**TUKUP1: Public policies and practices**

## A field study about implementation of adaptation to climate change at the French urban scale: the ABSTRACT-colurba project

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Launched in January 2014, the ABSTRACT-colurba project proposes to increase knowledge on climate risk management at the urban scale by analyzing the levers and barriers (economic, organizational, cognitive) attached to decision-making processes upstream to the implementation of adaptation strategies to climate change. Based on a field study through 10 French local urban communities, the project is conducted within an action-research approach integrating local stakeholders. The contribution aims to present the original approach and the preliminary results of the ABSTRACT-colurba project and to contribute to continue to define what adaptation to climate change means at local level.

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## It's Not All or Nothing: Partial retreat as a climate adaptive strategy for resilient coasts

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Despite the widespread acknowledgement of the mistakes that have been made in allowing development in dangerous coastal zones, communities impacted by destructive tropical cyclones repeatedly choose to rebuild. Sea level rise and climate change has increased the need for a new paradigm, but this outcome continues to persist, partly because property owners and communities do have many other options. Although retreating from the shore is considered one of the most effective means to manage this risk (Alexander et al 2011), retreat is politically challenging and often cost-prohibitive, since governments are prohibited from regulatory and actual expropriation without compensation.

In this paper we conduct a comparative study of the practice of coastal retreat as climate adaptation in the United States, Australia, and New Zealand using case studies such as those from New York's post-superstorm-Sandy buyout program, Cape Cod, Mass. de-development program; Byron Bay, Australia (Leitch, 2009), which has repealed a zoning system with retreat clauses; and the Kapati Coast in New Zealand.

We take the view that retreat is not an "all or nothing" strategy, and that de-intensifying coastal development is a legitimate means of retreating. We furthermore focus on the potential for temporary structures to provide a balanced strategy of economic use of coastal lands and as a way to increase adaptive capacity. The adoption of temporary strategies, open public markets, mobile businesses, and trailers have a critical role to play in coastal resilience and have been heralded by some as a manifestation of a more dynamic, flexible and adaptive urbanism (Bishop & Williams, 2012). Yet, they are generally prohibited by floodplain regulations.

Clearly, climate change adaptation solutions that provide value to landowners and simultaneously lead to land uses that are more resilient to storms and sea level rise is within the public interest of communities, yet many innovative solutions that might work are present illegal or politically impractical. It is imperative that solutions to these challenges be found for long-term resilience and sustainability of coastal cities and towns world-wide, and partial retreat and temporary structures have a critical role to play.

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## Integration of urban climate issues in urban planning : reflections on which are the keys of success

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The MapUCE (Applied Modeling and Urban Planning Law: Urban Climate & Energy) project, is a French National funded project that started on March 2014 for four years. Its main objective is to integrate quantitative data of urban micro-climate, climate and energy consumption, in urban policies and legal documents with a methodology applicable to all cities in France.

Some scientific goals deal with the production of climate and energy consumption data, for example: How to take inhabitants behavior on energy consumption into account in numerical simulations with TEB model? or how to produce building's energy consumption and UHI or thermal comfort indexes for any city on the territory? To reach the main goal of the project, research on how to integrate energy, micro-climate and climate change issues in urban planning at the right time with the right legal tool should be also addressed in parallel. The work presented here belongs to this second component of the project.

There is a specific task in MAPuCe project that deals with the analysis of “exemplary cases" of climate and energy issues integration in city planning and urban design. The objective, is to analyze the levers that permit the transfer from climatic knowledge to practices. And also, to understand what is the applicable scale of such information and what are the obstacles. In summary, why the transfer of climate information is successfully done in some places and not in others?

At the beginning a large panel of cases were identified in France and abroad (Europe, America, Asia and Oceania) based on scientific and Grey literature as well as some preliminary interviews with researchers. In a second time the focus was put on a panel of cases that seemed us particularly interesting: Germany and Japan due to their high degree of expertise at both research and implementation levels; Spain and Netherlands due to an incipient practice in this sense. In France the cities of Paris, Grenoble, Lyon, Marseille, Frontignan and Agen were also deeply analyzed.

Methodologically, the analysis was based on literature, institutional websites and interviews with both practitioners and producers of climatic data, almost always researchers. Three types of targets were considered: implementation at the urban politics level trough planning documents, implementation at the operational level (operations of urban spaces) and the development of dedicated agencies and transfer tools (climatic maps or atlas).

This work was done in coordination with the urban environmental lawyers team that analyzed for the same study cases the legal framework at the national, regional and local levels.

# What motivates urban poor in Bangladesh to adapt with urban ecosystem services and disservices?

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Urban ecosystem provides varieties of services. While urban poor get numerous benefits from many of these services, they are affected by disservices as well. Although enormous growth of literature on roles of urban ecosystem services are observed, yet little is known about the factors that motivate urban poor to adapt to urban ecosystem services and disservices. This study is aimed to attain twofold objectives. First to identify range of urban ecosystem services and disservices which the urban poor take into account to ensure their wellbeing. Second to examine the factors that motivate poor people to (a) take advantages of urban ecosystem services and (b) cope against ecosystem disservices.

This study is conducted in coastal Khulna, a metropolis exposed to climatic disasters. A total of 235 families selected randomly from Rupsha slum were interviewed through administering a semi structured questionnaire. From a list of 25 ecosystem services and disservices, respondents were asked to rate in a 5-point Likert scale (very low =1 to very high = 5) if they get benefit/affected from a particular ecosystem service. By employing Principal Component Analysis (PCA) their responses against these 25 categories are bought down to four practical utilities/negative utilities. These four categories are related to (a) livelihood, (b) comfort, (c) security and (d) recreation. Four indexes are developed and each index is used as a dependent variable in multiple regression model to examine the factors that influence poor people's access to ecosystem services and disservice for livelihood, comfort, security and recreation. Earlier, respondents who claimed to derive low benefits from a particular ecosystem services were asked if they are really motivated to derive higher benefits in the future. Their responses were binary coded, i.e. yes or no. Finally, to identify the motivating factors and to measure the extent of influence of those factors, a logistic regression model is employed. Here the dependent variable is "if respondents are really motivated to derive higher benefits from ecosystem services". As independent variables, in addition to variables that are identified in Personal Motivation Theory (PMT) (such as intrinsic benefits, extrinsic benefits, perceived severity, perceived vulnerability), variables related to socio-economic, demographic, behavioural, spatial and governance related aspects are employed in the Binary Logistic model.

Result shows that urban poor respondents are benefited from both green and blue ecosystem services. Green ecosystem services include making using of parks, streetscapes, urban forests, playgrounds as source of livelihood, comfort, and recreation. Similarly, the blue ecosystem services includes rivers, canals, urban swamps, natural drainage and artificially developed waterfronts. Ecosystem disservices include, waterlogging, storm water overflows, surface run off and smell from decomposed waste in natural drainage. Standardized beta values of Multiple Regression analysis show that access to ecosystem service related to livelihood are mostly affected by socio-economic and demographic variables while access to comfort and recreation related services are determined by resource governance related and spatial factors. Finally, the Binomial Logistic Regression analysis unveils that motivation to enhance access to recreation related ecosystem services are significantly determined by gender, family income, distance from house, access fees etc. On the other hand motivation to enhance access to livelihood related ecosystem services are significantly determined by level of education, fear for eviction, tenure of housing, length of stay in the city, perception about intrinsic benefit. On the contrary access to ecosystem disservices that relate to comfort and security are determined by risk perception, season of a year, tenure of housing, fear of eviction, and past adaptation behaviour. However, other factors such as occupation, age, access to information do not have significant influence in this respect. The policy implication of the findings is, this would help designing separate sets of intervention for enhancing urban poor's access to both green and blue urban ecosystem services for better livelihood, security and comfort particularly in the changing context of climate. Therefore, this finding would give synergies to ongoing efforts of building resilient city in an urbanizing world.

# The urban heat island in Beirut and transfer of the urban climate knowledge to urban planners

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One of the best-known effects of urbanization on the local climate is urban warming or what is more commonly known as the urban heat island (UHI). The UHI can lead to unpleasant effects on urban dwellers not least of all on air quality, energy consumption levels, human health, and even mortality rates. In Beirut, haphazard urbanization trends coupled with the relative high density of over 400 inhabitants per square kilometer, are leading to serious implications on the UHI. A study published by one of the leading academic institutions in the city, the American University of Beirut (AUB), has shown a strong positive correlation between increasing populations in the city and heat-related deaths. The serious implications on the urban climate and accordingly human health arising from the uncontrolled urbanization trends are not being studied in depth nor are they being communicated to the relevant parties that can make an impact in mitigating or correcting these trends. This paper studies the results of the UHI simulations carried out for the Beirut context using the Town Energy Balance model and proposes several scenarios for mitigation of the effects of UHI as such. It also proposes some suggestions for transfer of this urban climatic knowledge to the urban planning and environmental sectors while considering the many limitations in the administrative frameworks and information on the urban climatic discipline as such.

Key words: Beirut, UHI, Town Energy Balance Model, Urban Planning, Climate Knowledge

**TUKUP2: Governance challenges in urban planning and adaptation**

## The heat adapted city? A Constellation Analysis of urban governance and planning to tackle heat stress risks in mid-latitude cities

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Recently the awareness for the challenges that lie ahead of local policy makers and planners concerning urban heat risks in mid-latitude cities has been growing. Besides the problem of how to mitigate the Urban Heat Island(s) (UHI), cities need to adapt to the rising temperatures due to climate change. Vulnerabilities to urban heat are driven by a range of interrelated factors, e.g. demographic and social dynamics. These factors have to be taken into account when appraising the risk and respective strategies.

