Globalisation, Urban Metabolism and Waste Management

Cities as Flow Systems:

Urban Metabolism and Complexity

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Outline

- The Problem

- Examples, Exemplars

- Complex Systems: What Is Complexity Science?

- Systems as Networks, Cities as Flow Systems

- Simulating Urban Populations: The London Tyndall and Arcadia Models

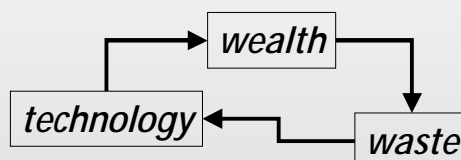- Predicting Waste: Physical and Organisational Systems for Waste Management

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The Problem

The volume of waste varies with income/wealth but how is still largely a mystery. We do not have good data.

Wealth and standards of living depend on technology and there is a virtuous circle connecting all three

As income varies substantially over space, so will waste.

It will also vary with time, in terms of the amount produced during the day, the week and across the seasons. All this is largely obvious.

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So to an extent predicting how much waste involves predicting where populations reside, are employed, how they move and in general, how they function

Our concern will be with cities, big cities and will focus on the complexity of this kind of prediction.

Nothing about cities is straightforward and that will be my message this afternoon, and we will follow it with discussion in panel session tomorrow. But let me begin by saying something more about how we might predict waste in terms of the demographics of population and economic activity.

We know a little about how incomes change with city size; they tend to scale more than proportionately.

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This means that as cities get larger, then they get richer per capita. This is a recent finding but it has a long history in that it relates to agglomeration economies

Strictly we are saying that as cities get larger, their metabolic rate gets faster with respect to income

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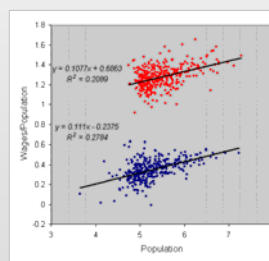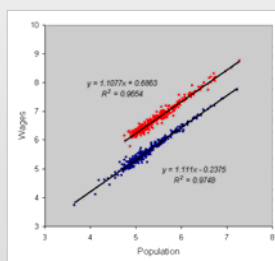
What we are implying is that as income increases, waste increases, but we don't know if this is more than proportionately. As population rises in cities, income rises more than proportionately, and waste rises even faster. Maybe?
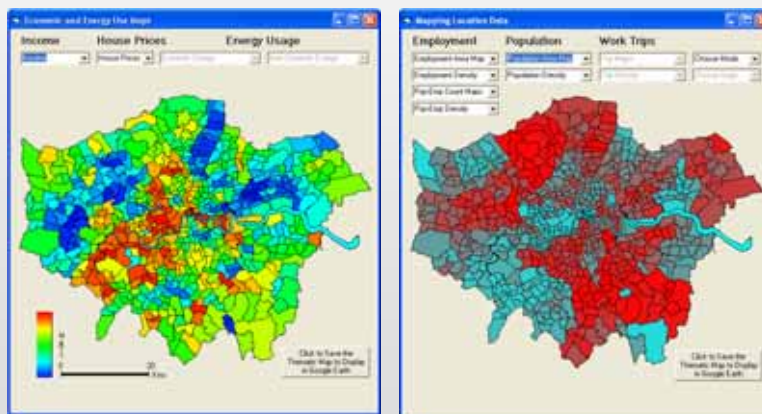
This will depend on many factors:

• the type of waste,

• how people substitute one form of consumption for another as they get richer,

• how they generate waste over time – during the day

• their social attitudes and so on

• Regulations and the whole institutional culture
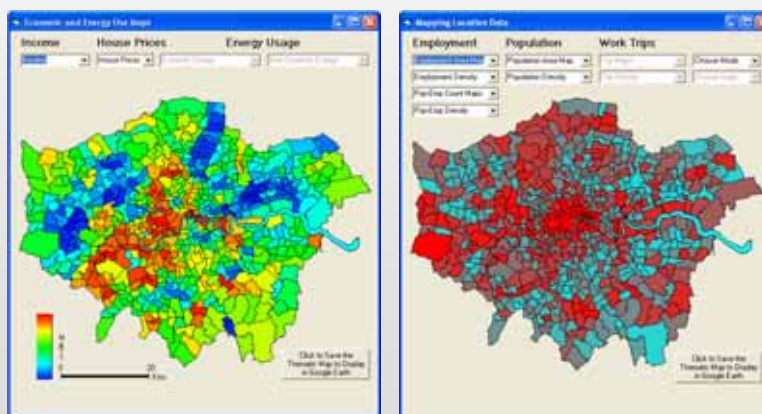
The production of waste will vary dramatically over
    space and time – let us look at London – here is a map
    of income distribution and one of how population
    varies during the day from home to work

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My point in this long preamble is that if we want to predict waste in future cities, for any city, we need to a very close attention to how it is generated and by whom, where and when it is generated

Only then can we really begin to develop good waste management systems for its disposal, breakdown and so on

So far most of our focus has been on very simple supply side solutions – very simple networks and what I suggest is that we could learn a lot by looking at how others are studying the complexity of cities.

My point is to introduce you to some of these ideas. Not to provide you with solutions, far from it.

Examples, Exemplars (from London)

Let me begin with some notions of how we examine flows of activities in a large city but begin with transport for networks are crucial to the way we deliver materials and people and information to sustain a cities parts.

