REPRESENTING PLANNING POLICY IN LAND-USE AND LAND-USE/TRANSPORT MODELLING

Andy Dobson
David Simmonds
Tom Simpson
Paul Minta
David Simmonds Consultancy, UK

INTRODUCTION

Scope

This paper considers the issues surrounding the representation of planning policies in land-use and land-use/transport interaction modelling. The examples are related to the authors' work in the UK with the DELTA package, but the issues are general and relevant to other models and to other planning systems.

Structure of the paper

The paper considers

- the need to represent planning policies in land-use and land-use/transport interaction modelling;
- general issues arising in trying to represent planning policies, especially for the longer-term future; and
- more specific issues in representing and assessing planning policies within formal models.

From these discussions we draw conclusions regarding the value of representing planning policy, the implications of the importance placed on the (very) long-term in some forms of transport appraisal, and likely ways to improve the representation and analysis of planning policies

The detail in this paper, and particularly the model details, relate to applications of the DELTA package which the authors and their colleagues have developed (in collaboration with various transport modelling teams) over recent years (see for example Dobson et al, 2009). However, the points considered, especially in the early parts of the paper, are equally applicable to other LU and LUTI models which are intended to forecast change over time.

The paper is concerned with why and how we represent planning policies in modelling. For discussion of the wider issues of how modelling is, or might be, used in transport and in land-use planning, and of linkages (or lack of them) between transport and land-use planning, we refer back to the "think piece" on " improving land use predictions informing transport planning" (Atkins et al, 2008) to which we contributed a few years ago. For further discussion of the use of models in appraisal of major planning proposals, see also Bramley et al (2008).

WHY WE NEED TO REPRESENT PLANNING POLICIES

The kinds of forecasting models we are considering are intended, amongst other purposes, to provide the "land-use" forecasts required for transport modelling. These measures of "land-use" typically consist of numbers of residents (by person and household type), numbers of jobs (sometimes by sector of industry and/or socio-economic group of worker), and possibly other information on variables producing or attracting travel and transport – all by zone (or in some cases by zone pair).

These forecasts are expected to reflect the planning policies which influence or control the use and development of land. For the appraisal of transport schemes or policies, it is usually assumed that these policies are known and that they should provide part of the fixed context within which the transport proposals are being assessed. In other cases, the objective of the modelling is to assess the consequences of land-use policies themselves – often in terms of their transport consequences, but also on occasion to investigate their impacts on economic growth, or the impacts of new developments on existing built-up areas, etc.

ISSUES ARISING FROM THE USE OF PLANNING POLICIES

Introduction

We consider here some of the key issues that arise about assembling quantified information to describe planning policies in ways that can be input to land-use models. In this section we identify the questions arising; in the following section we describe how they have been addressed in work to date, and in some cases how we hope to address them better in future projects.

Planning policies

At the local level, planning policies are the responsibilities of local authorities, and most studies therefore involve seeking information from local authorities on their plans and policies regarding the quantity and distribution of future development. The information typically held by local authorities and provided for use in modelling includes:

- committed development, for example where planning permission has been approved; and
- plan allocations, within Local Development Framework, Local Plan or similar.

Such information is extremely important. However, a major issue for forecasting, and hence for modelling, is that this information only provides for a proportion of the development that is likely to come forward. Whilst the above categories represent the forms of development which local authorities are best able to identify and to quantify, they tend to ignore

- "windfall" development possibilities,
- sequential policies that permit development subject to a set of criteria, and

- the likelihood that plans will be revised at relatively frequent intervals to take at least some account of demand pressures.

Particularly in high demand areas, considering only committed development and development allocations, would result in unrealistically restricted forecasts, especially for forms of development – notably retailing – where local authorities are often reactive rather than proactive.

We address these and other points in the following sections.

Time scales of planning

For transport planning purposes, land-use or LUTI models need to extend from

- the immediate future, where detailed information on current and imminent development proposals should be available, through
- the short to medium term, where for some land-uses there are fixed allocations of specific sites in published plans,
- the medium to long term, where allocations may be less specific, and are subject to review, and
- the very long term, where even long-term planning documents do not usually allocate development.