As part of the research group "Urban Climate and Heat Stress in mid-latitude cities in view of climate change" (UCaHS) we study the current policy integration of heat stress into the urban governance processes and respective ways of dealing with it in our test bed Berlin. Our aim is to present the results of our qualitative study which looks at the obstacles and potentials in urban planning and policy for heat risk reduction in a mid-latitude city. Our analysis focuses on the roles of regulatory approaches, policy and planning instruments and processes, and the legal environment related to local heat stress governance and planning in Berlin. We identified involved actors and institutions, their networks at different levels, as well as the interrelations with technical and natural assets. To do so, we used the recently developed approach of the Constellation Analysis (CA), an instrument which has been proved useful as a means to structure multi-faceted research objects, as we did in our research of the heat risks-city nexus.

Our results show the complexity that urban planning and governance have to consider when trying to reduce risk factors. To achieve heat risk mitigation by means of urban development, planning instruments need to be empowered and harmonized. Political backup, targeted discourses, a well-coordinated multi-scale cooperation of actors, leadership as well as knowledge integration and guiding principles on implementation are crucial factors to achieve this. Our presentation elaborates on these essential factors with regards to planning for urban heat stress reduction and good governance. Identifying the complex urban constellations and how they affect heat stress risks in an urban system is of the utmost importance when deliberating possible development paths for an urban area with different stakeholders.

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## Urban Planning and the Climate issues of Beirut and Hamburg: Comparison or approaches, tools and decision making processes.

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Urban climatic knowledge is limited amongst urban planners in Beirut. In fact, not much interest is given to study the interactions between urban planning and associated microclimatic effects and this is in part attributed to the lack of climatic knowledge. Considering the strong impacts of climate change and urban microclimates on the quality of life of urban dwellers, and the respective sustainable urban planning practices that are being implemented and talked about worldwide, Beirut seems to have potential to learn from others. This paper considers the results of the numerical analysis that has been conducted on the urban heat island (UHI) phenomenon in the Greater Beirut Area (GBA) using the Town Energy Balance (TEB) urban surface exchange modeling scheme and the various scenarios suggested for urban planners as such. The implementation of these scenarios is a major challenge for the case of Beirut that involves coordination between all concerned parties including the Higher Council for Urban Planning (HCUP) and the Directorate General of Urban Planning (DGUP) as well as climatic experts. Hamburg on the other hand is situated in a rather maritime and moderate climate and traditionally has many street trees and high percentage of water bodies and parks. Nevertheless, there is raising awareness for urban climatic questions in the administration. In this paper it is compared, whether methods can be transferred considering the great differences in background climates and economic situation. Capacity building, institutional strengthening, climatic training are amongst the few requirements to help implement controlled planning that considers its potential effects on the urban microclimate and accordingly urban populations.

Key words: Beirut, UHI, Urban Planning, Climate Knowledge, Hamburg

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## A review of studies on the relationship between urban morphology and urban climate towards better urban planning and design in (sub)tropical regions

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Rapid urbanization and urban growth have some negative effects on urban climate such as urban heat island, bad air quality and lower air flow, which consequently affect the health of habitants living in the cities. Thus better urban planning and design based on the scientific understanding of urban climate are of great importance to reduce the impact of built-up areas on the surrounding environments. Especially in (sub)tropical regions with rapid urban population growth , built-up areas in these regions expand fast with significant consequences for urban climate.

Researchers have conducted some studies in (sub)tropical regions on the relationship between urban morphology and urban climate. Some urban morphological parameters such as aspect ratio, sky view factor, and frontal area density, etc. have been understood that they have significant impact on urban climate. However, the link between urban morphological parameters and urban planning and design strategies is still weak. Scientific understanding of some morphological parameters affecting urban climate may not easily be transferred to planning and design guidelines to mitigate the negative effects of urban developments. The implication of urban morphology parameters to better urban planning and design in (sub)tropical regions needs to be assessed.

The study reviews the studies on the dependency of urban climate on urban morphological parameters in (sub)tropical regions in several aspects including 1) the spatio-temporal aspect; 2) the dimensions of urban morphological parameters; and 3) the implication of urban climate studies to urban planning and design. This review assesses the urban morphological parameters in terms of similarities and contrasts to recommend some suitable urban morphological parameters for urban climate studies under (sub)tropical climate conditions, which can be transferred to architectural practices without difficulty towards better urban planning and design to improve the urban living quality. Also further work is recommended for collaborative efforts between climatologists and urban planners and designers based on understanding the scientific needs of urban climate studies and the practical needs of urban planning and design applications in (sub)tropical regions.

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## Reasons to adapt to urban heat (in the Netherlands)

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Dutch urban professionals understand the need for climate adaptation, but have indicated that they need arguments and appealing examples to convince others of the urgency to adapt to urban heat. In recent years, much research in the Netherlands has been conducted into the effects of climate change (extreme precipitation, summer droughts and rising temperatures) and the increased risks for urban areas. From these studies, the need for climate change adaptation in urban environments has become evident at the national level. However, at the local (municipal) level, climate adaptation is not always obvious. Particularly in the field of urban heat, local governments are struggling with defining the urgency and finding the right arguments for adaptation to this aspect of climate change.

Based on literature, we have studies reasons and examples for adaptation to urban heat. We investigated national and international knowledge and policy reports and scientific literature. Questions that were raised in this literature study were: How is the urgency of adapting to urban heat assessed in the Netherlands, in Europe and worldwide? What arguments play a role? What are the explanatory examples that support the notification that urban heat calls for adaptation? The literature study summarizes arguments and appealing examples that local professionals can use to convince others of the need for a climate adaptation with respect to urban heat.

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# Capacity for Urban Adaptation to Climate Change: Case Study of Erzurum and Kayseri

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Climate change is a growing problem for urban areas, which should be held by the governance institutions with growing significance. In this process, there is a great need for greater capacity for adapting climate change in urban areas through effective urban policies. However, the research has shown that even if the related bodies had shown some eagerness on urban adaptation, the required steps to reduce the vulnerability of urban areas and urban populations could not be taken. Thus, it is obvious that there is a great need for adapting climate change and thus built a capacity for this both through political institutions and civil society.

Turkey started to experience an important construction boom after 2004. It was aimed to trigger the economic development owing to the backward and forward linkages of construction sector. Urban transformation is used as a tool to ease and control the building processes of the cities. Through these urban transformation processes, most of the urban areas had been re-built. This paper aims to question whether this rapid and intense change experienced on the urban built environments could have been used as an opportunity for the climate change adaptation of the related cities. The recent urban policies and implementations of local governments of Kayseri and Erzurum will be analysed in this regard. Thus, analysing the climate adaptation capacities of two cities (Kayseri and Erzurum); that are differing through their sizes and economic structures; it is aimed to put forward the capacity of Turkish urban policy to adapt climate change.

Keywords: Climate Change, Adaptation, Capacity, Urban Policy

**TUKUP3: Amendment and development of urban planning regulation**

## Urban Climate, Human behavior and Energy consumption : from LCZ mapping to simulation and urban planning (the MapUCE project)

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The MApUCE project aims to integrate in urban policies and most relevant legal documents quantitative data from urban microclimate, climate and energy.

The primary objective of this project is to obtain climate and energy quantitative data from numerical simulations, focusing on urban microclimate and building energy consumption in the residential and service sectors, which represents in France 41% of the final energy consumption. Both aspects are coupled as building energy consumption is highly meteorologically dependent (e.g. domestic heating, air-conditioning) and heat waste impact the Urban Heat Island. We propose to develop, using national databases, a generic and automated method for generating Local Climate Zones (LCZ) for all cities in France, including the urban architectural, geographical and sociological parameters necessary for energy and microclimate simulations.

As will be presented, previous projects on adaptation of cities to climate change have shown that human behavior is a very potent level to address energy consumption reduction, as much as urban forms or architectural technologies. Therefore, in order to further refine the coupled urban climate and energy consumption calculations, we will develop within TEB (and its Building Energy Module) a model of energy consumer behavior.

The second objective of the project is to propose a methodology to integrate quantitative data in urban policies. Lawyers analyze the potential levers in legal and planning documents. A few “best cases” are also studied, in order to evaluate their performances. Finally, based on urban planning agencies requirements, we will define vectors to include quantified energy-climate data to legal urban planning documents. These vectors have to be understandable by urban planners and contain the relevant information.

To meet these challenges, the project is organized around strongly interdisciplinary partners in the following fields: law, urban climate, building energetics, architecture, sociology, geography and meteorology, as well as the national federation of urban planning agencies.

In terms of results, the cross-analysis of input urban parameters and urban micro-climate-energy simulated data will be available on-line as standardized maps for each of the studied cities. The urban parameter production tool as well as the models will be available as open-source. LCZ and associated urban (and social!) indicators may be integrated within the WUDAPT database.

