The Role of the Transport Model for Scotland and the National Land use and Economic Model for appraising local policy

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Abstract: Local Authorities in Scotland are charged with delivering a range of policies and strategies relating to the future direction of development within their area. These include land use planning, transport plans, strategies for regeneration, economic development and carbon reduction. The process of developing policy across these various areas is broadly similar, involving identifying issues, looking at options, identifying a preferred option, and ideally testing the robustness of that option.

Key to the development of policy is the need to understand the likely outcomes of different policy interventions. For example: what will be the local economic impact of improved transport links, or how will the level of carbon emissions differ if we pursue a policy of concentration of development rather than allowing dispersal.

Transport Scotland has over a number of years developed a suite of models centred on the Transport Model for Scotland (TMfS) and the land use /economic forecasting model TELMoS, which form a national land-use/transport interaction (LUTI) model. These were presented to CUPUM 2009 by Bosredon et al. In the present paper we explore how TELMoS and TMfS can support the plan and strategy making process. The paper starts with an overview of the model system describing the main processes modelled and the range of outputs that are available for future years. It then shows how these can support different stages of the plan-making process, looking in particular at examples where the model(s) have been used to appraise different options,. Finally we draw on applications of similar models from other parts of the UK to consider how they can support the process of appraisal during the choice of preferred options and in the formal processes (public hearings, parliamentary committees, etc).

Keywords: land-use/transport interaction modelling, policy analysis, appraisal

1. INTRODUCTION

This paper describes how the land use model TELMoS, in conjunction with the transport models TMfS, can support the plan and strategy making process. It firstly provides an overview of the land use model including the main processes modelled and the range of outputs that are available for future years. It then shows how these can support different stages of the plan-making process, looking in particular at examples where the model(s) have been used to appraise different options, Finally it considers applications of similar models from other parts of the UK to consider how they can support the process of appraisal during the choice of preferred options and in the formal processes (public hearings, parliamentary committees, etc).

2. DELTA AND TELMOS – AN OVERVIEW

2.1 The DELTA package

General - The development of DELTA started in 1995 in response to a perceived demand for a new "land-use" modelling package with two key characteristics: to complement free-standing transport models (see Roberts and Simmonds, 1997); and to leverage the wide range of research related to change processes in urban and regional economics, geography, demography, sociology, etc. Since its first application, in conjunction with the transport model of Edinburgh, in 1996, the model has been used in a number of applications to regions of Great Britain.
DELTA models are based on four components (see **Error! Reference source not found.**). The **transport and urban models** work at the level of zones, whilst the **migration and economic models** work at the broader level of areas. Areas typically correspond to travel-to-work areas, at least within the region of main interest; zones represent finer units within these areas (or within the area of concern).

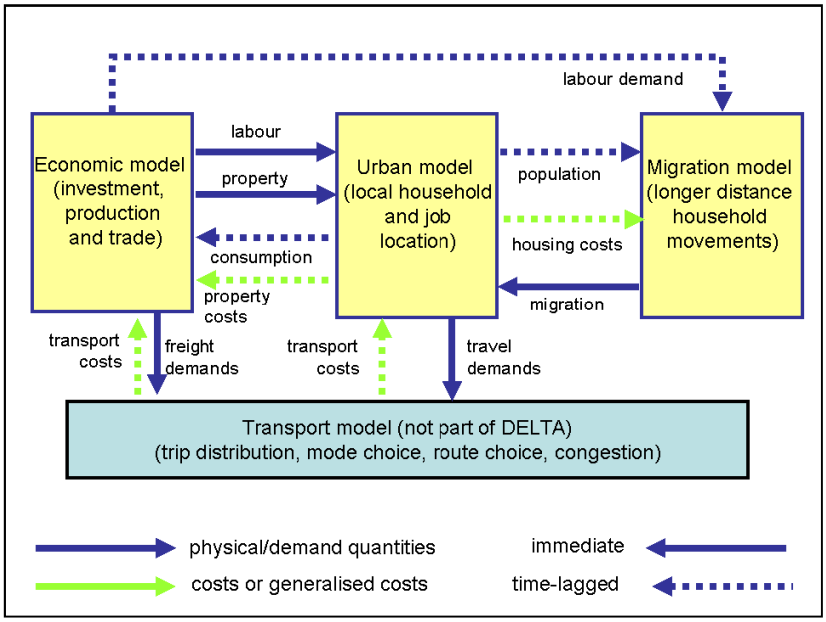

Figure 1 Overall structure of a DELTA-based model

Calibration - The approach to calibration of DELTA has been that on the one hand it is unrealistic to expect to be able to estimate the required change from local data for each application of the package, whilst on the other hand it is positively desirable that the model responses should be informed by a wider range of circumstances than are likely to be observed in one area at one time, and in particular that they should draw upon the wide range of research into urban and regional change that is carried on in academic and other institutions. The intention and expectation has therefore always been that model coefficients would be based largely on a range of previous findings and experience, and relatively little on formal statistical calibration carried out specifically for one model application. The coefficients used in TELMoS reflect this approach. Some, such as the initial input-output parameters, are taken directly from survey data; others (such as the demographic transition rates) are based on survey data adjusted to reproduce the overall demographic scenario for Scotland.