This progression from the short term to the longer-term horizon is often also one from 'data-rich' to 'data-poor', with a wealth of data on the short term but information on longer term development often limited to a handful of allocated sites as the levels of uncertainty as to both the scale and distribution of likely development increases. The profile of development foreseen over time that results from simply asking about committed development and plan allocations typically shows a falling-off in development

The graph below illustrates this point. It shows the planning inputs received for a sub-region with each colour, within each block representing the inputs from a different local authority. The total amount of permissible development identified in 2023-2028 is roughly one third of that identified in 2002-8. In some local authorities there is no development identified in the later years.

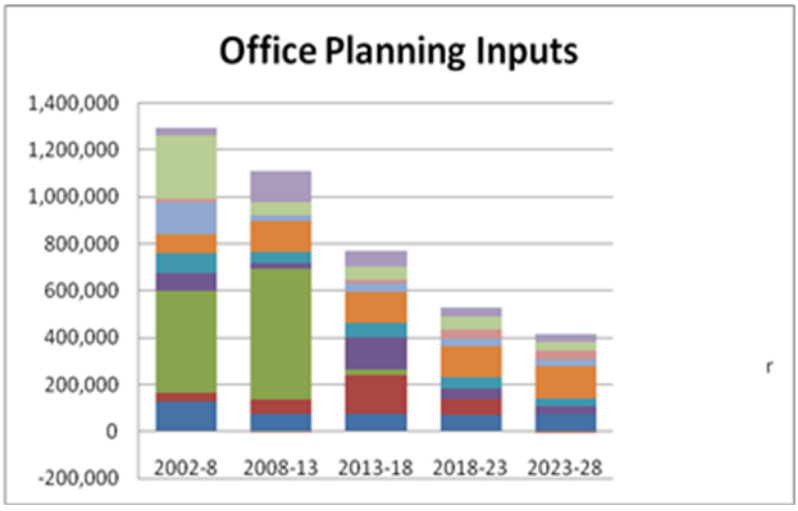

Figure 1 Example of office development planning inputs (m^2; real data, anonymized)

If these figures are used without further adjustment, the forecasts may be unduly constrained with (for example) no further office development in some areas after 2017. Such constraints are certainly not realistic. Moreover, if such constraints are imposed upon a model which is also controlled to forecast TEMPRO-based rates of employment growth (for transport appraisal purposes), then there is a risk that the model may be forced to predict unreasonably high densities for the occupation of commercial floorspace, or even that the model may be unable to find a solution which fits the continuing growth of employment and households into the constrained supply of buildings. The issue then arises of how the "shortfall" between identified developments and a realistic level of development should be filled in order to set up reasonable forecasts – what kinds of assumptions should be made, and who should make them?

Employment Allocations

Plans often allocate land for economic use without any specific mention of whether the site will be for office-based activity, warehousing, industrial processes or other use. The detail as to the end use may only become apparent at some point in the future when a planning permission is submitted.

Clearly in transport terms these different types of activity (office, warehousing, industrial process) will have different levels of trip generation. How should we handle this uncertainty? Do we make assumptions as to the likely end use or do we model the processes by which developers determine the demand for different end uses and develop the one which will generate the best return?

Sequential and Reactive Policies

Many plans contain policies that require a sequential test. For example retail development may be allowed in a specific area (the edge of the town centre) so long as firstly there are no sites within the town centre and secondly no possible sites in an alternative designated area. Office-related development may be permitted within an identified 'Office Quarter' subject to design or other criteria. These policies provide guidance as to the likely distribution of development but they do not quantify the scale of that development.

More pertinently for transport planning, they are often applied to land uses such as retail and offices that are key trip generators.

Redevelopment and re-use of built up areas

National planning policy has placed an emphasis upon the re-use or intensification of use of brownfield or previously developed land. Much of this development will be windfall development and will involve new uses of existing sites. Local Plan policies may provide guidance, similar to the sequential policies described above, as to what uses may be permitted in specific areas. Many of the sites where redevelopment may occur in the medium to long term will be occupied and being used at this point in time. Changes in use from one activity to another will impact upon travel patterns and demand.