A city is effectively an organism and efficient cities are those where their networks evolve to supply their needs in the most efficient way.
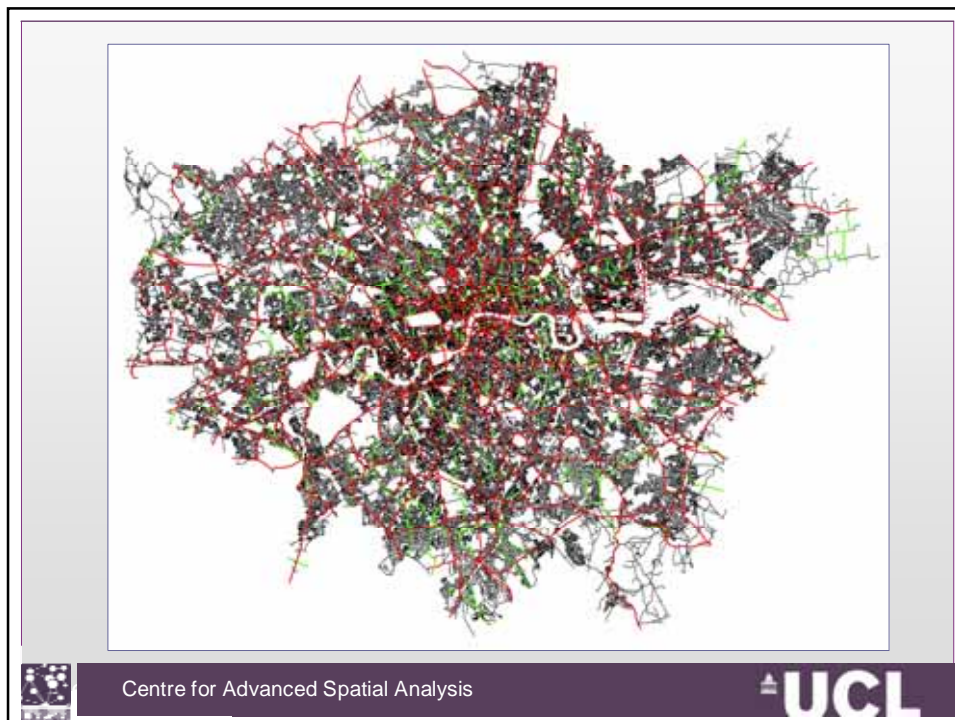
Networks evolve in all systems which grow from the bottom up as tree-like structures – as what we call fractals – and here is how the basic transport network has evolved in London over the last 200 years.

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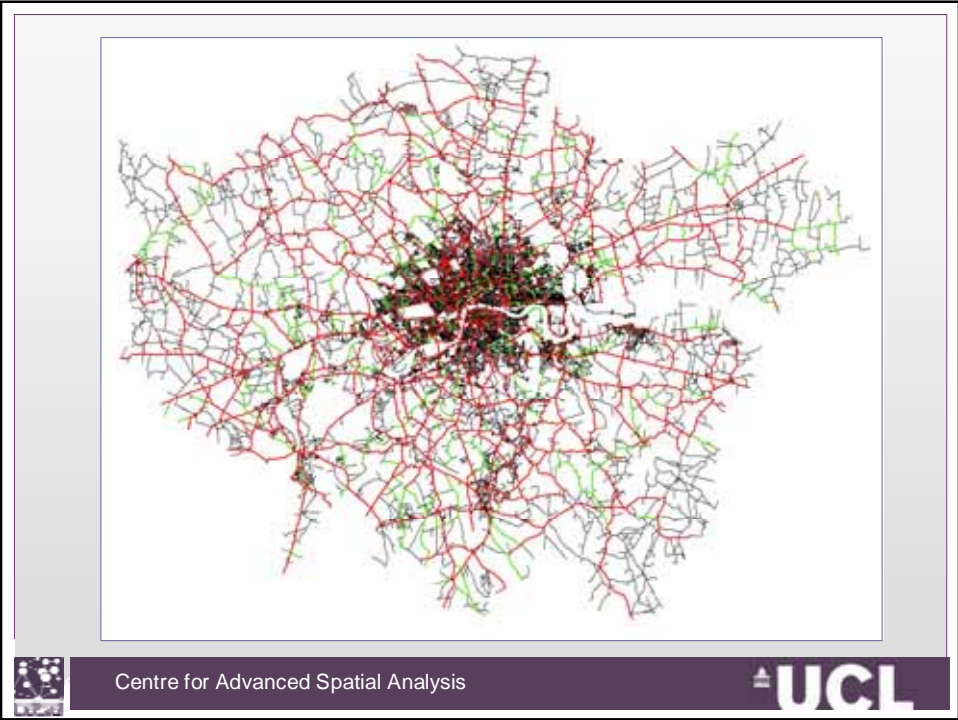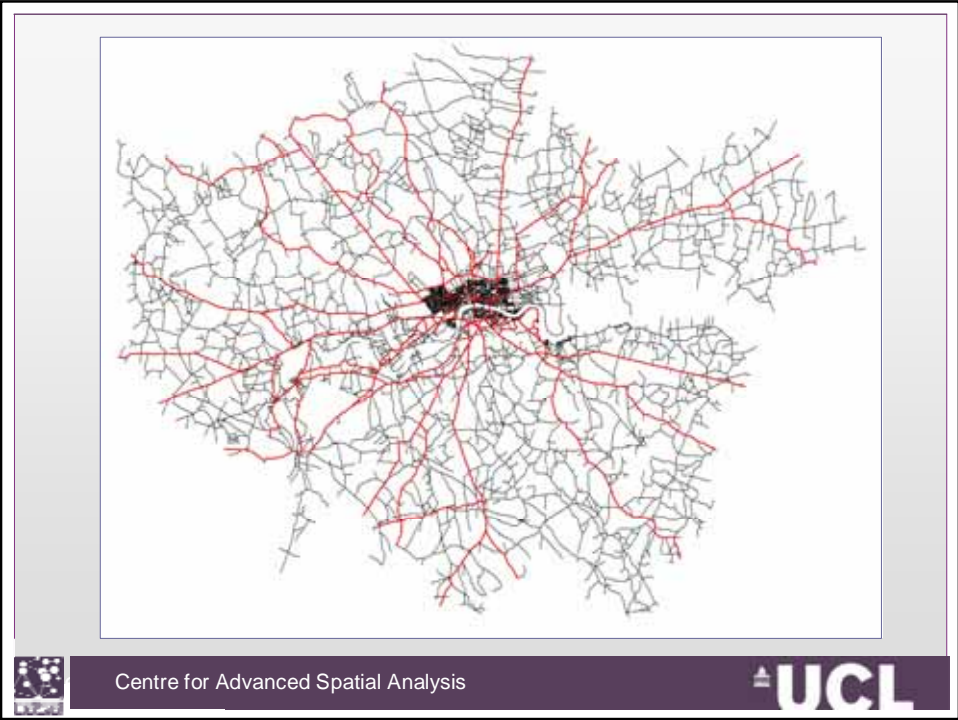
If we look at wet waste – sewerage, the networks that were established in the 19th century are extremely simple, and basically planned with little regard to detailed location and density of population or employment