2.2 The Transport/Economic/Land-use Model of Scotland (TELMoS)

TELMoS, the Transport/Economic/Land use Model of Scotland, is an integrated land use and transport model combining the DELTA package and the Transport Model for Scotland (TMfS). It interacts in the following manner:

the land use model provides information to the transport model on the patterns of residential, retail, commercial, industrial and other activities. This information is used to generate the origins and destinations of the various trips that are modelled within the transport model (ie journeys-to-work, journeys to shop, school etc); and in return

the transport model provides information on the accessibility of different areas. This information is used, along with information on rents, floorspace, quality etc, by the land-use package when modelling the location (and relocation) of economic activity, employment and residents across the modelled area.

A key application of the model is to look at change in transport patterns over time. To do this effectively it takes account of factors that will influence future demand for travel. These include:

future development patterns; if new residential or commercial developments are built then the associated trips will impact upon the transport network; perhaps causing increased congestion in one area and/or easing congestion in other areas; and

changes in activity without changes in development. The model represents the continuing turnover of households and jobs in the 'second-hand' property markets, as well as forecasting the take-up of new property. The intensity of use of the stock may change. For example, the opening of a new road or public transport route may increase the attractiveness of an established residential area for commuters to a neighbouring employment centre with the effect that, over the course of time, the area will attract in-migrants.

2.3 Model scope

Error! Reference source not found. provides an overview of the model, highlighting the key inputs, in terms of base year data, scenarios and planning policy inputs and the land use model's interaction with the transport model.

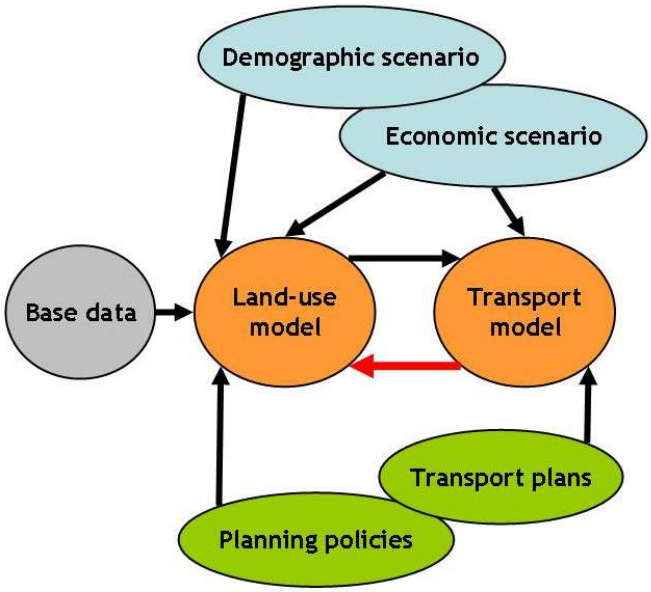

Figure 2 The key inputs to the Land Use and Transport Model

The model starts at a base year and then forecasts through time in single-year steps, taking the output from one year as the inputs to the next. For each year, the model calculates the changes in floorspace by land use type (ie residential, retail, office and industrial), as well as the changes in the activities that use that floorspace. This calculation generates information on the change year-by-year for each zone.

The main inputs to the model are:

Base year data: the initial base year was set to 2001 and the forecast period runs to 2032. This choice of base year allows the 2001 Census Small Area Statistics to be used to inform on the number and characteristics of the population, households, employment and car ownership levels within each zone. Subsequently a base of 2007 was introduced;

Demographic and economic scenarios: these are taken as given at the Scotland-total level, but are reproduced by modelling processes of demographic and economic change (as distinct from simply inputting control totals for each year). The demographic scenario has been constrained to reflect:

- General Registrar Office Scotland (GROS) mid-year population estimates for the period 2001-2006 at the national level;
- GROS household estimates for the period 2001-2006 at local authority level; and
- GROS 2006-based population projections for the period 2006-2022.

The economic scenario has been based upon work done by consultants Tribal for Transport Scotland's Strategic Transport Projects Review, which in turn used national projections from Oxford Economics; and

Planning policy inputs: both the amount of available land for development and distribution of that development are derived from the information provided by local planning authorities.

