

Comparative Genetics of Cities Workshop

22nd May 2010, UCL

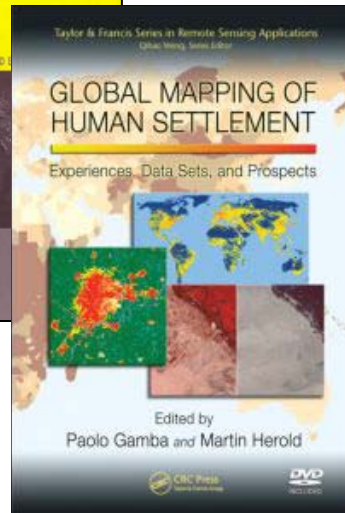
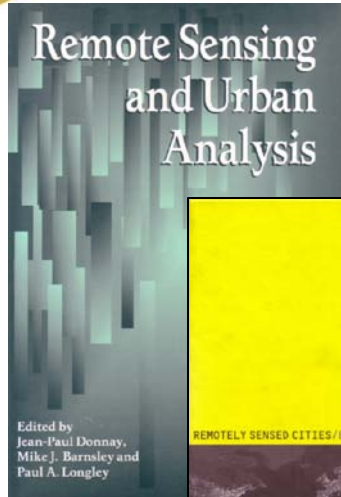
Integrating Urban Remote Sensing with GIS

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Cities, Remote Sensing & GIS



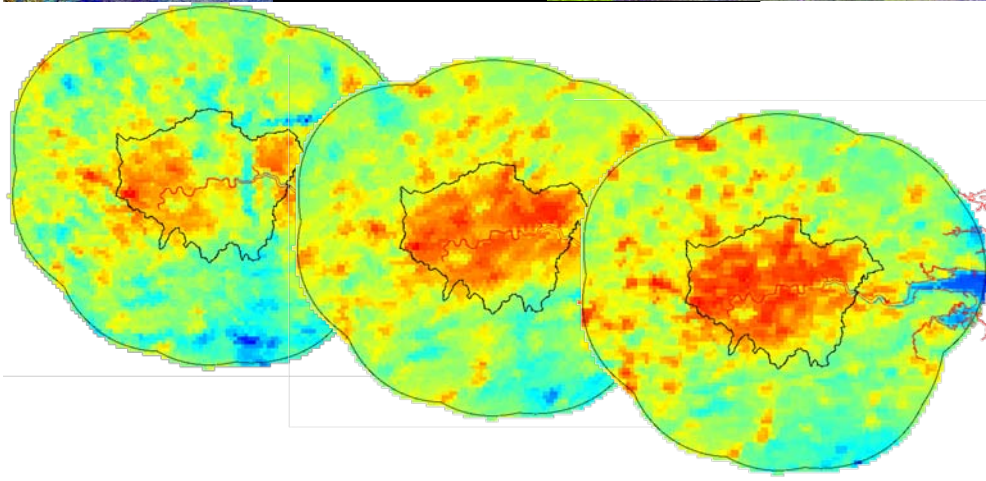
Significant interest over the past 20-years in remote sensing of cities/urban areas.

Slightly less interest in using GIS as basis of this analysis but often stated as being the way forward.

Broad research literature but questionable how much this has been used in an operational sense.

New monitoring programmes for sustainable cities both in developed and developing nations has lead to a renewed interest in remote sensing