Joseph Bazalgette is credited with organising three main sewers that ran west to east taking waste out towards the north sea.

I will show these below but also note that current proposals are even more simplistic – the Thames Tunnel that is planned for example

The Proposed Thames Tunnel

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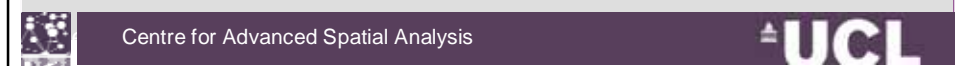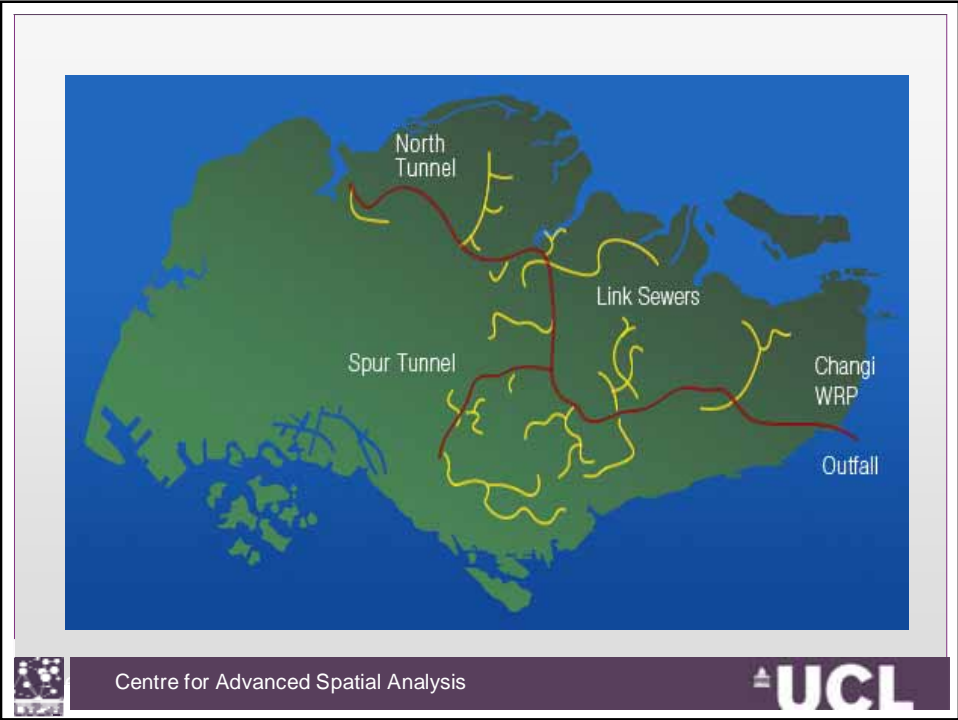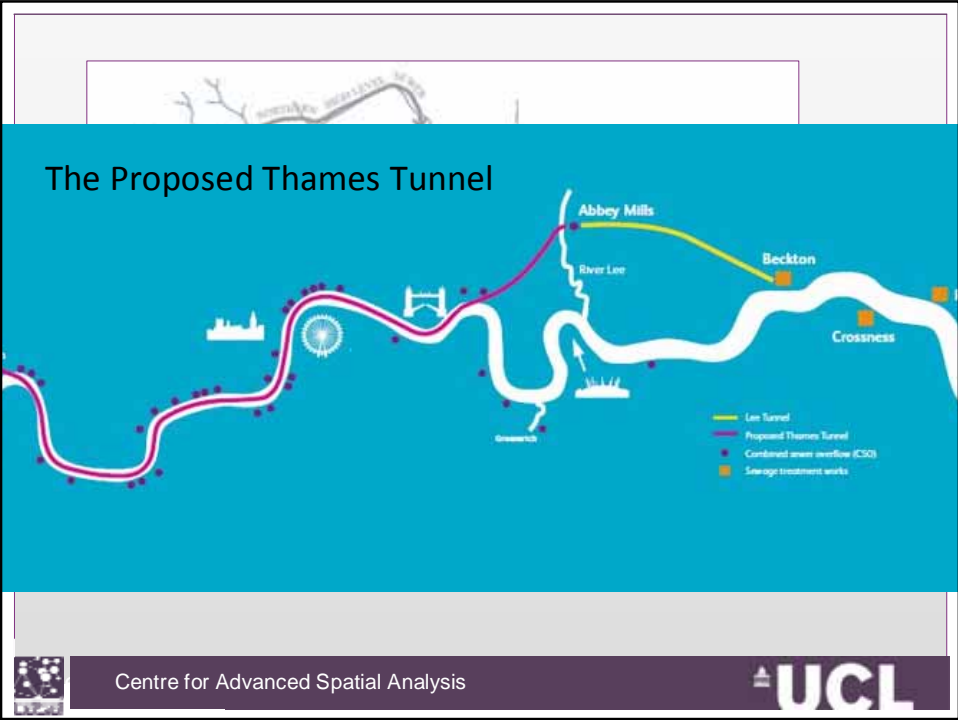
Let me now suggest that we need to examine flows
during the day as well as over space and show you an
animation of flows on the public transport system in
London

