USING HISTORICAL DATA TO ANALYSE & VISUALISE THE COMPOSITION OF THE UK BUILDING STOCK AND CHANGE WITHIN IT

An exhibition produced by

The Bartlett Centre for Advanced Spatial Analysis (CASA) at UCL

Hosted by Alan Baxter Associates, London

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PROJECT TEAM

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The Bartlett UCL Energy Institute – visualisation by Steve Evans

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3figs.com—4D Evolution animation

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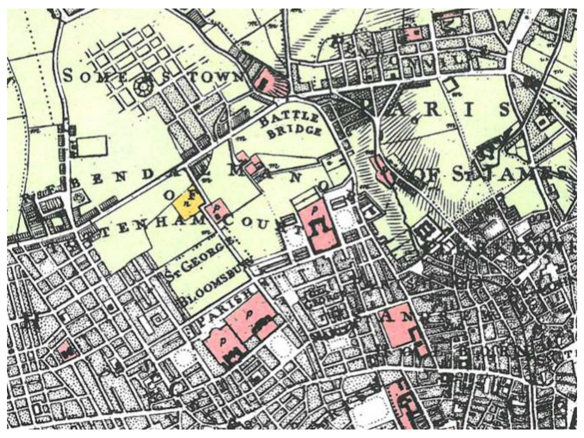
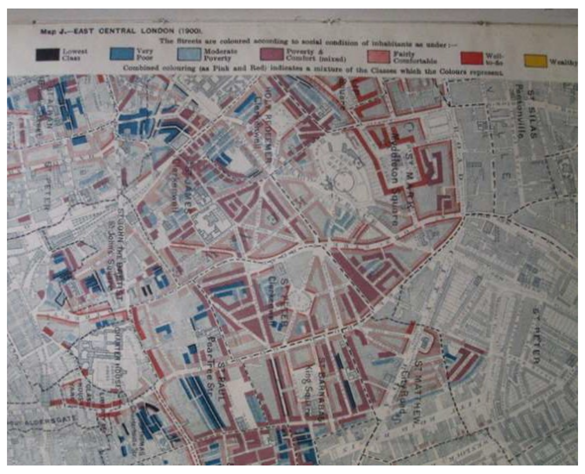
Introduction

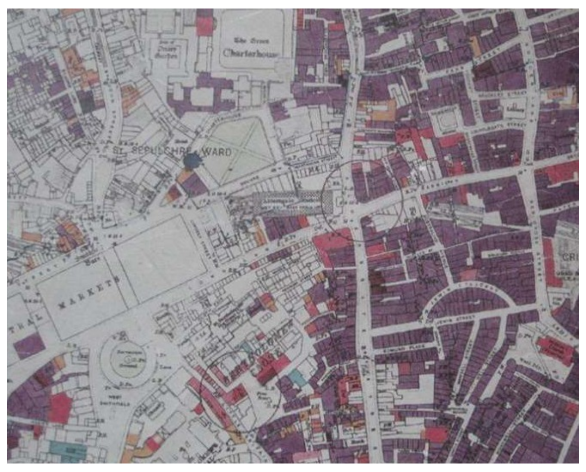
As London and other cities face increasingly stringent energy legislation, and growing pressure on infrastructure and natural reserves, the efficient use of urban resources becomes ever more critical.

Urban efficiency relies on a detailed knowledge of a city's resources: How much do we have? How long will they last? Where are they located? At what rate are they being depleted? How valuable are they and why?

Yet these questions are rarely asked about our largest, most important and most complex manmade resource, our building stock. This exhibition, curated by the Bartlett Centre for Advanced Spatial Analysis at UCL (CASA), looks at reasons for this and seeks to find possible solutions by combining new technologies with historical spatial data.







Examples of the lost tradition of citywide, spatial, building stock metadata and its colour coded visualisation

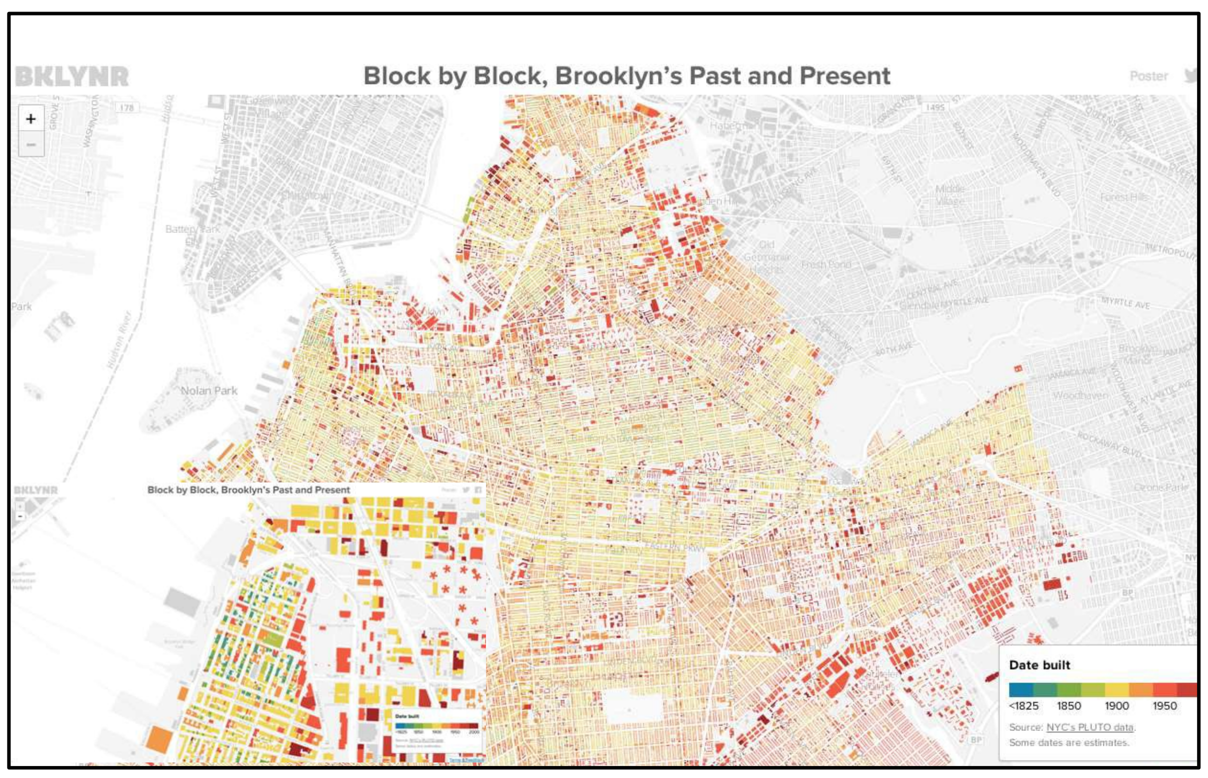
Reproduced courtesy of London Metropolitan Archives

Top: Milne Land Use Map 1800
Middle: Booth Poverty Map 1900
Bottom: LCC Bomb Damage Map 1940

International context

In 2011 a European-wide survey by the Building Performance Institute Europe highlighted that nations' limited knowledge and understanding of their building stocks presented a major obstacle to monitoring energy regulation.

