FiBRESERIES

THE APPLICATION OF GIS TO ANALYSE OCCUPIER CHAINS AND PROPERTY MARKET FILTERING

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Key findings

With funding from the RICS Education Trust, Paul Greenhalgh and Helen King of Northumbria University, UK sought to investigate whether using Geographic Information Systems (GIS) can enhance the representation and analysis of property occupier chaining data – the method used to analyse the chain of moves that take place when firms occupy new premises. The way that they tested this was by transferring a dataset of office and industrial occupier chains in Tyne and Wear that had been collected by Paul Greehalgh for his PhD study (see opposite page) into a GIS to illustrate, measure and analyse the chaining data more effectively than had previously been possible. What they were able to show was that, although the process is time-consuming, it is a relatively straightforward and logical process to translate property occupier chaining data into a GIS.

The resultant GIS representation was able to replicate and verify findings of the original research. For example, it confirmed the accuracy of the original calculation of the distances that occupiers move, but it also revealed that the average distance moved diminished the further that they occur along a chain. The team then used rateable value and VAT registration datasets to interpret the origin of occupiers of new office and industrial developments, and the location of vacant chain end property. Of the two, the strongest correlation was with new VAT registrations within a three year period. New VAT registrations are associated with levels of economic activity and enterprise which would generate new businesses or start-ups that would typically take up small office and industrial units, thus absorbing vacant accommodation and contributing to property market filtering.

Although the work used the Tyne and Wear region as a practical example, the key objective of the work was to test the applicability and robustness of the approach. As such, the key findings from the work relate as much to the process involved as to any specific insights into the Tyne and Wear region.

- **The application of GIS to property occupier chaining data was successfully demonstrated** and was able, not only to verify the findings of the original research, but was able to extend the breadth and depth of analysis

- The GIS was used to produce maps of the Tyne and Wear conurbation, displaying occupier chaining data, to enable further interpretation and analysis

- By exploiting existing datasets **it was possible to characterise the locations where occupiers relocate from and where property voids persist**; this enhances our understanding of the impact of occupier displacement on the dynamics of commercial property markets

- a multi-criteria analysis Business Activity Score (BAS) was developed with which to **measure the relative performance of Middle Super Output Areas** within the conurbation

- The property chaining GIS may be used, not only to evaluate previous property market interventions, but also to **inform the development of spatial strategies that shape new ones**.

The detailed and comprehensive investigation of occupier chains, generated by occupiers relocating to new commercial and industrial developments, makes an important contribution to our understanding of the spatial impact of development on local property markets, in terms of the displacement of property occupiers, the operation of property market filtering and the side-effects of public sector intervention in land and property markets.

The original PhD research

'Grease to the wheel or a spanner in the works? An investigation of office and industrial occupier displacement and property market filtering generated by public sector assisted property developments: a case study of Tyne and Wear' (Greenhalgh, P. 2006)

The original research by Paul Greenhalgh concentrated on 20 of the most significant office and industrial developments to have been built in the Tyne and Wear conurbation, in the North East of England, during the last 25 years, all of which benefited in some way from public sector funding and support (e.g. Enterprise Zone, Urban Development Corporation, gap funding etc.).

The data used for this project was collected by a chaining survey of over 500 office and industrial occupiers in Tyne and Wear and represents the most extensive chaining survey, of this type, completed in the U.K. to date. Having ascertained the status and origin of all occupiers of the 20 developments, the chains of firms that were not new to the metropolitan area were investigated to record what had happened to their old premises. By identifying 251 occupier chains that resulted in 376 chain ends spread across the conurbation the research was able to represent the extent and spatial distribution of the displacement of office and industrial occupiers in the conurbation. By manually plotting the origin of firms on the 20 developments, the geographical distribution of premises vacated by relocating firms within Tyne and Wear was recorded, and the distance that occupiers had moved, was measured. The average distance of moves for each development and for different types of occupier was calculated, as well as a total of all relocations within the conurbation. In addition, the location of vacant property, at the end of occupier chains, was plotted to identify which areas have been most affected by displacement within the conurbation.

The data collected for the PhD study was analysed without the assistance of Geographic Information Systems (GIS) but it was apparent that GIS could offer an enhanced level of representation and analysis.

 With this RICS Education Trust grant, Paul Greenhalgh and Helen King were able to exploit the existing dataset and use GIS to illustrate, measure and analyse the occupier chains more effectively than had previously been possible.

Background

Displacement of property occupiers may be caused when new property developments come on to the market and occupiers relocate to these new developments, vacating their old premises in the process. This is not a problem per se, as their old premises may only remain vacant in the short term, before being reoccupied by a new business or organisation.

This process is called filtering and operates in most property markets. The chaining technique, used to investigate property market filtering, although well established in residential property markets, has rarely been used in industrial and commercial sectors (see Figure 1 for a model of commercial property occupier chain).