These are taken from real time data, in the first case
from swipe cards – what we call Oyster card data

We have assembled a weeks worth of data about flows
every 15 minutes and we show this for the tube.

Let me run the movie and then talk over it – what you
will see is the network of subway trains and how the
flows vary at the two peaks and in the evening in
London. And then I will show tube trains running –
this is the kind of thing we need to do for waste.
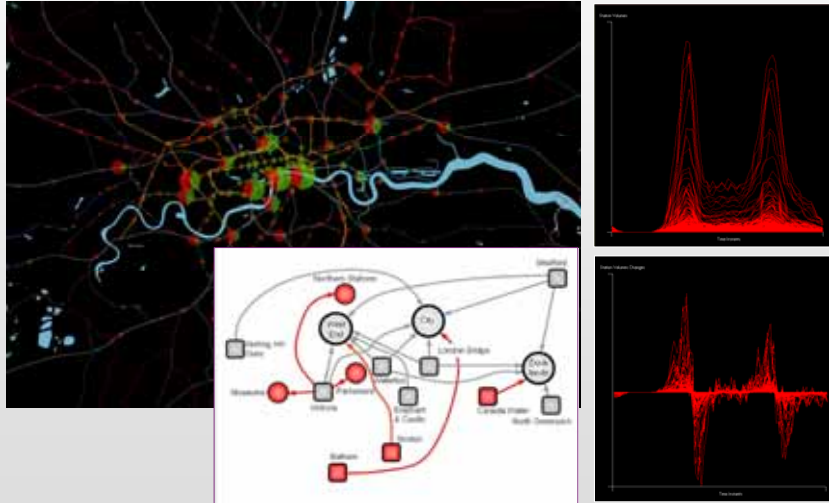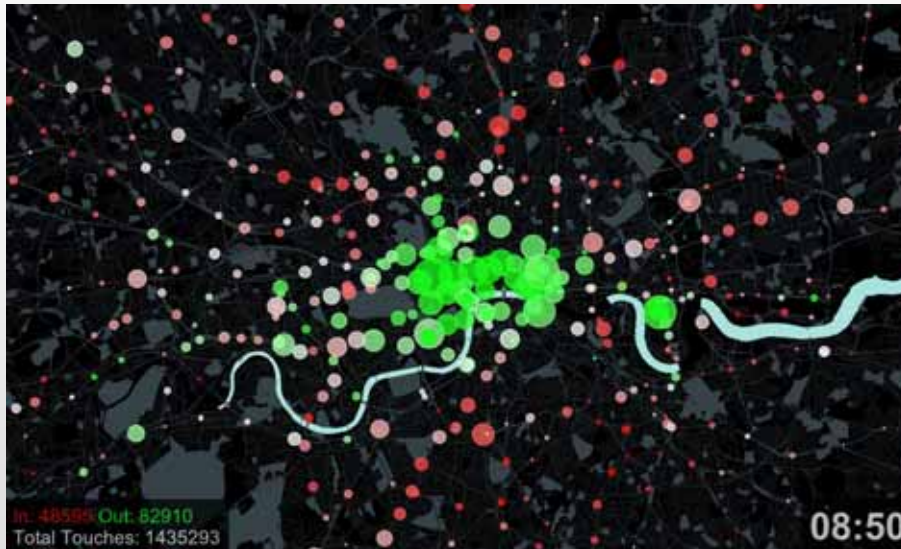
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Ok some more examples that make the point ; first our Oyster Card Data – interpreting urban structure, multitrips, etc.

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In: 48595 Out: 82910
Total Touches: 1435293

08:50

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Complex Systems: What Is Complexity Science?

Ok – what has all this got to do with waste? Well let me say that this point of view considers the city as a complex system

These are:

Systems based on a hierarchy of interacting components, usual open to their environment, full of positive feedbacks that lead to unanticipated effects, not usually in equilibrium, admitting innovation and often highly non linear in their behaviour.

