New Developments in GIS for Urban Planning

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Ever since computers were first developed in the mid 20th century, planners saw an immediate use for them in not only organizing large quantities of data about the city but also in the analysis of that data, the construction of simulation models of how cities functioned, and in forecasting the future form of cities. All these ideas were put in place in the 1950s and 1960s mainly in North America and there were even moves to automate the city planning process itself by formulating models that could generate idealised plans based on data pertaining to the current situation as well as to the specification of future goals.

This technology began with main frame machines where most techniques were operated offline but with increasing networking of computers and miniaturisation down to minicomputers along with the parallel development of personal computers, much of this activity came online. The convergence of communications and computing which has occurred in the last twenty years with the development of the internet and its graphical interface in the form of the world wide web has moved many of these functions into networked environments. The prospect now exists for all stages of the planning process and its interfacing to the public at large to become accessible online.

By 1990s, various computational techniques that were being developed in urban planning were being heavily influenced by three related developments. First geographic information systems (GIS) technologies which represented the fusion of spatial database technology with computer cartographies, were being ported from minicomputers to PCs, second various forecasting techniques were being developed on PCs using standardised software such as spreadsheets, and third, this great potpourri of technologies was being fashioned together in what Britton Harris (1989) called 'planning support systems' (PSS) in his seminal article[†]. Since then much of this technology has begun to move online with PSS being used not only for strategic planning but also for more routine uses in the control of development and also plan implementation. There are now so many developments that in a short article like this one, we cannot do justice to the hundreds of potential applications in urban planning. What the modern computing environment has opened up is the prospect that any kind

[†] B. Harris (1989) Beyond geographic information systems: computers and the planning professional, **Journal of the American Planning Association**, **55**, 85-92.

of application can be fashioned in any kind of software – within limits of course – and that any kinds of software can be plugged into any other. Forecasting models, traffic models, GIS and so on can be interfaced with one another with no one software necessarily dominating the other. The prospect now also exists of planners being able to draw on data and software which is configured and operated on remote sites such is the present connectivity and power of the internet.

Here was will focus on just three of these developments but there are many more and interested readers are referred to the recent book edited by Brail (2008)[±] which reviews many of these techniques. In our group at University College London (see http://www.casa.ucl.ac.uk/), we are developing several new techniques which are targeted at urban planners, many of them associated with visualising urban problems and their solution. Our most routine applications involve presenting spatial data to the public at large using non proprietary map technologies such as **Google Maps** and **Open Street Map**. These developments are beginning to transfer simple GIS functions from desktop specialist software like **ArcGIS** to the internet in that maps can now be moved easily into the online environment so that users can not only explore these online in much the same way that a GIS professional might but also develop simple functionality – obviously pan and zoom but also simple overlay and the computation of simple spatial statistics. We have developed a simple tool called **GMapCreator** which lets users take any map file (which consists of attributes and vector boundaries) and to configure this so that it can be overlayed across any non proprietary map base such as a **Google Map** or **Open Street Map**. The user can thus develop his or her own web page with the map embedded within and thus it can be seen by anyone with an internet connection. We have also developed a site called **MapTube** – A Place for Maps – which lets users share their maps through an archive of web links – all created using our software – but stored in various ways so that they can be overlayed with one another. These techniques let users at any stage in the planning process access maps and perform simple comparisons. These maps might be for professionals at the survey or analysis stage but they might also be for public participation and engagement either as simple web sites or under the auspices of formal process of public consultation. In this sense, these techniques are almost independent of their role in planning support system as they are germane to many different uses and users.

We show the creation of such a map in Figure 1 and the **MapTube** site in Figure 2 but once we have a 'flat' 2-dimensional map – in plan form – it is not so hard to develop the software so that we might build 3-dimensional maps. In fact, our second project is built around the development of 3-d models of cities for many purposes – first for urban design but then also for communicating urban designs in terms of the quality of the environment created to clients and users and the public-at-large. We have built a large 3-d model of Greater London which contains 3.6 million building blocks. It is built with digital plot data which is then extruded to the third dimension using remotely sensed 3-d LIDAR data generated from flying the city at low level. The model is originally built in **ArcScene** which is the 3-d component of **ArcGIS** but is then ported into various **Autodesk** products such as **3d Max** for making of movies and fly-throughs while it is being made available to local planning authorities using

[±] R. Brail (Editor) **Planning Support Systems for Urban and Regional Planning** (Lincoln land Institute, Cambridge, MA, 2008)

Google Earth. The big challenge is to populate such a model with data and we are currently tagging all the buildings with land use, population and employment totals and even energy levels. We are also able to layer the model with surface data which enables us to smooth data from various administrative units and compare this with the building geometries. Physical data such as air pollution is also easy to add and we have illustrated how we are able to change the water table by flooding the model according to different scenarios associated with global warming. In Figure 3, we show a picture of the model in **Google Earth** and in Figure 4 we show what happens when we flood the model to a raised sea level of 3 metres.