The model can be seen as a means of allocating given rates of change for Scotland down to area and zonal levels, taking account of numerous factors and interactions including the supply of built environments and the planning policies affecting changes in these. In forecasting, only the top-level scenarios and the zonal planning policy inputs are strictly fixed by the model user; everything in between is to some extent variable over time and in response to other variables within the model. Some additional factors are adjusted so as to match, for example, particular regional trends, but these are done so as to influence rather than to control the results of the model.

The distributions of households and economic activity are also influenced, as mentioned before, by the performance of the transport system, taking account of infrastructure, public transport services and congestion. Transport infrastructure and public transport services are inputs specified by the model users; the location and level of congestion is generated as a result of the interactions between economic activities and the travel of household members, given the available infrastructure and services.

2.4 Planning policy inputs

As part of the original development of TELMoS, DSC undertook a round of consultation with Local Planning Authorities in 2004 in order to collect information on future levels and distribution of development within their area. This relied heavily upon development plan land allocations and their databases of outstanding planning permissions.

Further consultations took place in 2006, late 2007/early 2008 and 2009. This regular updating ensures that the model's development inputs reflected the latest plans and commitments.

3. REFERENCE CASE

David Simmonds Consultancy and MVA Consultancy were commissioned in late 2009 by Transport Scotland to deliver a new TELMoS/TMfS Reference Case. This is a full LUTI model with the land use and economic model running in every year over the period 2007-2032 and the transport model being run in 2007, 2012, 2017, 2022, 2027 and 2032. This Reference Case is referred to as Test 'NK'.

The following sections describe the model's forecasts of population, households and

employment to 2032.

3.1 The population and household forecasts

The total population and the change in households by type are constrained to ensure consistency with the household estimate data published by GROS.

Over the period to 2032 the population, at national level is forecast to increase by 5.7%. At the same time the number of households is forecast to grow by 20.9%. Table 2 shows the change in composition of households, with more single person households and fewer two adult households with children.

The following table shows the household composition in 2006 and 2031 for both TELMoS and GROS. (Please note this comparison is for the years for which data is published by GROS rather than TELMoS' base year and end year).

Table 1 Household Composition 2006 and 2031

Household Type	*TELMoS 2006*	*TELMoS 2031*
One person hhlds	*36%*	*43%*
Two adult no children	*30%*	*32%*
One adult plus children	*7%*	*8%*
Two plus adults plus children	*19%*	*11%*
Three plus adult	*8%*	*5%*
Total	***100%***	***100%***

Maps 1 and 2 show the change in population and households over the forecast period at zone level.

Map 1 Population changes

TELMoS_07
Test NK - Reference Case
10 December 2009 - MB

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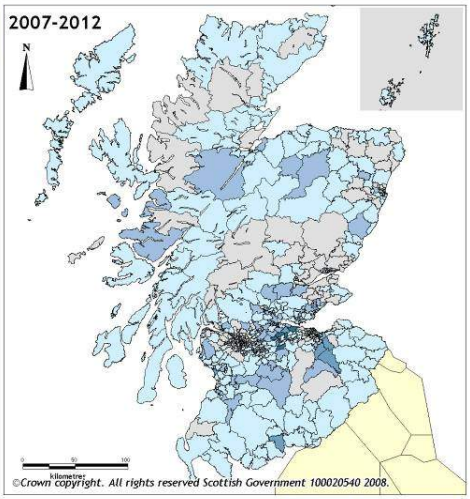
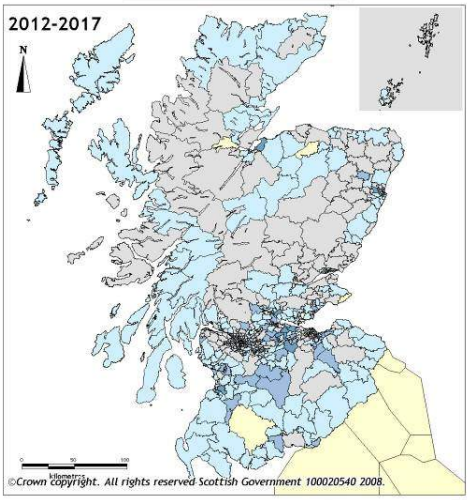
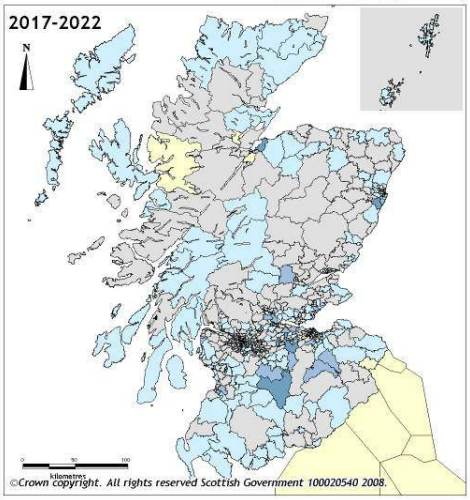
Population changes
in percentage