## Developing design guidelines for climate-responsive green infrastructure

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Climate-responsive green infrastructure in urban areas alleviates urban heat and enhances human health, well-being and thermal comfort. Green infrastructure encompasses the broad range of vegetated spaces or elements within cities that range from scale levels of urban greenways down to the level of gardens or green walls. There is a growing body of scientific micrometeorological knowledge about green infrastructure and its positive effects on urban climate and thermal comfort. However, only few studies translated that micrometeorological knowledge into utilizable design guidelines. Hence, micrometeorological knowledge about the climate-responsive effects of green infrastructure is hardly taken into account in the design of outdoor urban spaces. This leads to sub-optimal designs of the urban environment regarding its potential to contribute to human health, well-being and thermal comfort.

A major reason for this 'utility gap' is the rigidity of the scientific microclimatological knowledge when it has to be translated into design guidelines. The rigidity cannot easily be compromised with important issues of urban and landscape design, such as various functions in the city and their requirements and many other issues. Therefore, we investigated how design guidelines based on rigid micrometeorological results could be improved in terms of utility. To do so the design guidelines were implemented in design processes and thus subjected to other functional issues occurring in urban and landscape design.

Our research questions concerned various aspects describing the utility of empirically based design guidelines. These aspects include comprehensibility, applicability and feasibility. Comprehensibility is related to clarity and intelligibility of the design guidelines; are designers with their specialised knowledge able to understand meaning and content of the guidelines in order to apply them? Applicability describes in how far designers with their specialised knowledge are able to easily, flexibly implement the design guidelines in specific site situations? Feasibility is related to workability of the design guidelines; are the site specific conditions suitable for the implementation of the design guideline?

We used a 'Research through Designing' method that actively employs designing within the research process. Within this study we provided members of the professional community (landscape architects, urban designers and landscape architecture students) with the design guidelines that were derived from earlier micrometeorological research of green infrastructure in moderate climates. We then asked participants to actively apply these guidelines in two separate design processes; one for professionals, the other for students.

The research design comprised observations of the design processes, plan analyses of the design results and interviews with participants about their experiences during the design process. In all observations, plan analyses and interviews the focus was on the aspects of comprehensibility, applicability and feasibility of the design guidelines. The studies took place in a design studio of landscape architecture students at Wageningen University, the Netherlands (Atelier 2014) and a workshop for professional landscape architects and urban planners/ designers organized by the Aorta Centre of Architecture in Utrecht, the Netherlands (Aorta workshop 2014). We compared the outcomes of the plan analyses, observations and interviews.

Our results enabled us to refine the original 'rigid' design guidelines derived from empirical micrometeorological research. The refined design guidelines offer utilizable knowledge for climate-responsive designs of green infrastructure in moderate climates. This study, furthermore, shows the value of combining scientific evidence and practical knowledge of landscape architects urban designers to develop more utilizable design guidelines. Eventually, the application of design guidelines for climate-responsive green infrastructure in future urban design projects will result in more healthy and thermally comfortable outdoor urban spaces.

# Enhancing adaptation to climate change in urban environments through brownfield or vacant land

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Climate change, causing temperatures and sea levels to rise and an increase in the frequency and intensity of extreme events such as heat waves, droughts, heavy rainfall and storm events, presents risks to human and natural systems. Whilst mitigation actions have been acknowledged as essential for some time, adaptation has more recently emerged as a central area in climate change research, in country-level planning, and in the implementation of climate change strategies. In particular, increasing concern is being raised about the impacts of climate change on urban environments, their growing populations and valuable assets, and the urgent need to invest in adaptation strategies to ensure that urban areas are resilient to climate change.
Urban green spaces provide important ecosystem services, including climate services such as cooling and flood protection, which can increase the resilience of cities through aiding adaptation to climatic hazards. However, the high density of urban centres and restricted opportunities for new development are particular barriers affecting the local capacity to adapt cities to climate change, such as by enhancing the existing green space.

Many urban areas, particularly in post-industrial cities, however, have previously developed land scattered across a city suffering dereliction or abandonment due to the ownership status, contamination, and other reasons. Recent research has found that such brownfield or vacant land is of great biodiversity value and provides many other ecosystem services, such as important regulating and cultural services, and could be extremely important in aiding adaptation of urban areas to climate change. Thus, restoring brownfield land to greenspace should be promoted by planning policy. However, with competing development priorities, economic pressure in urban areas, and the traditional view that brownfields are degraded and unsightly environments, means that rates of brownfield development are high and key sites of importance for adapting urban areas to climate change may soon be lost.

This research frames and assesses the current services provided by brownfields and their benefits and contribution to adapting the city to climate change, and assesses their potential additional services if greened. Using Manchester, UK, as a case study, the research analyses the ecosystem services provided by individual brownfield sites with a focus upon those services that aid building resilience to climate change, using a range of indicators and geospatial datasets. Manchester's industrial legacy has left behind large numbers of derelict sites following the economic transformation to a predominantly service-based economy in the late twentieth century. There are now over 2,000 brownfield sites, occupying 42 square kilometres. The assessment aids strategic decision-making and assists planners in prioritising brownfield land most valuable in building climate change resilience in key areas across the city. The devised assessment framework is widely transferable to other cities experiencing similar concerns with previously developed or vacant land and requiring adaptation to climatic events such as heat waves, fluvial and pluvial flooding.

# How is urban climate taken into account in urban design? Focus on French eco labels of urban design

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Global warming leads to increase the extreme climatic events such as heat waves and urban areas, that concentrate population and economical activity, are particularly vulnerable to it. Indeed, the urban heat island amplifies the effect of heat waves. It can provoke dramatic consequences such as health issues for the inhabitants when the temperatures are high during summer time. Moreover, it can also affect water and energy supply causing energy breaks linked to high demand for cooling. In this context, it is a necessity to find a way for cities to adapt to the future climatic conditions. Using eco-labelling which prove environmental performance in urban design can be a solution. But one wonders if these preoccupations are discussed and taken into account in French current urban eco labels. This paper first proposes to question the way of how urban climate (and more broadly environmental quality) is considered in French eco labels of urban design. These labels such as « Ecoquartier » or « HQE aménagement » are known to require more than usual urban legislation. They are the most popular ways to think an urban design respecting the new paradigm of environmental quality. That's why this study aims to analyse how urban climate issues are treated in these labels, whether it be adaptation or mitigation questions. It aims to evaluate the importance accorded to these issues compared to the others themes that refer to environmental quality. In order to do this, several eco labels are selected and analysed in relation to environmental and climatic questions.

In a second time, we want to define the link between theory and practice. This analytic approach will be completed by the review of some specific cases of urban projects using these labels in order to analyse how climatic questions are taken into account through real cases.

By these analyses, we can develop the point that eco labels don't give the same importance to adaptation and mitigation questions. We can also presume that the transition from theory to practice can have consequences such as minimising the scope of some preoccupations.

# The Assessment Report for Climate Change in Cities (ARC3 -2) Urban Planninng and Design

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This ICUC Abstract is a draft excerpt based on the work in progress of the Second Assessment Report on Climate Change and Cities (ARC3-2) document. The final and complete document will be published in 2015 by Cambridge University Press, and launched by the end of 2015 at a side session at the 21st UNFCCC Conference of the Parties (COP21) in Paris. This abstract draws from the chapter on Urban Planning and Design, which attempts to bring together literature and strategies on how urban decision-making can enhance or moderate urban climate effects.

The chapter's research findings endorse the concept of adaptive mitigation: climate management activities designed to reduce the global greenhouse gas effect, while increasing climate resilience to urban heat and flooding (Stone, 2012). These activities are measured in terms of function and form, including:

* Urban functions: Reducing waste heat and energy emissions from human activities and infrastructure networks, including buildings, transportation, and industry

* Morphology: Configuring climate-responsive three-dimensional urban form comprising orientation, natural ventilation, and solar impacts

* Construction materials and surface coating: Optimally modifying the built environment's surface reflectivity and associated thermophysical properties

* Surface cover: Strategically enhancing the built environment's vegetative coverage

The chapter urges urban decision-makers to promote sustainable-resilient cities that:

* Prioritize investments in mitigation strategies that yield concurrent adaptive benefits, over mitigation strategies that do not

* Ensure long-range strategies across scales, jurisdictions and electoral time-frames

* Embed Climate-Responsive Design into Planning and Design Process

* Consider local conditions to generate climate-responsive strategies

* Deliver quality of life for urban citizens as the key performance outcome across all sectors

* Invest in social cohesion as key to resilience, whose success hinges on people-centred urban spaces

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**TUKUP4: Weather forecasting for city actors**

## From Urban Meteorology, Climate and Environment Research to Urban Integrated Services

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WMO recognizes that the rapid urbanization that is currently taking place will require new types of services making best use of science and technology and considers this problem as one of the main priorities. Such Integrated Urban Weather, Environment and Climate Services (Grimmond et al., 2014) should assist cities in facing hazards such as storm surge, flooding, heat waves, and air pollution episodes, especially in changing climates.

A number of recent international studies have been initiated to explore these issues. In particular relevant experience from the European projects FUMAPEX and MEGAPOLI will be demonstrated. MEGAPOLI studies aimed to assess the impacts of megacities and large air-pollution hotspots on local, regional and global air quality; to quantify feedback mechanisms linking megacity air quality, local and regional climates, and global climate change; and to develop improved tools for predicting air pollution levels in megacities (Baklanov et al., 2010). FUMAPEX developed for the first time an integrated system encompassing emissions, urban meteorology and population exposure for urban air pollution episode forecasting, the assessment of urban air quality and health effects, and for emergency preparedness (Baklanov et al., 2007).