Our last example takes us back to strategic issues in terms of forecasting the long term future of a large city such as London while at the same time remaining with the topical issue of global warming. We have built a land use transportation model as part of an integrated assessment of the impact of future rises in sea level on the population of Greater London. This is a model which simulates the movement of people from home to work and to commercial facilities such as shopping. It enables us to predict the future location of development in small zones of the metropolitan area and to figure out what the likely impact of rising sea level will be in these locations. This is being used to evaluate long term options for true change and growth in residential population in the light of the climate change forecasts which if borne out, will require a radical restructuring of London's population, particularly in terms of what is happening in the Thames Gateway and its estuary. We have not built this model within a GIS but have simply generated a graphics-based interface to the conventional model, building in all our own graphics functionality. In short the GIS is strongly coupled to the model and this enables us to run the model on the desktop or over the web with considerable flexibility for demonstration. Users can see the model by clicking the link at the end of this article. The model can thus be used to display future scenarios very quickly but also at the same time interrogate the data in considerable detail at every stage of the modelling process. It is important to have the model in this graphic form because the other scientists involved in the integrated assessment process need to learn about all the models in the sequence: graphics is an essential way of achieving this.

This short article has presented three rather different techniques which support different kinds of urban planning processes. Although this is only a small set of applications, it is indicative of the fact that at every stage of the planning process and in every type of planning process at whatever scale, modern information technologies are central. Moreover our first example shows that maps are rapidly going online and this will be followed by much functionality which will come to be embedded in web pages. Within a decade, most GIS will be in the online environment while increasingly analysis tools and forecasting tools will be configured and delivered through the online world. What used to reside on the mainframe computer is rapidly drifting onto the network where the distribution of hardware, software, data, those who design and use these systems, everything will become remote; in short location no longer matters when it comes to accessing the tools needed for urban planning. Not everything of course can go online and there will still be a role for conventional support but as GIS and related services migrate to ever smaller and more intimate devices, this raises the possibility that government and public processes such as urban planning will become ever more accessible and hopefully relevant and accountable.

CASA has developed many resources and trhese are available from its web site at http://www.casa.ucl.ac.uk/ MapTube can be accessed at http://www.maptube.org/ while the 3d and multimedia work is available at the digitalurban blog which is located at http://www.digitalurban.blogspot.com/ The agent-based blog which links these models to GIS is at http://gisagents.blogspot.com/. CASA has a related site for London called the London Profiler and is at http://www.londonprofiler.org/

About the authors

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Figure 1: Creating a Map Using GMapCreator

Users can input a shape file or any file that can be transformed into a shape file, set the level of zoom, fix the colour range of the attributes, and then generate a **Google Map** of their file as part of this one-stop shop