How should the processes of redevelopment or re-cycling of land use be reflected in planning inputs?

Long term policies

As the focus moves to the long term and the very long term, it is increasingly necessary to take account of the period beyond the end date of the current plans and to consider the likely future scale and distribution of development. Will there be a continuation of existing planning policy with allocations in the same settlements? Will the scale of development reflect that of the current plan period? One question of particular importance in considering the impact of transport proposals is whether future land-use plans are likely to be different as a result of the transport schemes themselves. The classic example of this was the way that land-use plans around High Wycombe changed (or evolved) as a result of the building of the M40 motorway, documented by Headicar and Bixby (1992)

HOW WE REPRESENT PLANNING POLICIES

Modelling development

The **development model** typically consists of

- an econometric model forecasting the total quantity of each type of floorspace that developers will seek to start building in each year
- a choice model distributing this to the zones where development of this type of floorspace is possible and permitted.

The development model usually involves a double set of time-lags – developers respond to the immediate past situation, and it takes time for their responses to come to fruition in the form of new floorspace available to occupiers.

The model of total development responds mainly to conventional economic signals such as rents, interest rates and (for some non-residential types) employment in relevant activities. In our own work the future rents and employment levels are forecast within the model itself, whilst interest rates are part of the macro-economic scenario and are inputs to the model

The development distribution model responds to

- the amount of permissible space (ie the inputs describing planning policy);
- immediate past rents (which are taken as indicating developers' expectations of future rents); and
- cost of development (input exogenously and typically varying according to the expected density of construction).

The process doesn't necessarily assume that all of the permissible floorspace is developed rather, as in the real world, the amount developed will reflect demand. Some sites will remain either wholly or partially undeveloped.

It is, of course, possible to treat plans or proposals for specific developments as exogenous and input them, into the model, as 'built' developments that are ready for occupation. This approach, which is more fully described below, is especially useful for appraising the impact of particular developments or for modelling developments such as schools or hospitals where decisions on whether or not to develop relate to public expenditure rather than market factors.

In recent applications of the DELTA model, development processes have also been modelled at two distinct geographical levels: the fully modelled area level reflecting the activity of regional or nationwide developers and where decisions on where to build and how much to build will be influenced by national economic signals and the more local 'area' level where development will be influenced by local factors.

Representing planning policy

It follows from the model design that the main input required to represent planning policy is the amount of each type of floorspace that may be built in each zone at any time. A number of points arise relating to the interpretation of the data that is received.

The phasing of data

Within DELTA, where the model calculates the demand for and the amount of development within each year of the forecast period, it has been our practice to assume that unless there is explicit phasing of a development (for example a site for 1000 dwellings will be built in four years, with fifty dwellings completed in the first year, four hundred in each of the second and third years and one hundred and fifty in the final), the development is built in equal amounts for each of the years between the likely start data and the latest completion date, rather than assuming it to be available for occupation in the first year. This reflects observed practice on major development sites where there will be maximum number of dwelling units built (and sold) in each year or an explicit phasing of the construction of a business park or similar.

Exogenous Developments

In addition it is common to represent development that is expected to take place within the next two to three years and other developments which are regarded as certain rather than merely possible as "exogenous development". These are then automatically added to the floorspace stock irrespective of the workings of the development model. These may be defined as additional to the permissible development inputs, or as using up some of those inputs. This approach reflects the fact that many sites, with planning permission are at an advanced stage of planning and that the decision to go ahead with the development has already been made (and is not subject to further reflection of the economic indicators described earlier).

One particular use of exogenous developments inputs rather than permissible development inputs is where model tests are being carried out to answer the question "what if these developments occur?" rather than "what if these developments are permitted?". This approach was taken, for example, in the use of the SITLUM DELTA model by the then Glasgow and Clyde Valley

Structure Plan team to test the impacts of the allocations contained within their Structure Plan modifications in 2008.

Expected Occupiers

Some developments may be being planned with a specific end-user in mind. eg a retirement complex for elderly persons or an industrial development for port-related activity. Within DELTA there is the option to apply an expected occupier function that will constrain the type(s) of activity that can occupy newly constructed development. This is clearly relevant in examples like that cited where the end users will have specific trip characteristics.