Other recent European studies have found fragmentation and incompleteness of information to be caused, largely, by different sectors' focus on specific aspects of the stock, and though land registers and property tax databases often hold detailed and comprehensive data, as seen in the UK, access to these can be costly and/or heavily restricted.

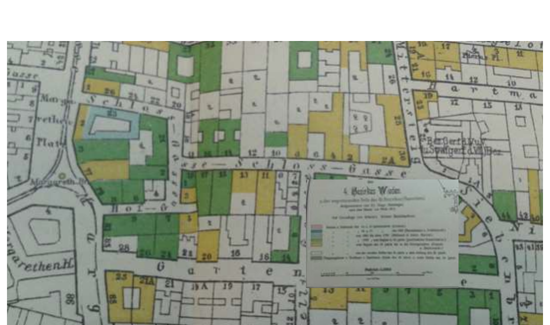


Brooklyn construction date interactive map
http://bklynr.com/block-by-block-brooklyns-past-and-present/. Thomas Rhiel's trendsetting 2013 visualisation of the PLUTO (Property Land use Tax Lot) database showing construction date data for 320,000 buildings.
Images courtesy of Thomas Rhiel

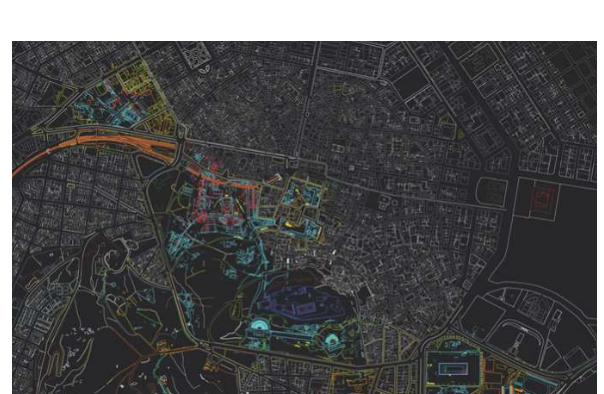
In June 2013 a US designer, Justin Palmer, came across an age dataset for Portland's buildings. He visualised this using a software called TileMill and uploaded it online. A few days later Thomas Rhiel, employed the same method to show the age of Brooklyn, using New York City's highly sought after PLUTO dataset (comparable to the UK's Valuation Office Agency's property details) for which charges had recently been dropped.

The idea was subsequently picked by developers in areas of the world where building age and building footprint data had been released. Stunning visualisations are now available for cities in the Netherlands, Slovenia, Iceland, Canada and the US.

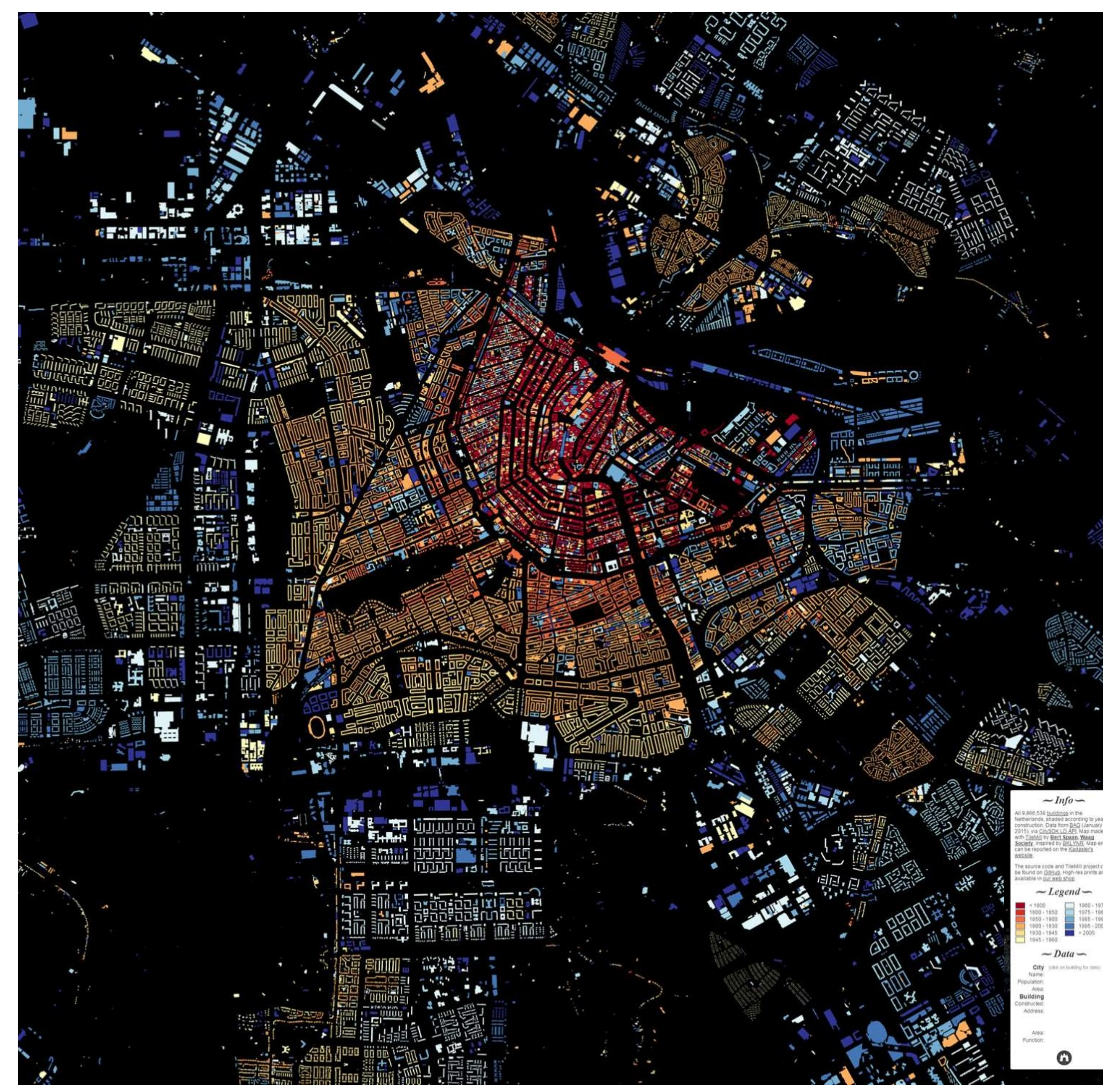
If VOA property details, and Ordnance Survey footprint Data, were to be released, information on the form and function of every taxable UK building could be rapidly visualised too.