I can't give you a primer on this here but suffice it to say that most complex systems evolve, not planned

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One of the key issues that has overtaken our thinking is the notion that systems need to be thought about in terms of the way they build and evolve from the bottom up

They depend on their history – history matters – and they are never ever in equilibrium

Look at the modern city – London or Singapore – continually in flux – a kaleidoscope of movement, cities look the same to an extent from generation to generation but everything in them changes

Networks are an excellent example as we have shown and here are some more examples from London
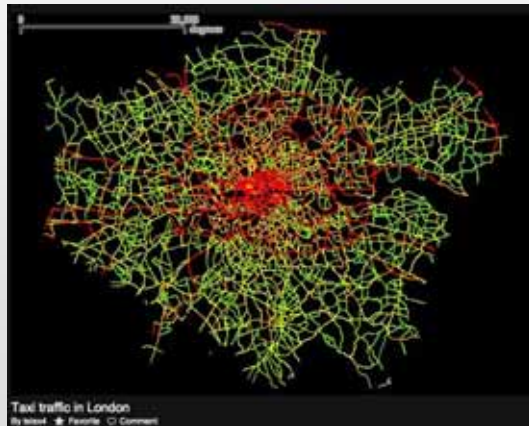
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Systems as Networks, Cities and Flow Systems

Public Transport Vehicle (not People) Flows
from Timetable and OS Streetline Data by
Joan Serras (CASA)

Taxi traffic in London

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http://vimeo.com/21351143

Public Transport flows, UK
by Joan Serras

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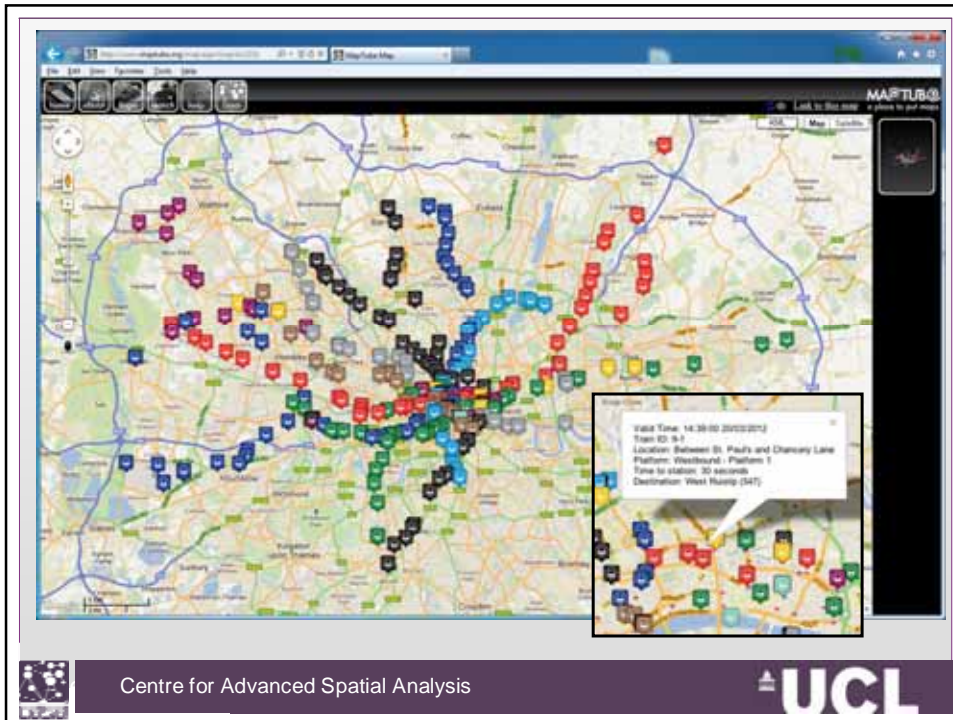
Simulating Urban Populations: The London Tyndall and Arcadia Models

Let me speed up and begin to illustrate how we might tackle all this complexity and use some of our existing models to predict waste

We do have quite elaborate models for predicting the locations of future employment, population and related activities in cities
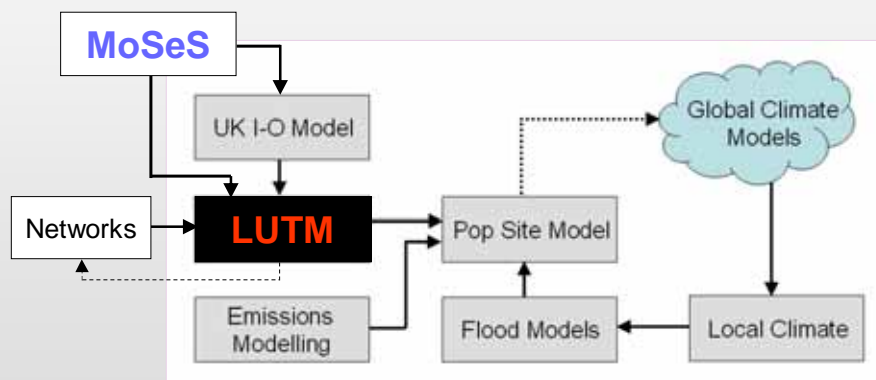
Some of these are used to generate pollution but seldom are they connected to notions about predicting waste. We would need of course much better relations between demography and waste but..