Figure 1 – Model of How Occupier Chains are Generated by Occupier Displacement and Vacant Property is Absorbed by the Filtering Effect in Commercial Property Markets (Greenhalgh 2006)
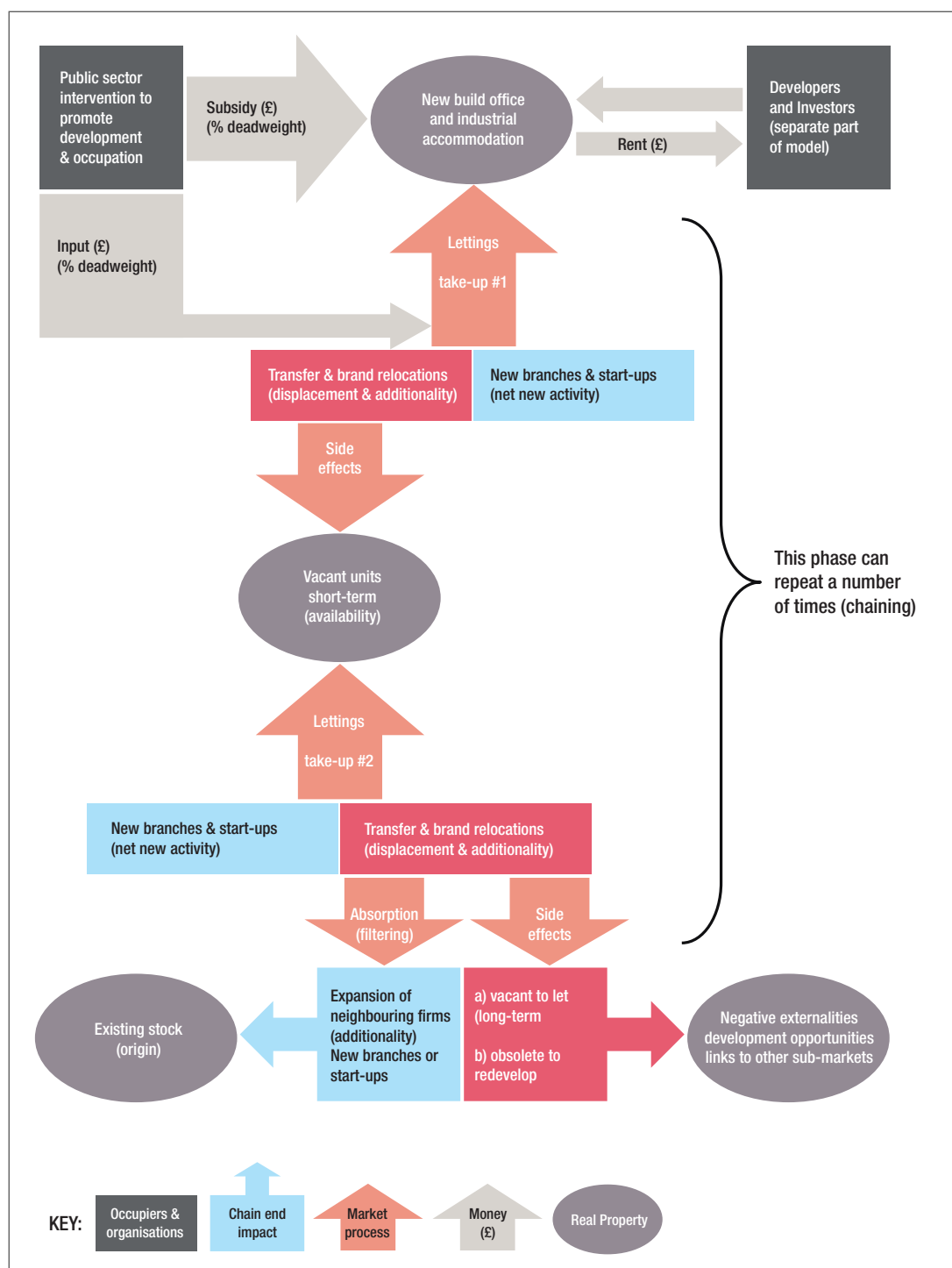
What is the problem?

Chains that end in vacant property are significant because they represent the final manifestation of the impact of new property developments coming on to the market and generating the displacement of existing occupiers from within the study area. Through filtering, vacant chain-end properties may be concentrated in locations that are particularly vulnerable to occupier relocation, and are typically characterised by obsolescent building stock, a poor physical environment, out-dated infrastructure, economic blight and social stigma. The chaining technique helps identify the spatial impact of the spill-over effects of property development and regeneration.

The spatial distribution of the origin of relocating occupiers and vacant chain end property is valuable data with which to assess the impact of new property developments. By plotting the origin of firms, it is possible to represent the geographical distribution of premises vacated by relocating firms within a city, and it is also possible to measure the distance that they had moved. In addition, the location of properties at the end of occupier chains may be plotted to identify which areas have been most affected by displacement within the conurbation.

A key question that this raises is why firms were unable to meet their accommodation needs without moving. What are the characteristics of the donor locations e.g. the locations from where occupiers originate, and can these characteristics explain the reasons for moving, for example forcing (push) factors? Why are some locations better able to absorb vacant property via market filtering or take-up?

Why does it need to be solved?

This project exploited data that had been collected on 251 office and industrial occupier chains in Tyne and Wear. The purpose of this project was to find out whether GIS could enhance the representation and analysis of this chaining data. This new work initially comprised data processing, but also required the accurate capture of geospatial coordinates for all points within the 251 chains (approximately 550 points). It was anticipated that the resulting GIS would be capable of capturing the spatial concentration of chain ends and their status to identify locations that are slow to absorb vacant office and industrial property.

