Temperature) is applied. Thresholds for strong and extreme heat stress based on thermal perception classification are used and build the first approach of the HHWS. Furthermore, the threshold of strong heat stress includes a short term adaptation component and considers the previous thermal stress conditions of the last 30 days. The second step includes nocturnal conditions, based on forecasted minimum air temperature or a simulated maximum indoor temperature for typical houses. Both criteria are important for the decision about warnings for the present and next days. Warnings are generated by daily weather forecast automatically and are additionally confirmed or adjusted by a bio meteorological forecaster. The warning is valid on county level considering several elevation classes. The heat warning is available as a map on the internet and registered users can receive information by a daily newsletter. A specific Smartphone app is also available for general use. The main target groups are the public, nursing homes and ministries of the federal states and other authorities.

Paper ID: 81

The effects of commuter travel behaviour on transportation heat and pollution emissions

Man Li[1], Yupeng Wang[1], Jun Zhou[2]
[1]Xi 'an Jiaotong University (China)
[2]Shenzhen Urban Planning and Land Resource Research Center (China)

Abstract:

Transportation systems have been identified as significant component of the gross anthropogenic heat emission, which was investigated in cities of America and Australia. Existing empirical studies, however, lack to answer whether individual commute travel behaviour influence the UHI effect through affecting anthropogenic heat from transportation. Using Shenzhen as a case, this paper answers this question by: a) estimating how the heat and pollution from transportation changes in different behavioural models; b) identifying factors affecting individual commute travel behaviour change; c) finding methods contributing to reducing anthropogenic heat from transportation. Results show that individual commute travel behaviour do have a great influence on urban thermal environment and some effective measure can be applied to achieve a lower anthropogenic heat from transportation.

Outdoor Comfort and Health in the Urban Environment-3

11:30am – 01:00pm (December 4, 2019)

Paper ID: 96

Study on the Microclimate Effect of Water Body Form in Urban Square

Ziyu Tong[1], Cong Zhang[2], Juelun Zhou[1]
[1]Nanjing University (China)
[2]Beijing Zhonghuan Century Engineering Design Co., Ltd. (China)

Abstract:

In urban areas, water bodies have a positive effect on the microclimate of the surroundings. However, there is less information on the relationship between artificial water body forms and the microclimate, especially the artificial water bodies in urban squares. The study of the microclimate effect of the water body form and layout in the city square can provide the necessary reference for the design of a city square. This study first summarized the basic shape and area of the city square in Nanjing. Through the investigation of the water body form of the city square, two quantitative indicators of the water body were summarized: the water body area ratio and the water body shape index. According to these indicators, a series of different water body models were generated in the basic square model, which was used as the object of microclimate simulation. Using ENVI-met, simulations of city square models with different water forms were performed for a typical day of summer and winter, and their effects on thermal comfort were recorded. Through the statistical analysis of the simulation results, it was found that there is a clear correlation between the water body form indicators and the microclimate effects, although the microclimate effect intensity of different morphological indicators is different. The analysis results can provide a valuable reference for the design of city squares.

Paper ID: 172

Experimental evaluation of thermal comfort improvement due to innovative solutions for tensile structures

Federico Rossi[1], Mirko Filipponi[1], Beatrice Castellani[1], Andrea Nicolini[1],Marta Cardinali[2], Alberto Maria Gambelli[2]
[1]University of Perugia, Perugia (Italy),[2]CIRIAF Interuniversity Centre, Perugia (Italy)

Abstract:

In urban areas characterized by strongly prevailing cooling climate, an effective reduction of urban overheating might be pursued by using modular, adaptable structures as curtains, tensile structures or temporary coverings. Such solutions could contribute to reduce outdoor discomfort conditions, but a careful design phase has to be conducted, coupling with the appropriate choice of suitable materials for outdoor applications. The aim of the present research is to assess possible outdoor thermal comfort improvements under the coverings, due to the adoption of a textile with a low infrared emissivity layer downward. For that purpose, two tensile structure facilities were installed at University of Perugia in order to test and compare materials for awnings and curtains. Thus, two different textiles, a traditional and a low emissivity downward one, have been selected and tested. Both textiles are characterized by high solar reflectance towards the external environment. The experimental campaign was conducted in August 2019 and it consisted in the monitoring of thermo-hygrometric microclimate under the coverings. Therefore, outdoor human thermal comfort parameters have been calculated for both awning solutions. Results allowed determining the benefits in terms of outdoor thermal comfort conditions given by the low infrared emissivity awning with respect to the standard textile material; furthermore, the experimental campaign allows to establish the suitability of the proposal for contributing to the improvement of urban microclimate and the mitigation of urban heat island and climate change phenomena.

Outdoor Comfort and Health in the Urban Environment-3

11:30am – 01:00pm (December 4, 2019)

Paper ID: 207

Effects of the Green Façade on Thermal Comfort in the Transitional Spaces: Field Measurements in Munich, Germany

Hankun Lin[1], Ata Chokhachian[2], Florian Musso[2], Yiqiang Xiao[1]
[1]School of Architecture, South China University of Technology (China)
[2]Faculty of Architecture, Technische Universität München (Germany)

Abstract:

As a countermeasure to the high-density urbanization and urban heat island, urban green infrastructure has been promoted as an approach to improving human health and adapting to climate change. However, after rapid development in recent years, some high-density areas even lack green space in neighbourhoods. In response to the limitation of green land and soil condition in some extreme urban space, planting the climbing plants strategically in both urban and building environment reveals a potential for increasing canopies and optimizing the pedestrian thermal comfort. This paper attempts to test the climbing plants facades', which are defined as green façades, effects on human thermal comfort in a dormitory building in Munich, Germany. Field measurements were set up with a toolkit to record the indices of micro-climate on the different floors of the test building alternately in order to compare the thermal environment of the shaded and unshaded area. Results reveal that the green façades reduced global solar irradiation, globe temperature, and air temperature significantly in typical summer days due to the shading effect. However, as a result of the dragging effect, the green façades also reduced wind flow velocity and influenced on the optimization of thermal comfort in the shaded area. This paper reveals the potential of improvement for thermal comfort in a transitional space via applications of green façades. Further studies would be taken in the urban environment in the future as well.

Analysis of UHI and its effect across scales - 4

11:30am – 01:00pm (December 4, 2019)

Paper ID: 191

Evaluating urban heat island due to built morphology in Pune city

Shruti Khandelwal[1], Namrata Dhamankar[1], Sujata Karve[1]
[1]SavitriBai Phule Pune University (India)

Abstract:

Urban heat island describes built up areas that are hotter than nearby rural areas. The cities are becoming complex character consisting of different surface materials of low albedo and with lack of vegetative cover provide multiple surfaces for the reflection of solar radiation as well as absorption & storage of heat. Urbanization is taking place at a faster rate in India. Population residing in urban areas in India, according to 1901 census, was 11.4%. This count increased to 30% according to 2011 census. According to a survey by UN State of the World Population report in 2007, by 2030, 40.76% of country's population is expected to reside in urban areas. Pune is one of the fastest growing cities in India. It is the seventh largest metropolitan city of India and the second largest in Maharashtra. Urbanization has led the migration of people from rural to urban areas which increase the need of infrastructure. Between 1991 and 2001, the city grew by 40%, increasing from 1.6 million to 2.5 million and it's estimated that population will hit 5.6 million by 2031 if this trend continues. The Environment Status Report (ESR) for 2016 by the Pune Municipal Corporation (PMC) has categorically stated that "construction activities in the city and use of heat-absorbing construction materials have increased in the last few years, leading to UHI Effect. This effect has resulted in a difference of 4 to 5 degrees between the temperatures of the Pune city to that of surrounding rural areas". The report states that there is a direct impact of the Urban Heat Island Effect on human health issues such as heat stroke, headache, and tiredness. This project aims to study and analyze the impact of urban morphology on the formation of UHI in Pune city and also focuses on investigating mitigation strategies. Objectives are to Generate thermal maps for Pune, to identify Local climatic zone (LCZ), To identify construction materials. The study shows how the urban factors such as the vegetation cover, shadings, orientation and aspect ratio of canyon are important elements that urban planners may take into account, especially for new urban developments in Pune.