Data Rich, Integration Poor

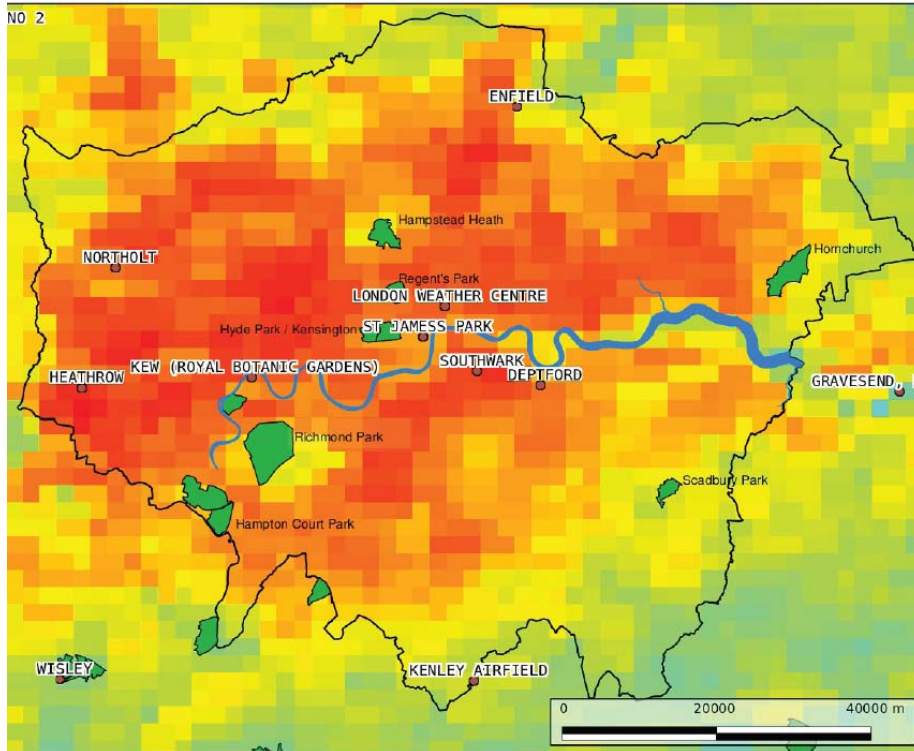


Immense volumes of data, captured over many years at monthly, weekly or diurnal temporal scale

Few dedicated approaches to integrated management from disparate sensors, at different scales and of different properties (e.g., Lidar, multispectral, SAR etc.).

Data initiatives underway – ASU JEarth.

GIS & Numerical Analysis



Many GIS lack numerical analysis methods required for remotely sensed data.

Also lack the ability to genuinely analyse simultaneously in a seamless manner different geometry in a spatial analytical/numerical framework.

Spatial numerical techniques required, for example, to compare and correlate point geometry of weather station records with raster pixel data of at-surface temperature by AVHRR.

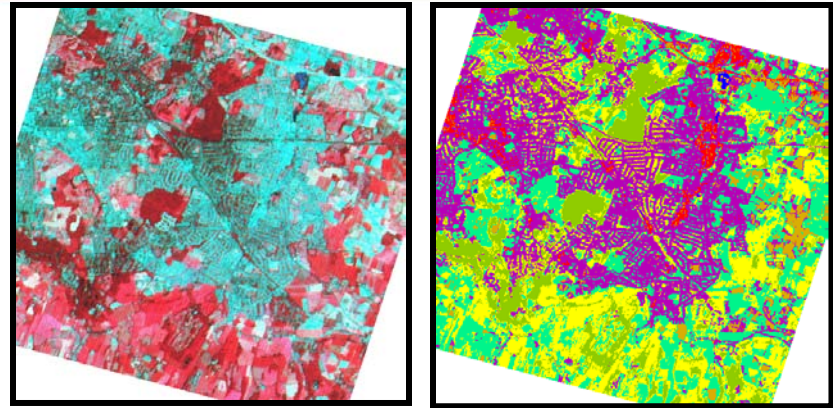
Remote Sensing & Spatial Analysis

We require robust inferential tools that work in a spatially explicit manner.

These need to move beyond per-pixel and work in terms of object space (parcels).