The advantages of using GIS is that it can:

- provide quick and easy access to large volumes of data

- select data based on categories provided

- integrate data and highlight spatial characteristics observed

- focus on a given area

- edit, update and incorporate more information

- provide tailor-made output in the forms of maps, graphs and summary statistics (see Heywood *et al.,* (2006) *An introduction to Geographical Information Systems*, 3rd Edition, Prentice Hall, Harlow).

While the primary aim of the research was to test the robustness of GIS for this purpose, the team was able to pursue further analysis, using the GIS, to characterise the areas that were the source of occupiers or contained clusters of vacant property and determine whether they stared common characteristics.

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About the research

The 20 office and industrial developments in Tyne and Wear captured by the research comprise over 500 buildings, totalling in excess of 500,000 square metres (5,500,000 square feet) of accommodation on nearly 500 hectares (1,200 acres) of land (see Figure 2). The developments are occupied by over 800 firms employing over 25,000 people, and the total investment in buildings, plant and machinery exceeds £2 billion (Greenhalgh *et al.,* 2003).

A methodological approach was developed to convert data for use within GIS software. The most time-consuming part of the exercise was the conversion of occupier locations, represented by postal addresses, into geo-spatial (easting and northing) coordinates so that data can be displayed in a GIS. This was achieved using postal address and postcode databases that are publicly available. Once all the data had been transferred into GIS it was possible not only to verify the original chaining analysis, but to pursue further analysis that was impossible using manual techniques.

The project:

- converted all chain and nodes to a geo-referenced point location GIS dataset

- provided comprehensive data about each property chain and categorical information linking together occupier chains by:
  - type of move
  - type/nature of business
  - expansion or contraction.

- compiled a database allowing a comprehensive interpretation of the data (see Figure 3)

- enabled visual display of the chaining data within a geographic context, allowing analysis of associations on locations (see Figure 4)

- calculated the distance of moves for all links in the chains

- represented the spatial impact of a business development and effects of multiple developments, of different sizes and scale.