Analysis of UHI and its effect across scales - 4

11:30am – 01:00pm (December 4, 2019)

Paper ID: 302

Evaluation of sleep disorder caused by urban heat island based on the Pittsburgh Sleep Quality Index

Tomohiko Ihara[1], Daisuke Narumi[2], Sanae Fukuda[3], Hiroaki Kondo[4]
[1]The University of Tokyo (Japan), [2]Yokohama National University (Japan)
[3]Kansai University of Welfare Sciences (Japan), [4]Japan Weather Association (Japan)

Abstract:

Climate change directly affects the human body. When exposed to the heat, there is a possibility that sleep is disturbed. Several epidemiological studies have clarified the relationship between outdoor temperature and sleep disturbance. However, the damage of heat-related sleep disturbance has not been shown as numerical values comparable with other heat-related health outcomes. A self-administered questionnaire for daily sleep quality, the revised Sleep Quality Index for Daily Sleep (SQIDS2) was developed for assessing daily sleep disturbance by referring and simplifying Pittsburgh Sleep Quality Index (PSQI). The study conducted in Nagoya city in August of 2011 and 2012. The participants' sleep quality was measured by SQIDS2.The number of the respondents was 574 for 2011 survey and 710 for 2012 survey. Sleep disturbance prevalence calculated from SQIDS2 score was correlated to daily minimum temperature (p=0.0067) and increased when daily minimum temperature was above 24.8 °C. DALY loss due to heat-related sleep disturbance of Nagoya city (population: 2,266,851) was estimated to 97.4 years in 2012. This value was comparable to DALY loss due to heat stroke death there. Policymakers should recognize that the damage of sleep disturbance caused by night-time high temperature is not small. Additionally, if they create a goal or regulation for night-time temperature, daily minimum temperature of 25 °C would be a guide.

Paper ID: 303

Evaluation of the Daily Cycle of UHI using Multi-site Measurements in a Central European Capital City

Rita Pongrácz[1], Judit Bartholy[1], Zsuzsanna Dezső[1], Csenge Dian[1], Dóra Incze[1], Máté Kurcsics[1]
[1]Eötvös Loránd University (Hungary)

Abstract:

We aim to analyze the urban climatic effects in several districts of Budapest (the capital city of Hungary) relative to the synoptic station of Budapest that is located in the south eastern suburban district. Thus, we initiated a specific urban climate program with multi-site in-situ meteorological measurements (air temperature and humidity) in the spring of 2015. In order to calculate the urban heat island intensity, temperature measurements are compared to the hourly recorded data of the synoptic station of Budapest. The full daily cycle of air temperature is analyzed in this study from recorded continuous measurements in different seasons of 2016-2018. The resulting climatic conditions are evaluated along a pre-defined route, which consists of 24 measuring points within the studied area. The measuring sites are located in different characteristically points of the district, such as green parks, narrow streets, paved squares, and wider roads with busy city traffic. After the initial phase, the measuring program has been extended to other districts with continuous measurement at fixed measuring points.

Analysis of UHI and its effect across scales - 4

11:30am – 01:00pm (December 4, 2019)

Paper ID: 49

Study On Appropriate Ground Cover Configuration of Open Spaces to Mitigate Urban Heat Island Effect

Yuvraj P Meshram[1], Shirish A. Deshpande[2], Sheeba Valsson[3]
[1]Radhikatai Pandav Institute of Architecture, Nagpur, India,
[2]Visvesvaraya National Institute of Technology, Nagpur, India
[3]Shri. Datta Meghe College of Architecture, Nagpur, India