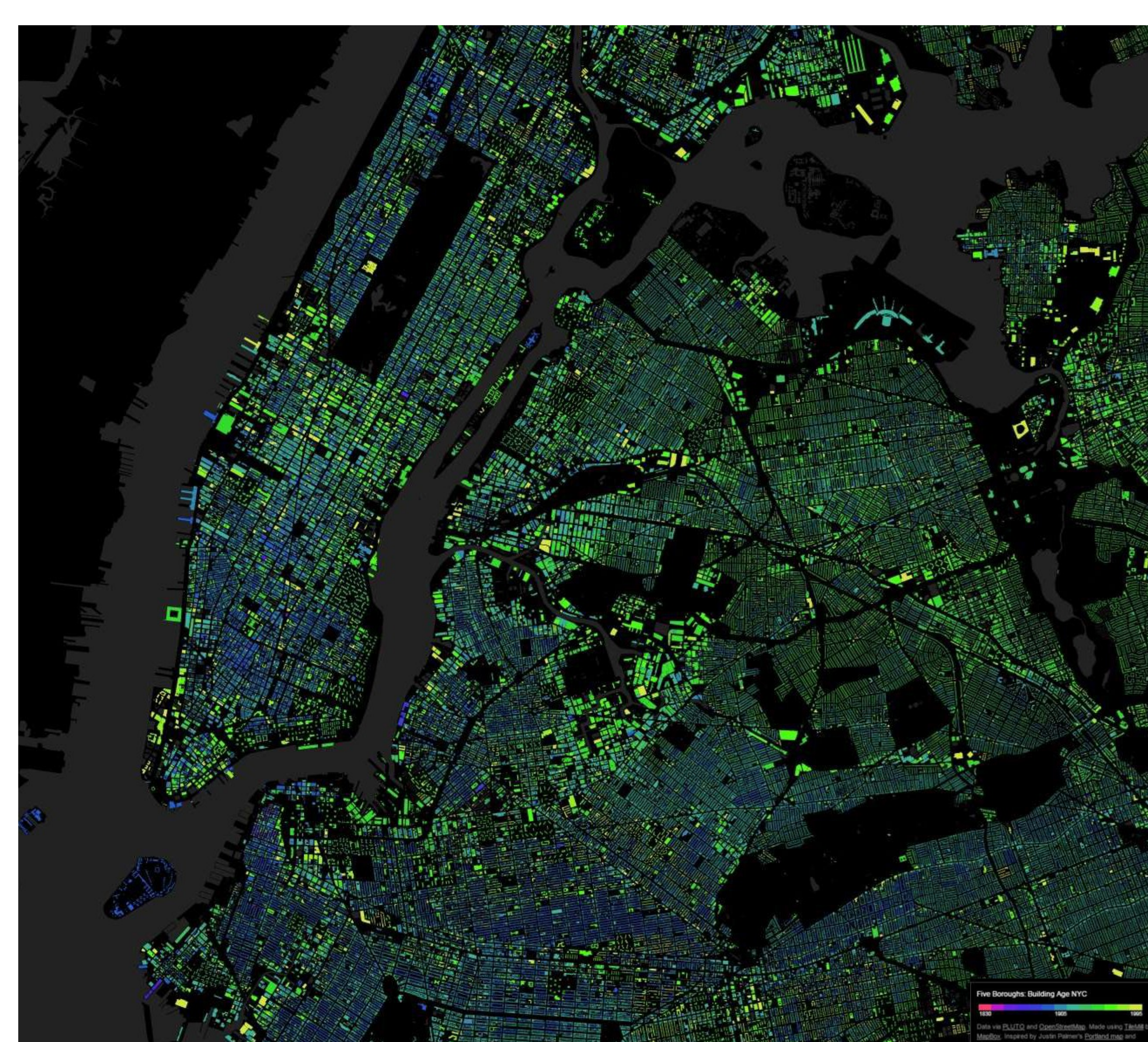
Art Historical Atlas of Vienna 1916
Created by Hugo Hassinger this is one of the earliest examples of colour-coding and spatial visualisation of citywide construction data. Hassinger was part of the emerging urban morphology movement, which continues to promote the importance of research into the character and evolution of the urban landscape.
Photographed courtesy of the British Library



Athens, stockdate mapping. 2004
Produced in CAD this image shows Greece's early interest in the visualisation of citywide construction metadata which was freely circulated to planners, students and architects.
Image courtesy of the Greek Authorities



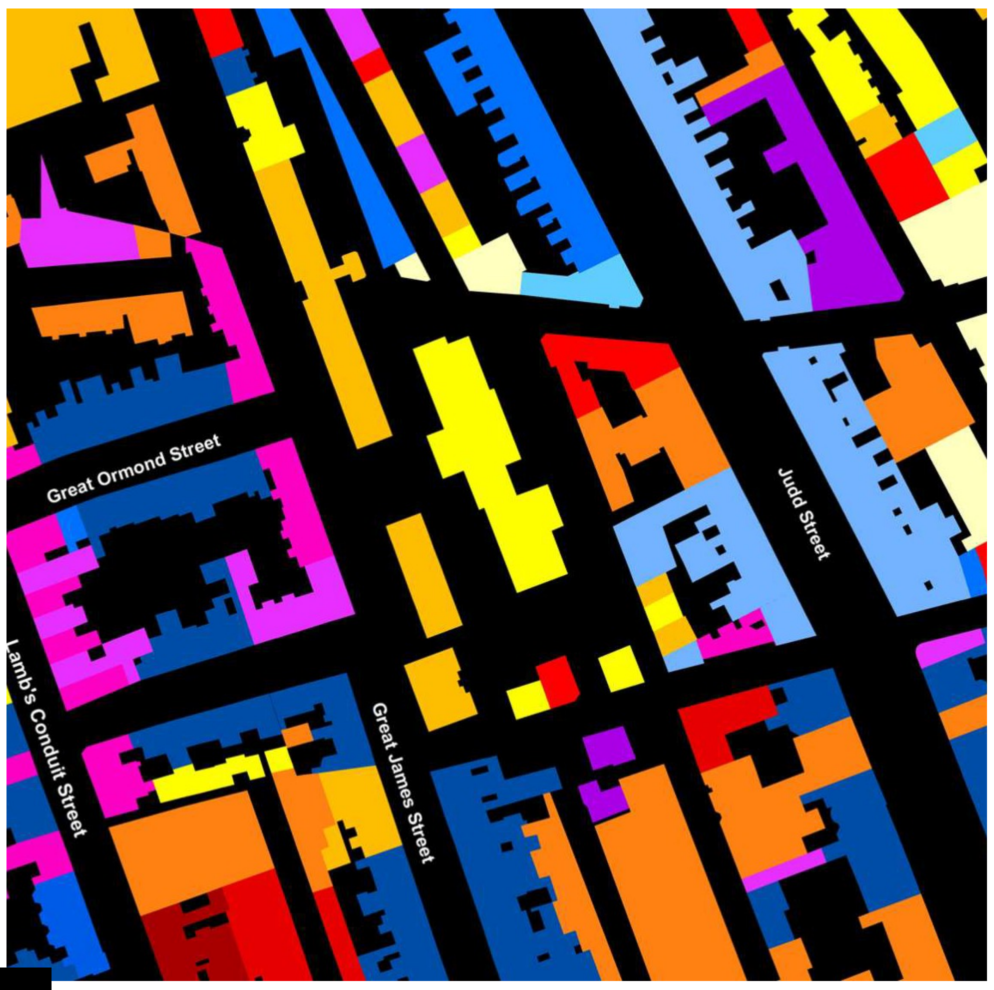
Waag Society. Netherlands metadata map.
http://code.waag.org/buildings/
Created in 2013 by Bert Spaan for the Waag Society this interactive map includes updated information on date, property type and area for all 9,866,539 buildings in the Netherlands, using Kadaster land registry data. Here blues denote new construction and reds old.
Image courtesy of Bert Spaan



