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<td>09:30-11:00</td>
<td>P1 Panel Session (keynotes), (H-GF), Chair: P. Rode, LSE</td>
<td>09:30-11:00</td>
<td>P2 Panel Session (keynotes), (H-GF), Chair: R. Dawson, Newcastle</td>
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<td>11:30-13:00</td>
<td>S1 Urban Governance</td>
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<td>S7 Urban Climate Modelling</td>
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<td>S16 Understanding cities as systems</td>
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<td>S4 Damage and Adaptation</td>
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<td>S10 Promoting Adaptive Cities</td>
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<td>S18 Solutions to mitigate urban heat</td>
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<td>Costs in Cities</td>
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<td>S2 Urban Heat Islands Effect</td>
<td>14:00-15:30</td>
<td>S8 Urban Climate &amp; Health Burden</td>
<td>14:00-15:30</td>
<td>S17 Involving Stakeholder in the Transformation Challenge</td>
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<td>15:30-16:30</td>
<td>Postersession &amp; Coffee Break (Building H, Foyer)</td>
<td>15:30-16:00</td>
<td>S14 Organising and Innovating Cities (A56-0.38)</td>
<td>16:00-17:30</td>
<td>S19 Energy Efficiency and Mobility (A56-BM)</td>
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<td>16:30-18:00</td>
<td>S3 Infrastructure and Buildings (H-GF)</td>
<td>16:00-17:30</td>
<td>S11 Urban Atmospheric Pollution and GHG Emissions (A56-BM)</td>
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<td>Chair: F. Creutzig, MCC</td>
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<td>16:00-17:30</td>
<td>S6 Informed Cities / Creation of Knowledge (A56-BM)</td>
<td>16:00-17:30</td>
<td>S12 Adaptation Planning &amp; Success Factors (A56-BM)</td>
<td>16:00-17:30</td>
<td>P4 Concluding Panel, (A56-BM), Chair: JP Kropp, PIK</td>
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<td>Stimulus talk: F. Creutzig, MCC</td>
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Room Abbreviations:
- A56 (Trefoil) - lecture hall (basement)
- Building H - lecture hall (ground floor)
- A56 (Trefoil) 0.38 - tele-presence room (ground floor)
- Poster Session
- A56 - BM
- H - GF
- A56 - 0.38 GF
- max. 150
- max. 300
- max. 40
Panel Session 1  
(TUE, Sept 19th, 9:30-11:00 in H - GF)  

Cities' complexity: what does it imply for ideal cities?  
Jürgen P. Kropp & Hans Joachim Schellnhuber, Potsdam Institute for Climate Impact Research, GER, University of Potsdam, Dept. Geo. & Env. Sciences, GER

Visioning for cities of the future: The European Commission's view (tbc)  
Ugo Guarnacci, European Commission, DG Research & Innovation, Brussels, BEL

Session 1: Urban Governance  
(TUE, Sept 19th, 11:30-13:00 in H – GF)

Governing Compact Cities  
Philipp Rode, LSE Cities, London School of Economics and Political Science, UK

This presentation investigates how governments and other critical actors are organised to enable sustainable and compact urban growth which combines higher urban densities, mixed use and urban design quality with more walkable and public transport-oriented urban development. It draws on empirical evidence from London and Berlin and examines how urban policymakers, professionals and stakeholders have worked across disciplinary silos, geographic scales and different time horizons. Focusing on the underlying institutional arrangements that have connected urban planning, design and transport since the early 1990s, three conclusions are drawn: First, integrative outcomes are linked to a hybrid model of integration that combines hierarchical and network governance. Second, continuous adjustment of integration mechanisms has been more effective than disruptive, one-off 'integration fixes'. Third, integrated governance facilitating
Institutional innovation for adapting to climate change in urban governance

James Patterson, The Institute for Environmental Studies (IVM), Vrije Universitiet
Amsterdam, The Netherlands

Institutional innovation is crucial for effective climate change adaptation in cities. Adapting to climate change requires governance institutions that can adapt to changing knowledge, uncertainty, risks, and priorities over time. However, this is a major research and policy challenge because institutions are often path-dependent and difficult to change. Despite rapidly increasing attention to innovative climate change action in cities across the globe, the institutional dimensions of adaptation remain poorly understood. This paper explores the key problem of conceptualizing and analyzing institutional innovation in cities under climate change. Institutions are "sets of rights, rules and decision-making procedures that give rise to social practices" (Young et al. 2008). Institutional innovation, in this paper, refers to intentional changes in institutions that enhance the ability of cities to adapt to climate change (e.g. accounting for relevant knowledge, dealing with uncertainty, recognizing risks, incorporating evolving societal priorities). This could include changes in legislation, policies, organizations, and inter-organizational arrangements. However, it is not always clear exactly how much ""teeth"" such innovations have, raising questions about their impact and durability in practice.

This paper proposes a novel heuristic to conceptualize institutional innovation across three levels: (1) ""visible"" changes in legislation, policies, organizations, and inter-organizational arrangements, (2) underlying ""rules"" that determine how decisions are actually made in practice, and (3) broader ""governance dilemmas"" that an urban governance system must continuously contend with under climate change. It applies this heuristic to case studies of urban water adaptation in two large cities in the Global South (Cape Town, South Africa, and Santiago, Chile). It analyzes types of institutional innovations occurring, and the extent to which they contribute to adapting their respective urban governance systems. Overall, this demonstrates a novel approach for comparative analysis of institutional innovation, and opens up new avenues for studying the institutional dimensions of climate change adaptation.
Promoting adaptation and building community climate resilience through institutional partnerships: Climate-Adaptive Design

Gabrielle S. D. Weiss, Bard College Center for Environmental Policy, Annandale on Hudson, New York, USA

The Climate-Adaptive Design (CAD) Program of the New York State Hudson River Estuary Program helps make necessary climate adaptation part of an empowering, growth-oriented process for communities. Through a partnership with the Cornell University Department of Landscape Architecture, CAD uses design-based visualization of climate impacts and adaptation options to promote community resilience-building. The main policy goals of CAD are to build climate resilience, galvanize community participation and education, and build links within communities and to external sources of support by engaging municipalities and stakeholders in a collaborative design process. This paper situates the program in a science and policy context and reviews community resilience and adaptive planning and design. Based on this review, a survey and matrix for evaluating the resilience of, and adaptive actions undertaken by, communities participating in CAD or similar programs are included. Next, a case study of a community that has already participated in the program is presented with insights relevant for ongoing work. Finally, policy recommendations are made for further CAD or similar partnership work with higher educational institutions.

Ameliorative Governance, Spatial Planning, and the Pot of Melting Climate in Cape Town, South Africa

Sara Azeem, Maarten J. Bavinck, Universiteit van Amsterdam, NL

In this paper, I analyze how local governments in developing countries deal with climate vulnerability. For this purpose, I study the City of Cape Town metropolitan municipality (CCT) in South Africa. South Africa poses a special challenge, as it is unique among developing countries. Given its brutal history of apartheid, the shadow of problematic spatial planning still looms large. I determine the interplay between climate vulnerability and spatial planning, and examine the governance steps that CCT takes in dealing with this dynamic. For this, I examine how climate vulnerability is understood by various departments working within CCT, and the policies they undertake to tackle this vulnerability. I conducted in-depth interviews with multiple government officials from five CCT departments, scrutinized several
policy documents and studied data collected from departmental workshops. Through my analysis, I find that distrust of people in the government and silos mentality within local government departments serves to hamper the efforts for dealing with climate vulnerability. Further, local government policies often focus primarily on economic development. Ironically their efforts still fail to address grave social inequalities leading to societal disillusionment. Put differently: the combination of grave social inequalities, exclusivist (often failing) efforts for economic development, and the wealth-favoring spatial configuration of Cape Town leads to a melting pot where climate vulnerability is exacerbated and a feedback loop occurs between the resultant spatial design and climate vulnerability. I conclude that to break this feedback loop a broad range of stakeholders including civil society and private sector need to be involved, since the complexity of the problem defies being solved by a single body such as the local government. Finally, I present a diagnostic framework for governing systems called Ameliorative Governance that helps shed light on some of the challenges faced by cities to achieve sustainability and resilience.

**Governance Practices for Climate Change Adaptation: A Comparative Study**

Sabrina Dekker, City of Dublin Energy Management Agency, IRL

The capacity of cities to respond to climate change is contingent upon their ability to develop, implement and monitor policies and plans that endeavour to adapt the urban environment to be resilient to the impacts of climate change. However, this capacity is connected to the institutional structures in which local governments operate, which differs globally as highlighted by John Friedmann (2005) in his research on planning systems globally. As such, the remits of local governments vary widely, from some cities holding responsibility for public education and health (i.e. New York City, USA) to others only holding responsibility for development planning (i.e. Dublin, Ireland; Portland, USA). Therefore, while international and national governments may put forth local governments as the level of government best able to address climate change; local governments, whilst acknowledging this role and being keen to take leadership in responding to climate change, may face constraints in their capacity to develop responses. As such this paper discusses the capacity of three local governments (Glasgow, Portland, and Vancouver) in differing institutional structures to respond to climate change. Further, as resilience in the context of climate change calls for responses
to be adaptive and developed with diverse stakeholders; this in turn calls for an adaptive governance approach that supports collaboration amongst stakeholders. Therefore, through the lens of collaborative planning the policy development process of each local government was investigated to understand how they are collaborating with stakeholders in responding to climate change. The lessons learned from these local governments in the process of developing climate action plans provides valuable insights on collaborative planning in the context of resilience building and adaptive governance.

Session 2: Urban Heat Island Effect
(TUE, Sept 19th, 14:00-15:30 in A56 - BM)

'Surface', 'Satellite' or 'Simulation': mapping intra-urban microclimate variability

Evyatar Erell, Shai Kaplan, The Jacob Blaustein Inst. for Desert Research, Ben-Gurion University of the Negev, IL
Aviva Peeters, TerraVision Lab, IL

Cities are characterized by high heterogeneity of built form, land use and land cover, which contribute to diverse microclimate effects. As urban planners and city authorities seek to address the effects of past environmental degradation and the potential consequences of global climate change, detailed mapping of the spatial and temporal variability of a wide range of indicators is becoming increasingly important. This study compares three methods of mapping the microclimate of the city of Beer Sheva in the Negev Desert of Israel. Surface temperature was obtained from satellite thermal images, at night (about 22:00) and during the day (about 10:00). To highlight the intra-urban surface temperature variability, the Surface Urban Heat Island (SUHI) was estimated by subtracting the average land surface temperature of the desert from each pixel in the scene. Analysis shows a nighttime SUHI of 2-4 degrees, with strong correlation to urban canyon geometry - but in the morning, the city surface was cooler than exposed desert terrain. Mobile traverses coinciding with the satellite passage overhead comprised two routes crossing representative landscapes and land uses categories including parks, the CBD and streets with different aspect ratios (H/W). To determine the UHI, the co-temporal air-temperature from a fixed local meteorological station was subtracted from each mobile reading. Finally, canopy level air temperature was modelled
using the Canyon Air Temperature (CAT) model. The original 1D model developed by Erell and Williamson (2006) was adapted to modeling at a larger spatial scale by linking inputs from a GIS database and remote sensing products to predict air temperature simultaneously for multiple locations in an urban environment. The presentation will compare results of the spatial distribution of temperature obtained by the three methods. Discrepancies among them will be analyzed and implications for the use of such tools in urban planning will be discussed.

The role of city size and urban form in the surface urban heat island

Bin Zhou\textsuperscript{1}, Diego Rybski\textsuperscript{1}, Jürgen P. Kropp\textsuperscript{1,2}, \textsuperscript{1}Potsdam Institute for Climate Impact Research, \textsuperscript{2}University of Potsdam, Institute for Geo- and Environmental Sciences, DE

Urban climate is determined by a variety of factors, whose knowledge can help to attenuate heat stress in the context of ongoing urbanization and climate change. We study the influence of city size and urban form on the Urban Heat Island (UHI) phenomenon in Europe and find a complex interplay between UHI intensity and city size, fractality, and anisometry. Due to correlations among these urban factors, interactions in the multi-linear regression need to be taken into account. We find that among the largest 5,000 cities, the UHI intensity increases with the logarithm of the city size and with the fractal dimension, but decreases with the logarithm of the anisometry. Typically, the size has the strongest influence, followed by the compactness, and the smallest is the influence of the degree to which the cities stretch. Accordingly, from the point of view of UHI alleviation, small, disperse, and stretched cities are preferable. However, such recommendations need to be balanced against e.g. positive agglomeration effects of large cities. Therefore, trade-offs must be made regarding local and global aims.
Interactions between urban heat island effects and heat waves

Lei Zhao, Michael Oppenheimer, Princeton University
Qing Zhu, Lawrence Berkeley National Laboratory
Jane Baldwin, Princeton University

Heat wave (HW) is recognized as one of the most impactful climate extreme events to the human society. Its frequency and severity are projected to increase over this century consistently by global climate models. The heat stress caused by heat waves is further exacerbated for urban residents because of the urban heat island (UHI). Here we use a climate model to investigate the interactions between the UHI and HWs over a large number of cities in the United States under both current and future warmer climates (RCP 4.5 and RCP 8.5 scenarios). We examine both UHI2m (defined as urban-rural difference in 2m-height air temperature) and UHIs (defined as urban-rural difference in radiative surface temperature). Our results show consistent spatial and temporal patterns between UHI2m and UHIs to interact with HWs. We find significant impacts of local background climate and warming scenarios to the synergistic effects between UHI and HWs. These patterns also differ between daytime and nighttime. We use a biophysical factorization method to disentangle the mechanism behind the interactions between UHI and HWs and to explain the spatial-temporal patterns of the interactions. Results show that the difference in the increase of urban-rural evaporation and the enhanced anthropogenic heat release during HWs are key contributors to the synergistic effects at daytime. The contrast in degree of water availability between urban and rural land plays an important role in determining the contribution of evaporation. At night, our results show consistent synergistic effects across local climate regions and climate scenarios. The enhanced release of heat storage and anthropogenic heat during HWs are the primary contributors to the synergistic effects at nighttime. Our study highlights even greater heat stress risks for urban residents during HWs in current and future warmer climates.
Anthropogenic Heat Flux Estimation from Space: Results of the final phase of the URBANFLUXES Project

Nektarios Chrysoulakis, FORTH (Foundation for Research and Technology Hellas), GR
Mattia Marconcini, German Aerospace Center (DLR), DE
Gastellu-Etchegorry, Centre d’Etude Spatiale de la Biosphère (CESBIO), FR
Sue Grimmond, University of Reading, UK
Christian Feigenwinter, University of Basel, CH
Fredrik Lindberg, University of Gothenburg, SWE
Fabio Del Frate, GEO-K s.r.l., IT
Judith Klostermann, ALTERRA, NL
Zina Mitraka, Stavros Stagakis, FORTH (Foundation for Research and Technology Hellas), GR
Thomas Esch, German Aerospace Center (DLR), DE
Lucas Landier, Centre d’Etude Spatiale de la Biosphère (CESBIO), FR
Andy Gabey, University of Reading, UK
Eberhard Parlow, University of Basel, CH
Frans Olofson, University of Gothenburg, SWE

The H2020-Space project URBANFLUXES (URBan ANthropogenic heat FLUX from Earth observation Satellites) investigates the potential of Copernicus Sentinels to retrieve anthropogenic heat flux, as a key component of the Urban Energy Budget (UEB). URBANFLUXES advances the current knowledge of the impacts of UEB fluxes on urban heat island and consequently on energy consumption in cities. In URBANFLUXES, the anthropogenic heat flux is estimated as a residual of UEB. Therefore, the rest UEB components, namely, the net all-wave radiation, the net change in heat storage and the turbulent sensible and latent heat fluxes are independently estimated from Earth Observation (EO), whereas the advection term is included in the error of the anthropogenic heat flux estimation from the UEB closure. The Discrete Anisotropic Radiative Transfer (DART) model is employed to improve the estimation of the net all-wave radiation balance, whereas the Element Surface Temperature Method (ESTM), adjusted to satellite observations is used to improve the estimation the estimation of the net change in heat storage. Furthermore the estimation of the turbulent sensible and latent heat fluxes is based on the Aerodynamic Resistance Method (ARM). Based on these outcomes, QF is estimated by regressing the sum of the turbulent heat fluxes versus the available energy. In-situ flux measurements are used to evaluate URBANFLUXES outcomes, whereas uncertainties are specified and analyzed. URBANFLUXES is expected to
prepare the ground for further innovative exploitation of EO in scientific activities (climate variability studies at local and regional scales) and future and emerging applications (sustainable urban planning, mitigation technologies) to benefit climate change mitigation/adaptation. This study presents the results of the final phase of the project and detailed information on URBANFLUXES is available at: http://urbanfluxes.eu

**LCZ Classification Quantifies UHI Intensity**

George Thomas, National Centre for Earth Science Studies, Thiruvananthapuram , India and Catholicate College, Pathanamthitta, IND

Zachariah E J, Thiruvananthapuram, IND

A large proportion of the global population lives in urban regions and the trend is intensifying. The urban population in India is projected to increase from its 2008 value of 30% of the total to 40% by the year 2030. The urban climate and the impact of urban growth on the climate thus affect vast majority of global population. Kochi, being a coastal city and interlaced by wetlands, effect of water bodies on heat island intensity is highly variable. Mobile surveys were conducted in the city of Kochi in Southern India, during summer and winter seasons, covering pre-dawn and early evening periods. Wind, sea breeze, humidity and other parameters have a complex correlation with urban heat island and a single parameter alone fails to explain the magnitude and distribution of UHI effectively. However change in the urban geometry and urban materials are scarce in the survey period. Considering building properties, properties of materials used in urban environment, urban geometry, vegetation cover, paved surface fraction, etc., are more effective than considering the environmental parameters in the analysis of urban heat island. In the present study Local Climate Zone (LCZ) classification method based on the above parameters was used to study the growth of UHI intensity in the coastal city of Kochi. The UHI shows good correlation with the local climate zone classification. An Urban Heat Island (UHI) develops when urban cooling rates are lower than the adjacent suburb and rural areas. Thermal gradient between different zones and cooling rates observed in these zones were computed, which validates the LCZ classification. Maximum intensity was seen in Compact Midrise zones which cover the central part of the city. Most intense cooling was observed in openset and sparsely built regions in all seasons.
The Development of the Series of Green Building Standards in China towards Urban Adaptation to Climate Change

Yuan Huang, Southwest Jiaotong University, CHN

In the Action Plans for the response to Climate Change in many countries in the world, although it has reached consensus on classifying the strategies into Mitigation and Adaptation levels, the development of Adaptation strategies has never gone hand in hand with Mitigation strategies. This phenomenon is particularly evident in urban construction in China. It has been a decade for the development of the publishment and implementation of the "Climate Action" policy documents in China, the status of Mitigation strategies has never been shakable, even once Mitigation was wholly filled the content of "Climate Action" policies. However, the Adaptation issues in urban construction has just been paid attention to in "Climate Action" policies since 2014.

In this paper, it has sorted out the provisions in urban construction concerning Adaptation to Climate Change. The Green Buildings Standards have been found one of the most effective way in urban construction to address Climate Change collaborating with the policy documents mentioned.

Therefore, it has studied the development of series of Green Building Standards in China towards Urban Adaptation. The urban climate elements are extracted systematically from the frames and the articles of the Green Building Standards. It has discussed the classification of Green Building Standards in different functional types and different scales. Moreover, the Well Building Assessment Standard has been included in research for Urban Adaptation.

A questionnaire to architects and engineers has been done specifically to investigate their understanding on the role of Urban Adaptation in implementation of their green building projects.

Finally, this paper has concluded the progress and defects in the development of Green Building Standards in China from the view of Urban Adaptation. It has also explored the possibility to implant more Urban Adaptation strategies into the Green Building Standards especially on the operational level.
Infrastructure investments and its multiple benefits to climate change efforts

Oliver Heidrich, School of Civil Engineering and Geosciences, Newcastle University, Tyndall Centre for Climate Change Research, UK
Graham Thrower, Centre for Urban and Regional Development Studies, Newcastle University; UK
Jane Gibbon, Business School, Newcastle University, UK
Andy Pike, Centre for Urban and Regional Development Studies, Newcastle University, UK

Current and projected climate change is heightening the demand for adaptation and mitigation efforts and the provision of infrastructure systems. The levels of investments into infrastructure systems fluctuates worldwide and it is evident that financing infrastructures has a deep-seated influence on the way it is used, the quality of services that it provides and the public benefit that is derived from the service.

Infrastructure as an asset class is attractive to institutional investors, from pension funds looking for low risk, economically regulated assets, to banks working with experienced contractors to finance large scale projects. However it is not clear if and how infrastructure investment is addressing environmental and social agendas. Emergent research with a wide range of major institutional investors in infrastructure from across the public- private spectrum (Thrower, 2017) is beginning to provide an empirical insight into the aggregated institutional behaviours (and their underlying causes) that contribute to the construction of markets for financialised infrastructure. Our research has shown that where those pools of capital are at their most dense (typically in major OECD markets) there can be opportunities for informed and proactive state actors.

Central Government is on multiple sides of transactions e.g. market maker, regulator, concession granter and debt investor; and the contractual aspects of public private partnership render ongoing 'soft' political policymaking into hard contractual commitments over an asset lifecycle. Future research should quantify the impact of financing on the use, quality and equity of infrastructure provision of e.g. bridges, energy, rail, roads. The impact is not only for investors as a financial rate of return but also on society as a whole.

References
The Local Building Culture approach as adaptive response to Climate Change

Philippe Garnier, Vuk Markovic, CRAterre - ENSAG, France and LabEx AE&CC, FR

The climate change effects bring another layer of challenges to the most vulnerable people that are least responsible for the anthropogenic greenhouse gasses emissions. They are often more exposed to severe natural disasters that negate achieved levels of growth and ruin potentials for development. Increasing people's resilience, adaptive capacity, and reducing their vulnerability is an imperative of the international Climate Change Adaptation (CCA) framework.

