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Applied Urban Modelling 2015 (AUM2015)
Green Cities

24-26 June 2015
Little Hall, Sidgewick Site, Cambridge, CB3 9DA, UK.

Conveners:

Ying Jin, Steve Denman and Claudio Martani
Department of Architecture, University of Cambridge

Scientific Committee:

Marcial Echenique (University of Cambridge)
Mike Batty (Centre for Advanced Spatial Analysis, UCL)
Michael Wegener (Spiekermann & Wegener Urban & Regional Research, Dortmund)

Conference Summary:

AUM2015 is the fifth in a planned series of annual symposia on applied urban simulation models. The symposia offer insights into different aspects of urban change and the realisation of practical policy initiatives. Since the launch of the AUM series in 2011, the symposia have attracted delegates from a wide spectrum of disciplines, universities, professional institutions and government agencies in many countries.

The overarching theme of AUM2015 is ‘green cities'. The term ‘green’ is defined in its wider sense. It highlights the growing importance of urban ecosystem services and green space across the world’s city regions, whilst addressing the grand challenges of urban sustainability. The symposium themes aim to place the discussions on urban ecosystem services, green space and environmental sustainability in the practical urban development context, i.e. to treat them as integral components in rationalizing urban energy use, in reducing the emissions of and human exposures to pollutants, in improving urban air quality and the quality of life, in addressing social inequality, and ultimately in finding feasible pathways to transform cities today into liveable habitats for all citizens.

Symposium sessions (as presented)

Day 1 – Wednesday 24th June	
9.00	**Registration opens; Marquee, Lady Mitchell Hall Lawn; Tea and coffee**
10.00	**Symposium Opens** • **Wendy Pullan** (Head of Department of Architecture, University of Cambridge, UK) *Opening address* • **Marcial Echenique** (University of Cambridge, UK) *Introduction*
10:45	**<u>Session 1: Understanding the urban economy and infrastructure (Chair: David Newbery and Ying Jin, University of Cambridge)</u>** • **Alex Anas** (SUNY Buffalo, US) and Ioannis Tikoudis (VU University Amsterdam & Tinbergen Institute, Netherlands): *Numerical solution of general equilibrium models of urban transportation and land use: decomposition versus all-in-one approaches* • **Robin Morphet** (CASA, UCL, UK): *Spatial interaction under imperfect competition* • **Vasco Carvalho** (University of Cambridge, UK): *Supply Chain Disruptions: Evidence from the Great East Japan Earthquake* • **Scott Swisher** (University of Cambridge, UK): *Reassessing railroads and growth: Accounting for transport network endogeneity*
12.45	**Buffet Lunch – Marquee**
13:30	**<u>Session 2: Energy and urban form (chair: Paavo Moilanen, Strafica Oy, Finland)</u>** • Björn Schwarze, **Michael Wegener** and Klaus Spiekermann (Spiekermann & Wegener Urban and Regional Research S&W): *Are polycentric cities more energy-efficient?* • **Yang Jiang (**Tsinghua University/China Sustainable Transportation Center, Beijing, China)**,** Qizhi Mao (Tsinghua University, Beijing, China) and Dongquan He (The Energy Foundation, Beijing, China): *Modelling the impact of urban form on household travel energy consumption and carbon emissions: a multi-scale approach* • **João Fumega,** Samuel Niza and Paulo Ferrão, (IN+ Research Centre, Instituto Superior Técnico (IST), University of Lisbo, Portugal): *Modelling the impact of urban form on energy performance* • **Javier Urquizo** (Newcastle University, UK): *A spatial domestic energy framework for sub-city areas: a case study from the United Kingdom*
15.30	**Afternoon Tea - Marquee**

16:00	**<u>Session 3: Planning for sustainable land use and travel (Chair: John Bates, University of Oxford)</u>** • **Paul Waddell,** Fletcher Foti and Michael Reilly, (University of California, Berkeley, US): *Innovations in urban modelling to support operational sustainability planning in the San Francisco Bay Area* • **Michael Reilly** (Metropolitan Transportation Commission, US): *Recent microscale innovations in Bay Area UrbanSim* • **Panagiotis Sourtzinos** and Dimitrios Makris, (Kingston University, UK), James Amos and Vassilis Zachariadis, (Legion, UK): *Modelling pedestrian shopping behaviour* • **Kiril Stanilov** and Ying Jin, (University of Cambridge, UK): *Examining the correlation between road network growth and urban spatial structure: The case of London*
18:30 - 19:30	**Wine Reception and buffet supper – Marquee**

Day 2 – Thursday 25th June	
9:00	**<u>Session 4: Mapping cities (Chair: Peter Ferguson, CASA, UCL)</u>** • **Michael Batty** and Elsa Arcaute, Carlos Molinero, Erez Hatna (Johns Hopkins), Anders Johansson (Bristol/Crowd Vision), Pete Ferguson, Camilo Vargas-Ruiz, Roberto Murcio, Jaiqiu Wang, Paolo Masucci and Clementine Cottineau (Authors from CASA, UCL unless otherwise noted) *City Size & Performance Defining Nations, Regions & Cities Through Percolation* • **Yan Liu** and Long Cheng (The University of Queensland, Australia): *An entire-array-polygon (EAP) mapping approach to assess urban development suitability: a case study of Ezhou City, P. R. China* • **Edwin HW Chan** and Lang Wei (The Hong Kong Polytechnic University, Hong Kong)**:** *Land Use Pattern and spatial analysis of the major cities in China*
10.30	**Morning Tea - Marquee**

10:45	**<u>Session 5: Urban transitions and the new normal (Chair: Johannes Bröcker, University of Kiel)</u>** • **Robert Cervero**, (University of California, Berkeley, US): *Mass Transit Needs Mass: Urban Density Thresholds for Cost-Effective Fixed-Guideway Transit in the U.S.* • **William Fawcett** (Cambridge Architectural Research, UK): *Upgradability of infrastructure and buildings* • **Amy Fotheringham** and David Simmonds, (David Simmonds Consultancy, UK): *The case for land value taxation and the treatment of land value taxation in urban modelling* • **Coen Teulings** (University of Cambridge): *Secular stagnation, human capital, house prices, and bubbles*
12.45	**Buffet Lunch – Marquee**
13:45	**<u>Session 6: Transformation towards sustainable cities (Chair: Ying Jin, University of Cambridge)</u>** • **Barry Zondag**, Jasper Willigers (Significance, NL) and Eric Molenwijk, (RWS, Ministry of infrastructure and Environment, NL): *Exploring the impacts of public transport oriented land use policies, a case study for the Rotterdam and The Hague area* • **Pan Haixiao** (Tongji University Shanghai, China) and Wei Peng, (Wuhan Urban Planning Bureau, Hubei Province, China): *Effects of suburban rail transit proximity on commuting greenhouse gas emission* • **David Greenwood,** Matthew Duckett, Shrikant Sharma and Anders Johansson (BuroHappold Engineering, UK): *Are city parks an instrument for creating happier communities?*
15.15	**Afternoon Tea - Marquee**
15:45	**<u>Session 7: Sustainable urban travel (Chair: Vassilis Zachariadis, UCL and University of Cambridge)</u>** • **Mark Padgham**, (University of Salzburg, Austria): *Using origin-destination data to discern the scales of cities* • **Ian Williams and Ying Jin**, (Cambridge University, UK): *Relating traffic growth rates in urban densification* • Gramham Bell (Jacobs), **Amy Fotheringham** (David Simmonds Consultancy, UK) and **David Simmonds**, (David Simmonds Consultancy, UK): *Assessing the impact of home-working upon traffic patterns*
18.00	**Ad hoc discussion session on the lawn: The question of equilibrium in applied urban modelling – Q&A with Alex Anas**
18.45	**Conference Dinner (pre-booked only) - Old Music room, St. Johns College.**

Day 3 – Friday 26th June

9:00	**Session 8: Cities and its ecosystems (Chair: Steve Denman, University of Cambridge)** • **Philip James** (Salford University, UK): *Urban ecosystems – challenges for applied urban modelling* • **Athanasios Votsis** (University of Helsinki & Finnish Meteorological Institute Finland): *Investing in ecosystem services: The spatial economic impacts of the type and location of urban green* • **Nahid Mohajeri**, Jean-Louis Scartezzini (Ecole Polytechnique Fédérale de Lausanne, EPFL, Switzerland), Agust Gudmundsson, (Royal Holloway University of London, UK) and Jon R. French, (UCL, UK): *How green are British cities? Scaling relations and CO2 emissions* • **Christina Chatzipoulka** (University of Kent, UK): *The impact of urban geometry on the radiant environment in outdoor spaces: evidence across London*
11:00	**Morning Tea - Marquee**
11:15	**Session 9: Climate in cities (Chair: Koen Steemers, University of Cambridge)** • **Andreas Matzarakis** (University Freiburg, Germany): *Urban climate and micro climate for urban planning and architecture – examples from Freiburg, Germany* • **Tania Sharmin** and Koen Steemers (University of Cambridge, UK): *Understanding micro-climatic conditions and outdoor thermal comfort perceptions from field measurements in the tropical megacity Dhaka, Bangladesh* • **Alistair Ford** (University of Newcastle, UK): *Modelling the impact of extreme rainfall events on urban transport systems* • **Marialena Nikolopoulou** (Kent School of Architecture, UK): *Limitations of thermoregulatory models in outdoor thermal comfort: have we forgotten the person?*
13:15	**Buffet Lunch - Marquee**
14:15	**Session 10: New tools for assessing green growth initiatives (Chair: Tim Gent, WSP, UK)** • **Shoshanna Saxe** and Steve Denman (University of Cambridge, UK): *The greenhouse gas impacts of the Jubilee Line Extension ridership, London, UK* • **Vassilis Zachariadis,** Carlos Vargas-Ruiz, Peter Ferguson, Joan Serras and Mike Batty, (UCL, UK): *Economies of scale in retail location modelling* • **Claudio Martani**, Simon Stent, Sinan Acikgoz, Vassilis Zachariadis, Steve Denman, Ying Jin and Kenichi Soga (University of Cambridge, UK): *Ahead-of-real-time modelling of crowd flows at the London Bridge Station*
15:45	**Afternoon Tea - Marquee**
16:00	**Round table discussion (Moderator: Michael Wegener)**
17:30	**Conference close**
18:45	**Conference Dinner – Professor Mike Batty's Birthday (pre-booked only) - Old Kitchen, Trinity College, Cambridge.**

Short abstracts – in session order

DAY 1 – 24 June

Session 1: Understanding the urban economy and infrastructure

Alex Anas (SUNY Buffalo, US) and Ioannis Tikoudis (VU University Amsterdam and Tinbergen Institute, Netherlands):
Numerical solution of general equilibrium models of urban transportation and land use: decomposition versus all-in-one approaches

Because computable general equilibrium (CGE) models of urban land use and transport are complex and usually large scale, their accurate solution by numerical methods is an important issue. The typical approach is to decompose the CGE model into a transportation sub-model and a land use and urban economy sub-model and to iterate between the two in order to find the equilibrium solution as described, for example, in Anas and Liu (2007). We discuss the issues involved in such decomposition and the various approaches for cycling between the two sub-models and for checking convergence. We present numerical examples which solve the same problem with and without decomposition and to compare convergence behaviour and computational speed.

Robin Morphet (CASA, UCL, UK):
Spatial interaction under imperfect competition

The spatial interaction model as represented by the entropy maximising trip distribution model is located in economic theory as a model that represents spatial interaction under imperfect competition. In doing so we seek to respond to the statement of Fujita and Thisse by presenting one of the central tools of economic geographers in the framework of geographical economists. We examine the construct of deadweight loss associated with imperfect competition, how it may be calculated in an interaction model and its use in interpreting the benefits associated with "new users". The evaluation of benefits under imperfect competition is a problem highlighted in the UK Government's SACTRA report. We show that the resolution of this problem requires the inclusion of changes in land rent but is in other respects not dissimilar to the standard cost benefit analysis. The inclusion of land rents within a modified generalised cost makes it possible to work directly with the demand curves of the before and after cases of the evaluation. A hypothetical worked example for London examines this and the use of the new analysis in evaluating a notional Thames Crossing. A comparison is made with the conventional rule of a half approach. The change in rents may be expected to be larger than that in trip costs since, in considering a trip interchange, the occupiers of an origin zone may only include a minority who travel to destinations that make direct use of the reduced trip cost. However, as the rents of these users rise in relation to reduced trip costs, so do those of their neighbours as they are in the same market. This market, after allowing for differences in size, environment etc., is a market for job potential which takes into account all potential destination zones. The double counting of reduced trip costs and increased rents which, under perfect competition, would be total, is seen under imperfect competition to be partial but decreasingly so as the combined land and transport market moves closer to perfect competition The Thames crossing example shows that rent gains exceed trip cost savings and hence that any double counting is at most only partial.

It is argued that the increase in rents and their capitalisation may be considered inequitable as it accrues to land owners. For a benefit that is largely created by public investment and by the location choices of the population at large this may seem unfortunate unless a part of it is retrieved through taxation,

although this should be taxation on land and not on development. The inclusion of land rents in benefit estimates implies that such increases in value can be exploited by land owners hence appraisal needs to take into account the plans and policies for benefit realisation encompassing both transport and land use changes and the means used to bring them about.