Building Age New York City 2013
http://pureinformation.net/projects/building-age-nyc/
1,053,713 building addresses and construction dates produced by Brandon Liu, a 24 year old computer programmer in San Francisco using PLUTO data. Liu's website also provides an interesting link to Columbia University's assessment of error.
Image courtesy of Brandon Liu

Creating and visualising UK metadata

As access to government metadata is currently blocked, alternative methods for demonstrating the importance and impact of its release are required Below are experimental samples currently being developed at CASA. The aim is to identify methods of producing and releasing accurate open-access information on building type, construction date (providing methods, materials and form) height, area and volume for every building in the UK.



Initial work is focusing on the London Borough of Camden, carried out in five stages. **Stage 1**: Draft dating using historical OS maps only. **Stage 2**: Detailed dating using (primarily) Edina Digimap Ancient Roam's OS historical maps, Pevsner's *Buildings of England*, Historic England's 'List', The Survey of London, British History Online, Google Street View and Bing Birdseye. This method can be seen applied between Oxford Street and Primrose Hill below.

Stage 3: Rechecking of date data to reduce margin of error. Addition of height and land use information. **Stage 4**: Adapting open footprint data to release metadata online. **Stage 5:** Development of methods for updating and public contribution. Testing against LIDAR dating method described below.

Camden stockdate map. DRAFT

Here we see building dating in progress; Stage 1 drafting to the north of the borough and at the southern tip. Stage 2 detailed dating (first draft) between Camden Town and New Oxford Street (and beginning in Highgate and Parliament Hill). Both similarity and diversity quickly become apparent as does the amount of rebuilding close to London's ancient core. A single date is used to trigger the colour coding, with the date range and historical source included as separate GIS fields.

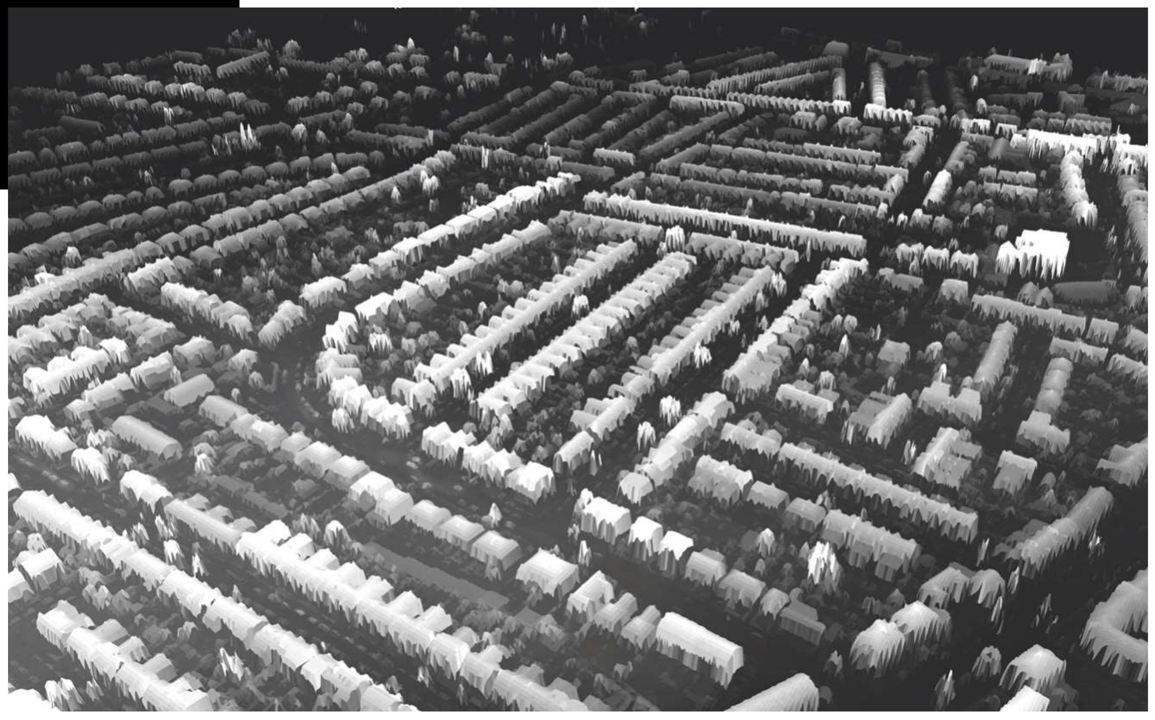
Stage 1 production Louis Jobst. & Polly Hudson. Stage 2 production Polly Hudson.

LIDAR data 2015 (right)

LIDAR is a remote sensing technology that measures distance by lighting a target with a laser and measuring the distance travelled by the reflected light. This provides information on the shape of the earth, building height and building form. Recent Canadian research has demonstrated that LIDAR can also be used to estimate construction date. The image shows Camden terraces visualised using

LIDAR data..