Figure 2 – Twenty Office and Industrial Developments in Tyne and Wear
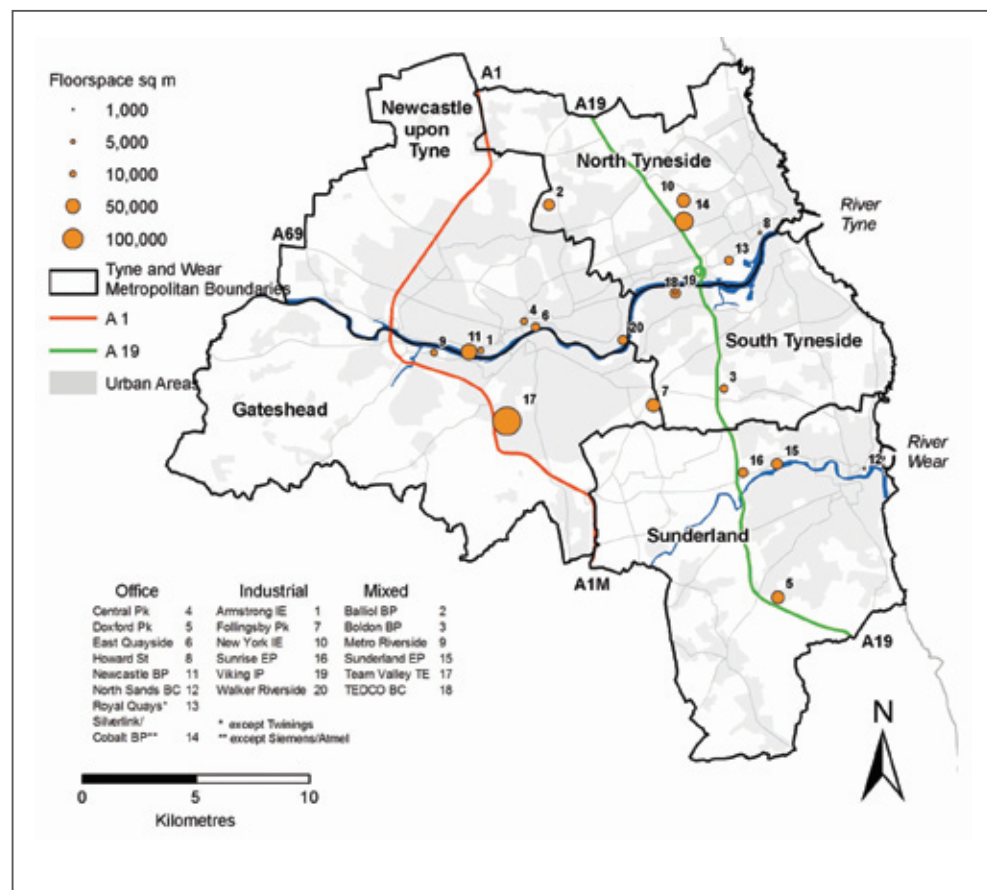
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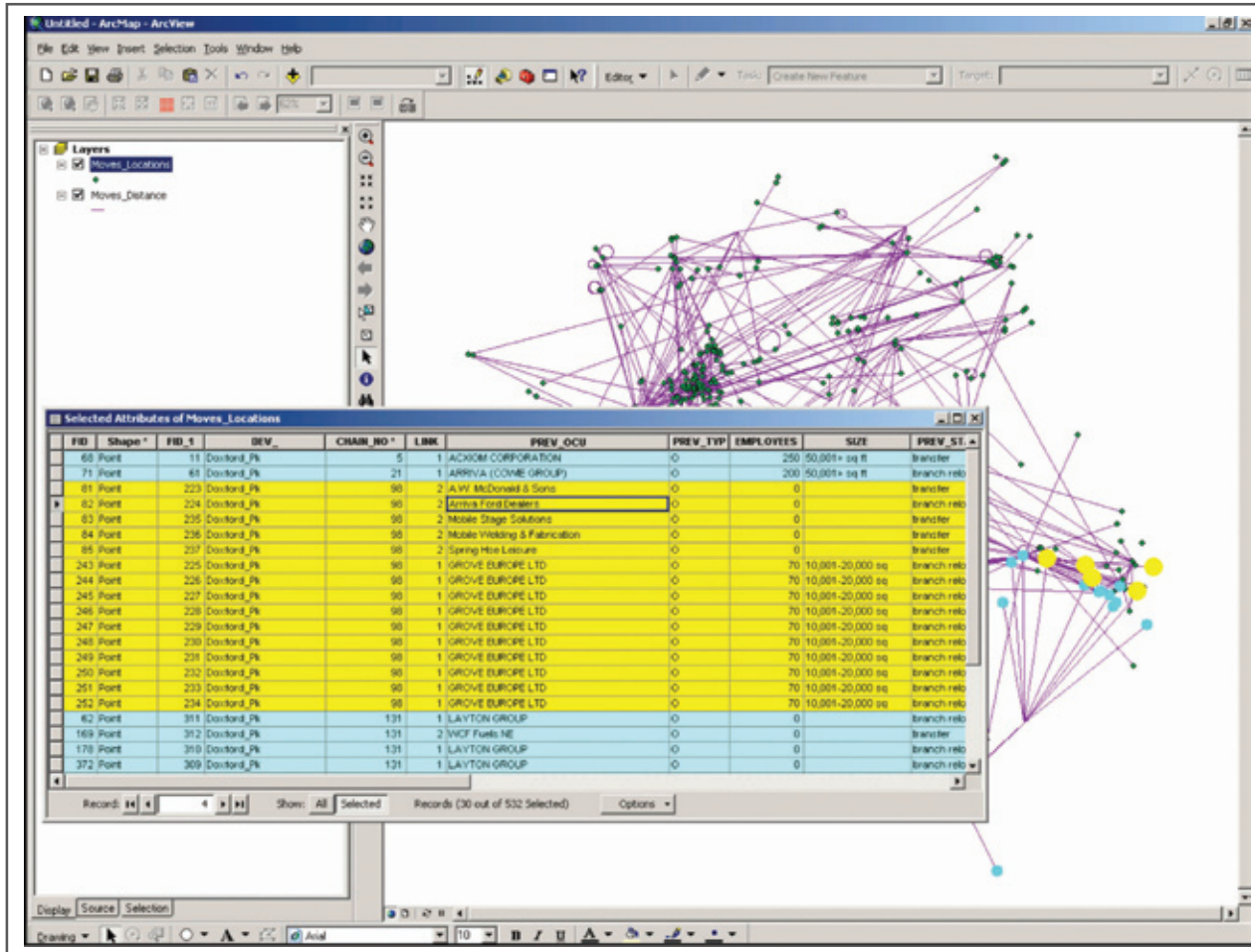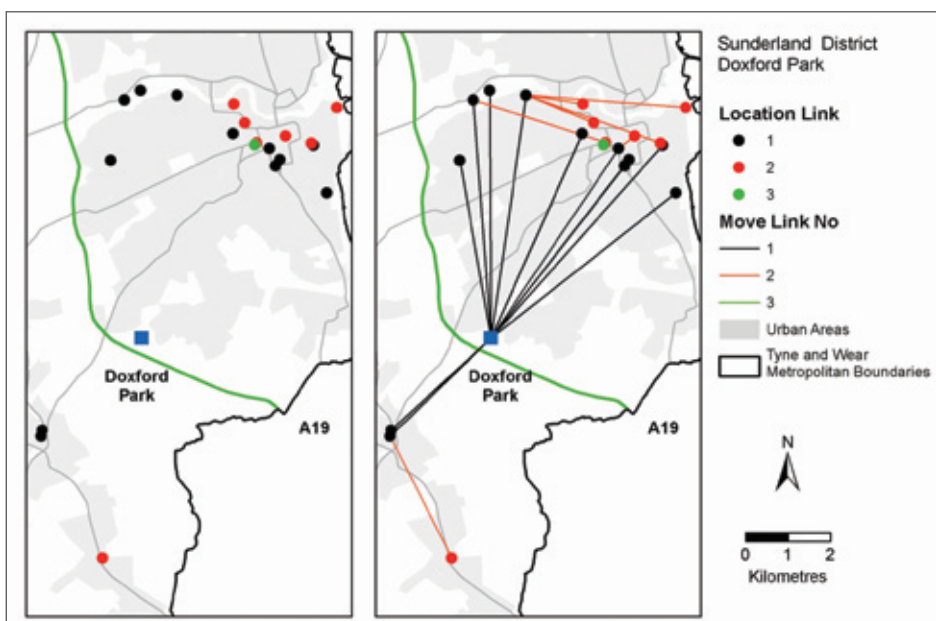
Figure 3 – GIS working database

