

Land-Use & Transport Integration in Scotland (LATIS)

TELMoS Model Demonstration Report

Draft Report for Transport Scotland

In association With David Simmonds Consultancy

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In August 2006 Transport Scotland commissioned MVA Consultancy and David Simmonds Consultancy to a Term Commission for the maintenance and enhancement of the Transport Model for Scotland (TMfS) and Transport Economic & Land-Use Model of Scotland (TELMoS).

A central element of the Commission was to develop and deliver an enhanced 2007-based land-use and transport modelling system. MVA proposed a hierarchical modelling framework, with a single National Strategic Travel demand and Land Use Modelling framework as the upper tier, Regional Travel Demand Models as the mid-tier and detailed local models (eg microsimulation) as the lower tier. The National Modelling Framework has now been developed. It incorporates a number of technical enhancements and new and more robust data and will, in time, replace its predecessor TMfS/TELMoS:05).

On 6 November 2008, the TMfS Term Commission changed its name to Land-Use and Transport Integration in Scotland (LATIS). The service is provided by Transport Scotland and their supporting consultants and offers a wide range of support and technical advice.

The LATIS service currently includes four distinct elements, as follows:

- a user engagement programme, consultations, discussions and advice on a range of transport and travel planning issues;
- the collection and provision of land-use planning data;
- the collection of transport data through the use of the Data Collection Contract; and
- a travel demand and land-use modelling suite.

The TMfS:07 and TELMoS:07 models are designed to deliver the fourth of these elements.

TMfS:07 & TELMoS:07 Model Reports

This report describes the calibration of the TELMoS:07 Model Demonstration Report and is one of a series of eight documents describing the construction, calibration and validation of the TMfS:07 and TELMoS:07 models, as shown below:

TMfS:07 National Travel Demand Model

1. TMfS:07 Demand Model Development Report.

TMfS:07 National Road Model

2. TMfS:07 National Road Model Development Report; and
3. TMfS:07 National Road Model Calibration & Validation Report.

TMfS:07 National Public Transport Model

4. TMfS:07 National Public Transport Model Development Report; and
5. TMfS:07 National Public Transport Model Calibration and Validation Report.

TELMoS:07 National Land Use Model

6. TELMoS:07 Model Description Report;
7. TELMoS:07 Assembly of Planning Policy Inputs; and
8. TELMoS:07 Model Demonstration Report

1 Introduction

1.1 Introduction

- 1.1.1 This report documents the TELMoS:07 Demonstration Tests that have been undertaken in order to assess the response of the model to changes to the model inputs.

1.2 Structure of the Report

- 1.2.1 The Report is divided into two main sections. In the first we provide a brief overview of the Land Use Model, describing the key inputs and outputs. In the second we describe the four demonstration tests. These have been designed to show the response of the land use model to changes in some of the key inputs to the model. The tests include:

- **Changes to Planning Policy Inputs:** this test adjusts the spatial distribution of residential planning policy inputs within the Lothian Area. The test assumes that there is no residential development within Midlothian, East Lothian and West Lothian but that there is an equivalent amount of development (to that permitted within these three local authority areas in the reference case) permitted within the City of Edinburgh;
- **Changes to the Demographic Scenario:** this test adjusts the level of population growth at the national level. Instead of net in-migration, this test assumes a net zero-migration, with the numbers of in-migrants and out-migrants being equal;
- **Transport Intervention on the Road Network:** this test involves the adjustments to the Road Network to test the impacts of the M74 Completion; and
- **Transport intervention to the public transport network:** this test involves the re-opening of the Airdrie to Bathgate railway.

- 1.2.2 The Auditor has requested that the Model Demonstration Report should contain reporting on the model reference case. The previous version of this report included an additional chapter, Chapter 8, describing the then reference case and a comparison, at the national level, between the outputs from that model run and the demographic and economic scenarios that the model had been constrained to be consistent with. That reference case, Test JA was an interim reference case. It has since been refined and revised in the light of further work and the comments and suggestions of the Auditor. We have retained the description of Test JA within this report.
- 1.2.3 A new reference case is currently being prepared and reporting relating to this updated scenario is likely to become available that would complement the information within this report.
- 1.2.4 It should be emphasised that these tests are intended to demonstrate that the model is responding to interventions in a reasonable manner. They are not intended to reflect national or Local Government policy.

2 TELMoS:07 : An Overview

2.1 Structure of the Model

2.1.1 TELMoS:07, the Transport/Economic/Land use Model of Scotland, is an integrated land use and transport model. It comprises a land use model (an application of DSC's DELTA package), working in conjunction with the Transport Model for Scotland (TMfS). The two models interact 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.

2.1.2 It should be noted that the land use model is concerned with more than basic land use, and provides forecasts of future levels of population (in total and for sub-sections of the resident population), households, employment levels, car ownership etc at a detailed zonal level.

2.2 TELMoS:07 model scope

2.2.1 We do not attempt here to provide a full description of the workings of the model, but only to define its overall scope and the range of interactions within it. Figure 2.1 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.

2.2.2 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 include:

- **Base Year Data:** the current base year has been set to 2007 and the forecast period runs to 2021;
- **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 current demographic scenario reported here has been constrained to reflect the GRO(S) 2006-based population projections for the period to 2021;
- the current **economic scenario** reported here has been set so as to reflect the forecasts used in Transport Scotland's Strategic Transport Projects Review. These are based upon economic forecasts prepared by Oxford Economics; and
- **Planning Policy Inputs:** both the amount of available land for development and the distribution of that development are derived from the information provided by local planning authorities. The process for collecting this information are reported in a separate report, 'TELMoS:07 The Assembly of Planning Policy Inputs'.

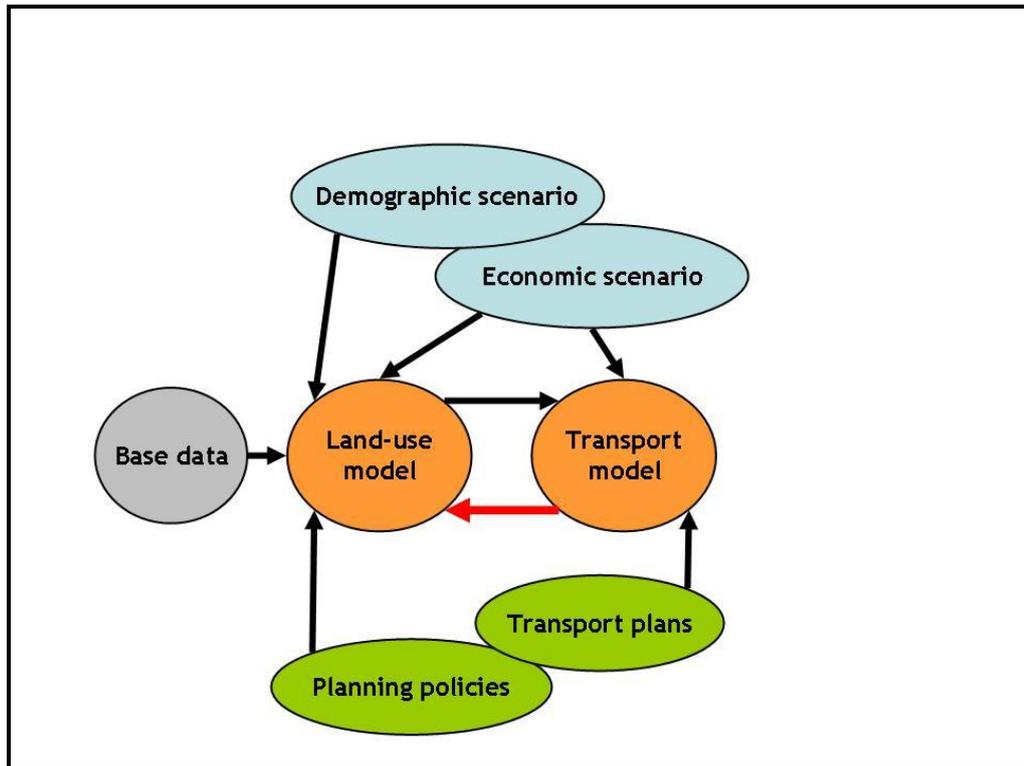


Figure 2.1 The Key Inputs to the Land Use and Transport Model

- 2.2.3 The model as a whole can therefore 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.
- 2.2.4 The distributions of households and economic activity are also influenced 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.

3 Demonstration Tests – An overview

3.1 Introduction

3.1.1 Four demonstration tests are described in the following chapters. These are:

- Demonstration Test 1 – adjustments to the planning policy inputs. In this test we consider the response of TELMoS:07 to changes in the planning inputs, with the intention of gauging how changes in development influence the distribution of the population and employment;
- Demonstration Test 2 – adjustments to the demographic scenario. In the test we examine the response of the model to a change in the overall level of population;
- Demonstration Test 3 – a transport intervention to the Road Network. In this test we consider the response of the TELMoS:07 land use model to changes in the TMfS:07; and
- Demonstration Test 4 – a transport intervention to the Public Transport Network. In this test we consider the response of the TELMoS:07 land use model to changes in TMfS's Public Transport Network.

3.1.2 In all four tests we have run the model as a Land Use only model rather than a full Land Use and Transport Interaction Model. In Demonstration Tests 1 and 2 generalised costs from TMfS:07 are input to the model in 2007 and then remain unchanged over the course of the demonstration tests. In Demonstration Tests 3 and 4 generalised costs that take account of the relevant transport interventions are provided for 2011 and these remain unchanged over the course of the demonstration test.

3.1.3 In all four tests, the demonstration test is compared with an appropriate reference case. In Demonstration Tests 1 and 2 the reference case is Test HD. This was the 'working' reference case in January 2009 when these tests were undertaken. For Demonstration Test 3 the reference case is Test ME whilst for Demonstration Test 4 the Reference Case was Test MQ; this contained one or two refinements to the reference case used in Test 3. It contains a number of enhancements and revisions including a revised set of generalised costs from TMfS.

4 Demonstration Test 1 –Planning Policy Inputs

4.1 Objective of the Test

- 4.1.1 This test is designed to demonstrate the response of the land-use model to a change in the planning policy inputs

4.2 Description of the intervention

- 4.2.1 This test involves the following adjustments to the TELMoS:07 planning policy inputs (in comparison to the TELMoS:07 Reference Case):

- The removal of all residential planning policy inputs within East Lothian, West Lothian and Midlothian (Zones 36-60 and 119-142 inclusive).
- The allocation of an equivalent amount of residential development within City of Edinburgh Zones (Zones 61-117 inclusive). The phasing of this development is similar to the phasing of the development that was removed from the three Lothian Authorities.
- The additional development in Edinburgh is allocated, between zones, according to the distribution of residential floorspace in 2007. This distribution is shown in Table 4.1.
- Planning Policy Inputs for the period to 2011 are treated as exogenous. TELMoS assumes that these are constructed and available for occupation. Planning Policy Inputs for the period beyond 2011 are treated as permissible. The model calculates the market demand for additional floorspace and develops sufficient of the permissible inputs to meet that demand.

- 4.2.2 No changes were made within TMfS compared to the reference case.

- 4.2.3 TELMoS:07 Testrun HP describes the outputs from the demonstration test, Testrun HD the reference test.

Table 4.1 Additions to residential planning policy inputs (sq metres)

Zone Number	Zone Name	Exogenous Development	Permissible development	Total
61	SOUTH QUEENSFERRY	26,764	63,367	90,131
62	NEWBRIDGE	14,636	34,653	49,290
63	KIRKLISTON	18,715	44,310	63,026
64	RATHO	15,829	37,478	53,307
65	DALMENY	24,473	57,943	82,417
66	BALERNO	27,793	65,802	93,594
67	GOGAR	50,416	119,365	169,780
68	CRAIGMOUNT	60,943	144,289	205,232
69	CURRIE	18,376	43,507	61,883
70	EDINBURGH PARK	58,081	137,513	195,594
71	CRAMOND/BARNTON	55,057	130,353	185,410
72	CORSTORPHINE	57,362	135,810	193,171
73	WESTER HAILES	45,154	106,907	152,061
74	CLERWOOD	38,884	92,063	130,947

Demonstration Test 1 –Planning Policy Inputs

Zone Number	Zone Name	Exogenous Development	Permissible development	Total
75	SAUGHTON & STENHOUSE	44,810	106,092	150,901
76	COLINTON	20,524	48,592	69,116
77	KINGSKNOWE	47,194	111,737	158,931
78	DRYLAW	63,583	150,540	214,123
79	PILTON	40,336	95,499	135,835
80	SAUGHTONHALL	41,078	97,256	138,334
81	RAVELSTON	29,744	70,422	100,166
82	SLATEFORD	23,272	55,098	78,370
83	CRAIGLOCKHART	22,012	52,115	74,126
84	GORGIE	31,138	73,723	104,861
85	MERCHISTON	24,188	57,269	81,457
86	HAYMARKET	50,236	118,939	169,175
87	GRANTON	37,370	88,477	125,847
88	OXGANGS	37,553	88,912	126,465
89	INVERLEITH	52,990	125,460	178,450
90	DALRY (EDINBURGH)	62,912	148,951	211,863
91	MORNINGSIDE	47,998	113,641	161,639
92	STOCKBRIDGE	45,914	108,706	154,620
93	MARCHMONT/BRUNTSFIELD	37,578	88,969	126,546
94	TOLLCROSS	49,990	118,357	168,347
95	FAIRMILEHEAD	19,172	45,393	64,565
96	EDINBURGH CENTRE	58,476	138,448	196,924
97	NEWHAVEN	15,575	36,875	52,450
98	OLD TOWN	65,965	156,180	222,145
99	BROUGHTON	50,560	119,706	170,267
100	SOUTH SIDE	63,454	150,234	213,688
101	MAYFIELD	56,009	132,608	188,617
102	PILRIG	43,039	101,900	144,939
103	KAIMES	67,435	159,660	227,096
104	ABBEYHILL	25,018	59,233	84,250
105	HOLYROOD	46,565	110,247	156,812
106	LIBERTON	45,029	106,610	151,639
107	LEITH	17,231	40,797	58,028
108	PRESTONFIELD	56,268	133,219	189,487
109	RESTALRIG	28,541	67,574	96,114
110	GILMERTON	55,774	132,050	187,824
111	MOREDUN	39,929	94,536	134,466
112	NORTHFIELD (EDINBURGH)	5,475	12,964	18,439
113	ERI	26,360	62,411	88,771
114	NIDDRIE	51,524	121,988	173,512
115	DUDDINGSTON	40,856	96,731	137,587
116	PORTOBELLO	36,219	85,752	121,970
117	BRUNTSTANE/JOPPA	18,385	43,528	61,913
	Total	2,255,764	5,340,755	7,596,518

4.3 Model Response to the Intervention

- 4.3.1 With this test we have introduced a change in the volume of planning policy inputs. There are reductions of around 620,000, 149,000 and 460,000 square metres in East Lothian, Midlothian and West Lothian respectively. In the City of Edinburgh there is an increase of over 980,000 sq metres.
- 4.3.2 The response of the model, in terms of additional floorspace built is shown in Figure 4.1 and Table 4.2.
- 4.3.3 There is a 32% increase in residential floorspace within the City of Edinburgh by 2021 and declines of around 18%, 27% and 36% in East Lothian, Midlothian and West Lothian respectively. In additions there are slight reductions across other parts of the modelled area. These typically represent less than a one percent difference in floorspace compared to the reference case; they reflect the relative attractiveness and high demand for residential floorspace in Edinburgh. Within the demonstration test, by increasing the supply of floorspace in Edinburgh there is a drawing in of households and population from across most parts of the modelled area.

Demonstration test
Changes in the planning policy inputs
Edinburgh / Lothians

c1.42.07 TELMoS_07
 Tests HP-HD
 29 January 2009

Residential floorspace
Percentage changes in 2021 (Test HP-Test HD)

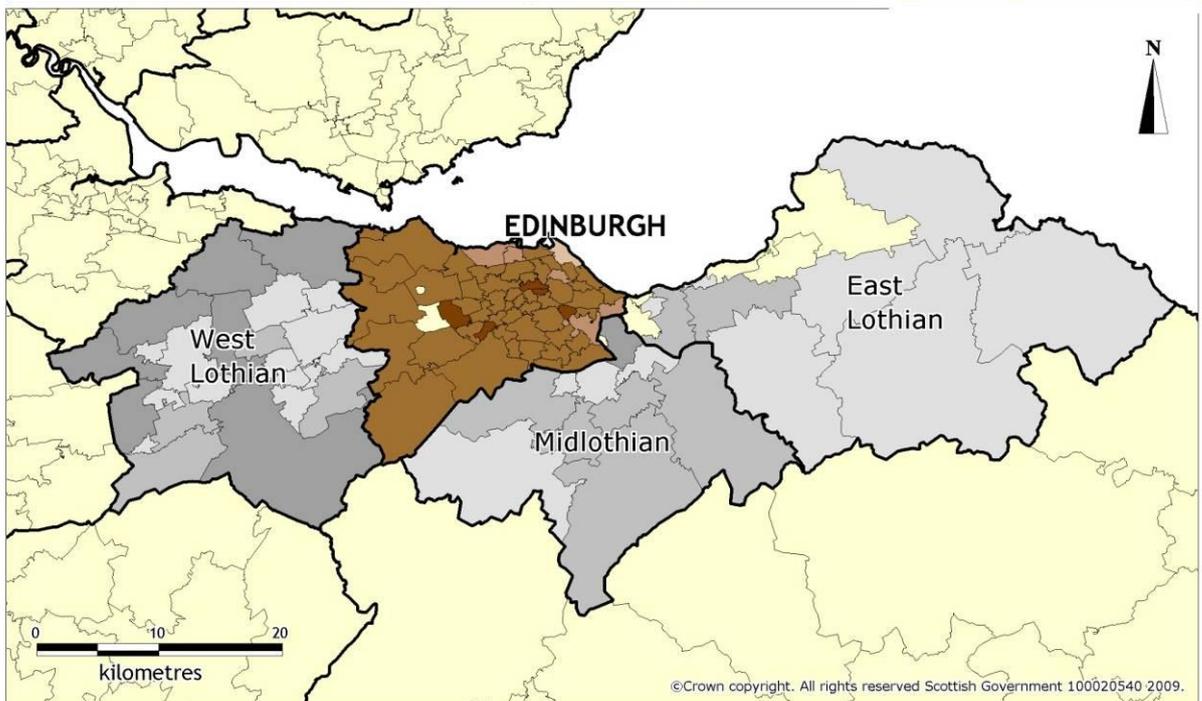
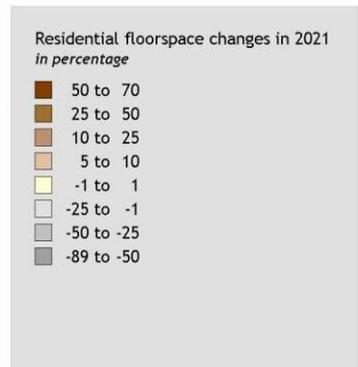
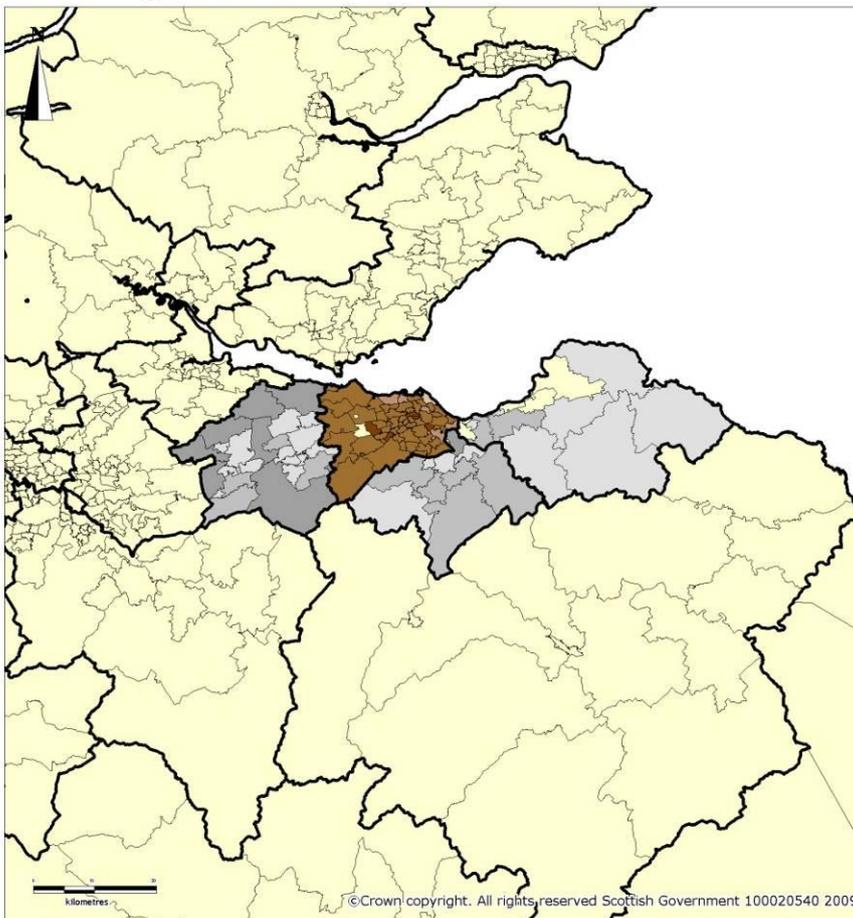


Figure 4.1 Change in Residential Floorspace, 2021 (Test HP-Test HD)

Table 4.2 Comparison of residential floorspace built (Test HP-HD)