Representing development in terms of floorspace

DELTA measures the supply of housing (as well as the supplies of different forms of non-residential building) in terms of the stock of floorspace (in square metres) in each zone. This is obviously different from the standard unit of dwellings, used by local planning authorities. The reasons for measuring housing in this way need to be explained. In all the standard applications of the DELTA package, as in various other land-use modelling packages, the occupation of housing is represented in terms of a floorspace/household ratio which is modelled as a continuous variable which can take any value above a defined minimum. In addition, and again as in many other land-use and economic models, households are modelled as if they all lived in rented housing, rather than being explicitly modelled as owner-occupiers. The modelling of floorspace per household is such that as rents increase in a particular zone, households in that zone will occupy space at higher densities and hence there may be more households occupying the same quantity of residential floorspace ; although this may appear odd for zones where there is no change in the housing stock, it makes sense in terms of a sequence of changes where (typically) if the cost of housing is rising, most households will occupy slightly smaller dwellings than they would have chosen at the lower rents, and some of the larger dwellings will be occupied by households sharing or in multiple occupation. Other arrangements having the same effect as sharing may also come into play as a response to higher costs, such as households taking in lodgers. Variable floorspace per household implicitly allows for all of the different mechanisms by which a predefined number of households can fit themselves into an insufficient supply of floorspace.

In passing, it should be noticed that we have some experience of alternative approaches to measuring housing supply. We carried out a major modelling project for the UK Department of Transport, known as LASER 4.1, in which we implemented a modified version of DELTA which represented dwellings, with one household per dwelling, different types of dwelling (from flats to detached houses) and different tenures, with explicit representation of owner-occupation as distinct from renting. Modelling one household per dwelling removed the need to convert housing supply into floorspace units and avoided the sometimes-surprising result of a changing number of households in a fixed supply of housing, but required additional and complex mechanisms to be added to the model to represent sharing or other equivalent responses to housing shortage. These involved changing the household growth scenario, and meant that the number of households located appears not to equal the originally defined demographic scenario. There were also considerable

additional complications in terms of representing the supply of dwellings by type and tenure, in addition to identifying their number and location. We concluded that whilst dwelling-based modelling may in the long term be an appropriate way forward, it undoubtedly adds a set of complications which are conveniently avoided by the present rented-floorspace approach, as well as making the household location process itself much more complex to model.

For commercial floorspace, there is a large problem in creating the base database. Good quality and detailed commercial floorspace data is much harder to obtain at a fine geographic level. When combined with base year employment data, the resulting worker/floorspace densities can be extremely variable and sometimes implausible. The sources of difficulty lie in both data sets. The commercial floorspace data available from the Valuation Office Agency (ie based on property taxation records) classifies the floorspace into 4 major bulk types: retail, office, warehousing and industrial, but it does not sufficiently explain complex modern mixed land-uses. The employment database suffers from similar problems of definitions, and this is combined with the DELTA requirement that employment activity may only occupy one category of floorspace, and that the floorspace types are discrete and non-competing. There is no guarantee given the complexities in categorising both floorspace and employment as single broad types of land use, that we are modelling land use accurately, and the resulting densities only highlight the disconnect between the two sources.

Recent DELTA applications have typically had base years 8-10 years past the date of the last census, which provides many of the starting data inputs for DELTA. This means a large amount of the work in creating the base database is in taking the census year data and using observed data from the interim period, to create the base year database. Whilst the commercial floorspace data is updated annually and has proved useful in updating the space database files, employment data is harder to locate. For models with a ward/middle super output area level zone system or finer, finding recent employment by type at a fine level has proved difficult. Typically DELTA has used growth by broad sector at district level, and also total employment change at finer levels to synthesise the base data. Because of this, the match between employment and floorspace tends to degrade the further from the census year the base year is. A certain amount of data adjustment is therefore often required to ensure that the base year situation is reasonable; sometimes this is achieved by running the model from an earlier and better-known year, with constraints, so that the necessary reasonableness is imposed by the model itself.