Figure 4 – Joining up the dots – illustrating occupier chains in GIS

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Findings

The tangible output of the work was an interrogable spatial database of office and industrial occupier chains across the Tyne and Wear conurbation. By creating this, it demonstrated that the approach enabled the geography of the chains, spatial impact of occupier displacement and side-effects of property-led regeneration projects to be investigated and better understood.

It was possible to accurately calculate the average distance of moves for each chain link. As new properties are supplied at the top of the property market, occupiers move (filter) up the property ladder, vacating older and generally smaller properties that filter down the property ladder. Typically, the further that a property is along a property chain the smaller it is and the distance that an occupier is likely to move to such premises would reduce e.g smaller organisations move shorter distance to smaller properties than larger firms higher up the chains. This proved to be the case, with the average distance of chain links decreasing from 4.8 km for first moves, to 2.8 km for second and 2.6 km for third.
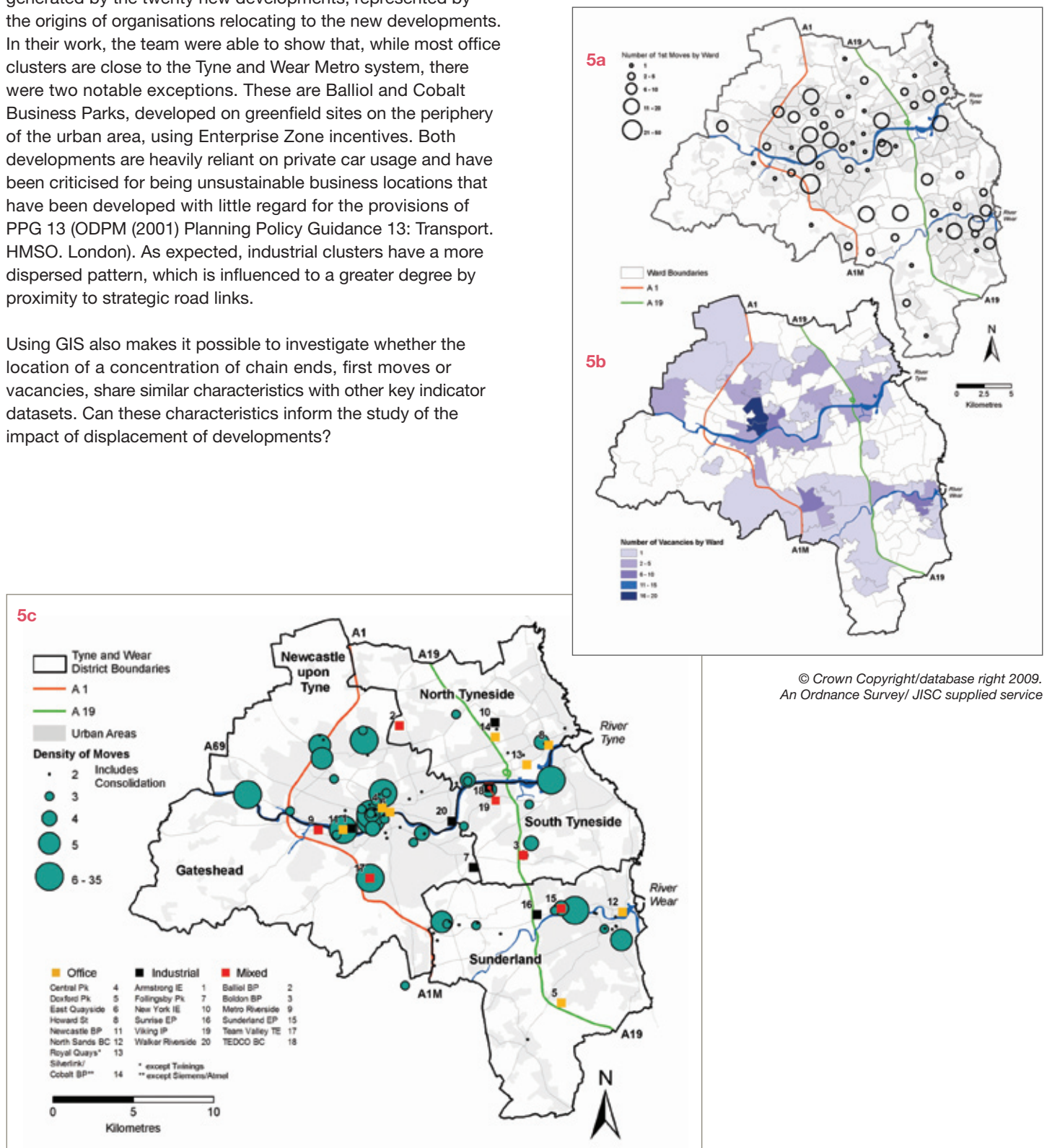
The GIS analysis showed the spatial distribution of relocations, from first moves to chain ends and all points in between, and confirmed the hollowing-out of Newcastle and Sunderland CBDs and Washington New Town. A particular focus of the research was to see how it could represent the spatial distribution of vacant chain ends, and the GIS can be used to produce maps of the conurbation representing the relative density of concentration of both the origin of first moves and incidence of vacant chain-end property (see Figures 5a, 5b and 5c). This permitted the identification of the donor wards of occupiers that relocate to new office and industrial developments and those wards where there is a relative concentration of vacant chain ends. It was also possible to capture the overall density of occupier movement by ward.