While important advances have been made, new interdisciplinary research studies are needed to increase our understanding of the interactions between emissions, air quality, and regional and global climates. Studies need to address both basic and applied research and bridge the spatial and temporal scales connecting local emissions, air quality and weather with climate and global atmospheric chemistry. WMO has established the Global Atmosphere Watch (GAW) Urban Research Meteorology and Environment (GURME) project (http://mce2.org/wmogurme/) which provides an important research contribution to the integrated urban services.

The numerical models most suitable for integrated urban weather, air quality and climate forecasting operational systems are the new generation of limited-area models with coupled dynamic and chemistry modules (so called Integrated Meteorology-Chemistry Models (IMCM)). These models have benefited from rapid advances in computing resources plus extensive basic science research.

Current state-of-the-art IMCMs encompass interactive chemical and physical processes, such as aerosols-clouds-radiation, coupled to a non-hydrostatic and fully compressible dynamic core that includes monotonic transport for scalars, allowing feedbacks between the chemical composition and physical properties of the atmosphere. However, simulations using fine resolutions, large domains and detailed chemistry over long time durations for the aerosol and gas/aqueous phase are still too computationally demanding due to the models' huge complexity. Therefore, IMCM weather and climate applications must still make compromises between the spatial resolution, domain size, simulation length and degree of complexity for the chemical and aerosol mechanisms.

Representation of the urban land surface and urban sub-layer has undergone extensive development, but no scheme is capable of dealing with all of the surface exchanges. To complicate this further, the increasing resolution of models, combined with the large size of urban buildings in many cities, challenges the limits of current understanding.

Other research needs relate to secondary organic aerosols and their interactions with clouds and radiation, data assimilation that includes chemical and aerosol species, dynamic cores with multi-tracer transport efficiency capability, and the general effects of aerosols on the evolution of weather and climate. All of these areas are concerned with an efficient use of models on massively parallel computer systems.

Operational centres that base their products and services on IMCMs need to closely follow the evolution of the research and development of these coupled models, but they also need to interact with these activities. Research on basic physical and chemical processes and the development of numerical models and tools are integral and central components of reliable and accurate forecast products and services.

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## Numerical Weather Prediction System dedicated to Urban Comfort and Safety during the 2015 Pan-American Games in Toronto

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A Sub-kilometer atmospheric modeling system with grid-spacings of 1 km and 250 m and including urban processes is currently being developed at the Meteorological Service of Canada (MSC) in order to provide more accurate weather forecasts at the city scale. A real-time forecasting system has been designed over the Greater Toronto Area (GTA) and has provided forecasts for the last year, including new thermal comfort indices. Surface physical processes are represented with the Town Energy Balance (TEB) model for the built-up covers and with the Interactions between the Surface, Biosphere, and Atmosphere (ISBA) land surface model for the natural covers. Surface temperatures for the Great Lakes are prescribed using 2-km hourly output from an ocean model. This system is devoted to help issuing alerts during the Pan-American and para-Pan-American games in Toronto during July and August 2015 (Panam TO2015).

In this study, results from different weather conditions forecasted with this new system over the GTA will be presented. As typical summertime features, the region is concerned with localized heavy rainfall, complex lake-breezes flows, and with human discomfort during heat waves. Results will be confronted against observations gathered with the dense surface and atmospheric PanAm Observational network, as well as with traditionnal EC network.

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## Urban Climate Services in Hangzhou City, China

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Hangzhou, Zhejiang Province China has approximately quadrupled its population in the last 20 years. This megacity now has a population of close to 9 million people. Given its close proximity to Shanghai and the significant tourist attractions of the city, the number of people in the city is often significantly larger. The regional setting of this city, close to the coast and within the area that regularly experiences typhoons, with major rivers that are tidal (+/- 10 m a day), and surrounded by mountains, means this is a complex, weather sensitive area to provide climate services to those who need them. The objective of this talk is to consider the different aspects that need to be considered. These include: (1) Urban disasters, especially driven by flooding; (2) Environmental Services, especially driven by air quality related issues; (3) General public services, especially routine weather forecasts and indices delivered across multi-platforms of communication (TV, radio, web, twitter, text, hotline); (4) Economically sensitive services, especially electrical and water supply, and for tourism and agriculture. The combination of modelling and observations, across a range of time-scales will be considered. The challenges of needing to now-cast the impact of intense precipitation to ensure the safety of tourists, to ensure that the electrical supply agencies are aware of the most vulnerable locations for icing of transmission lines, and the public is prepared for the arrival of typhoons all will be considered in the context of a changing climate driven by both rapid urbanization, regional and global changes.

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## Urban Climate Services in China: Current capabilities and future needs

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China is rapidly urbanizing. Over the last two decades, the urban population has grown to well in excess of 700 million, with a doubling of the fraction of the population living in cities (26% in 1990 to 53% today). This is resulting in areas with large and dense populations, tall buildings (in Shanghai alone the number of buildings taller than 8 stories has risen from 3,500 to more than 32,000 in the last decade) and well-documented air quality problems. The complexity of these highly urbanised environments presents enormous challenges in providing the necessary climate services to cities and regions that are weather sensitive. The dense populations (exceeding 49000 people per km2 in Shanghai, for example) mean that extreme weather events expose large numbers of people to risks including typhoons, heat stress, air quality events, etc. In this talk attention will be directed to both current capabilities and future needs for urban weather and climate services for the range of different climate zones across China, with a special focus on the multi-scale needs. The results draw on a detailed survey and interviews with those providing and using existing services.

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## Climate information application for improved planning and management of cities

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In 2014, the population of Seoul and its surrounding metropolitan area exceeds 25 million people, which is about half of the national population of Korea. In Seoul, the population growth from one million (1942) to ten million (1998) was archived about half century and recent population of Seoul is slightly decreased since 1992 (12,245,960) despite the population increase of surrounding metropolitan area. As a result of this explosive urban growth, many kind of human-induced urban developments have changed the topography and land cover of Seoul. The changes of the land cover and the physical properties of the land surface during this period also induced the changes of air temperature, humidity, and wind. Korea also experienced a significant increase of the daily maximum temperature in major urban areas since 1960s. Many studies showed the increase of urban structure accelerated the growth in anthropogenic heats or urban heat island, which is usually called urban climatology by its climatic uniqueness. Since 2009, Climate Analysis Seoul (CAS) workbench as a rule-based urban climate analysis and evaluation tool has developed by KMA and TU Berlin to assess urban climate modifications caused by urbanization and to support the urban climate friendly decision-making in urban planning and design. During the period, project team have collaborated and improved an analytical workbench to determine the influence of buildings and vegetation areas on near-surface air temperature and wind conditions within the Seoul metropolitan area. Several results such as BioCAS, urban planning support, and urban design support were applicable. However, further challenges such expanding application area to enhance the reliability and extend the applicability, urban surface parameter development.

CAS workbench has a plan to extend the ground truth sources such as commercial telecommunication network based weather Information service, use of urban flux tower, radiosonde and LiDAR measurements field campaign. Additionally, CAS workbench will be integrated with other state-of-art models such as WRF-chem, CFD, SOLWEIG, PT to enhance the reliability and extend the applicability. Fundamentally, urban surface parameters which are more reliable and fit to Seoul metropolitan area will be developed. Finally, to make CAS workbench do its work, we shall develop more connections with neighbored projects. CAS project has a plan to integrate the developed workbench into the governmental urban planning supporting system until 2020.

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## Summer in the city - High Resolution Modelling and Validation of Urban Weather for Amsterdam

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It is well known that urbanization affects human thermal comfort and health, especially for vulnerable groups such as the elderly and people with established health issues. To mitigate adverse thermal comfort and accompanying excess mortality there is an urgent need of tools for forecasting urban heat on short to medium-ranged time scales. We present the setup of a prototype of such a high-resolution forecasting system which allows assessment of urban heat on neighbourhood and block scale. The forecasting system is based on simulations with the Weather Research & Forecasting (WRF) model with adapted parameterizations schemes and a novel 25-m resolution land use map, which is applied to the center of Amsterdam on a very high spatial resolution of 100 meter. These forecasts are validated against observations that were gathered during the summer of 2014 in Amsterdam. The observations include continuous observations from 25 fixed meteorological stations (temperature, humidity, and wind speed) in urban areas, bike traverses by mobile platforms (cargo bikes) equipped with state-of-the-art meteorological measurement devices (Heusinkveld et al., 2014), and stations operated by hobby meteorologists (Steeneveld et al., 2011). Besides the numerical forecasting system, we also evaluate the skill of a statistical downscaling (large-scale) algorithm that translates traditional weather forecasting system output for the rural environment of Amsterdam to the inner city. Both the validation of the forecasting system using WRF and its benchmarking against a statistical downscaling approach are performed for warm weather condition episodes that have been observed in Amsterdam during the summer of 2014.

**TUKUP5: Indicators and climate maps I : risks & vulnerability**

## Method for evaluating the health hazard risk in urban pedestrian space in extremely hot summer conditions based on the total analysis of mesoscale and microscale climates

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Health hazards in extremely hot summer conditions (e.g. heatstroke) have increased rapidly in recent years with urban heat island, severe weather, etc. In this study, the increase of heatstroke patients caused by extremely hot summer conditions was defined as a disaster and a new evaluation method for outdoor thermal environment based on the concept of risk evaluation was developed.