The planning data supplied by local authorities, is typically as “land available“ often in hectares, and can be used by any of the major commercial use types. Because within DELTA, different employment activities, can only occupy one type of floorspace, and each type of floorspace is essentially a single non-competing property market, in converting the land available for development to floorspace, each floorspace type receives a fixed proportion of the total available, potentially limiting the amount of development of one of the other types of floorspace.

The conversion of land-available into quantities of permissible development is an aspect of the process which is certainly open to further improvement. One of the issues that needs to be considered is the likelihood that future policies will put more emphasis on developing upwards rather than outwards, with the possibility of significant physical intensification or redevelopment of sites over the forecast period. Given the long forecast periods we are often required to deal with for transport appraisal purposes, it is quite possible that some sites will be redeveloped more than once within the timescale we are considering. Redevelopment and intensification are considered further below.

Often local authorities provide planning policy inputs in terms of the total number of jobs expected to be created on the site, generally using standard jobs/m^2 or jobs/ha ratios. For modelling purposes, we generally need to convert these back into quantities of permissible floorspace, since the purpose of the modelling is generally to forecast whether these developments will take place at all, whether they will be occupied, and if so at what densities.

In some areas where there are considerable demands on the planning system, such as Greater London, there has been a lot of extremely detailed and useful data provided for DELTA, because of the systems in place needed to monitor and plan development there. There is obviously a need for higher level macro-management of the planning system in a city the size of London in order to coordinate all aspects of it. DELTA has benefitted from this, having access to site development data with floorspace and employment estimates, both historically and future estimates, providing very accurate estimates of development by floorspace type.

Representing redevelopment and intensification

Reference was made to those policies that are sequential or reactive. In recent versions of data we have modelled the process of redevelopment and intensification.

The redevelopment process starts by identifying a site which becomes underused or vacant. Depending on demand, developers or the landowner propose alternative uses for the site and subject to planning consent (and consistency with planning policies) the site is re-developed for an alternative use. An example would be the redevelopment of vacant industrial or office plots for housing, as witnessed within many city centres.

Redevelopment is represented by setting a minimum threshold occupancy ratio. Where the occupancy level falls below the specified level, the floorspace may be redeveloped into a different floorspace type in accordance with the planning policy limitations.

Intensification is the process by which demand for a particular land use type increases within an area and rents rise. Developers or landowners may respond to this by seeking to intensify the use that is made of sites. For example, a six storey office block in a city centre location may be demolished and replaced with a twelve storey office block.

Intensification is represented by setting an upper threshold for occupancy level. Where the occupancy level rises above the threshold rate, the floorspace is intensified for the same land use type by providing additional floorspace to meet demand.

Redevelopment therefore require three conditions to be met: that the model forecasts relatively low demand for the use from which floorspace may be redeveloped; that it forecasts relatively high demand for the use to which it will redeveloped; and that the planning policy inputs permit that particular change to occur. Intensification requires only a forecast high demand for the one type of floorspace in question and that the planning policy should allow greater quantities of that type of floorspace to be developed in that zone.

The modelling of intensification and redevelopment may be one way of addressing the modelling of land use plans in the longer term, beyond the current horizon of local planning authorities. Development will be brought forward in areas of high demand where it is likely to be acceptable, but will continue to be prevented in areas where environmental or other concerns are expected to persist.

Representing health and education-related developments

There are often gaps in the level of detail on future health and education-related development. There may be comprehensive information for the short term, drawn from health and education authority capital programmes, in the longer term there may be some information associated with major developments (for example a new school or medical centre may be planned as part of a strategic residential area). However there may be a lack of information on the longer term development associated with the needs of the authority's population. One way of overcoming this problem, may be by looking at the key drivers of demand for health or education namely the resident population and the way the population of key sectors of the population (school-age children, the elderly etc) change over time.

Representing public realm and quality effects

A further process that has been modelled in some recent applications of the DELTA land use model has been the process of regeneration through public sector investment in improving the quality of the public realm.