Local Authority	HP-HD change				HP-HD % Change			
	2007	2011	2016	2021	2007	2011	2016	2021
Dumfries & Galloway	0	0	-19,790	-1,350	0.00%	0.00%	-0.24%	-0.02%
Scottish Borders	0	0	-6,870	1,340	0.00%	0.00%	-0.11%	0.02%
East Lothian	0	-351,720	-814,200	-916,600	0.00%	-7.73%	-16.24%	-17.92%
Midlothian	0	-701,331	-1077,021	-1338,301	0.00%	-16.60%	-23.41%	-27.52%
City of Edinburgh	0	1,884,801	4,818,277	6,482,887	0.00%	10.09%	24.66%	31.84%
West Lothian	0	-831,910	-2629,339	-4184,848	0.00%	-10.21%	-26.43%	-36.38%
South Lanarkshire	0	0	-12,363	-1,778	0.00%	0.00%	-0.09%	-0.01%
East Ayrshire	0	0	-12,740	-688	0.00%	0.00%	-0.21%	-0.01%
South Ayrshire	0	0	-20,836	-4,587	0.00%	0.00%	-0.36%	-0.07%
North Ayrshire	0	0	-19,393	-2,413	0.00%	0.00%	-0.28%	-0.03%
East Renfrewshire	0	0	-1,140	-90	0.00%	0.00%	-0.03%	0.00%
City of Glasgow	0	0	-870	-140	0.00%	0.00%	0.00%	0.00%
North Lanarkshire	0	0	-1,794	-71	0.00%	0.00%	-0.01%	0.00%
Falkirk	0	0	-3,660	470	0.00%	0.00%	-0.05%	0.01%
East Dunbartonshire	0	0	-2,230	-560	0.00%	0.00%	-0.05%	-0.01%
Renfrewshire	0	0	-2,390	-30	0.00%	0.00%	-0.03%	0.00%
Inverclyde	0	0	-233	1	0.00%	0.00%	-0.01%	0.00%
West Dunbartonshire	0	0	-1,110	-121	0.00%	0.00%	-0.03%	0.00%
Stirling	0	0	-430	-30	0.00%	0.00%	-0.01%	0.00%
Clackmannanshire	0	0	-6,100	-90	0.00%	0.00%	-0.25%	0.00%
Fife	0	0	-39,211	-12,052	0.00%	0.00%	-0.22%	-0.07%
Perth & Kinross	0	0	-3780	-250	0.00%	0.00%	-0.05%	0.00%
City of Dundee	0	0	-7090	-890	0.00%	0.00%	-0.11%	-0.01%
Angus	0	0	-8790	-980	0.00%	0.00%	-0.16%	-0.02%
Aberdeenshire	0	0	-30,130	-9,470	0.00%	0.00%	-0.23%	-0.07%
City of Aberdeen	0	0	-7640	-1,020	0.00%	0.00%	-0.08%	-0.01%
Moray	0	0	-10,970	-4,380	0.00%	0.00%	-0.24%	-0.09%
Argyll & Bute	0	0	-4,924	-1,619	0.00%	0.00%	-0.12%	-0.04%
Highland	0	0	-77,714	-17,409	0.00%	0.00%	-0.56%	-0.12%
Eilean Siar	0	0	-2310	-380	0.00%	0.00%	-0.14%	-0.02%
Orkney Islands	0	0	-3100	-500	0.00%	0.00%	-0.26%	-0.04%
Shetland Islands	0	0	-2200	-600	0.00%	0.00%	-0.18%	-0.05%
Total	0	-160	-12,091	-16,549	0.00%	0.00%	0.00%	-0.01%

- 4.3.4 The change in supply of residential floorspace affects the distribution of households and population. Tables 4.3 and 4.4 show the changes at Local Authority level whilst Figures 4.2 and 4.3 show the change at zone level. Again most of the change is in the local authorities directly affected by the demonstration test adjustments. However there are small changes to numbers of households and population over a wider area. Some of these are quite direct effects, for example the increases in Falkirk and the eastern fringes of North Lanarkshire indicate that on balance (and compared with the reference case) more households are moving into these areas because of the reduction of supply in neighbouring West Lothian.
- 4.3.5 The longer term household changes are also affected by the changes in longer-distance migration patterns, which will be further affected by changes to the distribution of those service jobs whose location is influenced by the distribution of population as well as by a 'domino' affect with changes in population or housing in one area impacting upon adjacent areas. It should also be kept in mind that changes in household numbers are generally the result of changes in the balance between larger numbers of households moving in and households moving out of any one zone or area; and that the changes in this balance may be different for different types of households, so that there is not necessarily a simple relationship between the impacts on household numbers and the impacts on population.
- 4.3.6 The change in distribution of population and households will have some secondary effects. In the previous paragraph the changes in service sector employment were referred to in this context. Table 4.5 shows the changes in employment at Local Authority level. Again the major changes occur in those Authority areas where the planning inputs were adjusted. There is a 2% increase in employment in the City of Edinburgh and decreases within East Lothian, Midlothian and West Lothian.
- 4.3.7 Much of the change across the rest of Scotland involves percentage changes at the local authority level of less than 1%.

4.4 Conclusion

- 4.4.1 The purpose of this test was to examine the responses of the model to a change in the planning policy inputs. We have demonstrated that:

- the change in planning policy inputs resulted in comparable changes to the amounts of residential development, and that the distribution of this development was consistent with where the additional development was introduced;
- that the changes to residential floorspace result in changes to the distribution of both households and population; and
- that there are a number of secondary impacts, including slight adjustments to the distribution of employment where the pattern of jobs changes in response to population and household movement in turn these secondary impacts will affect the demand for residential floorspace and result in changing levels of demand in different parts of the modelled area.

Demonstration test
Changes in the planning policy inputs
Edinburgh / Lothians

c1.42.07 TELMoS_07
 Tests HP-HD
 29 January 2009

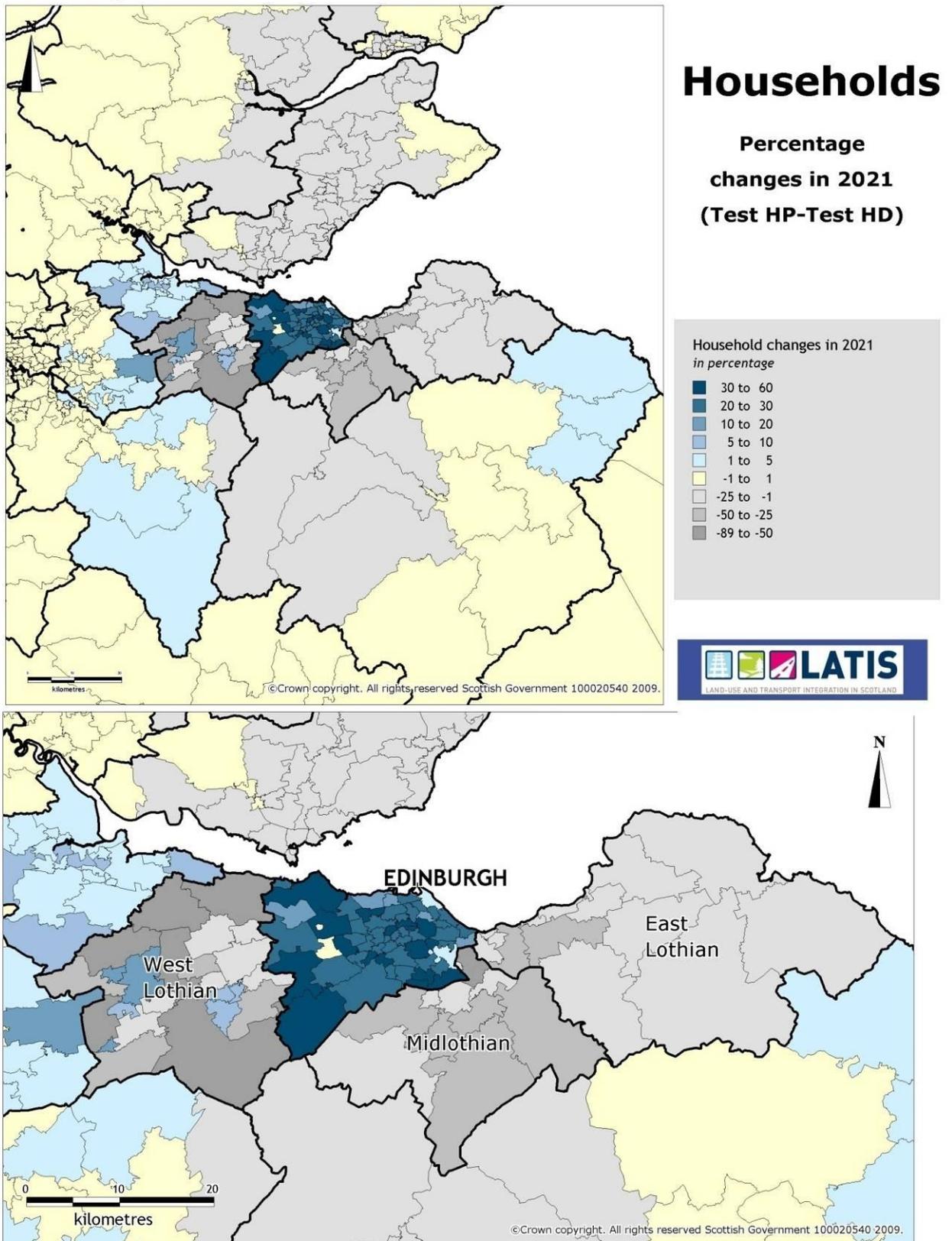


Figure 4.2 Changes in Households 2021, (Test HP-Test HD)

Demonstration test
Changes in the planning policy inputs
Edinburgh / Lothians

c1.42.07 TELMoS_07
 Tests HP-HD
 29 January 2009

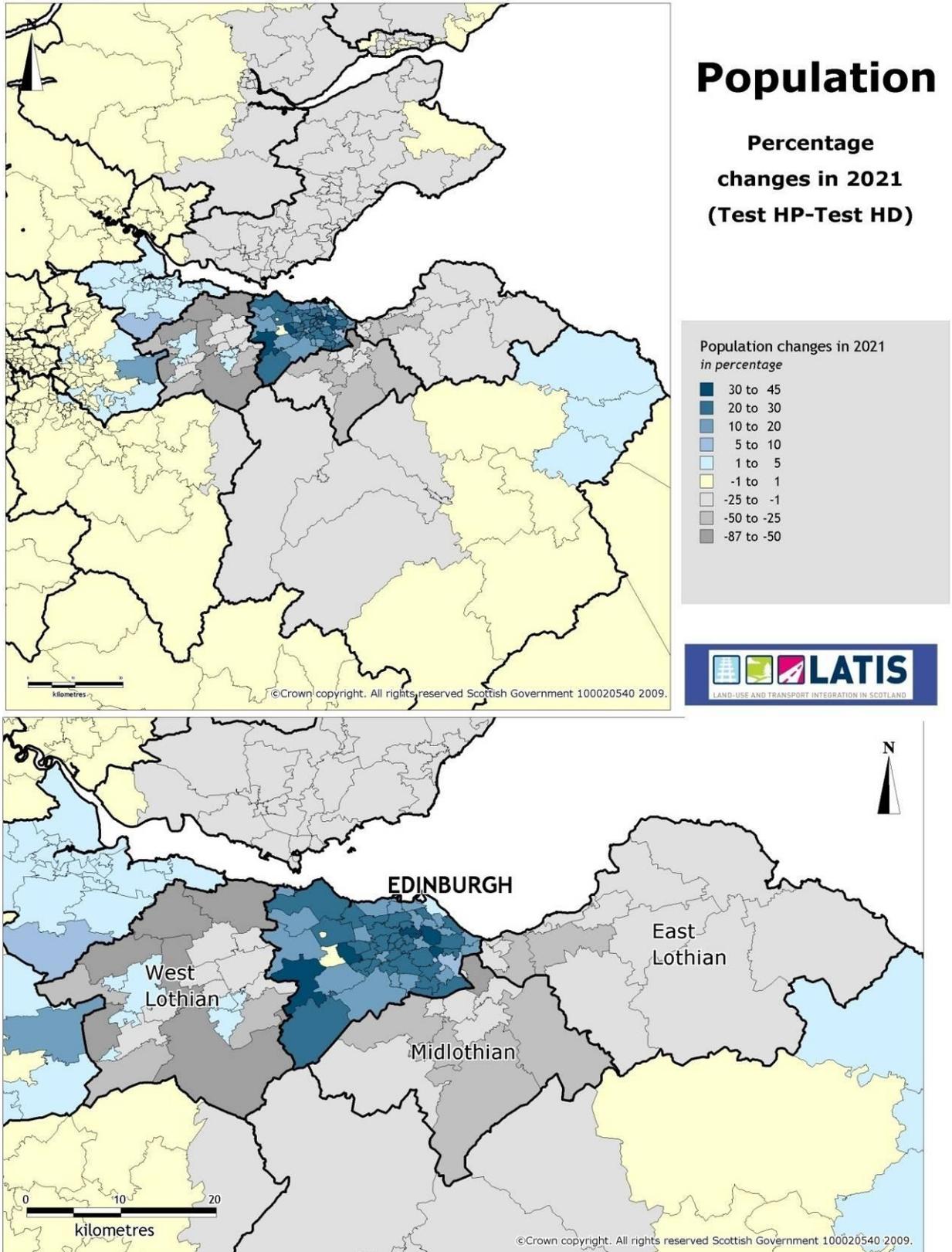


Figure 4.3 Change in Population, 2021 (Test HP-Test HD)

Table 4.3 Comparison of Households by Local Authority (HP-HD)

Local Authority	HP-HD change				HP-HD % Change			
	2007	2011	2016	2021	2007	2011	2016	2021
Dumfries & Galloway	0	-9	-59	-34	0.00%	-0.01%	-0.08%	-0.04%
Scottish Borders	0	144	16	-242	0.00%	0.26%	0.03%	-0.39%
East Lothian	0	-1,902	-8,864	-10,810	0.00%	-4.40%	-18.60%	-23.26%
Midlothian	0	-3,464	-9,674	-13,108	0.00%	-9.21%	-23.43%	-31.27%
City of Edinburgh	0	8,230	37,063	53,747	0.00%	3.85%	16.66%	23.00%
West Lothian	0	-2,671	-19,248	-32,571	0.00%	-3.49%	-20.71%	-30.75%
South Lanarkshire	0	48	602	1,074	0.00%	0.03%	0.41%	0.69%
East Ayrshire	0	9	50	114	0.00%	0.02%	0.08%	0.18%
South Ayrshire	0	2	-79	9	0.00%	0.00%	-0.15%	0.02%
North Ayrshire	0	3	-49	61	0.00%	0.01%	-0.07%	0.09%
East Renfrewshire	0	9	55	67	0.00%	0.03%	0.17%	0.22%
City of Glasgow	0	104	845	1,090	0.00%	0.04%	0.28%	0.34%
North Lanarkshire	0	103	1,101	1,730	0.00%	0.07%	0.73%	1.19%
Falkirk	0	93	1,787	3,640	0.00%	0.13%	2.30%	4.65%
East Dunbartonshire	0	16	116	135	0.00%	0.04%	0.29%	0.36%
Renfrewshire	0	13	72	75	0.00%	0.02%	0.09%	0.10%
Inverclyde	0	2	36	25	0.00%	0.00%	0.09%	0.06%
West Dunbartonshire	0	6	47	50	0.00%	0.01%	0.10%	0.11%
Stirling	0	14	219	280	0.00%	0.03%	0.51%	0.61%
Clackmannanshire	0	-1	32	105	0.00%	-0.01%	0.13%	0.41%
Fife	0	-516	-2,699	-3,265	0.00%	-0.31%	-1.60%	-1.91%
Perth & Kinross	0	-109	-409	-538	0.00%	-0.17%	-0.62%	-0.80%
City of Dundee	0	-83	-474	-708	0.00%	-0.12%	-0.70%	-1.07%
Angus	0	-18	-170	-277	0.00%	-0.04%	-0.33%	-0.54%
Aberdeenshire	0	-7	-163	-248	0.00%	-0.01%	-0.16%	-0.24%
City of Aberdeen	0	-8	-1	-161	0.00%	-0.01%	0.00%	-0.14%
Moray	0	-2	-21	-65	0.00%	-0.01%	-0.05%	-0.16%
Argyll & Bute	0	0	4	-4	0.00%	0.00%	0.01%	-0.01%
Highland	0	-5	-119	-123	0.00%	0.00%	-0.11%	-0.11%
Eilean Siar	0	-1	-6	-15	0.00%	-0.01%	-0.05%	-0.12%
Orkney Islands	0	-1	-4	-10	0.00%	-0.01%	-0.04%	-0.11%
Shetland Islands	0	-1	-6	-12	0.00%	-0.01%	-0.06%	-0.12%
Total	0	1	1	12	0.00%	0.00%	0.00%	0.00%

Table 4.4 Comparison of Population by local authority (HP-HD)

Local Authority	HP-HD change				HP-HD % Change			
	2007	2011	2016	2021	2007	2011	2016	2021
Dumfries & Galloway	0	-6	-87	-52	0.00%	0.00%	-0.06%	-0.03%
Scottish Borders	0	296	-104	-815	0.00%	0.26%	-0.09%	-0.67%
East Lothian	0	-3,916	-14,991	-17,159	0.00%	-4.22%	-15.30%	-18.25%
Midlothian	0	-6,948	-16,493	-21,495	0.00%	-8.50%	-19.35%	-25.35%
City of Edinburgh	0	16,824	67,041	95,951	0.00%	3.64%	13.88%	18.80%
West Lothian	0	-5,712	-34,856	-57,156	0.00%	-3.49%	-18.83%	-28.49%
South Lanarkshire	0	118	1,081	1,892	0.00%	0.04%	0.37%	0.63%
East Ayrshire	0	23	98	243	0.00%	0.02%	0.08%	0.20%
South Ayrshire	0	7	-115	67	0.00%	0.01%	-0.11%	0.06%
North Ayrshire	0	10	-73	151	0.00%	0.01%	-0.05%	0.11%
East Renfrewshire	0	23	142	199	0.00%	0.03%	0.19%	0.30%
City of Glasgow	0	256	1,787	2,444	0.00%	0.04%	0.27%	0.35%
North Lanarkshire	0	235	1,868	2,814	0.00%	0.07%	0.59%	0.93%
Falkirk	0	213	2,136	3,541	0.00%	0.14%	1.40%	2.38%
East Dunbartonshire	0	41	243	311	0.00%	0.04%	0.28%	0.38%
Renfrewshire	0	32	201	316	0.00%	0.02%	0.12%	0.20%
Inverclyde	0	6	79	74	0.00%	0.01%	0.10%	0.09%
West Dunbartonshire	0	17	125	191	0.00%	0.02%	0.13%	0.20%
Stirling	0	32	362	507	0.00%	0.04%	0.40%	0.55%
Clackmannanshire	0	-5	19	111	0.00%	-0.01%	0.04%	0.23%
Fife	0	-1,093	-5,779	-7,798	0.00%	-0.30%	-1.65%	-2.28%
Perth & Kinross	0	-227	-912	-1,299	0.00%	-0.17%	-0.68%	-0.98%
City of Dundee	0	-161	-888	-1,355	0.00%	-0.11%	-0.60%	-0.94%
Angus	0	-36	-396	-665	0.00%	-0.03%	-0.37%	-0.65%
Aberdeenshire	0	-8	-255	-396	0.00%	0.00%	-0.11%	-0.18%
City of Aberdeen	0	-10	18	-229	0.00%	0.00%	0.01%	-0.10%
Moray	0	-3	-30	-103	0.00%	0.00%	-0.04%	-0.12%
Argyll & Bute	0	3	23	13	0.00%	0.00%	0.03%	0.01%
Highland	0	-5	-213	-218	0.00%	0.00%	-0.10%	-0.10%
Eilean Siar	0	-1	-11	-28	0.00%	0.00%	-0.04%	-0.11%
Orkney Islands	0	-1	-8	-21	0.00%	-0.01%	-0.04%	-0.11%
Shetland Islands	0	-1	-10	-23	0.00%	0.00%	-0.05%	-0.12%
Total	0	2	1	12	0.00%	0.00%	0.00%	0.00%

Table 4.5 Comparison of Employment (Tests HP-HD)

Local Authority	HP-HD change				HP-HD % Change			
	2007	2011	2016	2021	2007	2011	2016	2021
Dumfries & Galloway	0	5	-2	0	0.00%	0.01%	0.00%	0.00%
Scottish Borders	0	6	53	121	0.00%	0.01%	0.12%	0.28%
East Lothian	0	61	-72	-400	0.00%	0.22%	-0.27%	-1.56%
Midlothian	0	79	-72	-441	0.00%	0.19%	-0.17%	-1.02%
City of Edinburgh	0	491	2,888	6,399	0.00%	0.18%	1.02%	2.16%
West Lothian	0	-124	-788	-1,786	0.00%	-0.16%	-1.02%	-2.30%
South Lanarkshire	0	-8	-79	-148	0.00%	-0.01%	-0.07%	-0.12%
East Ayrshire	0	2	-3	2	0.00%	0.01%	-0.01%	0.00%
South Ayrshire	0	1	-13	-38	0.00%	0.00%	-0.03%	-0.08%
North Ayrshire	0	2	-10	-21	0.00%	0.00%	-0.02%	-0.05%
East Renfrewshire	0	0	-14	-25	0.00%	0.00%	-0.05%	-0.09%
City of Glasgow	0	-9	-212	-591	0.00%	0.00%	-0.06%	-0.16%
North Lanarkshire	0	-20	-161	-426	0.00%	-0.02%	-0.14%	-0.36%
Falkirk	0	-52	-290	-655	0.00%	-0.08%	-0.47%	-1.05%
East Dunbartonshire	0	-1	-12	-34	0.00%	0.00%	-0.05%	-0.14%
Renfrewshire	0	-2	-23	-57	0.00%	0.00%	-0.04%	-0.09%
Inverclyde	0	0	-8	-29	0.00%	0.00%	-0.02%	-0.08%
West Dunbartonshire	0	-1	-12	-29	0.00%	0.00%	-0.04%	-0.09%
Stirling	0	-11	-78	-188	0.00%	-0.02%	-0.15%	-0.35%
Clackmannanshire	0	-3	-22	-68	0.00%	-0.02%	-0.16%	-0.49%
Fife	0	-3	-179	-430	0.00%	0.00%	-0.12%	-0.30%
Perth & Kinross	0	0	-27	-89	0.00%	0.00%	-0.05%	-0.17%
City of Dundee	0	0	-18	-64	0.00%	0.00%	-0.03%	-0.10%
Angus	0	2	-5	-20	0.00%	0.01%	-0.01%	-0.06%
Aberdeenshire	0	6	-7	-30	0.00%	0.01%	-0.01%	-0.04%
City of Aberdeen	0	0	-25	-68	0.00%	0.00%	-0.02%	-0.05%
Moray	0	2	-2	-8	0.00%	0.00%	-0.01%	-0.02%
Argyll & Bute	0	2	-4	-22	0.00%	0.00%	-0.01%	-0.06%
Highland	0	4	-31	-44	0.00%	0.00%	-0.03%	-0.04%
Eilean Siar	0	1	0	-2	0.00%	0.01%	0.00%	-0.02%
Orkney Islands	0	1	1	-2	0.00%	0.01%	0.01%	-0.02%
Shetland Islands	0	0	-1	-4	0.00%	0.00%	-0.01%	-0.03%
Total	0	433	771	804	0.00%	0.02%	0.03%	0.03%

5 Demonstration Test 2 –Population Scenarios

5.1 Objective of the test

- 5.1.1 This test is designed to demonstrate the response of the land-use model to a change in the demographic scenario.