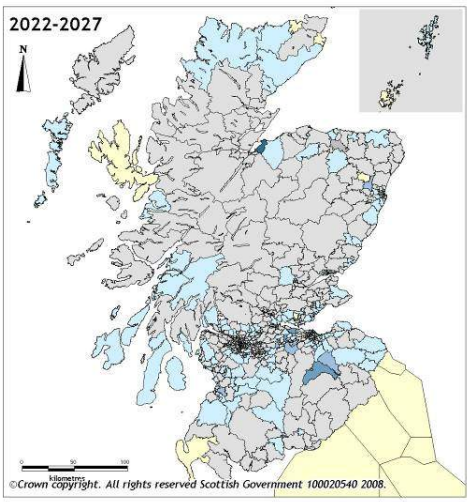
Population changes
in percentage - Test NK

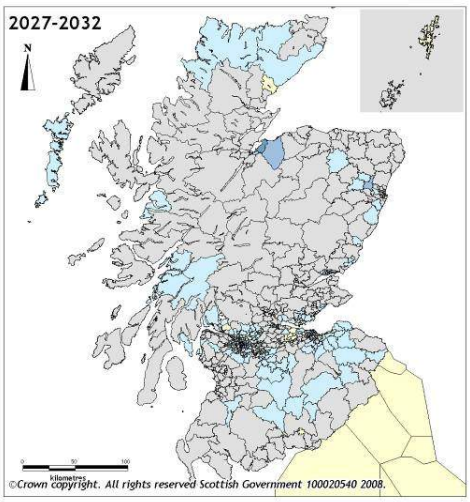
- More than 100
- 50 to 100
- 25 to 50
- 10 to 25
- 0.1 to 10
- -0.1 to 0.1
- -10 to -0.1
- -20 to -10
- Less than -20