In recent years there has been considerable investment within the urban fabric of many UK towns and cities, this has ranged from relatively small investment in environment improvement to major schemes for the regeneration of large areas. Examples of the latter category are the developments around the London Olympics sites, the investment within the east end of Glasgow associated with the 2014 Commonwealth Games, and Manchester City Council's plans for Manchester Eastlands. In all these examples public sector investment is intended to make the area markedly more attractive as a place to live or to work or for leisure related activities.

Within DELTA we have identified a number of processes, that are associated with regeneration and public sector investment, that can be modelled in order to show the impact(s) of improvements to public realm. These are:

- impacts of urban quality on the preferences of customers and clients;
- impacts of urban quality on the preferences of employees ie their willingness to work in one location rather than another; and

- impacts of urban quality directly upon the preferences of business managers.

The use of quality variables has been illustrated in a number of applications - see for example Whitehead et al (2006).

Representing long-term policies

The earlier discussion identified the gaps in long-term planning data and the uncertainty that surrounds the approach that may be taken in future policy formulation; will it be a continuation of past policy or a departure in response to as yet unforeseen circumstances? Typical current practice is that members of the modelling team have to estimate inputs, primarily in terms of permissible development, which can be taken as representing likely future policies – sometimes, where the use of TEMPRO-based scenarios is important, by working backwards from TEMPRO projections to a compatible set of planning policy inputs. An example is shown in the figure below. In graph a) we show the retail planning inputs received from five local planning authorities, in graph b) we have calculated the additional floorspace that would be required within each district and within each time period if the increase in floorspace were to be consistent with the growth in retail-related employment contained within the economic scenario (in this instance TEMPRO). Finally in graph c) we show the additional planning inputs that would be required over and above the amounts shown in graph a) in order to provide for the quantities within the scenario.

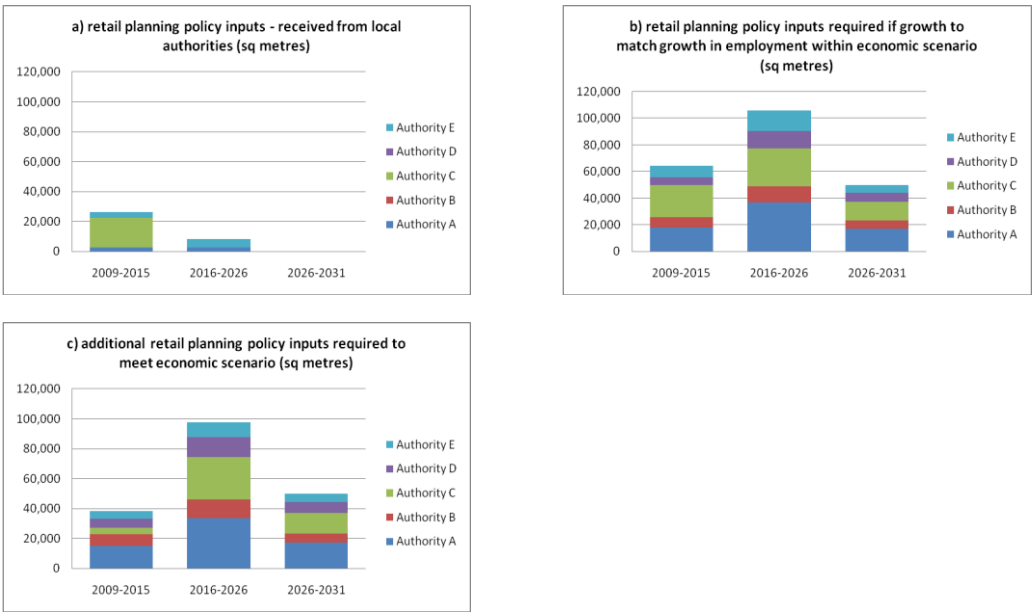

Figure 2 Comparison of planning inputs received from local planning authorities and the growth of the economic scenario (real data, m^2, anonymized)

It is preferable that such inputs should be produced by the local authorities concerned, but they are sometimes reluctant to do so – partly for reasons of not wishing to appear to prejudge future policy-making and planning application decisions, partly for practical reasons of workload and priorities.