Vasco Carvalho (University of Cambridge, UK):
Supply Chain Disruptions: Evidence from the Great East Japan Earthquake

This paper examines the propagation of firm-level shocks through input-output linkages. Using a large-scale dataset on supply chain linkages among Japanese firms and information on firm-level exposures to the Great East Japan Earthquake in 2011 we quantify the earthquake's impact on firms that were (directly or indirectly) linked to affected firms. We find that having a supplier in the earthquake-hit region led to a 3% loss in terms of sales growth. We show that these losses do not remain confined to the disrupted firms' immediate customers and suppliers. We find that cascade effects of the original this supply chain disruption caused a 1% drop in Japan's aggregate output in the year following the earthquake.

Scott Swisher (Cambridge University, UK):
Reassessing railroads and growth: Accounting for transport network endogeneity

I develop a model where trade costs are endogenous, taken from the equilibrium of a network formation game played by firms building transportation infrastructure. Motivated by the seminal work of Robert Fogel on U.S. railroads, I reformulate Fogel's original counterfactual history question on U.S. economic growth without railroads by treating the transport network as an endogenous equilibrium object. I quantify the effect of the railroad on U.S. growth given the level of technology available in four specific years ranging from 1840 to 1910. Thus I provide separate estimates for the technology of 1840, 1860, 1890, and 1910. Specifically, I estimate the output loss in a counterfactual world without the technology to build railroads, but retaining the ability to construct the next-best alternative of canals. My main contribution is to endogenize the counterfactual canal network through a decentralized network formation game played by profit-maximizing transport firms. I perform a similar exercise in a world without canals.

My counterfactual differs from Fogel's in three main ways: I develop a structural model of transport link costs that takes heterogeneity in geography into account to determine the cost of unobserved links, the output distribution is determined in the model as a function of transport costs, and the transport network is endogenized as the equilibrium of a particular network formation game. I find that the degree of complementarity between railroads and canals is larger than previously thought. Therefore, the output or welfare loss can be quite acute when one or the other is missing from the economy. However this loss becomes increasing asymmetric over time as railroads outpaced canals in terms of sectoral productivity growth. For example, in the case of a social planner with the 1890 level of technology, welfare is 17.4% lower in the no railroads counterfactual and 0.4% lower in the no canals counterfactual relative to a planner that can build both canals and railroads. This welfare loss is due to two main mechanisms: inefficiency of the competitive equilibrium due to network externalities and local market power for transport firms, and complementarity due to spatial heterogeneity in costs across the two transport modes.

Session 2: Energy and urban form

Michael Wegener, Björn Schwarze and Klaus Spiekermann (Spiekermann & Wegener Urban and Regional Research S&W, Germany):
Are polycentric cities more energy-efficient?

The paper asks whether the general held hypothesis is correct that polycentric cities are more energy-efficient with respect to mobility than monocentric or dispersed urban regions. This is explored assuming different fictitious distributions of population and workplaces, everything else being equal. The result is that the hypothesis about the energy efficiency of polycentric cities cannot be confirmed by the method applied so that policies making car driving slower or more expensive and policies making public transport, cycling and walking more attractive are required to promote sustainable mobility.

Yang Jiang (Tsinghua University/China Sustainable Transportation Center, Beijing, China), Qizhi Mao, (Tsinghua University, Beijing, China), and Dongquan He, (The Energy Foundation Beijing Office, Beijing, China):
Modelling the impact of urban form on household travel energy consumption and carbon emissions: a multi-scale approach

A conceptual modelling framework to assess the impact of urban form on household travel energy consumption and carbon emissions is introduced under the China's context. Our pilot work in Jinan city is presented to demonstrate the capabilities and features of the suggested modelling approach.

João Fumega Samuel Niza and Paulo Ferrão (IN+ Research Centre, Instituto Superior Técnico (IST), University of Lisbo, Portugal):
Modelling the impact of urban form on energy performance

We propose an urban-energy analysis that assesses the impact of the urban form on the energy performance of 5 urban typologies. Climate, urban form, structure and systems, and behaviour data is used. Urban form parameters calculated are the shape factor, passive volume ratio and daylight availability. Embodied energy and operational energy calculations are made through the Rhino 5 UMI plugin. Statistical analysis is used to assess the relation between the urban form parameters and energy consumption; impact of the different case studies forms on energy performance; comparison between the modelled energy performance of typologies and the corresponding predominant energy certificates performance to assess the validity of the model.

Javier Urquizo (Newcastle University, UK):
A spatial domestic energy framework for sub-city areas: a case study from the United Kingdom

This research focuses on spatial domestic energy modelling of sub-city areas in the United Kingdom using Newcastle upon Tyne as a case study. The model estimates the energy end-use at single dwelling level and in three aggregate scales: district, neighbourhood and community.

Session 3: Planning for sustainable land use and travel

Paul Waddell, Fletcher Foti and Michael Reilly, (University of California, Berkeley, US):
Innovations in urban modelling to support operational sustainability planning in the San Francisco Bay Area

California legal requirements to integrate land use and transportation planning in order to meet greenhouse gas emissions reduction targets have led to major initiatives within Metropolitan Planning Organizations to improve their capacity to model alternative scenarios using integrated land use and transportation models. In 2013, the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) completed their first Sustainable Community Strategy (SCS) using an integrated land use and activity-based travel model system. The Bay Area SCS was the first one completed that met the goals of using integrated land use and transportation modelling to support the analysis of alternatives in a rigorous way. It used a combination of benefit-cost analysis and multi-criteria evaluation to evaluate each of the alternative scenarios as well as over 100 individual transportation projects.

Lessons learned from this operational effort, which resulted in four lawsuits, of which three are now settled, have informed further innovations in the model system that are now being used to update the SCS for the Bay Area.

These model innovations include the following:

- A more sophisticated short-term price equilibration algorithm has been implemented that efficiently iterates between household location choice and price models, adding a shadow price to a baseline prediction from a hedonic regression, holding supply constant within a single time period. Submarkets used in the short-term equilibration are defined by parcel catchment areas around each local street node (of which there are over 200,000 in the Bay Area), by property type and tenure (rent/own).
- A 'vision-solver 'algorithm has been implemented, to compute the level of subsidies that would be required to achieve desired spatial development outcomes. This methodology is designed to automate a process to meet a set of desired targets without requiring excessive manual experimentation.
- Model limits related to deed-restricted properties have been implemented, enabling more detailed accounting of units only available to lower-income households.
- Refinements have been implemented in the modelling of rent burdens and their propensity to contribute to displacement of lower income households from rapidly appreciating submarkets, including those receiving significant investment in transit service and increased entitlements for development at higher intensities. These innovations include more explicit representation of rent burdens in the household mobility model, and more explicit representation of the availability constraints in the housing market imposed by budget constraints – particularly for renters.
- More explicit representation of affordable housing supply and policies have been implemented in the real estate supply model, enabling the analysis of policies intended to mitigate displacement pressures.
- More explicit handling of annual development permit caps has been implemented, better reflecting localized development capacity imposed by jurisdictions that want to manage the pace of their development.
- An 'accounts framework' has been added to represent more explicitly policies such as tax increment financing.

The model improvements are complemented by a region-wide effort to develop a shared development and zoning database, with capacity to generate, simulate and visualize alternative sustainability scenarios for the updated SCS planning effort.

Michael Reilly (Metropolitan Transportation Commission, US):
Recent microscale innovations in Bay Area UrbanSim

The ongoing development and application of UrbanSim and a linked travel model in the San Francisco Bay Area has provided insights into database development, model design, and policy relevance. UrbanSim differs from most land use models in its emphasis on microsimulation of household, firm, and real estate developer choices, and in its use of high resolution units of spatial analysis such as parcels and buildings. Two recent improvements that leverage Bay Area UrbanSim's microscale approach are discussed here: a four step data assembly process and a framework to better represent realistic land use policies in UrbanSim's developer pro forma model.

Panagiotis Sourtzinos & Dimitrios Makris, (Kingston University, UK) and James Amos & Vassilis Zachariadis, (Legion, UK):
Modelling pedestrian shopping behaviour

In this paper we present a model of pedestrian shopping behaviour, based on pedestrians' visual perception of the built environment and its impact on their decisions and behaviour. Simulation is used to synthesise theory into plausible action and movement patterns, however the focus is on the perception of the environment and its translation into routing choices. The aim is to develop a baseline memory-free cognitive framework for simulating pedestrian shopping behaviour, which can be extended in the future to encompass spatial knowledge in complex built environments.

Kiril Stanilov & Ying Jin, (University of Cambridge, UK):
Examining the correlation between road network growth and urban spatial structure: The case of London

Throughout the ages, the growth of cities has been strongly influenced by the development of their transport networks. These networks define both travel opportunities and the patterns of socio-economic activities, thus exerting a strong influence on urban spatial structures (Anas et al., 1997; Meyer and Miller, 2001). Among the various types of transport infrastructure networks, urban roads are undoubtedly the most important. This is a result of the multiple functions that urban roads have served: accommodating multiple transport modes (walking, horse-drawn carriages, omnibuses, tramways, buses, bicycles, and cars); serving as main corridors for the delivery of essential utilities; providing access to properties. The road network thus shapes the organization and distribution of urban activities as well as comprising the most important element of public space. Urban roads are also the longest lasting elements of urban form (Southworth and Ben-Joseph, 2003). This paper examines the co-evolution of the road network and urban spatial structure using a long time series going back to the Industrial Revolution in London

DAY 2 – 25 June

Session 4: Mapping cities

Michael Batty (CASA, UCL, UK):
Defining Nations, Regions and Cities in Britain Using Percolation Theory

Defining urban and regional phenomena in spatial terms of riddled with difficulties. The ecological fallacy has been known for 75 years or more, but recently the problem has emerged again in the debate concerning how cities perform economically as they get bigger. It has been supposed and sometimes demonstrated that as cities get bigger, some indicators such as income, patents crime, and inequality scale super-linearly with size, suggesting that cities are more productive and innovative the larger they are. In Britain, we have found however that cities do not grow in terms of their wealth as they get bigger. To explore these ideas, we use percolation theory to define the boundaries of cities, starting from the giant cluster formed by the street network for England, Wales and Scotland and then thresholding this at different levels to produce a unique decomposition in terms of connectivity. When we do this we not only define cities but also the nations that compose Britain, its regions, and then its cities. There are some very surprising results of doing this for historically the relative independence of Scotland immediately emerges, the north-south divide, the Welsh periphery, the southern Cornish Peninsula, Lincolnshire and the Wash, all places with their own identities.

Yan Liu and Long Cheng (The University of Queensland, Australia):
An entire-array-polygon (EAP) mapping approach to assess urban development suitability: a case study of Ezhou City, P. R. China

China has been experiencing rapid urbanization since the economic reform and open-up in the late 1970s, with many new cities emerging and existing ones being restructured and expanded at an unprecedented pace. However, it remains challenging by urban planners and decision-makers to identify and assess the suitability of areas for future urban development. Building on previous studies, this paper presents a new approach termed the entire-array-polygon (EAP) mapping model to assess the urban development suitability in the fast developing city-regions in China. A suitability indicators system was developed to reflect the environmental and economic conditions as well as resident living status. However, unlike other land suitability analysis methods such as multiple-criteria analysis or Analytic Hierarchy Process (AHP), the EAP model does not reply on the assignment of weightage of different indicators but rather maps all factors on one standardised platform. An application of the EAP model in Ezhou, a county-scale city adjacent to the provincial capital city of Wuhan in Hubei Province, China, over a 10-year period (1998-2009) shows that the three districts of the city have experienced differentiated suitability evolution for urban development over the 10-year period, and the EAP approach is effective in helping urban planners to map urban development suitability and identify potentials for future urban development.

Edwin HW Chan and Lang Wei (The Hong Kong Polytechnic University, Hong Kong):
Land Use Pattern and spatial analysis of the major cities in China

In light of the challenges raised by fast urbanization, most Chinese cities have to face diverse issues of ageing population, energy cost, environmental obstacles and sustainable urban land use for future development. A quantitative method to characterize the urban land allocation and pattern are essential so that the urban spatial characteristics of cities can be visually demonstrated with land use patterns. This study provides an approach to quantitatively measure urban spatial structure through studying the land use patterns of major cities in China. This spatial analysis may allow comparison on the quality of

life and general wellbeing of the citizens between different cities. It brings us a step closer to achieving an objective matrix to properly present the situation of urbanization.

We employ urban growth model using cellular-automata in ArcGIS python to reconstruct the land use patterns of major Chinese cities, such as Beijing, Guangzhou and Hong Kong, etc., which can be characterized by the three measures of spatial heterogeneity: (a) a variant of spatial entropy ST, which measures the spread of residential, commercial, and public sector of land use, (b) land use radius rT, which is defined by the range of influence for each land use sector, and (c) an index of dissimilarity D (T1|T2), which quantifies the degree of spatial mixing of these land use activity parcels, which each of these sectors spatially aggregate into clusters.

Through literature review, we understand and identify the contributing values of the three measures for urban growth in China. By experimenting with the changing value of these measures to find best-fit values for each measure, through which we could use the land use patterns approach to look for optimal conditions for sustainable urbanization. This dynamic urban growth model aims to recognize spatial power law of urbanization in Chinese cities and provide knowledge-based support for measuring the sustainability of urban land use. Urban land use in our study cities is more spatial fragmented and functional segregated.