This paper will present the Local Building Culture (LBC) approach within the current CCA framework. The approach emerged from more than 38 years of practice of CRAterre, the International Center on Earth Construction and its partners.

The LBC is a community-based approach that aims to reach human settlements sustainability. The process is based on a comprehensive assessment of local building systems, resources and community organization in order to provide adaptable solutions that meet people's capacities and basic needs. Using a random sample of CRAterre's implemented projects, the paper presents this adaptation of human habitat on different levels and in different contexts. Although these projects were not necessarily initially designed within a CCA framework, the analysis show that the LBC approach holds potential for avoiding maladaptive practices in building sector and in other development projects that aim to improve housing conditions. With its adaptive nature and transformative actions, the LBC approach reflects characteristics needed for an adequate response to the challenges of climate change.

Heat island influence on space-conditioning loads of urban and suburban office buildings

K. R. Gunawardena, N. McCullen, T. Kershaw, Department of Architecture and Civil Engineering, University of Bath, UK

A warming climate, increasing frequency and severity of extreme heat events, and the urban heat island (UHI) effect are cumulatively expected to exacerbate thermal loading on buildings. This paper examines how the UHI affects space-conditioning
loads within urban and suburban office buildings, and how the trend of replacing traditional heavyweight facades with lightweight alternatives affect both the magnitude and timing of the UHI and resulting building energy use. The paper addresses this through simulation studies of typical street canyons based on the urban Moorgate and suburban Wimbledon areas of London. Results show that including the UHI within a dynamic thermal simulation has an adverse effect on urban annual space-conditioning, with a 4 % increase in demand for buildings with stone facades, while a glazed alternative show a 10 % increase. For the corresponding effect on suburban annual space-conditioning, a modest 1.2 % decrease for buildings with brick facades is shown, while the alternative white painted timber construction shows a marginal 0.8 % increase. The study demonstrates that the trend in urban centres to replace heavyweight facades with lightweight insulated ones would increase space-conditioning loads by 2.3 %, and therefore adversely affect the UHI to create a vicious cycle of additional urban warming. Within a suburban context however, changing from heavyweight to lightweight insulated facades decreased space-conditioning loads by 5 % to provide a beneficial effect. The study in turn stresses the significance of accounting for UHI loads in estimating urban and suburban energy use, for which a combined simulation approach has been presented as a practical pathway.

Climate change effect on deteriorations of asphalt pavements in the north central coast of Vietnam

Pham Viet Hung, Hue University, VN

According to the Vietnam National Institute of Climate Change, climate change leads to projected increases in frequency and intensity of extreme weather conditions in Vietnam (particularly the North Central Coast). It reports a very high rainfall (standard deviation of annual rainfall about 400-700mm), large diurnal temperature variation (about 27oC/73oC) along with increasing sea levels and increasing risk from storm surges. Asphalt pavement is the most frequently used pavement material in Vietnam, accounts for 90% of roads. Climate change has lots of adverse effects on asphalt pavement in the North Central Coast with extreme increases in asphalt pavement deterioration such as rutting, shoving, slippage, potholes. This study has discussed failure mechanisms of asphalt pavement associated with the presence of moisture, water and large diurnal temperature variation. In addition this study has also used the testing data for the evaluation of environmental susceptibility. Different types of the frequently used bitumen and
aggregates in the region are evaluated in the study. It was found that most roadways in Vietnam do not withstand local weather and climate, the unpredictability of weather conditions due to climate change make pavement design a bit more challenging.

Session 4: Damage and Adaptation Costs in Cities (TUE, Sept 19th, 11:30-13:00 in A56 – BM)

Urban Adaptation to Extreme Weather: how can we assess effectiveness and co-benefits?

Alistair Ford, Maria Pregnolato, Richard Dawson, Newcastle University, School of Civil Engineering and Geosciences, Tyndall Centre, UK

Urban areas will face increasing threats from extreme weather events, such as heatwaves and flooding, as global temperatures increase due to climate change. Understanding how those threats may change in the future, as a result of both a changing climate and socio-economic changes in cities, is of importance to planners and policy-makers. Urban areas present a particularly complex challenge, as networks of infrastructure mean that impacts can be propagated through the urban system. Adaptation options must be explored to help in reducing the future risk and ensuring that urban areas remain resilient to climate change. This paper will explore some of the modelling techniques employed during the RAMSES project in the case study cities of London and Antwerp. A methodological framework for assessing the impacts of pluvial flooding on these cities through the use of hydrological and transport modelling will be presented. The complex interactions between the hazard, vulnerability, and exposure components of risk will be discussed, with results presented for extreme rainfall events and impacts on the transport infrastructure in the two cities. In addition to direct impacts, in terms of damage and disruption to the function of transport networks, a method for analysing indirect impacts through the urban economy will be presented. Finally, adaptation options will be explored through different points of intervention in the urban system. Comparison of green and grey adaptation, alongside hard and soft adaptation measures, will be presented, demonstrating a means of assessing the benefits of various adaptation options. Co-benefits between pluvial flood risk reduction and urban temperature reduction will also be examined.
demonstrating the limits to green adaptation for extreme weather events. Limitations and assumptions for simulating adaptation options will be discussed, with ideas for future research directions proposed.

**A Life Cycle Costing framework to assess the costs of climate change adaptation options**

Oliver Heidrich, School of Civil Engineering and Geosciences, Newcastle University, Tyndall Centre for Climate Change Research, UK

Diego Rybski, Climate Impacts and Vulnerabilities, Potsdam Institute for Climate Impact Research, DE

Maria Pregnolato, Richard Dawson, School of Civil Engineering and Geosciences, Newcastle University, Tyndall Centre for Climate Change Research, UK

Jürgen P. Kropp, Climate Impacts and Vulnerabilities, Potsdam Institute for Climate Impact Research and Institute for Geo-and Environmental Sciences, Potsdam, DE

Sea-level rise is a likely consequence of changes in climate patterns in the future. Flood defences represent a conventional means to protect coastal cities. Failure to consider the costs of adaptation strategies can be seen by decision makers as a barrier to implement protection measures. In order to validate adaptation strategies of coastal protection, a consistent and repeatable assessment of the costs is necessary. This presentation extends current knowledge on cost estimates by developing probabilistic functions of dike costs, on the basis of real coastal dike data.

Life Cycle Costing (LCC) is an emerging, although complex and resource intensive, approach to support economic decision. In this paper it was applied to provide a reproducible estimate of typical sea dike costs and uncertainty, in comparison with traditional cost-benefit analysis. The objective of LCC is to provide decision-makers with the ability to select the most appropriate alternative options at any time throughout the life cycle of a sea dike. Conducting the LCC will reduce a potential uncertainty on the protection costs, which can remove potential barriers in decision making.

We provide data from Netherlands, Canada and the UK and show that the unit costs depend not only on the country and land use (urban/non-urban) but also on characteristics included in the costs, e.g. property acquisition (Lenk et al., 2017). Although the focus of this research is sea dikes, our approach is applicable and transferable to other adaptation measures, like riverine dikes or indeed other adaptation infrastructures. We aim to provide a framework for policy-makers to
prioritize adaptation options and to allocate financial resources, in a context of increasing climate pressures.

**Influence of climate change on summer cooling costs and heat stress in urban office buildings**

Hans Hooyberghs, Stijn Verbeke, Dirk Lauweat, Flemish Institute for Technological Research, Atmospheric Modelling Group, UK
Helia Costa, Graham Floater, London School of Economics and Political Science, UK
Koen De Ridder, Flemish Institute for Technological Research, Atmospheric Modelling Group, B

Indoor climatic conditions are strongly influenced by outdoor meteorological conditions. It is thus expected that the combined effect of climate change and the urban heat island effect negatively influences working conditions in urban office buildings. Since office buildings are particularly vulnerable to overheating because of the profound internal heat gains, this is all the more relevant.

The study at hand focuses on office buildings, either equipped with a cooling system or 'free-running', i.e. without active cooling equipment. In the latter type of buildings, unfavorable conditions due to overheating have an important influence on the wellbeing and the productivity of the office workers. If these adverse conditions become too severe, ISO-standards require additional work break, causing lost working hours and economic losses. One possible measure to guarantee favorable indoor thermal conditions, is to equip the building with an active cooling system. Cooling energy demands in such buildings will however rise significantly over the course of the 21st century.

Within the RAMSES project, we have developed a methodology incorporating urban climate modelling and building energy simulations to assess cooling costs and lost working hours in office buildings, both for current-day and future climate, extending towards the end of the 21st century.

The methodology is tailored to additionally assess the impact and benefits of adaptation measures, and it is designed to be transferable from one city to another. Results for a prototype building located in three different European cities (Antwerp, Bilbao and London) illustrate the challenge in keeping Western-European office buildings without appropriate adaptation measures comfortable by the end of the 21th century, and the beneficial effect of adequate adjustments.
Costs of coastal flooding and protection for 600 European cities

Boris F. Prahl, Markus Böttle, Luis Costa, Diego Rybski, Climate Impacts and Vulnerabilities, Potsdam Institute for Climate Impact Research, DE

Costs of coastal flooding and protection are essential information for natural hazards research and risk assessment, but there are few systematic attempts to quantify cost curves beyond the case study level. City wide cost curves are particularly needed for economic assessments of climate impacts and adaptation in coastal cities. Here, we present a set of systematically derived damage cost curves for direct monetary damages within the 600 largest (by area) European coastal cities. For the estimation, a consistent and transparent methodology is applied, which takes into account the orographic and socioeconomic composition of each coastal city. Furthermore, we derive complementary protection cost curves which describe the relation between dyke costs and design protection level. Bringing together the costs from damage and adaptation, this work lays the basis for the elaboration of comparative cost-benefit analysis of coastal flooding under climate change. All data products have been derived from publicly available information and will be freely available online.

A probabilistic multi-variable loss estimation model for pluvial floods in urban areas

Viktor Rözer, Heidi Kreibich, Kai Schröter, Stefan Lüdtke, Bruno Merz, GFZ German Research Centre for Geosciences, DE

Pluvial flood events like the cloudburst in Copenhagen in 2011 have caused severe losses to cities in Europe and elsewhere in recent years. These floods are caused by storm events with high rainfall rates well above the design levels of urban drainage systems, which lead to inundation of streets and buildings. Pluvial floods often happen with little warning in areas not obviously prone to flooding. With an expected increase of extreme weather events and an ongoing urbanization, adaptation strategies are needed to avoid an increase of pluvial flood damage in the future. For an efficient adaptation of urban areas to pluvial flooding, a quantification of the flood risk is essential. Therefore, we present a probabilistic
multi-variable loss estimation model for pluvial floods based on empirical data. The model was developed in a two-step process using machine learning and a comprehensive database comprising 783 records of direct damage to residential buildings after four pluvial flood events in Germany between 2005 and 2014. In a first step important loss influencing variables were identified from a set of 35 potential loss-influencing factors, including hydrological and hydraulic aspects at the building, early warning and response, precaution, building characteristics and socio-economic variables. In a second step, the most important loss influencing variables were used to derive a probabilistic multi-variable pluvial flood loss estimation model by learning a Bayesian Network. The model is validated using cross-validation. Unlike usual approaches that relate inundation depth or rainfall rates to absolute or relative economic damage, the presented Bayesian Network model includes factors like private precaution or emergency response in the damage estimation. Together with the ability to cope with incomplete information and expert knowledge, as well as inherently providing quantitative uncertainty information, loss estimation using Bayesian Networks extend the information basis for pluvial flood risk assessment and management.

Session 5: Visioning Urban Transformations
(TUE, Sept 19th, 14:00-15:30 in H – GF)

Positive visions of urban transformation and adaptation

David Iwaniec, Georgia State University, Urban Studies Institute, USA

How do we address persistent and emerging challenges? What are the futures we hope to create? And, how can we guide the development of these futures?
I will present on a framework for co-developing scenarios to explore social-ecological-technological futures and demonstrate how scenario co-development can enhance urban decision-making capacity. We engage with local stakeholders in cities across North and Latin America to envision alternative desirable, plausible, and resilient future urban scenarios. Through a series of workshops with local partners, we co-develop scenarios to explore urban sustainability and resilience solutions and challenges, such as extreme climatic events, population growth, and changing resource availability. We then evaluate tradeoffs among scenarios with multi-criteria sustainability and resilience assessments and modeled outputs of
future regional climate, micro-climate, flood, population, land use, spatial distributions of resources and infrastructure, and changes in water availability and demand. For example, researchers have engaged with municipal, county, state, federal, tribal, and community decision-makers to co-develop and assess six distinct scenarios for the Phoenix, AZ region. Three sustainability scenarios highlight large transformational changes across a broad range of strategies for equitable redistribution of services. Three resilience scenarios emphasized adaptive changes in built and green infrastructure and land use, specifically to address extreme heat, drought, and flood events. Transition pathways for social-ecological-technological strategies were co-developed for all post-assessment co-selected scenarios. Since engaging in scenario workshops, city planners in Phoenix have incorporated co-developed ideas and social-ecological-technological futures into the development of their Sustainability Plan. We demonstrate that the transdisciplinary collaborative research on scenario and vision development of future pathways can enhance urban decision-making capacity.

Towards better civic decision-making on climate change

Lindsay M. Wood, Resilienz Ltd., NZL

A case-study-based exploration of issues that compromise regional public decision-making in New Zealand. The Nelson region of New Zealand, flanked by mountains and the sea, is among the world’s most isolated regional economies. It comprises 10,000 km² split into two very different councils: Nelson City, 422 km² and 50,000 inhabitants, is the commercial centre and transport hub, linking the highways, the port and airport. Tasman District, also 50,000 people but over 9,000 km², includes three national parks, major rural industries, many small towns, and a minor port. Main economic drivers of the region are all environmentally sensitive: forestry, tourism, horticulture/viticulture and fisheries. There is no railway, minimal public transport, and globally extreme private car use.
In 2011 Nelson City Council adopted as policy "Nelson 2060 - The Vision", a widely-consulted vision for the ensuing 50 years, and featuring 10 goals targeting community, environmental and economic outcomes. Minor environmental aspirations have received attention, but until very recently there has been persistent failure to consider, let alone implement, the important larger ones, moving to exclusively renewable energy, Goal 6, switching from fossil fuels to renewable energy, is absent from all key city plans.
Ongoing engagement with this and other related issues has revealed a broader systemic failure the council experiences in translating significant information (technical reports, public consultation, and adopted policy) into effective action plans. This is clearly a major vulnerability of the Council, and a serious constraint on its ability to respond to events like Climate Change and related issues.

Reasons for such significant failure will be explored, along with intriguing approaches by some central government watchdogs.

Conclusions will identify and connect key elements in this complex situation, draw international parallels, and indicate areas for research and change to promote robust, well-considered public decision-making.

High level versus detailed level adaptation pathway: a step-by-step methodology for different urban contexts

Maddalen Mendizabal, Efren Feliu, Tecnalia, ESP

The flexible pathway approach could be a potential way to support the transition and transformation towards future city resilience, managing the deep climate uncertainty. The adaptation pathways can be designed with different levels of concretion depending the urban context analysed (hazards affected, socio-economical characteristics, institutional awareness to climate change, etc.) and the corresponding baseline and starting point (existing diagnostics, adaptation planning already in place, etc.). Depending on that urban context and starting point, the adaptation pathway can be designed at a high level with less resolution or in at detailed level with more concretion.

The high level adaptation pathway consists in a quickly design, without existing detailed information, involving a small group of stakeholders. This high level design reduces decision making dependency on available climate change scenario and information. This can lead to avoids early maladaptation. The detailed pathway requires involving more stakeholders and experts and is linked to the use of quantitative models and tools which helps developing more specific pathways (e.g. UHI or flood modelling, cost-benefit analysis etc.).

In the present work both adaptation pathways are described. A step-by-step methodology for the pathway design and its validation in several workshops are also presented. The application in different urban contexts (e.g. London, Antwerp) are analysed and compared. Some conclusions from the validation process are: i) the authorship and the owner of the pathway need to be identified as a first step; ii)
the pathway approach is a good tool to work under deep uncertainty; iii) aspects of developing pathways will require interpretation of data and therefore the outputs need to be always "sense-checked" with local experts. Cities can begin to make progress by starting with a high-level pathway design. This option will reduce the required resources and could provide an initial basis to identify resource and information needs.

**Pro-Poor Approach (PPA) Integration in Adaptation Strategy of Climate Change (ASCC) In Indonesia, case study: Yogyakarta City**

Andie A. Wicaksono, IHS-Institute for Housing and Urban Regional Studies, Erasmus University Rotterdam and LPDP-Indonesia Endowment fund for education, NL
Jurian Edelenbos, Peter Scholten, IHS-Institute for Housing and Urban Regional Studies, Erasmus University Rotterdam, NL

Responding to climate change involves mitigation and adaptation approach. Ideally, both approaches should work together. However, there are different perspectives between the developed and the developing countries regarding to adaptation strategy to climate change. The developed countries tend to do more on the mitigation side of climate change, on reducing the impact, while the developing countries do more on the adaptation strategy, on coping with climate change. Interestingly, in regard to adaptation strategy, the poverty alleviation is included as part of strategy in the developing countries, while not in the developed countries.

In Indonesia, the pro-poor approach (PPA) has been an integral part of adaptation strategy of climate change (ASCC). This is due to the national government's perception that climate change adaptation strategy would have better chance of success, when coined to poverty alleviation. This research is a part of researcher's PhD trajectory. This case study research uses empirical exploratory approach with purposive sampling derived from a list of related participants: local government (Local Government) officers, Yogyakarta City Leaders (The Mayor, The Vice and The ex-Mayor), NGO personal, local academia, and communities. The primary data is collected using interview with snowball sampling, while secondary data is collected from policies and reports to understand the context of problems and setting of multi-stakeholders. The result shows that there are two levels of implementation happened in this integrations stage: governance level and managerial level. These two levels can contribute to the knowledge of climate change adaptation strategy in Indonesia or other developing countries.
Transition agents for transitional economies: Can cities drive climate policies in the Eastern-European countries with economies in transition?

Maria Falaleeva, International NGO EKAPRAEKT, Belarus and EVRESCO, IRL
Anton Shkaruba, Central European University, H
Hanna Skryhan, Joint University of Belarus and Russia, BLR

The paper analyses whether major cities in Eastern European countries with economies in transition can lead local and national climate policy processes. Such countries represent a particular subset of the parties to the UNFCCC. Due to the extremely high baseline level of emission in 1990 and its drastic fall after the collapse of Soviet Union, the present targets set in (I)NDP and declared as ambitions (-28% for Belarus, -25-30% for Russia, 20% for Ukraine) in quantitative terms mean increase of emission and rated by experts (Climate Tracker) as "inadequate". In this situation, the real change needs new climate champions to lead the process.

To illustrate the barriers, opportunities and trade-offs related to the implementation of climate policies by municipalities, we analysed agenda-setting environment, climate change adaptation and mitigation policies in thee major cities: Mahilio? in Belarus, St.-Petersburg in Russia and Kharkiv in Ukraine.

The most important barriers include: low awareness and understanding of the problem, needs and options for independent climate actions at the scale of a city; poor integration between sectoral policies in highly centralised administrative system; lack of culture of political leadership by municipalities; poor information available in local languages; heavy reliance on international funding in the absence of strategic visions and local climate action plans.

Emerging positive trends involve: increasing integration of cities into international networks, notably the Covenant of Mayors; starting recognition of climate change impacts (also future ones), including floods, heat waves, strong winds and snow falls causing damage to human health and city infrastructure; emerging trends of institutional change supporting more flexible approaches to planning, including more powerful mandates for independent actions by municipalities.

The paper concludes with the rational and recommendations for promoting the leadership of cities in the region and each individual country (Belarus, Russia, Ukraine) in the national climate action.
Session 6: Informed Cities/Co-creation of Knowledge  
(TUE, Sept 19th, 16:30-18:00 in A56–BM)

Progressing knowledge for urban adaptation in Europe

Aleksandra Kazmierczak, European Environment Agency, DK

The aim of this presentation is to provide an overview of the current state of knowledge for urban climate change adaptation in Europe and to highlight the emerging gaps and challenges. The presentation draws on the recent reports published by the European Environment Agency and on the ongoing work of the Agency in the field of urban adaptation.

The key messages emerging from the reports 'Urban adaptation to climate change in Europe 2016' and 'Financing urban adaptation' (2017) are that whilst there is a good level of awareness of the need to adapt among European cities, adaptation is mainly at the planning stage and implementation is done by a few front-runner cities. Many adaptation measures implemented are nature-based solutions as the multiple co-benefits they provide help to justify their cost. A significant number of cities are focusing on coping with the climate variability and there is a need longer term, more systemic solutions. One of the key obstacles to applying more transformative adaptation measures is the limited capacity of cities to secure funding. Therefore, support in identifying and accessing appropriate funding is crucial to progress urban adaptation in Europe.

The knowledge production in adaptation is no longer focusing only on climate variables and projected climate impacts but is increasingly considering adaptation as a social science problem. This is particularly valid for cities, where the majority of European citizens live. Currently EEA, supported by the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation, is exploring the issues surrounding social vulnerability to climate change and provision of socially just solutions. The presentation concludes with the summary of insights into this topic from a recent expert workshop.

Science communication and climate services for cities in transition
European cities are highly heterogeneous systems. Local governments' (LGs) technical staff from different departments has to be involved in the planning and management of adaptation policies, as they might relate to different areas of expertise. Furthermore, stakeholders that are external to the city administration (e.g., businesses, community groups, etc.) need to contribute to the process of adaptation policy-making. This requires a continuous effort in communication and coordination, and makes it challenging for LGs to communicate scientific findings and turn them into integrated strategies for climate change adaptation. In many cases, the people that are in charge of coordinating climate adaptation activities in a city lack the necessary information to carry out their duties. When it comes to adaptation in cities, scientific information needs to be transmitted and translated in a way that makes it understandable to a heterogeneous audience with different levels of knowledge.