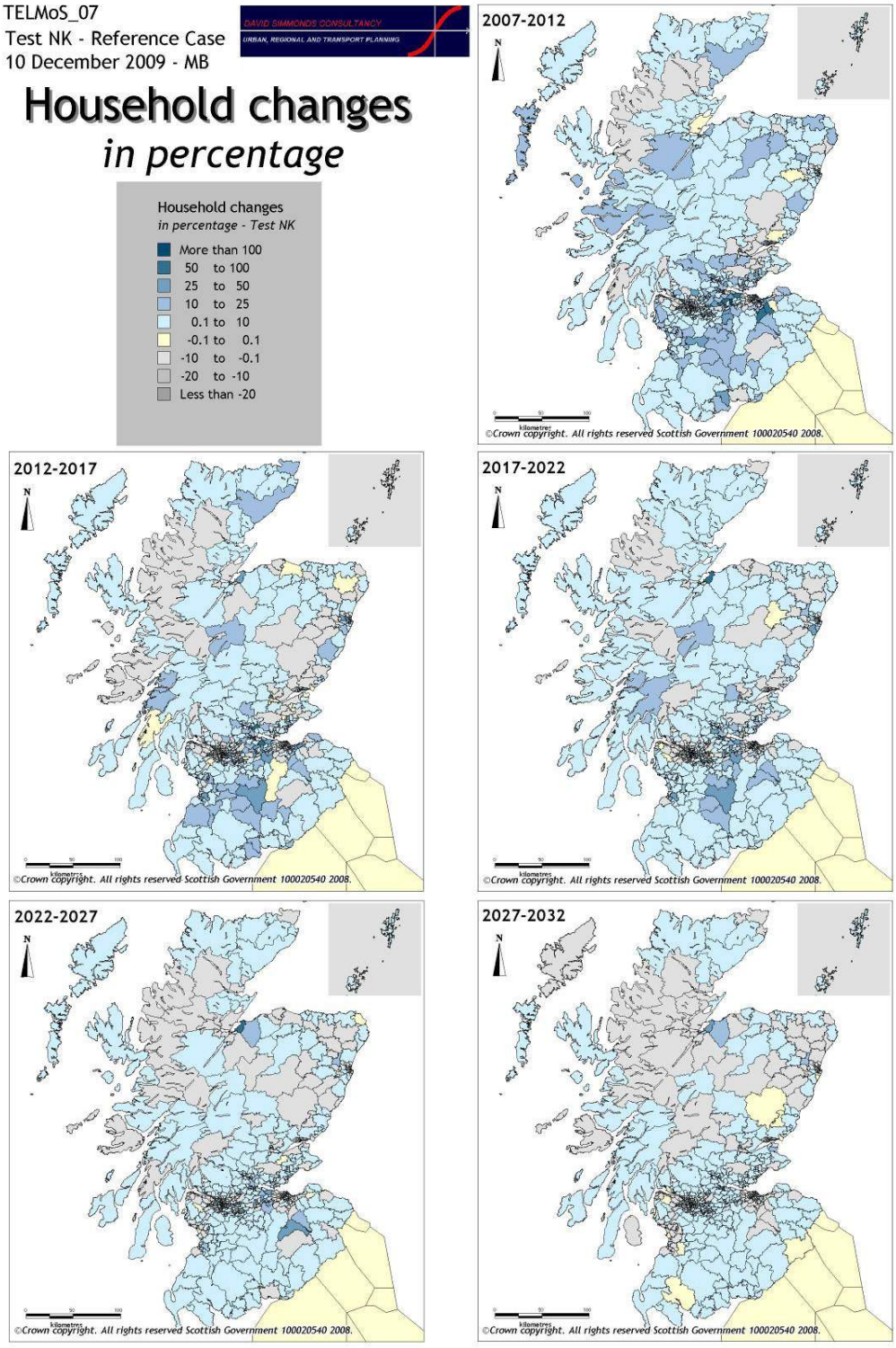








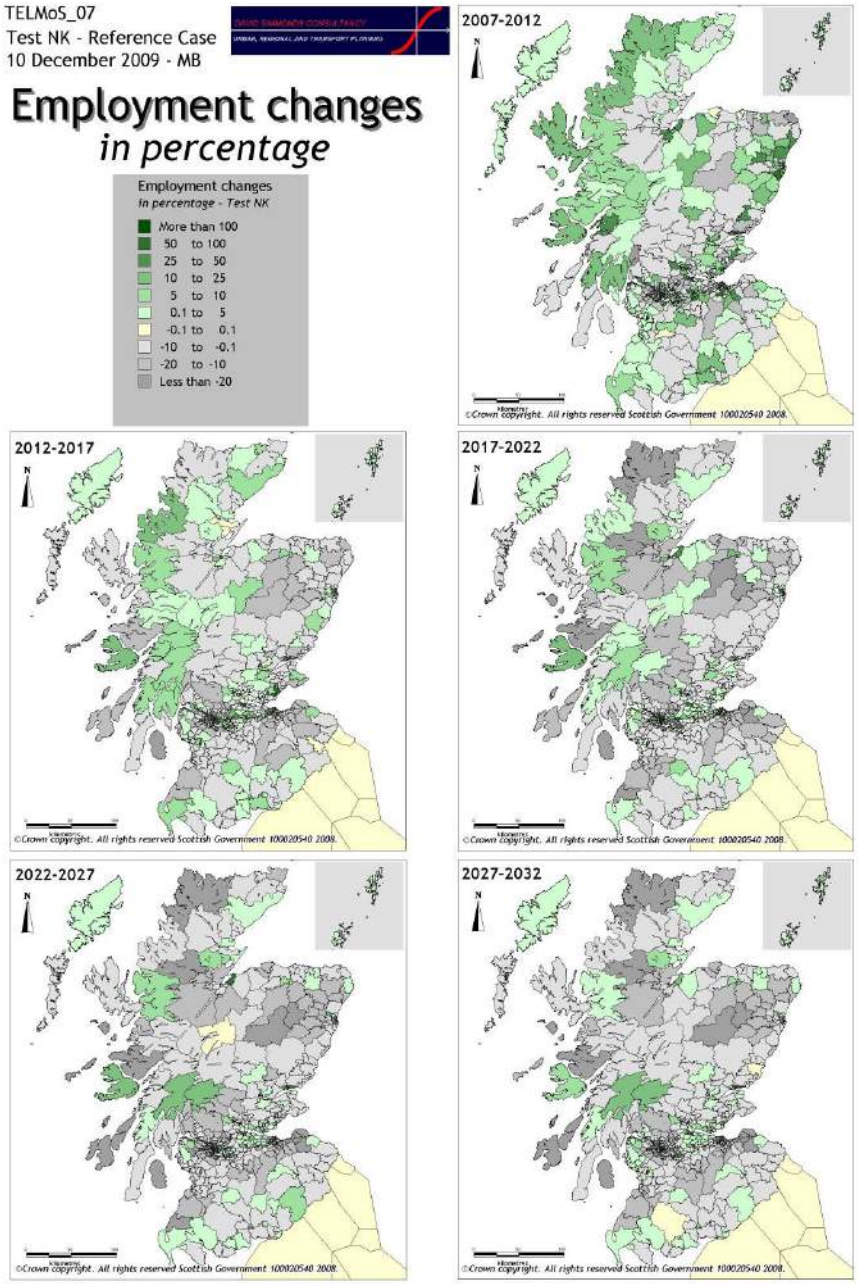
Map 2 Household change



3.2 The employment forecasts

Over the period to 2032 the number of people in employment, at national level is forecast to increase by 4.2%. Map 3 shows the percentage growth at zone level.