In order to assess the health risk in extremely hot conditions, the emergency transport rate of heatstroke was selected for evaluating the risk. Risk evaluation was performed using the emergency transport probability curve which is function of wet bulb globe temperature (WBGT) and outputs the emergency transport rate of heatstroke. Furthermore, outdoor thermal environment is often severer at the pedestrian height within urban areas than that above buildings due to the effects of increase in artificial ground cover, decrease in green space, etc. In other words, inappropriate urban planning amplifies a threat caused by weather conditions above urban area. To comprehend the increase in health risk caused by hazard amplification due to urban structures, risk amplification ratio was defined in this study. This index enabled us to evaluate whether the environmental urban planning of target urban area is suitable or not.

To present an example of the applications of this method, the hazard distribution was predicted by the total analysis of mesoscale and microscale climates for actual urban area in Sendai and the risk in extremely hot summer conditions and the risk amplification ratio were evaluated based on the hazard distribution. The result indicated that the roadside trees considerably reduced the risk.

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## Urban Heat Island measurements and sustainability maps to help access vulnerability and potential mitigation techniques in Birmingham and Auburn-Opelika, Alabama

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Urban Heat Islands and their thermodynamic nature can exacerbate the effects of severe weather events including heat waves and heavy precipitation. Thus it is important to understand the physical characteristics of individual cities, its vulnerabilities and potential for sustainable development to deal with the microclimatic variability within a city, UHIs and how they modify the dynamism of urban areas. This study compared the UHIs of a mid-sized metropolitan area in Alabama (Birmingham) to a small-sized urban area in Alabama (Auburn-Opelika). The research objectives of this study is to quantify magnitudes and intensities of the average monthly diurnal UHIs in Birmingham and Auburn-Opelika by measuring atmospheric temperature 6-8 feet above the ground (i.e. atmospheric UHI), using iButtons. The research will be conducted for the spring and summer months of 2014 and record hourly temperature data in order to analyze temperature patterns and variability. The results of this research will feed into another project which will build 'Urban Sustainability Maps' (USM) for Birmingham and Auburn-Opelika urban areas. Developing the USMs requires the collection and input of several different sets of data. The subsets of data include: climatic elements, such as Local Climate Zones (LCZs), temperatures, precipitation amounts, wind speed and direction, and humidity levels; geospatial information, such as Digital Elevation Models (DEMs), landuse maps, soil type maps, and topographic maps; and socioeconomic Data, such as population density and economic disparity within the cities. With the inclusion of the demographic data, USMs can assess potential effects on the city population from extreme weather events. GIS interactive layers like solar potential map, urban flood risk map, rainwater harvesting potential map will be created to benefit better future planning. Projects like this are significant given the likelihood increase of extreme climatic events like hurricanes, heat and cold waves, and global temperatures as stated in the Intergovernmental Panel on Climate Change (IPCC) V report. The results of this research will highlight the importance of mitigation procedures such as increased vegetation, green spaces, energy-efficient building practices, and a reduction in emissions; all of which would ameliorate the UHI and other anthropogenic effects.

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## Spatial analysis for climate vulnerability assessments: How much granularity do we need?

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Efforts to identify the high-risk areas within cities that are especially vulnerable to the impacts of weather extremes such as heat waves and floods developed rapidly in the last decade of increasing risk for coastal populations. Geospatial analysis is increasingly used to evaluate associations of a range of vulnerability characteristics at the intra-urban scale, including socio-demographic, biophysical, built environment and housing characteristics to population health outcomes during extreme events, such as hospital admissions or excess mortality. These climate-health spatial analyses tend to confirm prior findings of significant health disparities found in high-poverty and minority neighborhoods that endure similar patterns of health disparities for chronic diseases and for other environmental exposures. To evaluate whether six large American cities follow this spatial and social pattern, we use spatial analysis with vulnerability characteristics and mapping to identify intra-urban "urban climate and health riskscapes" and discuss their relevance for current municipal planning for hazard risk reduction and climate resilience. We conclude by proposing a new framework for assessing the spatial scales relevant for city climate risk assessments that support public investment in climate resilience.

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## Study of urban climate as a basis for climate adaptation and urban planning in Chilean cities

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Due to the fact that the impacts of climate change and vulnerability levels are geographically differentiated, it's critical to have high-quality spatial data for assessing these impacts and vulnerabilities, and from that analyse and propose strategies for adapting to climate change. At a national level (Chile), progress has advanced in determining sectoral impacts of climatic change, however the urban scale continues to be a developing area. The purpose is to analyse the relationship between climate and urban morphology in order to propose guidelines for adaptation to the potential and actual impacts of the local climate change process in Chilean cities that are under different climatic and geographical conditions. With meteorological information, temperature recorders, digital analysis of satellite images and field work the local climate zones (Oke), heat islands, thermal comfort and climate extreme indices in various cities are studied: Antofagasta, coastal desert; Calama high desert; Copiapó desert; Santiago, mediterranean, Valparaíso, coastal mediterranean, Chillán temperate; and Concepción coastal temperate, and climatically different urban settings are modeled: neighbourhoods, parks and urban canyons. We employed lidar data, Envimet and Echotect program, GIS modeling (ArcGIS), and interviews with relevant stakeholders (urban planners).

Cases directly or indirectly associated with urban climate and climate change are also reviewed: mudslides in coastal areas, Valparaiso fire, forest Panul in Santiago, Concepcion walkways and comfort.

Guidelines and adaptation strategies that should regulate remodeling, design and urban planning are proposed.

**TUKUP6: Indicators and climate maps II : urban planning**

## Experimental Modelling of Stratified Flows over Idealized Urban-like Roughness Elements

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Keywords: Air pollution, Atmospheric turbulence, Street canyons, Stably stratified flows, Building-height-to-street-width ratios (ARs)

On account of rapid urbanization and industrialization, the adverse impact of built environment have become noticeable. There is a need for accurate prediction of ground-level air pollutant concentrations in order to help understand the air quality in the atmospheric boundary layer (ABL) over urban areas. Stratified flows, which are commonly found in nocturnal ABL environment, generally suppress vertical mixing of mass and momentum. However, only a few studies have been conducted for the stratified flows over the urban areas. In this study, a series of reduced-scale physical modelling using water channel is employed to study the pollution dispersion mechanism over urban-like roughness elements. The reduced-scale models are fabricated by square acrylic bars placed in different separation, forming hypothetical urban areas in the form of idealized street canyons of building-height-to-street-width ratios (ARs) in the range of 1/10 to 2. The size of the acrylic bars is selected to minimize the blockage and to ensure the fully developed turbulent flows as well. Based on the flow velocity and water depth, the Froude number is varied from 2 to up to 4. Preliminary results of the mean profiles of streamwise and vertical velocities are plotted. The fluctuating velocities for flows over the urban roughness elements of different ARs are also plotted to compare with the results from large-eddy simulation (LES). The experiments simulate well the night-time ABL in which the flows are shallow with strong shear. Analysis of the turbulence characteristics over different roughness elements is performed to compare with the current LES results. It is found that the current LES results generally describes the results from the water channel experiment well.

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## Thematic visualization of built environment using microclimatic coupled mapping methodology to support urban neigbourhood Design

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Abstract: In order to understand the relation between urban neigbourhood design and its effects on microclimate, two experimental software cycles have been applied to a newly designed urban site in Cairo. These cycles were applied for outdoor-indoor microclimate meteorology generation; also a 3D web based modelling method was used to increase the awareness in the Egyptian research society about the importance and benefits of climate based urban design. The first cycle was shown by visualizing meteorological output data. The concluded thematic maps were then plotted on the 3D models in the second cycle. Results in terms of 3D meteorological mapped perspectives of the selected site show a strong relation between outdoor and indoor conditions for architects and urban planners who may not normally deal with the many interdisciplinary field of urban climate. However, these results show that climate based modelling using CAAD can become an informative process specifically to support sustainable design and climate change awareness. It also proves the effectiveness of adopting passive design options such as green roads in urban neighborhood design.

Keywords: Thematic visualization, coupled mapping, outdoor-indoor meteorology coupling, climate based CAAD, climate change, green roads.

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# Preparing urban climate maps using Local Climate Zones (LCZ) methodology to improve communication with urban planners: the case of Tandil city, Argentina

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Local Climate Zones (LCZ) is a new methodology to improve the characterization of urban station localization. This new methodology has great potential to prepare urban climate maps and improve the way of communicating the results of urban climate research to urban planners. These kinds of maps are a highly accurate way to inform of the application of new mitigation strategies related to the climatic and construction characteristics of a city.

Tandil is a mid city located in Buenos Aires province in Argentina. It has a transition temperate climate and is surrounded by the center of Tandilia's Hill System from west to south. It takes up the top and middle basin of river Langueyú. The city's population is of 116,916 inhabitants and it has a diversified economy with a well developed service sector.

This is the first study in it's kind in Argentina. The preparation of the LCZ map of Tandil takes into account such climatic information as temperature, humidity, precipitation, wind and comfort. This data was obtained throughout a three year measurements using meteorological stations and transect methods. Urban characterization parameters regarding construction, population density and land use were employed to build up the LCZ map.

As a result, 17 LCZs were determined in Tandil, each one with its own climatic and construction characterization. The analysis of each LCZ situation puts into context the need to improve the already existing urban development plan which does not take into account climatic parameters. The mitigation strategies were mainly based on three types of intervention: gas emission control, improvement of urban vegetation and some construction restrictions.