Sometimes the problems of making assumptions about future policies can be avoided by running the models repeatedly with a range of alternative policy inputs, which should at least provide an appreciation of the sensitivity of the critical model outputs to different land-use policy options.

A further possibility, for future discussion, is whether it is both possible and desirable to construct a 'model' of the policy process that forecast change in the underlying trends and the responses that policy planners might make? Such a model might take a single value as "policy" for each zone – on a scale from "no change" to "maximum change" – and "forecast" how much development of each type might be permitted in each zone, given that policy variable and the data contained within the LUTI model about demand, prices, availability of land, accessibilities, network congestion and so on. It should be noted that models have been estimated to forecast the flow of planning permissions (see for example Bramley et al, 1995, chapter 7) and that such a representation of planning policy is not far removed from the approach to housing land policy advocated by the Barker Review (where the proposed controlling variable was housing affordability), though both the models of planning permission and the proposed rules for housing land related to a district or higher level rather than to individual zones within districts. This kind of idea to representing future, long-term policy-making has been the subject of heated debate in the planning/modelling community, with some specialists considering it a reasonable way to deal systematically with the necessary uncertainties of planning and others regarding it as anathema that "policy inputs" should be the subject of any kind of modelling at all.

CONCLUSIONS

Within this paper we have considered many of the issues associated with the use of local authority planning information and their appropriateness, as an input to transport models. The paper has drawn upon our experience of using this source within a number of different land-use and land–use/transport interaction models.

Planning policies exert a powerful influence on the distribution of land-uses, and it is critical that these should be taken into account in transport planning, or better still integrated with transport planning. However, central to the discussion has been the incompatibility of a land use planning system that, whilst planning for the future development of an authority area or region doesn't necessarily quantify policy and future levels of development, with the requirements of transport planning where representing (and quantifying) policy is a requirement of the current approach to appraisal and where testing alternative planning policies is necessary to an 'evidence-based' approach.

In the short to medium term the planning policy inputs may exclude many windfall and opportunistic development proposals. Each site, when taken on its own, may have little impact upon the transport networks. However the cumulative impact, especially upon particular areas or corridors may be significant.

In the longer term and especially beyond the end of the plan period there is increased uncertainty both to the scale and distribution of development. A

flexible approach is required that consider a range of possible options for development.

Within the paper we have considered a number of improvements to the representation of planning in modelling. These fall into two broad categories, those that improve the interpretation of particular development proposals, for example the concept of expected occupiers and those that broaden the modelling of planning policy input to include the modelling of complimentary processes for example the redevelopment of land and the modelling of windfalls or the modelling of policy. Wider use of these methods, and other potential enhancements that have been mentioned in passing, will help to improve the representation of policy in modelling, and hence help to improve the assessment and appraisal of transport and land-use plans.

REFERENCES

Atkins, David Simmonds Consultancy, Katalysis and Roger Tym & Partners (2008): *Reducing the need for travel by improving land use predictions informing transport planning.* Report prepared for the UK Department for Transport.

Bramley, G, W Bartlett and C Lambert (1995): *Planning, the market and private housebuilding.* UCL Press, London.

Bramley, B, D C Simmonds and A C Dobson (2008): *Using Land Use Transport Interaction (LUTI) Models to Assess the Sustainability of Strategic Planning and Infrastructure Proposals: the potential scope and illustrative applications.* Paper presented to the 7th International Workshop on Evaluation in Planning: Towards methodological innovation in planning evaluation, Edinburgh, 10-12 December 2008. (Book version of proceedings in preparation.)

Dobson, A C, E C Richmond, D C Simmonds, I Palmer and N Benbow (2009): *Design and use of the new Greater Manchester Land-Use/Transport Interaction Model (GMSPM2)*. Paper presented to the European Transport Conference, Netherlands, October. In Proceedings (on CD) and available on European Transport Conference website.

Headicar, P and B Bixby (1992): *Concrete and Tyres: Local Development Effects of Major Roads: M40 Case Study*. CPRE, London.

Whitehead, T B, D C Simmonds and J Preston (2006): The effect of urban quality improvements on economic activity, *Journal of Environmental Management,* vol 80, pp1-12.