In order to support cities in this major endeavour, the RAMSES-project developed different tools. Specifically, the 'RAMSES Toolbox' includes: 1) A handbook and training package, condensing the knowledge gathered during the project to provide concrete steps to support cities in their adaptation work; 2) An audio-visual video application, where cities can find more than 100 videos from experts in different sectors, who present and communicate in a short format many crucial issues for adaptation; 3) A slide-deck that cities can use as a tailor-made support tool to explain climate adaptation to their local stakeholders.

Finally, the RAMSES toolbox is intended to foster and guide city transformation. During the session, this and other dissemination activities of the RAMSES project will be presented, shedding a light on different methods and tools that can be used to communicate urban climate change adaptation and can provide a climate service to cities.

Co-creating science with cities and practitioners

Alberto Terenzi, ICLEI - Local Governments for Sustainability, European Secretariat, DE
Maddalen Mendizabal, Tecnalia, ESP
Co-creating science with cities and practitioners is crucial to lead to the production of information apt to support the development of adaptation strategies, plans and actions. In fact, if science is produced in a void of cooperation with city staff and other stakeholders, it will be far more difficult for the results to be applicable in practice and lead to concrete positive outcomes. Furthermore, if cities are involved in the process of co-producing policy outcomes, they will also be more prepared to take them up and use them to inform their policy making. This session, drawing on the experiences of ICLEI and Tecnalia in the RAMSES and RESIN Projects (http://www.resin-cities.eu/home/), will focus on the benefits of co-producing adaptation and resilience research with practitioners, and will build capacity for other organisations to replicate this virtuous practice.

Specifically, ICLEI will present on the experiences gathered during the 3 RAMSES Stakeholder Dialogues, whose implementation the organisation has coordinated, with a particular attention to the process of involving stakeholders (cities but also regional and national governments, the private sector, etc.) and designing these events in order to optimise the interaction and mutual understanding of both researchers and practitioners. Tecnalia, who has participated in all the 3 stakeholder dialogues to gather information for the development of its transition pathways, will present on the interaction occurred with stakeholders during the dialogues and on how the results deriving from it informed and were incorporated in the final research results. Furthermore, both organisations will present on their experience in the RESIN Project, were they are involved in a co-creation process with 4 cities in Europe (Manchester, Bratislava, Bilbao and Paris) to develop tools to support adaptation policy-making in European cities, so as to present the benefits of such innovative co-creational approach.
Participatory Decision-Making to Support Climate Resilient and Inclusive Urban Development in Latin America Cities

Manuel Winograd, Wageningen University (WEnR/Alterra), NL
Ebru Gencer, Center for Urban Disaster Risk Reduction and Resilience, USA
Jorgelina Hardoy, International Institute for Environment and Development, ARG
Michiel van Eupen, Wageningen University (WEnR/Alterra), NL
Ingrid Olivo, Center for Urban Disaster Risk Reduction and Resilience, USA
Yuliana Montoya, Corporación Autónoma Regional de Risaralda, CO
Norma Ramirez, Universidad Tecnológica de Pereira, COL

This paper presents results of a "Participatory Decision-Making for Climate Resilient Urban Development" project that explores an innovative way to develop a practical process in which stakeholders are integrated into the decision-making process. The process, will not only empower citizens, but also will facilitate the implementation of strategies and actions that are identified by stakeholders for a resilient urban development. This research is currently in process in the cities of Santa Ana (El Salvador); Santo Tomé (Argentina) and Dosquebradas (Colombia). All three cities encounter different urban problems, are in different stages of planning process and at risk from different impacts of climate change requiring various disaster risk reduction strategies, climate change adaptation and mitigation actions and resilience building options.

This research uses a multi-disciplinary methodology bringing together social sciences (sociological research) with that of natural sciences (climate and risk science), geo-informatics sciences (decision support tools) and urban design and planning. The research starts with a diagnostic process on the current status quo, undertakes a stakeholder participatory workshop using an innovative decision-making tool, and explores and assesses different options towards DRR, CCA and resilience building.

As result, in the three cities, to implement the needed options and actions, the main limitations are found to be related to policy options and the decision making process. Lack of information or technological gaps do exist, but can be solved, particularly through stakeholder partnerships.

On this basis, during the workshops, the main priority options identified and explored to make cities more climate resilient and achieve a more sustainable and inclusive development, were:
1. In Dosquebradas, option explored were Integral Neighbourhoods Management and implementation of green and grey infrastructure.

2. In Santa Ana, options explored were urban management including integrated water and land management of green and grey infrastructures and early warning and emergency management.

The relevance of co-development to ensure a high-resolution urban climate model’s practicability and user-friendliness

Bettina Steuri, Jörg Cortekar, Steffen Bender, Climate Service Center Germany (GERICS), DE

Cities and urban agglomerations are particularly vulnerable to the expected impacts caused by climate. A building-resolving urban climate model as a tool for urban planning can contribute to prepare to these issues. Such a model enables demand-oriented and practical actions for climate change adapted development in urban planning. However, currently available urban climate models and their results do not correspond to the level of expertise of the various user groups, e.g. urban planners or project developers, their computing infrastructures and interfaces to further software such as visualisation tools.

The German research programme [UC]² - Urban Climate Under Change, which is funded by the German Federal Ministry of Education and Research (BMBF), aims at the development, validation and application of an innovative urban climate model for entire cities. UseUClim, as one of the four joint projects, reviews the model’s user-friendliness and practicality. To do so, the living lab approach has been chosen and, thus, multiple stakeholders from urban planning practice are involved and part of a multi-disciplinary research team.

So far, several stakeholder-workshops have been conducted and an online-survey has been completed by a wide range of potential climate model users. Furthermore, a literature review has been carried out to complement the findings of the practice-oriented living lab approach with a scientific perspective. The results of the requirements specification have been structured into five categories: 1) technical requirements and system prerequisites, 2) functional and scientific requirements, 3) input data, 4) output data, and 5) user interface. It is recognisable, that functionalities have a tendency to be user-group-specific, whereby all user groups have consistent requirements in terms of the urban model’s usability.
During the first project phase, it became apparent that this joint collaboration of planners, software engineers, policy makers, economists and scientists is relevant to obtain a versatile, but comprehensive compilation of potential users’ requirements on an urban climate model’s practicality. With this approach we involve relevant actors and their demands in the software development. Thus, we encourage the model’s future application and herewith support climate-change-adapted urban development and planning.

Panel Session 2
(WED, Sept 20th, 9:30-11:00 in H - GF)

Building capacity and cross-sector dialogue to accelerate sustainable urban services in emerging and developing cities

Anne Maassen, World Resources Institute, Ross Centre for Sustainable Cities, Washington, USA

Scaling up urban solutions for global environmental change

Felix Creutzig, Mercator Institute for Global Commons and Climate Change, DE

Session 7: Urban Climate Modelling
(WED, Sept 20th, 11:30-13:00 in A56-BM)

Convection Resolving Regional Climate Modeling

Johann Züger, Austrian Institute of Technology, Vienna, AT

Numerical downscaling of climate data and projections is usually carried out at resolutions down to 10 x10 km. This is far too coarse for applications in urban areas. Climate data at higher resolutions are usually generated by statistical downscaling methods with the main disadvantage that the different parameters are no longer physically coherent and the extracted climate change signals still remain at the initial coarse resolution. Therefore an urban climate simulation run with a horizontal resolution of 1x1 km and selected input data described below have been started at AIT. This simulation is conducted applying a special version of Cosmo-CLM (cclm_4.8_clm19_c6) which includes selected urban extensions. Two additional
fields are used and need to be added to the standard model input to make it work. These fields include the urban fraction (URBAN) and annual-averaged anthropogenic heat flux (AHF). These data are based on the EEA dataset for soil-sealing over Europe http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m and the anthropogenic heat flux pattern based on Flanner, 2009, http://www.cgd.ucar.edu/tss/ahf/; (Flanner, M. G. (2009) Integrating anthropogenic heat flux with global climate models, Geophys. Res. Lett., 36, L02801,doi:10.1029/2008GL036465.) At a resolution of 1x1 km generic parameter sets within the model are no longer required. Instead the equations are fully solved which allows the model to deal explicitly with convection in the atmosphere. Besides this the higher resolution of the input data like terrain height, soil type, sealing and vegetation is extremely beneficial. With the model set up currently used at AIT phenomena like the urban heat island effect can be resolved. This allows to look in more detail into urban regions where problems under future climate conditions may arise.

Currently the hindcast runs forced by ERA40/ERAinterim data from the European Centre for Medium-Range Weather Forecasts (ECMWF) covering the years from 1960 to 2015 are finished and used to validate the model performance. In parallel the climate scenario run forced by HadCM3 GCM simulations (Hadley Centre Coupled Model, version 3) using the IPCC SRES-scenario A1B has been started. Actually the period between the years 1959 and 2080 is finished and will be extended to 2100.

Global Urban Climatology: advance strategy for representing urban areas in global weather models

Alvin Christopher G. Varguez, Nisrina Setyo Darmanto, Manabu Kanda, Shun Takakuwa, Tokyo Institute of Technology, JP

Global urban climatology, a sub-field of urban climatology which focuses on the preparation of datasets needed to acquire a global understanding of urban-climate interactions, is introduced along with its on-going implementation and findings to a rapidly developing megacity, Jakarta. First, high spatial resolution globally-available urban morphological parameters, anthropogenic heat fluxes, and detailed urban land cover are estimated as necessary inputs to running a numerical weather prediction model, a modified version of the Weather Research & Forecasting Model. Second, the urban-representative parameters are projected
using a combination of tools such as an urban growth model and country-level shared socioeconomic pathways 1 and 3. Using a top-down approach of the bulk information of population, energy consumption, and GDP, the urban-representative parameters were derived. In addition to the surface boundaries, meteorological boundaries were also prepared to down-scale the effect of climate change to the megacity using the Pseudo-Global Warming (PGW) method. Ensemble averages of 5 GCMs for Regional Concentration Pathways for 2.6 and 8.5 were prepared. From the levels of urbanization dictated by the two SSP levels and its corresponding RCP, case simulations were conducted covering 10 years between 2006 - 2015 and 2046 - 2050. Three cases represent present condition, pure climate change by PGW, and climate change with urbanization. Results show that urbanization plays a significant role of increasing air temperature and reducing wind ventilations within the city and at the areas of expansion in addition to climate change. Through the approach of this study, separate contributions of urbanization (as represented by increased anthropogenic heating, urban sprawling, and detailed building volume increases) and climate change can be precisely quantified for any city of interest. The research is funded by the S-14 Project of the Ministry of the Environment, Japan.

Parameterisation of radiation interactions in urban climate modelling: How much detail should we include?

Mohamed Salim, Sebastian Schubert, Christoph Schneider, Humboldt-University, Berlin, DE

Urban Climate Models (UCM) have been used extensively over the last decades to study the complex interaction between urban areas and the atmosphere as well as to assess the effectiveness of adaptation strategies for climate change. In such models, radiation parametrisation plays a crucial role to determine the quality of UCM in terms of modelling energy exchange between various components of urban surfaces and the atmosphere. This energy exchange along with both boundary-layer and large-scale synoptic processes influences the flow turbulence which in turn affects all urban applications such as urban air quality and thermal comfort.

Within the framework of the joint project Model-based city planning and application in climate change (MOSAIK), a project funded by the German Federal Ministry of Education and Research (BMBF), the parametrisation of radiation interactions within urban area is implemented to develop a new urban climate model based on
the well-established large-eddy simulation code PALM (PArallelized Large-Eddy Simulation Model for Atmospheric and Oceanic Flows). Radiation interactions include shortwave radiation from the sun (SW) and longwave (LW) thermal emissions from urbane surfaces (pavements, walls, and roofs), reflections of SW as well as reflection and emission of LW within the urban canopy, radiation absorption by urban surfaces, SW absorption by vegetation, etc. However, considering all these processes requires extra code development, computation time, and input data.

In this presentation, the effect of each one of these processes will be quantified to monitor its individual effect via a numerical simulation of an urban area in order to answer the question raised in the title to show how much radiation interaction details can reasonably and usefully be considered in simulations.

Assessment of current and future urban heat islands

Hans Hooyberghs, Dirk Lauwaet, Koen De Ridder, Flemish Institute for Technological Research, Atmospheric Modelling Group, B

As a consequence of the urban micro-climate, cities are warmer than their rural surroundings, a phenomenon known as the Urban Heat Island effect (UHI). During heat waves, the UHI is known to exacerbate the impact on population health, because of a combination of two effects: higher night-time temperatures and increased day-time heat-stress levels. In the latest report of the International Panel on Climate Change, the effect is identified as one of the key risks for the coming decades.

Within the EU RAMSES and NACLIM projects, we have studied the urban climate effects using the urban climate model UrbClim. The model scales large-scale weather input data down to agglomeration-scale and computes the impact of urban development on the most important weather parameters, such as air temperature and humidity, at a resolution of a few hundred meters. UrbClim has been subjected to extensive validation and is found to be of the same level of accuracy as more sophisticated models. To study the day-time heat stress, the model is coupled to an off-line radiation module, yielding heat exposure maps at a resolution of a few metres.

We present summer night-time temperatures for more than hundred European cities, covering agglomeration-scale domains at a resolution of 250m. For selected cities (Antwerp, Berlin, and Brussels), high resolution day-time heat stress levels
are calculated for typical hot summer days. The maps identify the neighbourhoods most vulnerable to heat hazards. Furthermore, a coupling was established between UrbClim and CMIP5 ensemble climate projections employed by the IPCC allowing the assessment of the urban heat island and heat stress effects under future climate conditions, both for the near (2026 - 2045) and far (2081 - 2100 future).

Urban Effects on Summertime Air Temperature in Germany under Climate Change

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Susanne Grossman-Clarke, Shelburne, VT, USA
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The impact of climate change on urban relative to rural summertime air temperatures is investigated for nine major cities in Germany, under the Representative Concentration Pathway trajectory 8.5. The analysis is based on simulations of representative historical and projected future summers with the regional climate model COSMO-CLM in conjunction with the multilayer urban parametrization DCEP when driven by three global circulation models (GCM). Each GCM provides boundary conditions for two historical and two future summers that resemble average conditions for Germany with respect to 2-m air temperature statistics for the periods 1976-2005 and 2031-2060, respectively. The simulations show climate change signals (CCS) in summer mean urban-rural air temperature differences of the city ensemble of up to 0.15K. Across all driving GCMs, the largest changes are projected for the city of Berlin. Characteristics of the diurnal courses of urban-rural air temperature differences, the magnitude of the CCS and its physical reasons are GCM specific. Specifically, CCS are caused either by positive or negative changes in the Bowen ratio of the rural boundary with little changes in the urban surface fluxes, or vice versa. The study emphasizes the importance of the driving GCM in COSMO-CLM simulations when investigating urban effects on air temperature under global climate change.
Session 8: Urban Climate & Health Burden (WED, Sept 20th, 14:00-15:30 in H - GF)

Quantification and warning of heat stress in urban areas in Germany

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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 biometeorological 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 and smartphone app. The main target groups are the public, nursing homes and ministries of the federal states and other authorities. The HHWS is in operation since 2005 and preliminary studies indicate a reduction of the heat related mortality after implementation.

In addition micro climate models can be applied (e.g. RayMan, SkyHelios) in order to quantify the conditions in a long term context and to detect hot spot areas as well as to provide opportunities to reduce heat stress in urban areas.
Analysis of human thermal comfort in central European city during summer period: a case of Novi Sad, Serbia

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Daniela Arsenović, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Novi Sad, SRB
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Urban meteorological network (UMN) was established in the Central European City of Novi Sad (Serbia) based on 'local climate zones' (LCZs) system. Physiologically Equivalent Temperature (PET) index was used for the assessment of outdoor thermal comfort in the 'built' and 'land cover' LCZ classes of Novi Sad. The index was calculated in the RayMan software based on the meteorological, physiological as well as building and vegetation data. Temporal analysis was performed for extreme heat stress days (PETmax > 41 °C), extreme heat stress hours (PETav > 41 °C) and days with occurrence of 'tropical nights' (Tmin > 20 °C) during exceptionally hot summer of 2015. Our results show that extreme heat stress hours are the least frequent in compact midrise LCZ 2, followed by dense trees LCZ A. On the contrary, countryside (low plants - LCZ D) showed to be the most uncomfortable area during daytime followed by open midrise areas (LCZ 5). Tropical nights are the most frequent in midrise LCZs 5 and 2 (40-46 nights) and decreasing towards open, sparsely built and natural 'LCZs' (6-8 tropical nights in LCZs A and D). This is almost 800% decrease and it has implications for health and recreation of urban population and emphasizes the need for UMN development based on LCZ system.


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Sustainable energy-efficient urbanization and public health improvement are major development challenges for India. While both issues are intensively studied, their interaction is not well understood. Here we assess how specific urban development measures affect public health and mobility and energy spending,
identifying synergies and trade-offs by analyzing nationally representative household surveys from 2005 and 2012. Our analysis confirms previous characterizations of the environmental-health transition, but also points to an important role of energy use and urbanization as modifiers of this transition. Our analysis suggests that a 10% increase in urbanization and concurrent access to modern cooking and water infrastructures could reduce traditional disease prevalence in 2.4 million people. Household electricity related emissions would modestly rise to 0.084 mtCO2e. Promoting energy-efficient mobility systems can reduce modern disease prevalence and reduce transport-related GHG emissions. For instance, a 10% increase in cycling could avoid prevalence of major morbidity by 0.3 million and reduce emissions by 1500 tCO2e annually. These findings suggest that energy-efficient and sustainable urbanization can address both morbidity and climate change challenges simultaneously.

**Past and future heat-related hospital admissions in Berlin**

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Susanne Breitner, Helmholtz Zentrum München, DE
Annette Peters, Helmholtz Zentrum München, DE
Wilfried Endlicher, Humboldt-Universität zu Berlin, DE

Cities have to address urban heat islands, environmental pollution, consequences of climate change, high population density and many conflicting interests, e.g. due to rising pressure on settlements. Urban environments substantially determine living conditions in cities. The demographic change, population growth and increases in socioeconomic disparities as well as chronic diseases enhance health risks and demands in urban development and public health care already today and very likely in the future. In terms of mitigation and adaptation, knowledge of heat-related health impacts in cities contribute to devise appropriate short- and long-term strategies.

This study aims to analyse retrospectively associations between daily maximum air temperature and hospital admissions as well as in-hospital deaths during summer months (June - September) from 2001 - 2010 in Berlin. The study approach provides a comparison between morbidity and mortality effects, diagnoses and age groups (all ages and 65+). Based on exposure-response curves and relative risks for the reference period 2001-2010, we calculate expected numbers of daily hospital admissions and in-hospital deaths for the future period 2021-2030. The projections consider different climate change scenarios (RCPs 2.6 and 8.5) and
the mean demographic forecast provided by Berlin’s Senate Department for Urban Development (version 2016). General assumptions, limitations and different acclimatisation and adaptation approaches will be discussed. In Berlin, the relative risks for hospital admissions and in-hospital deaths augment with increasing temperatures. The exposure-response relationships and relative risks vary with diagnosis and age. We identified stronger impacts of daily maximum air temperature on respiratory system diseases than cardiovascular system diseases, stronger impacts on mortality than morbidity and for patients older than 65 years. Due to population growth and climate change, the projections indicate increased heat-related hospital admissions and in-hospital deaths in the near future with biggest increments for persons older than 65 years because of demographic change.

**Drivers and Evolution of Present and Future Threshold Temperatures for Heat Mortality**

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Assessing the onset of excess mortality from heat is of particular interest for climate impact studies because it allows to infer the temperature above which the capacity of a city's population to cope with heat is exhausted. Such threshold temperatures for excess mortality are given only sporadically, mostly for cities, on case study basis and usually for present-day climate conditions. This way, it is not feasible to deduce general statements from this location-specific information and it remains unclear at what city-specific temperatures future excess mortality will set in under conditions of climate change. To address these issues we elaborate a statistical model to estimate threshold temperatures for most geographic locations for the present and future climate. Estimated present-day threshold temperatures for more than 600 major European cities cover a range between 11 °C to 30 °C. When applying our model to the future (2051-2080), threshold temperatures are expected to increase in most cities, especially when using climate scenario RCP 8.5. The results for this scenario show extended "hotspot" areas in Southern and Southeastern Europe. For RCP 2.6 in comparison, which complies with the 2°C marker, these hotspot areas are smaller in number and size. Methodologically, our work is based on a meta-analysis of threshold temperatures given by epidemiological studies on heat-related mortality. Multivariate non-linear regression was used to identify relevant independent variables explaining the sample of
threshold temperatures. Our work provides a novel and alternative method to derive threshold temperatures for excess mortality that does not require epidemiological records. This method can be applied to present and future climate data.