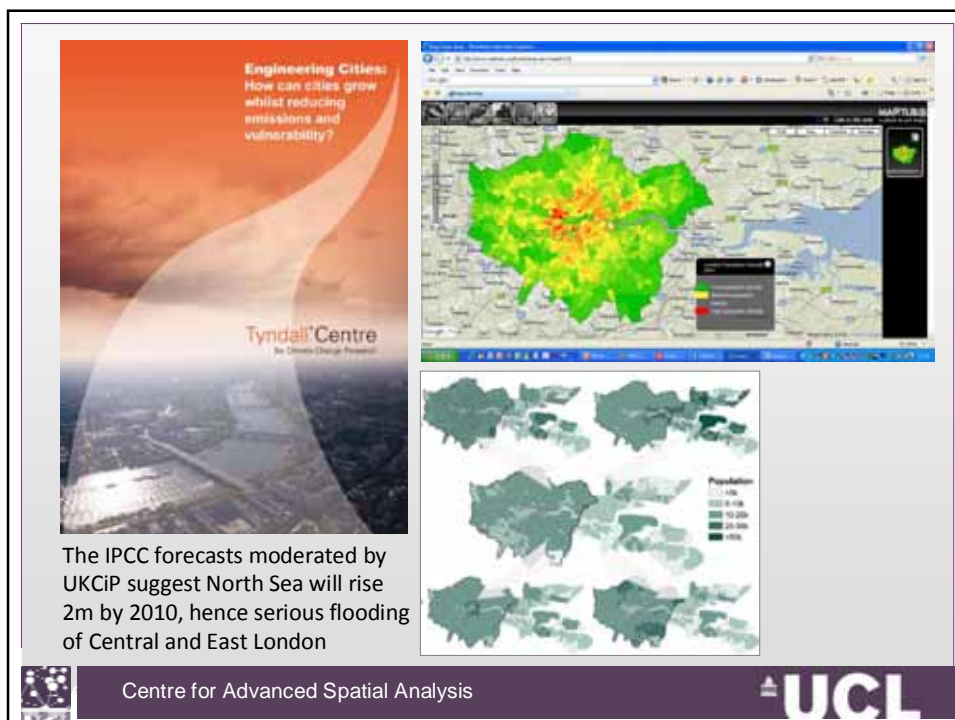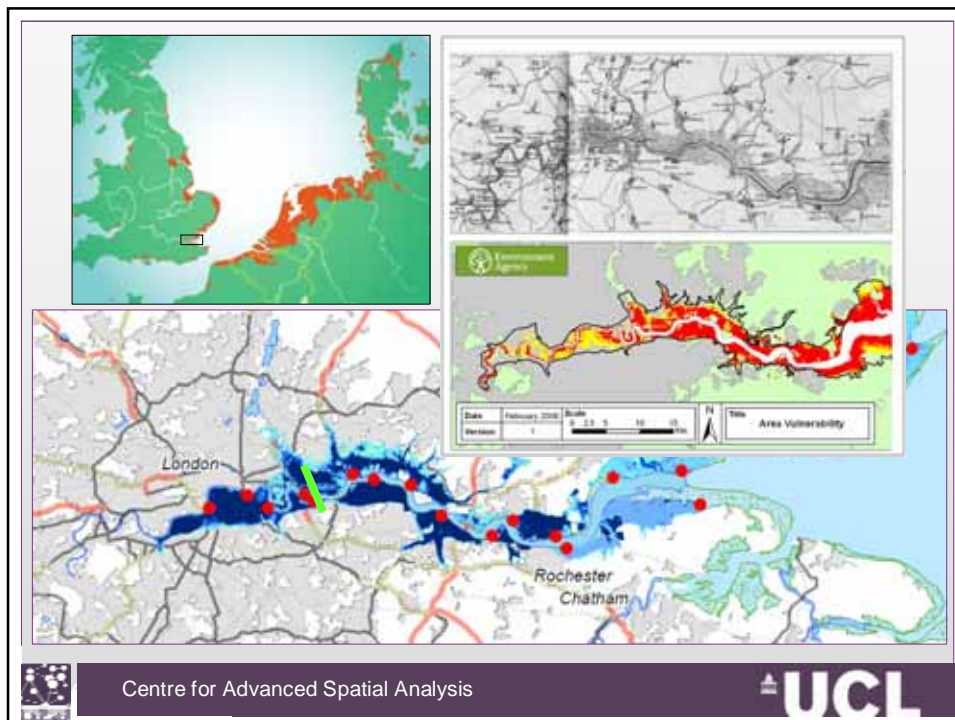Centre for Advanced Spatial Analysis

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The model sits lies at the core of a process of chaining models together built by different groups and coming from different traditions

MoSeS

UK I-O Model

Networks

LUTM

Emissions Modelling

Pop Site Model

Global Climate Models

Flood Models

Local Climate

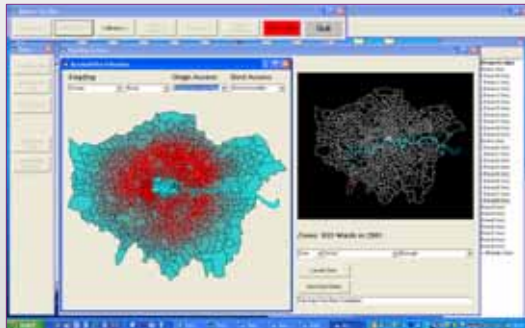Centre for Advanced Spatial Analysis

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The IPCC forecasts moderated by
UKCiP suggest North Sea will rise
2m by 2010, hence serious flooding
of Central and East London

