CASA

VIRTUAL REGENERATION

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ABSTRACT

Regenerating our increasingly polluted, worn-out urban infrastructure is becoming the singly most important challenge facing our cities. **Simon Doyle** and **Michael Batty** explain how spatial information technologies and online laboratories can enable many diverse interests to participate in creating informed planning policies that best address these issues.

Western cities, like their populations, are ageing. Their renewal in ways that alleviate the pollution and conflict over the use of public resources that increasing wealth is bringing will be the critical planning problem of the new millennium. In Britain, this debate is currently nowhere more polarized than around the issue of where we should accommodate over 4 million new households which will be created over the next 20 years due to the demand for new lifestyles in the wake of the break-up of the nuclear family. Whether or not these should be housed on greenfield or brownfield sites, on the edge of cities or within existing towns, is the focal issue.

These kinds of problem cannot be tackled by expert professionals using single disciplinary sciences. They are intrinsically systemic, require methods which integrate engineering with economics and the sciences of the natural environment, and are set within a social and organisational milieu which embraces many different, often conflicting ethical and political perspectives. The taskforce led by Lord Rogers which is inquiring into the problems of bringing brownfield sites back into residential use has to grapple not only with whether it is scientifically and even economically feasible to decontaminate such sites but whether such sites are likely to be available for housing. This involves questions of ownership and the market for land, whether or not such sites are near to existing (and future) centres of employment, transportation and retailing, and whether or not such in-city development is able to preserve and enhance the green space so necessary for urban living.

Hitherto, these problems have been tackled using the Town and Country Planning system. But as cities have become more complex and diverse, it has been increasingly difficult to integrate the requisite science with the requisite politics necessary to produce effective and workable plans. New technologies however seem to hold the key to effective action. In the last 10 years, spatial or geographic information systems (GIS) have emerged which are able to integrate many different types of socio-economic, physical and bio-ecological data in ways that make these comparable, even commensurable. Representing such data digitally is making such integration possible, providing a more systemic understanding of urban problems. Advances in visualising data using various types of multimedia such as 3-d fly-through, and textual/photo-realistic enhancement, are forcing such systems towards virtual reality (VR), thus adding new ways of incorporating qualitative insights.

At the same time, such software systems are fast moving to the net and it is this ability to interact with such systems remotely that holds the key to new ways of developing appropriate solutions. The idea of virtual laboratories which bring experts at remote locations together to share data and expertise and to develop new levels of collaborative science, is not new but extending the idea to involve a very wide public with widely different levels of interest and skill concerning urban problems which can only be resolved consensually, is. This is only now becoming possible due to the massive proliferation of the internet and clever ways of treating problems that intrinsically involve participation and cannot be addressed without it.

Urban environmental problems require many different types of data concerning the way economic activities in cities compete for land, thus generating both benign and polluting impacts whose effects vary widely on different groups within the population. Hitherto, these effects have either been ignored or at best handled somewhat badly by the existing urban planning system which has been rarely provided with enough intelligence concerning the way different environmental systems interact. Widening the scope of such concern has not been easy using traditional public participation but the idea that such issues might be put into the much domain of the internet is being seized upon as a means of widening access to many interested parties. many web sites now exist which aim to involve, albeit passively, a wider public in such issues.

In London, we are going well beyond this kind of dissemination which at best raises awareness. We are devising a system based on information through which any user can make sense of the urban environment while beginning some rudimentary data analysis. We are structuring the system so that users can interact with it on different levels, dependent upon their interest and expertise. Its organisation is modular, built from a loose confederation of other systems linked across the net. It is hierarchical in that different groups have different levels of access. It is interactive in that users can upload and down load data but more importantly engage in dialogue with one another through bulletin board-like conversations. The system proffers potential users a range of tools to engage in further analysis of data but also to visualise data in different modes - as maps, as 3-d models and so on. At the same time, it offers users the power to pose and react to policy questions and to even begin the construction of policies that address the critical problems raised. The pilot model from which the illustrations here are drawn operates at all scales from the metropolitan-wide area of Greater London itself down to specific sites at the level of building parcels and plots.