Session 9: Urban Form and Thermal Burden (WED, Sept 20th, 16:30-18:00 in H - GF)

Impact of urban compactness on outdoor thermal comfort using "Zeilenbebauung" in Berlin as a case study

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Sahar Sodoudi, Free University of Berlin, DE
K. Heinke Schluenzen, University of Hamburg, DE

Heat events due to high atmospheric temperatures in summer are a major cause of weather-related deaths in Europe and are projected to become more frequent under anthropogenic climate change. Adapting the design of buildings, for example increasing their height, has been proposed as a heat mitigation strategy. In this study, we simulate the effects of urban compactness on outdoor thermal comfort using a numerical model of the urban micro-climate. For this purpose, we investigate nine building scenarios with different building height and different numbers of horizontal building extensions for which we assess the day-time and night-time mean and maximum values of the Universal Thermal Comfort Index at three locations in our model domain. We simulate a representative hot summer day in Berlin, derived from measurement records, and distinguish between three wind directions. Our results indicate that, overall, compactness tends to improve day-time thermal comfort but that its effect on night-time thermal comfort is ambiguous. Furthermore, taller buildings tend to improve day-time thermal comfort irrespective the wind direction and location, although for some wind directions and at some locations horizontal extensions yielding the same compactness improve thermal comfort more effectively. Our results conflict with previous findings that indicated that a rectangular building with a courtyard is the best suited building form to mitigate heat stress in mid-latitude cities.
Assessment of the influence of urban geometry on outdoor thermal comfort and its spatial variation over tropical metropolitan city of Pune, India

Manasi Suresh Desai, Ashish Gopikrishna Navale, Amit Gulabrao Dhorde, Department of Geography, Savitribai Phule Pune University, Pune, IND

India is experiencing rapid emergence of metropolitan cities and accelerated urban growth. Thriving urbanisation in absence of adequate infrastructure and lack of efficient adaptation strategies pertaining to inadequate socio-economic abilities has increased vulnerability of climate change in urban centres of developing countries. The urban areas are characterised with unique microclimatic conditions attributed to urban geometry, and urban materials. Altered urban microclimate has distinct effect on outdoor thermal environment and human thermal comfort. The present study aims to understand effect of urban geometry on outdoor thermal comfort during summer daytime hours for metropolitan city of Pune. To evaluate the outdoor thermal environment field survey was carried out in May 2016. The survey was conducted during clear summer days for more than hundred spatially well-distributed public places and at crucial crowded city crossroads. The weather parameters along with black globe temperature and sky view factor (SVF) were obtained at each site with portable weather station and fish eye lens camera. The India Meteorological Department weather station was considered as a base station for selected survey days. The data obtained was used to analyze spatial variation in mean radiant temperature (Tmrt) and Physiologically Equivalent Temperature (PET) over the city. The spatial variation in outdoor thermal comfort was assessed with PET, Tropical summer index (Tsi) and Heat Index (HI). The result depicts that, unshaded exposed areas have high Tmrt and PET compared to shaded areas. It was observed that green areas like city parks and canopy covered places are thermally comfortable. While the places with complex congested urban geometry leads to high thermal discomfort possibly, pertaining to trapped heat in built up areas and obstruction to wind speed. The comprehensive analysis of outdoor thermal comfort comparing various thermal discomfort indices showed that Tmrt is one of the crucial parameter affecting outdoor thermal comfort.
Identification and characterisation of “hot” and “cool” islands in a tropical city

P. Kabano, S.J. Lindley, A. Harris, University of Manchester, Department of Geography, UK

Traditionally, most urban climate studies divide the landscape into urban and rural areas. A classic example of such studies is the urban heat island phenomenon, which is associated with health risks. Recent developments in urban climate research have highlighted the need for investigations at a local scale, acknowledging that the landscape spectrum is too diverse to be simplistically split into only urban and rural areas. Ecological forcing functions tend to be directly linked with the level of alteration of a given area. Much of the existing literature has focused on cities in higher latitudes, with little or no information in the tropics. Temperate cities and tropical cities are inherently different because of their latitudinal locations. Moreover, cities in the tropics are currently experiencing the highest rates of urban expansion with different forms of urbanisation compared with many study sites referred to in the academic literature. Urban populations in the tropics are more likely to be vulnerable to the vagaries of climate change (e.g. heat stress) because of their location close to the equator and current urbanisation practices. This study investigates the spatial and temporal variability of local climate in Kampala. Different locations were chosen that represent the heterogeneity in cover represented by the local climate zone classification developed by Stewart and Oke (2012). Air temperature, relative humidity, mean radiant temperature, and soil moisture were monitored over the rain and dry seasons. Preliminary examination of the data shows that there is large heterogeneity between study sites and that the differences vary temporally. Each site shall be characterised for impervious, building and green fractions within a minimum radius of 200 m from the sensors and further analyses conducted to identify possible relationships in the observed spatial and temporal differences.
Urban development patterns' influence on thermal environment and energy consumption: Hanoi and Taipei compared

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The conjunction of urban heat island effect with increasingly severe hot spells has become a recurring threat to public health in large cities all over the world. This also threaten sustainable development by increasing the electricity demand for cooling. To assess the risk in cities of subtropical Asia, we examine the relationships between urban development patterns, thermal environment and electricity consumption in Hanoi and Taipei.

We use LANDSAT 8 satellite imagery to observe land surface temperature heterogeneity within the cities, and to identify the characteristics of land development patterns using the 'Local Climate Zones' scheme. This scheme classifies lands into climatological related zones according to the physical attributes of buildings and land cover including their types, density and height. With a focus on June/July 2016, we then examine to what extent the use of electricity is influenced by dominant local climate zone and urban heat island effect intensity at the district level for both cities.

We present initial findings for Hanoi and Taipei assessing the relationship between residential and commercial electricity use, local climate zone and population. Smarter land use choices can mitigate the urban heat island effect, and ultimately conserve electricity in summer. Our method demonstrates how combining remote sensing data with socio-economic survey results has potential to help cities attain climate co-benefits, in this case building fresher, more liveable neighborhoods and contributing to greenhouse gases emission mitigation.

Moreover, we argue that mapping urban heat islands and the excess electricity demand they entails also makes apparent the need to consider spatial justice issues related to urban climate change. Comparing our results with poverty maps highlights how technical and planning interventions can impact vulnerable citizens.
Evaluation of strategies for mitigation of the urban heat island and increased compactness regarding their impact on the urban micro climate of Berlin

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This study evaluates strategies for mitigation and adaptation of the urban heat island of Berlin, Germany, on a summer day with the help of the urban climate model Muklimo_3. Scenarios of white coating, green roofs and a combination of both are analysed regarding their cooling ability on the 2m-temperature. Additionally, horizontal and vertical compactness are simulated and their respective impact on the micro climate is assessed. An enhanced reflectiveness of the urban surfaces leads to the highest cooling ability with a significant daily average mean decrease of 0.2K per 0.1 increase of albedo, while green roofs have only a small cooling effect on the street level. An increased vertical compactness has a cooling ability due to the higher amount of shading, enhanced horizontal compactness shows a negative impact on the micro climate due to the raised percentage of sealed surfaces and the additional urban structures that can emit additional heat during the night. All strategies have a high effect on the temperature during the daytime and a smaller influence on the nocturnal temperatures.

Session 10: Promoting Adaptive Cities (WED, Sept 20th, 11:30-13:00 in H - GF)

From cities to coastal communities: RAMSES's results and their transposition to smaller towns, observations conducted in 7 coastal sites.

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Using RAMSES project framing of policy tools, we propose to analyse whether these may be downscaled at a smaller, local community, level. In order to conduct this analysis, we use Cash et al. (2003) "Knowledge systems for sustainable development" framework. This framework is centred the three following
dimensions of knowledge: Salience, legitimacy and credibility. Using this framework, we scope the various RMASES project policy tools using corpuses collected in 7 coastal sites.

The corpuses used are associated to the following sites and associated communities that have been the subject of extensive field work within another project: Uummannaq, Greenland, Tiksi, Sakha republic, Russian Federation, Cocagne and Grande-Digue, New Brunswick, Canada, Bay of Brest watershed, Britany, France, Mbour, Senegal, Vypin Island, Kerala, and Kanyakumari, Tamil Nadu, India.

Our results show that, while RAMSES approach is indeed scalable, some of its dimension are more attuned to the specifics of smaller sites that other. We also see that a central feature of local communities' adaptive capacity, i.e, connectedness to higher scales of governance, is not as critical for larger cities.

We conclude by proposing a nested multiscale approach geared at fostering mutual learning between larger cities and smaller communities.

Second Assessment of Local Climate Plans in European Cities – State and progress of adaptation and mitigation planning across EU 28 urban areas

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Urban areas are pivotal to global adaptation and mitigation efforts due to the amount of people, assets, and infrastructures (Rosenzweig et al. 2010, 2011; Hunt and Watkiss 2011) entailing concentrated risk and greenhouse gas (GHG) emissions. But how do cities actually perform in terms of climate change response? This presentation sheds light on the state of urban climate change adaptation and mitigation planning in European cities. Based on the First Assessment of Climate Change Planning in 11 countries across Europe (see Reckien et al., 2014; Heidrich et al., 2016) we here present new evidence from the Second Assessment of Climate Change Planning. The assessment comprises reviewing the urban climate change plans across all, currently about 900 Urban Audit (UA) Cities in the EU-28, using a common protocol. With that, the Second Assessment of Climate Change Planning in Europe as here presented does not
relies on self-report measures such as questionnaires and/or interviewing of city representatives, potentially incorporating bias, but on a scientific analysis supported by administration-external researchers that have worked and are familiar with the language and respective urban and climate policies. With this paper shows a valid, comparable account of the climate change response and preparedness of European Urban Audit cities.

Promoting Resilient Cities Through Assessment of Legal and Institutional Barriers to Long-Term Community Recovery Following Disasters

John T. Marshall, Georgia State University College of Law, Georgia State University Urban Studies Institute, USA

Current and anticipated climate change challenges are already requiring transformation of essential urban systems. Stormwater, road, and flood protection infrastructure are just a few of the fundamental systems that cities are re-examining, redesigning, and rebuilding. But these major physical infrastructure projects are not the only urban transformations necessitated by climate change. Recent major U.S. storm events also point to critical vulnerabilities associated with cities' legal infrastructure.

Often overlooked is the important function that specific laws and institutions serve in organizing a city and carrying out its essential affairs. Laws and policies, ranging from comprehensive plans, to zoning codes, constitutional provisions authorizing public expropriation of private property, and statutes creating land banking agencies are frequently foundational to city resilience. In the U.S., recent major urban disasters have demonstrated that neighborhood recovery has been significantly impeded by the absence of laws and institutions that would help promote urban recovery. These same disasters have also exposed impediments to recovery associated with existing laws - laws that either slow down or threaten to render unlawful the interventions necessary to help neighborhoods rebuild, recover, and in some cases, retreat.

Although recent U.S. storm events may not accurately frame the full range of challenges that cities can anticipate due to climate change, they provide an indication of the ways in which cities may be vulnerable to climate change-related forces. Hurricane Katrina, Superstorm Sandy, and the Colorado Front Range Floods each capture situations in which communities' inadequate legal
infrastructure undermined their capacity to recover quickly, efficiently, and inclusively. Drawing on lessons from Katrina, Sandy, and the Colorado Front Range Floods, this presentation advances a growing body of scholarship that examines ways in which local ordinances, statutes, and state constitutions help define a city's capacity to solve pressing problems, including responses to threats posed by climate change.

New challenge with the usual suspects. The interplay of local institutional capacity and social vulnerabilities in the imperative of urban adaptation to climate change.

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The predicted impacts of climate change are already becoming a challenge for urban systems with limited resource availability to sustain the level of wellbeing of their citizens. The main aim of this research is to contribute to the understanding of the elements of urban governance that play a key role to manage this challenge. The focus is exclusively on the role of local institutions. By considering socioeconomic conditions of vulnerability, the aim is to analyse if i) specific local institutional capacity and ii) the inclusion of risk prevention actions in development planning are associated with reductions in the negative effects of two particular possible impacts of climate change on urban areas: floods and landslides. In order to do so, this study has carried an analysis of a sample of Colombian urban areas that share the same national institutional framework and have been affected relatively frequently by flood and landslides events. Drawing from the results of interviews with practitioners and experts, as well as quantitative tests, this work aims to contribute with empirical evidence to the discussion about the key elements for local governments to reduce de impact of climate hazards in the development process.

The results of the analysis point to the fundamental importance of local institutional capacities of local governments in the future challenges. Additionally both the perspectives of practitioners and experts on the subject in addition to unexpected directions of the association between institutional capacities and the negative effects of the emergencies point to the importance of goal setting in urban development planning.
Implementing Urban Adaptation Policies: Decision-making and decision tools

François Gemenne, Université de Versailles Saint-Quentin-en-Yvelines, Sciences Po, FR; University of Liège, B
Dina Salakhova, Yorghos Remvikos, Charlotte Da Cunha, Jean-Paul Vanderlinden, Université de Versailles Saint-Quentin-en-Yvelines, FR

This paper reviews the different policy tools that cities can use to implement adaptation strategies and policies. The efficiency and possible use of each tool is assessed, so that this paper can serve as a toolkit for local policy-makers wishing to implement local adaptation strategies. This toolbox is at the same time dynamic and contextual, meaning that cities can adapt new tools in the adaptation process, but needs to be tailored to local needs.

There are many policy tools that can be used by cities, both at the design and implementation stages. Policy tools that are not initially designed for adaptation can also intentionally or unintentionally serve for adaptation purposes.

The design and implementation of adaptation strategies calls for horizontal (across sectors) and vertical (across governance scales) integrations, including the actions and initiatives of civil society. Our analysis shows that certain cities tend to privilege responses to recent extreme events, while other favor responses to events forecast by scientific models. For example, following hurricane Sandy, New York City has focused on the submersion risk, while Paris has mostly addressed flooding and heat waves.

A key lesson from this paper is the need to go beyond traditional adaptation strategies to incorporate other types of policies that were not initially intended for adaptation. Civic involvement can develop into adaptation initiatives, despite the fact that engagement was initially for other reasons.

Overall, adaptation is a concept that remains in need of clarification for stakeholders, especially at the local level. Most policy-makers already have a portfolio of policy tools that can be fine-tuned for climate change adaptation purposes.
Session 11: Urban Atmospheric Pollution and GHG Emissions (WED, Sept 20th, 14:00-15:30 in A56 - BM)

Particulate matter source attribution for Berlin

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Martijn Schaar, TNOinnovation for life, NL

Particulate matter (PM) is associated with a range of health problems ranging from asthma to lung cancer and cardiovascular problems. PM2.5 is estimated to cause over 400,000 premature deaths each year in the EU28. To formulate effective policies to limit PM exposure of urban populations, it is important to know the origin of the pollution in terms of region and economic sector as this gives valuable information about which measures that have the highest potential of reducing PM concentrations.

We have used the LOTOS-EUROS model to address the origin of PM in Berlin for the year 2015. The model incorporates a dedicated labelling routine to quantify the source contribution of sectors and regions to PM components. To assess the contribution of transboundary transport to PM levels in Berlin we quantified the impact of all EU-28 countries. It is shown that these countries contribute 30% to the PM10 levels in Berlin. 17% was allocated to natural sources. German and local emissions each contribute about a quarter of the PM10 levels in the urban background. In a relative sense the contributions of the urban area remain constant with increasing PM concentrations, whereas those from other German and international source rise in importance at the cost of the natural contribution.

Evaluation shows good agreement between modelled and observed levels of secondary inorganic aerosol. However, carbonaceous material is largely underestimated. To improve on the source apportionment and the model performance, we are addressing sources missing in emission databases as well as improving the modelling of temporal variability of emissions. For example, accounting for the meteorological dependence of residential combustion clearly improves model performance during cold spells in winter, but leaves the underestimation in summer unchanged. Hence, more effort should be put in understanding the origin of carbonaceous aerosol.
The efficient, the productive and the intensive: Insights from Urban Kaya Relation

Ramana Gudipudi, Diego Rybski, Matthias K. B. Lüdeke, Bin Zhou, Potsdam Institute for Climate Impact Research, DE
Zhu Liu, Harvard University, California Institute of Technology and University of Cambridge, USA
Jürgen P. Kropp, Climate Impacts and Vulnerabilities, Potsdam Institute for Climate Impact Research (PIK) and Institute for Geo-and Environmental Sciences, Potsdam, DE

Considering their current CO₂ emissions globally, the role of cities in climate change mitigation is unprecedented. Given the strong global urbanization trend, it is crucial to understand whether large urban areas are more emission efficient in comparison to smaller ones. Recent literature on urban scaling properties of emissions as a function of population size led to contradicting results and more importantly lacked an in-depth investigation of the factors leading to such scaling properties. Therefore, in analogy to the well-established Kaya Identity, we developed an urban Kaya relation to investigate different scaling properties of the indicators within the Kaya Identity for a global dataset of 61 cities. Contrary to traditional urban scaling studies which use ordinary least squares regression, we show that orthogonal regression is necessary when complex relations among scaling exponents are to be investigated. Our results show that large cities in developed countries are typically more emission efficient than smaller ones due to their less than proportional emissions given their energy consumption. In contrast, our results display that large cities in developing countries are typically less emission efficient owing to more than proportional GDP and emissions with respect to population and energy consumption, respectively. From a climate change mitigation point of view, our results indicate that large cities in developed regions should prioritize actions on improving energy efficiency while cities in developing regions should focus on adopting improved technologies to reduce emissions from energy conversion.
Exploring the prospects for early and later stage low carbon transitions: The role of long term, high resolution, city- and community-scale carbon accounting

Andrew Sudmant, Andy Gouldson, Joel Millward-Hopkins, University of Leeds, UK

In this paper, we draw a distinction between the early and later stages of a low carbon transition. We posit that early stage transitions are likely to focus on the options that are most technically, economically, socially or politically viable and that can be most readily assimilated into existing structures and systems. By contrast, we posit that later stage transitions are likely to require the adoption of options that are more technically, economically, socially or politically challenging, and that are likely to disrupt or require deeper changes in existing structures and systems. Empirically, we conduct an analysis of past, present and future emissions from 418 UK local authorities. We contrast production-based (or territorial) with consumption-based (or extra-territorial) carbon accounts at the city- and community-level. Preliminary results show production-based emissions have declined substantially in the last 25 years but consumption-based emissions are continuing to increase. We then evaluate the impacts of a continuation of recent trends. We find that the suite of existing national and local actions may not be enough for the UK as a whole and for cities and communities within to maintain a production-based trajectory consistent with an 80% cut in emissions by 2050, and we find deeper challenges when we consider future trajectories in consumption-based carbon emissions. In addition, we find limits to the level of transition that can be delivered based on the existing stock of technically and economically viable options. As a consequence, we highlight the risk that many of the options being adopted now with very significant levels of investment may deliver mildly but not deeply decarbonised cities and communities, and we question whether we are approaching a point where mild decarbonisation is locked-in but deeper decarbonisation is locked out.
Carbon footprinting of buildings

Ayodeji Oluleye, Department of Meteorology and Climate Science, Federal University of Technology, Akure, NGA

Carbon footprint estimation is an expression of greenhouse gas (GHG) intensity contribution of an activity to the global warming. Two similar buildings which are similar in architectural design and electrical fittings are considered for this work. By cheer providence, while landscaping the surroundings of the buildings some big trees were retained close to one of the buildings while the other had no trees. These trees cast shadow on the building for a minimum of 4 hours in a day providing cooling effect on the building. The carbon footprints of the two building were estimated by calculating the energy consumption in the building using standard procedures. The results show that the Global warming potential of the shaded building was reduced by up 150% compared to the un-shaded building. The results indicate the significant contributions of shade provided by trees in reducing energy consumption and global warming.

Accountable Governance of Cities’ GHG Emissions

Cathrin Zengerling, HafenCity University Hamburg, DE

Urban infrastructures and lifestyles are responsible for significant shares of global greenhouse gas emissions. With a growing urban population these shares will even rise. The crucial role of cities in combating climate change is increasingly recognized by states and fully embraced in key documents of the global governance agenda such as the 2030 Agenda for Sustainable Development and the Habitat III New Urban Agenda. In addition to these international political mandates adopted by states and the respective national urban policies, cities themselves are increasingly engaging in international networks and developing voluntary pledges to reduce greenhouse gas emissions. However, despite this international political activity, empirical research has shown that even those cities, which have adopted GHG emission reduction targets, did not put in place a strategic governance mechanism to ensure that the targets are met.

The presentation addresses this gap and builds on interim results of my interdisciplinary post doc research. Bridging disciplines of legal sciences and urban
studies I aim to provide a concise comparison of current strategic urban governance of climate change mitigation action in Hamburg, New York and São Paulo. An essential component of successful strategic governance is accountability - in both senses of the term. On the one hand, it addresses the political and legal responsibility of cities to make GHG emissions a central part of their political agenda. On the other hand, it refers to the ability to measure and thus, account for, urban GHG emissions. Both forms of accountability are inherently interconnected. Accountable governance of urban GHG emissions presupposes the ability to measure urban GHG emissions and trace changes. The presentation will compare and discuss the municipal scope of action under German, U.S. and Brazilian jurisdictions, multi-level mechanisms and institutions of urban climate action planning, and methodologies applied to measure and monitor urban GHG emissions.

Session 12: Adaptation Planning & Success Factors  
(WED, Sept 20th, 16:30-18:00 in A56 - BM)

Assessing and comparing the adaptation measures performance

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Ambika Markanday, Basque Center for Climate Change, ESP  
Jeremy Carter, Angela Connelly, University of Manchester  
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Cities are facing many climate change impacts (e.g. heat effects on the population, flood impacts on the build environment, etc.), and, consequently, the field of adaptation is becoming more and more important. Cities need to transition to a more resilient future and increase their capacity to respond to these future impacts. Many tools that help the cities in this process already exist, such as the Urban Adaptation Support Tool which assists signatories of Mayors Adapt and the integrated Covenant of Mayors for Climate and Energy initiative in planning for adaptation. However, appropriate adaptation measures need to be identified and choosing the options may be a difficult task as adaptation measures are often not
comparable: some options aim to strengthen social and institutional resilience (e.g. increase awareness.) whilst others aim to reduce the hazard (e.g. technical solutions). Therefore, cities need a tool to select the required adaptation measure for each contextual situation. Many inventories for consultation are available (e.g. Climate-ADAPT, ClimWatAdapt Inventory of Measures, ADAM Digital Adaptation Compendium, Global and local Adaptation Support Action, etc.). However, the information in these tools does not provide the necessary detail to enable the cities to know how much adaptation measures reduce the impact, they do not provide the quantitative performance of the measure (e.g. effectiveness, cost-efficiency), and the adaptation measures are not comparable. This session, therefore, aims to cover the quantitative evaluation of the adaptation measures performance and the need for having comparable and harmonized information (performance variable, units and evaluation process will be the main elements covered). The key issues that condition the performance and some guidance to obtain harmonized values will be presented in the session.