Representing the density of office and industrial occupier movements effectively identifies those locations (hot spots) which had the greatest levels of property market excitation generated by the twenty new developments, represented by the origins of organisations relocating to the new developments. In their work, the team were able to show that, while most office clusters are close to the Tyne and Wear Metro system, there were two notable exceptions. These are Balliol and Cobalt Business Parks, developed on greenfield sites on the periphery of the urban area, using Enterprise Zone incentives. Both developments are heavily reliant on private car usage and have been criticised for being unsustainable business locations that have been developed with little regard for the provisions of PPG 13 (ODPM (2001) Planning Policy Guidance 13: Transport. HMSO. London). As expected, industrial clusters have a more dispersed pattern, which is influenced to a greater degree by proximity to strategic road links.

Using GIS also makes it possible to investigate whether the location of a concentration of chain ends, first moves or vacancies, share similar characteristics with other key indicator datasets. Can these characteristics inform the study of the impact of displacement of developments?

Figure 5a, 5b and 5c – Analysis of concentration of origin of first moves, vacant chain ends and density of moves by ward

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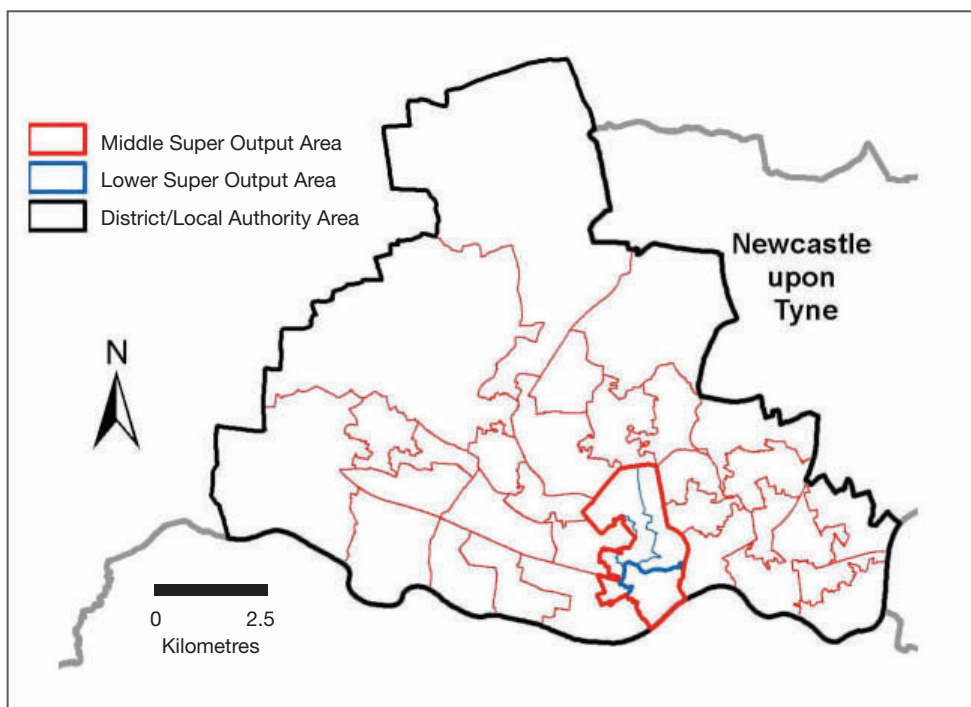© Crown Copyright/database right 2009. An Ordnance Survey/ JISC supplied service

Findings

The team tested this data against three other datasets (Rateable Value, VAT registrations and Index of Multiple Deprivation) based on Middle Super Output Areas MSOA areas (see Figure 6 and box), the first two of which were combined to provide a multi-criteria Business Activity Score (BAS) with which to compare areas. Individually these indicators may be used to characterise the nature of the location of the vacant properties, first moves or chain ends. Rateable Values can be used as a proxy for property market vitality, with high values representing healthy occupier demand. A higher number of VAT registrations within an MSOA are an indicator of the economic vitality of the area. When this information is used in combination, the role of GIS as a tool in adding value to data becomes most apparent.

Using GIS to score each individual dataset, on a scale from 1-5 that represents the best spread of values, (MSOAs with higher rateable values and the highest number of VAT registrations will have a higher score), allows the combination of datasets collated in different units of measurement. When combined, MSOAs with the highest scores represents greater vitality or 'business activity' relative to other MSOAs in the Tyne and Wear Region. It is then possible to identify the score of MSOAs where first moves, chain ends and vacancies are predominantly found and identify the Business Activity Score that characterises their relative vulnerability. This distinctive signature or quantitative measure can then be used to identify areas vulnerable to the impact of future developments.