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The Thames Barrier built 1978 to 1984 in operation, likely to be ineffective by 2040? due to new predictions of sea level rise forecast at 1-2 metres by 2100 – somewhat debatable, but ….
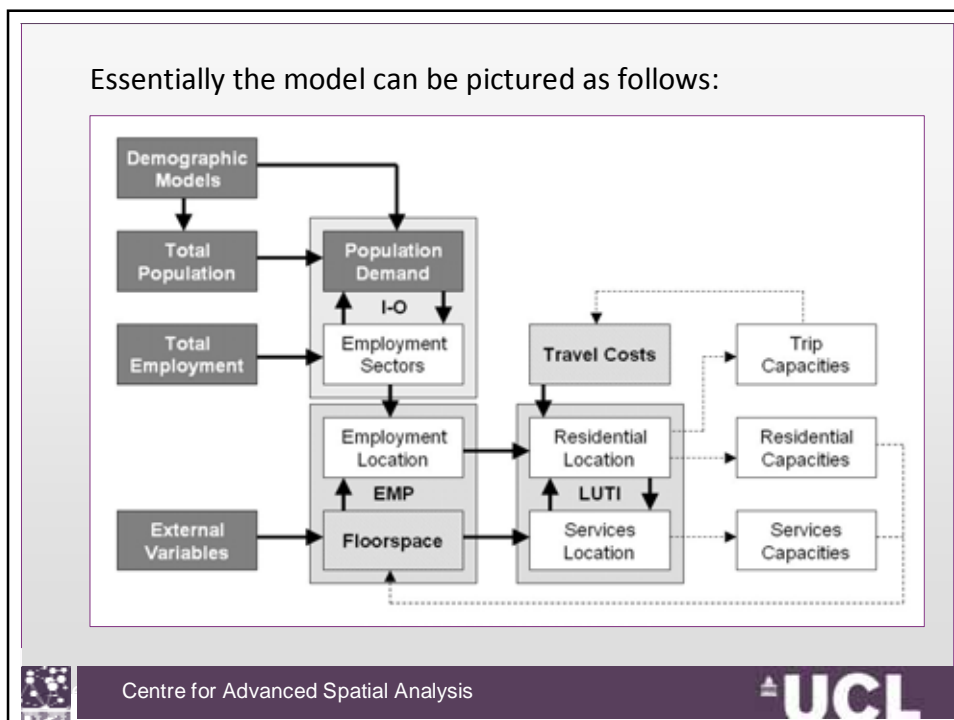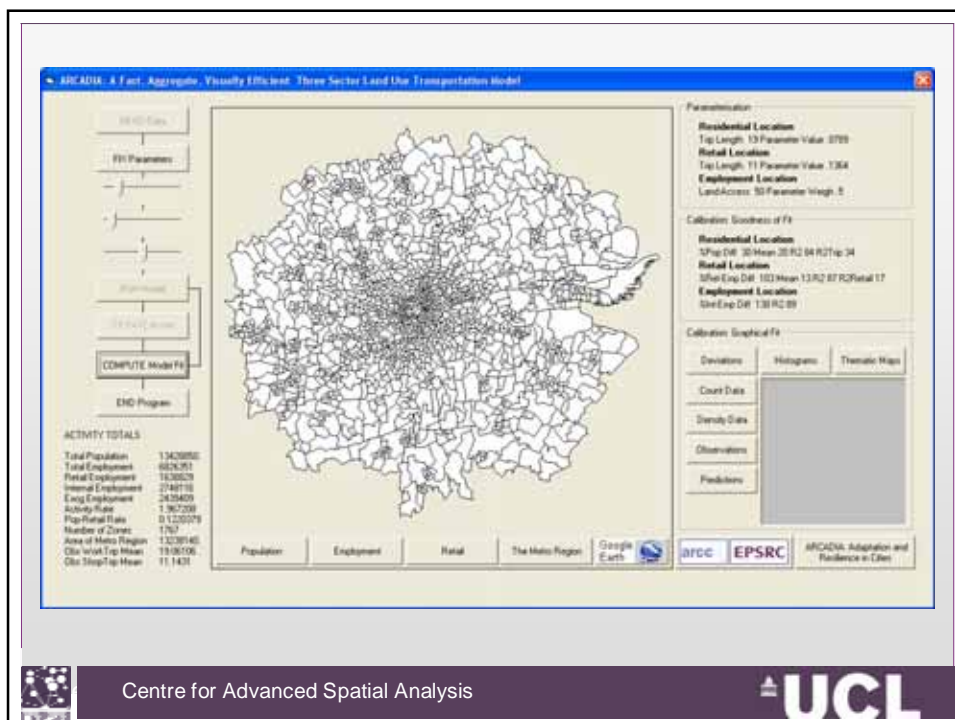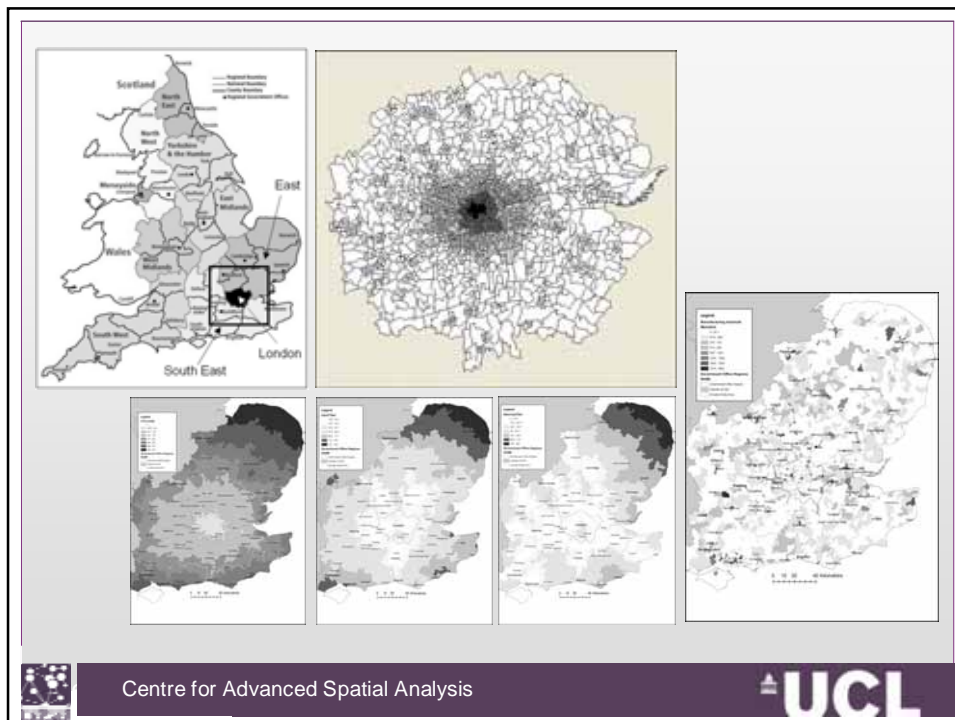