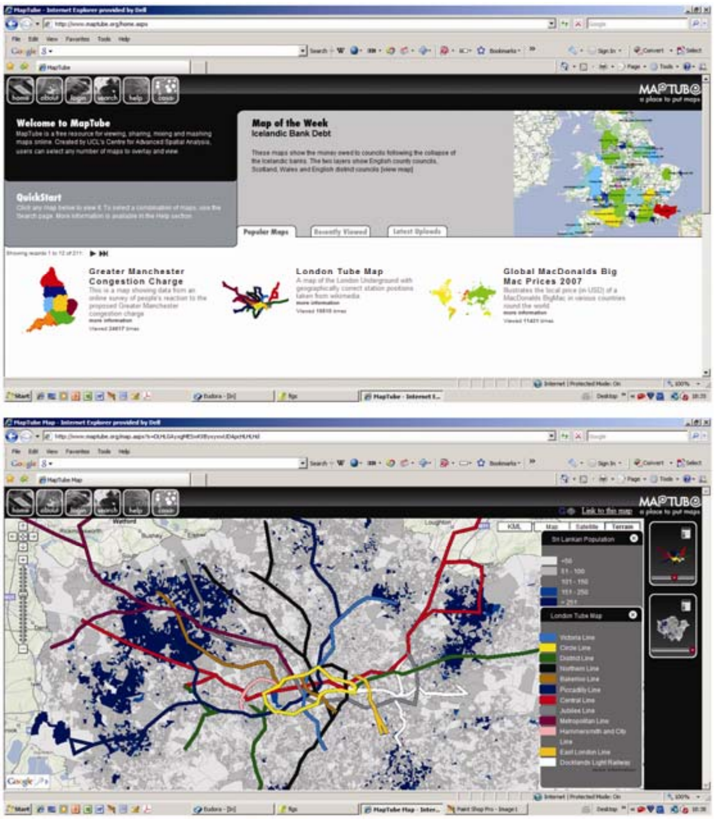

Figure 2: MapTube: A Place for Maps

Users can create their maps using **GMapCreator**, generate their own web page, share their maps with other using the archive, and overlay any map onto any other. The first map is the splash page with a sample of maps; the second map below is a selection of the concentration of the Sikh population in London with an overlay of the subway (tube) map.

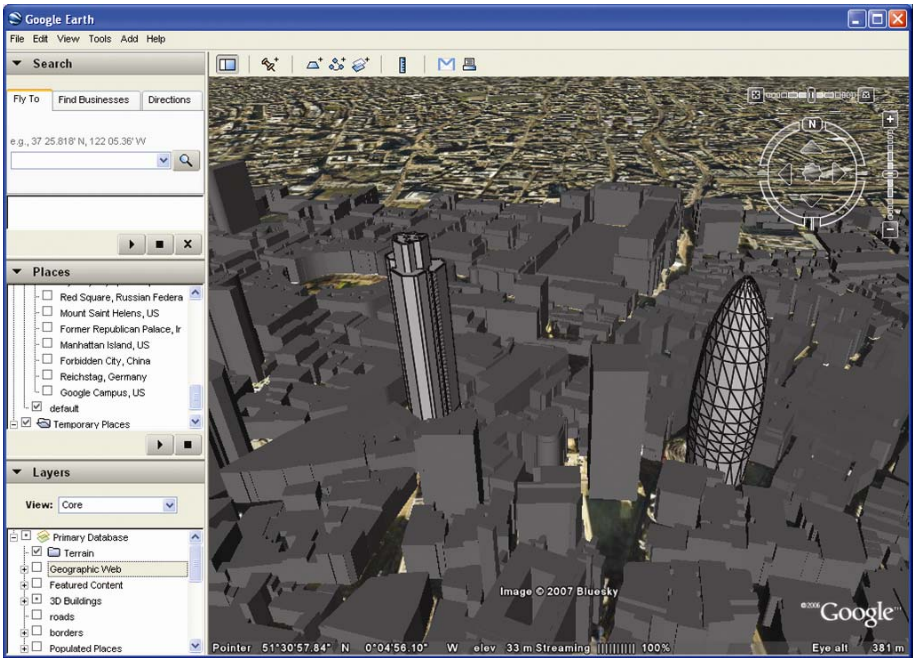

Figure 3: Virtual London within ***Google Earth***

3.6 million building blocks are generated in this model where users can fly out 30 kilometres to the edge of the city and can pan and zoom to street level. This model is used for many different purposes

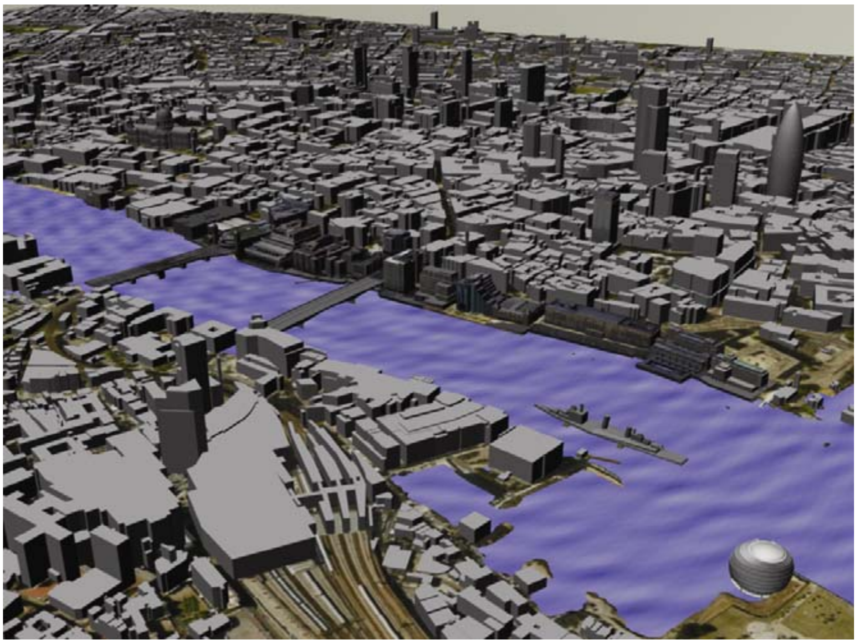

Figure 4: A Virtual Flood

We create a movable layer in the 3-d GIS and intersecting this with the geometry to give the impression of the city which would be flooded if the sea level were to rise by different levels