Open LIDAR courtesy of The Environment Agency, visualised by Flora Roumpani

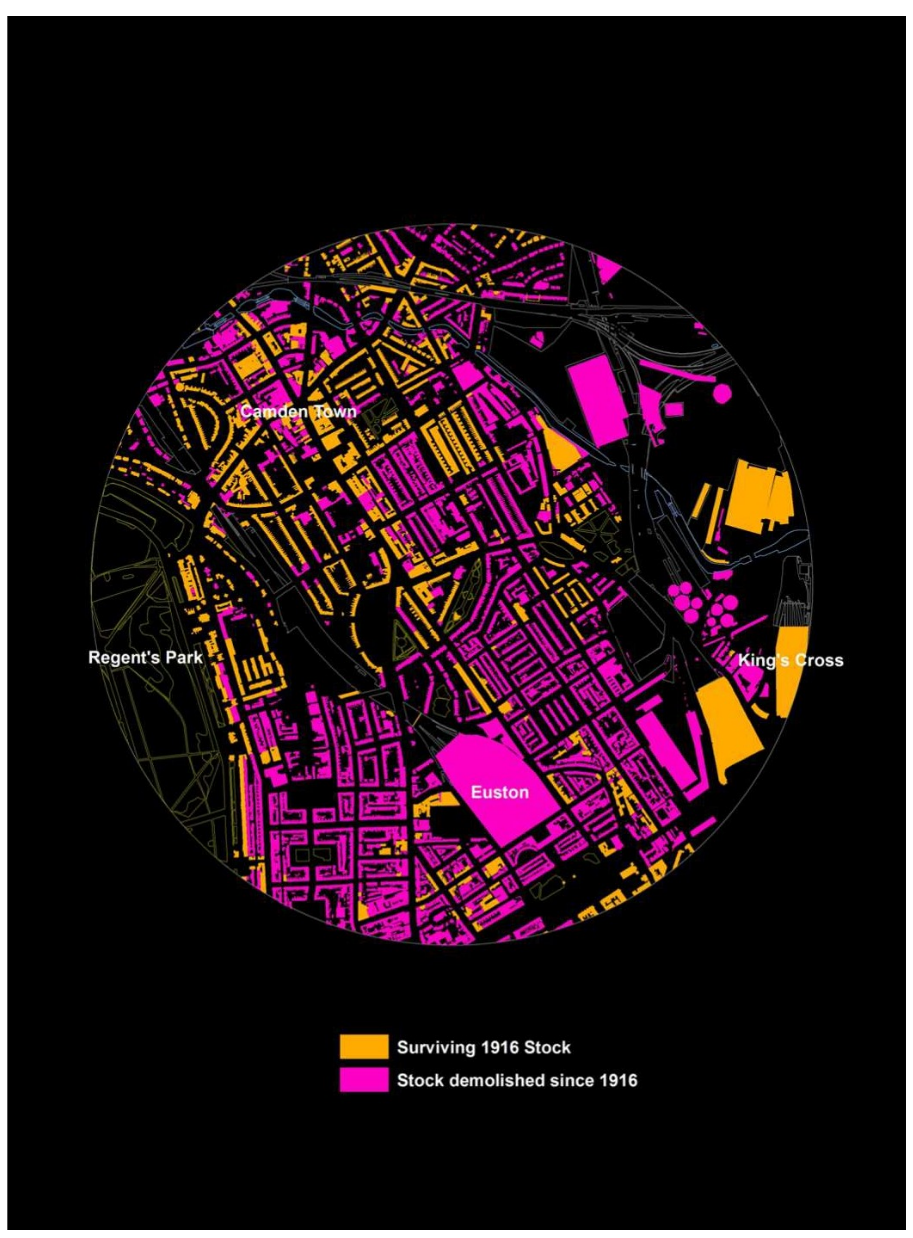


Analysing rates of demolition

Despite being our most important manmade resource it is estimated that around a fifth of our existing building stock could be demolished over the thirty years.

Though Europe is gradually shifting from a culture of new build to refurbishment (driven by waste directives), UK local authorities are still not required to assess demolition in detail nor to geolocate or publish building loss.

Work has begun at CASA to develop simple methods of spatially tracking demolition. Using a 2km diameter area in central Camden we show how digital building outlines traced from scanned and geo-referenced historical maps can be used to assess long-term survival and loss. For more recent demolition OS MasterMap editions can be overlaid and changes between editions visually recorded.



1916 - 2014

Total buildings in 1916 9,239

Demolitions since 1916 6,714 (72%)
Survivals in 2014 2,525

Over 70% of buildings built in this area by 1916 have been demolished over the last hundred years. The difference |between the higher number of buildings in 1916 than 1955 is largely explained by the fact that pre-war buildings are generally smaller than post-war, with outhouses also being more common.

1955 - 2014

Total buildings in 1955: 6,536

Demolitions since 1955: 3,434 (53%)
Survivals in 2014: 3,102

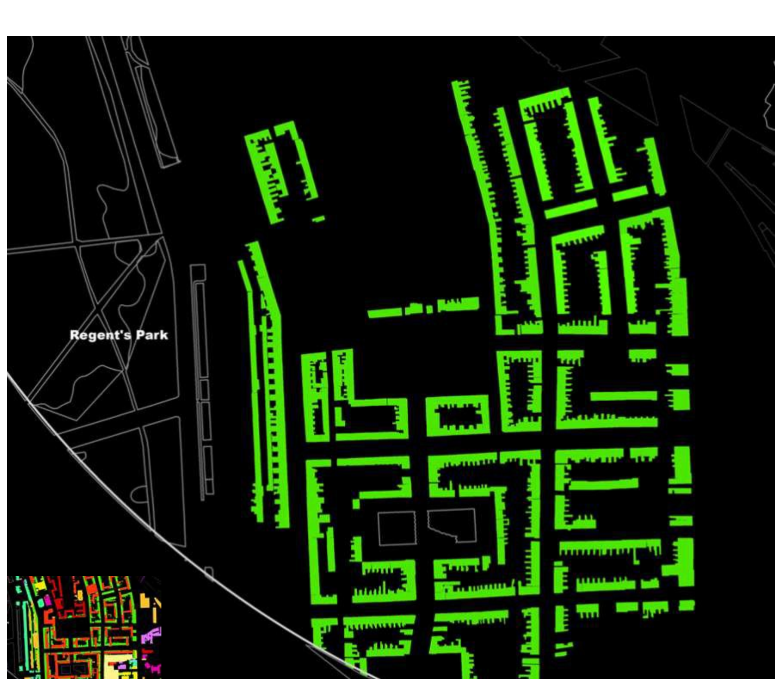
Central Camden was a key target for German bombs during World War II owing to its high concentration of mainline stations. Damage was recorded in meticulous detail by the LCC's Bomb Damage maps. From this it is clear that many buildings in the area, demolished after the war, were structurally sound.

2006 - 2014

Demolition: 204 buildings

Survival: Unable to be estimated at present owing to the way OS currently subdivides structures

Recent demolition can be identified as occurring mainly around King's Cross and Regent's Canal. Google's Historical Street View, launched in 2014, now allows demolished structures to be re-viewed. The product also represents the growing commercial interest in historical data.



To the east of Regent's Park around 1000 Georgian buildings were demolished in the 1950s. This followed a post-war trend to replace older stock with new housing estates (see insert) rather than to refurbish them to create social housing. The capital value of these Georgian buildings today is estimated at around £2 billion.

Above we begin to assess the extent of demolition in the City of London since 1970. This was largely driven by the deregulation of financial markets during the 1980s and the consequent need for large trading floors (with many older facades today fronting modern cores). Combined with extensive WW11 bomb damage, this has resulted in the loss of most of the City's intricate pre war fabric and its ancient, intimate, connection with the Thames.