Abstract:
Natural landscapes are continuously being built over at the cost of concrete jungle / hard surfaces as buildings, roads, paved areas act as barriers for the proper dissipation of heat energy to the retention capacities. This calls for monitoring of temperature changes, especially in urban areas. There is a steady increase in global temperature in association with climate changes in the past 150 years, and at least partially this is a direct result of mankind's activities such as "Urban Heat Island" (UHI). UHI is characterized by amplification of temperature values, lower relative humidity values and moderation of wind velocity, can create unpleasant micro-climatic conditions for human. On the other hand, green areas within the urban space can create a cooling effect, lowering temperatures and increasing relative humidity. The cooling effect of urban park creates a "Park Cool Island" (PCI), and is most prominent in an urban area that has developed a UHI. Materials that are used within private or public spaces, included ground surfaces and building materials determine the micro-climate and affect the energy consumption, thermal and visual comfort as well as the thermal balance. Generally, utilization of high reflectivity materials in the buildings, as well as the covered urban surfaces reduces the absorbed solar radiation and preserves the coolness of the surfaces. These materials are also known as "Cool materials". Specification of the proper structural and cladding materials in the cities and buildings is considered to be one of the most promising mitigation techniques concerning improvement of the urban micro-climate. Micro-climatic conditions in parks are influenced by both Pervious - soft surfaces and Impervious – hard surfaces and their physical properties. Vegetation and plantation, particularly in the presence of high moisture level, plays a vital role in the regulation of air temperature. The aim of this paper is to evaluate the impact of Cool pavements with variation in percentage of perforations, and by exploring the possibilities of vegetation configuration to maximize the cooling effect in urban open spaces of Nagpur city.

Paper ID: 300

Land surface temperature variations: Case study Bhopal (MP)

Pallavi Tiwari[1], Arka Kanungo[1]
[1]School of Planning and Architecture, New Delhi

Abstract:
With the increasing urbanization the cities today are facing multiple urban risks. Rising temperatures within the city is one such risk that the city dwellers are exposed to. Not only is the temperature both air and surface an issue of concern, but also the varied distribution of this increase is a cause of many issues. The land surface temperature study is important to address and analyse the various impacts caused thereby. The land surface temperature is globally rising all across the world. The present study takes Bhopal in Madhya Pradesh as a case study to develop a framework for the estimation of land surface temperature. The temperatures have been compared for the month of June in year 2014 and 2019. Normalized vegetation index and land surface temperature data has been computed for the case study to analyse the area under various temperature ranges. Results have been drawn through a correlation of NDVI and LST and the impact of reduction in the area of upper lake.

Case Study Presentation: Plenary

2:30pm – 03:00pm (December 4, 2019)

Cool Streets LA: Los Angeles' Cool Pavement Pilot

Jennifer McDowell and Bryn Lindblad
Mayor's Office of City Services, Los Angeles

Abstract:

Los Angeles is the first city in California to pilot the installation of a cool pavement coating on a public street. A gray pavement coating can reduce the surface temperature of the roadway by 5 degrees Celsius, potentially reducing the Urban Heat Island Effect. The presentation will describe the process of sourcing potential coatings, testing them for wet traction performance, field-testing in off street locations, installation on the public street on individual city blocks and in entire neighborhoods, and subsequent maintenance considerations. The presentation will also share preliminary findings from our research with partners including the Los Angeles Urban Cooling Collaborative, University of California Los Angeles, University of Southern California, and Arizona State University about the potential impact of cool road surfaces on human heat comfort. Furthermore, the presentation will report on recent multifaceted urban cooling projects in Los Angeles that integrate cool pavement, shade trees, and shade structures with multi-modal street improvements.

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Volunteer Team

We are thankful for the constant support of the following team members and IIIT Hyderabad staff:

Bhargavi Boyina
G. Shravan Kumar
Giri
Madhur Garg
Md. Anam Raihan
Prabhakar Kandukuri
Rishika Agarwal
Ritwik Agarwal
Ronak Aghera
Sam Babu Goditi
Simran Singhal
Sraavani Gundepudi
Vaibhav Rai Khare

GAD Team:

C.H. Manohar
N. Sailaja
V V Ramana
V. Srinivasulu

IT Team:

D. Madhubabu
G. Srinivasa Rao
Sriranjani

Engineering Wing: K. Venugopal

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