Map 3 Employment changes in percentage



4. THE PLANNING PROCESS

Planning guides the future development and use of land. It is concerned with where development should take place, where it should not and how new development interacts with its surroundings.

Within Scotland a new framework for planning was introduced in the 'Planning Etc (Scotland) Act 2006'. This required that there should be a plan-led system with development plans setting out the long-term visions for their areas. The guidance also emphasized that these plans should have 'a clear focus on the quality of outcomes'.

The primary responsibility for the operation of the planning system rests with the 32 local and 2 national park authorities. These authorities are required to prepare local development plans. In addition, in the four largest City Regions (covering Glasgow, Edinburgh, Aberdeen and Dundee and their surrounds) strategic development plans are required; these address both cross local-authority boundary issues and matters related to strategic infrastructure. The plans set out development over a twenty year time period.

The process of plan preparation differs between the City Regions and the rest of the Country. The key stages of the process can be described as follows:

a) Preparation of a Vision Statement. This should comprise a statement of how the development of an area could and should occur and the matters that might be expected to affect that development. The guidance identifies a number of factors that should be taken into account including:
    a. The physical economic and social characteristics of the area
    b. The principal land uses of the area
    c. The size, composition and distribution of the population
    d. The infrastructure of the area
    e. Any anticipated changes in these matters
b) Development of a Spatial Strategy. This should look ahead over a twenty year period, providing details of proposed development in the short to medium term and a broad indication of the scale and growth in the longer period. The precise requirement differs between the City Regions and the rest of Scotland. In the former the Strategic Development Plan's spatial strategy is required to provide a locational strategy for the first twelve years of the plan period and then identify areas of growth for the remainder of the twenty year plan period. This will be complemented by Local Development Plans containing the main proposals for the ten years following plan adoption. In the rest of Scotland the Local Development Plan contains both details of development in the ten years following plan adoption and a statement of the scale and location of growth for the rest of the twenty year plan period.

In preparing both Strategic Development Plans and Local Development Plans authorities are required to produce a Main Issues Report. This sets out the general proposals for development. It should contain one or more 'reasonable alternative sets of proposals'.

The Main Issues Report is the subject of consultation with local residents, businesses, service providers etc. A process is prescribed for the plans amendment and modification, examination in public, revision and ultimately adoption by the planning authority.

Following adoption Authorities are required to keep their plans under review and to replace on a regular basis.

5. AREAS WHERE TELMOS AND LAND USE MODELLING CAN ASSIST IN THE PREPARATION AND MONITORING OF STRATEGIC AND LOCAL DEVELOPMENT PLANS

The development and design of TELMoS was described in Section 2. In this section we consider how it can support the preparation of Strategic and Local Development Plans, considering each stage of the plan preparation process separately.

Preparation of the Vision Statement: the TELMoS reference case provides key information on the scale and distribution of development both across Scotland and within local and strategic planning areas. This provides an insight into the likely outcomes associated with existing development and transport plans in terms of the changes over the plan period, in population, household composition, employment, car ownership levels and the pattern of urban land uses. The fact that the model is a nationwide model also allows strategic planning authorities to consider the interactions between their City Region and surrounding areas.

In reviewing or revising a vision statement the model can be used to explore the likely impacts of different options for development and/or different assumptions on overall demographic and economic growth.

Development of a Spatial Strategy: TELMoS is a powerful 'what-if' tool for better understanding the outcomes associated with different spatial options. Typical applications would include:

- Examining the impact of different spatial options for example a residential policy that concentrates new development in a specific location as opposed to a policy of dispersed development across an authority's area;
- Examining the impact of introducing a new transport scheme, for example a ring road around a major settlement or a new rapid transport scheme that improved levels of public transport along a transport corridor
- Applying sensitivity tests to explore the robustness of different spatial options against higher or lower levels of economic growth.

TELMos could assess these and other spatial options in terms of:

- The impact upon the distribution of population and households both across an area and in total
- The impact upon the composition of households within different poarts of the plan area
- The impact upon the economy of an area in terms of levels of employment and industrial mix.
- The take up of development associated
- The impact upon rents in different parts of the plan area
- The impact upon specific policy areas for example regeneration areas, or areas

identified as having particularly high levels of deprivation.

And with the transport model:

- The impact upon the transport networks in terms of levels of congestion
- The transport derived carbon emissions associated with different spatial options.
- The impact, in terms of traffic flows and emissions upon specific areas, for example areas with an environmental designation.

All of this information can inform the selection of a preferred option.

Monitoring and Evaluation: much of local authority monitoring is ex-post, focusing on what has taken place. Monitoring Reports are produced that describe the levels of development that have taken place (for example in the past twelve months) or the change in population reported in published statistics.