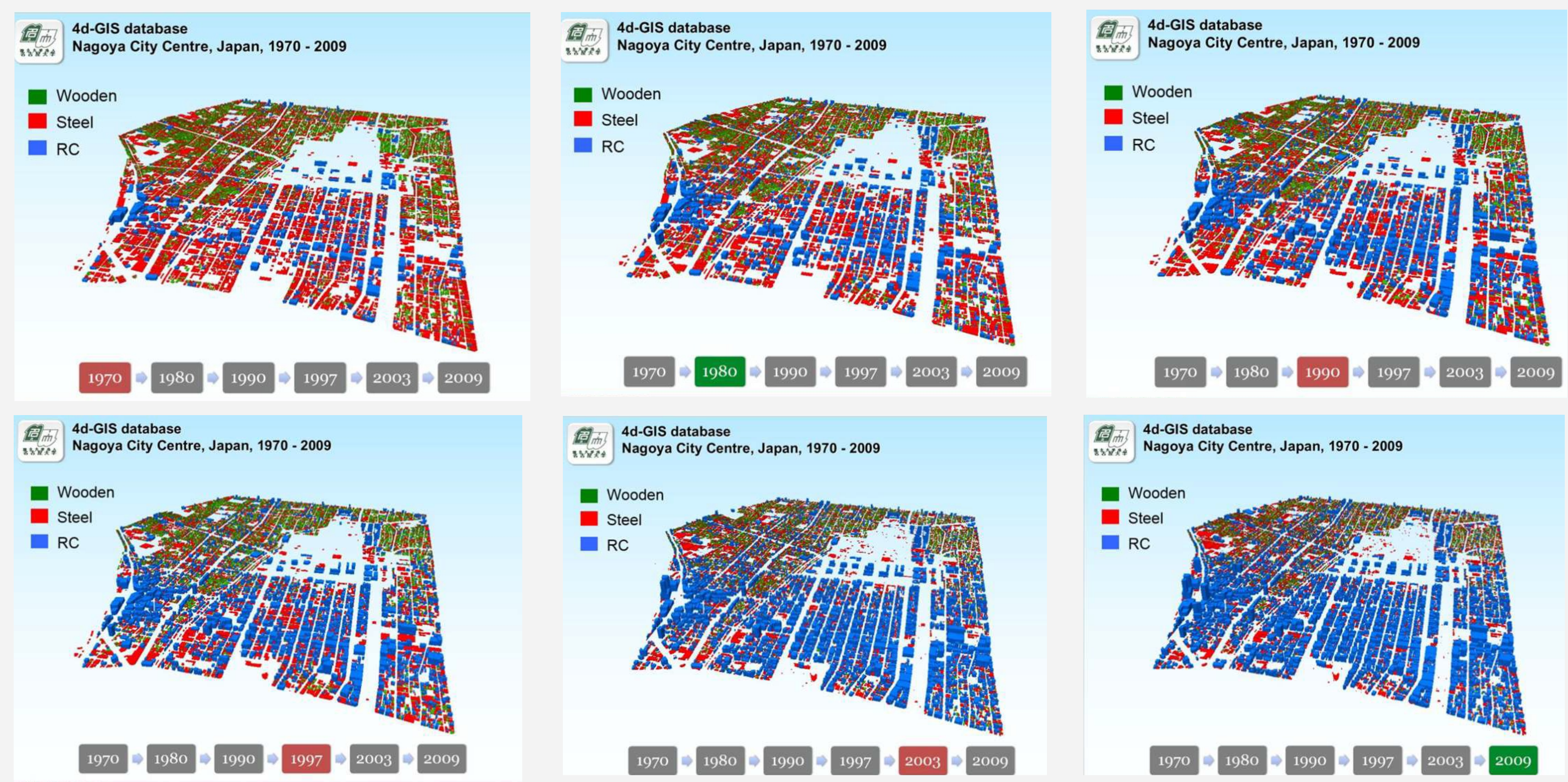
c1700 –c1850 buildings extracted and visualised. Work will soon begin to assess the percentage of stock surviving in Camden (from each historical period) compared to original levels.

Applications for historical spatial data

Historical spatial data are anticipated to become increasingly prized over the next decade, with experimentation already under way within the energy and waste sectors. Here we look at other examples of their potential use.

Waste management and material stock flows

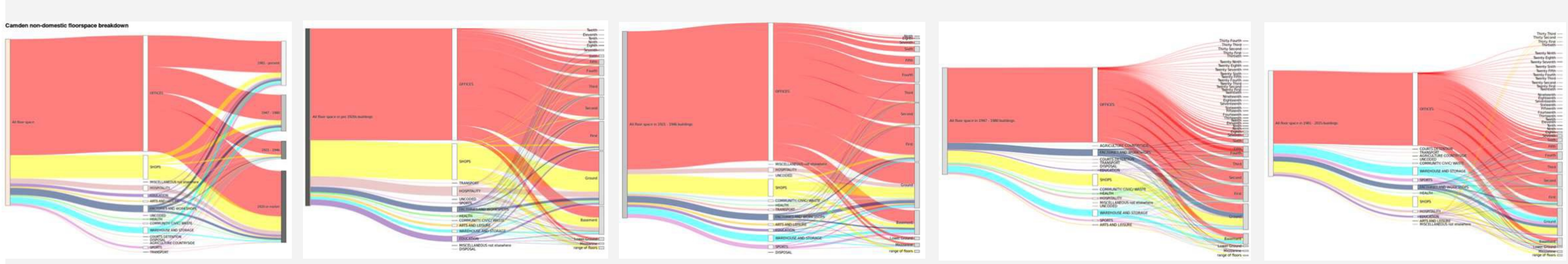
Japanese researchers have argued that affluent cities need to reduce their material extraction levels by extending the length of time materials are held within infrastructure and building stock. Historical mapping is used to assess building longevity and to identify the volume and composition of material flows. Research hubs relating to this work are currently being set up in Japan, China and Manchester, UK.



4D-GIS database showing material stock flows in Nagoya City Centre, Japan 2007- 2012

Reproduced courtesy of Hiroki Tanikawa (Nagoya University) & Seiji Hashimoto (National Institute of Environmental Studies, Japan. www.nagoya-u-ac.jp/

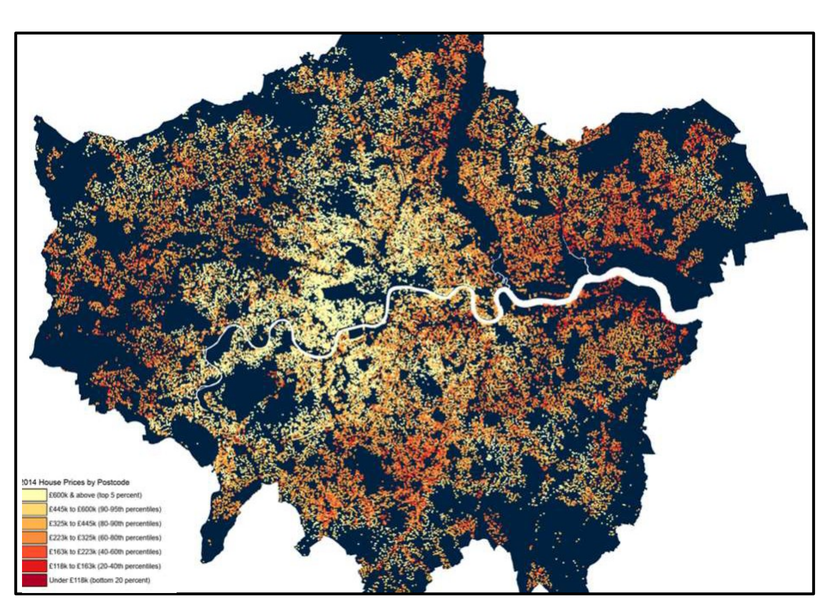
Energy consumption



Sankey diagrams showing non-domestic floor space in Camden buildings by building age