5.2 Description of the intervention

- 5.2.1 Migration rates between Scotland and the rest of the World are specified for ten household groups as part of the definition of the demographic scenario discussed in section. The input consists of two values for each household group, namely the proportion of each household group that migrates out of Scotland each year, and the ratio of in-migrants to out-migrants (arrivals to departures). The basis of the present test is to assume that the levels of in-migration and out-migration between Scotland and the rest of the world are the same, rather than assuming the net in-migration that is included in the reference case scenario. The coefficients specified in the input files have been adjusted accordingly (see Table 5.1).
- 5.2.2 The immediate impact of this change will be to dramatically reduce the numbers of young single, older single, young couple with no children and three adult households with no children households. These are the households that drive the in-migration within the model. In the longer term the reduction in these households will affect the levels of newly forming households (for example if there are fewer young single households (and people) then there will be fewer instances of young single households joining together to form couple households).
- 5.2.3 Note that the reference case was an 'interim' scenario, refinements were made to the ratios of arrivals to departures, and revised coefficients are used in the current reference case.

Table 5.1 Adjustments to migration coefficients

Household Group	description	departures	ratio of arrivals/departures	
			reference case	demonstration test
-4	Young Single Households	0.01	10.26	1
-5	Older Single Households	0.01	1.20	1
-6	Retired Single Households	0.004255	0	1
-7	Single Parent plus child Households	0.018139	0	1
-8	Young Couple No Children Households	0.01	5.25	1
-9	Older couple no children Households	0.022593	0	1
-10	Couple with children Households	0.004036	0	1
-11	Retired couple Households	0.001238	0	1
-12	3 adults no children Households	0.01	1.43	1
-13	3 adults + child Households	0.03171	0	1

5.3 Model Response to the Intervention

- 5.3.1 The population scenario within the Reference Case assumes a net in-migration into Scotland through the forecast period. This is consistent with the GRO(S) population forecasts. It is the additional inflow of people that accounts for the increase in population over the period to 2031. In this demonstration test there is zero-net migration and hence the total population doesn't grow to the same extent. Indeed the population declines.
- 5.3.2 In examining the response of the land-use model to this adjustment to migration, we look first at the population levels, then at how the change in population affects the occupation of and demand for residential floorspace. Finally we consider some of the secondary effects that result from a net decline in population.
- 5.3.3 The two tests have the same population in 2007. Table 5.2 describes the change at national level over the period to 2021. Over the fourteen years the total population, in the demonstration test declines by 133,485 or 2.54 %.

Table 5.2 Comparison of Ref. Case and Demonstration Test Populations

	2007	2011	2016	2021	2007-2021
Reference Case	5,101,783	5,155,087	5,212,883	5,250,014	148,231
Demonstration Test	5,101,783	5,137,365	5,140,271	5,116,529	14,746
Difference	-	17,721	72,612	133,485	
(%)		0.34%	1.39%	2.54%	

- 5.3.4 Table 5.3 shows the change in population by children, working-age adults and retirees. The impact of a zero-net migration affects some age groups more than others. This reflects the propensity to migrate of different household types; key in-migrants in the reference case include young single and couple households. Within the demonstration test there is an increase in the number of children and decreases in both the populations of working age and retirees.

Table 5.3 Comparison of population by sub-group (Ref. Case & Demonstration Test)

Children	2007	2011	2016	2021	2007-2021
Reference Case	922,231	911,308	907,043	903,939	-18,292
Demonstration Test	922,231	933,557	922,154	909,812	-12,419
Difference (demonstration – reference)	-	22,249	15,111	5,873	
(%)		2.44%	1.67%	0.65%	

working age adults	2007	2011	2016	2021	2007-2021
Reference Case	3,258,457	3,267,852	3,240,989	3,188,611	-69,846
Demonstration Test	3,258,457	3,221,805	3,144,965	3,092,334	-166,123
Difference (demonstration – reference)	-	-46,047	-96,024	-96,277	
(%)		-1.41%	-2.96%	-3.02%	

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Retirees	2007	2011	2016	2021	2007-2021
Reference Case	921,095	975,926	1,064,850	1,157,463	236,368
Demonstration Test	921,095	982,004	1,093,696	1,114,383	236,368
Difference (demonstration – reference)					
(%)	-	6,078	28,846	-43,080	

5.3.5 Table 5.4 shows the percentage change at Local Authority level. The impact of the zero-net migration varies across local authority areas, with a range of population declines from -5.6% in West Lothian to -0.2% in the City of Dundee. Figure 5.1 shows the change in population at zone level.

Table 5.4 Local Authority Population Change (Test HM-HD)

Local Authority	Percentage Change			
	2007	2011	2016	2021
Dumfries & Galloway	0.00%	-0.40%	-1.97%	-3.63%
Scottish Borders	0.00%	-0.59%	-2.28%	-3.91%
East Lothian	0.00%	-0.20%	-1.23%	-2.14%
Midlothian	0.00%	-0.42%	-1.59%	-2.19%
City of Edinburgh	0.00%	-0.62%	-1.55%	-2.51%
West Lothian	0.00%	-0.88%	-3.66%	-5.64%
South Lanarkshire	0.00%	-0.46%	-1.83%	-3.44%
East Ayrshire	0.00%	-0.26%	-1.35%	-2.25%
South Ayrshire	0.00%	-0.40%	-1.60%	-2.84%
North Ayrshire	0.00%	0.04%	-0.59%	-1.32%
East Renfrewshire	0.00%	-0.19%	-1.37%	-2.25%
City of Glasgow	0.00%	-0.11%	-0.39%	-1.20%
North Lanarkshire	0.00%	-0.22%	-1.20%	-2.31%
Falkirk	0.00%	-0.76%	-2.37%	-3.88%
East Dunbartonshire	0.00%	-0.39%	-1.48%	-2.31%
Renfrewshire	0.00%	-0.21%	-0.98%	-1.59%
Inverclyde	0.00%	0.00%	-0.67%	-1.50%
West Dunbartonshire	0.00%	-0.08%	-0.61%	-1.03%
Stirling	0.00%	-0.63%	-2.35%	-4.81%
Clackmannanshire	0.00%	-0.53%	-2.07%	-3.69%
Fife	0.00%	-0.46%	-1.79%	-3.40%
Perth & Kinross	0.00%	-0.33%	-2.07%	-4.03%
City of Dundee	0.00%	0.04%	0.40%	-0.20%
Angus	0.00%	-0.02%	-1.15%	-1.98%

Local Authority	Percentage Change			
	2007	2011	2016	2021
Aberdeenshire	0.00%	-0.21%	-1.28%	-2.36%
City of Aberdeen	0.00%	-0.77%	-1.72%	-2.68%
Moray	0.00%	0.03%	-0.77%	-1.75%
Argyll & Bute	0.00%	-0.25%	-1.88%	-3.74%
Highland	0.00%	-0.22%	-1.09%	-2.02%
Eilean Siar	0.00%	0.12%	-0.44%	-1.11%
Orkney Islands	0.00%	-0.52%	-1.50%	-2.33%
Shetland Islands	0.00%	-1.03%	-2.47%	-3.35%
Total	0.00%	-0.34%	-1.39%	-2.54%

5.3.1 Table 5.5 shows the percentage change in the number of households at Local Authority level. The decline in households is greater than for population reflecting the fact that a disproportionate amount of the in-migrants in the Reference Case comprise single adult households, and hence reducing their in-migration to zero in the demonstration test will not affect total population in the same way that a reduction in two or three adult households would. Figure 5.2 shows the change in households at zone level.

Change in Population (2021)

c1.42.07 TELMoS_07
 Test HM - 29 January 2009

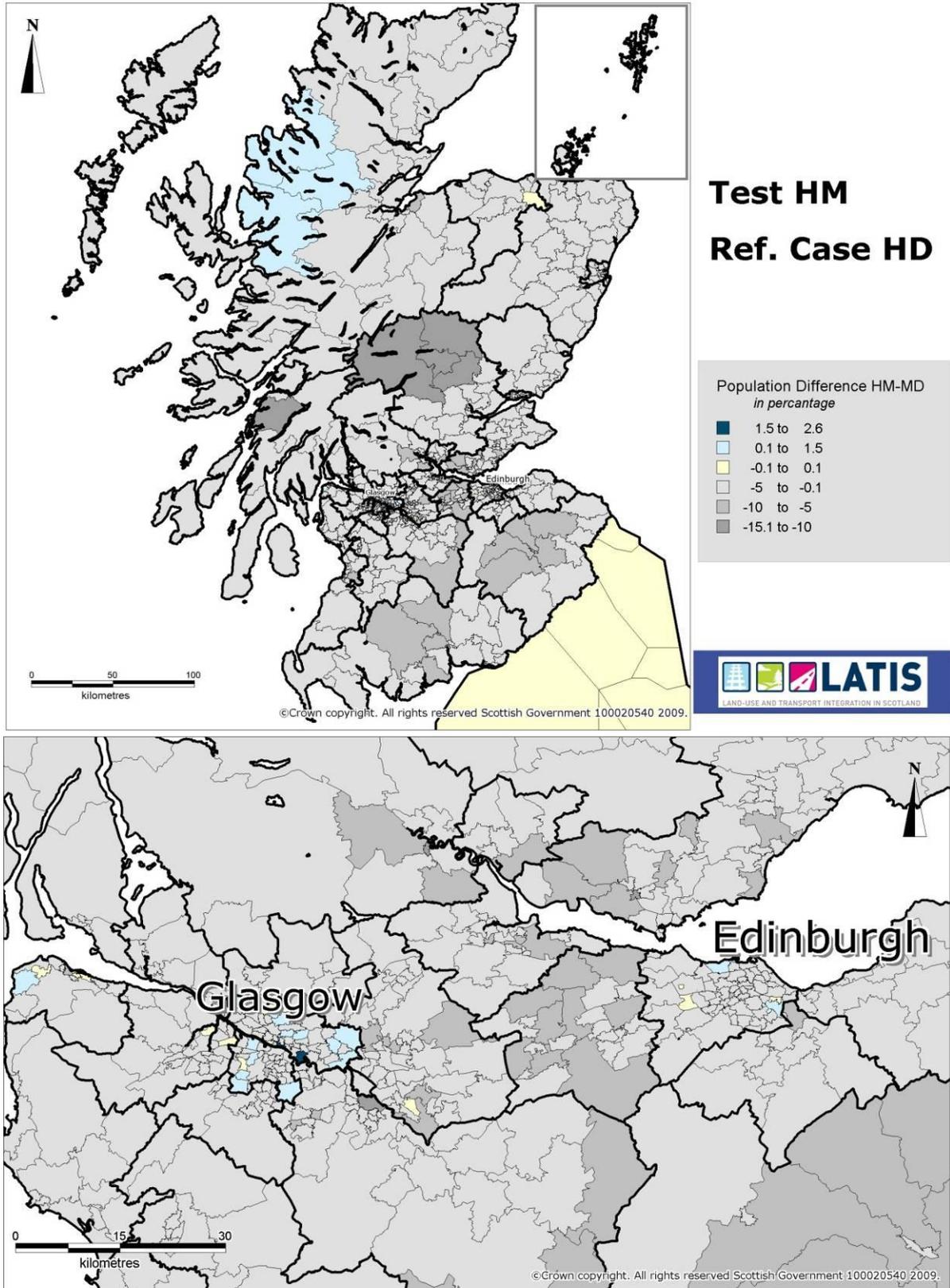


Figure 5.1 Change in Population, 2021 (Test HM-Test HD)

Table 5.5 Percentage Change in the percentage of Households (HM-HD)

Local Authority	Percentage Change in number of Households			
	2007	2011	2016	2021
Dumfries & Galloway	0.00%	-3.25%	-7.68%	-11.38%
Scottish Borders	0.00%	-3.44%	-7.76%	-11.37%
East Lothian	0.00%	-3.03%	-6.40%	-8.42%
Midlothian	0.00%	-3.41%	-6.85%	-8.34%
City of Edinburgh	0.00%	-2.41%	-4.78%	-6.55%
West Lothian	0.00%	-4.15%	-10.29%	-14.45%
South Lanarkshire	0.00%	-3.26%	-7.10%	-10.77%
East Ayrshire	0.00%	-3.13%	-6.92%	-9.74%
South Ayrshire	0.00%	-2.94%	-6.54%	-9.69%
North Ayrshire	0.00%	-2.43%	-5.06%	-7.10%
East Renfrewshire	0.00%	-2.75%	-5.47%	-7.16%
City of Glasgow	0.00%	-2.13%	-4.19%	-6.06%
North Lanarkshire	0.00%	-3.06%	-6.45%	-9.07%
Falkirk	0.00%	-3.86%	-8.32%	-11.97%
East Dunbartonshire	0.00%	-2.98%	-5.48%	-7.00%
Renfrewshire	0.00%	-2.58%	-4.72%	-6.12%
Inverclyde	0.00%	-2.62%	-5.69%	-8.29%
West Dunbartonshire	0.00%	-2.62%	-5.31%	-7.12%
Stirling	0.00%	-3.40%	-7.88%	-12.75%
Clackmannanshire	0.00%	-3.66%	-8.05%	-11.96%
Fife	0.00%	-3.27%	-7.09%	-10.90%
Perth & Kinross	0.00%	-2.77%	-7.27%	-11.62%
City of Dundee	0.00%	-1.89%	-3.24%	-4.73%
Angus	0.00%	-2.48%	-5.83%	-8.34%
Aberdeenshire	0.00%	-3.04%	-6.46%	-9.23%
City of Aberdeen	0.00%	-3.01%	-5.80%	-7.92%
Moray	0.00%	-2.48%	-5.68%	-8.38%
Argyll & Bute	0.00%	-3.02%	-7.63%	-11.75%
Highland	0.00%	-2.92%	-6.11%	-8.67%
Eilean Siar	0.00%	-2.41%	-5.19%	-7.42%
Orkney Islands	0.00%	-3.35%	-6.60%	-9.00%
Shetland Islands	0.00%	-4.39%	-8.11%	-10.48%
Total	0.00%	-2.88%	-6.17%	-8.90%

Change in Household (2021)

c1.42.07 TELMoS_07
Test HM - 29 January 2009

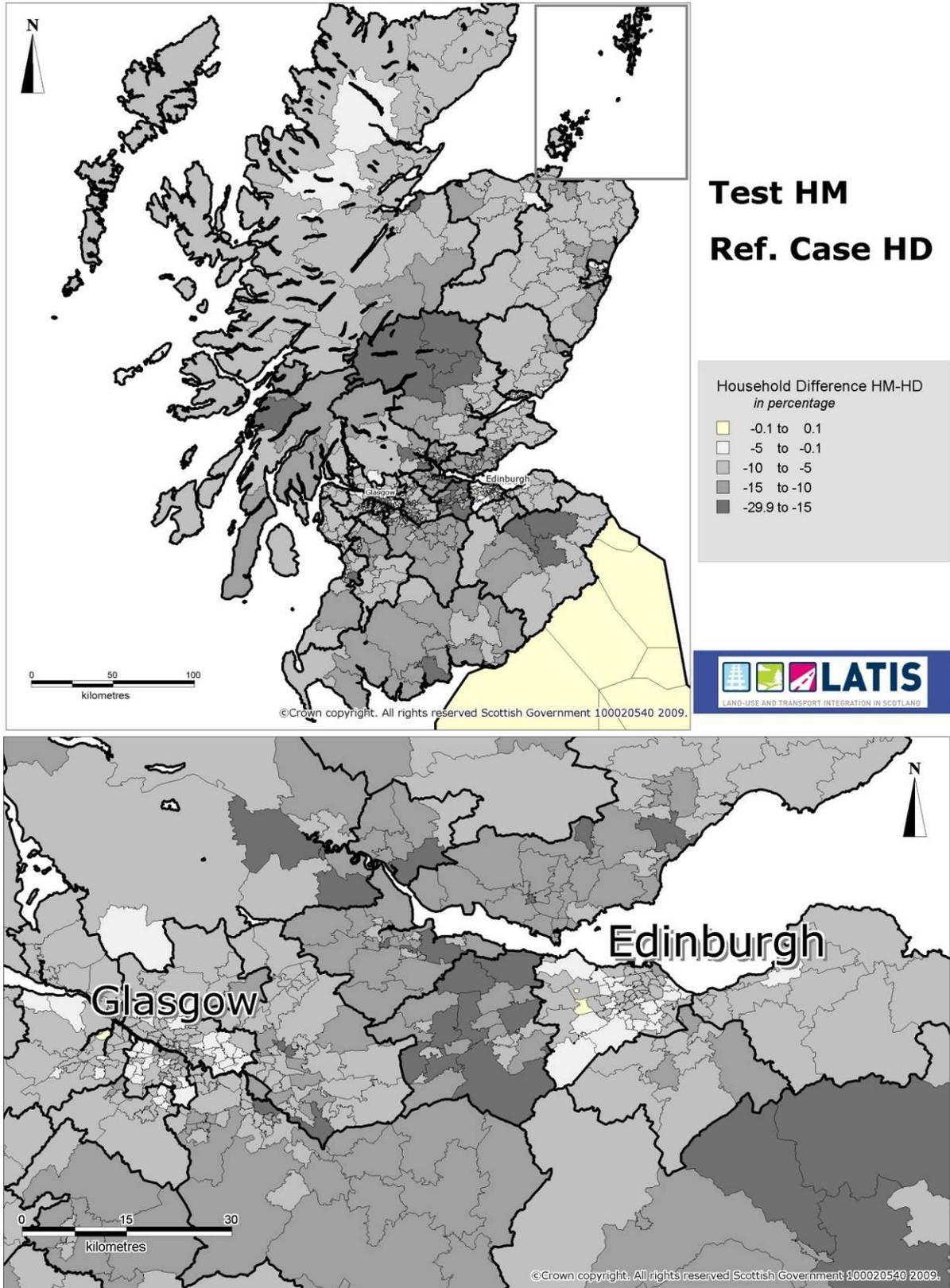


Figure 5.2 Change in Households, 2021 (Test HM- Test HD)

5.3.2 With fewer households the demand for dwellings, and hence residential floorspace should decline. This expected response is confirmed in Table 5.6 which shows declines in the average residential rent within all Local Authorities.

Table 5.6 Change in Rent (Test HM-HD)

Local Authority	Percentage change in residential rents			
	2007	2011	2016	2021
Dumfries & Galloway	0.00%	0.00%	-6.04%	-10.59%
Scottish Borders	0.00%	0.00%	-5.50%	-10.63%
East Lothian	0.00%	0.00%	-5.79%	-9.58%
Midlothian	0.00%	0.00%	-6.12%	-9.41%
City of Edinburgh	0.00%	0.00%	-4.29%	-6.76%
West Lothian	0.00%	0.00%	-8.21%	-12.72%
South Lanarkshire	0.00%	0.00%	-5.89%	-10.51%
East Ayrshire	0.00%	0.00%	-5.53%	-9.09%
South Ayrshire	0.00%	0.00%	-5.45%	-9.55%
North Ayrshire	0.00%	0.00%	-4.13%	-6.73%
East Renfrewshire	0.00%	0.00%	-5.73%	-9.64%
City of Glasgow	0.00%	0.00%	-3.56%	-5.89%
North Lanarkshire	0.00%	0.00%	-6.36%	-11.10%
Falkirk	0.00%	0.00%	-8.01%	-11.94%
East Dunbartonshire	0.00%	0.00%	-6.07%	-9.14%
Renfrewshire	0.00%	0.00%	-4.53%	-7.22%
Inverclyde	0.00%	0.00%	-4.98%	-9.43%
West Dunbartonshire	0.00%	0.00%	-4.47%	-7.29%
Stirling	0.00%	0.00%	-6.85%	-13.48%
Clackmannanshire	0.00%	0.00%	-6.86%	-11.40%
Fife	0.00%	0.00%	-6.16%	-10.32%
Perth & Kinross	0.00%	0.00%	-4.96%	-12.52%
City of Dundee	0.00%	0.00%	-3.01%	-2.76%
Angus	0.00%	0.00%	-4.24%	-7.98%
Aberdeenshire	0.00%	0.00%	-5.55%	-9.52%
City of Aberdeen	0.00%	0.00%	-6.21%	-8.81%
Moray	0.00%	0.00%	-3.99%	-7.97%
Argyll & Bute	0.00%	0.00%	-5.22%	-13.71%
Highland	0.00%	0.00%	-4.58%	-7.42%
Eilean Siar	0.00%	0.00%	-3.80%	-7.10%
Orkney Islands	0.00%	0.00%	-4.89%	-7.69%
Shetland Islands	0.00%	0.00%	-6.39%	-11.61%

- 5.3.3 Note that rents are calculated at zone level. Within each local authority there are likely to be a range of rents reflecting the relative attractiveness of different zones.
- 5.3.4 The largest falls in rent are in Stirling, Argyll and Bute and West Lothian with declines of -13.48%,-13.71% and -12.72% respectively. The lowest falls are in the City of Dundee (-2.76%).
- 5.3.5 The relative decline in demand for residential floorspace ultimately manifests itself as a reduction in the demand of additional residential floorspace that is developed. Table 5.7 summarises the difference in residential floorspace between the reference case and this demonstration test at local authority level. (Please note that in both tests the residential planning policy inputs in the period to 2011 are treated as exogenous developments and hence are all assumed to be developed).
- 5.3.6 Across Scotland there is a 0.13% reduction in residential floorspace. In West Lothian the reduction is -0.83% whilst in several authority areas (including East Renfrewshire, North Lanarkshire, Renfrewshire and Inverclyde there is little or no reduction).