At the heart of the system lies a spatial database which is accessed using a GIS, configured in such a way that it is able to deliver information to users across the internet in response to remote queries of the data. In fact, as the system is modular, it extends into a series of GISs which draw on different databases and are co-ordinated in such a way as to draw and display data from different systems in a

seamless fashion. It is supported by sets of functions, some custom-built but many of which are part of the standard GIS toolbox. These enable users to map and visualise different data sets, perform queries of the data and extract specific features while extending this capability to simple forecasts of trends and assessments of impacts.

The system is accessible through any standard internet browser which makes use of the world wide web. The 2-dimensional map lies at the core of the system but the ability to view data in 3d or as photographic images, video clips or abstracted animations is standard through any path the user might take in viewing data as we can show for many different areas of London such as central Westminster.

We can illustrate best how the system is useful for urban regeneration using some of the case studies currently part of the framework. At the metropolitan level, data from the 1991 Census of Population, from Ordnance Survey and other data providers in the quasi-public domain are part of the system. We also have extensive data on local pollution, from the London Research Centre's Greater London Atmospheric Emissions database, and we have linked the system online to the National Air Quality Information Archive web pages which contain data on pollutants recorded at 68 sites across London. This data is available hourly for 5 major pollutants and 4 particulates. It is possible for any user to download this data and to use standard GIS and CAD tools to display it in 2-d and/or 3-d. The concentration of nitrous oxides ($N0_X$) can be visualised as a contour map or as a 3-d surface. Visualising data in this way brings many advantages. At one level, it is a reality check in that errors in data can be spotted while the more important policy use is in setting up a visual base of data which informs discussion. There are important scientific problems in representing data at different scales but in the London context, the high concentrations in Hackney, Brent and Croydon require explanations which involve synthesising local knowledge of these places with the techniques used to record and then visualise the data in the first place.

Fig 1: How a User Interacts with the System Remotely

The map of Parliament Square on the left is the output from the internet GIS displayed on the 'client' which gives the user options for viewing different 'layers' of data. When an option is selected, this request is sent to the central data base at a remote location on the 'host', is processed and back comes the map. If the user activates a 'hotlink' on the map, then another frame of information is opened up. On the right of the map, this is displayed as a 3-d block model of central Westminster and the user can then 'navigate' around it using the controls beneath.
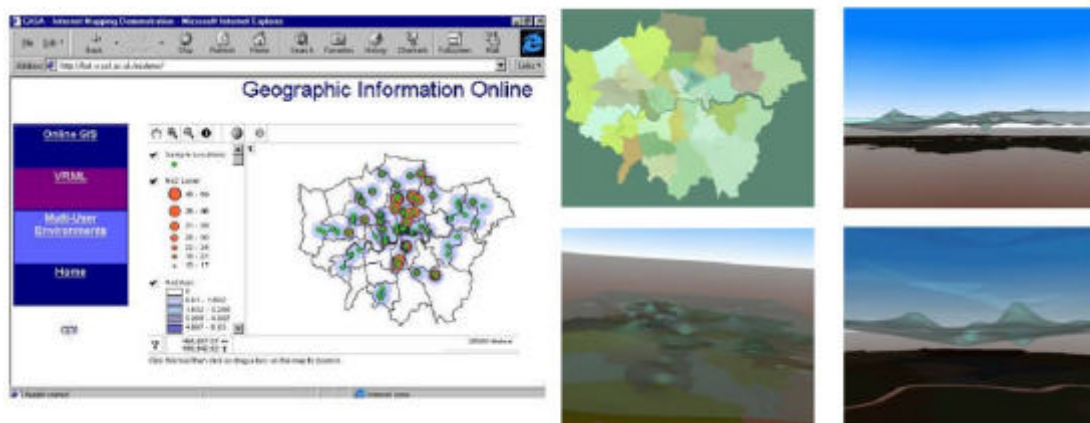

Fig 2: Visualising Air Pollution Surfaces across Greater London

The map shows contours of concentration which have been interpolated on the fly by the user around the 68 sites, with the user being able to specify the colour gradation used to visualise this incidence. The same data can be visualised as a 3d surface, and the different views show different positions as the user navigates around the city.