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Exporting data and predictions to external software on the fly

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Essentially the model can be pictured as follows:

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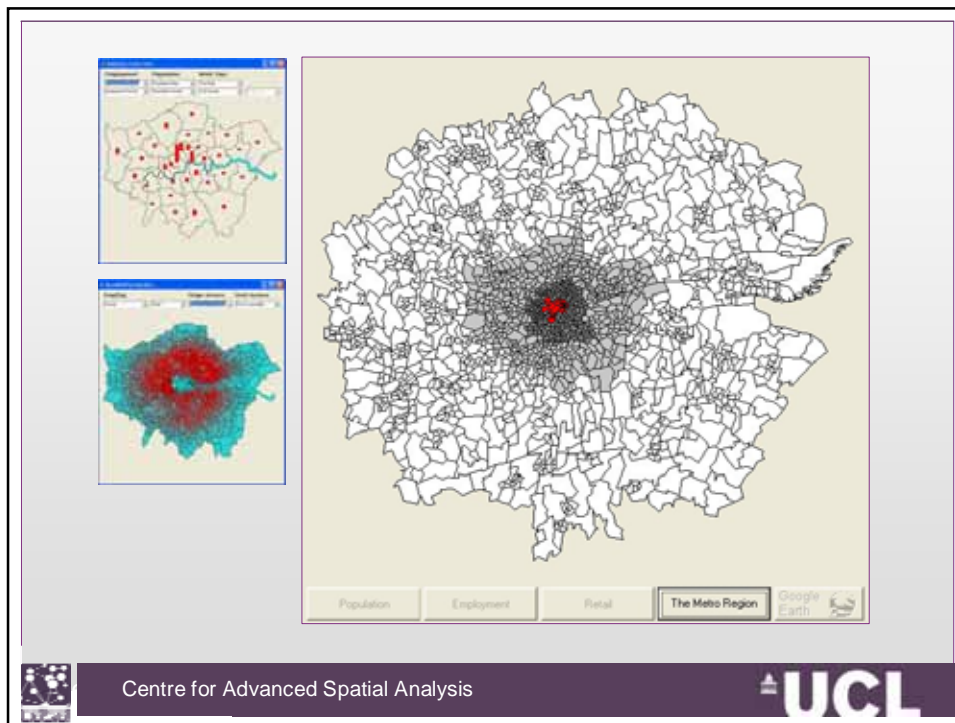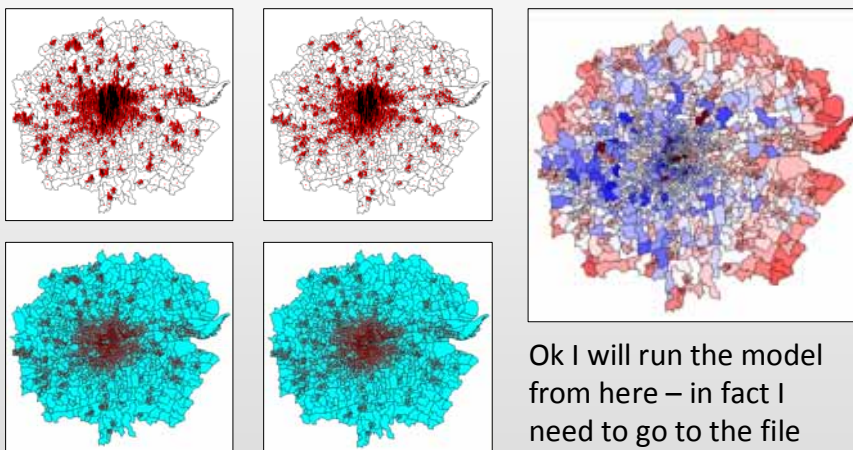Centre for Advanced Spatial Analysis

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Here are some sample outputs – I will run the model as speed is important – here goes

Ok I will run the model from here – in fact I need to go to the file

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Predicting Waste: Physical and Organisational Systems for Waste Management

Ok let me wrap up rather quickly and summarise

Basically what I have tried to convey is a point of view – that for every kind of flow and flux in the city, we need to figure out what is related to what

I think we can produce much better estimates of waste across the whole spectrum by considering demographics and socio-economics but spatially as well as temporally.

We have some of the rudiments of theory and models now to do this.

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Thanks, Questions?

**I would like to refer
you to our Blogs on all this**

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