Smart Sustainable District Berlin-Moabit - Success criteria for the implementation of climate adaptation projects

Georg Hubmann, TU Berlin, CHORA Conscious City
Nadine Kuhla von Bergmann, TU Berlin, CHORA Conscious City and Creative Climate Cities, Potsdam, DE

Developing innovative planning tools to bring climate adaptation measures into action is the aim of the project Smart Sustainable Districts. The article outlines the process, barriers, and the approach taken for Berlin-Moabit, a typical European inner-city district with existing mixed-use built environment. The long-established urban fabric in Moabit implies a heterogenic ownership structure, diverse stakeholder networks and a low to medium income distribution.
Taking the existing local urban development plan called 'StEK Green Moabit' as a starting point, opportunities were scoped together with relevant stakeholders and integrated project ideas were developed. Based on the commitment of key local partners, two demonstrator projects were initiated. This process was accompanied by enabling tools such as the setup of a Smart Citizen Network Board to be able to steer decisions more effectively, a District Data Atlas that allows more centralised data access, and a crowd mapping platform to identify traffic problems.
The first demonstrator is lifting up the ambitions of a street refurbishment by implementing sustainable components such as tree drains that increase evaporation by 30% and reduce irrigation by 70%, thus contributing to a reduction of the local heat island effect; or a technically advanced street light system that saves up to 95% of CO2 emissions. The second demonstrator is targeting the accessibility of the industrial area in the district by introducing an autonomous E-bus shuttle. Simulations projected a better accessibility off peak times and a 45% reduction of NOx emissions as well as 10% less CO2 emissions on local routes.

The article illustrates the challenges of the process towards climate-related solutions for Berlin-Moabit. Furthermore, a systematic evaluation of the success criteria for the two demonstrator projects was carried out that identified 'local leadership' and 'sharing the same vision' as the two main drivers for climate-related implementation projects.

Networks as adaptation tools for cities: the UCCRN and its European hub, in the light of RAMSES's results.

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Chantal Pacteau, UCCRN European Hub, Institute or Ecology en Environmental Sciences – Paris and Centre national de la Recherche Scientifique, FR
Dina Salakhova, Université de Versailles Saint-Quentin-en-Yvelines, CEARC Research Center, FR

The global Urban Climate Change Research Network (UCCRN), based at Columbia University's Earth Institute, brings together figures from the world of the environmental and human and social sciences and the various realms of society. Its goal is to institutionalise an ongoing process of updating what we know about climate change in relation to urban issues and towns and cities' experience with adaptation and mitigation.

By building on its potential and skills, this global network has decided to switch from focussing on the drawing up of global reports/assessments to initiatives relating to the ongoing monitoring and assessment of knowledge on urban "climate" questions and the solutions employed. With this in mind, proactive regional platforms have been set up, each with its own director, programme coordinators and scientists, one of whose major tasks is to strengthen
collaborative scientific projects. Using RAMSES policy tools approach, we frame
the setting up of UCCRN's European hub as an adaptation tool geared at cities.
The ambition of the European network is to establish long-term consortiums
combining academics, elected representatives, NGOs, economic decision-makers,
etc. in European towns and cities in order to -for example- develop and
disseminate nature-based solutions with the aim of enabling the towns and cities to
adapt to climate change and also for the purposes of their environmental transition.
The central question we will address are the following: may we, and under what
condition can we consider such a network as a policy tool, and, may we, and under
what condition use the policy tools assessment framework developed in the course
of the RAMSES project to such a network.

Multi-level Climate Change Planning: Scale, capacity, and the ability
for local action

Neha Sami. The Indian Institute for Human Settlements, IND

Although climate change continues to be imagined as a global problem requiring
solutions at international and national scales, there has been a growing
involvement of municipal governments and other actors at the local (city) scale in
dealing with challenges posed by a changing climate (Bulkeley, 2010). As urban
regions across the world emerge as critical actors in the struggle to deal with
climate change (Revi et al., 2014 ; Stone Jr., 2012; Bulkeley, 2010; The
International Bank for Reconstruction and Development/The World Bank, 2010),
India's urban transition presents both an opportunity and a challenge to achieve
equitable and inclusive development (Anand et al., 2014). Climate change in
particular is emerging rapidly as a critical economic and political concern that may
impact India's economic growth rate and affect the livelihoods of vulnerable urban
populations (Revi, 2008).

Given this, the near absence of urban governments in India's domestic climate
policy as well as institutional framework is a serious concern. Focusing on two
states in India: Karnataka and Tamil Nadu, and the primary urban regions in these
states: Bangalore, and Chennai, this paper examines if and how environmental
governance processes are being implemented at the local (city) level, investigate
the outcomes where this has been implemented and analyse the implications of
doing so. Drawing on interviews with local government officials, academics,
Session 13: Climate Impact Assessment for Cities (WED, Sept 20th, 11:30-13:00 in A56 – 0.38)

Future changes in heat-waves, droughts and floods in 571 European cities

Selma B. Guerreiro, Richard Dawson, Chris Kilsby, Elizabeth Lewis, Alistair Ford, Newcastle University

Future changes in heat-waves, droughts and floods were assessed for 571 European cities. We used all available climate model runs from the Coupled Model Intercomparison Project Phase 5 - CMIP5 - for their higher emission scenario (RCP8.5) and grouped the projections into Low, Mid and High impact scenarios. This resulted in impact projections outside the range of published literature, but enabled us to better understand uncertainties in future climate projections (due to climate model errors but also the effects of natural variability) therefore providing the basis for broad scale risk analysis and thereafter identification of robust adaptation strategies.

While heat-waves will worsen for every European city, changes in droughts and floods are spatially variable and climate model dependent. The largest increases in the number of heat-wave days are shown to be in southern Europe, but higher heat-wave maximum temperature increases are expected in the mid-latitudes. In the low impact scenario, drought conditions are expected to intensify only in southern Europe while river flooding is expected to worsen in the north. However, in the high impact scenario most European cities show increases in both drought conditions and river flooding.

There is a very wide range of projections for future changes in Europe with disagreement between different studies, partly due to their methodological
differences but potentially also due to the small number of climate model runs that limits the uncertainties due to natural variability and model errors that each study captures.

Climate proofing European cities: the EU LIFE UrbanProof project

Christos Giannakopoulos, Konstantinos V. Varotsos, Anna Karali, Dimitra Founda
Vasilis Tenentes, Giannis Lemesios, National Observatory of Athens, GR

The impacts of climate change are heavily felt in cities, where critical infrastructure, networks and the majority of population are found. UrbanProof (entitled "Climate Proofing Urban Municipalities") is an EU LIFE funded project aiming to increase the resilience of municipalities to climate change equipping them with a powerful tool for on climate change adaptation. The project will provide a holistic and automated approach to assess climate change related vulnerabilities and risks and to develop appropriate adaptation strategies. The ongoing project is implemented in four municipalities: Strovolos and Lakatamia (Cyprus), Peristeri (Greece) and Reggio Emilia (Italy). These municipalities were selected based on their different characteristics and climate change vulnerabilities, which are at the same time typical for the Mediterranean, and south continental Europe.

During the first project steps, climate change related impacts including heatwaves, flood and drought events, peri-urban fires, air quality and ozone exceedances were investigated using long-term observational data from stations located in the partner municipalities. In addition, composite indexes regarding energy consumption and population discomfort were calculated. The analysis revealed that during the past 30 years the partner municipalities have faced statistically significant increasing trends in heat-wave events, ozone pollution episodes, summer time human discomfort and energy consumption. This is of particular interest since future climate change is expected to affect negatively these trends already recorded. Not only the frequency and strength but also the timing of extremes, as for instance occurrence of 'early' or 'late' heat waves and subsequently the length of 'extremes season' is of particular importance. Knowledge of expected 'extremes season' will enable better preparedness and scheduling of measures against thermal risks, as well as expected energy demands.
An Assessment of Climate Change in Cities in The Context of Resilience: The Case of Konya

Sevde Derman, Necmettin Erbakan University, Urban and Regional Planning, TR
Ülkü Yüksel, Gazi University, Architecture, TR

Resilience has critical importance for improving the ability to cope with the risks resulting from climatic changes in cities and to minimize threats. Uncertainties, particularly in the process of climate change and the varieties and differences in urban living spaces, require decision makers (policy makers) to evaluate resilience in the urban context.

Resilience is a complex concept that is difficult to assess in a quantitative manner. In recent years, several methods have been developed to assess the concept of resilience. In this study, the resilience assessment studies for climate change at the urban scale will be examined, and then the studies conducted at the neighborhood scale will be examined in a conceptual manner and in terms of their methods. In accordance with the studies examined and considering the accessible data/databases at the neighborhood scale in Turkey, the indicators of resilience will be determined. Resilience assessments at the neighborhood scale will be conducted in Konya, which was selected as the study area, using the specified indicators. It is believed that the results of this study will contribute to the planning of measures at the neighborhood scale to reduce the risks resulting from climate change in Konya and help enhance resilience in all parts of the city in an operational manner by moving from part to the whole.

Adaptation in urban transport systems to extreme pluvial flooding

Maria Pregnolato, Alistair Ford, Vassilis Glenis, Richard Dawson, Newcastle University, UK

Rainfall and storms can be extreme events causing significant disruptions to transport networks. Climate change is projected to increase the magnitude and impact of such hazards, causing up to £27bl of direct and indirect damages in the UK. Despite the severity of the phenomenon has been widely acknowledged, current methods of disruption appraisal are currently unsatisfying and preventing from the implementation of adaptation measures.
This paper presents an integrated framework that couples simulations of flooding and transport networks, integrating hazard, vulnerability, and consequences. This framework quantifies the flooding risks from extreme rainfall, measured in terms of expected travel time across the road network for a range of current and future flooding scenarios. It calculates the impacts of disruption and the effectiveness of potential interventions of urban adaptation (e.g. drainage improvement) after identifying the most vulnerable locations in a city.

The benefits of the adaptation options are measured over 50 years. Using the Green Book method of Net Present Value (NPV) to compute the long-term costs and benefits, discounted to present day rates to account for inflation. The NPV of the benefits in terms of risk reduction, NPVr, is calculated by summing over the disruption cost and the likelihood of a range of flood events.

The framework is demonstrated on Newcastle-upon-Tyne (UK) and shows that adaptation decreases delays to travelers under all scenarios, which include current and "uplifted" climatic conditions (to simulate climate change). For example, the improvement of the drainage system capacity across the network can reduce the impact by up to 50% for 1-in-10-year event (low intensity, high probability event).

Results are compared by computing the NPVr for the different considered strategies, developing a tool to support decision-makers in prioritizing investment to maximize returns and to adapt urban infrastructure by making improved business cases.

Socioeconomic Resilience: Multi-Hazard Estimates in 117 Countries

Mook Bangalore, Stephane Hallegatte, Adrien Vogt-Schilb, Grantham Research Institute and Dept. of Geography and Environment, London School of Economics, UK

This paper presents a model to assess the socioeconomic resilience to natural disasters of an economy, defined as its capacity to mitigate the impact of disaster-related asset losses on welfare. The paper proposes a tool to help decision-makers identify the most promising policy options to reduce welfare losses from natural disasters. Applied to riverine and storm surge floods, earthquakes, windstorms, and tsunamis in 117 countries, the model provides estimates of country-level socioeconomic resilience. Because hazards disproportionately affect poor people, each $1 of global natural disaster-related asset loss is equivalent to a $1.6 reduction in the affected country's national income, on average. The model also assesses policy levers to reduce welfare losses in each country. It shows that
considering asset losses is insufficient to assess disaster risk management policies. The same reduction in asset losses results in different welfare gains depending on who (especially poor or nonpoor households) benefits. And some policies, such as adaptive social protection, do not reduce asset losses, but still reduce welfare losses. Post-disaster transfers bring an estimated benefit of at least $1.30 per dollar disbursed in the 117 countries studied, and their efficiency is not very sensitive to targeting errors.

Session 14: Organising and Innovating Cities (WED, Sept 20th, 14:00-15:30 in A56 – 0.38)

Spatial optimisation of future urban development to meet adaptation, mitigation and sustainability objectives

Richard J. Dawson, Stuart Barr, Daniel Caparros-Midwood, Newcastle University, UK

Future urban development needs to adapt to a number of climate risks, mitigate to reduce greenhouse gas emissions, plan for changing demographics, and tackle other sustainable development objectives. Planners therefore face a challenge of multidimensional, spatial optimization in order to balance potential tradeoffs and maximize synergies between climate adaptation, mitigation and other objectives. To address this, we have developed a spatial optimization framework which uses a spatially implemented genetic algorithm to generate a set of Pareto-optimal results that provide planners with the best set of trade-off spatial plans. The framework is applied to Greater London (U.K.) and the optimisation demonstrated for six objectives: (i) minimize heat risks, (ii) minimize flooding risks, (iii) minimize transport travel costs to minimize associated emissions, (iv) maximize brownfield development, (v) minimize urban sprawl, and (vi) prevent development of greenspace.

Results show that spatial development strategies can be identified that are optimal for specific objectives and differ significantly from the existing development strategies. The analysis reveals tradeoffs between different climate risks: for example, increases in heat or flood risk can be avoided, but there are no strategies that do not increase at least one of these. Furthermore, tradeoffs between climate risk and mitigation objectives can be more severe: for example, minimizing heat risk is only possible if future development is allowed to sprawl significantly.
The results highlight the importance of spatial structure in mediating climate adaptation, mitigation, and other sustainability objectives. However, not all planning objectives are suited to quantified optimization and so the results should form part of an evidence base to improve the delivery of risk and sustainability management in future urban development.

Outdoor Thermal Comfort in 3D: From Modeling Practice to Urban Design Application

Negin Nazarian, Singapore-MIT Alliance for Research and Technology, Center for Environmental Sensing and Modeling and Massachusetts Institute of Technology, Department of Architecture, SGP, USA
Leslie Norford, Massachusetts Institute of Technology, Department of Architecture, USA

In the face of climate change and increased urban temperature, adverse thermal comfort is challenging the livability of several cities and threatening the health of vulnerable urban dwellers. Therefore, it is crucial that urban climate, and specifically outdoor thermal comfort (OTC), is taken into consideration in urban design. Achieving this goal and enabling a climate-conscious design requires a comprehensive and accurate evaluation of OTC that intersects the fields of climatology, architecture, and urban planning. We introduce a numerical model of Outdoor Thermal Comfort in 3-D (OTC3D) and demonstrate an example of thermal comfort analysis in a realistic urban configuration. This model can be used for a) conducting parametric studies on the effects of design factors (such as urban density and surface material properties) on thermal comfort, and b) evaluating various design scenarios for building complexes and outdoor spaces. The talk will discuss the strength of OTC3D as a comprehensive tool with a modular approach, and further address the limitations in detailed consideration of vegetation and water body.

Although the spatial variation of thermal comfort is very important in the design analysis in urban areas, in order to obtain meaningful results from these 3D maps, the temporal variation of OTC during the year should also be considered. Accordingly, this study discusses the methods to optimize the number of geometrical or hourly calculations throughout the year in order to achieve a computationally efficient analysis. Additionally, a concept of Outdoor Thermal Comfort Autonomy will be introduced, such that the spatial maps of OTCA represent the percentage of time during a year that each location exhibits a
thermally comfortable environment. In doing so, OTCA identifies the areas that require additional design elements, such as fans and shade cover, as well as those that are appropriate for outdoor facilities, such as patios and seating areas.

Energy efficiency through IoT based smart heating control and load shifting of district heat in the city of Järvenpää

Vesa Jaakkola, City of Järvenpää, Finland

City of Järvenpää is located 37 km north of Helsinki. With its current population of 41 039 it ranks the 26th largest city in Finland. During the years 2014-2017 smart heating and load shifting of district heating has been piloted in Järvenpää’s property portfolio in cooperation with energy company Fortum and high technology startup company Leanheat. The project was carried out in 20 residential sites (1-3 buildings each, total of 600 apartments), Järvenpää City Hall, Järvenpää Highschool and technical center. Each building space or apartment were equipped with temperature and humidity sensors and an artificial intelligence based control method was developed to control the heating systems of the buildings. Different control methods such as dynamic price signals (offered by Fortum) were piloted to find out suitable ways of achieving energy savings and reducing greenhouse gas emissions without compromising comfort of residents. Results show that firstly, on average around 10% heating energy savings and greenhouse gas reductions can be achieved when buildings are heated with an artificial intelligence based control method. Secondly, on average 20% reduction in building peak power requirement can be achieved if around +/- 0,5 Celsius variation in indoor temperatures is allowed as needed, meaning that district heating companies need to use 20% less peak power capacity (typically fossil fuels such as oil and gas; load shifting in 1250 apartments equals on average 1 MW of peak power capacity). Thirdly, preliminary results show that if implemented widely, load shifting capacity could replace current backup power plant (currently used just few times in 10 years), which is located at a prime location that would be suitable for building new apartment buildings to support Järvenpää’s growth.
The role of tree evapotranspiration in Singapore's urban climate

Xian-Xiang Li, Xuan Liu, Erik Velasco, Singapore-MIT Alliance for Research and Technology, SGP
Matthias Roth, Suraj Harshan, National University of Singapore, SGP

As a 'city in the garden', Singapore has a very high green cover ratio. Many of the urban greenery are trees, which have brought many environmental benefits to urban residents. It is well known that in urban climate models, accurate representing urban vegetation is vital for the correct simulation of the surface energy balance. This research will focus on the evapotranspiration effect of urban trees in Singapore's urban climate. A single layer urban canopy model (SLUCM) with enhanced hydrologic processes was used for an offline evaluation during a 11-month period. The forcing data measured at a low-rise residential site in Singapore was used as input data. Results showed that, after introducing the tree evapotranspiration, the simulated latent heat flux was considerably improved compared with the observed data. The systematic error of the model was also greatly reduced. The roles that tree evapotranspiration played in the urban surface energy balance were also demonstrated during an unusual dry spell in Singapore using Weather Research and Forecasting (WRF) model. This study demonstrated that at sites with large tree coverage in a humid climate, the contributions of tree evapotranspiration to the latent heat flux are very important, ignoring which may cause serious underestimation of the latent heat flux and humidity. However, the WRF simulated results show that, with the improved latent heat flux, the air temperature and humidity do not show statistically significant change. This may be due to the hot and humid climate characteristics in Singapore, which is relatively insensitive to the change in latent heat flux.

Establishment of a new network for temperature and humidity measurement in Berlin

Ralf Steikert, Sahar Soudoud, Ines Langer, Free University, Berlin, Germany

Temperature and humidity are highly heterogeneous in time and space due to meteorological conditions and urban characteristics. Building structure, urban geometry, soil sealing, and less vegetation in urban area creates its own temperature/humidity field which plays an important role in urban planning and
climate change adaptation strategies. In the framework of the BMBF project Urban Climate Under Change (UC2) we are aiming to establish a new urban network for temperature and humidity which will be used to evaluate high resolved urban models (e.g. PALM-4U).

Therefore monitoring network must cover the different air temperature characteristics in urban area and appropriately monitor the places with extreme air temperature.

The empirical and physical studies has demonstrated that surface temperature is the most important predictor for air temperature estimation. Surface temperature data is utilized as representative predictor for implementation of a site selection algorithm for installing air temperature stations. It was decided to use ASTER (Advanced Spaceborne Thermal Emission Radiometer) data for preparation of necessary LST data. The LST dataset has been computed from all clear-sky pixels of ASTER scenes acquired from 2000-2008, as the landuse of Berlin had no significant changes during this period. This product presents maps of mean LST and standard deviation (SD) of LST for Berlin.

The mean LST map was classified into 35 different classes using natural breaks technique. Then similary, the SD map of the LST was classified to three classes. Applying this classification and merging it with the classes of existing stations (20), 15 new stations have been installed in Berlin. Statistical analysis will show, if LST is the appropriate predictor or local climate zones should be used.

A comparison will be shown and strength and weakness of each method will be discussed.
Session 15: Climate Change, Societal & Political Actors  
(WED, Sept 20th, 16:30-18:00 in A56 – 0.38)

A concept to support students' evaluation and action competencies concerning climate change effects on ecology in cities and the sustainability of adaption strategies

Lena Neumann, Alexander Siegmund, Heidelberg University of Education, Department of Geography - Research Group for Earth Observation and Heidelberg University, Heidelberg Center for Environment & Institute of Geography

Climate change is currently one of the biggest social, ecological, and economic challenges. Cities, where according to the World Bank 54% of the worlds and even 76% of the European population lived in 2015, are particularly affected by climate extremes because of their heat island effect and their high population density. Among other phenomena like heat-related health problems and unusual flooding events, climate change leads to a shifting of urban biodiversity and ecology. Because climate change is unavoidable and its consequences already take place in the present, besides climate change prevention research investigations on adaption strategies for cities become increasingly important.