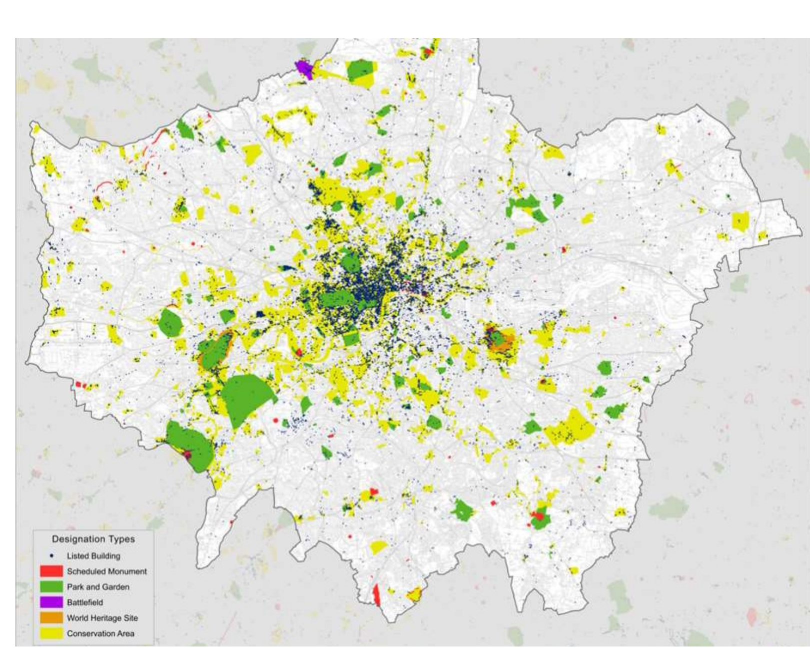
Reproduced courtesy of The UCL Energy Institute. Diagrams Steve Evans

The Bartlett UCL Energy Institute is currently working with CASA's Camden date data to assess the potential relationship of building date to energy consumption. Above we see Camden's non-domestic buildings broken down by age, activity and floor level. This is an important step towards being able to simulate and test the amount of energy used.



London House Prices 2015

Reproduced courtesy of Neal Hudson, Savills



Designated Assets in London

Reproduced courtesy of Historic England. Visualisation by Tom Duane
Background mapping OS Open Data

Socio-economic value

Change in cities is both essential and inevitable but how can we know what type of stock will benefit a city most in the future? Over the next two years research at CASA will analyse the relationship between the form and age of stock, and capital value, health (currently being investigated in the Netherlands), crime, deprivation and socio-economic diversity.

This will enable us to see whether a 'value toolkit' could potentially be created against which all proposed demolitions could be assessed. In the images to the left, we begin to see the relationship between capital value and stock age, and how older stock has determined prime locations.

Predicting change

A remarkable study carried out by Kiril Stanilov at CASA has shown how historical spatial data, when employed within computerised mathematical models, can be used to predict the spatial patterns of urban growth and change. The astonishing accuracy of this method is shown in the images below.

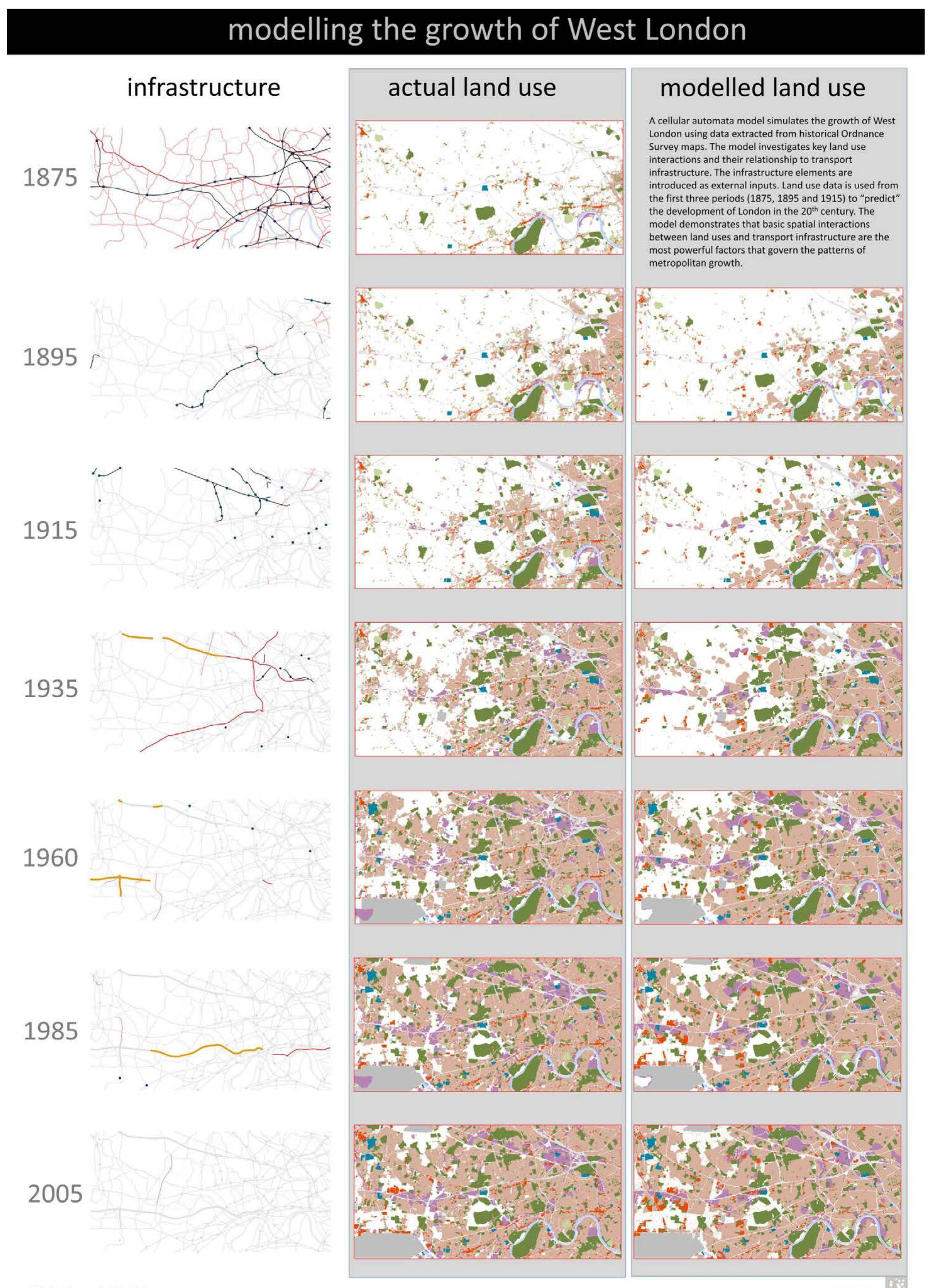
The research throws light on the powerful role of policy and planning in determining urban growth, and explores the existence of systematic spatial relationships, resilient to change, which are defined as an 'urban code'.