Session 5: Urban transitions and the new normal

Robert Cervero, (University of California, Berkeley, US):
Mass Transit Needs Mass: Urban Density Thresholds for Cost-Effective Fixed-Guideway Transit in the U.S.

Urban density thresholds needed to support cost-effective fixed-guideway transit investments are investigated based on empirical experiences for metrorail, light rail, and bus rapid transit investments in the U.S. Factors that interact with urban densities, such as car parking prices and transit service quality, are examined. High employment densities, combined with mixed land uses and walkable neighbourhood designs, are found to be important, though by themselves insufficient, factors in predicting cost-effective transit investments in the world's most auto-dependent country, the United States.

William Fawcett (Cambridge Architectural Research, UK):
Upgradability of infrastructure and buildings

The performance expected of cities changes over time, but most buildings last for generations and perpetuate the standards and expectations of the time of construction. Current investments that are simply based on today's standards will quickly become obsolete. In response to this problem, urban improvements should adopt the principle of upgradability and make conscious provision for a continuing but uncertain sequence of upgrades, by incorporating features that reduce the cost and disruption of future upgrades. The upgradability of current decisions can be quantified with probabilistic life-cycle evaluation in which future upgrade decisions are modelled.

Amy Fotheringham and David Simmonds (David Simmonds Consultancy, UK):
The case for land value taxation and the treatment of land value taxation in urban modelling

This paper provides a brief introduction to the case for tax reform involving the adoption of land value taxation (LVT). It reviews the potential for such a reform to affect the processes of urban development, and considers how urban modelling will need to advance in order either to contribute to the debate about alternative forms of taxation or to consider the public planning decisions (such as major transport investments) in the presence of LVT.

Coen Teulings (University of Cambridge):
Secular stagnation, human capital, house prices, and bubbles

The global slowdown in economic growth and the steady decline in real interest rates has raised the question whether we have entered an era of secular stagnation, where only a negative real interest rate can clear the capital market and where the nominal interest rate is at or close to the zero lower bound. At the same time, there is worldwide trend for human capital to benefit from agglomeration externalities in major cities. Both secular stagnation and the agglomeration benefits increase house prices in city centres. We consider whether these phenomena lead to bubbles on the housing market, and if so, whether or not this is bad for the economy.

Session 6: Transformation towards sustainable cities

Barry Zondag, Jasper Willigers (Significance, Netherlands) and Eric Molenwijk, (RWS, Ministry of infrastructure and Environment, Netherlands):
Exploring the impacts of public transport oriented land use policies, a case study for the Rotterdam and The Hague area

In the foreseeable future the continued trend of urbanization calls for a new approach to allow for better joint-use of space and mitigation of undesirable effects. A more integral solution is required and the Ministry of Infrastructure and Environment of the Netherlands has launched a new programme to explore a wider approach to improve accessibility. At the core of the programme is an integrated regional approach, to be worked out by national, regional and local stakeholders, including multi-modal, ICT and land-use strategies besides the traditional infrastructure investment measures. The programme calls for a better co-ordination between land use and transport measures. For a successful answer many research questions are still to be addressed, among others on valuable design options, stakeholder cooperation, methods to calculate the impacts of integrated strategies and especially comprehensive evaluation measures and procedures.

This paper focuses in particular on the last two aspects, it gives an example on how to calculate the impacts of the land use policies on land use and transport, by applying a land use and transport interaction model, and the paper discusses the model results for various output indicators originating from different research disciplines. The research questions in this paper are addressed in the form of a case study for the larger Rotterdam and the Hague area in the Netherlands.

Pan Haixiao (Tongji University Shanghai, China) and Wei Peng, (Wuhan Urban Planning Bureau, Hubei Province, China):
Effects of suburban rail transit proximity on commuting greenhouse gas emission

The commuting GHG emission was calculated, based on the survey in two sites of Shanghai Suburban area. It is found availability of rail transit will have an impact on GHG emission, but close to station do not mean less emission due to the higher car ownership. The importance of electric bicycle should not be neglected in land use/transport planning.

Seiyong Kim (University of Korea, South Korea), Gunwon Lee, Mokwon (University of Korea, South Korea), Yunnam Jeong (Politecnico di Milano):
Impact of individual transit, urban character and urban form (The lead author is now unable to come to symposium because of MERS disruptions in South Korea)

At present it is often the case that urban planning is about planning infrastructure on the basis of demand predictions, with few regards to consequent energy consumption. Smart city management expects environmental quality and energy consumption to be considered as key factors from an early stage of urban planning. But so far it has not been the case in South Korea. This study aims to create an urban carbon emission model after analysing 230 cities in South Korea. As an outcome of this study, a carbon emission model for the identified types of cities has been established. We expect to be useful in forecasting the urban environmental impacts in the planning process.

David Greenwood, Matthew Duckett, Shrikant Sharma and Anders Johansson (BuroHappold Engineering, UK):
Are city parks an instrument for creating happier communities?

It is well known that there is a pervasive dark side to urbanisation. Physical inactivity is now a leading cause of disease and an urban-rural happiness gradient is observed in Western Europe and North America. On the other hand, city parks have the potential to encourage physical activity and social encounters thus providing planners and policy makers with an instrument for creating healthier and happier urban communities. Problem: Despite the potential benefits of city parks they are often islands of under-utilised emptiness compared to their surrounding streets. Planners and decision-makers can often be at a loss concerning how-to improve their utilisation and which interventions are most effective. Aim: The aim of this research is to provide designers, planners and decision-makers with models of the utilisation of parks so that they can diagnose the cause of under-utilisation and estimate the impact of an intervention on park utilisation.

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The objectives of this study are to: 1) identify a set of factors that planners & policy makers are able to influence that increases the utilisation of parks e.g. park features & accessibility; 2) identify the relationship between park utilisation and measures of health & happiness. Method: Our investigation adopts a quantitative case-study approach. We selected a portfolio of eleven parks and gardens in central London within 5km of Hyde Park. We collected social media data, open street maps, open datasets, on the ground observations and performed linear regression modelling and multivariate spatial modelling [5]. The data collected included: Twitter data (used as a proxy for utilisation), Type of

activity (pedestrians vs cyclists and runners), Features (such as footpaths, water features and facilities such as shops), Accessibility, and Crime rates.

Session 7: Sustainable urban travel

Mark Padgham, (University of Salzburg, Austria):
Using origin-destination data to discern the scales of cities

Urban planning is best conceived and implemented at the "natural" scales across which people enact their urban lives. Origin-destination data are used to quantify the way that similarity of place decays with distance, and to reveal how cities manifest multiple intrinsic scales that are hierarchically inter related. The analyses reveal an important extension to "Tobler's first law of geography," in that near things are more related when judged from afar than when judged from nearby. This finding has particular implications for the appropriate scaling of urban planning.

Ian Williams, (Cambridge University, UK):
Relating traffic growth rates in urban densification

Traditionally, the direct relationship between the rate of growth in the local resident population and the resulting rate of growth in local road traffic is at the core of most transport models, including the UK Department for Transport's National Transport Model that it has recently used for its biennial 2015-based road traffic forecasts. This presentation explores how the rate of growth of traffic, particularly its car traffic component, may differ significantly between areas with different population densities in its response to the rate of local population growth.

We first set out the evidence on the evolving pattern of population growth over the last 30 years in England and Wales. This has gradually reversed from initially having its fastest growth in low density rural areas to now having the fastest growth in the highest density urban areas. We build on this to examine the evolution over the last twenty years of the local relationship between population growth and car traffic growth. The analysis indicates that this direct relationship is no longer as simple as that represented in many of the unimodal models in current use. The relationship has changed over time in a manner that differs strongly between different areas.

The scale and nature of these changes is heavily dependent on the current rate of population growth and on the local pattern of urban form and density. In lower density rural areas there continues to be a positive elasticity of car traffic w.r.t. population growth. However, in an increasing number of higher density urban areas there is now a strong negative elasticity of car traffic w.r.t. population growth. The underlying behavioural influences that generate this counter-intuitive response are explored, as well as its implications for transport model design and segmentation. Finally, the implications of these behavioural trends for land-use planning policies and for long-term transport infrastructure investment are examined.

Gramham Bell (Jacobs), Amy Fotheringham (David Simmonds Consultancy, UK) and David Simmonds, (David Simmonds Consultancy, UK):
Assessing the impact of home-working upon traffic patterns

[Abstract pending]

DAY 3 – 26 June

Session 8: Cities and its ecosystems (Chair: Steve Denman, University of Cambridge)

Philip James (Salford University, UK):
Urban ecosystems – challenges for applied urban modelling

The concept of an ecosystem can be understood as the sum of the biotic and abiotic elements in an area of study, or as the patterns and processes that operate within that area of study as a result of the interactions between the biotic and abiotic components. In the urban context we often refer to ecology in a city and ecology of a city. Ecology in a city relates to the first definition of an ecosystem, an understanding of the components of an ecosystem while ecology of a city relates to the second definition and to an understanding of the processes that take place within the city.

As our understanding of ecology has radically changed since the 1960s, we have begun to appreciate how tensions develop between an ecological and a more traditional, deterministic understanding of the world. While there is much that is predictable regarding ecology, there is a significant stochastic element to the detailed development of ecosystems such that while general trends can be in some ways foreseen, stochastic processes mean that the detail of exactly what will happen cannot be predicted with any great certainty. We see the tensions played out in urban planning every day as developers ask ecologists where they want space for nature, how much space they want, what they want to do in that space, etc. Here deterministic thinking collides with stochastic models. Addressing the two modelling perspectives is a critical task for applied urban modelling. Examples from Greater Manchester and Merseyside will be used to illustrate the points above.

Athanasios Votsis (University of Helsinki & Finnish Meteorological Institute Finland):
Investing in ecosystem services: The spatial economic impacts of the type and location of urban green

For urban economics and planning, the provision of ecosystem services represents a spatial problem: if more land is allocated to green infrastructure, how do the economic effects propagate throughout urban space? This paper focuses the question on the formation and differentiation of housing prices, and estimates spatial hedonic models on a large sample in Helsinki. The results indicate that the implementation of green solutions has varying marginal effects, depending on the kind of green (forest, park, or open field). Importantly for broader urban economic dynamics, the price effects spill over to and from neighbouring locations, and the simulated direct, indirect, and total impacts are conditional on the choice of green solution. Lastly, all effects exhibit a persistent urban-core-to-fringe gradient.

Nahid Mohajeri, Jean-Louis Scartezzini (Ecole Polytechnique Fédérale de Lausanne (EPFL) Switzerland), Agust Gudmundsson, (Royal Holloway University of London, UK) and Jon R. French, (University College London, UK):
How green are British cities? Scaling relations and CO2 emissions

How green or environmentally friendly urban areas are in comparison with rural areas is a topic that has received much attention in recent years. This is understandable because urban areas already emit around 70% of the global greenhouse gases. This percentage is likely to rise in the near future. This follows because the majority of the future growth in the global population is expected to be in urban areas. Key questions for the future relate to how green the cities will be, especially in terms of energy use and the emission of global greenhouse gases. Are there, for example, particular sizes or forms of cities that are energy efficient and have comparatively low emission rates of greenhouse gases?

One of the most important of the greenhouse gases is carbon dioxide (CO2), whose human-activity related emission is widely regarded as a major contributing factor to recent global warming. The rate of

CO2 emission is thus one measure of how green or environmentally friendly urban areas are. In view of this, we here report the results of a study of estimated residential and transportation CO2 emissions (at local authority levels) from 406 areas in the UK in relation to various other factors such as population, population density, fuel consumption, and income. We present as maps the variation in CO2 per capita throughout the UK. For transport CO2, there are notable lows in emission per capita in large cities and urban areas such as London, Liverpool-Manchester, and Glasgow-Edinburgh. For residential CO2 per capita, the low values are again in the large cities and city clusters. The highest emission values, however, are very clearly in the rural areas, in particular in the western part of Wales, in North England and in Scotland, particularly in the Highlands. These variations can partly be explained in terms of the climate in these areas.

The residential CO2 shows a close-to-linear scaling relation with population; that is, the scaling exponent is 0.92. This implies that as the population grows, residential CO2 emissions grow at a similar but slightly lower rate. By contrast, transport CO2 shows a clear sub-linear relation with population; that is, the scaling exponent is 0.66. This implies that as the population grows, transport CO2 emissions grow at a much lower rate. We also analysed the residential CO2 emission in relation to population density, measured as number of people per square kilometre (N/km2). The resulting relation is non-linear and suggests that as the density increases the CO2 emission per capita decreases somewhat. All these results may suggest

Christina Chatzipoulka (University of Kent, UK):
The impact of urban geometry on the radiant environment in outdoor spaces: evidence across London

The paper will present the results of a research which explores the impact of urban geometry across London on the radiant environment in outdoor spaces, and more specifically on mean radiant temperature (Tmrt) at the pedestrian level. Urban geometry represented in a DEM format is analysed with image processing techniques; while simulations of 3D radiation fluxes and mean radiant temperature are performed using SOLWEIG model, for representative days in a year. Statistical tests reveal the strong relationship between specific urban parameters and outdoor thermal environment.