The map made it possible to improve the communication of the results to the urban planner since it contains the climatic and construction characteristics of each zone, the relation between both and the mitigation strategies that should be implemented to mitigate the negative effects that changes made by the city construction have caused in the population.

## Urban Climate Zoning for Making "Hint Map for Urban Planning"

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In recent year, urban heat island phenomena caused by land cover change or increase of anthropogenic heat release occurs in many cities of Japan. The temperature rises in urban area because of this urban heat island phenomenon and global climate change. Accordingly, various problems have happened, for example, the uncomfortable outdoor environment in summer, the increase of energy consumption, the effect on urban ecosystem and the damage to human health. In Hiroshima, reportedly, the severe urban heat island phenomenon engenders high temperatures. Therefore, urban planning incorporating mitigation of the urban heat island phenomenon is needed in Hiroshima. The authors intend to produce Urban Environmental Climate Maps of Hiroshima as the ultimate objective of this study.

Few examples in which planners (or stakeholders) consider urban heat island phenomenon mitigation based on scientific knowledge in their planning processes exist. That is true apparently because the urban climate phenomenon is difficult to understand for stakeholders: residents, local government officials, designers, and planners. UECMs are therefore proposed as a tool for supporting urban planning. Although trial UECMs incorporating urban heat island mitigation have been made in Japan, their definition is slightly different due to each of them. Therefore, the authors supply a definition for UECMs as follows. “UECMs are made for urban planning, architectural design, and environmental policy making that considering urban heat island mitigation. The role of this map is to provide some information from the view of urban climate to the place of decision making (including public involvement). Therefore, the purpose of creating these maps is to support design. On UECMs, the essence of climate research results and recommendations by experts are described. When stakeholders (citizen, planner, architect, specialist, and so on.) make decision about urban planning, architecture design, and environmental policy making, they and experts can use these maps as communication tools.” Actually, UECMs consists of a Climate Analysis Map (CAM) and a Hint Map for Urban Planning and Design (HM). The role of CAM is representing actual climate conditions. That of HM is representing the recommendations for urban planning and design.

In Japan, trial UECMs has been made for Tokyo and Osaka. Those maps, which show the present climate conditions of the object area (e.g. wind patterns), are thought to be effective in elucidating present climate conditions. However, when trying to produce an urban plan that incorporates urban heat island mitigation, practical countermeasures are difficult for many people to decide. UECMs should therefore include recommendations for urban planners. On the other hand, some maps presenting recommendations have been made at the district level, showing some proposals from a climatic environment perspective. However, such maps showing recommendations for entire city areas are also needed. Because stakeholders must incorporate various elements in their process when they plan the whole city area, the map should show issues to be considered in planning processes and climatic resources, rather than only actual proposals. Therefore, indicating zones that are classified from a climatic perspective is thought to be effective. This study analyzes the urban heat island phenomenon in Hiroshima using a meso-scale meteorological model and observed data, yielding a climate zoning based on the analyses, with a map providing hints for planning.

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## A GIS-based Modelling-Mapping Approach for Fine-Scale Natural Ventilation Evaluation in High Density Cities

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Analysis of urban aerodynamics properties is important on urban planning and design to improve the current living quality in high-density urban areas. These analyses, particularly at pedestrian level, depend on high resolution modeling. Aerodynamic modelling for the real urban design or planning project requires high computational cost; thus, modelling results cannot sustain quick planning and design processes. Therefore, this study aimed to develop a low-cost Geography Information System (GIS)-based modelling–mapping approach to estimate and map the pedestrian-level wind speed at high resolution for the urban planning and design practices. Based on the analysis of the momentum transfer in the street canyon, the point-based distance-weighted frontal area density (lambda f-point) was developed as a new indicator to evaluate city-scale air ventilation. Annual average wind speed data from wind tunnel experiments were entered into regression models with lambda f-point. lambda f-point was validated as a good indicator to assess the annually average wind environment, and the regression equations were correspondingly developed to estimate the pedestrian-level wind speed by pixel (1m × 1m). This GIS-based modeling–mapping approach consumes considerably less time and requires less support technology compared with CFD simulation and wind tunnel experiments. Using this practical tool with GIS data, urban planners and architects can easily estimate local near-ground wind environment and optimize proposed planning and designs at the beginning of design procedure to improve the environmental quality in urban areas.

**TUKUP7: Warning plans & Decision support tools**

## CLIMATIC CHANGE ADAPTION AMIDST OTHER ENVIRONMENTAL HAZZARDS

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It is suffice to constantly assess community vulnerability and capacities with regard to climatic change and build their resilience through adaptation efforts, complementing mitigation efforts aimed at reducing the rate and magnitude of climate change. This framework has shifted from Disaster management to a sustainable approach of Disaster risk Reduction. Disasters are associated with extreme weather events. Climate change directly interacts with the exposure to climatic extremes. The challenge in the context of adaptation is to move from the understanding that climate change is occurring to concrete measures that reduce existing vulnerabilities of human and ecological systems. The focus in this study is the effects and responses of flood risk imposed by storm water among the urban poor living in the highly vulnerable shanty neighborhoods on the outskirts of Kampala city centre. It explores the underlying vulnerabilities of the two areas and the challenging problem of how to effectively shape human institutional responses to the risk of natural disasters with a special focus on floods. The social risk management and asset-based approaches on which the study is based provide a conceptual framework for understanding the sequential links between risks; human exposure and sensitivity; the impacts of risky events; and risk management strategies. The outcome of the study shows marked differences in the vulnerability factors and the management of flood related disasters in the two study areas. Furthermore, it was revealed that the indigenous coping mechanisms employed by the poor may become less effective as increasingly flimsy livelihood systems struggle to withstand disaster shocks. Strategies to reduce vulnerability should be entrenched in vulnerability analysis and greater understanding of both household-level and universal-response options that are available to decrease the vulnerable exposure to climate risk

Keywords: Storm water, flood risk, Climate change adaptation, Vulnerability, Kampala, Disasters, shanty neighborhoods

## Water Induced Livelihood Impact and Adaptation Strategy of Farming Households in Manohara River, (A peri-urban area of Kathmandu, Nepal)

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Abstract

People living in the flood plains of peri-urban area are vulnerable to the damages caused by recurrent annual floods and flood induced land degradation resulting from river channel shifting, bank cutting and deposition of coarse sediments in the land along the river course. The degradation of the land and land based resources are crucially linked to the livelihood of the people living in the flood plains. People develop their own adaptive strategies to respond to flood and flood induced land degradation. This study based on urban flood responses stems from the argument that the processes of degradation of land and land based resources in the flood plains of the rivers and peri-urban people's responses to degradation from each damaging event go simultaneously. These responses, when aggregated, constitute the livelihood adaptation strategy of the people in the flood plain of the rivers. This study attempted to understanding the pattern of damages to land and land based resources as a result of flood and flood induced land degradation, the causes thereto and the responses of the people to the damages and using these responses in understanding the adaptation strategies of the people. The study was focused to 5 km long peri-urban stretch of the river that had known history of shift in the river channel in the recent past. The study involved both qualitative and quantitative approaches in collecting and analyzing relevant information. An important part of the study methodology was analyzing the shift in the river course at different periods of time. This was carried out by defining the river alignment for three time periods- 1992, 1998 and 2006 on available maps of the area.

The study pointed to the need of developing urban land use policy for Kathmandu valley considering rapid urbanization in the valley which is expected to accelerate in future. Delineating the river waterway and defining the boundary of the private property along the river course was identified to be most important initiative to this end in order to maintain river ecology. The average lateral shift of 121.60 m in the river channel between 1992 and 2006 indicated that the channel width of 80 m set by cadastral map of 1964 was unrealistic considering that the lateral shift in the river course had been larger than this amount in merely 15 years time span between 1992 and 2006. Rivers have their own flow characteristics, morphology and flow path, therefore safe and free passage for the river rather than people containing or putting restrictions of any kind on the river flow, would be desirable to maintain river ecology. Enforcing restrictions on river bed sand mining and regulating the mining of sand from the pit reserves along the river course was found to be desirable initiative to minimize environmental damages in the area that would be crucial in maintaining the river ecology.

Key words: peri-urban, river shifting, adaptation, urban floods

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## Assessing the health impact of the Urban Heat Island of Birmingham, UK

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Although there has been some research on the impact of extreme weather on the number of ambulance call-out incidents, especially heat waves, there has been very little research on the impact of cold weather on ambulance call-outs and response times. In the UK, there is a target response rate of 75% of life threatening incidents (Category A) that must be responded to within 8 min. This research compares daily air temperature data with ambulance call-out data for Birmingham over a 5-year period (2009–2014). A significant relationship between extreme weather and increased ambulance call-out and response times can clearly be shown. Both hot and cold weather have a negative impact on response times. In December 2010 (the coldest December for more than 100 years), the response rate fell below 50% for 3 days in a row (18 December–20 December 2010) with a mean response time of 15 min. For every reduction of air temperature by 1°C there was a reduction of 1.3% in performance. Improved weather forecasting and the take up of adaptation measures, such as the use of winter tyres, are suggested for consideration as management tools to improve ambulance response resilience during extreme weather. Also it is suggested that ambulance response times could be used as part of the syndromic surveillance system at Public Health England (PHE).