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These kinds of metropolitan-wide analysis of pollution only become useful when they are contrasted against other data with a view to exploring the way different sectors impact and interact on one another. One of the great advantages of using GIS as the engine to store and drive the query and display of spatial data is that the idea of treating different data by different map layers enables immediate comparisons to be made. GISs are very highly tuned to make such comparisons, and there are many standard functions which can be used to combine, transform, aggregate, exaggerate various data layers, thus providing new patterns which can generate new insights about the problems of the urban environment. A useful example which clearly demonstrates this as well as showing how important it is to provide links between demography, health, pollution and transport involves the delivery of health case in the Riverside Health Trust area (which covers the boroughs of Westminster, Kensington, Hammersmith and part of Ealing). The Trust routinely records the trips made from local district nurse stations to patients requiring home-based care; one of their objectives was to minimise these trips in the first instance because of concerns for both the pollution being added by car trips as well as the monetary expenditure on fuel and vehicles, and the time spent travelling. Various options were being considered ranging from car pooling by nurses to the wholesale relocation of nurses' stations as well as providing different levels of care to patients in the home. What the system enabled us to do was to show how different types of information are correlated with such trips, such as showing how other emissions data relates to the trip pattern, showing how the density of nurses visits to patients could be correlated with health data from the 1991 census, but most importantly it provided a method for showing how the pattern of trips might be radically reorganised by linking the nearest nurses to the nearest patients.

The almost chaotic pattern of trips in that area of London is contrasted against the pattern that is feasible by reallocating nurses to patients to minimise distance (and hence pollution generated and money expended). Standard functions in GIS are models that enable such spatial reallocation and in this case, by reallocating trips, around £1m can be saved from the travel budget for the health authority simply by changing who visits who, with commensurate reductions in pollution and this is before any other changes in location are considered. This example shows how the system is able to handle data of different types at different scales, metropolitan-wide data providing a frame for local data.

Our last example brings the discussion down to the local scale of brownfield sites. In Kings Cross, developers are excavating a site for the new Channel Tunnel Raillink. The noise and dust from the excavations are considerable, and although this is typical of any large scale development on contaminated disused land, it demonstrates the kinds of problems that will be normal if a large scale redevelopment programme to reclaim inner city sites of this kind for housing is begun. In these excavations, Camden are monitoring pollution levels for this reclamation and we visualise these by interpolating their impact contours. Their visualisation shows how pollution diffuses with distance

from the sites but it also shows how pollution clusters are formed. From these contours, different levels of acceptability might be implied and using the internet GIS, users can query what buildings and land uses are contained within and without certain levels. For example, by defining a certain standard, the buildings within the affected area which infringes the standard can be identified and the user can compute the affected population and other characteristics of the impact from related data. Imagine this process being operated on a wide area with multiple types of data and multiple viewpoints concerning acceptability being considered and this gives some idea of the potential of this approach to exploring and resolving urban environmental problems.
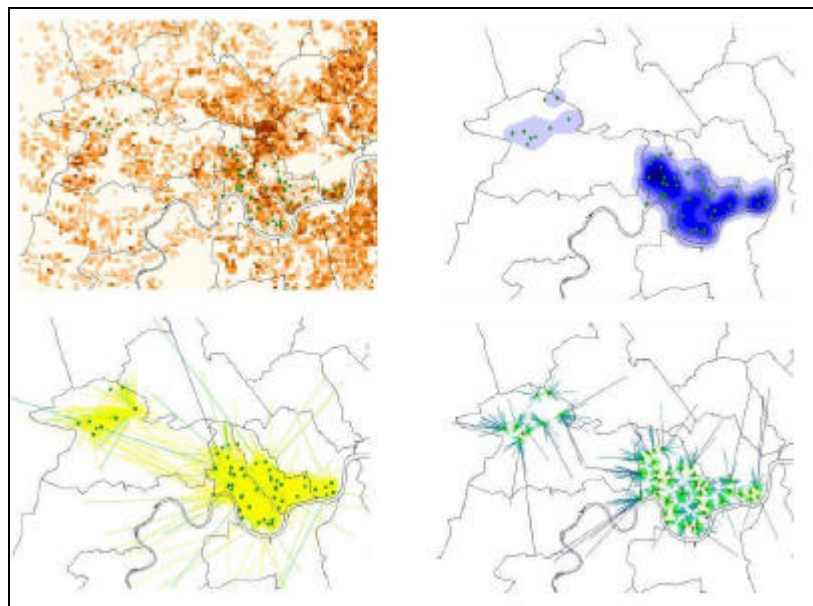