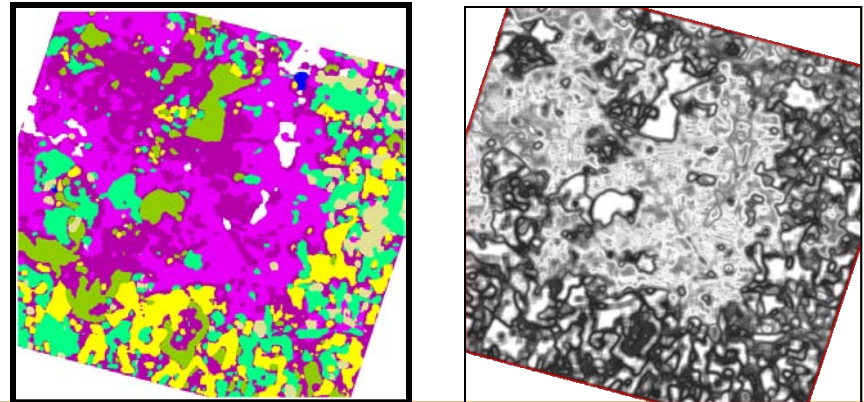
Packages such as **Ecognition** have made a start but focus on image segmentation.

We need to extend these to other inferential tasks – e.g., land use from land cover



$$\Delta_k = 1 - \sqrt{\frac{1}{2(N^2)} \sum_{i=1}^c \sum_{j=1}^c \{ \mathbf{A}_{ij}(f) - \mathbf{T}_{ij}(f) \}^2}$$

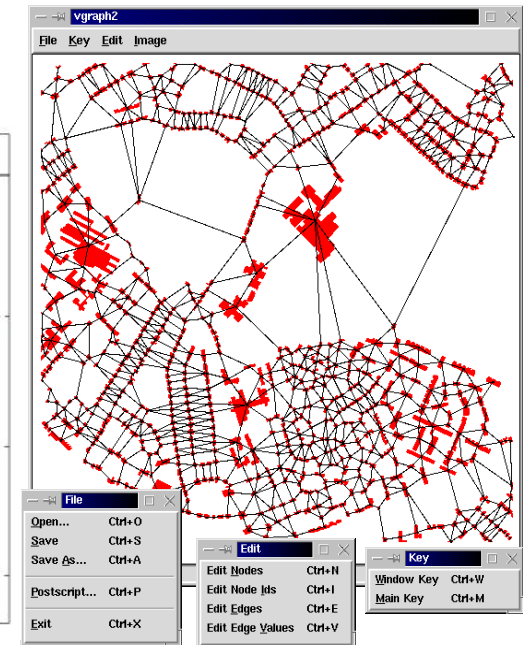
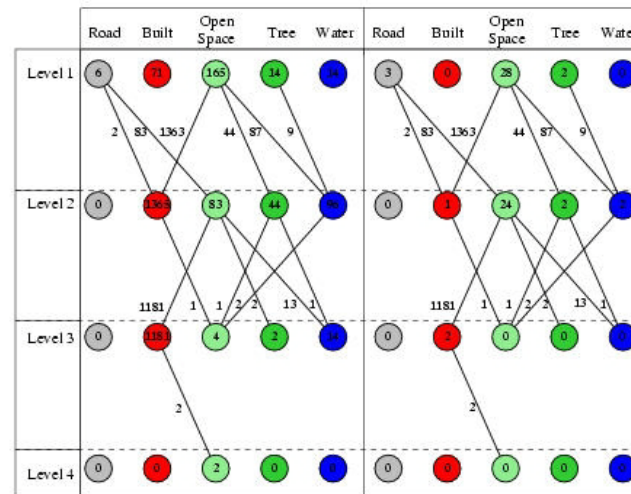
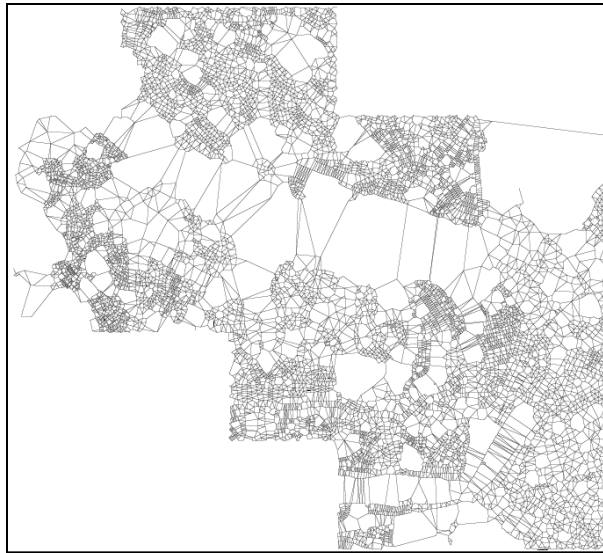
$$P_{rc} \leftarrow k \text{ where } \Delta_k = \max(\Delta_1, \Delta_2, \dots, \Delta_l) \geq \delta$$