TELMoS allows the planning authority to explore what the future implications are of this ex post activity. For example to adjust the reference case model inputs to reflect observed data on population change and completed development and then to consider the impact of those changes over the remainder of the plan period. This approach allows the planning authority to answer questions such as:

- Is the plan on track to deliver the Vision statement's outcomes
- What is the impact of any departures to the plan – for example the granting of planning permission for development that had not been factored into the original strategy
- Are external factors, such as the level of growth of the national economy impacting upon the local area in ways that represent a departure from the Vision Statement's outcomes

6. USE OF TELMOS TO SUPPORT THE PLANNING PROCESS

6.1 Overview

In this section we describe examples where TELMoS has been used to appraise the impact of changes to land use upon the transport network and secondly the impact of changes to the transport network upon land use. Three examples are described. These are:

- The testing of land use options to the west of Edinburgh;
- The appraisal of transport impacts of the land use allocations within the South Lanarkshire Local Plan;
- The economic impacts of improving connectivity between Ayrshire and the Glasgow Conurbation

6.2 Land use options to the west of Edinburgh

This exercise was part of the West Edinburgh Planning Framework review and was

commissioned by the Scottish Executive. It followed the recent development of a major international headquarters on the western outskirts of Edinburgh and was intended to:

- examine the major land use change that had or was expected to take place to the West of Edinburgh;
- assess the likely transport growth that would be associated with these developments; and
- consider the impact upon levels of congestion and traffic levels, of a range of complementary transport interventions.

Several scenarios were tested. These considered different transport and land use packages including the Edinburgh Tram, the Edinburgh Airport Rail Link and several different road schemes and the development of additional strategic HQs. The combination of transport options and land use options enabled the client to gain a detailed understanding of the likely impacts of different packages of development both in terms of transport and planning (see Fig 3).

Analysis of the results was undertaken for several geographical areas. In addition to looking at the West Edinburgh area, attention was also given to the impacts across the whole of Edinburgh. These were reported in terms of both transport congestion and changes in transport-related emissions.

6.3 Local Plan Housing Allocations in South Lanarkshire

In this example the model was used to assess the transport impact of the South Lanarkshire Local Plan housing allocations. South Lanarkshire lies to the south east of the Glasgow and Clyde Valley Conurbation.

In running the model for this application, new information was incorporated on the levels of residential development that were planned for within South Lanarkshire**.** No alterations were made to the planning data that related to the other modelled land uses (retail, office, industrial, leisure, health and education). As such the model application was only testing one ‘strand’ of the local plan strategy.

All future proposals for residential development, were treated as ‘exogenous development’. Hence there was an assumption that the developments would be built. Normally development proposals, for future years, are treated as ‘permissible development’; whether they come forward for development or not are influenced by the model’s calculations of market demand.

Two different sets of planning policy input were tested within this application. These were :

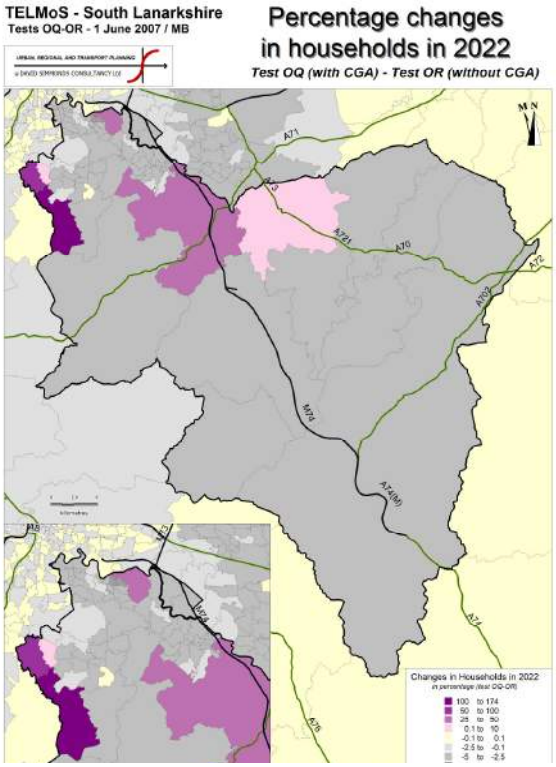
- The Local Plan provision of 16,232 dwellings
- The Local Plan and the Community Growth Areas (CGAs) provision of 24,732 dwellings.

A comparison of the testruns with and without the community growth areas (CGAs)

shows that the inclusion of the CGAs results in an additional 5% of residential floorspace in South Lanarkshire. The population of South Lanarkshire decreased by 5,496 (-1.9%) during the period 2005-2022 in the test including the CGAs and by 13,159 or -4.5% in the other one (excluding the CGA). See Map 4.

Despite this decline, there is a forecasted increase in households. In the test including the CGAs there are an additional 8,400 households (6.2% increase). In the other test (excluding the CGA) there are only an additional 4,258 households (3.2%).