Table 5.7 Comparison of Residential Floorspace (Test HM-HD)

Local Authority	Percentage change in residential floorspace			
	2007	2011	2016	2021
Dumfries & Galloway	0.00%	0.00%	-0.14%	-0.18%
Scottish Borders	0.00%	0.00%	-0.09%	-0.22%
East Lothian	0.00%	0.00%	-0.02%	0.00%
Midlothian	0.00%	0.00%	-0.33%	0.00%
City of Edinburgh	0.00%	0.00%	0.00%	-0.01%
West Lothian	0.00%	0.00%	-0.79%	-0.83%
South Lanarkshire	0.00%	0.00%	-0.06%	-0.10%
East Ayrshire	0.00%	0.00%	-0.14%	-0.19%
South Ayrshire	0.00%	0.00%	-0.06%	-0.35%
North Ayrshire	0.00%	0.00%	-0.02%	-0.11%
East Renfrewshire	0.00%	0.00%	-0.01%	0.00%
City of Glasgow	0.00%	0.00%	0.00%	-0.01%
North Lanarkshire	0.00%	0.00%	-0.01%	0.00%
Falkirk	0.00%	0.00%	-0.14%	-0.05%
East Dunbartonshire	0.00%	0.00%	-0.03%	-0.04%
Renfrewshire	0.00%	0.00%	-0.01%	0.00%
Inverclyde	0.00%	0.00%	0.00%	0.00%
West Dunbartonshire	0.00%	0.00%	-0.01%	-0.02%
Stirling	0.00%	0.00%	0.00%	-0.30%
Clackmannanshire	0.00%	-0.05%	-0.21%	-0.25%
Fife	0.00%	0.00%	-0.06%	-0.14%
Perth & Kinross	0.00%	0.00%	-0.02%	-0.06%

Local Authority	Percentage change in residential floorspace			
	2007	2011	2016	2021
City of Dundee	0.00%	0.00%	0.01%	-0.01%
Angus	0.00%	0.00%	-0.04%	-0.01%
Aberdeenshire	0.00%	0.00%	-0.07%	-0.28%
City of Aberdeen	0.00%	0.00%	-0.02%	-0.08%
Moray	0.00%	0.00%	0.01%	-0.15%
Argyll & Bute	0.00%	0.00%	-0.04%	-0.23%
Highland	0.00%	0.00%	-0.02%	-0.14%
Eilean Siar	0.00%	0.00%	0.01%	-0.07%
Orkney Islands	0.00%	0.00%	-0.01%	-0.03%
Shetland Islands	0.00%	0.00%	-0.09%	-0.23%
Scotland	0.00%	0.00%	-0.07%	-0.13%

5.3.7 As well as the direct effects of a decline in population, one would expect to see some secondary effects, particularly as the decline in population leads to a decline in consumer demand and ultimately to a negative impact upon the economy as a whole.

5.3.8 By 2021, this Demonstration Test predicts 3000 fewer jobs within Scotland. The major declines are spread across the service sector jobs including the retail sectors (activities 43-46), real estate, renting and business activities (activity 52), Hotel and Restaurant (Activity 46) and the Health Sector (Activity 56). These changes are described in Figure 5.3 and Table 5.8.

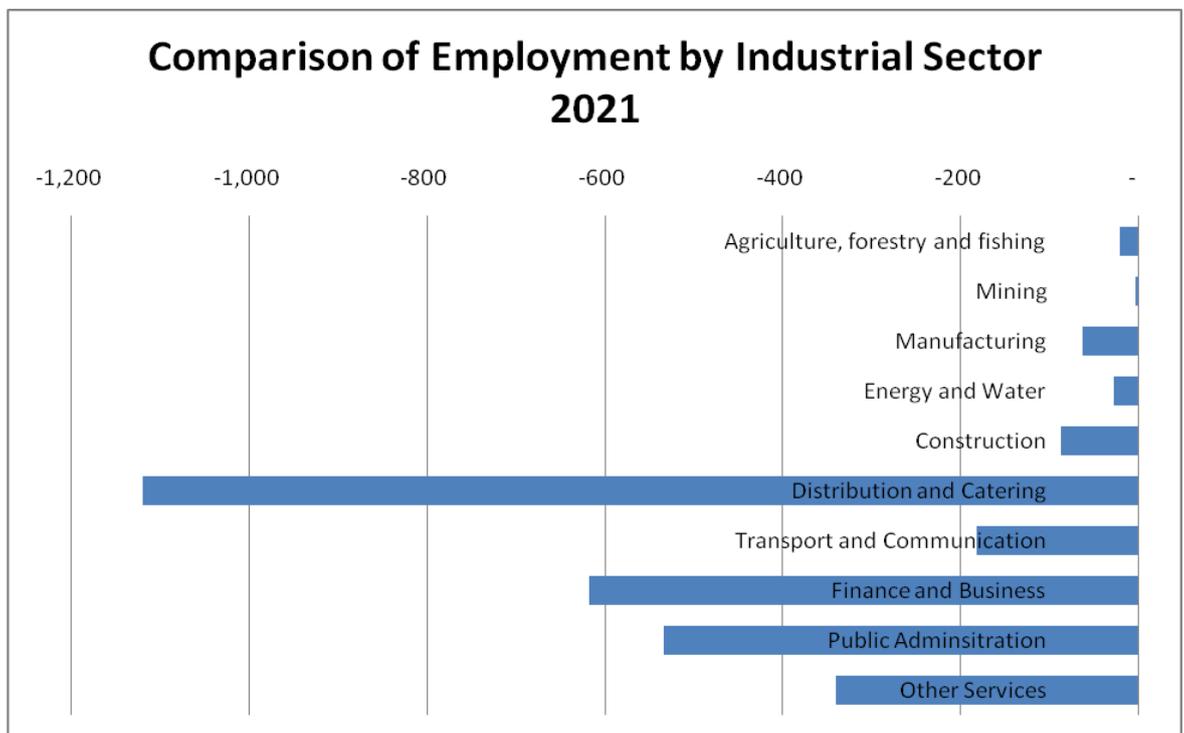


Figure 5.3 Comparison of Employment by industrial sector

Table 5.8 Change in Employment Activities (HM-HD)

Activity	Description		2011	2016	2021
31	Agriculture, hunting and forestry	Non-manual	0	0	0
32	Agriculture, hunting and forestry	Manual	-6	- 6	- 19
33	Fishing	Non-manual	0	0	0
34	Fishing	Manual	-1	-1	-3
35	Mining and quarrying	Non-manual	0	0	-1
36	Mining and quarrying	Manual	-1	-1	-4
37	Manufacturing	Non-manual	0	0	0
38	Manufacturing	Manual	-19	19	-64
39	Electricity, gas and water supply	Non-manual	0	0	0
40	Electricity, gas and water supply	Manual	-8	-8	-28
41	Construction	Non-manual	0	0	1
42	Construction	Manual	-23	23	-89
43	Wholesale & retail trade, repairs - <i>RETAIL</i>	Manual & Non-manual	- 127	- 127	- 471
45	Wholesale & retail trade, repairs - <i>OTHER</i>	Non-manual	2	2	2
46	Wholesale & retail trade, repairs - <i>OTHER</i>	Manual	-97	97	354
47	Hotels & restaurants	Manual & Non-manual	-79	- 79	- 296
48	Transport, storage & communications	Non-manual	1	1	1
49	Transport, storage & communications	Manual	- 48	- 48	- 184
50	Intermediaries – FINANCIAL MANAGENT	Manual & Non Manual	- 2	- 2	- 10
51	Intermed. – LOCAL FINANCIAL SERVICES	Manual & Non Manual	-34	- 34	- 138
52	Real estate, renting & business activities	Manual & Non Manual	-114	-114	-469
53	Public admin, defence, social security	Non-Manual	1	1	- 1
54	Public admin, defence, social security	Manual	-34	-34	-137
55	Education	Manual & Non Manual	- 36	-36	-147
56	Health	Manual & Non Manual	- 59	- 59	-248
57	Other	Non-manual	2	2	-1
58	Other	Manual	- 91	-91	-340

5.3.9 Table 5.9 shows the percentage change in employment at Local Authority level. Whilst the changes are relatively small (at the end of a fourteen year period), there are some authority areas that have slight gains in employment and others where there is a decline.

Table 5.9 Comparison of Local Authority Employment Levels (Tests HM-HD)

Local Authority	Employment			
	2007	2011	2016	2021
Dumfries & Galloway	0.00%	-0.01%	-0.14%	-0.32%
Scottish Borders	0.00%	0.00%	-0.08%	-0.21%
East Lothian	0.00%	0.12%	-0.02%	0.07%
Midlothian	0.00%	0.13%	0.14%	0.22%
City of Edinburgh	0.00%	0.02%	0.11%	0.13%
West Lothian	0.00%	0.01%	-0.23%	-0.47%
South Lanarkshire	0.00%	0.00%	-0.10%	-0.23%
East Ayrshire	0.00%	-0.02%	-0.11%	-0.23%
South Ayrshire	0.00%	-0.03%	-0.24%	-0.41%
North Ayrshire	0.00%	0.00%	-0.04%	-0.09%
East Renfrewshire	0.00%	0.03%	-0.07%	-0.18%
City of Glasgow	0.00%	0.00%	0.04%	0.05%
North Lanarkshire	0.00%	0.00%	-0.19%	-0.37%
Falkirk	0.00%	-0.01%	-0.27%	-0.55%
East Dunbartonshire	0.00%	0.02%	-0.05%	-0.14%
Renfrewshire	0.00%	0.01%	-0.03%	-0.09%
Inverclyde	0.00%	0.04%	0.07%	0.07%
West Dunbartonshire	0.00%	0.03%	0.05%	0.07%
Stirling	0.00%	0.02%	-0.08%	-0.25%
Clackmannanshire	0.00%	0.01%	-0.08%	-0.30%
Fife	0.00%	-0.01%	-0.15%	-0.34%
Perth & Kinross	0.00%	0.03%	0.16%	0.29%
City of Dundee	0.00%	0.00%	0.12%	0.26%
Angus	0.00%	0.00%	-0.16%	-0.34%
Aberdeenshire	0.00%	0.04%	-0.06%	-0.23%
City of Aberdeen	0.00%	0.01%	-0.02%	-0.08%
Moray	0.00%	-0.01%	-0.13%	-0.29%
Argyll & Bute	0.00%	0.01%	0.00%	-0.14%
Highland	0.00%	-0.05%	-0.23%	-0.41%
Eilean Siar	0.00%	0.01%	-0.05%	-0.15%
Orkney Islands	0.00%	-0.09%	-0.37%	-0.61%
Shetland Islands	0.00%	-0.20%	-1.00%	-1.34%
Total	0.00%	0.01%	-0.05%	-0.13%

5.4 Conclusion

5.4.1 The purpose of this test was to examine the responses of the model to a change in the demographic scenario. We have demonstrated that:

- the population model responds to adjustments to the migration coefficients;
- the total population changes as expected and the changes within the broad age-bands used within the model reflect the intervention to the migration model;
- the changes to the number of households again reflects the intervention; a reduction in single person households clearly having an immediate impact upon the number of single-adult households but ultimately an impact upon the formation of couple and other households;
- the reduction in population and households results in a reduced demand for residential floorspace which results in a reduction both in terms of rents and the take-up of residential permissions and new development; and
- secondary impacts (negative multiplier effects) occur as the reduction in population leads to reductions in consumer demand and the demand for products from the Scottish economy.

6 Demonstration Test 3: Road Network

6.1 Objective of the Test

- 6.1.1 This test is designed to demonstrate the response of the land-use model to a major change in the road network.

6.2 Description of the test

- 6.2.1 This test involves modelling the impacts of the M74 Completion. The scheme itself (now under construction) involves extending the M74 from its present end at the Fullarton Road intersection around the south side of Glasgow to join the M8 west of the Kingston Bridge. This connection provides additional capacity for east-west road travel across Glasgow and some relief of congestion on the sections of the M8 north and west of Central Glasgow.
- 6.2.2 The M74 Completion (M74C) is already included in the TMfS:07 Reference Case and therefore the demonstration test actually involved removing the new motorway links from the TMfS Reference Case networks. However, it is much easier to discuss the model results in terms of the impacts of adding a motorway rather than the impacts of not adding a motorway, and hence the rest of this chapter discusses the demonstration test in terms of the impact of the with-M74C case compared with the without-M74C case.
- 6.2.3 The inclusion or exclusion of M74C is the only change made in the inputs to the model. The inputs to TELMoS were identical for the with- and without-M74C cases. The comparison of the two tests therefore shows the impact of the road scheme alone, and excludes the impact of any changes in planning policies which might accompany the scheme.
- 6.2.4 Two sets of transport costs were provided by MVA, from runs of the TMfS:07 model for 2011, with and without M74C. Initial comparison of these cost outputs showed around a 10 minute peak period time saving for vehicles travelling across Glasgow (ie A8 to Glasgow Airport) and smaller time benefits for some movements to/from central Glasgow.
- 6.2.5 In broad percentage terms, the M74 scheme reduces the generalised cost of driving between South Lanarkshire and Glasgow in the AM peak by around 6%, while the corresponding generalised cost of driving between South Lanarkshire and Renfrewshire drops by an average of around 10% (see Appendix 1).

6.3 The Model Runs

- 6.3.1 Two sets of transport costs were obtained from runs of the TMfS:07 model for 2011, with and without M74C. These were used in two TELMoS tests:
- Test ME: the reference case including the M74 extension; and
 - Test MG: this test does not include the M74 extension.
- 6.3.2 Both tests were run for the ten year period from 2011 to 2021, and both incorporate some further refinements and adjustments to TELMoS inputs and coefficients relative to previous work. The transport costs are assumed to remain unchanged after 2011 in both tests.

6.4 Model Response to the Intervention

- 6.4.1 The modelled impacts (the differences between the with- and without-M74C results) stem
- 6.4.2 Entirely from the differences in the generalised costs that are passed from TMfS to TELMoS in 2011. Within TELMoS we would expect these to modify the costs of trade between areas, and the relative accessibilities of zones both as origins (the ease in which it is possible to travel from the zone to others) and destinations (the ease in which it is possible to travel to a zone). Such changes should influence the location decisions of households and business and hence result in changes in the spatial distribution of these activities. From previous work we expect the changes in generalised costs to be significant enough to have a noticeable effect on the distribution of economic activity across Scotland as well as on the distribution of land-uses within Glasgow and the Clyde Valley.
- 6.4.3 In reporting upon the demonstration test we follow this sequence from intervention to changes in spatial distribution.
- 6.4.4 Within TELMoS measures of origin and destination accessibility are calculated, at zone level, for each of the seven transport measures and three car ownership levels used within the model (see Model Description Report section 8). Here we focus upon three measures of accessibility:
- Measure 1 (Access to work, non-manual workers), households with one car. These accessibility calculations are based on generalised costs for the AM and PM peaks;
 - Measure 4 (business to business), households with one car. These accessibility costs are based on generalised costs for the off-peak period; and
 - Measure 6 (access for 'Other Goods Vehicles'). Please note, the term Other Goods Vehicles refers to those goods vehicles that are not in Measure 5 Light Goods Vehicles, and hence roughly equates to Heavy Goods Vehicles.
- 6.4.5 These provide an indication of change in accessibility in the peak and off peak periods, as well as for freight movement.
- 6.4.6 Figure 6.1 describes the zones within the area of study.

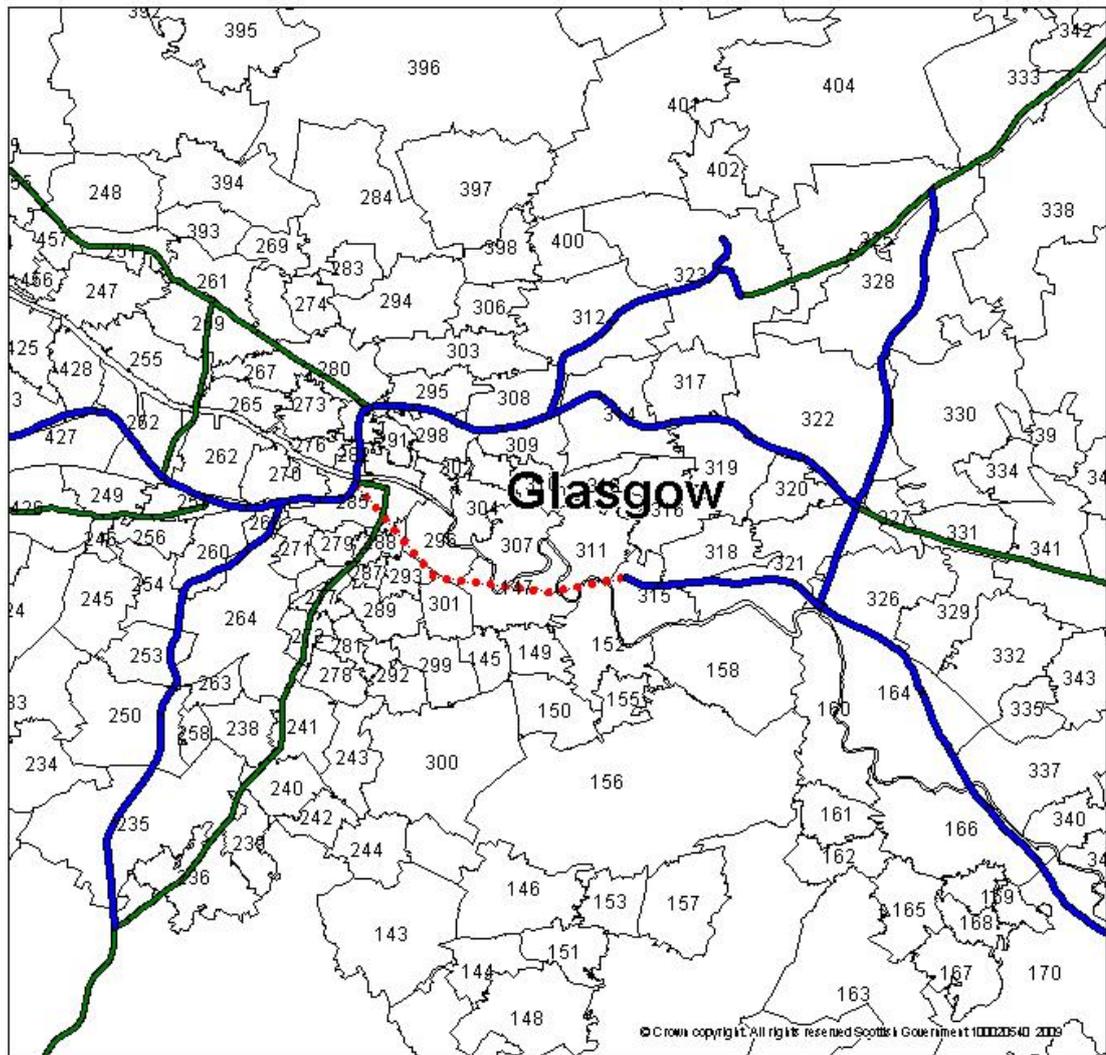


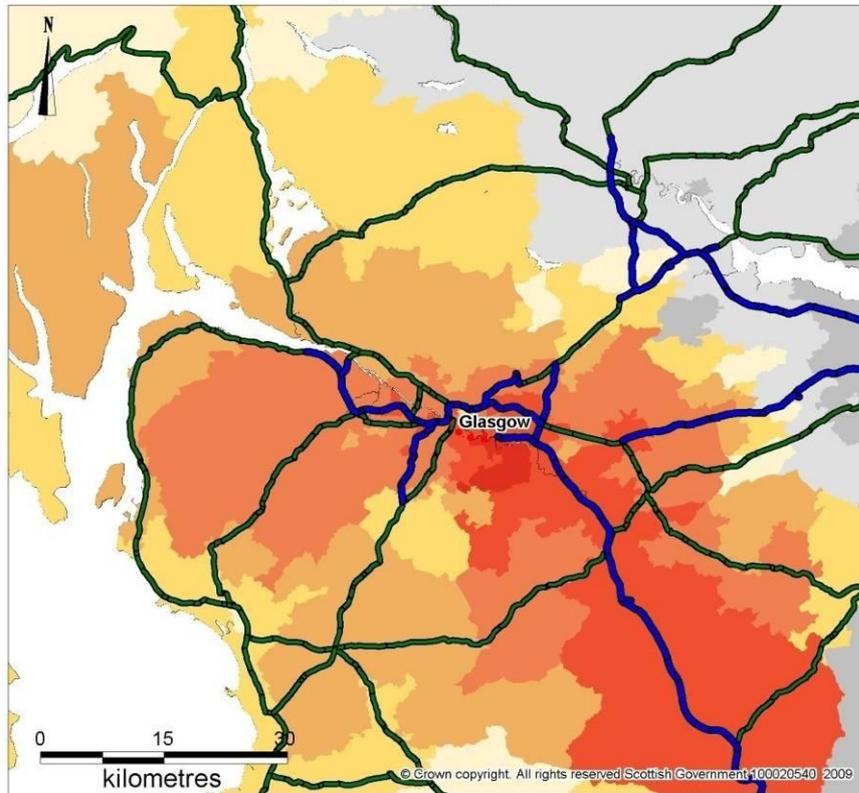
Figure 6.1 The TELMoS:07 zone system

- 6.4.7 Figures 6.2-6.4 show the spatial change in accessibility compared to the Reference Case. In all three maps there are widespread improvements in accessibility, but particular improvements along the route of the M74 extension, in the area south-east of Glasgow where the scheme will be particularly important in improving access to the rest of the conurbation, and along existing strategic road routes linked to the scheme including the existing M74 to the south, the M8 to the east and the M77 to the south-west. The geographical extent of the change in accessibility is largely limited to Strathclyde, Ayrshire and the Central Scotland Belt. Clearly there is a strong correlation between the patterns of changes for the three different types of accessibility, reflecting the fact that all are essentially measures of access to workplaces.
- 6.4.8 The accessibility measures are in units of the generalised cost of the expected average trip from each zone to relevant opportunities. As such, higher (more positive) values represent worse accessibility, and lower (more negative) values represent improvement. The maps show improvements in yellow-orange-red shades, worsening in different shades of grey and negligible change in cream. These maps are for 2021 so the results reflect some of the forecast economic redistribution that is described later.