Remote Sensing & Spatial Analysis

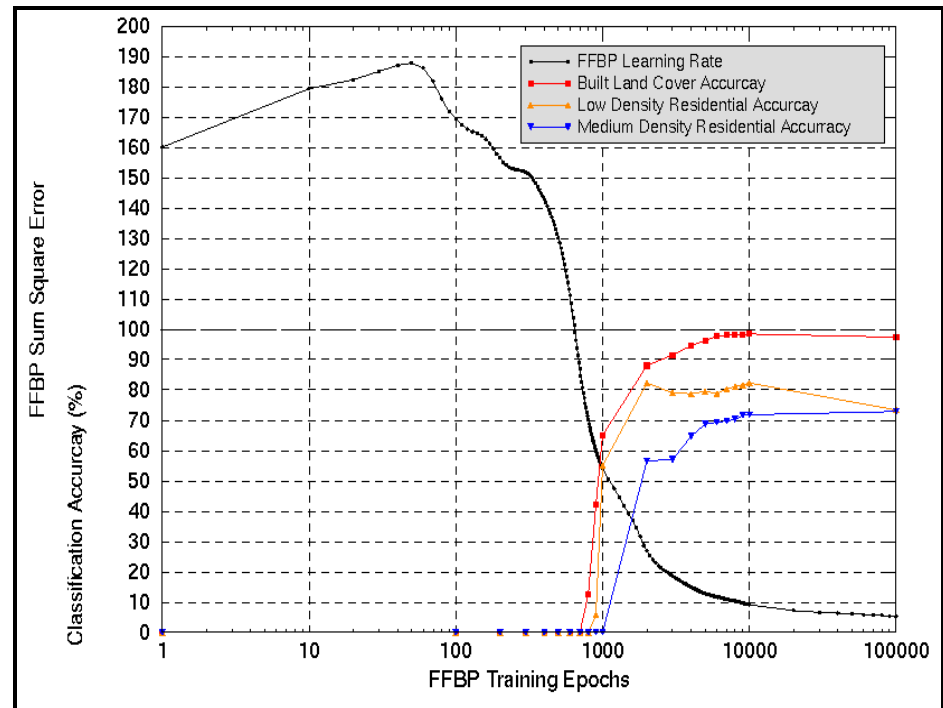
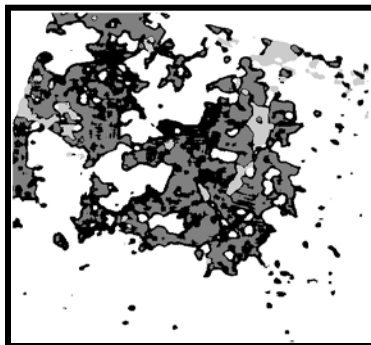
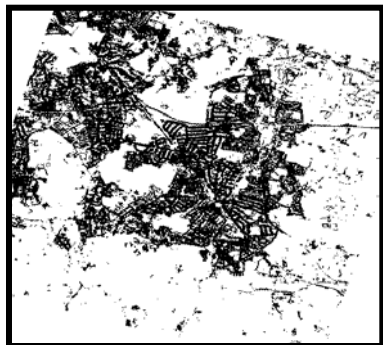
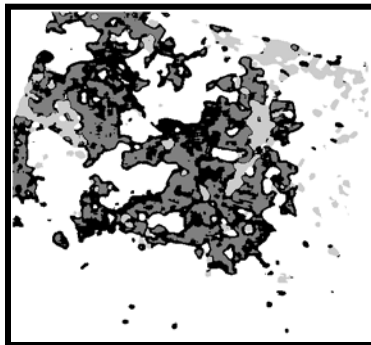
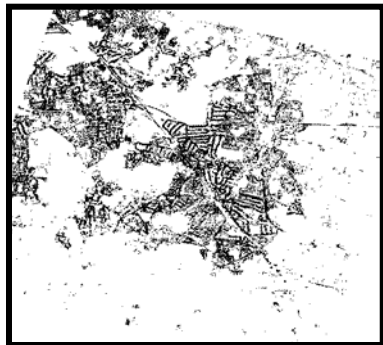
Understanding the spatial structure and organisation of cities in remotely sensed images in combination with digital map data is essential to operational use of remote sensing for cities analysis.