Session 9: Climate in cities

Andreas Matzarakis (University Freiburg, Germany):
Urban climate and micro climate for urban planning and architecture – examples from Freiburg, Germany

Freiburg belongs to one of the warmest cities in Germany because of its geographical location in the upper Rhine valley. More than 30 days with heat stress can be detected each year. During extreme summers like the one in 2003, the number of days with heat stress was much higher. Air pollutants are dominantly produced by car traffic due to the absence of industrial emissions. Freiburg is located at the foothills or plains of the Black Forest, specifically at the exit of the Dreisam valley. In general, during cloudless and less windy weather conditions, a mountain breeze is formed. During the daylight hours, both air masses move in the direction of the Black Forest and an air mass exchange is produced. During the night time hours, cold airflows from the slopes of the valleys are formed, and the induced cold air flows to the city of Freiburg from the east, affecting the climate conditions there. This local wind system called “Höllentäler” is very well known and is accompanied with the ventilation of parts of the city of Freiburg. The cold airflows depend on the synoptic conditions with a diverse intensity and range. In the Dreisam valley the local wind system occurs during 65% of the night hours per year. Therefore, Freiburg has a specific role because of its location in the south of Germany and its complex topography. It

combines many relevant aspects of climate and the effects of urbanisation and topographical effects, not only due to the Black Forest, but also due to its location in the upper Rhine valley.

Since the 1960s, several studies concerning local climates and urban effects in the city have been conducted in the vicinity of Freiburg. In the 70s, a whole approach for the quantification of the urban climate in Freiburg was conducted and was the basis for the authorities and decision makers of the city. This was followed by specific urban climate studies and had effects on diverse projects, i.e. new building areas or the modification of sport facilities were only limited in terms of single effects concerning wind conditions. At the start of the 21st century, the municipality realised the importance (not only because of climate change issues) of urban climate and demanded a new integral climate analysis for Freiburg. In order to obtain and quantify the distribution of the climatological and air pollution conditions, several approaches based on measurements and modelling have been performed and applied. Several factors, e.g. air temperature, wind, human thermal bioclimate, and air pollutants have been aggregated and summarised into maps. These maps was based on measurements (thermal imaging by airplanes, thermal mapping (day and night), screen level measurement campaigns, tracer gas experiments), modelling (cold air drainage flow simulation, ventilation analysis, analysis of thermal bioclimate, analysis of air pollution situation, affect analysis) and finally on the demanded maps by the municipality of Climate function map and Planning advices map. Based on the results of the integral analysis several new planning areas have been analysed afterwards by the municipality for new developments.

In addition specific urban places (place of old synagogue) and new projects (planning of new football stadium) have been climatically analysed and assessed by human biometeorological methods.

Tania Sharmin and Koen Steemers (University of Cambridge, UK):
Understanding micro-climatic conditions and outdoor thermal comfort perceptions from field measurements in the tropical megacity Dhaka, Bangladesh

The research intends to present a comparative analysis of the micro-climatic states and comfort conditions between the formal and traditional residential areas in Dhaka with special reference to urban geometry parameters. Both quantitative and qualitative research methods have been used to investigate the impact of urban geometry on environmental variables as well as pedestrian thermal sensations along with micro-climatic measurements. In addition, advanced micro-climate simulation models like ENVI-met and RAYMAN were used to obtain a complete picture of the case-study areas while presenting a clearer understanding of the relations between urban form and environmental variables.

Alistair Ford (University of Newcastle, UK):
Modelling the impact of extreme rainfall events on urban transport systems

The research presented in this paper looks at climate impacts on urban transport networks, in particular surface water flooding from extreme rainfall. By the use of a dynamic surface water flooding model, CityCAT (Glenis et al, 2013), future extreme rainfall events simulated by climate downscaling techniques (Kilsby et al, 2007) can be translated into depths and velocities of flood water during an event. Such flooding can lead to direct impacts on urban area (e.g. flooding of buildings, danger to life, damage to infrastructure) but the extent of indirect impacts can be much larger. Adaptation to reduce such floods can take a variety of forms, from grey adaptation (improvement to infrastructure) to green adaptation (provision of increased greenspace to allow water to permeate or capture water for slow release.

Marialena Nikolopoulou (Kent School of Architecture, UK):

Limitations of thermoregulatory models in outdoor thermal comfort: have we forgotten the person?

The presentation will focus on some of the challenges of using thermo-regulatory models of biometeorology in outdoor thermal comfort. Looking at extensive field surveys in different climatic contexts predominantly across Europe as well as north Africa, northern America and south-East Asia, it will highlight the need to look beyond thermal physiology – focusing particularly on behavioural and other cognitive factors - to enhance our understanding of the discrepancy between actual and modelled data and how modelling can be integrated effectively in the design of urban environments.

Session 10: New tools for assessing green growth initiatives (Chair: Tim Gent, WSP, UK)

Shoshanna Saxe and Steve Denman (University of Cambridge, UK):
The greenhouse gas impacts of the Jubilee Line Extension ridership, London, UK

This paper models the mode shift and mode share changes associated with the opening and operation of the Jubilee Line Extension in East London to calculate the net greenhouse gas impact of ridership from 1999 to 2011. The world is currently experiencing a renaissance in the promotion and construction of metro rail transit. As cities consider new rail infrastructure, focus is often centred on the benefits of metro rail. These include reductions in greenhouse gas (GHG) associated with changing travel behaviour due to increases in accessibility provided by the new infrastructure. Few studies, however, have examined the actual GHG impact of new metro rail. Real world GHG savings are dependent on mode changes as travellers take up the new infrastructure, reductions in travel distance and associated propulsion energy provided by increased path efficiency and the difference in GHG intensity of the travel modes considered. The paper examines initial mode shift after the line opened in 1999 and ongoing mode share trends through to 2011.

Vassilis Zachariadis, Carlos Vargas-Ruiz, Peter Ferguson, Joan Serras, and Michael Batty, (UCL, UK):
Economies of scale in retail location modelling

The rise of social media and the open government movement are revolutionising data-driven research in social sciences. In this paper we use passively collected datasets of human mobility and public records of economic activity to develop a shopping location choice model that considers internal and external economies of scale at the outlet level. Our findings highlight the impact of scale and agglomeration on shopping location choices and form a platform for further research.

Claudio Martani, Simon Stent, Sinan Acikgoz, Vassilis Zachariadis, Steve Denman, Ying Jin and Kenichi Soga (University of Cambridge, UK):
Ahead-of-real-time modelling of crowd flows at London Bridge Station

The high concentration and flow rate of people in stations during rush hour is a prominent risk to passenger safety. The prediction of passenger flows in real-time may provide asset managers with the ability to foresee congestions (i.e. the unexpected short interruption of London Bridge station operations on the 3 March, 2015) and act early to avoid them, thus improving passenger safety and comfort. We present a new station passenger flow monitoring and modelling tool and its first round of tests at the London Bridge Station in central London.

Posters

Gerard Casey, Elisabete Silva, Kenichi Soga and Peter Guthrie (University of Cambridge, UK):
HSR Vs Aviation In Terms of Life Cycle Carbon: An ABM supported by Live Big Data

A transport ABM using real-time big data was developed specifically for a comparison of HSR and aviation over the short haul distance of London-Paris. This methodology provides a means to relate quantifiable metrics, such as time and cost to traveller decision-making. Thus, it can be used to understand how these factors change with time. This knowledge can then be utilised to inform how these metrics may be manipulated to bring about desirable global and local behaviour change. This manipulation is carried out upon a temporally dynamic dataset, allowing for scenario testing of hard and soft interventions.

Hsin-tzu Ho, Ying Jin and Steve Denman, University of Cambridge, UK
Understanding Discretionary Travel with Social Media and Microblogging in Commercial Centres in Taichung, Taiwan

This poster presents methods for the use of crowd sourced data to inform a land use and transport model for Taichung, Taiwan. We use four sets of popular social media and rating websites in Taiwan: TripAdvisor (3824 entries), Foursquare (12274 entries), IPeen (33133 entries), Airbnb (707entries) and TaiwanStay (381 entries) - to map the activities in the city at different times of the day and by different user types; both local and non-local. These datasets each have their own unique features and can help inform the land use model in a much higher resolution in terms of location, time and land use type. Popularity of each commercial centre within the City can be estimated using popularity ratings, reviews and ranking by online users. The use of crowd sourced data can help identify up and coming locations across the city and emerging new centres of activity which cannot be easily captured by the conventional survey method.

Xihe Jiao and Ying Jin, University of Cambridge, UK
Modelling Spatial Distribution of Outdoor Recreation Trips of Urban Residents - An in-depth study in Greater Manchester, UK

Outdoor recreation is one of the most important leisure activities of urban residents, and urban greenspace accruing the highest value of benefits among all greenspaces in the UK. However, access and trip-making to outdoor greenspaces by urban residents remain poorly understood. This research aims to investigate the strengths and weaknesses of predictive models of outdoor recreation travel. An output of the research is a new model which is able to make an assessment on number of outdoor recreation trips from given origins. It also links the spatial distribution of visits to key spatial factors, such as distribution of population, location of recreational sites, travel time and environmental characteristics. The resulting quantification of the impacts of policy interventions provide a robust basis for decision making.

Bharat Kunwar, Filippo Simini and Anders Johansson (University of Bristol, UK):
Are UK cities fit for pedestrianised evacuation?

An aspect of `Green Cities' is provision for transport infrastructure with minimal environmental impact which may include walking, cycling, shared transport, etc. while minimising the need for driving individual cars to get around. At the same time, the combination of rising instances of extreme events and growing urban settlements pose a serious threat to humanity. A city needs to keep the inhabitants safe and ensure that they can reach safety easily. Cars not only take up more of precious urban space but frequently run into the issue of congesting quite easily. As physical constraints are used to encourage people to use low impact means of transport, catering for pedestrian evacuation is becoming more important as most people can choose to mobilise by foot immediately at a moment's notice to reach safe zones.

Mingfei Ma and Ying Jin (University of Cambridge, UK):
Alternative Configurations of Beijing's Greenbelt: New Insights from a Recursive Spatial Equilibrium Model

Greenbelts are considered a key instrument for halting pancake-like urban expansion. However, Beijing's first greenbelt of the 1990s disappeared under urban expansion and its second is under a similar threat. We use a Recursive Spatial Equilibrium Model building upon 1990-2000-2010 to simulate urban growth of Beijing. This model not only represents the equilibrating interactions between work, living and travel but also the temporal dynamics of urban land expansion. Alternative historic-if scenarios for 1990-2000 and 2000-2010 are tested. The model results suggest that the configuration and timing of greenbelts have significant impacts on a city's economic performance.

Andreas Matzarakis and Dominik Fröhlich (University Freiburg, Germany):
Sport events and climate for visitors: The case of FIFA World Cup in Qatar 2022

The effect of weather on sport events is not well studied. It requires special attention if the event is taking place at a time and place with extreme weather situations. For the world soccer championship in Qatar (Doha 2022), human biometeorological analysis has been performed in order to identify the time of the year that is most suitable in terms of thermal comfort for visitors attending the event. The most popular thermal indices applied in human bioclimatology are the perceived temperature (PT), the Universal Thermal Climate Index (UTCI), and the physiologically equivalent temperature (PET). It can be noted, that the results for the three indices are distributed quite differently. Furthermore, they respond quite differently to modifications in the input conditions. All of them show particular limitations and shortcomings that have to be considered and discussed. While the results for PT are unevenly distributed, UTCI shows limitations concerning the input data accepted. PET seems to respond insufficiently to changes in vapour pressure. The final analysis is based on thermal indices like Physiologically Equivalent Temperature (PET). The results show that this kind of event may be not appropriate for visitors, if it is placed during months with extreme conditions. For Doha, this is the period from May to September, when conditions during a large majority of hours of the day cause strong heat stress for the visitors. A more appropriate time would be the months November to February, when thermally comfortable conditions are much more frequent. The methods applied here can quantify the thermal conditions and show limitations and possibilities for specific events and locations.

Paul Minta, Andy Dobson, Emma Revill and David Simmonds (David Simmonds Consultancy, UK):
Implementing reference case scenarios in applied land-use/transport modelling

Applied urban modelling commonly draws upon exogenous economic and demographic projections to define scenarios of overall growth in employment and population. This paper considers the relationship between urban modelling and these exogenous scenarios, particularly in smaller regions where growth will vary according to the consequences of interventions. It proposes how such scenarios can be used to make best use of the relative strengths of the different models, and to ensure a clear relationship between different sets of forecasts which will assist decision-makers. It describes both the overall logic and the modelling techniques used.

Li Wan and Ying Jin (University of Cambridge, UK):
Modelling Local Amenities with Online Open-Source Data in a New Spatial Equilibrium Model: Insights from Applications for Beijing

This paper presents a new, general purpose method for modelling local amenities in a city-level spatial equilibrium model with emerging data sources. We use the online open data of schools and hospitals in Beijing to improve model parameterization and calibration at high spatial resolution. The new local amenities element can improve the model's fidelity on residence location choice by a large margin. Moreover the local amenities component provides a new interface to municipal decision making, where quantification of the combined effects of urban land-use and local amenities policies can be simulated on a more consistent basis. The calibrated model of Beijing shows that uncoordinated local amenities provision may undermine or even overturn the long-term plans for building a polycentric city region.