Change in Accessibility in 2021

Test MG - Test ME (Ref Case)

c1.42.07 TELMoS_07
Test MG - 8 September 2009



Access to work
non-manual workers
1 car

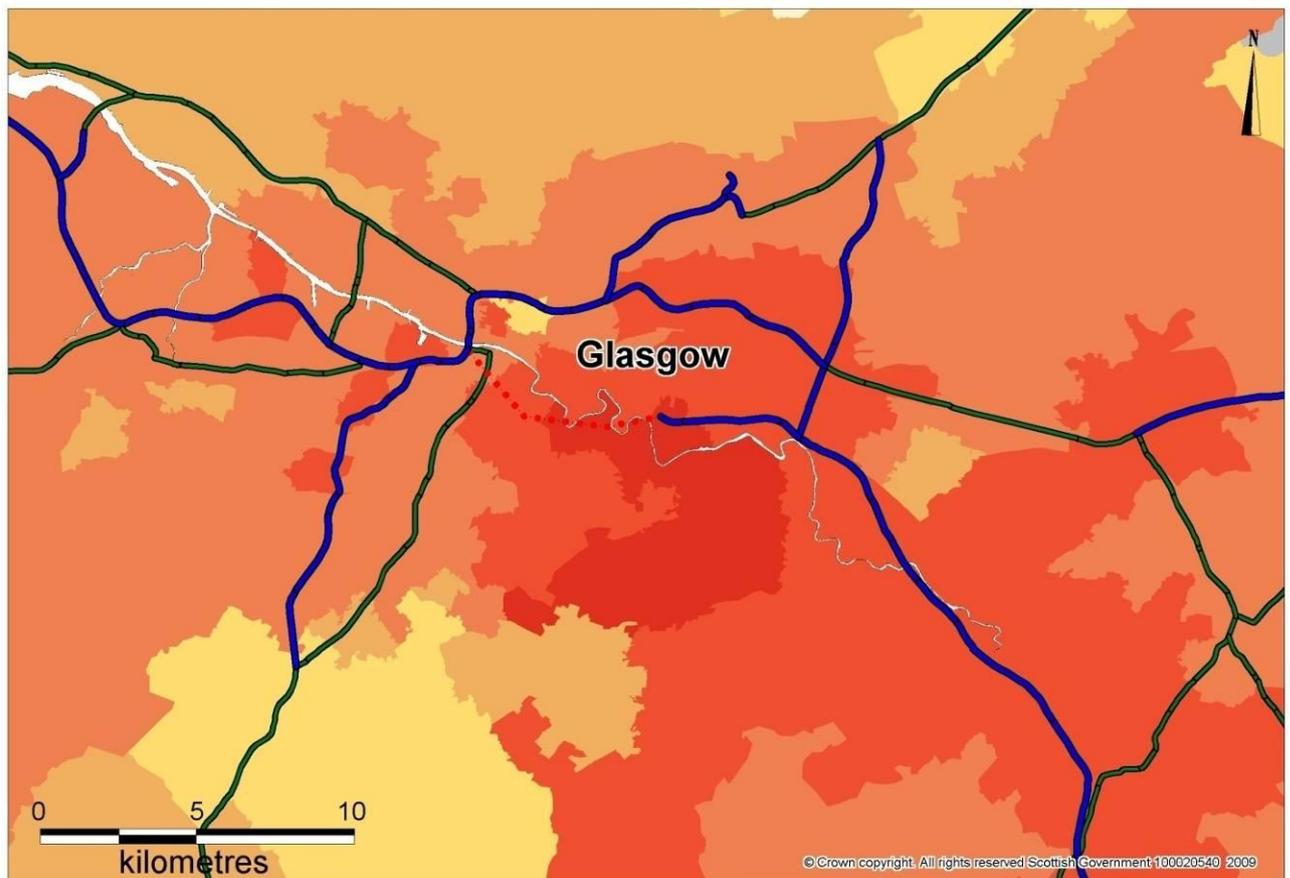
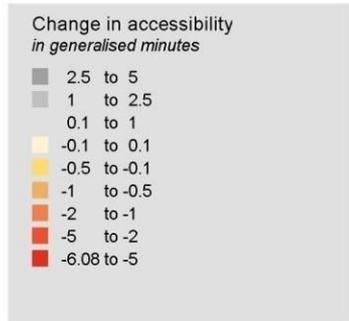


Figure 6.2 Change in Accessibility Measure 1, households with one car

Change in Accessibility in 2021

Test MG - Test ME (Ref Case)

c1.42.07 TELMoS_07

Test MG - 8 September 2009

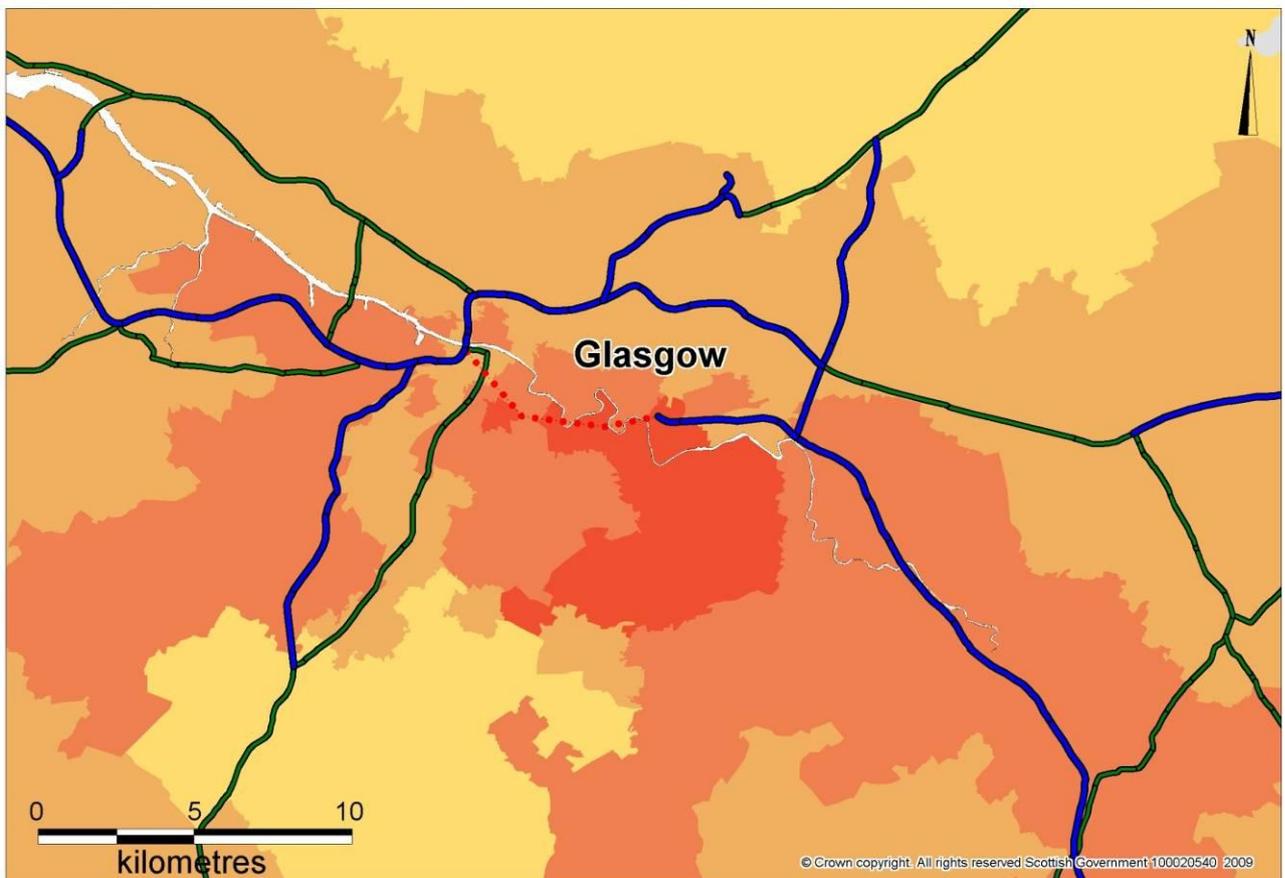
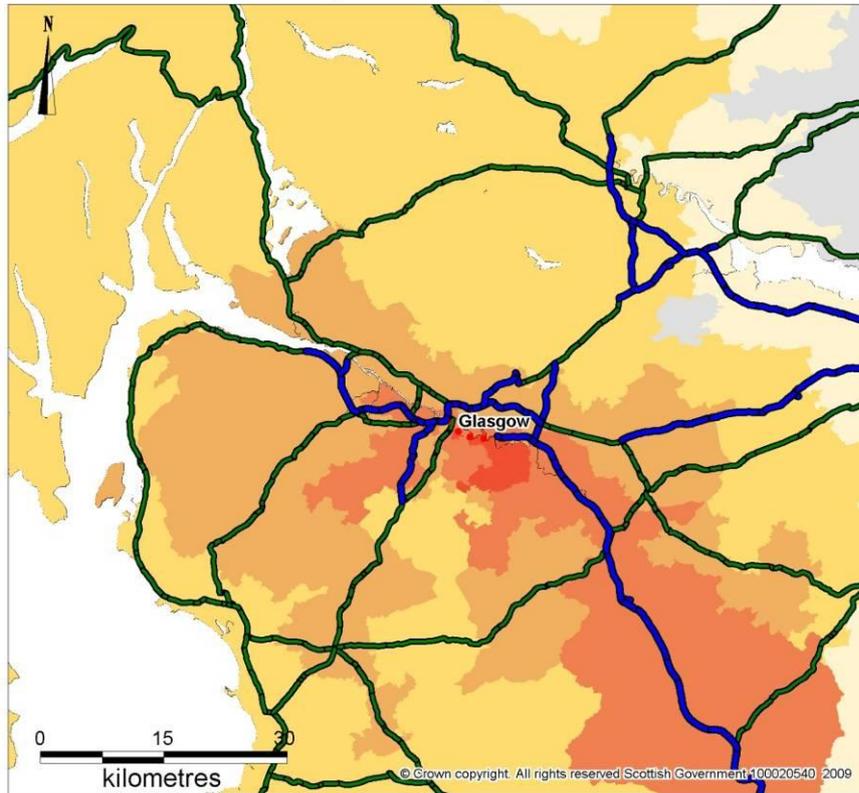


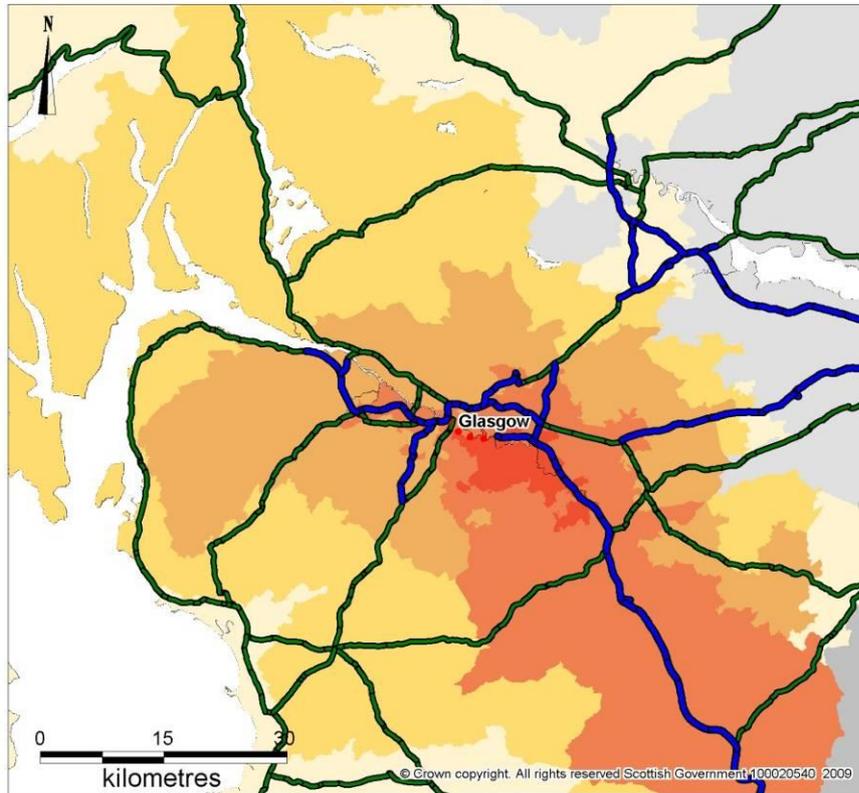
Figure 6.3 Change in Accessibility Measure 2, Households with One Car

Change in Accessibility in 2021

Test MG - Test ME (Ref Case)

c1.42.07 TELMoS_07

Test MG - 8 September 2009



Access for OGV

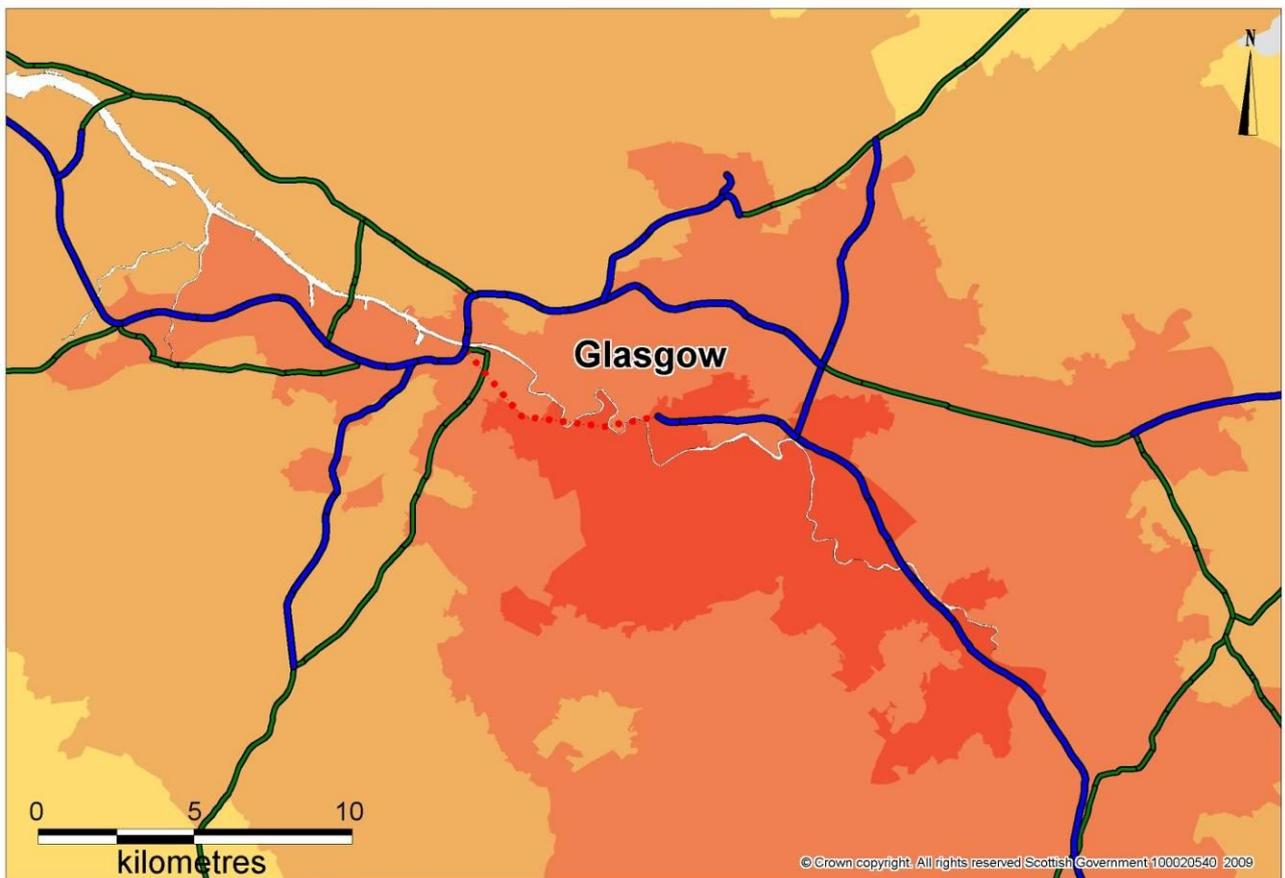
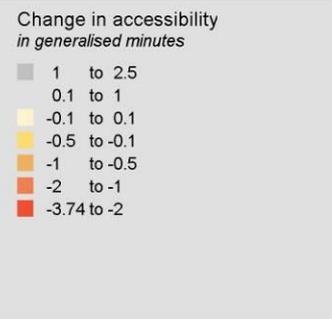


Figure 6.4 Change in Accessibility Measure 6, Other Goods Vehicles

6.4.9 This improvement, in turn, influences the relative attractiveness of zones along these corridors. The following maps demonstrate the consequences of these changes:

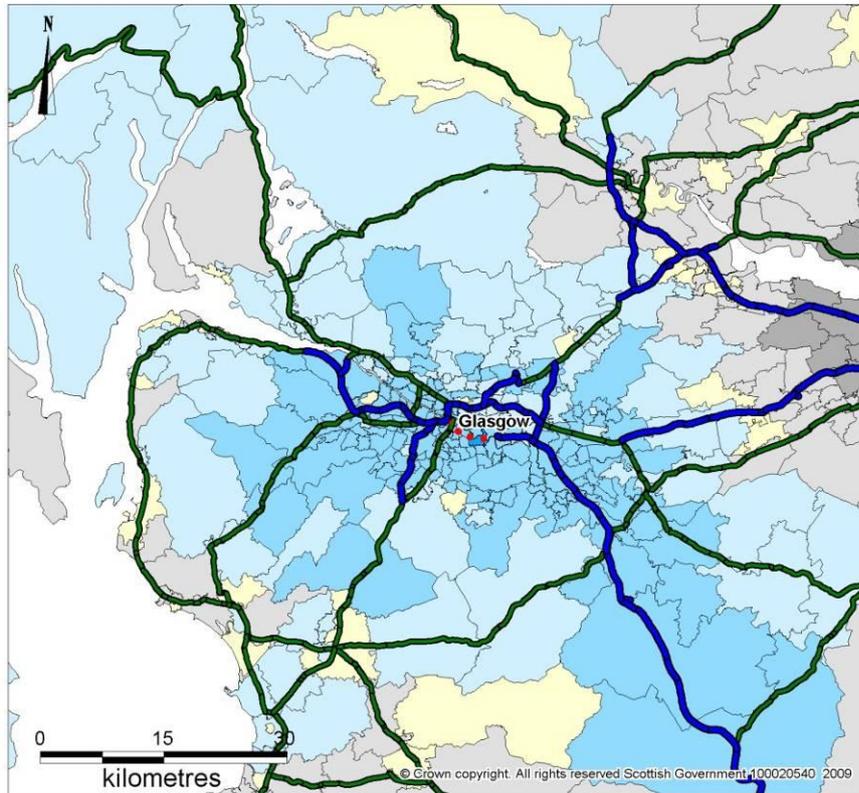
- Figure 6.5 shows the predicted changes in rent for residential floorspace. One zone has a forecast increase in rent of 5% or more. This is Zone 147 (Rutherglen, South Lanarkshire). Two zones have increases of between 4 and 5%. They are Zone 152 (Cambuslang) and Zone 158 (Newton). Both are likewise in South Lanarkshire;
- Figure 6.6 shows the predicted changes in rent for office floorspace. Seven Zones have forecast increases in rent of 25% or more, five of these are in South Lanarkshire (Zones 147, Rutherglen, 152, Cambuslang, 155, Kirkhill, 156, Flemington, 158 Newton (Lanarkshire)), and two in Glasgow (Zones 315 Carmyle and 326 Birkenshaw). One zone had a decline in rent of 20% or more (zones 367 Hartwood in North Lanarkshire);
- Figure 6.7 shows the predicted percentage change in population in 2021, compared to the Reference Case. There are increases of 2% or more in six zones, five within South Lanarkshire (Zones 145 Croftfoot 147 Rutherglen, 152, Cambusland, 156 Flemington, and 158 Newton) and one within Glasgow (293 Govanhill);
- Figure 6.8 shows the predicted percentage change in employment in 2021, compared to the Reference Case. Five zones have increases in employment of 10% or more. Three of these are within South Lanarkshire, the rest within Glasgow;
- Figure 6.9 shows that there are virtually no predicted changes in housing floorspace. This is due to the fact that nearly all permissible housing developed is taken up in each year, and there is very little scope for the development process to respond to increased demand; and
- Figure 6.10 shows the predicted changes in office floorspace stock in 2021, showing significant changes in the spatial distribution of supply as a result of the impact of M74C on demand and rents during the decade since 2011. The distribution of office supply is clearly influenced by where permissions for office development occur. Some of the zones that show little or no impact do so because there are no permissions located within those zones.

6.4.10 All of these maps show the impacts of the M74C by 2021 as percentage changes to the equivalent 2021 value in the without M74C case. The rents are those resulting from modelled “transactions” in 2021. The population, employment and floorspace variables mapped are the totals forecast for 2021. For the floorspace variables, in particular, the impacts would appear more dramatic if we plotted the changes in new floorspace built during the period 2011-2021.

6.4.11 The maps show that the impacts on rents (which reflects the changing demand to locate in each zone, relative to the space available there) and on population and employment (resulting from the changed competition for space in each location) broadly follow the changes in accessibility, but with modifications resulting both from the changes in non-residential floorspace and from the changes in the overall economic activity of West Central Scotland (considered further below).