Concerning the social acceptance and implementation of adaption strategies, a raising awareness on the effects of climate change among the population is necessary – especially among young people as actors and decision makers of the future. In this context climate change education becomes relevant. The project „Klimawandel findet Stadt“ (“Climate changeS Cities”), carried out in cooperation with the universities of Bochum and Trier, supports the development of students' evaluation and action competencies with regard to climate change consequences and sustainable adaption strategies. The project part developed at the Heidelberg University of Education at the Department of Geography – Research Group for Earth Observation (rgeo) focuses on the design of learning modules with emphasis on urban ecology and biodiversity. The learning modules deal with three different topics: Ruderal vegetation, the change of the phenological stages and roadside greenery under climate change. According to the Federal Agency for Nature Conservation (BfN) 2006, a decrease of 5-30% of all plant and animal species is expected for Germany during the 21st century, if the temperature rises a further
2°C. Ruderal vegetation has the potential to conserve biodiversity in cities and plays moreover an important role for air circulation. The shifting of the phenological stages due to higher temperatures can cause problems, if late frosts occur and plant shoots die. Furthermore long droughts in summer lead to the drying of traditional plantings, if they are not intensively watered. As urban greenery is of high importance for the cities’ microclimate by providing shade and reducing the air temperature through transpiration, the development of sustainable and flexible planting concepts for cities is necessary.

Generating adaption strategies is part of the learning modules which are action-orientated and consist of a triad of observation sphere, laboratory sphere and action sphere. The observation of selected green spaces in the city serves the student’s knowledge acquisition, combining traditional geographic methods like mapping, measuring or counting with up-to-date-methods like plant identification with a mobile phone application or GPS orientation. In the laboratory students apply multiple scientific methods to explore a variety of adaption strategies of plants from different exposed locations and evaluate the results of their investigations. Additionally scientific planting trials are carried out in the laboratory and in the field to test plant growth under varying climate scenarios in urban environments. In a final step the students implement sustainable urban green space planning in a city’s territory self-reliant or communicate their acquired knowledge in a workshop.

**Civic Change Agents as Drivers for a Low-Carbon Transition in Cape Town**

Nadine Kuhla von Bergmann, Creative Climate Cities, Potsdam, DE

This presentation argues developed by municipalities in collaboration with experts from the fields of climate science, energy, economics, technology and urban planning. Besides ambitious goals, African cities are struggling with economical and human resources to implement sustainable measures in accordance to the global SDGs due to the lack of municipal assets such as administrative power, financial resources and urban development tools. Meanwhile, the same cities act as the breeding grounds for innovative bottom-up solutions and creative start-ups that are transforming urban environments and shaping urban systems on the base of limited resources and finances.
In this presentation, creative actors and innovative Urban Change Agents (UCAs) are acknowledged as potential drivers for a low-carbon transition at city level. The research outcomes presented derive from recent field research in Cape Town, South Africa and give an insight about motivation, barriers and opportunities of grassroots, start-ups and creative actors who are active in transformative fields. The presentation argues the following questions: How can African cities benefit from such initiatives and actors in their pathways to low carbon urban futures? How can creative small businesses be more integrated into top-down climate change planning instruments? What would support the up-scaling and multiplication of innovative and non-established operational models of self-driven climate-friendly initiatives? How could the impacts be measured?

Defining involved stakeholders on the process of developing climate change awareness

P. Maraña, M. Iturriza, Tecnun Universidad de Navarra, ESP

Nowadays, global climate change has been identified as complex emerging challenge difficult to address. Certainly, climate change is not a palpable and easily quantifiable phenomenon and therefore discordant perceptions and opinions can be found among different groups in society. In fact, not even the scientific community working on topics related to this challenge has reached a consensus regarding the nature and origins of climate change (Seacrest and Kuzelka). Some stakeholders reject the existence of this phenomenon arguing for instance that, climate change has been created by high level politicians and big multinational industries to create a new market niches in order to make profit out of them or that the climate follows cyclical tendencies and therefore that it is natural to be suffering certain changes in the climate (Pidgeon). However, others defend that the increase on the frequency and scope of natural disasters such as floods, heat waves, periods of drought or sea level increase are strong signs that show that the impact of human performance in climate change (Etkin and Ho). Actually, climate change is a complex issue per se. Its wide scope highlights the need to embrace a wide range of different stakeholder groups to be able to address it. However, the lack of alignment in their perspectives makes it difficult to produce a meaningful contribution.

In this context, the proactive role of governments seems to be a key element as they are the ones in charge of investing resources in order to develop climate
change adaptation plans to increase resilience (Reed et al.). Therefore, the awareness and commitment level of local governments is essential to promote climate change adaptation plans but not enough.

Apart from local governments other stakeholder groups need to be aware that climate change is a first row problem (Seppänen et al.) and committed with finding a solution to it. In fact, in order to face the complex phenomenon of climate change, the contribution of different stakeholder groups is needed.

Taking into account that in some cases there is a little consensus whether climate change is a scientifically proven phenomenon among the stakeholders, this paper aims to identify the relevant stakeholder groups that need to be aware and committed with this issue in order to be able to develop and implement climate change adaption plans that contribute to increasing resilience in the most effective manner.

Moreover, the role of each stakeholder in the development of climate change adaption plans will be described and illustrated using real cases as evidences. Apart from that, the paper also presents a brief discussion about the existence of barriers that may hamper increasing the awareness and commitment level of this stakeholders.

Population-driven urbanisation in Europe: diverging trends

Emma Terävä, Finnish Environment Institute, FIN
Mark Rousevell, Karlsruhe Institute of Technology and University of Edinburgh, UK, DE
Timothy Carter, Finnish Environment Institute, FIN

Artificial surfaces cover approximately 4% of European land surfaces. Despite their restricted extent, they are home to nearly three quarters of the European (EU-28) population (Eurostat, 2015), account for ~80% of European energy use (EC, 2016) and emit ~69% of Europe’s CO2 (EEA, 2015). Indirectly, urban areas, and their wider footprint, influence society’s capacity for food production and the long-term resilience with respect to biodiversity and ecosystem service provision.

Urban areas are dynamic and constantly evolving to meet the needs and demands of society. Key factors driving the form of future urban areas include; (i) a changing population and demographic structure, (ii) changing cultural/societal values and living standards, (iii) environmental and social policy, and (iv) regulatory frameworks. Drivers of change do not act in isolation; urban policies may, for
example, improve living standards which in turn influence societal behaviour/preferences.

In this paper we present how (i) population structure and dynamics, and (ii) changing values and preferences drive urban land use up to 2100. We will present methods and outcomes of integrating population projections across spatial scales with a regional urban growth model. By linking shared socioeconomic pathway (SSP)-specific national population projections to present-day population distributions at sub-national scale, we deploy a downscaling approach that provides input into a regional urban growth (RUG) model that in turn distributes the population on a 10' latitude-longitude grid across Europe.

We investigate the combination of population structure and residential living preferences on sub-national scale urban land use trends. RUG model runs which include/exclude preferences and population density parameters allow the influence of societal change (i.e. residential preferences and spatial planning regulations) on residential extent to be explored. We witness the effects that (i) baseline (2010) year differences in demographics (age structure) have on future regional change, (ii) SSP-specific demographic assumptions on fertility and (iii) scenario specific societal preferences have on intra-European development, causing a clear difference in sub-national, regional patterns.

The results provide a discussion point on the importance of population structure as well as development of living preferences in driving future artificial surface demand (urbanisation) in the already highly urbanised parts of Europe. The presentation will demonstrate that including population structure gives rise to total population change that is regionally variable. Population structure at the baseline is shown to have a significant influence on the regional variability of population dynamics over time: for example, in Germany age-groups are relatively evenly distributed at a regional scale, and hence variability in total population change is small, whereas in Spain greater regional variability, due to the uneven distribution of age-groups, is observed. At the same time, fertility assumptions in certain eastern European countries cause their national and subnational trends to deviate strongly from the rest of Europe despite similarities in other factors. This regional scale variability can be demonstrated to have substantive effects upon urbanisation trends across Europe. These trends drive regions within Europe in distinctly different directions, not least with the added complexity of the SSP-framework. Understanding the effects that current age structure has on future development helps plan for not only urban growth/decline but also against increased vulnerability under different climate futures, and a changing demand for functions and services across sectors.
Governance and Resilience: The Role of Political Institutions

Arabella Fraser, Amy Kirbyshire, Overseas Development Institute, UK

A variety of new ideas have emerged from different literatures and fields about how best to build climate and disaster resilience - that is, how best to manage complex, inter-related, uncertain shocks and stresses. Such ideas range from practically-applied to theory-based, including decentralised governance, many forms of multi-stakeholder governance, and adaptive governance. However, they often describe ‘idealised’ governance forms, and there is a mismatch with the reality faced in many countries and contexts. We therefore review what is known about the influence of broader political institutions on resilience governance, drawing on illustrative examples. We examine three elements of the political landscape - formal institutions, informal institutions and informal political actors - which influence the feasibility of the governance approaches that are considered necessary for building resilience, before discussing what this means for action on resilience. Finally, we suggest a set of principles for policy and programming.

Panel Session 3
(THU, Sept 21st, 9:30-11:00 in H - GF)

Deep-decarbonization in 1.5 degree world: Why cities are crucial?

Shobhakar Dhakal, Asian Institute of Technology, School of Environment, Dept. Resources and Development, Bangkok, THL

From Climate Risk to Food-Energy-Water Security in the City

Patricia Romero Lankao, Urban Futures, CSAP-RAL, National Center for Atmospheric Research (NCAR), Boulder, USA
Session 16: Understanding cities as systems  
(THU, Sept 21st, 11:30-13:00 in H – GF)

Resource Urbanisms: How land availability or scarcity shapes sustainable urban form?

Muhammad Adeel, LSE Cities - London School of Economics

Geography is destiny: the idea elaborates the role of geographical environment in determining the course of life for cities. Among all geographical characteristics, Land availability is probably the most important factor deciding the way cities are built and function. This paper highlights the role of land availability in shaping the divergent patterns of urbanisation and urban morphology in the cities of Kuwait and Abu Dhabi (a land abundance environment) and the East Asia cities of Hong Kong and Singapore (a land constraint environment). Using the historical paper maps, aerial photographs and LandSat satellite images over the last ninety years, the study measures and compares the evolution of urban growth and morphology in the four case study cities. It finds that, from sustainability perspective, the ample availability of land in the gulf case studies has led to an urban form which consumes more land and energy resources per capita in the long run. Majority of residential area in these cities comprises of low density large villa houses. On the other hand, a land scarce setting has resulted in more efficient use of land resources and more compact urbanisation in the East Asian cities. In these cities, high density apartment blocks house majority of population and the share of green areas is much greater. Thus, it concludes that while the abundance of land resources have had a negative effect, the scarcity of resources may become a positive precondition for more sustainable urbanisation.
Hungry cities in a changing climate, the quest for a sustainable food supply

Steffen Kriewald, Prajat Pradhan, Luis Costa, Diego Rybski, Juergen P. Kropp, Potsdam Institute for Climate Impact Research, Potsdam, DE

The rise in worldwide demand for food to nourish an increasing urban population, along with the necessity of drastically reducing the cross-scale environmental impact induced by urban population life-styles, is amongst the greatest present challenges faced by humanity.

The unprecedented urban dynamics has led to the fact that today, cities have many positive aspects in human development, but are also major emitters of greenhouse gases. Thus, cities are in the focus of policy makers, urban planners, and environmental researchers due to a multitude of aspects, namely how it is feasible to make cities sustainable and how they can contribute to the solution of the climate problem. We developed an advanced model which enables to assess the environmental gross effects of urban food production in a twofold way. First, it is examined how much local food production may nourish urban dwellers today and under different future scenarios. Second, how much carbon emissions can be saved in the food transport sector by optimizing urban food systems.

For a sample of over 500 European urban agglomerations we investigated the possibility of regional food production to shorten supply chains, increase local food security and reduce ecological footprint. Additionally we examined the main influencing factors which lead to a sustainable food supply, such as population growth, urban sprawl, and diets - both in terms of quantity and composition, food waste, as well as climate change.

Green Urbanization

Christoph Hedrich, Universitat Pompeu Fabra, ESP
Jan Eekhout, University College London and Universitat Pompeu Fabra, ESP

Large cities are more productive and generate more output per person. Using new data on energy demand and waste supply, we show that they are also more energy efficient at it. Large cities are therefore greener than small towns. The share of energy demanded and waste generated is decreasing in total output
produced. The energy demand elasticity with respect to city output, is 86%: as total output of a city increases by one unit, energy demand increases less than one unit with an Urban Energy Premium of 14%. The contribution to this energy premium decomposes into energy demand from household (10%), transport (18%) and industry (12%). Similarly, we find that the supply elasticity of waste is 88%. Per unit increase in total city output, there is a less than unit increase in waste supply, with an Urban Waste Premium of 12%. The dominant force behind these Urban Green Premiums is the behavioral response of citizens who share space with large populations. Due to the limited supply of space, the demand for housing and land is lower in response to higher housing prices. Smaller housing leads to less energy consumption and lower waste generation, and dense populations use energy efficient transportation. Because large cities are energy efficient ways of generating output, energy efficiency can be improved by encouraging urbanization and thus green living. A policy that makes income taxes contingent on city size will attract more people to big cities. We find that this pro-urbanization policy unambiguously generates economic growth and lowers pollution.

Urban transitions and diets – lessons from India

Christopher Bren d'Amour, Mercator Research Institute on Global Commons and Climate Change and Technical University Berlin, DE
Bhartendu Pandey, Meredith Reba, Yale University, USA
Felix Creutzig, Mercator Research Institute on Global Commons and Climate Change and Technical University Berlin, DE
Karen Seto, Yale University, USA

Today, the main food security debate revolves around sustainably feeding 9 billion people in 2050. Approximately 6.3 billion of these people will be living in urban areas, yet the implications are not well understood. Compared to their rural counterparts, urbanites consume more diversified and resource-intensive diets, including higher value food items such as meat and dairy products, with potentially wide-ranging implications. While a large body of descriptive literature comparing urban and rural diets exists, there is no clear understanding why urban dwellers consume differently. Most studies attribute the differences to rising incomes. However, urban areas can influence diets in multiple ways depending upon the level and type of urbanization and economic activity, for example via better accessibility and higher availability of different food types, restaurants, and supermarkets. Essentially, urbanization is a dynamic process, and depending on
where countries rank on this spectrum of urbanization, urban effects are likely to vary.

In this study, we explore the empirical relationships between urbanization and food consumption in India, using household survey data. We find no clear urban effect for most food items. However, we observe an urban effect for processed foods and food away from home consumption. The effect is strongest in the higher income quartiles, especially among younger households. In metropolitan areas, these households consumed a fourth of their meals away from home. We also observe a significant variation between different urban areas: urban effects are more pronounced in India’s metropolitan cities compared to non-metropolitan urban areas.

Our findings underline the importance of accounting for increasing consumption of food away from home when monitoring the nutritional status/health of populations. Furthermore, as the observed effects vary across different urban contexts; our results highlight the need for a more detailed understanding of urbanization as a process with different levels of complexity.

Resource Urbanisms: environmental lessons learned from contrasting Asian cities

Alexandra Gomes, LSE Cities, UK

As cities around the world are at the epicentre of a global shift of population, questions on how to make cities more efficient and sustainable have increasingly become a central policy consideration. Consequently the analysis of how the physical shape of the cities and infrastructure impact on resource efficiency and the environment is critical.

The point of departure for this research is the common assumption that cities and urban development are directly affected by the availability and costs of natural resources, and that in turn, these different urbanisms result in substantial differences in resource use and consequent impact on the environment.

To investigate the role of ‘resource urbanisms’ this presentation will primarily focus on the specific case of land and energy, and explore how they’re reflected in the city form and consequent mobility.

A variety of methodologies including remote sensing and GIS spatial analysis will be use to understand this relationship through a comparative case study approach
considering extreme and divergent urban models in Asia: Kuwait and Abu Dhabi with Hong Kong and Singapore. Therefore, this presentation will explore the assumption that a more compact and connected model of urban development may not only be more resource efficient but ultimately be more effective for harnessing the growth potential of cities and improve the cities’ environmental performance. Aiming at understanding the influence of resources on current urbanisation trends to ultimately help policy making (re)turn to a more environmental efficient city.

Session 17: Involving Stakeholder in the Transformation Challenge
(THU, Sept 21st, 14:00-15:30 in H – GF)

Resilience planning through coalition building; the case of Greater Manchester

Sarah Mander, Philippa Calver, Ruth Wood, Tyndall Centre and University of Manchester, UK

The concept of resilience is increasingly used within public policy to describe both the response and recovery to short term shocks, such as natural hazards, and planning to adapt to longer term change, including climate change impacts. This paper focuses on the UK city Region of Greater Manchester (GM), and considers both civil contingency planning for natural hazards, and the delivery of climate resilience in the longer term, within GM. It uses data from interviews with stakeholders, including a mapping of social networks, and documentary analysis. Strategies produced by various stakeholders, at different scales, plan for increasing the resilience of infrastructure and its adaptation to climate change, as well as for responding to events as they occur. We find, however, that in planning for future resilience to climate impacts, whilst some actors have a statutory obligation to develop strategies to reduce risks, others, including local authorities do not. Coupled with other factors, such as austerity and funding cuts, this means that there is not consistent capacity to take action across stakeholders, and challenges for the integration of different strategies. To overcome this challenge, stakeholders are coming together in various forums, including the GM Local
Resilience Forum, to work together and find opportunities and approaches to understand and seek to manage longer term risks. These include participation in research projects, as well as membership of international networks, such as 100 Resilient Cities. This, however, brings complexity and a need for coalition working, which sometimes means that opportunities to build climate resilience can fall between the remit of different stakeholders and are lost. We conclude by considering opportunities to improve this process, including new governance processes through devolution.

**New finance: investing in cities of the future**

Graham Floater, London School of Economics and Seneca Trade and Investment, UK; B Helia Costa, London School of Economics, UK

The Paris Climate Agreement and the UN Sustainable Development Goals have demonstrated the need for a more strategic approach to investing in sustainable public infrastructure in cities. A range of investments across multiple sectors will be required. Examples include mass transit systems, smart grids, distributed renewable energy, digital networks, flood defences, cooling systems, resource-efficient buildings, green infrastructure and water distribution.

Currently, even financing business-as-usual infrastructure is a major challenge. According to a range of estimates, the deficit in investment for global infrastructure is growing above 1 trillion US dollars a year. The need for more climate-resilient cities is likely to widen this financing gap further still, increasing pressure on governments which often lack the capacity, skills and public funding to deliver infrastructure at the speed and scale necessary.

In this paper, we present a review of alternative financing structures that municipal governments could consider in collaboration with national-level enabling frameworks to access public, private and institutional finance at scale. The review included consultations with experts from the World Bank, OECD, Global Commission on the Economy and Climate, United Nations Environment Programme, sovereign wealth funds, investor associations, and a range of commercial banks and global property developers.

We examine three areas of government action that will be needed for channeling substantial investments into sustainable infrastructure: (1) raising finance (e.g. through national government transfers, international funding and bond markets), (2) steering finance (creating markets for sustainable infrastructure investments
through pricing, standards and regulation) and (3) blending finance (to leverage the scale of private and institutional capital required). Underpinning these action areas, a range of promising financing mechanisms exist including land value capture, green bonds, fiscal decentralisation, development bank investments and PPPs. Effective combinations of financing mechanisms will need to be tailored to city-specific income levels, financial maturity and government capacity.

“URBAñinos”, Resilience and Education: a step further in tactical urbanism approach

Adriana Patricia Lopez-Valencia, Universidad del Valle, COL

This paper presents a first report in the development of an ongoing research project, which aims to understand the relationship between children education and their ability to intervene on the built environment, understanding how interactive communication elements can be used to learn the concept of urban resilience, in a simple language that encourages the participation of children in co-design processes and co-management of green infrastructure projects to reduce vulnerability.

The focus of this communication will be to show how to go further from the current state of the art about tactical urbanism as temporary interventions. We seek to improve the academic discussion on this topic including aspects such as pilot urban projects as “tactics” and big urban projects as “strategic”, this is an approach to involve both sides of the intervention processes from up to down and bottom up, using small scale and low cost projects to test big urban plans involving children in the participation and intervention moments.

The key concepts to promote URBAñinos® are i) Motivation: children participation in co-design of green infrastructure projects with a bottom-up focus; ii) Understanding: The relationship between education in children and their ability to intervene in the environment, understanding how interactive communication elements can be used to learn concepts about urbanism and urban environmental management; iii) intervention: based on the strengthening of the social capital of the communities, using tactical tools of citizen activation in the creation of projects that enhance the local value through its co-design and co-management.

The challenge of this project in the framework of “Green Growth” aims to increase the possibilities of building resilient, sustainable and inclusive spaces thought from
an innovative vision, forming citizens (of the future) informed, able to face the challenges of the processes of change and climate variability.