Figure 6 – Geographical context of datasets

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What are Middle Super Output Areas (MSOAs)?

Super output areas (SOA) are a statistical geography published by the Office for National Statistics (ONS). Unlike electoral wards, the SOA layers are of consistent size across the country and are not subjected to regular boundary change. They are made up of three hierarchical layers: lower, middle and upper that all fit within a borough boundary constrained by the 2003 local authority boundaries used for 2001 Census outputs. Middle Super Output Areas, of which there are 6,780 in England, are frequently used to collect information by the ONS. These datasets can represent a snapshot in time or a culmination of information over various different time scales.

See: http://www.ons.gov.uk/about-statistics/geography/products/geog-products-area/names-codes/soa/index.html

The results of applying this technique to the data for the Tyne and Wear region is shown in figure 7. Each individual MSOA (of which there are 706 in Tyne and Wear) has been given a score ranging from 1 -5 based on the spread of values for the whole dataset. It is apparent that when looking at the Rateable Value of MSOAs, there is an almost equal number of vacant chain ends and first move properties (green and purple columns respectively) for all scores. A greater number of vacant properties or first move properties is not associated with any score more than any other. There is no relationship between the Rateable Value of an MSOA and the presence or absence of vacant chain ends for first moves. However, it is evident that, when looking at the score for VAT registration (regarded as a proxy for the establishment of new enterprises), in both cases over 75% of the areas that contain vacant or first move properties score 3 and below (blue and red columns). From this,

we can deduce that both first moves and vacancies are located in areas with relatively lower levels of new business formation; firms move out of areas with lower levels of economic activity due to mis-match and property voids are concentrated in these areas due to the lack of new start-ups.

Most of these findings accord with our current understanding of property market dynamics. One surprise was the lack of correlation between Rateable Values by MSOA area and the origin of first move occupiers and the location of vacant chain ends. However, this analysis needs to be refined further by stripping the retail bulk class out of the dataset, combining factory and warehouse bulk classes to represent industrial property and providing a discrete analysis for both office and industrial chains.

Figure 7 – Histograms of the score of areas that contain vacant or first move properties
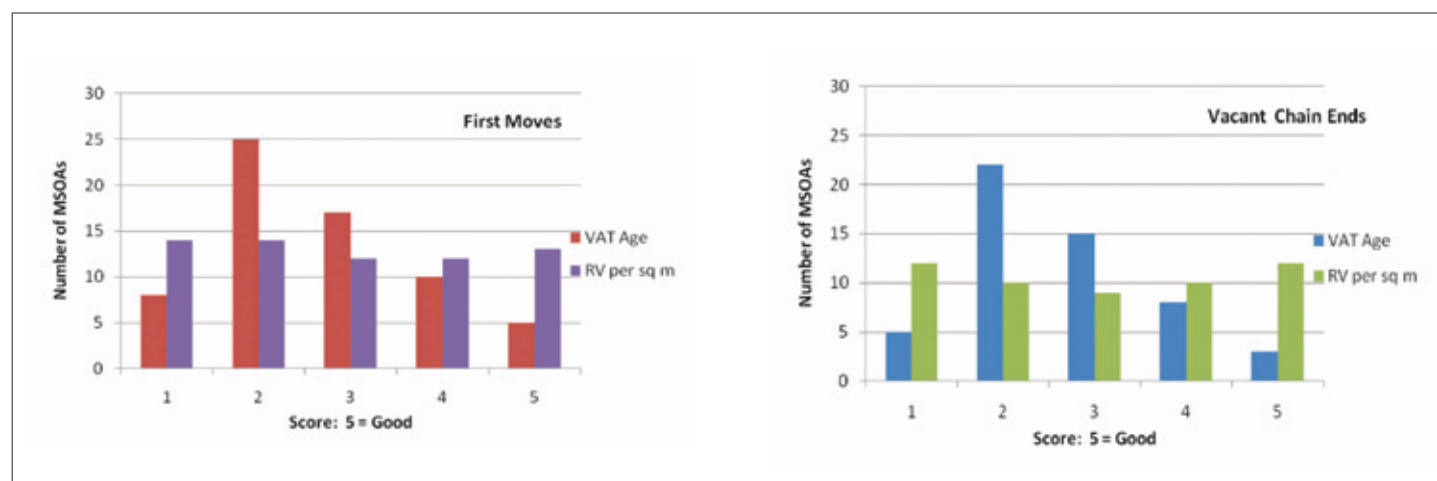
Makes an **important** contribution **to our** understanding of **property market** filtering, **occupier** displacement **and the** wider impact of **public sector** intervention in **land and** property **markets.**

The use of GIS facilitates an accurate, detailed and comprehensive investigation of occupier chains, generated by occupiers relocating to the new commercial and industrial developments and makes an important contribution to our understanding of property market filtering, occupier displacement and the wider impact of public sector intervention in land and property markets.

What the team found was that database design and development is important in increasing the functionality of the data and the ability to analyse interrelationships between the different categories of information provided. In some respects it is harder to import a pre-existing database into a GIS than to use one designed with GIS application in mind, but some key lessons have been learnt for further exploitation of this dataset and future studies.