Change in Rents (2021)

c1.42.07 TELMoS_07
Test MG - 8 September 2009



**Housing Flsp
Test MG
Ref. Case ME**

Change in Rents ME-MG
in percentage

- 5 to 6.48
- 1 to 5
- 0.1 to 1
- 0.1 to 0.1
- 1 to -0.1
- 1.62 to -1

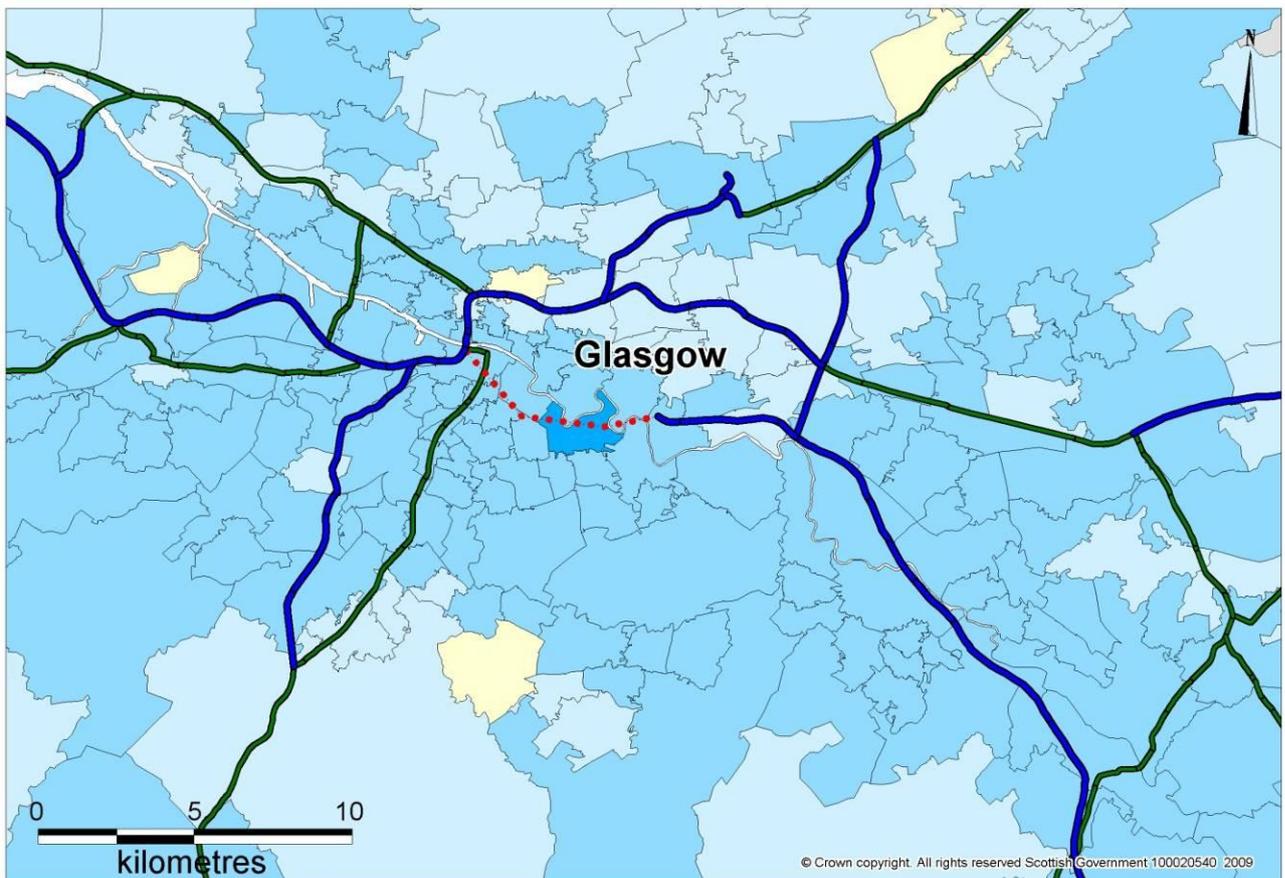


Figure 6.5 Change in residential rent 2021 (Test ME- Test MG)

Change in Rents (2021)

c1.42.07 TELMoS_07
 Test MG - 8 September 2009

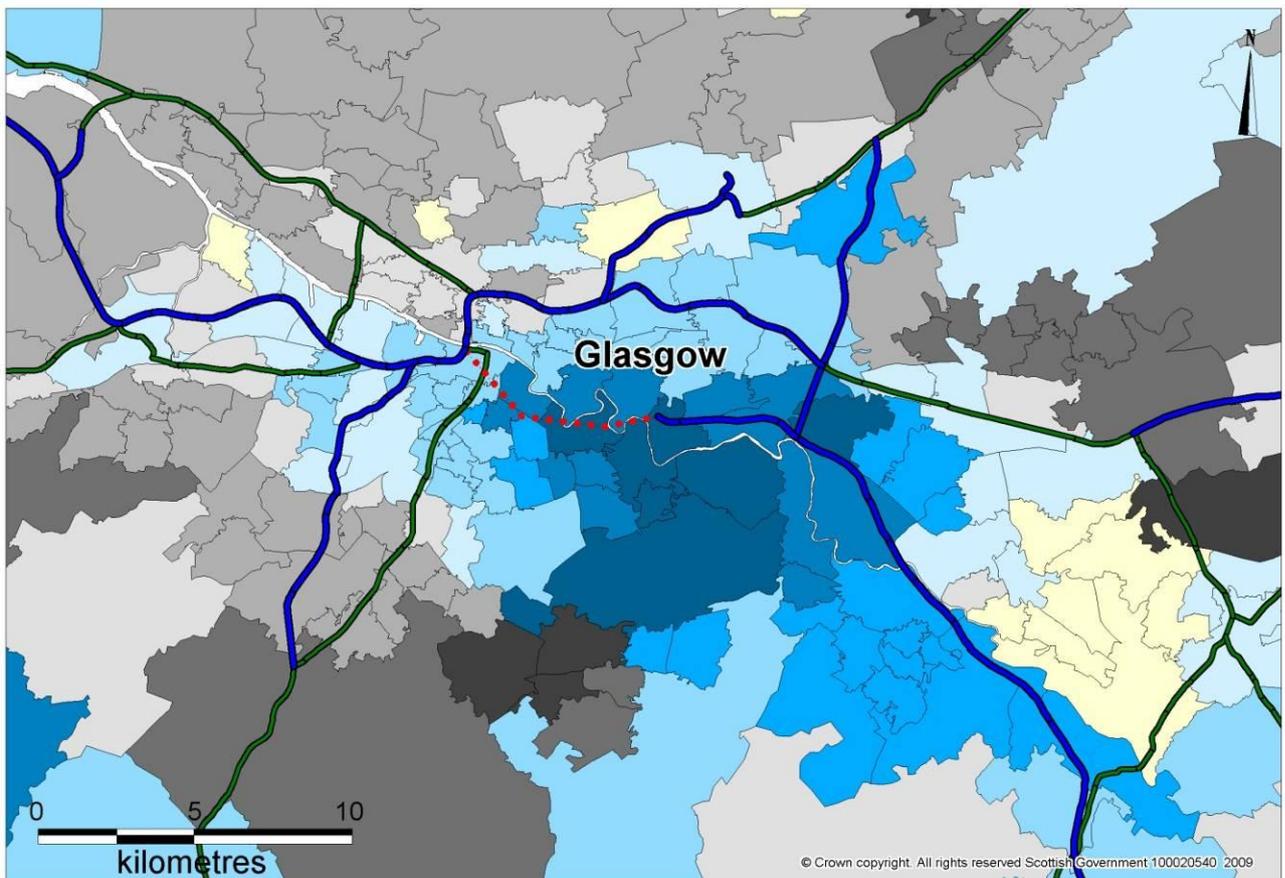
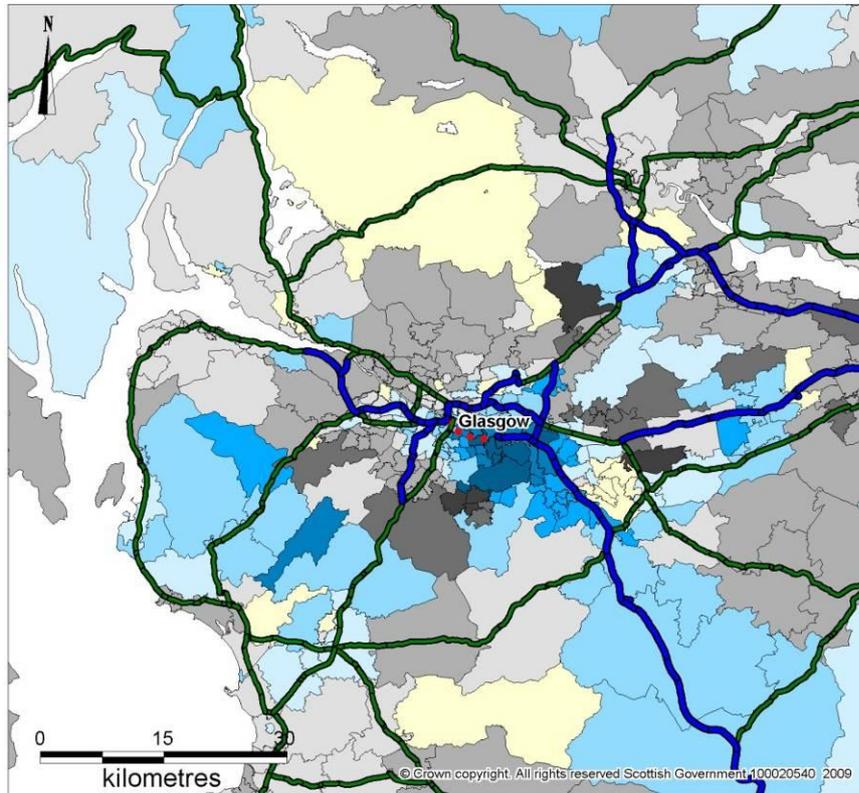


Figure 6.6 Change in Office Rent, 2021 (Test ME-Test MG)

Change in Population (2021)

c1.42.07 TELMoS_07
Test MG - 8 September 2009

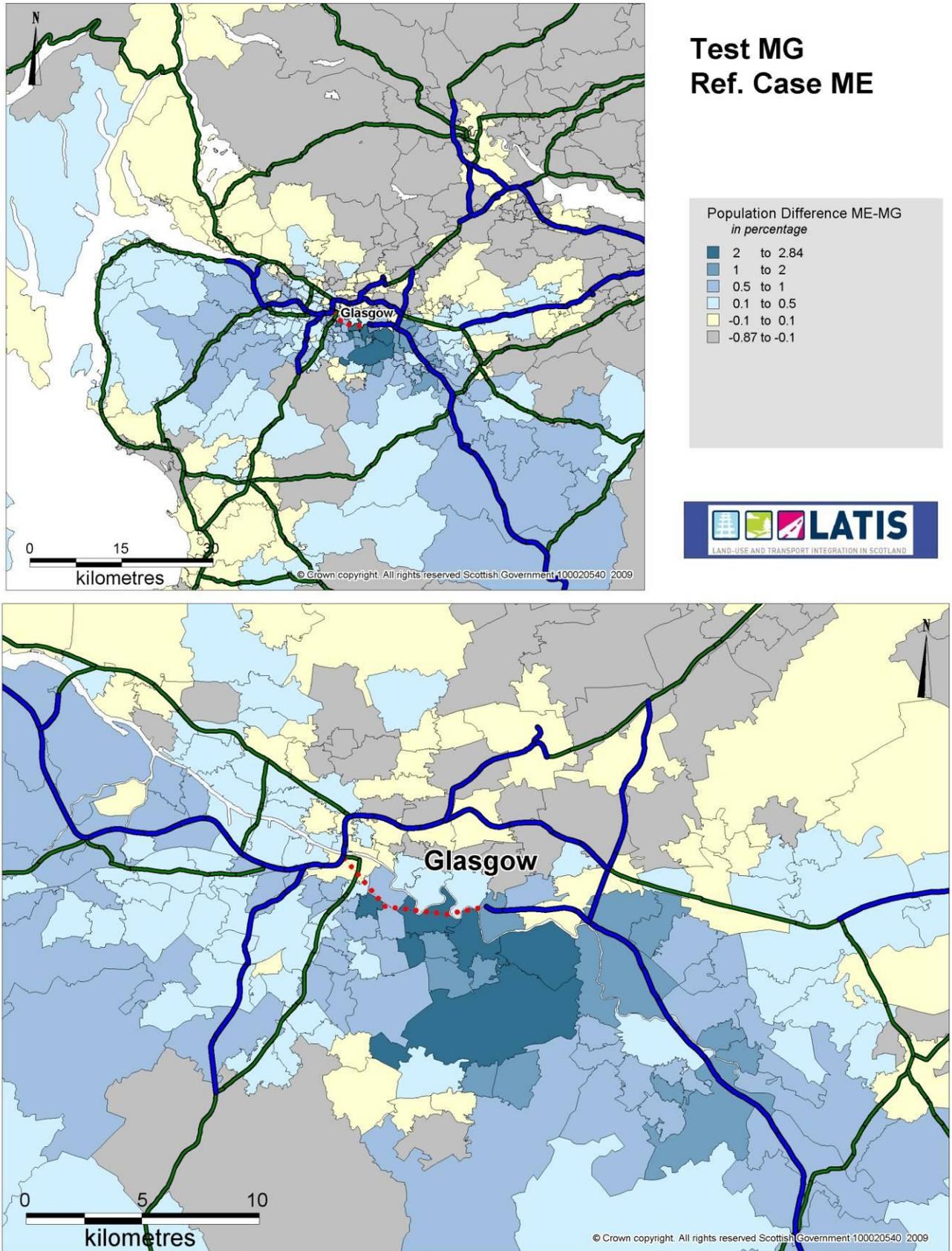


Figure 6.7 Change in Population, 2021 (Test ME- Test MG)

Change in Employment (2021)

c1.42.07 TELMoS_07
Test MG - 8 September 2009

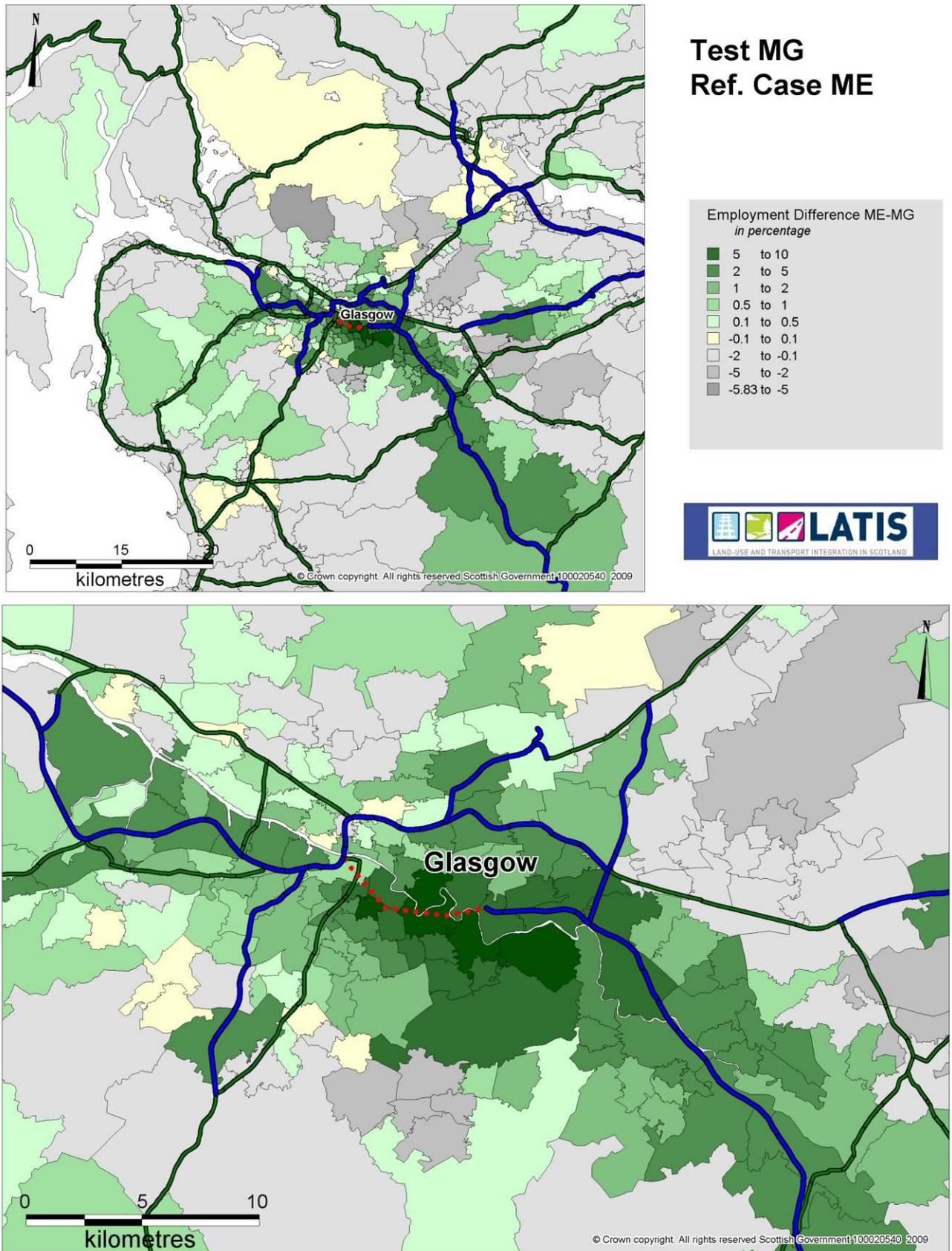
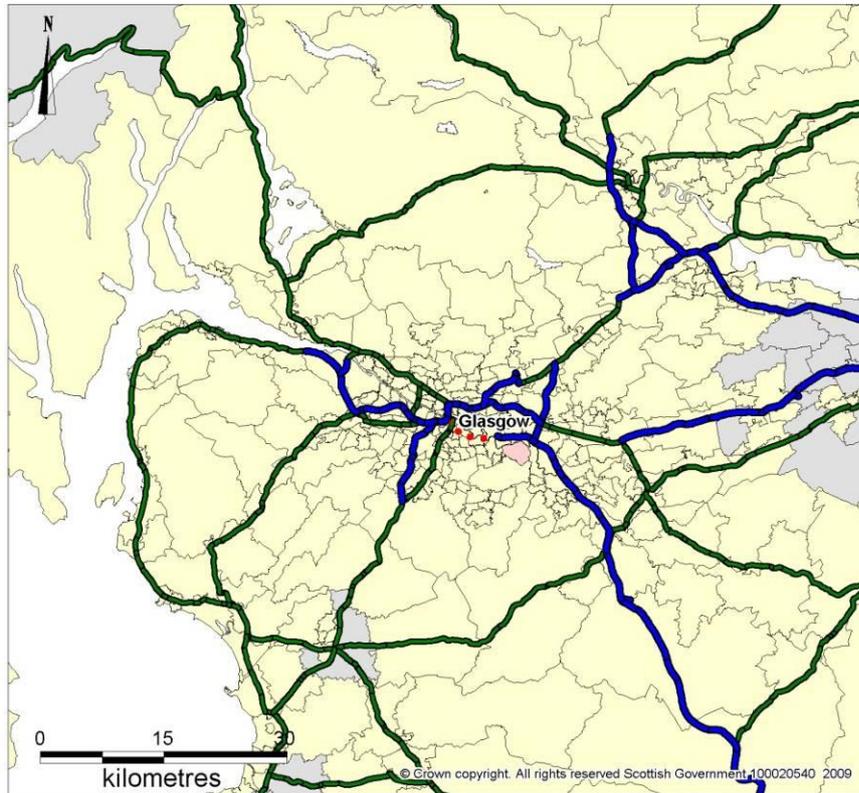


Figure 6.8 Change in Employment 2021,(Test ME-Test MG)

Change in Floorspace (2021)

c1.42.07 TELMoS_07
Test MG - 8 September 2009



Housing Flsp
Test MG
Ref. Case ME

Change in Housing Flsp ME-MG
in percentage

- 0.1 to 0.25
- 0.1 to 0.1
- 0.71 to -0.1

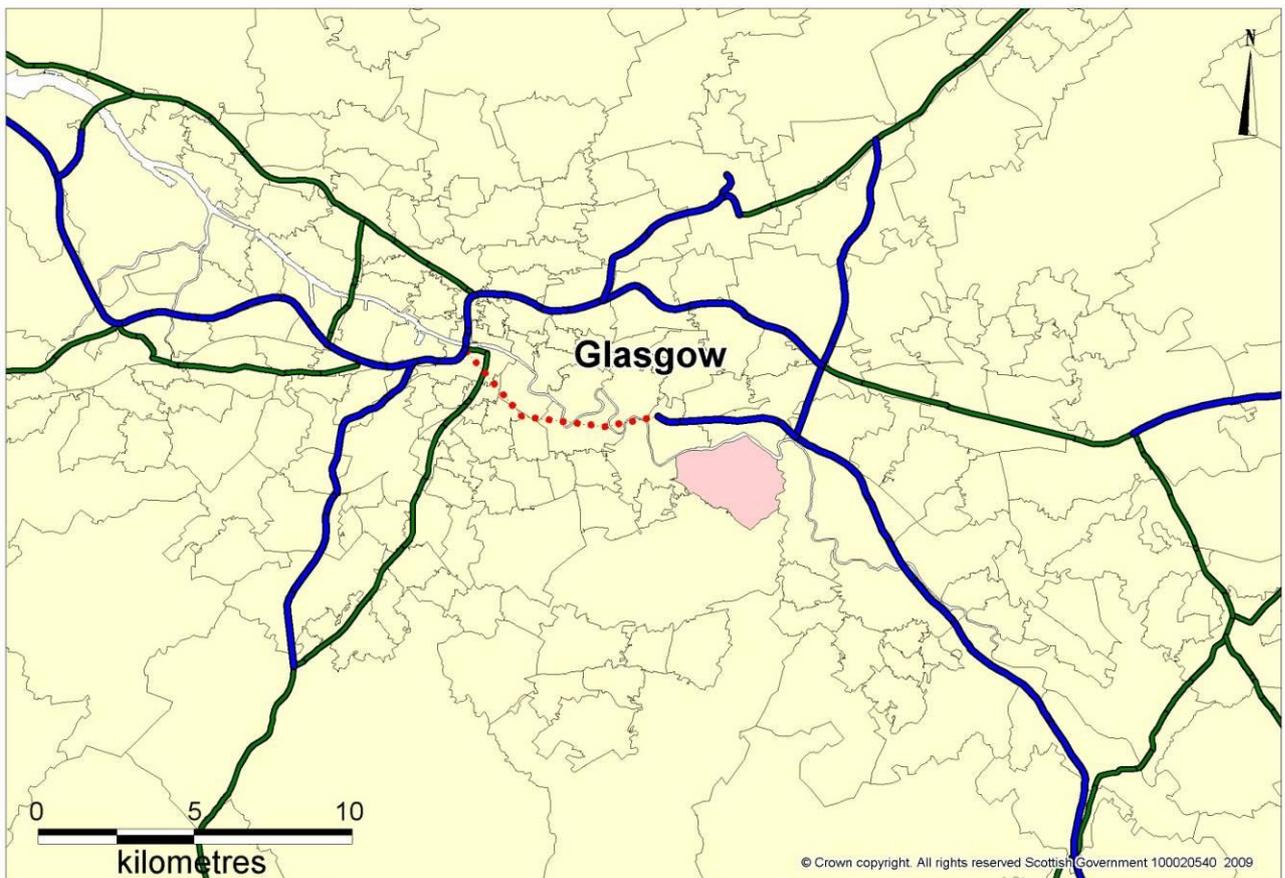


Figure 6.9 Change in Residential Floorspace 2021 (Test ME-Test MG)