Cities as partners: The impact of local development partnerships on administrative capacities in urban water supply management

Kei Namba, Graduate School of East Asian Studies, Free University of Berlin, DE

This paper aims to assess the impact of Global South-North municipal cooperation on enhancement of administrative capacities in urban water supply management in emerging economies in Southeast Asia, the global “hot spot” for water crisis due to poor governance and weak institutional capacity. Over the last two decades, different forms of multi-stakeholder partnerships such as PPPs and inter-municipal cooperation including non-state actors like private enterprises have emerged as effective tools in global governance and international development. However, scholars argue that the impacts of those partnerships in development cooperation lacks empirical evidence (Witte and Reinicke, 2005; Schäfferhof et al, 2009), and call for future research on the effects of partnerships on enhancing local capacity development. The water sector requires a strong network collaboration with local corporations and authorities compared to any other sectors. It is thus highly fragmented and contested with conflicting interests of multi-actors, including international donors’ political and economic interests. Moreover, the power and the ability of each actor to influence outcomes is highly uneven. This paper follows the discussion of multi-level environmental governance, institutional capacity building and effectiveness of partnerships in development cooperation. By examining case studies of local capacity development projects in water supply by Japanese cities and development agencies in Yangon, Myanmar and Phnom Penh, Cambodia, this paper identifies the conditions for best practices of learning and building on local institutional and governance structures when delivering common public goods through municipal partnerships.
"We are greener than you think": An Indian city’s response to climate change

Radhika Khosla, Ankit Bhardwaj, Centre for Policy Research, IND

Interventions to address climate change in India’s transforming cities have the potential to lock-in an urban form that enables inclusive and climate resilient infrastructures and lifestyles. Yet, we know little about the response of Indian cities to climate change. What forms of interventions find traction; what governance arrangements do they take? How can they be enhanced? We explore these questions through the case of a rapidly growing city, Rajkot, focusing on the city’s mitigation measures. Three insights emerge from the study. First, the political feasibility of climate actions is higher when linked with more familiar, and often more immediate, urban priorities (e.g., accessibility and safety from public transit). Second, municipal actions are derived from state and national level agendas, instead of being independent of them, reflecting a shift in the role that national and state policies play in framing city climate action (e.g., national Smart City mission). Third, cities have the ability to creatively interpret and adapt these national and state directives to enable further “climate friendly” features (e.g., implementing energy efficiency under the national affordable housing scheme). Additionally, the role of non-state actors is increasingly structured by city officers to enhance departmental agendas, with synergistic climate benefits, instead of non-state actors being the key enablers of climate action. In summary, this study points to how Indian cities can creatively achieve climate outcomes, yet it also indicates that the current approach is bounded by departmental mandates, with little incentive or opportunity for city officers to think cross-sectorally or strategically, ultimately limiting a city’s response. Effective and comprehensive responses to climate change at the city level will require deliberation on contextual challenges and opportunities, the integrated nature of urban infrastructure, and long-term risks. This will require fostering better cross-departmental co-ordination, and opportunities for Indian cities to strategize on their development pathways.
Session 18: Solutions to mitigate urban heat  
(THU, Sept 21st, 11:30-13:00 in A56 - BM)

The influence of surface material and sky view factor on the relationship between surface temperature and air temperature during day and night

Manuel Linsenmeier, University of Hamburg, DE  
Sahar Sodoudi, Free University of Berlin, DE

Urban heat islands (UHI), which are projected to be intensified by global warming, determine human health and well being in cities. Estimates of the UHI and local air temperature differences with fine spatial resolution can be used to identify priority areas for climate adaptation and disaster management in case of extreme heat events. These estimates can be derived from satellite images if the relationship between surface temperature and air temperature is known. This relationship is however complicated by surface characteristics, the effects of buildings, vertical and horizontal mixing, and potentially other meteorological variables. In this study, we analyse results from an extensive measurement campaign in September 2016 in El Gouna, Egypt. Diurnal Surface and air temperature at heterogeneous sites with different surface materials (5 types) and sky view factors (5 values) have been measured. We test models that have been proposed in the literature and estimate new models based on our own data using regression methods. Our results show different relationships for day-time and night-time and different performance of previously proposed models. Overall, our results show that models derived from remote sensing and automated meteorological stations can be improved if they are tested against data from in-situ measurements at heterogeneous measurement sites. Our outcome highlights the importance of sky view factors and highly resolved remote sensing data for urban climate research.
Influence of spatial configuration on cooling effect of urban waterfront green space

Huiwen Zhang, Sahar Sodoudi, Free University Berlinm DE
Zhang Deshun
Li Huidong
Wang Zhen

Urban heat pressure are currently aggravated in the worldwide. Green space and water body are taken as solutions mitigating this problem because of their urban cooling island (UCI) effect. As intersection of green space and water body, urban waterfront green space plays an important role in both cooling down ambient city area and providing outdoor thermal comfort for its users. This study aims at exploring correlations between spatial configurations and cooling effect of waterfront green space, finding out the most climatic efficiency spatial configuration of waterfront green space, providing suggestions for climate-adaptive design and planning of waterfront green space.

The common spatial configurations waterfront green space in Shanghai are classified into three main patterns—W-P-V(water body-pavement-vegetation), W-V-P-V and W-V-P. Each pattern is firstly measured through measuring experiments, and then is simulated by model ENVI-met. After that, a series of ideal scenarios are simulated to figure out the exact correlation and deep reason behind it.

Finally, the spatial configuration is found having obvious influence on cooling effect of waterfront green space. The correlation is also related to the cooling capacity of vegetation in waterfront green space. In overheating weather, when cooling capacity of vegetation is strong enough, the further the pavement in green space is placed away from water body, the cooler the pedestrian on pavement will feel. On the contrary, when the cooling ability of vegetation is feeble, it is better to place the pavement near to water body for pedestrian thermal comfort. In addition, if the cooling effect of waterfront green space on ambient city area is prior, the pavement should not be placed on the outermost of green space, directly adjacent to city area. These results are finally designed as an evaluation form to realize their utilization in practical design of waterfront green space.
Urban expansion and green roofs: mitigation of changes in temperature of a tropical mountain metropolitan area: A modelling framework for Aburra/Colombia

Laura Florez, Corporación Científica Ingeobosque and Universidad Nacional de Colombia, COL
Jose Jimenez, Andres Ochoa, Universidad Nacional de Colombia, COL

Urbanization modifies surface properties and leads to variations in energy flows and atmospheric dynamics. In the Aburrá Valley Metropolitan Area (AVMA), located in a tropical mountain valley, urbanization processes have changed the vegetated areas into non-natural ones in the border of the urban sprawl. In this study, we used a local parameterization for the urbanized version of the Weather Research and Forecasting (uWRF) model at high resolution (1km). Physically-based rooftop parameterization schemes were used to simulate the effects of urbanization and green roofs strategies in the surface energy balance, including urban fraction, roof height, roof width and road width. Temperature, sensible heat and latent heat fluxes were estimated for 4 scenarios: (1) actual, (2) urban expansion of AVMA, (3) urban expansion of AVMA and surrounding urban areas, (4) green roof strategy. Each scenario included a different urban green area configuration. Additionally, we analyzed the magnitudes and spatial patterns in the storage and the fluxes of energy between scenarios. Results suggest that the spatial distribution of vegetation within the city regulates the dynamics of the surface energy balance due to vegetation transpiration, surface albedo changes and the complex topography. A cooling effect of green areas in the AMVA over surrounding urban areas was also found. In urban expansion areas the temperature increased by 3°C at night, however, it decreased by 2°C in the west slopes of the metropolitan area by implementing green roof strategies in the 30% of the urban area. Our research provides useful information for land use planning and climate change adaptation, taking into account the regulatory role of vegetation in urban meteorology, specifically reducing the urban heat island (UHI) effect.
Global Climate Change – Successfull strategies to combat urban heat islands

Ulrich Reuter, Rainer Kapp, Municipality of Stuttgart, Office for environmental protection and Departement of Urban Climatology, DE
Silke Drautz, City of Stuttgart, Office for environmental protection, DE

The municipality of Stuttgart has operated a Department for Urban Climatology within the Office for Environmental Protection since 1938. Its function is to take into account climate in urban planning and to make sure that the local climatic situation will not be deteriorated by planning.

The most important urban climate issues in the City of Stuttgart shaped by urban planning are an impairment of ventilation and in consequence a deterioration of air quality and due to rising surface sealing and cubic capacity an increase of local human heat stress.

Climate Change outlines a new challenge for urban planning to develop and apply measures primarily aiming at shading of direct solar radiation and maintaining of sufficient ventilation. These are based on an optimised design of buildings and urban open spaces and the utilisation of the cooling potential of urban green.

A large number of smaller green spaces with their sum effect can contribute to a reduction in the thermal burden or the heat-island effect, as long as these green spaces are closely networked and exhibit a sensible arrangement from the perspective of the urban realm (e.g. corresponding with main ventilation corridors).

The presentation mainly focusses on how to adapt to heat in practice:

For example the planting of trees and shrubs along streets leads to a reduction of ambient heating (especially in built-up areas) and thus serves to balance out overheated city structures. Large-crown trees and their corresponding shade create comfortably-shaded spaces.

It is also important to take care of the local nocturnal cold and fresh air flows from the surrounding country into the city center. Within the Stuttgart region with only low wind speeds these thermally induced winds very often are the only possibility for cooling ventilation.
Analysis of Land-Surface Temperatures in Local Climate Zones of Novi Sad, Serbia

Dragan Milošević, Stevan Savić, Climatology and Hydrology Research Centre, Faculty of Sciences, University of Novi Sad, SRB
Daniela Arsenović, Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Novi Sad, SRB
Zorana Lužanin, Center for Mathematical Research of Nonlinear Phenomena, Faculty of Sciences, University of Novi Sad, Novi Sad, SRB

Urban meteorological network (UMN) was established during 2014 in a Central European City of Novi Sad located in Serbia. Novi Sad urban network (NSUNET) consists of 27 stations equipped with air temperature (Ta) and relative humidity (RH) sensors distributed across the City. This system provides 10-minute measured Ta and RH while wind speed (v), longwave and short-wave radiation fluxes (g) are obtained from automatic weather station located in the City. Human thermal comfort was investigated for the summer period (June-August, 92 days) of 2015 with the application of the Physiologically Equivalent Temperature (PET) index calculated in the RayMan software. The calculation is based on the meteorological (Ta, RH, v, g, etc.), personal (level of clothing, activity, age, weight, etc.) as well as building and vegetation data (dimensions, Albedo and emission coefficient). Obtained results showed that extreme physiological heat stress (i.e. maximum daily PET value > 41 °C) was noticed during 44 days (48 % of all days), especially in July and August. Furthermore, 36 tropical nights (i.e. minimum daily Ta > 20 °C) occurred during summer of 2015 in Novi Sad. Obtained results show that there is a need for the development of climate-conscious urban design in order to improve thermal comfort of urban residents in the investigated City. Furthermore, expected Ta rise in the cities as a consequence of climate change and urbanization processes in the following decades emphasize the need for the development of UMN in cities in order to monitor their thermal characteristics.
Passive Adaptive Strategies and Indicators for the Optimisation of Comfort and Energy Demand in Buildings in Hot Climates

Udo Dietrich, Gionatan Vignola, Hafencity University Hamburg, DE

Passive buildings are optimised in a way that indoor thermal comfort is reached as often as possible by using only passive systems (and their control): natural ventilation, window size and orientation, construction (heavy or light), shading, etc. Particularly in hot climates, one cannot expect indoor temperatures that are well below outdoor temperatures with natural ventilation only. On that basis, a new indicator for the assessment of the passive optimization of the building is developed. It counts exceeding hours only then if the indoor temperature exceeds outdoor temperature as well as comfort temperature. The lower the number of exceedings, the better is the optimisation.

A digital model of a standard room that could be representative for an office as well as for an apartment was built up in the Energy Plus based software Primero-Comfort. As a case study, the hot and dry location of Cairo was chosen, and the room optimised on the basis of the described indicator. The optimisation strategy that was developed - and that can be replicated for other projects as well - it is built up on a sequence of priorities. After having chosen the ventilation strategy, the fixed and operable shading systems of windows and external construction can be optimised, as well as construction type and materials for external and internal components.

The results show that by using this strategy, different optimisation possibilities can be found depending on the room’s use, be it an office or an apartment (bedroom). Furthermore, even though with some modern constructions and materials further improvements are possible, it has been found that the optimised room has a lot in common with strategies used in vernacular architecture.
Urban mobility: Decarbonization in the Context of the New Urban Agenda

Shritu Shrestha, Research Fellow at Wuppertal Institute for Climate, Environment and Energy, DE
Oliver Lah, Head of Research Unit Mobility and International Cooperation at Wuppertal Institute for Climate, Environment and Energy, DE

Cities currently account for about 70 per cent of energy consumption and energy related Greenhouse Gas Emissions. Urban mobility makes up a large part of this, in particular in developing and emerging economies. The integration of urban energy and transport sectors is a core element in the delivery on global climate change mitigation and sustainable development efforts. The research explores some of the key issues relating to low-carbon mobility pathways, in the context of delivering on the New Urban Agenda, the Paris Agreement and the Sustainable Development Goals. A main aspect of the work is the assessment of policy and governance processes and institutions in Europe and in developing and emerging economies for the mitigation potential and synergies of sustainable development objectives.

Analysis of the transferability of mobility concepts in the context of sustainable urbanization

Nicole Biedermann, Technische Hochschule Ingolstadt, DE

The megatrend urbanization is accompanied by growing wealth and an increase in mobility demand which is largely covered by individual motor car traffic. This results in negative impacts on various dimensions of sustainability which becomes apparent especially in urbanized space. For this reason, the present paper contributes to a more sustainable urban mobility. The result is a strategic framework for local decision-makers. It contains practical measures for the development of sustainable urban mobility and is subdivided into four activity directions:

1: Transformation of the individual motor car traffic
2: Integration of city planning and mobility planning
3: Advancement of intermodal mobility
In the present paper, a further area of focus is the discussion about the feasibility to transfer particular aspects from the case study to other cities. It reveals that a simple transference of the mobility concept is not feasible in practice. In this regard, the different circumstances as well as historically developed path dependencies play a decisive role as they make a difference in the individual character of a city. Ultimately, the consideration of preferably all measures of the strategic framework in the context of the individual urban circumstances is recommended. Furthermore, it is advised to take account of the circumstances that led the case study to success in sustainable urban mobility development. Thus, at best all dimensions of sustainability can be fulfilled.

Health and environmental co-benefits of increased active transportation in Nashville, Tennessee

Sohail Ahmad, Mercator Research Institute on Global Commons and Climate Change and Technical University Berlin, DE
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Felix Creutzig, Mercator Research Institute on Global Commons and Climate Change and Technical University Berlin, Germany
James Woodcock, MRC Epidemiology Unit and UKCRC Centre for Diet and Activity Research (CEDAR), University of Cambridge School of Clinical Medicine, Cambridge, UK
Marko Tainio, MRC Epidemiology Unit and UKCRC Centre for Diet and Activity Research (CEDAR), University of Cambridge School of Clinical Medicine, Cambridge, UK and Systems Research Institute, Polish Academy of Sciences, Warsaw, Poland

The transportation sector accounts for approximately 23% of total energy-related carbon dioxide (CO2) emissions worldwide and 26% in the US. Policy-makers and planners have sought several strategies, including promotion of active transportation, to mitigate emissions. Such strategies have significant health co-benefits through increasing physical activity. This study quantifies health benefits and reduction in CO2 emission of active transportation, using a micro data from
the Middle Tennessee Transportation and Health Study. Statistics on travel patterns, physical activity, and CO2 emissions in Nashville is input to a model that calculated the health impact of increased walking and cycling. We measured the change in all-cause mortality based on dose-response relationships between walking and cycling. If the propensity to walk and cycle in Nashville were equal with England, about 339 all-cause deaths could be avoided annually (273 due to increased walking and 66 due to increased cycling) and 36 ktCO2e (1.05%) of transportation-related emissions could be saved annually. Similarly, doubling density in Nashville could avoid 170 all-cause deaths and 370ktCO2e (8%) of transportation-related emissions. This study concludes that increasing physical activity associated with active transportation and a compact urban form could considerably reduce mortality and simultaneously reduce CO2 emissions in urban areas, like Nashville. Alternatives like expansion of public transport could reduce emissions, but active transport provides significant health benefits besides emission reduction, and even on lower per unit cost. Therefore, policymakers should aggressively expand active transport infrastructures before up taking big ticket projects.

Working on long-term (2050) climate-friendly mobility in Dutch cities

Ekki Kreutzberger, Kate Unsworth, Rob Konings, Delft University of Technology, Delft, NL

Many Dutch cities have long-term climate aims, like becoming climate neutral by 2050 and sometimes even 2040 or 2030, or becoming energy neutral by a certain year. However, the work to achieve these aims is lagging behind and there is limited certainty that the aims will be achieved on time. Currently, most cities in their strategic planning rarely reflect on developments beyond 2030. Many cities hardly know whether the effects of their measures to be implemented until 2030 are in line with the reduction aims for 2050. Also, to our knowledge there is no city that already knows how to tackle all required GHG reduction. The exploration, planning, preparation and implementation of many appropriate measures takes long: easily 20 or more years. Explorations and planning should start soon to get measures implemented on time.

An important challenge is to develop packages of measures that sufficiently and efficiently reduce GHG of mobility. The question is: How must urban mobility change to meet the aims? Sustainable mobility also depends on the spatial and cultural organisation of a city. Therefore it is also needed to look towards urban
development: How must a city’s structure and standards change to appropriately support sustainable mobility?

Central documents describing the policies and measures to change a city’s mobility are the strategic mobility plan and the strategic spatial/urbanism plan of a city and corresponding regional plans. This paper analyses the status quo of planning climate-friendly mobility and city measures in a number of medium to large Dutch cities by evaluating the latest set of their strategic planning documents. The analysis shows that current planning of numerous cities does not convincingly project a future in which urban mobility meets the long-term climate aims.

P4 Concluding Panel
(THU, Sept 21st, 16:30-18:00 in A56 - BM)

EU policy agendas and initiatives to promote adaptive cities: R&I to support better informed decision-making

Nicolas Faivre, Policy Officer, Climate Resilience, European Commission, Research & Innovation

The Paris international climate Agreement recognises the important role of and invites cities and regions to scale up their efforts to reduce emissions and to build resilience to the adverse effects of climate change. In light of the evaluation of the EU Adaptation strategy, the presentation will address how various policy frameworks at EU level are contributing to promote adaptive cities, in particular the role of EU R&I agendas and priority themes such as Sustainable use of land and Nature-Based Solutions in cities. Finally, an overview of relevant EU initiatives, knowledge-exchange platforms and networks (e.g. Covenant of Mayors for Climate and Energy) will be presented.

Panel discussion:
Visioning Future Cities, Research and Innovation Needs

With: Philippe Maillard (Veolia), Richard Dawson (UNEW), Nicolas Faivre (EC), Anne Maasen (WRI), Paty Romero Lankao (NCAR)
Cites around the world have been facing urban heat island (UHI) and its subsequent problems. Along with the background global warming, UHI makes urban residents more vulnerable to climate change. Thus, it is crucial to mitigate UHI in order to cope with future climate change. In this study, a mesoscale numeric model Weather Research and Forecasting (WRF) model coupled with Urban Canopy Model (UCM) was applied to investigate the effectiveness of cool roof and green roof as mitigation strategies of UHI in the city of Berlin, Germany during a heat event. Both cool roof and green roof help decreasing urban temperature by altering the surface energy balance (SEB) and by reducing the sensible heat flux and the heat storage in buildings but with different mechanisms. Five simulations were conducted in this study: a reference scenario with normal roof albedo and no coverage of green roof; two cool roof scenarios with increasing roof albedo; two green roof scenarios with increasing green roof coverage. The modelled 2m temperature of reference scenario was validated against the observations from German Weather Service. Results show that Berlin has a significant UHI effect during the simulation period with a daily averaged UHI intensity (UHII) over 1K. Modelled 2m temperatures from cool roof scenarios and from green roof scenarios all reduce compared to the reference scenario, which suggests that cool roof and green roof can be implemented as mitigation strategies of UHI effect in Berlin. Theoretically, based on the modelled output, cool roof is more effective than green roof.
The smart weather information for city tour using mobile sensors

Youngmi Lee, ECOBRAIN Co., Ltd
Dabin Park, ECOBRAIN Co., Ltd

This is the optimized weather information for tourists and conference participants in the city. Generally, most tourists including conference participants check the weather forecast information of the city where they visit. But, most information is the normal weather forecast from the agencies and companies.

This is the new and differentiated weather information using specific forecasting method. We are developing the ICT platform for the real time weather information using numerical model and mobile sensors. This weather information is produced from the platform in real time.

There are two specific features of this new weather information. One is that the specific numerical weather model is used for forecasting based on WRF. We have modified and optimized this model for the specific city. The horizontal resolution is high and the real time data assimilation by the weather measurement station in the city is applied.

The other is that the real time data from the mobile sensors is used for weather forecasting. The representative data from the mobile sensors are the pressure and the temperature from the smart phone. Also, we use the wind speed data from the mobile equipment. We can provide the more exact weather information at the place where the tourist is standing. We introduce the smart weather information for Jeju island, the popular tourist city in South Korea.

Trees as Indicators of the Urban Heat Island (UHI)

Sebastian Schneider, Institut für Geographische Wissenschaften, Freie Universität Berlin
Stefanie Elsholz, Geographisches Institut, Humboldt-Universität zu Berlin
Burkhard Neuwirth, Jahrringlabor "DeLaWi-Jahrringanalytik", Windeck
Ingo Heinrich, Department 5 Geoarchive, GeoForschungsZentrum GFZ, Potsdam
Christoph Schneider, Geographisches Institut, Humboldt-Universität zu Berlin

The project BIWi ("Bäume als Indikatoren der städtischen Wärmeinsel" - trees as indicators of the urban heat island) investigates chronologies of different tree-ring parameters (tree-ring width, pointer year catalogues, wood anatomical features) in
the district Neukölln within the City of Berlin. Approx. 150 trees from 12 urban-ecologically different sites in Berlin will be analysed. In Germany, Berlin is the city with the most pronounced urban heat island (UHI). The goal of the BIWi project is to attribute specific growth features to the effects of the UHI. Established techniques of measurement and data processing in dendroecology are used. Applied are time series analysis such as correlation and regression analysis, principal component analysis and extreme year's statistics. A set of methods useful and applicable for urban areas are to be developed.

This approach aims determining and prioritizing the growth factors for mean climatic and extreme weather conditions (dry seasons, heat waves, smog) at different sites. For this purpose, tree-ring chronologies as well as catalogues addressing extreme growth reactions and specific wood anatomical features (freeze circles, density fluctuations, etc.) will be generated.

The UHI effects will finally be separated from general climatic growth conditions by comparison with rural sites outside of Berlin at Telegrafenberg in Potsdam and close to the lake Müggelsee. In addition to the analysis of specific urban tree species (Platanus, Acer, Tilia cordata and similar species) the differentiating process particularly also requires the analysis of basic forest tree species such as Quercus, Fagus or Pinus to prevent the identified urban-rural diversities from being blurred by species-specific differences.