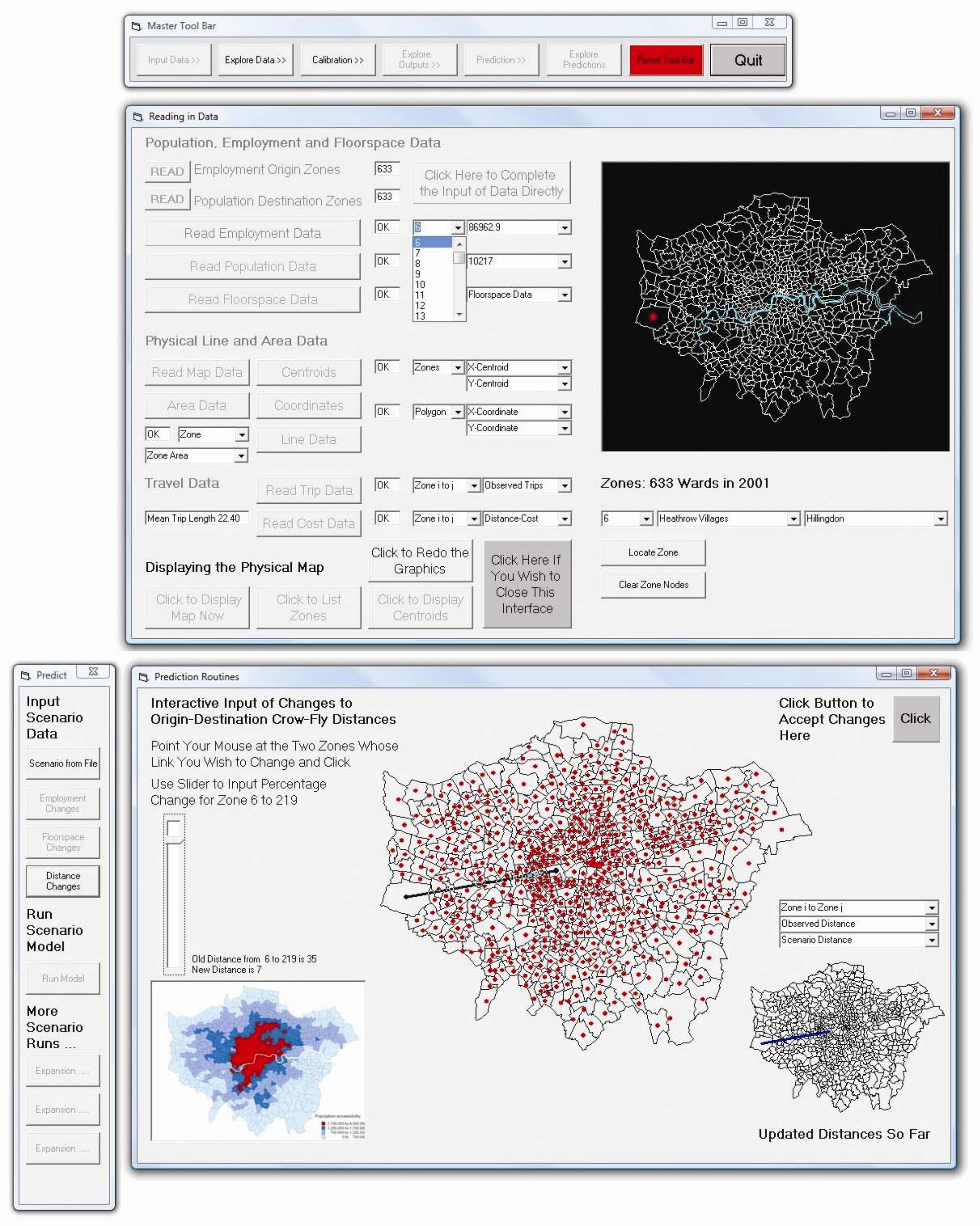

Figure 5: A Snapshot from the Land Use Transport Model for Greater London

Users can interrogate the data and the model results on the fly as the GIS functions are built into the desktop software. Here we show the data screen which is the first thing the user sees and then later on in the screen below, the results of a user changing a transport link to test a scenario