Biographies of authors and chairs

[In alphabetical order]

James Amos, Legion Limited, UK

James Amos is Head of Product Development at Legion Limited where he oversees the development of the company's pedestrian simulation products and is responsible for managing all research and development undertaken by Legion. James is a Computer Science graduate (BSc Computing Science, 1998, University East Anglia) with over 15 years' experience of commercial software development. He has extensive experience of taking new products and software applications from initial requirements through to testing and commercial release. Under James' management the Legion R&D team continues to undertake cutting edge research and develop market leading software. Recent work undertaken by the team includes research into multithreading of multiagent simulations; development of innovative space decomposition and pedestrian routing algorithms; BIM compliance; integration of pedestrian and traffic simulations; and advanced 3D visualisation of pedestrian simulations.

Youngsoo An, The University of Seoul, Korea

Youngsoo An received a doctorate in urban engineering, in 2013. Now, he belongs to the Department of Urban Planning and Design of the University of Seoul as a research professor. His main research field is forecasting long-term changes of urban employment. Above all, he is focusing the statistical and spatial change of firms or jobs in a city.

Alex Anas, State University of New York at Buffalo, US

Alex Anas has been Professor of Economics at SUNY-Buffalo since 1991 and Professor of Civil and Industrial Engineering and Economics at Northwestern University from 1975-1991. His research has focused on urban economics, encompassing theory, empirical studies and the development of computable general equilibrium models of urban areas. He is the developer of RELU-TRAN (A Regional Economy, Land Use and Transportation Model) which has been applied to Chicago, Greater Los Angeles and Greater Paris regions. In these applications RELU-TRAN was used to examine a variety of trends and policy issues such as the stability of travel times in the presence of urban growth and sprawl, the effects of gasoline pricing and cordon tolling (Chicago), substitution of the property tax and land taxes for distorting income and sales taxes (LA) and the effects of circumferential rapid transit lines planned for the Paris region. Anas is a fellow of the Regional Association International and the Homer Hoyt Institute for Advanced Studies in Real Estate

John Bates, University of Oxford, UK

John Bates is a mathematical economist, specializing in transport problems. For the last thirty-seven years, he has been working as an independent consultant. In addition to his work experience, listed below, he has lectured extensively, both in the UK and in Holland, France, Finland, Germany, Switzerland, Scandinavia, South Africa, Australia and New Zealand.

He has specialized in mathematical modelling, and has been at the forefront of transportation model development for the last forty years, with particular reference to travel demand, where he has contributed to a number of urban, regional and national transport models. He has been a leading figure in the development of stated preference techniques within the transport field, and has considerable expertise in evaluation methodology, in particular the valuation of time savings and reliability. In addition to his work in the UK, he has been an adviser to Value of Time studies in Sweden, Norway, New Zealand, Switzerland, Denmark and the Netherlands.

His modelling work makes extensive use of statistical principles, and he is a recognised expert in discrete choice modelling, where he has made a number of contributions to theory and practice over the years.

Michael Batty, CASA, University College London, UK

Professor Michael Batty is Chair of the Centre for Advanced Spatial Analysis (CASA) at University College London. His research involves the development of computer models of cities and regions, and he has published numerous books and articles in this area, such as Cities and Complexity (MIT Press, 2005), which received the Alonso Prize of the Regional Science Association. His most recent book is The New Science of Cities (MIT Press, 2013) which can be seen at his blog www.complexcity.info. This year he received the Lauréat Prix International de Géographie Vautrin Lud. He is a Fellow of the British Academy and the Royal Society, and received the CBE award in 2004 for services to geography.

Johannes Bröcker, University of Kiel, Germany

Johannes Bröcker is professor of international and regional economics. Before joining the department of economics at University of Kiel in 2000 he was professor of macroeconomics and regional science at the University of Dresden since 1992. He is also head of the Institute for Regional Research of the University of Kiel. His research interest is mainly in spatial economics, economic integration and transport economics. He was active in a series of EU projects on Trans-European Networks and other transport themes. He has published inter alia in *Regional Science and Urban Economics*, *Journal of Regional Science, Annals of Regional Science*, *Environment and Planning A* and *Transportation Research B*. He is member of the editorial board of *Annals of Regional Science*, *Letters in Spatial and Resource Sciences* and *Jahrbuch für Regionalwissenschaft*.

Vasco Carvalho, University of Cambridge, UK

Vasco Carvalho is a reader at the Faculty of Economics, University of Cambridge. He holds a PhD in Economics from University of Chicago and is the Senior Keynes Fellow and INET@Cambridge coordinator. He is also holder of an ERC Starting Grant "Macronets" devoted to the study of Production Networks in Economics.

Robert Cervero, University of California, Berkeley, US

Robert Cervero is the Friesen Chair of Urban Studies and Professor and incoming Chair of City and Regional Planning at the University of California, Berkeley, where he also directs the University of California Transportation Center (UCTC). He is currently an Overseas Fellow at Churchill College, University of Cambridge. Professor Cervero's research examines the nexus between urban transportation and land-use systems. He chairs the International Association of Urban Environments and the National Advisory Committee of the Robert Wood Johnson Foundation's Active Living Research Program and serves on the Advisory Board of the World Economic Forum's Future of Urban Development Initiative. He also served on the IPCC (International Panel on Climate Change), contributing to the Fifth Assessment. He was recently ranked among the top 100 City Innovators Worldwide by UMB's Futures Cities and 4th highest among 850 urban planning academics in Google Scholar.citations.

Edwin Chan, Hong Kong Polytechnic University, Hong Kong

Professor Edwin CHAN is Professor and Associate Head (Research) of Building and Real Estate Department, Hong Kong Polytechnic University. Edwin studied Architecture in England and then learnt Law in London and Hong Kong, and obtained his PhD degree at the King's College of London. He is a Chartered Architect and Surveyor and Barrister-at-Law. He carries out research relating to sustainable urban development including: Urban renewal/land use, Heritage conservation; Green building; Transaction costs analysis; and Community issues. He has published over 100 international journal papers, and serves as an editorial board member of research journals. He serves committee members of a number of government committees and professional bodies. He is a non-Panel Reviewer of Public Policy Research Funding Scheme, Central Policy Unit of HKSAR.

Christina Chatzipoulka, University of Kent, UK

Christina Chatzipoulka is a PhD student and Graduate Teaching Assistant in the Kent School of Architecture since 2012. She has a Diploma (Dist.) in Architectural Engineering from Aristotle University of Thessaloniki (2009) and a Master of Science degree (Dist.) in Environmental Design of Buildings from the Welsh School of Architecture in Cardiff University (2011). She has been awarded honours and grants from Greek and British institutions throughout her studies, among which a GTA scholarship from Kent University to conduct her own research project.

Her research investigates the impact of urban geometry on radiation and wind performance at the pedestrian level (as associated with outdoor comfort) and on the buildings' fabrics (as primarily associated with buildings' passive potential), with emphasis put on temperate climates. Its aim is to establish a method for the environmental assessment of urban forms using geometric indicators, which would facilitate design decisions regarding future developments as well as provide a better understanding of the performance of existing urban typologies.

Long Cheng, University of Queensland, Australia

Long Cheng received his B.Sc. and M.Sc. from Huazhong Agricultural University in China and is currently a PhD candidate at the School of Geography, Planning and Environment Management of the University of Queensland sponsored by the China Scholarship Council (CSC). Long's research focuses on land use planning, urbanization and land use policies in China. His current PhD research is on modelling the dynamics of China's urban-rural development in the context of state-led urbanization. He has published 16 academic papers and received various awards for his research papers on urban-rural development in China, including the Excellent Paper Award at the Geographic Society of China's Annual Conference in 2014, the Excellent Paper Award at the 2013 China Land Science Society Annual Conference, the First Prize Paper at the China Sustainable Development Forum (2013), and the First Prize Paper Award at the 8th China Rural Development Forum (2012).

Steve Denman, University of Cambridge, UK

Steve Denman is a Research Associate at the Department of Architecture, and Centre for Smart Infrastructure and Construction (CSIC) at the University of Cambridge. He is a geo-spatial data specialist and his particular research interest lies in analysing networks and people movement, particularly at the city scale. Recent research projects include the use of large scale, low frequency GPS datasets to estimate congested link speed; the effect of network topology and urban form on transport accessibility and usage; spatiotemporal analysis of urban flows from both conventional data and crowd sourcing.

Andy Dobson, David Simmonds Consultancy, UK

Andy Dobson studied Town and Country Planning at the University of Newcastle upon Tyne, and Operational Research at Lancaster. Before moving to DSC he spent over 20 years working in local government having worked within planning and research for Cumbria County Council, the Peak Park Planning Board, Hereford and Worcester County Council and as Corporate Research Manager at the Borough of Poole. During this time he had a wide range of responsibilities relating to planning, demographic forecasting and both economic and housing analysis. Since arriving at DSC in March 2005, he has led projects that involve every stage of the land use planning and modelling process including the development of new models, the development of enhancements to the DELTA land use package and the use of models to appraise transport and land use policies and strategies. He was appointed as a Director of DSC in January 2009; at the same time he moved to Edinburgh to establish the firm's Edinburgh office. He is currently directing work on a range of projects including major updates to the TELMoS, FLUTE and LLITM models, for Transport Scotland, Sheffield City Region and Leicester/Leicestershire respectively.

Marcial Echenique, University of Cambridge, UK

Professor Marcial Echenique is an international expert in urban and regional planning. He has been involved in the development of cities across the world and is particularly interested in the role of transport and pioneered the integration of land use and transport models. He has acted as a consultant to numerous governments and international bodies, including the World Bank and the United Nations. He is Professorial Fellow of Churchill College, Principal Investigator of the £3.8m EPSRC-funded ReVISIONS research programme, Co-Investigator for Cambridge University's Energy Efficient Cities initiative and the Centre for Smart Infrastructure and Construction, and the Director of Cambridge Futures Studies.

William Fawcett, Cambridge Architectural Research, UK

William Fawcett is an architect. After a Martin Centre PhD on 'A Mathematical Approach to Adaptability in Buildings' (1979) he worked in conventional architectural practice and taught at Hong Kong University, and was then one of the co-founders of Cambridge Architectural Research Ltd in 1987.

At CAR a major interest is in functional issues – this leads to design guidance publications (such as 'Design for Inherent Security', with Barry Poyner, 1995), or briefing ('pre-design') studies for specific projects. Design for flexibility is a continuing interest. A new approach to sustainable design for an uncertain future led to 'New Generation Whole-life Costing' and 'Whole Life Sustainability' (with Ian Ellingham, 2006 and 2013). CAR was part of the EC-funded CILECCTA consortium that developed software for real options-based LCC and LCA (2009-13).

He was appointed to the Chadwick Fellowship in Architecture at Pembroke College, Cambridge, in 2005 to develop the Activity-Space Research initiative, recorded in 'Built Space in the Digital Word' (2014).

Peter Ferguson, CASA, University College London, UK

Pete Ferguson holds an MA in urban design from Oxford Brookes University and a Bsc in Geography from the University of Birmingham. He is an honorary research associate with the Bartlett based Space Group and a course instructor on the MA in urban design course at Oxford Brookes University. He also collaborates with a number of industry educational organisations such as Urban Design London and the UK Planning Summer School.

His current research forms part of a larger ERC grant funded research project entitled MECHANICITY. MECHANICITY stands for Morphology, Energy & Climate cHANge In the CITY and is a five year project lead by Mike Batty. It will explore ideas about how energy flows tie the components of cities and their morphology together. The project aims to extend theories of urban morphology based on fractals and allometry to incorporate energetics in analogy to transport and network processes, drawing on the theory of metabolic scaling. As part of this the project will develop comparative analyses of city shape, compactness, energy use, and density.

Pete's work focuses on how the morphology of urban environments both reflects and influences social process. He is interested in the application of graph theory and complex network analysis to street and building systems as a means of understanding relationships between network structure, land use location and transport flow.

Amy Fotheringham, David Simmonds Consultancy, UK

Amy Fotheringham graduated from the University of Strathclyde in 2013 with a First Class Honours degree in Economics. For her final year dissertation she applied her knowledge of economics and her analytical skills to investigate the impact of land value capture mechanisms on housing market and macroeconomic stability in Hong Kong and Singapore. She was awarded the Sir Charles Carter prize for outstanding performance in Honours year and for being one of the top three performing students in her cohort.

Amy joined DSC in August 2013 and has worked on a range of DELTA model applications, including the development of new databases for the London and North Hampshire models, and extensive application of the London models to testing a range of infrastructure and other projects on behalf of Transport for London.

João Fumega, University of Lisbo, Portugal

João Fumega has a Bsc. in Geography - Urbanism, and a Msc. in Planning and Urbanism at the University of Lisbon. Currently he is a final year PhD candidate in the Climate Change and Sustainable Policies Doctoral Program (University of Lisbon, Lisbon Nova University, and East Anglia University, UK). His thesis is focused on the analysis of urban typologies and their patterns of energy consumption and greenhouse gas emissions. He is an invited research since 2007 in the Centre of Geographical Studies (CEG-UL), and he is also part of the recently founded Sustainable Cities and Urban Metabolism group at IN+ (IST – University of Lisbon). His research interests have always revolved around the relation between people and space in an urban sustainability perspective, through the importance of the built environment as a product but also as a determinant of cultural practice and social capital; and more recently, the importance of urban form in the patterns of energy consumption and greenhouse gases emissions. He has participated in 14 conferences, produced 6 papers in scientific journals, 1 book chapter, and 2 books as author/co-author. João Fumega is also an educational advisor in the Sustainable Energy Systems area of the MIT Portugal Program.