Fig 3: Patterns of Health Care Delivery in Inner London

Typical queries of the system which map the pattern the population registered as permanently sick from the 1991 Census (top left) are contrasted with the pattern of patient visits in west London (top right). We show the current "chaotic" pattern of trips made by nurses to patients (bottom left) and how the same level of service can be achieved much more efficiently by reallocating nurses to patients (bottom right). 50 percent of the current travel expenditure is reduced by the new pattern (over £1m per year) while the levels of car pollution are cut substantially even before car pooling is considered. With such tools, it is even possible to show that a judicious relocation of nurses' stations, car pooling, the movement of some patients from in-home to outpatient care could both reduce money spent and time used on travel even more dramatically while at the same time massively increasing the level of patient care.
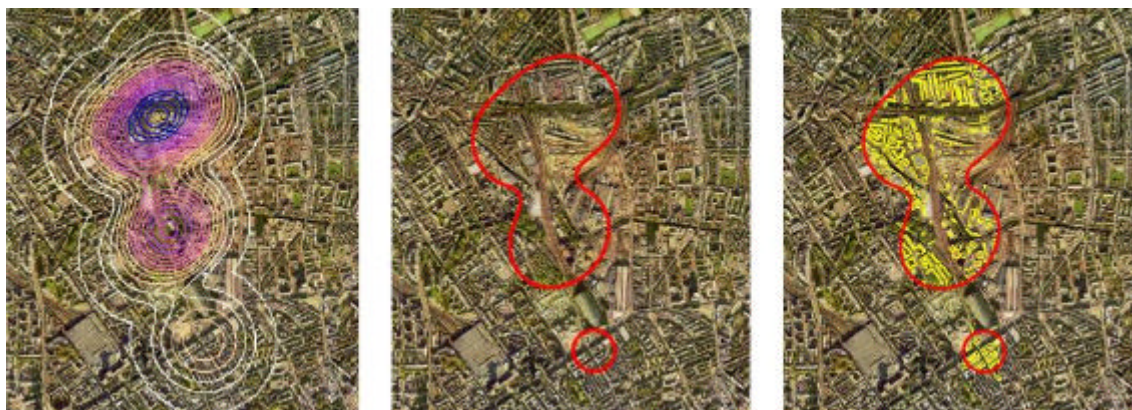
Fig 4: Pollution Generated from the Redevelopment of Kings Cross Site

The concentration of dust levels on the site of the new Channel Tunnel Raillink is visualised by diffusion contours (left). A contour above which levels of dust are unacceptable is identified (centre). The buildings that fall within this contour from which we can compute the 'at-risk' population, can then be selected (right).

The kind of environmental problems that can be explored depend ultimately on how the user articulates the problem in the light of data and information within the system. Its various elements are also tied together through different forums for interaction, based on opportunities for users to query the system through email-like requests and to peruse such information which is posted on bulletin boards, responding if appropriate. We envisage that dialogue between users will begin and that policy maps would emerge from structured and focused discussion concerning environmental issues. Ways in which users might sketch their ideas visually from remote sites have been developed through new extensions to the GIS software. Dialogue is currently entered, using the Online Planning Forum which is at present coupled to the system. and this is being rapidly extended to embrace other relevant interests and decision-making structures. Through its web pages, the system is linked to many other relevant sites, for example to the Friends of the Earth, to the Department of Environment, Transport and the Regions, to the Sustainable London Trust and so on, enabling users to search out the background to environmental issues but within the perspective of London.

Fig 5: Dialogue and Discussion within the Environmental Information System

Users are able to browse a library of different requests and responses concerning urban environmental problems, and to submit their own comments, thus enabling ongoing discussion of important issues and policies to begin

These are the tools that we consider should be used in exploring questions about urban environments in an integrated way which cross disciplinary, professional, and political divides. We would argue that if the quality of life in our cities is to be improved so that all benefit, then it is intrinsically participatory systems like these that must be developed. Only then might we avoid what Garret Hardin called the 'Tragedy of the Commons', where public resources are compromised by the individual over-exploitation of land use, with pollution impacts that affect us all. In the forthcoming debate about how we might exploit our brownfield sites, this is as important an issues as the current over-exploitation which such policies are intended to address.

Further Reading

M. Batty, M. Dodge, S. Doyle and A. Smith (1998) Modelling Virtual Environments, in P. A. Longley, S. M. Brooks, R. McDonnell, and B. Macmillan (eds) **Geocomputation: A Primer**, John Wiley and Sons, Chichester, UK, pp. 139-161

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