The project has established the potential to use GIS multi-criteria analysis and a business activity score technique as a tool, not only for evaluating the impact of property market interventions, but for modelling future area-based policy interventions, by representing spatial characteristics that may be used as a predictor of weakness and vulnerability or vitality and resilience. It could also make a useful contribution to spatial planning and the development of economic strategies at both regional and city region levels.

Who would benefit from this?

The key people who would benefit from a greater application of GIS to property market filtering would be public sector agencies and organisations that are responsible for shaping and implementing physical, area based interventions in urban areas that generate occupier displacements. Specifically this could include local authorities, Regional Development Agencies, the Homes and Communities Agency, Urban Regeneration Companies, and the emerging City Development Companies and City Region bodies.

How can the research be developed?

This is a fertile field for further research and development, offering a range of opportunities and a breadth of different applications. Even ignoring property occupier chains and property market filtering, there is value in using GIS to exploit existing and emerging datasets, that are increasingly available at finer resolutions, to characterise cityscapes from an economic and property market perspective. It may be possible to produce an Index of Property Market Vitality (IPMV) at, for example, city region level, to identify the 'push' and 'pull' factors that encourage occupier displacement, similar to the way that IMD and census data is used to represent the wellbeing of localities from a domestic and demographic perspective.

Ultimately, the value of this research is that it contributes to ways in which we can further our understanding of the spatial impact of commercial and industrial development on local property markets, in terms of the displacement of property occupiers and the operation of property market filtering.

By better understanding how occupiers respond to the availability of new accommodation and the likely extent of the side-effects that this may generate, public sector agencies should be better able to develop policies that maximise additionality and minimise negative outcomes. Where a significant level of displacement and occupier chain generation is anticipated, public agencies could consider the potential spatial impact and contemplate taking steps to reduce the negative impact on areas that are not able to sustain such displacement. GIS, as well as providing a means to visualize and display information, can also summarise and integrate a wealth of data highlighting key characteristics of a 'location' that this research shows may contain the majority of vacancies (see Longley *et al.,* (2005) *Geographic Information Systems and Science*, 2nd Edition. Wiley, Chichester). As Paul Greenhalgh concludes, "GIS enables us to use data to identify locations in a city or conurbation that are either vulnerable or resilient to the impact of new development. This would allow local authorities and other public bodies to identify areas that are potentially at risk and to plan spatial interventions accordingly."

What next?

In terms of taking the research forward, the team identifies ten opportunities for further study:

• Incorporate data gathered from revisiting vacant chain ends into the analysis

• Carry out longitudinal studies of office and industrial developments as they come on-stream in order to reveal more accurately the impact of the supply of new business space on occupier markets over time

• Gather comprehensive employment and floorspace data for all links in the occupiers chains in order to calculate full additionally

• Refine the use of VOA rateable value data in the multi-criteria analysis to achieve a better fit with discrete property market sectors

• Use VAT datasets to develop a diversity index of business; does a more diverse business base support greater local infrastructure or service provision and lead to a more desirable location from a business perspective?

• Incorporate experimental property vacancy dataset to enhance the analysis of the incidence and duration of property vacancy in relation to recorded occupier displacement

• Exploit other property market datasets compiled by Real Estate Analysts that may be compatible with GIS

• Pursue analysis of the proximity of transport infrastructure to office and industrial locations using network analysis, travel times and function

• Use data captured by other chaining studies to replicate the approach established by this project

• Use GIS analysis of property markets to inform spatial planning and strategic investment decisions.

About the study

The research was carried out by Dr Paul Greenhalgh and Dr Helen King of Northumbria University, UK. The data used by this project was originally collected by Paul Greenhalgh for his PhD study, and the data processing for this study was carried out by Simon Dolman, Graduate Researcher, Northumbria University. Funding for the study was provided by the RICS Education Trust

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Glossary of acronyms and terms

Additionality

the extent to which activity takes place at all, on a larger scale, earlier or within a specific designated area or target group as a result of an intervention (HM Treasury 2003)

CDC

City Development Company

Chaining

the study of the movement of occupiers when the relocation of one generates a void that is reoccupied by another, and so on, until an end point is reached whereby the property is absorbed or remains vacant or is developed for an alternative use

CLG

(Department of) Communities and Local Government

DETR

Department of the Environment, Transport and the Regions (became ODPM)

Displacement

the proportion of the intervention's output/outcomes accounted for by reduced outputs/outcomes elsewhere (ODPM 2004)

Filtering

when properties, that have become vacant due to their previous occupiers having relocated, are re-occupied by firms at different stages of their industrial and commercial development (DoE 1995)

Geo-referenced

X-Y spatial coordinates (easting and northing)

GIS

Geographic Information System

HCA

Homes and Communities Agency (formerly English Partnerships and the Housing Corporation)

IMD

Index of Multiple Deprivation

Mis-match

between the requirements of occupiers and the space supplied by owners

MSOA

Middle Super Output Area

ODPM

Office of the Deputy Prime Minister (now CLG)

PPG

Planning Policy Guidance

RDA

Regional Development Agency

RICS

Royal Institution of Chartered Surveyors

RV

Rateable Value

URC

Urban Regeneration Company

VAT

Value Added Tax

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