The impact of these demographic changes were fed through to the transport model to gauge the impact upon the transport networks of both traffic flows and transport related emissions.



Map 4 South Lanarkshire % change in households

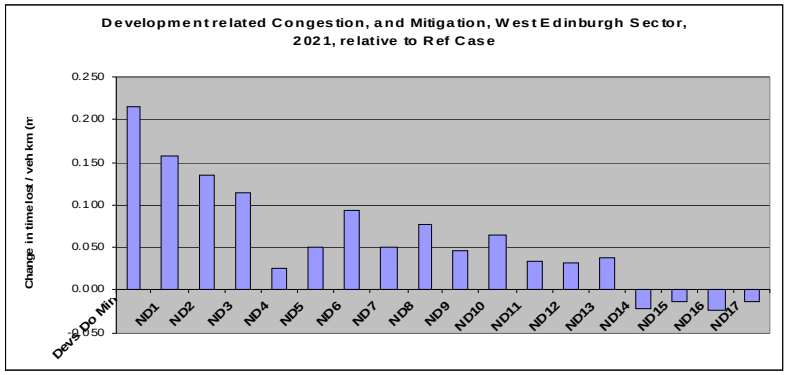


Figure 3 Impact on West Edinburgh of different land use options

6.4 The economic impacts of improved accessibility between Ayrshire and the Glasgow and Clyde Valley conurbation

In this test TELMoS was used to test the effect of changes to accessibility. Adjustments were made to TELMoS to represent the impact of introducing improvements to road transport on the main route between Ayrshire and the Glasgow and Clyde Valley Conurbation. This was represented as a 15 minute reduction in journey times along the A737 transport corridor. (NB These changes are approximations since they have been

applied directly into DELTA. The results are not as detailed as if the transport model was used).

The model runs suggested that there would be substantial increases within North Ayrshire in terms of population, employment and gross value added (GVA). The resident population grows by 1.4% (compared to the reference case), workplace employment by 10% and GVA by 11.9%. South Ayrshire also benefited from this improvement with increases of 2% for the population, 5.9% for the number of jobs and 5.4% for GVA.

There are decreases in employment within Glasgow, Lanarkshire and East Ayrshire. Glasgow and Lanarkshire also have a small decrease in population. However, East Ayrshire (where the employment declines) gains residents (0.4%).

	jobs		**population**		**GVA**	
	absolute values	*percentage*	*absolute values*	*percentage*	*absolute values*	*percentage*
North Ayrshire	4296	**10.0%**	1794	**1.4%**	149	**11.9**
East Ayrshire	-664	**-1.7%**	486	**0.4%**	-44	**-3.6**
South Ayrshire	2726	**5.9%**	2156	**2.0%**	65	**5.4**
Glasgow	-581	**-0.1%**	-257	**0.0%**	3	**0.0**
Lanarkshire	-469	**-0.2%**	-2431	**-0.4%**	-11	**-0.1**
Ayrshire total	**6358**	**4.9%**	**4436**	**1.2%**	170	**4.6**

This application allowed the local authority to gauge the likely impacts of different types of transport intervention.

7. OTHER APPLICATIONS

There are other examples of DELTA applications elsewhere within the UK (and beyond).

Several applications have incorporated a variable economic scenario. With this approach, when the model's calculation of accessibility within a modeled area shows a relative improvement (to a base or reference test) then this is reflected in an improvement in the economy of that area. The converse is also true that congestion deteriorates and the overall measure of accessibility declines then this will have a negative impact upon the economy. This approach was first applied in South Essex Thames Gateway area. This is an area that lies 20-30 miles to the east of the City of London and falls within Greater London's sphere of economic influence. The variable economic scenario was used to assess how the economy of the area might be affected by transport infrastructure investment.

The same approach has been used in a land use model of Leicester and Leicestershire. This area is located in the East Midlands Region and on the main strategic transport links between London, the Midlands and the North of England. The variable economic

scenario has been applied in this instance to inform on how the economy of the area may be affected by changing accessibility to these other areas.

In Greater Manchester a DELTA land use model has been used to appraise the combined impact of ten Local Development Frameworks (Local Plans) in terms of their impact upon the strategic network and transport related emissions. This conurbation-wide approach looks at the cumulative impact of local development plans and enables local planning authorities to view their plan (and its outcomes) within the context of what is planned for neighbouring areas.

8. CONCLUSION

In considering the future development of both urban and rural areas there is a need to understand the likely outcomes associated with different packages of interventions – both land use and transport. Within Scotland, the investment in a nationwide land use model, has provided a powerful tool to support this process.

Within the prescribed planning process there are a number of stages where the land use model can be used to explore alternatives and to appraise impacts. The examples that we have referred to provide a flavour of how the model may be used to support local, as well as national decisionmaking.

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