David Greenwood, BuroHappold Engineering, UK

Prior to starting his EngD at BuroHappold, David spent four years at the University of St Andrews modelling and analysing socio-technical issues that affect the engineering and operation of large-scale complex IT systems.

During his time at St Andrew David won the International Society for the System Sciences Anatol Rapoport Award for his work on using network analysis to analyse socio-technical models of system deployments. He was also awarded ‘best paper finalist’ at the Sixth IEEE Conference on System of Systems Engineering for his work on responsibility modelling for identifying threats to coalitions-of-systems.

Hsin-tzu Ho, University of Cambridge, UK

Hsin-tzu is a PhD student in urban studies in the Department of Architecture, University of Cambridge. She is working closely with Dr Ying Jin on linking a city-scale integrated land use and transport model with a micro-scale urban traffic model to study alternative planning, urban design and traffic management scenarios that would make a step change in urban sustainability. Her research involves employing big data from mobile phone apps and crowd sourcing to form a coherent database for traffic modelling to gain new insights into the behaviour of city dwellers and visitors and to inform the land use modelling. She also worked previously as a project assistant in Taiwan on a city wide cycling route project and as a transport planner in the UK on several urban regeneration initiatives including the London 2012 Olympic Legacy Masterplan Framework and urban development projects for cities in the Middle East and Far East.

Philip James, University of Salford, UK

Philip is Professor of Ecology and Leader of the Ecosystems and Environment Research Centre in the School of Environment and Life Sciences at the University of Salford. Together the 30 academic and 40 plus Postgraduate Researchers in the Ecosystems and Environment Research Centre address some of the major environmental challenges of the 21st Century: biodiversity resource management, climate and environmental change and spread of infectious diseases.

Philip's own research has led to establishing Ecological Networks in the UK and Italy. From that he worked to expand those ideas into urban areas which led to the creation of the Greater Manchester Ecological Framework. His research has developed to incorporate studies of ecosystem services that are delivered by divers habitats (salt marsh, brownfield sites, Sustainable Drainage Systems, woodlands, meadows, and lakes and ponds). His research is also used in guiding the development of landscape scale conservation and environment improvement interventions in for example, the River Irwell Catchment (777 km2), the Great Manchester Wetlands Partnership (400 km2) and the Upper Mersey Estuary.

Yang Jiang, Tsinghua University, China

Mr. Jiang is the director of urban planning at China Sustainable Transportation Center (CSTC), founded by the Energy Foundation. He has been managing implementation of a variety of projects in Chinese cities, including transit-oriented development, urban retrofits, non-motorized transportation system development, and city carbon emissions modelling. He also conducts related research and works on policy development, and has published over 20 papers. Mr. Jiang received his dual masters degrees of city planning and science in transportation from Massachusetts Institute of Technology, and master and bachelor degrees of architecture from Tsinghua University. Mr. Jiang is currently a part-time Ph.D. candidate at Tsinghua University. He also holds a national urban planner certificate in China.

Xihe Jiao, University of Cambridge, UK

Xihe Jiao is a PhD candidate in the Cities and Transport group in Department of Architecture at the University of Cambridge. His research interest is integrating urban ecology into urban design and urban planning through assessing urban ecosystem services, with a particular emphasis on high density area, eg. railway station, economic district etc. His current research focuses on modelling spatial distribution of outdoor recreation trips. Xihe obtained his Master degree in Landscape Architecture from University of Sheffield. Before starting his study at the University of Cambridge, he worked as a Landscape Architecture Assistant in Weddle Landscape Research Office Ltd. in Sheffield. Design experience includes business parks, urban riverside mixed use regeneration, university campus and offices area landscape.

Ying Jin, University of Cambridge, UK

Ying Jin is a University Senior Lecturer at Department of Architecture, University of Cambridge. He is Deputy Director of the Martin Centre for Architectural and Urban Studies, a co-Investigator at the Cambridge University Centre for Smart Infrastructure and Construction, and lead convenor of AUM symposia since 2011.

Seiyong Kim, University of Korea, South Korea [Unable to attend due to MERS disruptions]

Seiyong Kim is interested in creating and maintaining "cool" urban spaces in the 21st century when rapid transformations are taking place, emphasizing specific role of urban design while architecture intersects with urban planning, and striving through diligent disciplines to actualize cities of the 21st century. Especially, his essential focus is advanced through the careful analysis of theory, design, policy, and development to draw out concrete conclusions that can be translated into rigorous testing in real world situations. Currently, he is particularly interested in efforts to theorize and implement better strategies of urban renewal, urban landscape and low carbon urban architecture along with other diverse design techniques. In this 21st century of global interconnectivity, Seiyong Kim has partnered and networked with Columbia University, Harvard University in U.S, Waseda University in Japan, University of Sydney in Australia, Politecnico di Milano in Italy, and National Chengchi University in Taiwan.

Seiyong Kim received his Master Degree from Seoul National University, Korea and Columbia University, U.S, Bachelor Degree and Doctor of Engineering from Korea University, Korea. Then, he worked as an urban designer at Seoul Development Institute from 1992 to 1994. After that, he has worked as an architect and urban designer for National government, Seoul City, and several companies like Samsung, Daewoo, LH and K-Water. .He was also a visiting professor of University of Sydney, Australia in 2006 and a Fulbright Fellow at Harvard University from 2012 to 2013. Currently, he is teaching at Korea University(since 2006) and Columbia University(since2014).

He is a member of Presidential Council for Architectural Policy, National Urban Planning Committee, a director of Urban Reform Center. Also he is an advisor of Mayor of Seoul and a member of urban planning commission of Seoul. He conducted more than 70 projects, and held 6 exhibitions.

Bharat Kunwar, University of Bristol, UK

Bharat Kunwar is a PhD student in the Civil Engineering department at University of Bristol looking at crowd modelling for mass evacuation from cities. He is currently developing a rapidly deployable evacuation simulation toolkit for any given place on the planet for a wide band of crises conditions which could help emergency planners. His research interests include people behaviour, crowd dynamics and urban environment.

Seungil Lee, David Simmonds Consultancy, UK

Seungil, Lee received a doctorate in Urban and Regional Planning, Faculty of Spatial Planning, University of Dortmund, in 1998. Now, he belongs to the Department of Urban Planning and Design of the University of Seoul as a full professor. He is one of the most active researchers of Korea in land-use transport interaction model.

Yan Liu, University of Queensland, Australia

Dr Yan Liu is a Senior Lecturer in Geographical Information Science at the School of Geography, Planning and Environment Management of The University of Queensland. Her research interests lie in the fields of; 1) complex systems modelling and geo-simulation focusing on cellular automata (CA) and agent-based modelling (ABM) to describe, understand, model and predict environment and human change processes and interactions. The value of this research is to advance the constitution of these systems and assist with informed and evidence based decision support; and 2) social geographic studies using Big Data and GIS technologies, including human travel behaviours, spatial accessibility modelling and social inequalities associated with access to resources and service.

Mingfei Ma, University of Cambridge, UK

Mingfei Ma is a PhD candidate in the University of Cambridge. She is particularly interested in understanding how urban containment policies affect the development of the cities and the spatial choice of the residents, and in using this knowledge for creating new design solutions. Her main research focuses on assessing the performance of greenbelt policies using land-use transport interaction models and testing alternative configurations of large scale urban green space.

Claudio Martani, University of Cambridge, UK

Claudio is a Postdoctoral Research Associate at the Department of Architecture, University of Cambridge. He works with colleagues at Architecture, Engineering, the Computer Lab and the Judge Business School through the interdisciplinary Centre for Smart infrastructure and Construction (CSIC) of the University, which is a five-year, £17m centre funded by EPSRC, Technology Strategy Board with contributions from industry. He is working to develop an innovative model for assessing the level of flexibility required to manage uncertainty in infrastructure integration, particularly in the context of dense urban areas. The aim of the research is to take adequate account of uncertainty over the life cycle of infrastructure investments - through scenario tests and a new framework of flexible design (or option embedded design).

Within the context of this position he is also acting as a member of the board for the Smart Cities Interoperability Committee of BSi (British Standards Institution) in creating standards for Smart Cities in the UK, and as an Affiliated Postdoctoral Member at the Clare Hall College of Cambridge.

Claudio holds a PhD in Building Environment Project and Technology (TePAC) from the Politecnico di Milano (Italy), for which he developed a thesis on predictability and management of risks in the construction process.

Dimitrios Makris, Kingston University, UK

Dr Dimitrios Makris is an Associate Professor at the Digital Imaging Research Centre at Kingston University. His research interests are Computer Vision, Machine Learning and in particular Motion Analysis and Dimensionality Reduction. His work on learning scene semantic models and on multiple camera surveillance systems has been highly acknowledged by the international research community. His recent work is in the area of non-linear dimensionality reduction of time sequences with applications in human action recognition, style modelling and human body tracking. Dr Makris has been awarded a number of research project as principal investigator and has been financially supported by EPSRC, TSB as well as national (Ipsotek Ltd, Legion Ltd) and international companies (BARCO Ltd/Belgium, LG Electronics/Korea). He was the coordinator of the EPSRC Network on Vision and Language (VL-Net), the organizer of the IEEE workshop series on Visual Surveillance (2005-2008), the BMVA/EPSRC Summer School on Computer Vision (2009-2010) and the BMVA technical meetings (2008-2012). He was the invited speaker in Second IEEE International Workshop on Tracking Humans for the Evaluation of their Motion in Image Sequences (THEMIS2009). He was one of the two UK academics that have been interviewed by ZDF/Discovery Channel for their documentary: "2057 – The World in 50 years".

Andreas Matzarakis, Albert-Ludwigs University Freiburg, Germany

Prof. Dr. Andreas Matzarakis, Faculty of Environment and Natural Resources, Albert-Ludwigs-University of Freiburg since 2006. He was born at Pentalofos/Evros, Greece in 1960. He received a degree in Meteorology in 1989 from the Physics Department, Ludwig-Maximilians-University of Munich in 1989 and a Ph.D. degree in Meteorology and Climatology from the Aristotle University of Thessaloniki. From 1995 to 2001 he was a scientific assistant at meteorological Institute of the Albert-Ludwigs University of Freiburg and earned his habilitation about the "thermal component of the urban climate" in 2001. He is appointed to Professor at the University of Freiburg in October 2006. His research is mainly focused on urban climatology, human-biometeorology, tourism climatology, regional climatology, forest meteorology and climate impact research. He is founder and editor of the urban climate website. Since 1996 he chairs the commission on climate, tourism and recreation of the International Society of Biometeorology. He was vice-president of the International Society of Biometeorology (2008-2011). He is the developer of several models and tools in applied climatology and biometeorology i.e. RayMan Model, SkyHelios Model, Climate Mapping Tool and CTIS (Climate-Tourism/Transfer-Information-Scheme).

Paul Minta, David Simmonds Consultancy, UK

Paul Minta has a Bachelor's degree in Geodetic Engineering, and a Master's studies in Transport Planning and Engineering from the Napier University in Edinburgh. His earlier work included land and hydrographic surveys, and serving as a member of a team of engineering consultants who represented the Ministry of Works and Housing (Republic of Ghana), as client, in supervising the Keta Sea Defence and Resettlement Project in Ghana.

Paul joined DSC in April 2007, and has worked extensively on the application of the DELTA package in different parts of the UK, including several rounds of work with the TELMoS model, the national land-use/transport interaction model of Scotland. During 2013-14 he was heavily involved in application of the SITLUM model of Glasgow and the Clyde Valley, in collaboration with TRL and KPMG, in a program of work which helped to secure a valuable City Deal to support investment by the local authorities in the area. He is currently coordinating work on updated and enhanced versions of the LLITM and FLUTE models, for Leicester and Leicestershire and for the Sheffield City Region respectively.

Nahid Mohajeri, Ecole Polytechnique Fédérale de Lausanne *(EPFL), Switzerland*

Nahid Mohajeri is an Architect, Urban Designer, and Geographer. She is a postdoctoral fellow at Swiss Federal Institute of Technology in Lausanne (EPFL), Solar Energy and Building Physics Laboratory since September 2013. She obtained a PhD on 'City shape, entropy, and street network from University College London in 2013. Her main research interests are in physics of urban form, including urban complex systems and statistical modelling of urban patterns.

Paavo Moilanen, Strafica Ltd, Finland

Paavo Moilanen (MSc Civ.Eng. Helsinki University of Technology) is a land use and transport research and modelling enthusiast. Paavo's other areas of interests cover computing, transport systems planning, impact assessment, economics, policy processes and institutional issues. Paavo is a founding partner and chairman of the board in Strafica Ltd, a Finnish transport planning consultancy specialised in strategic transport and land use planning. The Company was established in 2000 and employs currently 20 professionals. Strafica's main clients in Finland are the Ministry of Transport and Communications, the Finnish Transport Agency, Regional Councils, Helsinki Region Transport and other major cities in Finland. Before founding Strafica Paavo learned the tricks of the trade from the great minds in the Government institute for Economic Research, Finland, LT-Consultants Ltd and Marcial Echenique & Partners Ltd, UK.

Robin Morphet, CASA, University College London, UK

Robin Morphet worked in Planning and Transportation in the GLC and London Boroughs, then as Head of Policy Analysis and Research in the London Borough of Hackney until 1991 when he joined the NHS as Regional Head of Information, SW Thames and later the Department of Health as Head of Information for London.