This requires a better transfer of research software into GIS software either via an opensource or commercial avenue.



Inferential Error Propagation

Remotely sensed information is inferred and contains errors. Yet rarely in GIS do we consider this. Ideally we need tools that quantify the error propagated in spatial analysis operations and the uncertainty introduced.



Typological Refinement & Meaning of Land Use

To date little work on spatially correlating remotely sensed properties (e.g., surface temperature) and inferred information (e.g., land use) with the socio-economic fabric of cities. Multi-level statistical modelling & microsimulation may be used to address these questions.

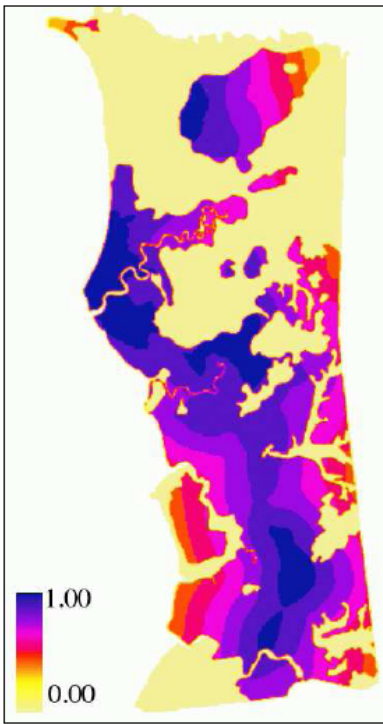


Remotely sensed data
Land use type
House type
House size
•

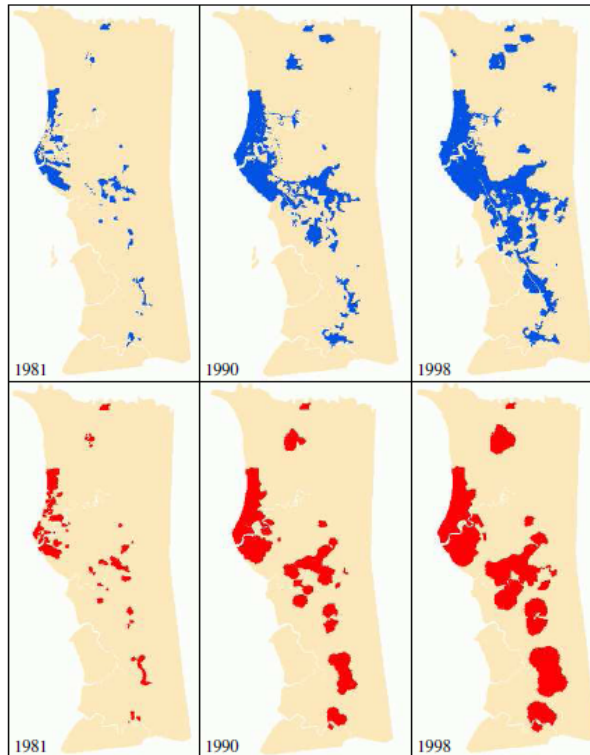
Spatial microsimulation
House type
Demographic data
Socio-economic data
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Developing Nations

Ultimately, the greatest contribution remote sensing in a GIS framework will be for cities where there is a lack of existing digital map data describing the urban fabric.