Methodology

The pattern of land development in a 200km² area of West London was tracked from 1875 to 2005, with data for 60 types of land uses over seven time periods digitally traced using historical OS maps. Transport networks were also meticulously digitised.

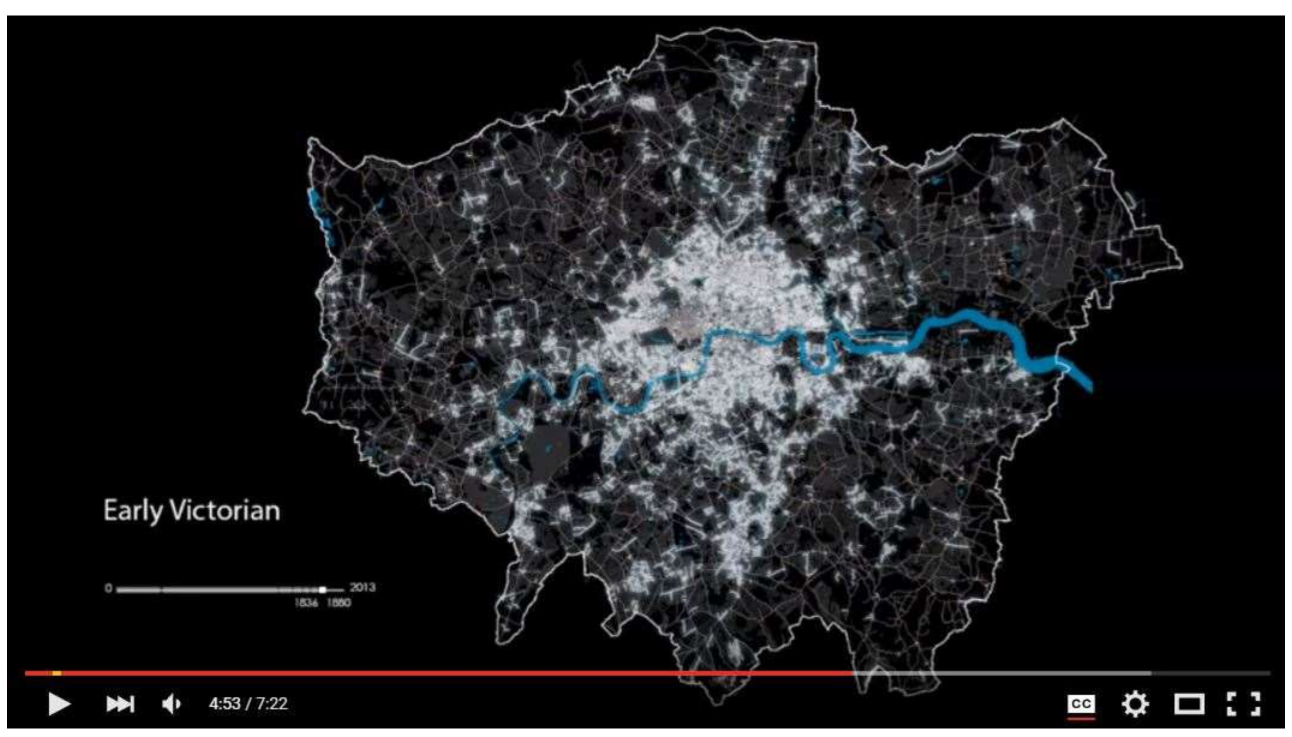
Changes in the patterns of land use from one period to another were then analysed in relation to distance to the Central Business District, major roads, railway and underground stations, and suburban centres. Specific policies such as those relating to the Green Belt and new building densities were also assessed, along with scholarly works on the history and planning of London.

Patterns identified between the first three time periods (1875 to 1915) were then translated into rules. These were fed into a cellular automaton model in which the land area was subdivided into 'cells' on a grid. The cells changed their state (land use) through discrete time steps according to the rules extracted from the analysis. These rules were then iterated to produce computer generated predictions for 1935, 1960, 1985 and 2005.



Evolution Animations and 3D City Models

Animations allow vast amounts of information to be visualised and communicated in a very short space of time. As such they are ideal for conveying information on the historical evolution of the urban landscape. They are also an important tool for understanding how long-term development patterns relate to planning issues today. The London Evolution Animation was built at CASA in 2012 for English Heritage's exhibition 'Almost Lost'. It was commissioned on behalf of English Heritage by Polly Hudson Design and created by Flora Roumpani who brought together thousands of georeferenced historical street network records. These were generously supplied by some of the key producers of historical spatial data for London: Dr Kiril Stanilov (CSIC University of Cambridge and CASA), Museum of London Archaeology. English Heritage (now Historic England), The Institute of Historic Research, The Centre for Metropolitan Studies, and The Historic Towns Trust. The animation has received over 350,000 hits on YouTube to date also demonstrating its pop- ular appeal. It can be accessed at https://www.youtube.com/watch?v=NB5Oz9b84jM.



Experimentation with 4D local evolution models, that is 3D models animated through time, has been carried out by Steve Evans (3figs.com/UCL Energy Institute) and Polly Hudson (Polly Hudson Design/CASA) over the past decade. Though this type of model requires extensive archive research prior to construction it can be used to visualise multiple narratives relevant to a wide range of sectors. Initially developed in 2004, in collaboration with The Building Exploratory for use as public information tools, evolution models are now argued to be of growing relevance to those working in energy consumption, planning policy, and urban resource conservation. Collaborators & funding contributors since 2004 include The Building Exploratory, The UK Green Building Council, The Wates Foundation, The Centre for the Historic Environment (Kellogg College, University of Oxford), The Heritage Lottery Fund and English Heritage. A sample narrative for the which the model was used is available at https://www.youtube.com/watch?v=px_qakrZQ4w.

4D evolution animations are also designed to complement 3D digital city models which are likely to play in increasingly important role in planning in the future. Research is currently underway at CASA to create a 3D interactive model for London, reviving the unit's earlier research in this field. Such models will allow the building stock to act as a vast filing cabinet into which metadata can be inserted, visualised, accessed, manipulated and connected. London 3D model samples, incorporating date data, shown at the exhibition, were produced by Lyz Zeno Cortes working in collaboration with Gareth Simons and Professor Andrew Hudson-Smith as part of a Future Cities Catapult funded initiative.