He has an academic background in Civil Engineering , Transportation and Environmental Planning, Mathematical Statistics and in Town Planning . He is currently a member of the Institute of Logistics and Transport and a Fellow of the Royal Statistical Society. Following retirement he has worked with the Centre for Advanced Spatial Analysis, UCL since 2009. His research has been concerned with the development of spatial interaction and land use models combining the methods of classical thermodynamics and economics in discrete modelling.

David Newbery, University of Cambridge, UK

David Newbery, CBE, FBA, is an Emeritus Professor of Economics at the Faculty of Economics, University of Cambridge, and Research Fellow in the Control and Power Research Group, Imperial College London. He was educated at Cambridge with undergraduate degrees in Mathematics and Economics, and received a PhD and ScD in economics also from Cambridge. He is a Fellow of the British Academy and of the Econometric Society. He is Vice-Chairman of Cambridge Economic Policy Associates and is an occasional consultant to the World Bank, Ofgem, Ofwat, and ORR. He has been a member of the Competition Commission and chairman of the Dutch electricity Market Surveillance Committee. He will be President of the IAEE in 2013. He is a member of Ofgem's Low Carbon Network Fund and recent advisor on Electricity Market Reform to the House of Commons Select Committee on Climate Change.

Marialena Nikolopoulou, Kent School of Architecture, UK

Prof. Marialena Nikolopoulou is Director of the Research Centre on Architecture and Sustainable Environment (CASE) at the Kent School of Architecture. Her expertise lies in environmental design with emphasis on people and their interaction with their environment, with extensive experience in monitoring of environmental conditions and occupancy surveys.

She has participated in various EPSRC, EU, TSB and UK/US-funded research projects on sustainability, use of open spaces and environmental quality, including perception of environmental stimuli, and interventions to encourage behavioural change. She is currently on the Steering Committee of the CIBSE Guide A on Environmental Design, co-authoring the Chapter on 'Environmental criteria for design' and leading the Chapter on 'Health issues'. Her work on outdoor comfort has received awards from diverse bodies (Royal Institute of British Architects, International Society of Biometeorology) and best paper prizes, and has influenced understanding of the topic across the world.

Mark Padgham, University of Salzburg, Austria

In his career as a professional student, Mark Padgham obtained degrees in mathematics, physics, meteorology, education, before moving on to a PhD in theoretical ecology. He has held research and teaching positions at Monash, Melbourne, and Canberra Universities, Australia, and at the University of Muenster, Germany. Since March 2015, he holds a position at the Inter-Faculty Department of Geoinformatics at the University of Salzburg, Austria, where his research focusses on the spatial structure of cities, and particularly on historically embedded processes that lead to the emergence of generic spatial structures such as neighbourhoods.

Haixiao Pan, Tongji University, China

Prof. Pan Haixiao, Department of Urban Planning, Tongji University. He is urban planning advisor for Shanghai Government, He is the chair of IVM China and LOC of WCTR 2016 Shanghai. Pan's major research interesting in urban spatial structure, mobility and sustainability. He has involved in implementation studies on land use plan and urban transport plan in more than dozen cities in China and responsible for 2010 Shanghai World Expo transport management strategy.

Michael Reilly, Metropolitan Transportation Commission, US

Michael Reilly is the Senior Land Use Modeller at the San Francisco Bay Area's Metropolitan Transportation Commission. He has overseen the agency's urban modelling development and application work since 2009. Other current projects include refining population synthesis techniques for microsimulation and the analysis of large non-motorized transport datasets. Mike previously did research and taught on global urbanization, land use modelling, and urban economics at Stanford University. He has consulted on urban modelling, spatial analysis, and remote sensing for clients including the California High Speed Rail Authority, Yale University's Seto Lab, and the California Natural Resources Agency. Mike has developed and applied a variety of urban models: UrbanSim, PECAS, CSDSL, SLEUTH, the California Urbanization and Biodiversity Analyst, and the second generation California Urban Futures model. Locations modelled include California, Nairobi, Bangalore, Tokyo, and the Pearl River Delta. Mike holds PhD and MCP degrees in City and Regional Planning from the University of California, Berkeley, and did post-doctoral work in urban remote sensing and spatial demographics at Columbia University's Earth Institute.

Emma Revill, David Simmonds Consultancy, UK

Emma Revill is an economist and specialist in land-use transport interaction modelling having worked in the field since graduating with a BSc in Economics from the University of Warwick. Emma has expertise in land use planning, modelling and economic appraisal with experience in developing new applications of the DELTA package and in running land use models to appraise land use and transport schemes.

Shoshanna Saxe, University of Cambridge, UK

Shoshanna Saxe (B.Eng M.Sc P.Eng) is a PhD candidate in the Centre for Sustainable Development. She is a certified Professional Engineer in Canada. Shoshanna's research investigates the intersection of metro rail infrastructure and urban sustainability. She completed a Bachelor of Engineering and Applied Mechanics at McGill University in Montreal, Canada (2007) and a Master's of Science in Engineering at the Massachusetts Institute of Technology in Cambridge, Massachusetts (2009). From 2009 to 2012 Shoshanna worked in the infrastructure group at Arup Toronto. Shoshanna's research is supported by the Commonwealth Scholarship Commission in the United Kingdom. She is a member of Jesus College.

Björn Schwarze, Spiekermann & Wegener Urban and Regional Research, Germany

Björn Schwarze is a partner in Spiekermann & Wegener Urban and Regional Research, Dortmund. His main research fields are interactions between transport and land use, population and labour and real estate markets, locational accessibility, sustainable spatial and transport development, geographic information systems, GIS-based analytical methods, simulation of land use development, integration of GIS and geodata in planning processes.

Tania Sharmin, University of Cambridge, UK

Tania Sharmin is a PhD Candidate at the Department of Architecture, University of Cambridge, funded by Schlumberger Foundation 'Faculty for the Future Award'. She holds a B.Arch from Bangladesh University of Engineering and Technology and MA in International Planning and Sustainable Development from the University of Westminster. She is a registered architect in Bangladesh and an Assistant Professor in Architecture at American International University, Bangladesh. Tania's PhD research focuses on integrating indoor and outdoor thermal comfort by ameliorating urban microclimate in tropical warm-humid high density cities in the developing countries. She is examining outdoor thermal comfort conditions with high resolution micro-climatic models and comparing the results with the actual thermal sensation of the pedestrians on site. The idea is to incorporate outdoor microclimate and thermal comfort information to inspect indoor conditions through building energy simulation. Tania is currently the Co-President and Seminar Coordinator of GreenBRIDGE Society at the University of Cambridge, Editor for the Scroope 24: Cambridge Architectural Journal and a member of the Parallel Forum for Sustainability and the Environment at the University of Cambridge. Previously she was a coordinator for the Martin Centre Research Seminars as well as number of workshops on Environmental Design in the Architecture Department.

David Simmonds, David Simmonds Consultancy, UK

David Simmonds qualified in Town and Country Planning at Newcastle University, and was awarded is PhD for research at the Martin Centre with Marcial Echenique. . He is a specialist in modelling and appraisal of the interactions between transport, land-use and the economy. Since 1995, much of his work has been focussed on the development and application of the DELTA package, from the Edinburgh prototype through to the dozen models in current use. He is an Honorary Professor in Heriot-Watt University, and has published widely on land-use/transport modelling.

Klaus Spiekermann, Spiekermann & Wegener Urban and Regional Research, Germany

Klaus Spiekermann is a partner in Spiekermann & Wegener Urban and Regional Research, Dortmund. His main research fields are structural spatial change, interaction between transport, land use and environment, sustainable spatial development; European spatial development, methods of spatial analysis, simulation models, geographic information systems, integration of GIS und simulation models and visualisation techniques.

Panagiotis Sourtzinos, Kingston University, UK.

Panagiotis Sourtzinos is a PhD student at Kingston University and a software developer/researcher in Legion Limited. After the completion of his MSc in Artificial Intelligence from the University of Edinburgh his main research interests has been Computer Vision and Pedestrian Simulation. Under a Knowledge Transfer Partnership (KTP) project, between Kingston University and Legion Limited, he researched and developed a software system for accurate pedestrian speed profiles estimation from monocular video sequences. Currently, for his PhD, Panagiotis is researching the field of deep learning and more specifically convolutional neural networks, with the goal of creating a system for people counting in images and video sequences.

Kiril Stanilov, University of Cambridge, UK.

Kiril Stanilov holds degrees in architecture, urban planning and urban design. Prior to joining the Martin Centre at the Department of Architecture, University of Cambridge as a senior research associate, he was an associate professor at the University of Cincinnati and a Marie Curie fellow at the Centre for Advanced Spatial Analysis, UCL. His research interests are centred on explorations of contemporary patterns of urban growth and change, and the evolution of urban form.

Koen Steemers, University of Cambridge, UK

Head of Department (2008-14), Director of Research (2003-08) and currently Head of Graduate Studies at the Department of Architecture, University of Cambridge. An architect and environmental design specialist, Koen was recently listed as one of the "top 50 most influential people in UK sustainability" by Building Design. His current work deals with the architectural and urban implications of environmental issues ranging from energy use to human comfort. He is Professor of Sustainable Design in the Department of Architecture, Professorial Fellow at Jesus College, and is a Director of Cambridge Architectural Research Ltd.

Scott Swisher, University of Cambridge, UK

Scott obtained his Ph.D. from the University of Wisconsin-Madison and joined the University of Cambridge as a postdoc in 2014. He models the economic behaviour of network-building firms like railroad companies or Internet service providers. He does empirical interdisciplinary research at the intersection of industrial organization, networks, and economic history.

Coen Teulings, University of Cambridge, UK

Coen Teulings (1958) is professor of Economics at the University of Cambridge and part-time Professor of Economics at the University of Amsterdam. He served 7 years as president of CPB, the Netherlands Bureau for Economic Policy Analysis, the influential 'Financial Thinktank of the Dutch Government' that decides on what is affordable in The Hague or not and that does the evaluation of platforms of political parties prior to general elections. Previously, he was CEO of SEO Economic Research in Amsterdam from 2004 until 2006, Professor of Economics at the Erasmus University Rotterdam and director of the Tinbergen Institute from 1998 until 2004.

He became Master of Economics cum laude at the University of Amsterdam in 1985 and in 1990 he got his PhD. His main publications are in the field of labour economics (minimum wages, returns to education and income inequality, job search, marriage markets in cities, and recently on returns to seniority in Econometrica).

Beside his main job, he was a member of the REA, an independent Council of Economic Advisors for the House of Commons and he chaired several committees, e.g. the committee that framed the new examination high school program economics. He is member of a number of supervisory boards and he recently joined the Advisory Panel of the OBR.

He writes a bi-weekly column in the NRC Handelsblad. www.coenteulings.com

Javier Urquizo, Newcastle University, UK

Javier Urquizo is a PhD Candidate in the school of Architecture, Planning and Landscape at Newcastle University, who has bachelor and master of engineering degrees in electrical engineering, a Master of Science in Civil/Environmental engineering and an MBA in Management. He has many years' experience in modelling, engineering design, spatial analysis, control systems, power systems, environmental studies and management.

Javier's doctoral work focuses on the application energy analysis in aggregating buildings as a mean to understanding relationships between detailed characteristics of the house, the energy system, the household characteristics, the climate, and the urban form. Other research interests include renewables, fuel poverty and sustainability.

Athanasios Votsis, the University of Helsinki and Finnish Meteorological Institute, Finland

Athanasios Votsis is a researcher at the Finnish Meteorological Institute (research group for the socioeconomic impacts of climate and weather / Climate Service Centre) and doctoral candidate at the University of Helsinki (Geoinformatics). His background is in urban and regional planning and design. His current theme of research is the impacts of climate change and ecosystem-related risks and amenities on residential property value, and their connection to the formal organisation of the built environment. Research interests include spatial analysis, urban economics, semiotics, and the archaeology of human settlements.

Paul Waddell, University of California, Berkeley, US

Paul Waddell teaches and conducts research on modelling and planning in the domains of land use, housing, economic geography, transportation, and the environment. He has led the development of the UrbanSim model of urban development and the Open Platform for Urban Simulation, now used by Metropolitan Planning Organizations and other local and regional agencies for operational planning purposes in a variety of U.S. metropolitan areas such as Detroit, Houston, Phoenix, Salt Lake City, San Francisco, and Seattle, as well as internationally in a growing list of cities in Europe, Asia, and Africa. His current research focuses on the assessment of the impacts of land use regulations and transportation investments on outcomes such as spatial patterns of real estate development and prices, travel behaviour, emissions, and resource consumption. He is also working on ways to engage public participation in making complex policy choices.

Over the past five years, Professor Waddell has served as PI or Co-PI on numerous research grants from the National Science Foundation, the Environmental Protection Agency, the Federal Highway Administration, and state and local governments. He is also active in providing consulting for local governments in developing and applying analytic tools for decision support, and began his professional career working as a regional planner with the North Central Texas Council of Governments.

Professor Waddell has served on the editorial boards of the Journal of the American Planning Association, Transportation Research Part A: Policy and Practice, Journal of Transport and Land Use, Transportation Letters, Applied Spatial Analysis and Planning, and International Journal of Microsimulation. His research is published broadly in journals in planning, geography, transportation, and urban economics.