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## The Urban Heat Island effect during heatwaves in Melbourne

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In urban areas the health of the population can be adversely affected during extreme heat conditions, leading to increases in hospital admissions and even deaths. Urban temperatures are regulated by both synoptic weather conditions and factors associated with the land surface. While urban areas are subject to higher than normal temperatures due to both heatwaves and the Urban Heat Island (UHI), it is not yet known the extent to which these co-occur. The city of Melbourne has a typical UHI of between -3.2°C and 6.0°C, yet its typical strength during heatwave conditions has until now been unknown. Therefore, this research examines the association between the UHI and heatwaves and whether they are exacerbated, or dampened, by an UHI effect. Temperature data from urban and rural locations in and around Melbourne are used to determine the magnitude of the UHI during heatwave and non-heatwave conditions. If there is some contribution from an UHI during extreme heating, there exists the potential to partially mitigate any associated health impacts through urban design.

Given the adverse impacts of heatwaves on health in urban areas it is imperative that any potential additive effect of the UHI on heatwaves is quantified. This is particularly pertinent given the future increases in heatwaves that are likely with human-induced climate change. The proportion of Australians living in capital cities is expected to increase into the future, with the percentage expected to rise from 66% in 2013 to 72% in 2053. The percentage of elderly and heat-vulnerable will also increase. When combined with this expectation of future increases in Australia's urban population, increasing heatwaves will have the potential to increase the number of heat related deaths in urban areas in Australia. This research improves the current understanding of the interactions between heatwaves and urban areas to better inform decisions around heat sensitive urban planning and design and health adaptation and management during heatwave conditions in urban areas.

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## Communicating Climate Change to Urban Planners in the Great Lakes: Cities Impacts and Adaptation Tool

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Climate change is already impacting the Great Lakes region and cities are beginning to plan ahead to prepare themselves for bigger impacts in the future. But what changes can they expect and what can they do to adapt to these changes? The Great Lakes Adaptation Assessment for Cities (GLAA-C) project has created the Cities Impacts and Adaptation Tool (CIAT) to provide decision makers at the municipal level with the data they need to begin planning for a changing climate. The CIAT is an online climate adaptation planning support tool for decision makers at the municipal level in the Great Lakes region. It provides usable local-scale data such as demographic and socioeconomic data from the Canadian and US Census, current and projected climate trends, and adaptation strategies pulled from existing municipal planning documents from across North America. It also identifies a unique set of "climate peer" cities, or cities whose current climate matches your city's projected climate, through an interactive map interface. The CIAT provides both current and projected climate trends at the climate division scale. To show how climate change has already affected the Great Lakes Region, the CIAT compares current seasonal and annual average temperature and precipitation for the period 1981-2010 to previous averages from 1951-1980. Additionally, the CIAT includes mid-century climate model projections for the period 2041-2070 to show how the user city's climate may continue to change in the future. For more precise information, the CIAT also provides climate station data for the Great Lakes Region. This includes average seasonal temperature and precipitation data at the city level, as well as information on days per year with extreme heat or precipitation. The seasonal averages are important for everyday operation, but it is these extreme events are the most harmful to human health and city infrastructure and recovery can be expensive. The CIAT matches this data to the user city's nearest climate station for easy comparison. Using this information, the tool identifies a potential network of cities from a set of all cities in the Eastern US and Ontario to help you find relevant information. This network of "climate peer" cities, which are cities whose current climate matches the projected climate of the user's city, are displayed through an interactive map interface. By looking at the peer city's conditions, the user gains an idea of what they may expect to face in their own city in the future. The user may also opt to filter these climate peer cities by socioeconomic and demographic data to identify which of those cities are most similar to their own city. In order to provide usable on-the-ground solutions to your climate adaptation concerns, the CIAT also includes a searchable database of over 500 unique adaptation strategies pulled from 53 existing municipal plans, ranging from climate action plans to hazard mitigation and stormwater plans, from 24 cities across the US and Canada. The user can search this database by several criteria, such as climate impact or region. The CIAT also contains links to each plan so the user may further explore any strategy in a

greater context. However, the CIAT is just the beginning. Planners in the Great Lakes region can use this tool to gain access to relevant climate data and adaptation strategies for their own use, but using their climate network to gain contacts in other cities can lead to great case study or even partnership opportunities moving forward. Publicly accessible tools like the CIAT will play a critical role in climate planning at all stages of city engagement and preparedness, especially in cities with limited time and resources. This presentation will run through the theory and features of the CIAT, as well as case studies of cities using it for planning purposes.

## Science communication with analysis by stakeholder themselves

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In general, detailed physical mechanisms of the urban climate knowledge are the black boxes for public, and stakeholders. Therefore, careful introduction and explanation are necessary when the topics are related with some kinds of stakeholders. In addition, it is frequently observed that the statement of the assessment submitted by different associations conflicts each other, even though these statements are completely analyzed with the scientific processes. These conflicts read confusions to stakeholders. One of the reasons to cause these conflicts is that the conditions of these analysis and model are not clear. To overcome these conflicts and confusion, we introduce some tools with which the stakeholder can analyze the topics by themselves. The procedure will cause concern to them, and they can deeply discuss the topics on the consensus conference using the data obtained from their own analysis. In this presentation, we introduce an outline of the tools. In addition, the importance of "bi-directionality" using the information and communication technology is also discussed.

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## The CapaCities project: from Concepts to Actions for a Proactive Adaptation of Cities

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This paper presents the research project CapaCities (from Concepts to Actions for a Proactive Adaptation of Cities). The project builds on previous results about the difficulty, for urban designers, to rely on quick-fix solutions to fully participate to sustainable urban development (Bonhomme, 2013; Dubois, 2014). Even if knowledge about sustainable urban development is increasing and several related design-aid tools have been created, a major issue remains: those tools hardly find their way into the professional practice. As explanations, two problems are identified in literature. The first one is the lack of interdisciplinarity and interoperability among existing tools. The second one is that tools, typically designed by research scientists, are not suited to the urban planner's needs. There is some evidence that their experience and insight are rarely acknowledged.

The purpose of this research project is to create a prototype version of a multicriteria design-aid tool that is able to address the two aforementioned problems.

The first objective is to increase the suitability of the tool for urban planners. One major issue is the level of details given by existing tools that is often too precise and specific to be truly useful for the professionals. With this in mind, interviews and workshops are conducted with urban planners to acknowledge and document their specific way of understanding and using data. In addition, the results should allow us to identify new ways to integrate their experience and insight into the design of a new multicriteria tool. The paper will detail the methodology of these interviews and the main findings.

The second objective is to support interdisciplinarity. In order to do so, the tool will gather the results of several research projects conducted by some of the CapaCities project team members over the past years with regards to (1) energy consumption, (2) renewable energy production and (3) urban microclimates. The tool will be based on a GIS platform (as this type of tool is well known by urban planners) calculating simplified and aggregated indicators to guide the designer through the differents stage of their project.

The prototype version of the multicriteria design-aid tool will be tested in partnership with the professionals involved in the development of real urban projects located in the Toulouse metropolitan area.

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# UMEP - An integrated tool for urban climatology and climate-sensitive planning applications

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The urban climate is influenced by processes taking place at a range of different scales. Based on application (e.g. land surface or thermal comfort modelling), the appropriate scale has to be considered to make accurate estimation of the phenomena examined. Furthermore, the interaction of processes taking place at different scales makes it important to accurately couple and understand the different scale-dependent processes controlling the urban climate and thus outdoor thermal comfort. In this paper UMEP (Urban Multi-scale Environmental Predictor), an integrated tool for urban climatology and climate sensitive planning applications is presented. The tool can be used for a variety of applications related to outdoor thermal comfort, urban energy consumption, climate change mitigation etc.

UMEP combines “state of the art” 1D and 2D models related to the processes essential for scale-independent urban climate estimations. The models include SOLWEIG (Lindberg and Grimmond 2011), SUEWS (Järvi et al. 2013), BLUEWS (Onomura et al. 2014) and LUCY (Allen et al. 2011) where each individual model has been extensively evaluated. Here, the new combined system is demonstrated and evaluated. The modelling system is designed to run from the street canyon to city scale (100-105 m) depending on the application. The ranges of scales are those that need to be understood for most urban climate, architectural and/or urban planning projects. The model is able to estimate a number of variables that relate to, for example, spatial variations of urban surface energy exchanges, or boundary layer developments. The ambition is to develop a tool designed for planners and architects, which, at the same time, can be used in more advanced research applications.

In order to easily use UMEP a major characteristic is the ability for a user to interact with spatial information to determine model parameters. This requires a dynamic approach where spatial data at different scales and from a variety of sources are needed. This is accomplished by using an existing application programming interface (API) for spatial data. UMEP makes use of QGIS - a cross-platform, free, open source desktop geographic information systems (GIS) application - that provides data viewing, editing and analysis capabilities. QGIS is both extendable by plugins and reducible to only the essential core features needed. Substantial advantages are offered by having GIS-software tightly coupled to the model. These include the ability to read and write a variety of geodata formats, ease of combining geodatasets so issues such as coordinate systems and scale are natively dealt with, visualization of inputs and outputs, and direct calculation of model parameters by pre-processing geodata thus reducing the number of preparation stages required and ensuring consistency between models and users.

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# Integration of adaptation to climate change within the design process of urban planning projects : new tool(s) and new methodology(ies)

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Climate change (CC) is acknowledged to be a fact and as stated in the IPCC reports, changes are already observed and future ones can even more noticeable. Future CCs will mainly depend on the progress on the reduction of greenhouse gases (GHG) emissions, hence, on the energy policies implemented in the countries with the greatest fossil fuels consumptions. It can be understood that urban areas will play a key role. Indeed, as stated by the International Energy Agency, more than two thirds of the world's energy consumption and more than 70% of GHG emissions can be observed over urban areas. Yet, the most suitable means are available over the urban areas in order to face CCs, hedge against them and adapt to their impacts.