Multi-Criteria Suitability

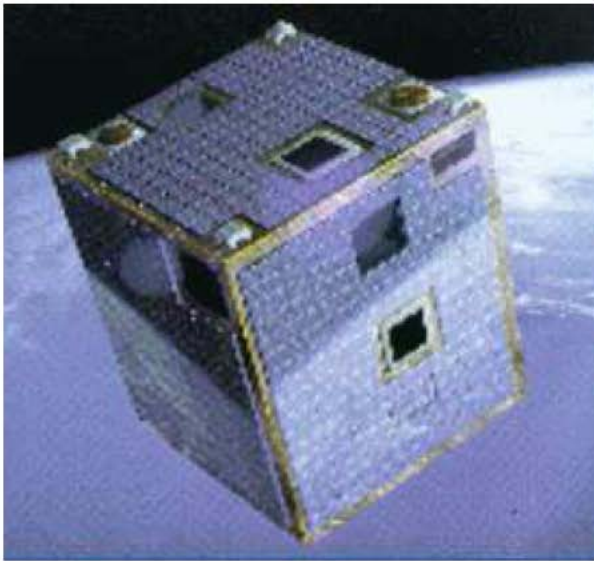


There has been some success in the use of remote sensing regional urban growth simulation.

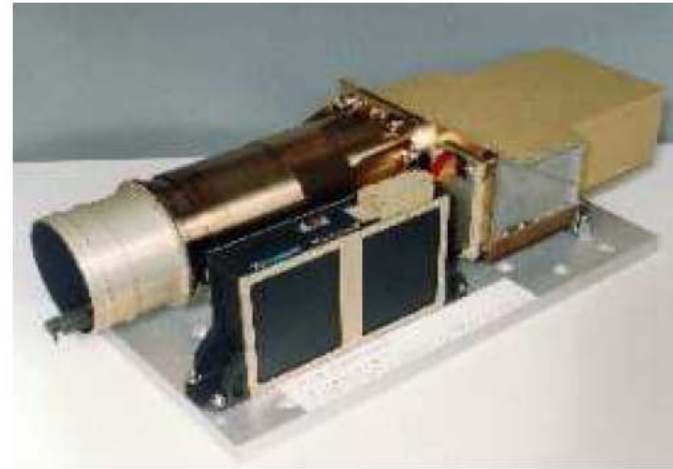
It can be used to verify results and is increasingly being considered in a spatial data assimilation framework to help direct urban growth models.

The Future – UrbSAT/CitySAT ?

As remote sensing becomes an increasingly important way to monitor the dynamics of cities there may ultimately be a case for a dedicated smallsat sensor.



PROBA – PProject for Onboard Autonomy



CHRIS – Compact High Resolution
Imaging Spectrometer

But we also need to focus on the analytical toolbox for analysis of data that may be captured by such a sensing platform.

The Future – The Toolbox ?

- GIS traditionally, and it can be argued still, has limited functionality for the analysis of remotely-sensed images.
- Traditionally little direct focus on urban areas in remote sensing – urban often an after thought of the inferential process.
- Need to design the analysis functionality required for remote sensing tools for cities research that use:
 - The inherent spectral content of image data;
 - The inherent spatial characteristics of the image data;
 - That move away from pixels to object space, and;
 - That allow genuine statistically rigours integration and assimilation.
- Ideally in an opensource framework.