Change in Floorspace (2021)

c1.42.07 TELMoS_07
 Test MG - 8 September 2009

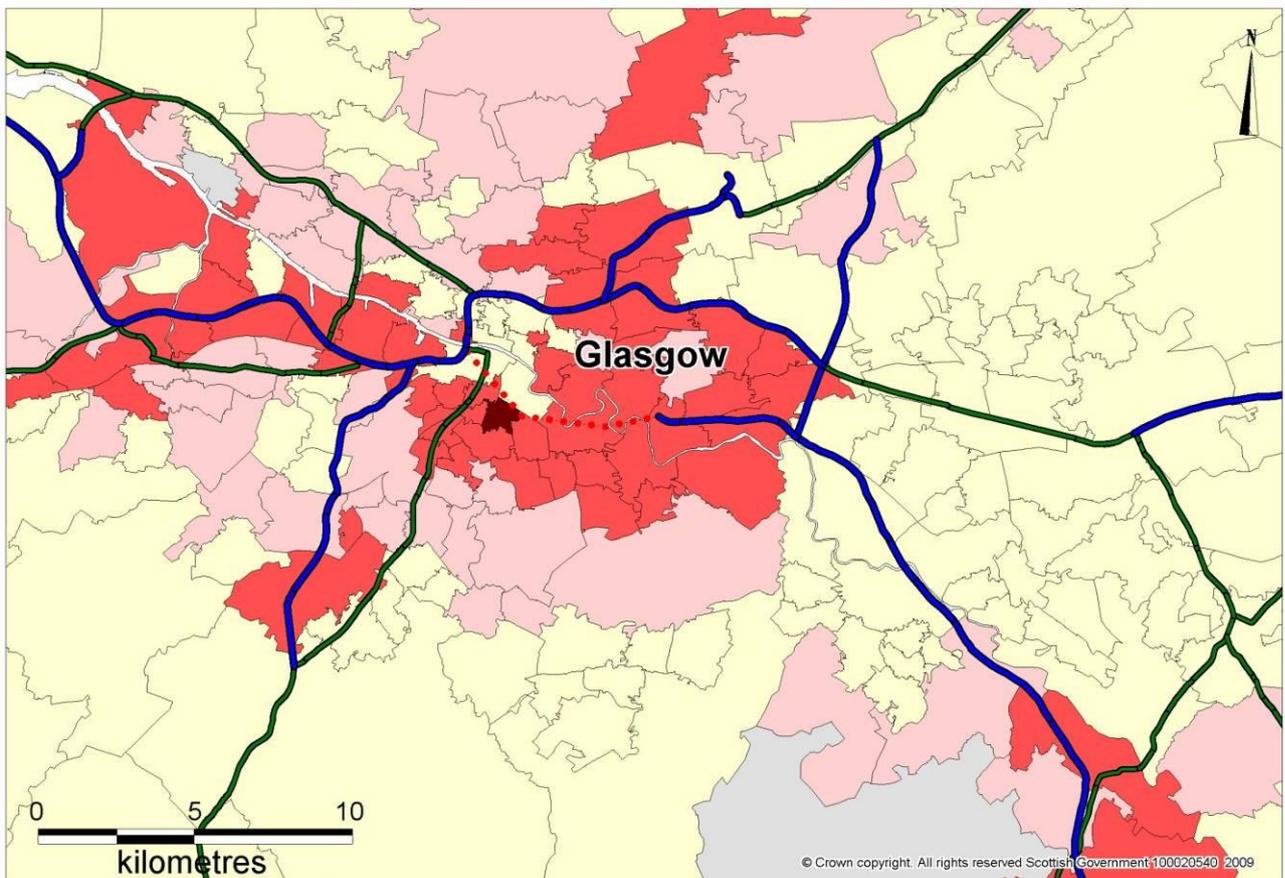
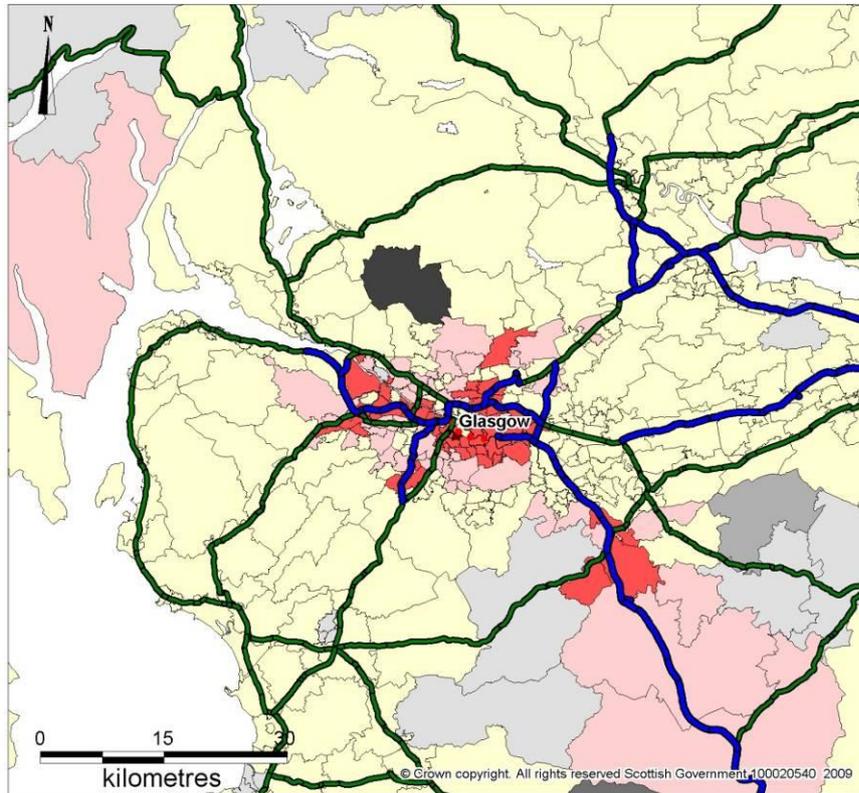


Figure 6.10 Change in Office Floorspace 2021 (Test ME-Test MG)

Demonstration Test 3: Road Network

- 6.4.12 The maps show that the largest impacts are within the immediate vicinity of the M74 extension, however there are other impacts both in zones along the strategic road network and in those zones principally within the Glasgow and Lanarkshire Areas where the relative accessibility (and attractiveness as a location) declines.
- 6.4.13 Tables 6.1 and 6.2 allow a nationwide assessment of the impact of this intervention. They compare the population and employment forecasts for 2017 for the demonstration test (Test MG) and the Reference Case (Test ME) at Local Authority level.
- 6.4.14 Table 6.1 shows a trivial change (-2) in the total population for Scotland, which is purely the result of numerical rounding errors within the model software. At a Local Authority level there is a slight re-distribution of population across the country, with increases over the ten year period in South Lanarkshire, East Renfrewshire, City of Glasgow, North Lanarkshire, Renfrewshire, West Dunbartonshire and Inverclyde and decreases elsewhere. The largest absolute increases were in South Lanarkshire (plus 2,688) and the City of Glasgow (plus 1,123). The largest absolute decreases were in the City of Edinburgh (-1427) and Fife (-969).
- 6.4.15 The increase in total employment for Scotland is again a trivial change caused by numerical rounding error. At a Local Authority level there is a re-distribution of employment across the country, with increases over the ten year period in South Lanarkshire, East Renfrewshire, City of Glasgow, East Dunbartonshire and Renfrewshire. The largest absolute increases were once more in South Lanarkshire (2,789) and the City of Glasgow (6,789). The largest absolute decreases were in the City of Edinburgh (-4,175) and Midlothian (-2019).
- 6.4.16 The general spatial pattern of these changes appears consistent with the nature of the adjustment to the road network. Those areas that gain in population and/or employment are those where there is a relative improvement in accessibility.

Table 6.1 Comparison of Tests ME and MD: Population

Local Authority	Test MG-ME absolute change			Test MG-ME % change		
	2011	2016	2021	2011	2016	2021
Dumfries & Galloway	0	79	21	0.0%	0.01%	0.05%
Scottish Borders	0	-224	-327	0.0%	-0.20%	-0.22%
East Lothian	0	-87	-217	0.0%	0.02%	-0.28%
Midlothian	0	40	-122	0.0%	-0.15%	-0.09%
City of Edinburgh	0	-967	-1427	0.0%	-0.08%	-0.30%
West Lothian	0	-103	-408	0.0%	-0.19%	-0.17%
South Lanarkshire	0	2069	2688	0.0%	-0.14%	-0.17%
East Ayrshire	0	-32	52	0.0%	0.46%	0.54%
South Ayrshire	0	-22	-56	0.0%	-0.18%	-0.35%

Demonstration Test 3: Road Network

Local Authority	Test MG-ME absolute change			Test MG-ME % change		
	2011	2016	2021	2011	2016	2021
North Ayrshire	0	9	37	0.0%	0.12%	0.06%
East Renfrewshire	0	91	282	0.0%	-0.04%	-0.13%
City of Glasgow	0	784	1123	0.0%	-0.07%	-0.08%
North Lanarkshire	0	408	739	0.0%	0.17%	0.16%
Falkirk	0	-289	-351	0.0%	-0.05%	-0.07%
East Dunbartonshire	0	-208	-8	0.0%	0.06%	0.08%
Renfrewshire	0	558	870	0.0%	0.70%	0.73%
Inverclyde	0	187	179	0.0%	0.41%	0.49%
West Dunbartonshire	0	-63	12	0.0%	0.23%	0.28%
Stirling	0	-195	-137	0.0%	0.12%	0.11%
Clackmannanshire	0	-128	-134	0.0%	0.44%	0.20%
Fife	0	-540	-969	0.0%	0.14%	0.25%
Perth & Kinross	0	-161	-215	0.0%	-0.18%	-0.14%
City of Dundee	0	-85	-77	0.0%	-0.01%	-0.07%
Angus	0	-134	-100	0.0%	-0.07%	-0.28%
Aberdeenshire	0	-238	-310	0.0%	-0.21%	-0.16%
City of Aberdeen	0	-109	-180	0.0%	-0.07%	-0.54%
Moray	0	-126	-170	0.0%	-0.16%	-0.25%
Argyll & Bute	0	-22	-36	0.0%	-0.20%	-0.16%
Highland	0	-346	-528	0.0%	-0.16%	-0.20%
Eilean Siar	0	-56	-88	0.0%	-0.14%	-0.34%
Orkney Islands	0	-31	-71	0.0%	-0.34%	-0.52%
Shetland Islands	0	-56	-70	0.0%	-0.35%	-0.64%
Total	0	2	-2	0.0%	0.0%	0.0%

Table 6.2 Comparison of Tests ME and MG: employment

Local Authority	Test MG-ME absolute change			Test MG-ME % change		
	2011	2016	2021	2011	2016	2021
Dumfries & Galloway	0	-159	-243	0.0%	-0.3%	-0.4%
Scottish Borders	0	-1	-77	0.0%	0.0%	-0.2%
East Lothian	0	-235	-492	0.0%	-0.8%	-1.6%
Midlothian	0	-259	-2019	0.0%	-0.7%	-3.7%
City of Edinburgh	0	-2560	-4175	0.0%	-0.8%	-1.2%
West Lothian	0	-231	-373	0.0%	-0.3%	-0.6%
South Lanarkshire	0	1565	2789	0.0%	1.4%	2.6%
East Ayrshire	0	-76	-78	0.0%	-0.2%	-0.2%
South Ayrshire	0	-116	-116	0.0%	-0.3%	-0.3%
North Ayrshire	0	-129	-131	0.0%	-0.3%	-0.3%
East Renfrewshire	0	31	320	0.0%	0.1%	1.2%
City of Glasgow	0	3529	6789	0.0%	0.9%	1.7%
North Lanarkshire	0	-263	-156	0.0%	-0.2%	-0.1%
Falkirk	0	-200	-317	0.0%	-0.3%	-0.5%
East Dunbartonshire	0	-40	87	0.0%	-0.1%	0.3%
Renfrewshire	0	411	912	0.0%	0.6%	1.3%
Inverclyde	0	-88	-141	0.0%	-0.2%	-0.3%
West Dunbartonshire	0	-40	-24	0.0%	-0.1%	-0.1%
Stirling	0	-83	-248	0.0%	-0.2%	-0.6%
Clackmannanshire	0	-69	-106	0.0%	-0.5%	-0.8%
Fife	0	-289	-600	0.0%	-0.2%	-0.4%
Perth & Kinross	0	-25	-77	0.0%	0.0%	-0.2%
City of Dundee	0	-186	-344	0.0%	-0.3%	-0.4%
Angus	0	-34	-152	0.0%	-0.1%	-0.4%
Aberdeenshire	0	-126	-270	0.0%	-0.2%	-0.3%
City of Aberdeen	0	-164	-373	0.0%	-0.1%	-0.3%
Moray	0	-22	-46	0.0%	-0.1%	-0.2%
Argyll & Bute	0	-51	-56	0.0%	-0.1%	-0.1%

Local Authority	Test MG-ME absolute change			Test MG-ME % change		
	2011	2016	2021	2011	2016	2021
Highland	0	-98	-197	0.0%	-0.1%	-0.2%
Eilean Siar	0	1	3	0.0%	0.0%	0.0%
Orkney Islands	0	3	1	0.0%	0.0%	0.0%
Shetland Islands	0	3	6	0.0%	0.0%	0.0%
Total	0	-2	95	0.0%	0.0%	0.4%

6.4.17 Figure 6.11 shows the profile of impacts over the modelled decade, spatially aggregated to the Regional Transport Partnership areas. This indicates that the impacts develop in two phases. The first is one of relatively rapid change over the first few years; the second is slower but actually accelerates towards the end of the period considered.

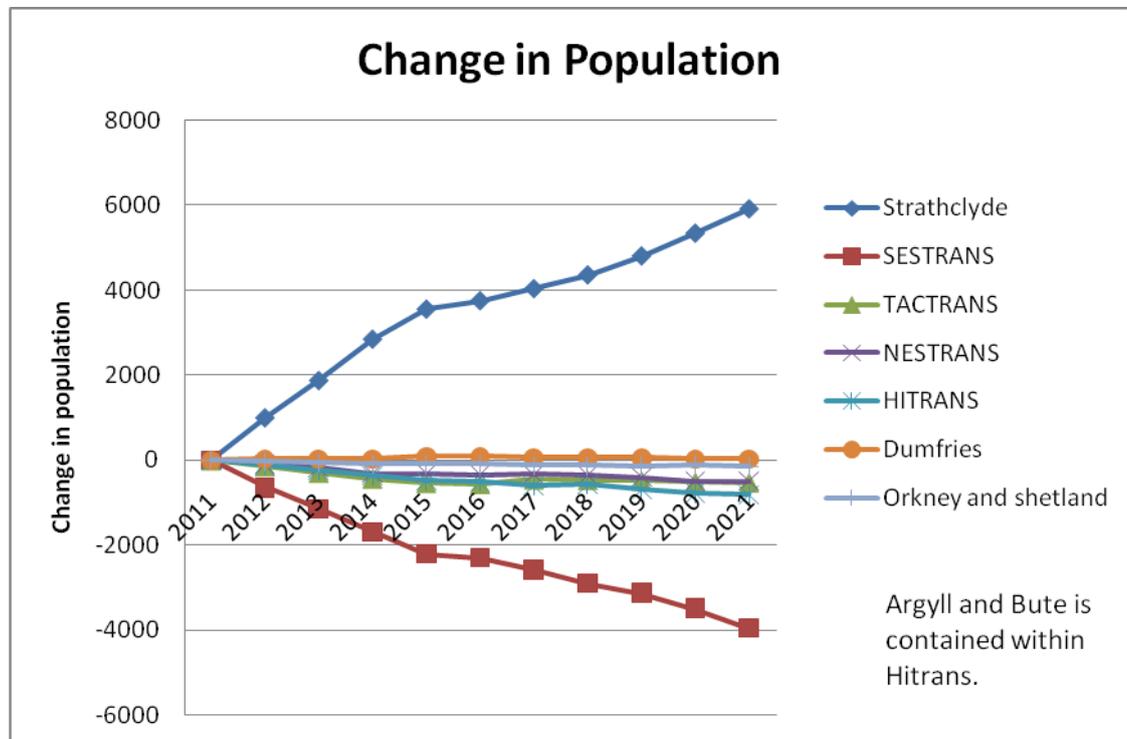


Figure 6.11 Change in population by RTP area (Test ME-MG)

6.4.18 From knowledge of the model design we believe that the short-term impacts are largely due to more local moves, ie changes in housing choice in response to the changed patterns of accessibility in around the Glasgow area, and that the longer-term impacts are likely to be due more to longer-distance migration in response to continuing economic impacts of the scheme. The latter is consistent with the fact that the population impact shows a tendency to increase towards the end of the decade; this is because the impact on migration patterns will tend to increase as the impact on the distribution of economic activity, and hence on the distribution of employment opportunities, grows over time (Eventually, of course, the economic impact would tend to stabilise, and after that the migration impact would in turn eventually cease to draw in additional population. From previous work we would expect that this could take another 20 years or more).

6.5 Commuting-related impacts of M74C in TMfS:07 and TELMoS:07

- 6.5.1 As part of the TMfS/TELMoS Audit process we were asked for information on the relationship between the changes in the TMfS travel to work matrices and the TELMoS travel to work matrices. The request for this information stemmed from the discussion of how travel-to-work patterns are represented in TELMoS:07 and TMfS:07, and from questions about the consistency of these patterns and of their changes in response to changing land-uses and transport costs.
- 6.5.2 It needs to be kept in mind that the travel-to-work matrices in TELMoS:07 are tables of all working persons by home zone and work zone, disaggregated by socio-economic group and car-ownership; those in TMfS:07 are tables of motorised trips by home zone, work zone, mode, car-availability segment and time of day.
- 6.5.3 In previous discussion it was noted that there had been difficulty in converging the new version of the where-to-work/whether-to-work¹ component of TELMoS which was introduced in order to provide an incremental model of these choices which would take 2001 Census travel-to-work data as its starting point. This was intended to replace the earlier where-to-work component, which produced a synthetic matrix in each year, and to improve the whether-to-work modelling. Up to now it has not been possible to use this.
- 6.5.4 The work on this new component (known as “wages-based ME12”) has reached the point where it is possible to make some use of it, though still impractical to run it in every year of every forecast as would be preferred. We will continue to try to improve the speed and reliability of its convergence, but in the meantime we have used it just in the 2012 TELMoS year for both the Reference Case and the no-M74 Case. The results below are therefore based on using this improved component. These are separate runs of the model from the “full TELMoS only” ME and MG tests reported in the preceding and following sections of this chapter, with some differences in detail. We hope to get to a point where “wages-based ME12” can be integrated into regular use of TELMoS in the not too distant future.
- 6.5.5 We have focussed on the 2012 TELMoS outputs (rather than a later year) because these involve a minimum element of the other land-use changes arising in response to M74C (ie a minimum of the impacts described in the preceding changes of this chapter), and this makes the 2012 impacts more appropriate to compare with the “pure transport” impacts produced by the 2011 TMfS runs with and without M74C (in future it might be possible to carry out a run where TELMoS would be used to produce where-to-work and whether-to-work responses to the M74C without all the other land-use/economic responses switched off, but this would be more complex).
- 6.5.6 Table 6.3 shows the TMfS 2011 changes in morning peak home-work trips by car between the four local authorities most directly affected. As with the rest of this chapter, for ease of understanding these are shown as the impacts of adding the M74, ie the impact of the with-M74C TMfS Reference Case compared with the no-M74C case. These impacts reflect all of the responses working within TMfS itself, ie mode shift, redistribution (within the doubly-constrained form of the model for commuting trips).

¹ “where-to-work/whether-to-work” correctly describes the model calculations, but the “whether to work” element is perhaps better (and equally accurately) seen as representing residents’ competition for the available jobs.

Table 6.3 2011 TMfS Major changes in AM peak car commuting trips due to M74C

LA	North Lanarkshire	South Lanarkshire	City of Glasgow	Renfrewshire
North Lanarkshire	-127 (-1.6%)	-32(-1.8%)	66(3.7%)	18(13.7%)
South Lanarkshire	-46(-2.8%)	-177(-2.3%)	106(5.2%)	40(21.5%)
City of Glasgow	46(3.7%)	60(4.6%)	-172(-1.2%)	-22(-1.7%)
Renfrewshire	23(18.4%)	35(19.6%)	-31(-1.9%)	-80(-1.6%)

6.5.7 Table 6.4 shows the changes in the home/work person matrices from the 2012 runs of TELMoS:07, using the improved where/whether-to-work sub-model as described above. Again this is shown as the impacts of adding the M74 Completion relative to the no-M74 Case. Note that the impacts here represent the combined effects of the first year's "land-use" changes in response to the M74 Completion. These are only a fraction of the ten year impacts described earlier in this chapter, but they include some additional employment attracted to the Glasgow/Lanarkshire areas due to the impact of the M74C in the TELMoS Regional Economic Model; some redistribution of employment within those areas, due to the more local impacts of the opening; and some redistribution of households, as well as the direct effect of the generalised cost changes on residents' choices of where and whether to work.

Table 6.4 2012 changes in persons by home and work due to M74C, TELMoS:07

LA	North Lanarkshire	South Lanarkshire	City of Glasgow	Renfrewshire
North Lanarkshire	-262	-13	406	53
South Lanarkshire	-79	-162	590	105
City of Glasgow	75	134	96	-15
Renfrewshire	53	80	-65	72

6.5.8 The associated "land-use" changes are shown in Table 6.5.

Table 6.5 2012 changes in land-use due to M74C, wages-based ME12 runs²

LA	Employment (workplace)	Population (resident)	...of which working-age	... of which working residents
North Lanarkshire	-135	+81	+34	+73
South Lanarkshire	+131	+751	+563	+422
City of Glasgow	+1103	+45	+20	+195
Renfrewshire	+267	+239	+181	+145

² As noted earlier these results are from tests which differed in detail from the ME/MG tests reported elsewhere in this chapter, so these impacts do not exactly represent the first year's worth of the 10-year impacts described earlier..