Li Wan, University of Cambridge, UK

Li WAN is a third-year PhD Candidate in Architecture, University of Cambridge. He has bachelor degree in Architecture from China and MPhil degree in Environmental Design in Architecture from Cambridge. His PhD research aims to establish an urban spatial equilibrium model for evaluating urban sustainable initiatives. The proposed model simulates the interaction between urban land-use and transport system, and provides quantification of impacts of different policy interventions on a consistent basis for a given time horizon. The incorporation of non-equilibrium module within the general equilibrium framework enables dynamic simulation of urban evolution trajectories in a recursive manner. An empirical application will be based on the city of Beijing, China.

Michael Wegener, Spiekermann & Wegener Urban and Regional Research, Germany

Michael Wegener was, until 2003, Director of the Institute of Spatial Planning and Professor at the Faculty of Spatial Planning of the University of Dortmund and is now a partner in Spiekermann & Wegener Urban and Regional Research, Dortmund. His main research fields are urban and regional development and European urban systems with a specialisation in urban and regional modelling, in particular of the land-use/transport/environment interface in cities and regions. He is the author of the IRPUD urban land-use transport interaction model and has written several reviews of the state of the art in urban modelling. His research includes various projects involving the application of urban models, such as SCATTER, PROPOLIS and STEPs and an ongoing project aimed at modelling the energy transition in the Ruhr area in Germany until 2050.

Lang Wei, Hong Kong Polytechnic University, Hong Kong

Lang Wei is a PhD candidate of Urban Planning at the Faculty of Construction and Environment, Hong Kong Polytechnic University since 2011, and visiting scholar of School of Environment and Design at UC Berkeley 2013-2014. He is a certified town planner (HKIP and APA). His thesis focuses on urban smart growth in China by assessing land use pattern and city scaling with a quantitative method, which applies spatial entropy and scaling law.

Ian Williams, University of Cambridge, UK

Ian is a mathematician/statistician by training and has 44 years research, academic and consultancy experience in transport planning. One of the founding partners in 1978 of the land-use and transport planning consultancy ME&P, he was its Managing Director for the six years prior to its merger into WSP in 2001. Ian continued at WSP until 2011 when he switched to become an independent consultant, combining this with land use and transport research back in the Architecture Department in Cambridge University, where he had started his research career in 1971.

His particular interest lies in research into understanding the many interlocking factors that influence the spatial and temporal evolution of demand for passenger and freight transport across all modes of transport. He has used this understanding to inform the design and implementation of freight and passenger forecasting models and their usage for policy analysis. Models he has designed include: many components of the National Passenger Transport Model of Great Britain in active use by DfT for more than a decade; the earlier SCENES passenger and freight model for all of Europe used by the EC; as well as many national, regional and metropolitan models in 12 countries spread across four continents.

Vassilis Zachariadis, CASA, University College London, UK

Vassilis Zachariadis is a Research Associate at the Centre for Advanced Spatial Analysis, UCL and the Centre for Smart Infrastructure and Construction, University of Cambridge. For a decade, he has been involved in the research and application of several land use and transport models, such as LUISA (Land Use Interaction and Social Accounting model) commissioned by EEDA (2010), and SimDELTA (2007), a microsimulation model of household behaviour, developed by DSC and commissioned by the UK Department for Transport. He is an expert in pedestrian behaviour and senior scientist at the pedestrian simulation company Legion Ltd. His research covers applied economic geography, location choice models, spatiotemporal analysis of urban activities (featured in the RICS Futures report, 2015), and situated multi-agent systems.

Barry Zondag, Significance, Netherlands

Barry Zondag is Managing Director of Significance. He holds a PhD in Civil Engineering from Delft University and has extensive experience in passenger- and freight transport forecasting and planning, land-use modelling and policy analysis. He has worked in applied transport and land use research for Hague Consulting Group, RAND Europe, Delft University of Technology and Netherlands Environmental Assessment Agency PBL. His main areas of interest are integrative land-use and transport modelling, ports and freight modelling, multi-sector scenario development, accessibility evaluation, cost benefit analysis and management of large scale models. He is the principal developer of the TIGRIS XL model, a land-use and transport model for the Netherlands. He has also substantial international experience and participated in studies for Europe, Black Sea region, Mediterranean region, Thailand and Indonesia.

Delegates

Name	Organisation
Youngsoo An	University of Seoul
Alex Anas	State University of New York at Buffalo
John Bates	University of Oxford
Mike Batty	CASA, UCL
Johannes Bröcker	University of Kiel, Kiel, Germany
Vasco Carvalho	university of Cambridge
Gerry Casey	University of Cambridge
Robert Cervero	University of California, Berkeley
Edwin H W Chan	Hong Kong Polytechnic University
Doreen Chan	Hong Kong Polytechnic University
Christina Chatzipoulka	Kent School of Architecture, University of Kent
Clementine Cottineau	CASA, UCL
Debbie Deng	University of Cambridge
Steve Denman	University of Cambridge
Andy Dobson	David Simmonds Consultancy LTD
Marcial Echenique	University of Cambridge
William Fawcett	Cambridge Architectural Research
Peter Ferguson	CASA, UCL
Alistair Ford	Newcastle University
Amy Fotheringham	David Simmonds Consultancy LTD
Franz Fuerst	University of Cambridge
João Fumega	MIT Portugal - IST (University of Lisbon)
Tim Gent	WSP
David Greenwood	University Bristol / Buro Happold
Tony Hargreaves	University of Cambridge
Tim Hillel	University of Cambridge
Hsin-tzu Ho	University of Cambridge
Martin Hughes	Cambridge Architectural Research
Kaveh Jahanshahi	University of Cambridge
Philip James	University of Salford
Yang Jiang	China Sustainable Transportation Center &Tsinghua University
Xihe Jiao	University of Cambridge
Ying Jin	University of Cambridge
Anders Johansson	University of Bristol
Bharat Kunwar	University of Bristol
Yan Liu	University of Queensland
Mingfie Ma	University of Cambridge
Claudio Martani	University of Cambridge
Andreas Matzarakis	Universität Freiburg
Nahid Mohajeri	École polytechnique fédérale de Lausanne EPFL
Paavo Moilanen	Strafica Ltd
Patricia Moreira Leal Salvacao	University of Portsmouth
Robin Morphet	CASA, UCL

David Newbery	University of Cambridge
Marialena Nikolopoulou	Kent School of Architecture, University of Kent
Bruno Osorio	University of Bath
Mark Padgham	University of Salzberg
Haixiao Pan	Tongji University
Wendy Pullan	University of Cambridge
Michael Reilly	Metropolitan Transportation Commission
Flora Roumpani	CASA, UCL
Xiao Rong	University of Cambridge
Jennifer Schooling	University of Cambridge
Joan Serras	CASA, UCL
Andres Sevtsuk	SUTD City Form Lab
Tania Sharmin	University of Cambridge
David Simmonds	David Simmonds Consultancy LTD
Panagiotis Sourtzinos	Kingston University
Kiril Stanilov	University of Cambridge
Koen Steemers	University of Cambridge
Scott Swisher	University of Cambridge
Coen Teulings	University of Cambridge
Ioannis Tikoudis	VU Amsterdam / Tinbergen Institute
Javier Urquizo	Newcastle University
Athanasios Votsis	University of Helsinki & Finnish Meteorological Institute
Paul Wadell	University of California, Berkeley
Li Wan	University of Cambridge
Chengjiao Wang	University of Cambridge
Jiaqiu Wang	CASA, UCL
Michael Wegener	TU Dortmund University
Ian Williams	University of Cambridge
Vassilis Zachariadis	CASA, UCL & University of Cambridge & Legion
Bing Zhao	University of Cambridge
Cheng Zhong	CASA, UCL
Barry Zondag	Significance

CSIC WOULD LIKE TO THANK ITS INDUSTRY PARTNERS

CSIC Cambridge Centre for Smart Infrastructure and Construction

EPSRC Pioneering research and skills

Innovate UK Technology Strategy Board

UNIVERSITY OF CAMBRIDGE

Notes

CONFERENCE VENUE

CONFERENCE LOCATIONS

All refreshments, lunches and buffet supper & wine reception (24th June - included in symposium registration) will be held in the marquee.

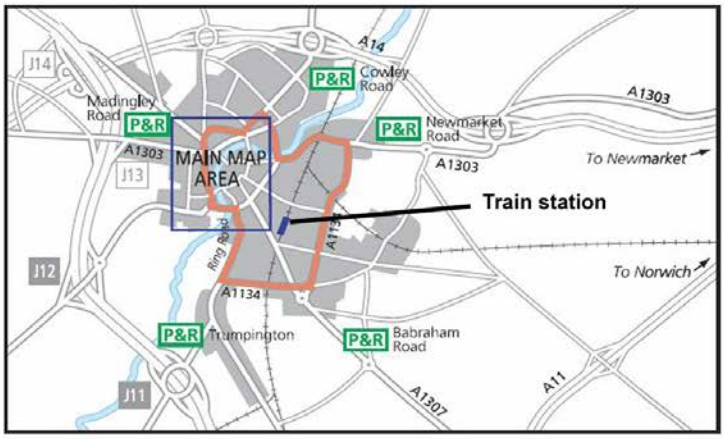
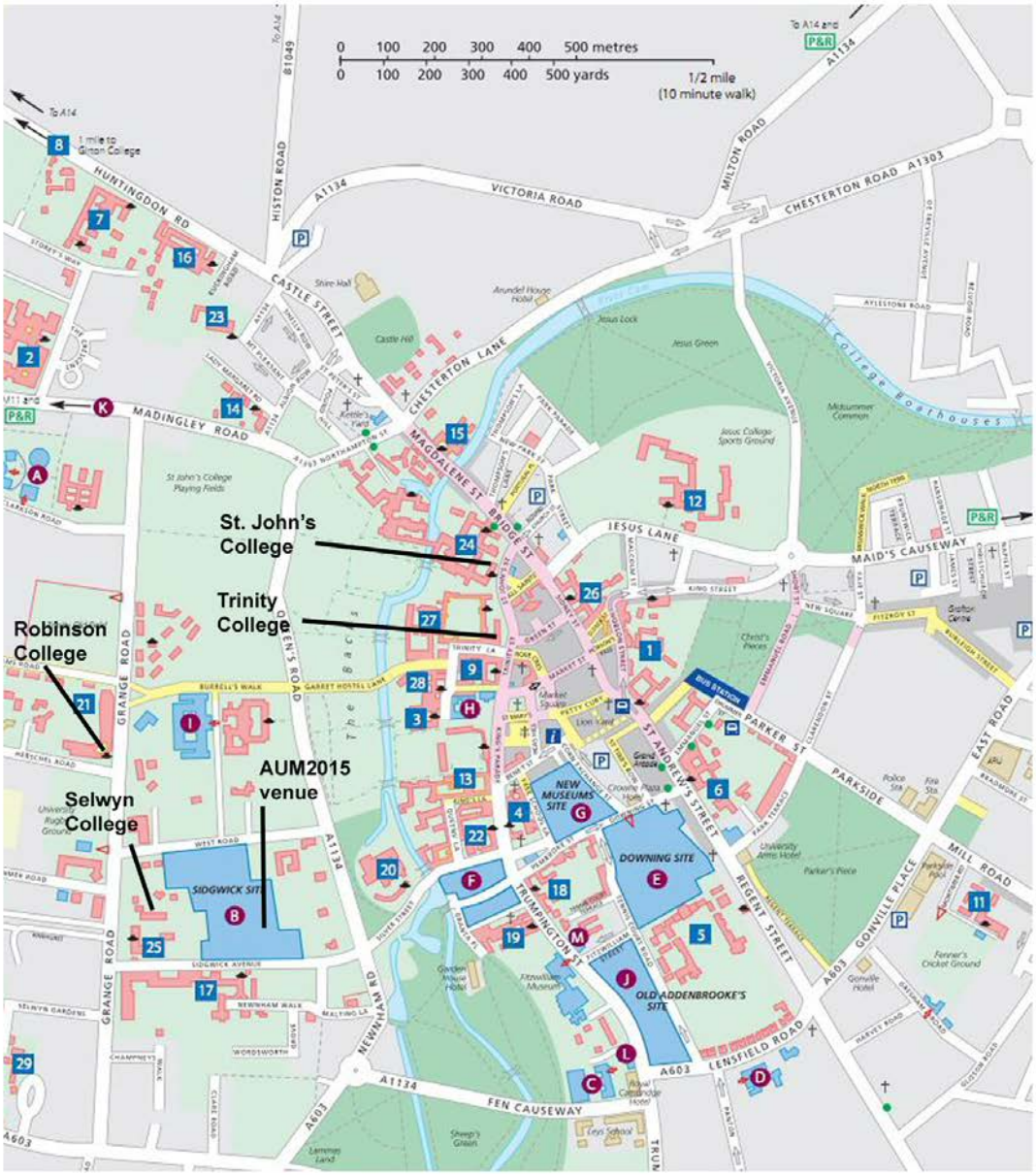
All symposium sessions will be held in the Little Hall Lecture Theatre.

Conference dinner on the 25th (pre-booked only) will be held at St John's College.

Conference dinner on the 26th (pre-booked only) will be held at Trinity College.

For locations of conference dinners and accommodation please see back cover.

CONFERENCE WIRELESS INTERNET ACCESS

Wireless access is via individual ticket. Please see a conference convenor (Steve Denman, Ying Jin or Claudio Martani) for a ticket.

MAP OF CONFERENCE LOCATIONS