The long-term is the development of a general procedure investigating the spatial distribution and spatio-temporal evolution of UHIs using dendroclimatological data. The poster will show the sampling approach and data processing as well as first results from the inter-site comparison of time series.

Reconciling Adaptation, Mitigation and Sustainable Development for cities

Ramses Team (EU Project)

The RAMSES project delivers much needed quantified evidence of the impacts of climate change and the costs and benefits of a wide range of adaptation measures, focusing on cities. In an integrated top-down and bottom-up approach risks, vulnerabilities, and damages from climate change have been quantified. In addition, associated costs and benefits of adaptation have been estimated to support the design of sustainable transition strategies in urban areas. RAMSES engaged with stakeholders to ensure this information is policy relevant and ultimately enabling
the design and implementation of adaptation strategies in the EU and beyond. The project focused on climate impacts and adaptation strategies pertinent to urban areas due to their high social and economic importance.

The estimation of health impacts and economic costs of air pollution in the metropolitan area of Skopje, the former Yugoslav Republic of Macedonia

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Dimitrios Chapizanis, Aristotle University of Thessaloniki, Department of Chemical Engineering, Thessaloniki, Greece
Mihail Kochubovski, Institute of Public Health, Skopje, The former Yugoslav Republic of Macedonia
Margarita Spasenovska, WHO country office Skopje, The former Yugoslav Republic of Macedonia

Air pollution causes a significant burden on health worldwide. Globally, the World Health Organization estimates that 3 million premature deaths annually were attributable to ambient air pollution in 2012. In the WHO European Region, the former Yugoslav Republic of Macedonia (37 μg/m3) ranks third after Bosnia and Herzegovina (42 μg/m3) and Tajikistan (41 μg/m3) in terms of annual population-weighted modelled urban and rural median concentration of PM2.5. Urban outdoor air pollution, especially particulate matter, remains a major environmental health problem in Skopje, the country’s largest city. Besides its health impacts in terms of increased premature mortality and hospitalizations, air pollution causes significant economic costs for the city. In 2012, long term exposure to PM2.5 caused an estimated 1,199 premature deaths, and an approximate 1.8 million years of life lost (CI 1,177-2,413). The social cost of premature mortality due to air pollution was estimated at between €260 million and €697 million per year. Moreover, PM2.5 was also responsible for 547 hospital admissions (CI 104 - 977) from cardiovascular diseases, and 937 admissions (CI 937 - 1869) for respiratory disease that year. Reductions in PM2.5 concentrations could provide substantial health and economic gains to the city of Skopje and the whole of the country. The average life expectancy of the residents of Skopje is reduced by 2 to 3 years through the largely preventable environmental factor of air pollution. The air quality monitoring system needs to be strengthened, particularly geographical and time
series coverage of measurements as well as the availability of adequate human and physical resources for monitoring. More research and local evaluations on the health and economic impacts of urban air pollution are needed, particularly in European Union accession countries and other neighbouring countries in which the local evidence base on this topic is limited.

Initiating Climate Adaptation Processes for the Aachen Agglomeration

Gunnar Ketzler, RWTH Aachen University, Physical Geography and Climatology
Andreas Witte, RWTH Aachen University, Chair and Institute of Urban and Transportation Planning, DE
Peter Quadflieg, City Region Aachen, Dept. of Geodata Management
Alice Neht, RWTH Aachen University, Chair and Institute of Urban and Transportation Planning, DE
Timo Sachsen, RWTH Aachen University, Physical Geography and Climatology
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Gerd Demny, Eifel-Rur Water Board, DE
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Andres Schmidt, RWTH Aachen University, Physical Geography and Climatology, DE

The agglomeration of urban areas around the city of Aachen it is situated partly in the North German Plain and the Eifel low mountain ranges. Additionally, it is situated in the border region to Belgium and the Netherlands. It shows typical characteristics of central-european urbanized areas as it consists of several cities and towns of different sizes with various complex economic histories and varying developing processes today.

In the ESKAPE Project (“Entwicklung StädteRegionaler KlimaAnpassungsProzessE” - Development of Regional Urban Climate Adaptation Processes) the spatial disparities and interactions are analyzed and concepts to integrate climate adaptation in partly common and different administrative procedures are developed. As some expected climate change effects are similar and others widely differ in the study region, spatially distinct concepts are needed. First results of a regional climate analysis show relevant interaction of cities and different catchments for example influencing cold air drainage flow as one of the main potential urban cooling effects in complex terrain. Here, a regional management strategy appears to be necessary.
Furthermore, climate adaptation proves to be not yet integrated in digital administrative and information media. In return, as digitalization in public services is still unevenly developed, climate adaptation processes can form a motivation for intensified digitalization activities.

Development and Implementation of an Online Chemistry Module to a Large Eddy Simulation Model for the Application in the Urban Canopy

Sabine Banzhaf, Freie Universität Berlin (FUB), Institut of Meteorology, DE
Basit A. Khan, Renate Forkel, Karlsruher Institut für Technologie (KIT), IMK-IFU, Garmisch-Partenkirchen, DE
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Klaus Ketelsen, Independent Software Consultant, DE
Matthias Mauder, Karlsruher Institut für Technologie (KIT), IMK-IFU
Björn Maronga, Siegfried Raasch, Leibniz Universität Hannover (LUH), IMUK, DE

Adequate modelling tools are required to support urban planning and the development of strategies aiming at minimizing climate change-related vulnerabilities and risks of human inhabitants such as poor air quality. However, a realistic implementation of urban canopy processes still poses a serious challenge for current air quality models owing to the small scale of the phenomena to be described.

Large-Eddy Simulation (LES) models explicitly resolve relevant scales of turbulent motion, so that these models can capture the inherent unsteadiness of atmospheric turbulence and advection. However, LES models are so far hardly applied for urban air quality studies, in particular when the chemical transformation of pollutants is involved.

Within the BMBF funded joint project MOSAIK (Model-based city planning and application in climate change) the state of the art LES model PALM is extended by an atmospheric chemistry scheme. Due to the high computational demands of an LES based model, compromises in the description of chemical and removal processes are required. A computationally less-demanding RANS mode of the model will also be developed. Chemistry modules of different complexity for both the LES and the RANS mode have to be supplied for practical applications. Therefore, gas-phase chemistry has been implemented using the Kinetic PreProcessor (KPP) in order to obtain the necessary flexibility in the choice of the chemistry mechanism.
For the LES mode a reduced chemistry mechanism, which includes only major pollutants namely O₃, NO, NO₂, CO, a highly simplified VOC chemistry and a small number of products is implemented while for the RANS mode a full complex chemistry module is available.

For practical applications, our approach is to go beyond the simulation of single street canyons to chemical transformation, advection and deposition of air pollutants in the larger urban canopy. Tests of chemistry schemes and initial studies of chemistry-turbulence interactions are presented.

Conceptual Modelling Approach to urban health

Malte von Szombatelly, Myriam Albrecht, Dejan Antanaskovic Jobst Augustin, Matthias Augustin, Benjamin Bechtel, Thomas Bürk, Jana Fischereit, David Grawe, Peter Hoffmann, Giedrius Kaveckis, Anne Caroline Krefis, Jürgen Oßenbrügge, Jürgen Scheffran, K. Heinke Schlünzen, University of Hamburg, DE

Cities influence human health in many ways. And at the same time, cities are key drivers of climate change. Yet, climate and health effects in cities are not only co-dependent but the stressors and resources are also internally differentiated due to the structural, social and natural heterogeneity of cities. Since access to livable and healthy spaces and infrastructures is unequally distributed, questions of well-being and environmental justice need to be linked to urban health studies, as well. Cities will have to transform in order to achieve sustainable urban futures for all. Consequently, social well-being in cities faces obstacles posed by globalization, demographic and climate change, new forms of social organization, and the fragmentation of lifestyles. These changes affect the vulnerability of city societies and impact their health-related urban well-being (UrbWellth). Our conceptual model systematizes the relevant variables within the urban system based on previous research, and establishes the target value UrbWellth. Our model differs from existing approaches mainly in the analytical distinctions it suggests. These allow us to group the relevant urban influence variables into four sectors and enable a more general and abstract consideration of health-related urban relations that integrates climate impacts on cities and urban climate modelling as well as governmental and socio-structural impacts. The introduction of vulnerability as a filter and transfer function acts as an effect modifier between UrbWellth and the different urban variables. In this way, urban adaptation measures for climate change can be developed, for example.
The concepts and results presented are connected to the UrbMod project at the University of Hamburg, an interdisciplinary working group examining influences on healthy cities.

Modern thermal hazards in a big city - how to detect, analyse and assess them? The case of Warsaw, Poland

Kinga Kulesza, Elwira Żmudzka, Kamil Leziak, Institute of Physical Geography, Faculty of Geography and Regional Studies, University of Warsaw, POL

In a time of climate change, it is important to define potential weather hazards and to develop a method for detecting them. Such knowledge is essential during the analysis and assessment of socio-economic vulnerability to climatic hazards, especially in urbanized areas, which are heavily transformed and densely populated at the same time. The purpose of this research is to identify modern thermal hazards in the area of Warsaw and to analyse the exposure of the city areas to the identified hazards. The increasing frequency of heat waves and its statistically significant influence on the rise in mortality in big cities suggest that thermal hazard (long-term occurrence of high air temperature) is the key climatic hazards of our times. The spatial distribution of the exposure to such hazard should be prepared on the basis of the energy balance measurements at the representative points or areas. Due to the lack of such measurements, the necessary information about the physical properties of the surface was obtained from the four input data layers: land cover, mean sums of global solar radiation, mean surface albedo and temperature in selected days of the warm half-year. The areas currently exposed to thermal hazards in Warsaw were thus identified and assessed with respect to the hazard level - lowered, medium or increased. The approach proposed in this study employs widely accessible spatial data and can be applicable to any other location. It can also play an important role in assessing the adaptation of urban areas to climate change. The research was conducted for Fundacja Instytut na rzecz Ekorozwoju within the LIFE13 Project INF/PL/000039 Life_Adaptcity_pl Preparation of a strategy of adaptation to climate change with use of city climate mapping and public participation, founded under LIFE+ by European Committee and polish National Fund for Environmental Protection and Water Management.
Climate Adaptation in Medium Sized Urban Agglomerations - First Results

Gunnar Ketzler, RWTH Aachen University, Physical Geography and Climatology
Andreas Witte, RWTH Aachen University, Chair and Institute of Urban and Transportation Planning
Kathrin Prenger-Berninghoff, RWTH Aachen University, Chair and Institute of Urban and Transportation Planning
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Timo Sachsen, RWTH Aachen University, Physical Geography and Climatology
Dimitri Falk, RWTH Aachen University, Physical Geography and Climatology
Andres Schmidt, RWTH Aachen University, Physical Geography and Climatology

While urban climate adaptation concepts typically follow the idea of an isolated city, in reality many cities are part of urban agglomerations which have particular preconditions. Especially inhomogeneous administrative or participatory structures and spatial and sectoral interdependencies are expected to affect climate adaptation strategies.

In two medium sized agglomeration areas, the "Bergische Städtedreieck" (620,000 inhabitants) and the "Städteregion Aachen" (550,000 inhabitants), integrated climate adaptation projects in a complex setting presently are under development where such structures and interdependencies are analysed as part of accompanying scientific projects.

First results prove that both spatial local climate interaction and differences in administrative and technical infrastructure lead to unexpected superpositions which at the same time open up additional climate adaptation potential.

Urban flood management - as one typical issue of urban climate adaptation concepts - often is considered as a local problem. However, extreme river discharge as the other effect of extreme precipitation events can only be handled by regional cooperation, which - from an administrative view - appears to be more complicated but can be subject to regional initiatives benefitting from increased digital public information.

In a similar way, high urban temperatures during heat waves widely depend on local land use effects - as long as differences in altitude are small. However, ineffective night time cooling mechanisms like insufficient cold air drainage flow often also are related to spatial interaction on a regional scale and even across watersheds. Here, even a regional perception is yet missing which needs to be
addressed in future and efforts should be made to facilitate actions on the regional level in order to efficiently mitigate the effects of heat waves on the quality of life in urban areas.

**GHG Emission Mitigation and CC Action Plan**

Ahmet H. Zembil, ISTAC Istanbul, TR

ISTAC is the waste management company of Istanbul. As ISTAC, we produce the electricity from municipal waste. All the wastes of Istanbul have been disposed on our 3 landfill area. In two of these have electricity generation facility that have 54 MW installed power. The electricity we produced is enough for a city have population of 1.2 million. However, because of this production we obtain the Gold Standard carbon credits approximately 1.5 million tons per year. We have approximately 5.5 million tons carbon credits now. This situation keeps us very active place in voluntary carbon market. In addition to electricity generation, we prepare "Istanbul Climate Change Action Plan" at the same time. The action plan has seven steps which are road map, greenhouse gas inventory, climate scenarios, vulnerability analyze, stakeholder meetings, action plan, sharing of outputs. First 3 step is finished, emission inventory of the city has been calculated and reported, now that's in verification stage. Now we are working on 4th and 5th steps at the same time. This project will finish end of the year.

**Urban mobile measurement system (URBMOBI-GIS 3.0)**

Janani Venkatraman Jagatha, Christoph Schneider, Geography Institute, Humboldt University of Berlin, Berlin, DE

Evert Nieuwkoop, Peter van der Mark, Netherlands Organisation for Applied Scientific Research, The Hague, Netherlands

Urban climate research is primarily based on point or location-based measurements of climate and air quality data. With the development and implementation of the third generation of an urban mobile measurement device, abbreviated as URBMOBI 3.0, we aim to amend this scenario. The URBMOBI 3.0 is a relatively small sensor unit equipped with micro-sensors for measuring the following meteorological parameters: temperature, relative humidity, and solar radiation. Additionally it measures ambient air pollutant concentrations of
particulate matter (PM) from 0.30 to 17 µm with a typical flow rate of 1.2L/min, nitrogen dioxide (NO₂), nitrogen oxide (NO), and ozone (O₃) up to 20 ppm. Geo tagging of the measured data is enabled via a Global Positioning system (GPS) device and the acquired data is stored in a built in SD card. It is expected that by 2018 vehicles such as trams, buses and/or cars will be mounted with URBMOBI 3.0 prototype devices in order to measure climate and air quality data at high spatial and temporal resolutions (1sec). These measurements can then take place on a regular basis, where conventional measurements systems are not built up or cannot be set up. Urban climate models and simulation tools will be fed with the acquired data, which in turn may provide a better understanding of the status and reasons of existing urban climate conditions. This will provide an opportunity to improve the urban climate by providing tools for enhanced city planning and air quality management. A high temporally and spatially resolved data set over a longer period will be of major importance for validation, testing and usage when microscale climate models and other simulation tools come into being.

Understanding Climate Change Induced Sea Level Rise in Coastal Cities

Erica T. Ellis, Fjolle Caka, Amy Chamberlain, Calvin Clessas, Nancy Tapan, George Washington University, USA

Sea level rise is a complex process. Its scale and rate are affected by climatic, geophysical and anthropogenic factors. Climatic factors include changes in ocean temperatures, changes in glaciers and ice sheet volumes, and shifts in ocean currents caused and/or exacerbated by rising levels of CO₂ in the atmosphere and oceans. Geophysical factors include land subsidence or uplift and glacial isostatic adjustments. However, it is human activities, such as coastal development, underground fluid extraction, and the destruction of natural coastal ecosystems, that have made the largest contribution to increasing rates of sea level rise during the last two centuries. A complete physical understanding of the mechanisms of sea level rise is still lacking, resulting in uncertain projections of its future impacts and rate of change. Nevertheless, the relationship between rising sea levels and air and water temperatures due to increasing greenhouse gas emissions is linear; hence, the IPCC posits that it is virtually certain that the global mean sea level will further rise during the next century. Sea level rise poses serious risks to coastal city populations’ health and wellbeing, economies, ecosystems, infrastructure, and
other systems through extreme events such as storms surges, flooding, erosion and saltwater intrusion. Addressing these risks requires proper understanding of the most prominent factors causing sea level rise in certain locations, as well as the most appropriate adaptation measures. This research elaborates upon the heterogeneous nature of causes and impacts of sea level rise, and describes specific adaptive responses in five diverse and highly vulnerable global cities: Shanghai (China), Rotterdam (Netherlands), Jakarta (Indonesia), Lagos (Nigeria), and Malé (Maldives). Our research finds that the outcomes of the adaptation policies, strategies, and infrastructure projects implemented across these five coastal settlements vary according to socioeconomic factors and governments' capacity to adapt to climate change induced sea level rise.

Assessing the weather-crime link in a 'torrid' urban zone

Juan C. Trujillo, Peter Howley, University of York, UK

This study investigates the relationship between weather and crime in Barranquilla, Colombia. The analysis is based on a panel dataset consisting of daily variations in four weather variables and two indicators of criminal activity (homicides and interpersonal violence). To help identify the effect of weather on crime we merge this panel dataset with temporal, lifestyle and economic variables and employ year, month and daily fixed effects. Overall, we find that weather (temperature, humidity and precipitation) is not related to the rate of homicides, but it is a significant predictor of interpersonal violence. We observe that the likelihood of interpersonal violence increases as temperature and relative humidity rise to 31.8°C and 79.3%, respectively, but drops thereafter. Our results also show that temporal variables (weekends), moonlight and rates of alcohol consumption are also important predictors of criminal activity. These findings could be a valuable tool for the allocation of law enforcement personnel, and highlight how changes in criminal activity could be another externality associated with climate change.
Recurrent Floods in Douala City in Cameroon: Can the Blame be placed on Climate Change Alone?

Teke Johnson Takwa, Central Bureau for Censuses and Population Studies, , Department of Geography, University of Yaounde-Cameroon

Douala like many low-lying coastal areas has witnessed and may continue to witness severe flooding. In 2014, Douala suffered one of its worst floods due to continuous rainfall. Floods in this densely settled industrial areas are recurrent and are often attributed to many causes especially changing rainfall patterns resulting from climate change. Many people equally attribute these recurrent floods to the rise in sea levels resulting from the melting of accumulated ice in the Polar and Temperate Regions which results from the gradual but steady rise of temperatures in is what is commonly known as global warming. Using statistical analysis of rainfall over a time frame of over 50 years and its attributes such as rainfall abnormalities, trends in rainfall, daily rainfall maximal and rainfall duration and frequencies as information on the rise in sea level, we have come to the conclusion that the attribution of the increase in the occurrence and severity of floods in this coastal city cannot be allotted to the changing pattern of rainfall and the rise in sea level only. The general view held in many policy circles in Cameroon seems to attribute these frequent floods almost solely to climate change. Observations show that this view is erroneous. The massive deforestation in this area resulting from the destruction of the mangrove vegetation, increasing coastal erosion and the low-lying nature of the areas are equally culprits. Indiscriminate disposal of industrial and household wastes into drainage networks, construction of settlements in marshy areas and the reduction of the river beds are equally responsible for these floods. Until policy makers understand that projected
increases in population, in industrial activities and climatic uncertainties, rise in the sea level can lead to more floods in future, measures curb these floods will remain unsuccessful.

Green mitigation actions to improve thermal comfort inside urban street canyons in Bilbao (Spain)

Gabriele Lobaccaro, Department of Architecture and Planning, Faculty of Architecture and Design, Norwegian University of Science and Technology NTNU, Trondheim, Norway

Urban microclimate analyses are being used more and more to address the planning decision process to create livable and healthy public spaces. The study, conducted in collaboration with the municipality of Bilbao (Spain), presents a comparative analysis of green actions to improve outdoor thermal comfort conditions. The evaluation was performed in three typical urban street canyons characterized by different geometric proportions and five urban greenery scenarios. More than 60 scenarios in typical summer day conditions were analyzed using ENVI-met. Firstly the actual current situation was studied; secondly the effects given by the presence of asphalt and red brick stones as ground finishing materials were evaluated, thirdly the benefits provided by planting grass and trees along the urban canyons were tested. The comparative analysis demonstrated that the orientations and aspect ratios of the urban street canyons strongly affect the magnitude and the duration of the period of the extreme heat stress; while the vegetation elements such as grass, green roofs and trees, improves the thermal comfort at pedestrian level. Thermal comfort is assessed using the PET (Physiological Equivalent Temperature) thermal index. The highest PET reduction occurs by combining the presence of trees and grass, which can lead to a reduction of about two PET thermophysiological assessment classes during the daily peak period. Additionally, the work demonstrates how aspect ratio and ground surface materials can affect the intensity and the duration of discomfort period (PET > 23 °C). The outcomes of this study will be used by the municipality to improve the actual planning recommendations for both new and consolidated urban development areas in Bilbao.
Adaptation measures and corresponding indicators for resilient architecture and infrastructure

James Kallaos, F. acre, G. Lobaccaro, N. Landa, F.F. Ferrara, A. Wyckmans, Norwegian University of Science and Technology - Norway

This report presents a taxonomy of adaptation measures and corresponding indicators for resilient architecture and infrastructure that can be implemented by public authorities at the building, neighbourhood and catchment scales of the city. The taxonomy was developed in cooperation between RAMSES researchers and city representatives, and comprises Deliverable 2.4 of the RAMSES project. The focus here is on structural and physical adaptation options for blue, green, and grey infrastructures, to support cost and impact assessment in the RAMSES project.
The “Cities and Climate Conference 2017” is the final conference of the RAMSES (Reconciling Adaptation, Mitigation and Sustainable Development for Cities) project. RAMSES has conducted innovative and extensive research over the past five years (2012-2017) to equip cities with the knowledge necessary to develop and implement climate resilience strategies and measures. The project focused on the impacts of climate change and their associated costs.

RAMSES has received funding from the European Community’s Seventh Framework Programme under Grant Agreement No. 308497 Project RAMSES - Reconciling Adaptation, Mitigation and Sustainable Development for Cities.

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For more information on the CCC2017 conference and the RAMSES project:
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