At present, transition towards low carbon cities seems to be an issue of concern, nevertheless, this issue cannot be thought separately from the question of adaptation to CCs and the need to adapt to changing climatic conditions. Extreme climatic events like the 2003 heat wave that occurred over Europe, revealed that urban areas are maladapted to such extreme heat conditions. This can be explained by the urban heat island effect which could be intensified by CC.

For years French territorial authorities have been supporting actions to reduce GHG emissions. Adaptation concern is more recent. Uncertainty concerning climatic projections hamper decision making concerning adaptation actions. Moreover such actions are not seen as rewarding and valuable from the citizens' point of views and can be even seen as a failure of the efforts done in order to hedge against CC.

Despite these barriers, there is place for action, not inaction. Due to the long life-cycle of buildings (typically 50 years), the importance of the stock and the low annual rate of new construction (about 1% of the stock), the impact of future climate on some key issues have to be anticipated. At the very local level of urban planning projects, the assessment of energy consumption over the life-time period is based on past temperature information, and not on future one. Since 2000, building energy regulations take confort during hot periods into account. This can be considered as a first step towards the integration of future evolutions of climate. Thus, urban planning projects are not currently assessed based on future climatic conditions which could have consequences on heating and cooling energy consumptions as well as on water demands. Therefore, considering, starting from today, the question of adaptation to CC would help avoid actions initially envisaged in order to reduce vulnerability to CC but at the end conducing to even worse effects like the accentuation of CC risks and the vulnerability increase of third parties (i.e. maladaptation).

The present paper presents a new methodology that aims to better address the complexity related to the question of adaptation to CC at the scale of urban planning projects. A particular attention is given on both adaptation and mitigation issues. This methodology is based on the development of a novel tool allowing to compute mainly energy consumption of an urban planning project based on different climatic scenarios. In addition the methodology proposes the participation of all the stakeholders in order to involve them in the innovation process.

## Review of tools for Quantifying the Contribution of Green Infrastructure to Carbon Performance

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The exchange of carbon between the atmosphere and biosphere is an important factor in controlling global warming and climate change. Consequently, it is important to examine how carbon flows and cycles between different pools and how carbon stocks change in response to afforestation, reforestation, and deforestation, and other land-cover, land-use activities.

Eco-cities and green-cities are emerging concepts for the retrofitting of our urban areas and important component in the creation of more sustainable development towards climate change adaptation and mitigation.Green infrastructure as a key part of Eco-cities and green-cities contributes as a major ecological pool for carbon cycles. The term “green infrastructure” refers to an interconnected network of landscape assets that are intertwined with engineered (grey) infrastructure and buildings.

The ability to assess the performance of green infrastructure, based on measurable criteria at a variety of temporal and spatial scales, is critical for defining the difference between effective and non-effective scenarios for sustainable urban development.

This paper aims to identify the most relevant evaluation tools, applications and methods for quantifying the carbon performance of green infrastructure.

The existing quantitative tools used to measure green infrastructures sustainable performance are varied in terms of the scale, components and input. This study has identified and tabulated the most relevant tools for quantifying the features and carbon services of green infrastructure. This will help policymakers, environmental groups and researchers to choose the most appropriate tool(s) for the intended context and it will lead them to a more useful and accurate carbon foot printing assessment outcome.

Key words: Green infrastructure, greenhouse gas emissions, carbon performance, assessment, valuation toolkits, sustainability, infrastructure

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## Results from the LUCIL research project for climate-smart urban planning in Lagos megacity, Nigeria

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Abstract

The urban heat island (UHI) is a well-known effect of urbanisation and is particularly important in world megacities of which Lagos, Nigeria is one. Overheating in such cities is expected to be exacerbated in the future as a result of further urban growth and climate change. Quantifying the UHI and demonstrating the impact of individual design interventions to ameliorate its effects is currently difficult due to lack of data and understanding of the phenomenon in Lagos.

The purpose of this article is to give an overview and some preliminary results from the ongoing research that is being conducted as part of the LUCIL (‘The Assessment of the Local Urban Climate in Lagos) research project and its application to the planning of a sustainable future climate-smart and resilient megacity.

The UHI effect is significant and there is a growing recognition of the existence of the complex relationship between built form, urban processes, local temperature, comfort, energy use and health. Developers and planners are seeking advice on design decisions at a variety of scales based on scientifically robust, quantitative methods. The LUCIL project will develop a set of tools that (1) quantify the effect of urbanisation processes on local environmental conditions, and (2) quantify the impact of such conditions on thermal comfort, energy demand and health. The use of such tools is vital, both to inform policy but also to be able to demonstrate compliance with it.

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At present, transition towards low carbon cities seems to be an issue of concern, nevertheless, this issue cannot be thought separately from the question of adaptation to CCs and the need to adapt to changing climatic conditions. Extreme climatic events like the 2003 heat wave that occurred over Europe, revealed that urban areas are maladapted to such extreme heat conditions. This can be explained by the urban heat island effect which could be intensified by CC.

For years French territorial authorities have been supporting actions to reduce GHG emissions. Adaptation concern is more recent. Uncertainty concerning climatic projections hamper decision making concerning adaptation actions. Moreover such actions are not seen as rewarding and valuable from the citizens' point of views and can be even seen as a failure of the efforts done in order to hedge against CC.

Despite these barriers, there is place for action, not inaction. Due to the long life-cycle of buildings (typically 50 years), the importance of the stock and the low annual rate of new construction (about 1% of the stock), the impact of future climate on some key issues have to be anticipated. At the very local level of urban planning projects, the assessment of energy consumption over the life-time period is based on past temperature information, and not on future one. Since 2000, building energy regulations take confort during hot periods into account. This can be considered as a first step towards the integration of future evolutions of climate. Thus, urban planning projects are not currently assessed based on future climatic conditions which could have consequences on heating and cooling energy consumptions as well as on water demands. Therefore, considering, starting from today, the question of adaptation to CC would help avoid actions initially envisaged in order to reduce vulnerability to CC but at the end conducing to even worse effects like the accentuation of CC risks and the vulnerability increase of third parties (i.e. maladaptation).

The present paper presents a new methodology that aims to better address the complexity related to the question of adaptation to CC at the scale of urban planning projects. A particular attention is given on both adaptation and mitigation issues. This methodology is based on the development of a novel tool allowing to compute mainly energy consumption of an urban planning project based on different climatic scenarios. In addition the methodology proposes the participation of all the stakeholders in order to involve them in the innovation process.

# Review of tools for Quantifying the Contribution of Green Infrastructure to Carbon Performance

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The exchange of carbon between the atmosphere and biosphere is an important factor in controlling global warming and climate change. Consequently, it is important to examine how carbon flows and cycles between different pools and how carbon stocks change in response to afforestation, reforestation, and deforestation, and other land-cover, land-use activities.

Eco-cities and green-cities are emerging concepts for the retrofitting of our urban areas and important component in the creation of more sustainable development towards climate change adaptation and mitigation.Green infrastructure as a key part of Eco-cities and green-cities contributes as a major ecological pool for carbon cycles. The term “green infrastructure” refers to an interconnected network of landscape assets that are intertwined with engineered (grey) infrastructure and buildings.

The ability to assess the performance of green infrastructure, based on measurable criteria at a variety of temporal and spatial scales, is critical for defining the difference between effective and non-effective scenarios for sustainable urban development.

This paper aims to identify the most relevant evaluation tools, applications and methods for quantifying the carbon performance of green infrastructure.

The existing quantitative tools used to measure green infrastructures sustainable performance are varied in terms of the scale, components and input. This study has identified and tabulated the most relevant tools for quantifying the features and carbon services of green infrastructure. This will help policymakers, environmental groups and researchers to choose the most appropriate tool(s) for the intended context and it will lead them to a more useful and accurate carbon foot printing assessment outcome.

Key words: Green infrastructure, greenhouse gas emissions, carbon performance, assessment, valuation toolkits, sustainability, infrastructure

# Results from the LUCIL research project for climate-smart urban planning in Lagos megacity, Nigeria

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Abstract

The urban heat island (UHI) is a well-known effect of urbanisation and is particularly important in world megacities of which Lagos, Nigeria is one. Overheating in such cities is expected to be exacerbated in the future as a result of further urban growth and climate change. Quantifying the UHI and demonstrating the impact of individual design interventions to ameliorate its effects is currently difficult due to lack of data and understanding of the phenomenon in Lagos.

The purpose of this article is to give an overview and some preliminary results from the ongoing research that is being conducted as part of the LUCIL ('The Assessment of the Local Urban Climate in Lagos) research project and its application to the planning of a sustainable future climate-smart and resilient megacity.

The UHI effect is significant and there is a growing recognition of the existence of the complex relationship between built form, urban processes, local temperature, comfort, energy use and health. Developers and planners are seeking advice on design decisions at a variety of scales based on scientifically robust, quantitative methods. The LUCIL project will develop a set of tools that (1) quantify the effect of urbanisation processes on local environmental conditions, and (2) quantify the impact of such conditions on thermal comfort, energy demand and health. The use of such tools is vital, both to inform policy but also to be able to demonstrate compliance with it.