6.5.9 The table shows that as a result of the M74C scheme,

- in these short-term (one-year), North Lanarkshire is losing jobs, but the other three districts are all gaining;
- all four districts are gaining total residents, residents of working age and residents in employment;
- in South Lanarkshire and Renfrewshire, about three-quarters of the additional residents are of working age, whereas in North Lanarkshire and Glasgow less than half of the additional residents are of working age; this indicates that South Lanarkshire and Renfrewshire are on balance gaining additional households with high proportions of working-age members, whilst on balance Glasgow and North Lanarkshire are gaining additional households with lower proportions of working-age members; and
- there is an increase in the number of working residents in all four local authorities. In Glasgow the increase is greater than the increase in total population. This is the result of comparing net change in working residents from two tests. However they suggest that there may be higher levels of employment amongst the population of working age as a result of the improvements to the M74.

6.5.10 We believe that the relationship between the TMFS:07 and TELMoS:07 outputs appears broadly reasonable given the differences in definitions. As in other analysis of TMFS:07 and TELMoS:07 outputs, the general ratio of trips to persons seems low. There are some positive values in the TELMoS 2012 results for home:workplace pairs within Glasgow and within Renfrewshire whilst the corresponding trip changes are negative in TMfS 2011. These may be explained by the overall growth in these authorities' areas as a result of the motorway scheme. Given the role of multiplier effects, etc, we would not expect that all the additional commuting would be in journeys where generalised costs have been reduced.

6.6 Comparison of the impacts with other evidence

6.6.1 It is not possible to check the results of impact tests against directly observed evidence. Even if we were to wait for the results of the M74C monitoring study (and if the results of that study include estimates of the impacts in terms of variables comparable with those in TELMoS) it would only provide the monitoring team's estimates of the differences between the with-M74C situation as it will exist in the near future and their assumptions about the without-M74C situation that might have existing then if the scheme had not been built.

6.6.2 Similarly, it is difficult to apply the concepts of elasticity to measuring the impacts of transport change on population and employment location. These concepts are widely used in testing transport models, particularly in reviewing the consequences of changes in fuel prices and public transport fares. It is highly significant that these variables are not spatially specific. Once we start to consider a spatially specific change in one part of the road network, and spatially specific consequences in terms of numbers of people and jobs located in particular zones, it is very difficult to formulate the relationship as a clearly-defined elasticity, still more difficult to establish empirically what that elasticity is.

6.6.3 As part of ongoing work for TfL we are reviewing what evidence can be brought to bear on the relationship between transport change and locational change, or indeed on any other relationships affecting the distribution of households and employment that could be tested to examine the performance of LUTI models. That has not yet identified any quantitative evidence that can usefully be applied to TELMoS:07.

6.6.4 The one area where we have made some progress is in comparing model results with findings from work in property economics, and specifically with the results of hedonic price or rent models. Hedonic property price models are regression models which attempt to explain property prices in terms of variables (often quite large numbers of variables) describing:

- the property itself;
- its neighbourhood or immediate surroundings; and
- its accessibility to other parts of the city or region.

6.6.5 The underlying theory is that the purchaser, in paying the observed price, is purchasing a bundle of "housing services" such as bedrooms, bathrooms, garages and garden space within the property; a quiet or noisy, leafy or wholly built-up neighbourhood; and more or less easy access to facilities and opportunities such as work, shopping, entertainment and so on. Hedonic rent analyses typically do the equivalent, with obviously different variables, for commercial property considered in pounds per square metre per annum.

6.6.6 The Glasgow area has been particularly well covered by hedonic analyses of property prices and rents. We have identified four studies:

- two on residential prices, one by Leishman (2001)³ and the other by Ismail⁴ (2005) (note that since the Ismail study is more recent and particularly helpful, as described below, we have not pursued the Leishman reference); and
- two on commercial rents – one for offices and the other for industrial property – both by Dunse and Jones (1998 and 2005)⁵.

6.6.7 Ismail's work on **residential** markets used as its accessibility measure one of the accessibility outputs from the base year of the CSTCS LUTI model, which DSC provided with the agreement of the Scottish Executive. She estimated a number of different models, and found significant coefficients on the accessibility measure showing that an increase of one minute (implying an increase of one minute in the expected all-mode average travel time from the zone to all work opportunities) would reduce the value of an average Glasgow property by 1.7% to 2.4%.

6.6.8 To test TELMoS:07 against this result, we have extracted the residential rent changes that occur as a result of the M74C scheme in 2012, and regressed these against the changes in the relevant accessibility measure in 2011. The rent impacts in 2012 are used because the timelags in the model are such that these show the impact on housing demand, due to the changes in accessibility modifying the preferences of locating or relocating households, before any other modelled consequences such as changes in employment or changes in floorspace supply can occur. The percentage rent changes are plotted against the accessibility changes in Figure 6.12. For comparability with Ismail's analysis, only the zones within Glasgow are shown.

³ Leishman, C. (2001) House building and product differentiation: an hedonic price approach, *Journal of Housing and the Built Environment*, 16(2), 131-152.

⁴ Ismail, S (2005): Hedonic Modelling of Housing Markets using Geographical Information System (GIS) and Spatial Statistics: A Case Study of Glasgow, Scotland. Unpublished PhD dissertation, University of Aberdeen Department of Land Economy

⁵ Dunse, N and C Jones (1998): A hedonic price model of office rents. *Journal of Property Valuation and Investment*, vol 16, no 3, pp 297-312.

Dunse, N and C Jones (2005): UK roads policy, accessibility and industrial rents. In Adams, D, C Watkins and M White: *Planning, public policy and property markets*. Blackwell, Oxford.

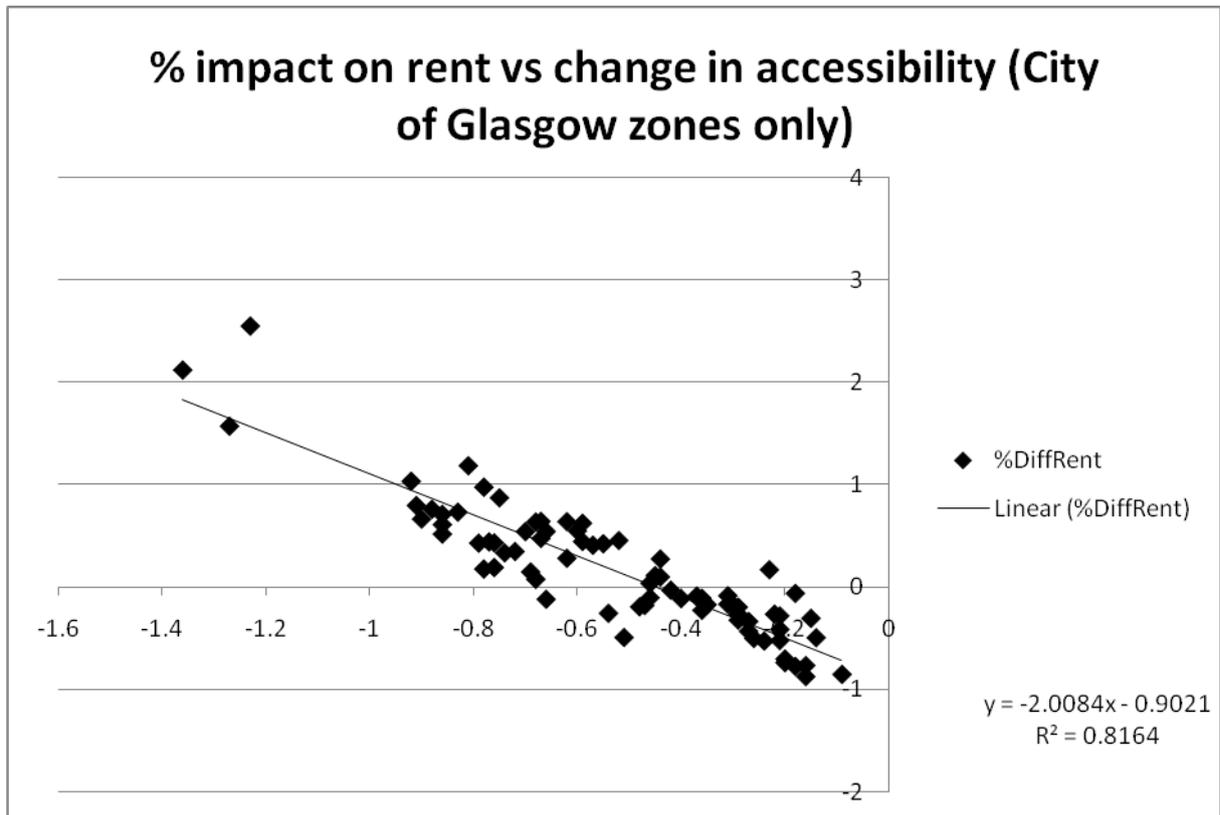


Figure 6.12 Percentage impact on rent compared to change in accessibility

6.6.9 Although the accessibility changes resulting from the M74C are the sole cause of the rent changes, the impacts on rents in individual zones are complicated by the facts that:

- household responses are affected by a number of accessibility measures, whereas in the regression we are considering only the one most closely matching that which Ismail took from the CSTCS outputs; and
- the household responses are also affected by the mix of households in each zone and by the distance deterrence effect in household moves.

6.6.10 Despite these complications, there is as we would expect a strong relationship between the accessibility changes and the rent changes, with an R-squared value in excess of 0.8. The slope of the regression line is very close to -2, showing that an increase of one minute in the accessibility measure is on average bringing about a decrease of 2% in housing rents, within the 1.7% to 2.4% range extracted from Ismail’s analysis. Note that this is a calibration result, not a validation, since one aspect of the adjustments mentioned earlier was to get this response into the right range.

6.6.11 The plot shows that all the accessibility changes are negative, ie (on the measure used) the M74C brings about accessibility improvements for all the zones in Glasgow – so it is as expected more appropriate to talk about decreases in the accessibility measure causing increases in rents. The plot also shows that the zones with the smallest accessibility improvements show decreasing rents; this is reflected in the negative intercept of the regression line, which indicates that a zone with no accessibility change can expected a 0.9% decrease in rents. This is as we would expect, in that in this short-term result there is limited scope for change in the total number of households in the Glasgow area; as these households exercise their increased preference for locating in the zones where accessibility has increased, demand and rents will necessarily tend to decrease in zones where accessibility is unchanged.

6.6.12 In the longer run, as the impacts of the M74C include population gains for the Glasgow area, we would expect the line to shift upwards – but also to be complicated by the effects of other changes arising from the scheme.

6.6.13 The comparison between model outputs and Ismail's empirical results makes a number of important assumptions, notably that:

- it is valid to compare the TELMoS rents with prices (this is supported to some extent by the fact that the base pattern of prices in TELMoS is informed by observed prices); and
- it is valid to compare the differences between two alternative forecast situations, as output from TELMoS, with Ismail's analysis of different in prices across properties at one observed situation.

6.6.14 Nevertheless we believe it is moderately encouraging that we were able to match Ismail's results in the way we have with very limited adjustments to the model that have had limited effects on the other outputs.

6.6.15 The comparison for **office rents** is slightly simpler in that the dependent variable in the empirical analysis was rent per m², as in the model. It is however more complex in that Dunse and Jones used distance from Central Glasgow, plus dummy variables for CBD and adjoining areas, as their location variables rather than a TELMoS-style accessibility measure. The critical result from Dunse and Jones was a decrease in rent/m² of £5.20/Km outside the central and Park areas. The comparison of TELMoS results against this finding involves:

- regressing a TELMoS accessibility measure against distance from Central Glasgow, and using this to convert the rent gradient per Km into a rent gradient per minute;
- converting the rent gradient from £/m²/year into £/m²/week (for reasons connected with the Family Expenditure Survey results, incomes and rents in TELMoS are per week); and
- regressing the TELMoS office rent changes against the accessibility measure in the same way as for the residential results considered above.

6.6.16 Zones within 1.5Km of the Glasgow Centre zone (Zone 291) were omitted from the analysis in order to avoid the complicating effect of Dunse and Jones' CBD dummy variables. They reported a decrease of £5.20 per additional kilometre from central Glasgow. Within TELMoS, we found that the accessibility measure for in-work access to other businesses increased (worsened) by an average of 0.52 minutes per kilometre from central Glasgow. The ratio of these suggests that an accessibility that is better by one minute, other things being equal, is valued at about £10/m²/year. Regression of the rent changes induced by the M74C scheme against the accessibility changes resulting from that scheme identified a relationship (after converting the rents to annual values) of about £9.41/m²/year per minute of accessibility improvement. This seems respectably close.

6.6.17 This comparison is subject to the same assumptions as for the comparison of house price results (except that in this case both the empirical analysis and the model are working in terms of rents), and could be further refined by adjusting for changes in rents from the period represented in Dunse and Jones' data to the 2001 basis of the model. Given the reasonably good match, however, we have not made any adjustments to the TELMoS coefficients, so this can be regarded as a validation result rather than the result of calibrating to match a new target.

6.6.18 The comparison for **industrial** rents is altogether more complex in that Dunse and Jones used several different location related variables:

- distance from the nearest motorway junction;
- distance from a “central access point”, which is (p142) the intersection of the M8, the M73 and the M74 (this actually extends over several Km, so presumably some mid-point was used); and
- distance from nearest principal town centre.

6.6.19 The first two measures were segmented so that the regression estimated different coefficients per Km according to the distance from the motorway junction or from the central access point. The authors also included a set of local authority area dummy variables which obviously also reflect location (but may be complicated by other effects such as the authorities’ planning policies). The analysis related to industrial property throughout the Strathclyde area

6.6.20 All of the distances used are straight-line distances, rather than network distances, which is understandable from a practical point of view, but probably unfortunate from an analytical one.

6.6.21 For our test of the M74 Completion, the only one of these variables which would be directly be changed would be the distance from the nearest motorway junction. Around the new Polmadie Road or Cambuslang Road intersections on the M74C itself, this distance would be reduced from 2-3Km to 0-1Km. Scaling from D&J’s Figure 7.4 (their page 145) indicates that in their model this would increase the industrial rent index shown from around 120 to around 150, ie by about 25%.

6.6.22 It is probably reasonable to assume that this is a lower bound to the impact of the new motorway on individual properties, since access to the “central access point” will also be improved in network distance and travel time terms, though not in the straight-line distance used in the regressions. (With further work we could possibly regress our accessibility measures for industrial location against distance from the M8/M73/M74 interchange, but doing and using this is complicated by the segmented distance function and the inclusion of other spatial variables.) At the same time this is spatially an upper bound in that it applies only to industrial properties immediately around the new intersections: properties that were 4Km from a motorway intersection and now find themselves 2Km from a new one would only expect about a 10% increase in rent. Although the TELMoS zones in the directly affected area are quite small, the average zonal rent impact of proximity to the new intersections would be smaller.

6.6.23 The actual rent increases in TELMoS zones range up to 10% in the first year. (By 2021 the increases range up to +20%, but the higher values in later years are probably due mainly to the growth in demand caused by the M74C improving accessibility for the Glasgow/Clyde Valley area as a whole and allowing it to attract a greater share of Scotland’s economic activity). As a zonal result this +10% does not seem unreasonable in relation to the figures quoted in the previous paragraph; however we note that if we could convert the other spatial variables from Dunse and Jones’ analysis into TELMoS-comparable terms the empirical effect might increase, which would leave the model looking under-responsive. We also have to note that proximity to motorway intersections is not an explicit element of the TELMoS accessibility function, though the generalised costs calculated in TMfS will reflect the differences in levels of service between motorways and non-motorway urban roads and hence the TELMoS accessibilities will include the advantage of being closer to intersections.

6.6.24 Overall we would conclude from this analysis that:

- for housing, the model has a good match to empirical results from hedonic property price analysis, though this after some recalibration to improve that match;
- for offices, the model has a reasonably good match to hedonic rent analysis, without any new adjustments being undertaken; and
- for industrial space, the evidence is less clear, but it would appear that the effects are in the right direction and of the right magnitude, again without any new adjustments having been needed.

6.7 Conclusion

6.7.1 The purpose of this test was to examine the responses of the model to a substantial change in the transport infrastructure. We have demonstrated that:

- the changes made within TMfS:07 to the road network are converted into plausible patterns of changes in accessibility within TELMoS:07;
- these changes in accessibility influence the relative attractiveness of zones both in the immediate vicinity of the changes to the road network, but also along those parts of the primary road network that would benefit from the addition of the extra road link;
- other zones within the same conurbation, but in locations that do not benefit from the improvement experience a relative decline in the accessibility;
- the demand for residential and employment floorspace is influenced by this change in accessibility and is reflected in the changing rents; and
- ultimately there are changes in the distribution of population and employment between different areas of Scotland as a result of the changes to the road network.

6.7.2 It is impossible to demonstrate that these results are correct, but we believe that they are plausible and consistent with the available evidence from property market studies.

7 Demonstration Test 4: Public Transport

7.1 Objective of the Test

- 7.1.1 This test is designed to demonstrate the response of the land-use model to changes in the public transport network.

7.2 Description of the intervention

- 7.2.1 This test relates to the impacts of the reopened Airdrie-Bathgate (A2B) railway line from the transport network for the TMfS 2011 run. This scheme is included in the Reference Case network for 2011, so the variant test involved removing it.
- 7.2.2 As with the M74 completion test, it is easier to consider changes in terms of the impacts of opening the line, rather than in terms of removing it from the Reference Case. Accordingly the rest of this chapter discusses the results in terms of the impacts of reopening the line and operating the associated services.
- 7.2.3 In broad percentage terms, the Airdrie-Bathgate rail scheme reduces the generalised cost of commuting by public transport between North Lanarkshire and West Lothian by around 10%, between West Lothian and Glasgow by around 7.5% and between North Lanarkshire and Edinburgh by around 6% (see Appendix 1).

7.3 The Model Run

- 7.3.1 The two sets of transport costs taken from TMfS:07 for this demonstration were:

- Test MQ: the reference case including the A2B reopening; and
- Test MR: a run excluding the A2B reopening.

- 7.3.2 For this test, TELMoS:07 was run (for both MQ and MR) for a ten year period, from 2011 to 2021. There was no interaction between the land use and transport models during this ten year period.

7.4 Model Response to the Intervention

- 7.4.1 The opening of the railway and its new stations, together with the associated improvements in services at the Edinburgh end of the line, produces a marked impact on accessibility. This is particularly true for non-car-owning households, but the impact on car-owning households is also sufficiently significant to have some impact on employment location.
- 7.4.2 The increase in demand for both housing and commercial floorspace leads to increased rents, and these lead to increases in development in zones and floorspace types where the rent increases are more marked and where there is permissible floorspace (permission to build) that is not been fully and immediately taken up in the Reference Case.
- 7.4.3 The employment and population impacts in 2021 are mapped in Figures 7.1 and 7.2.

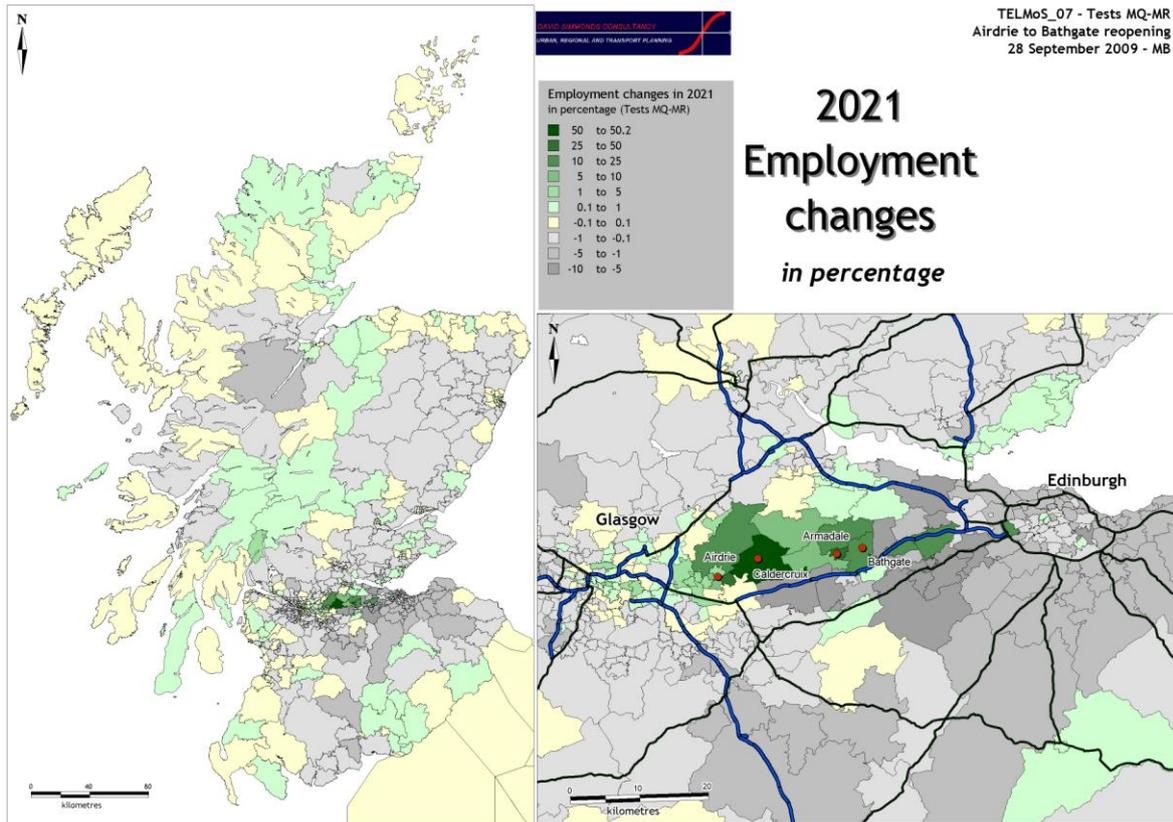


Figure 7.1 Employment Changes 2021 (Test MQ- Test MR)

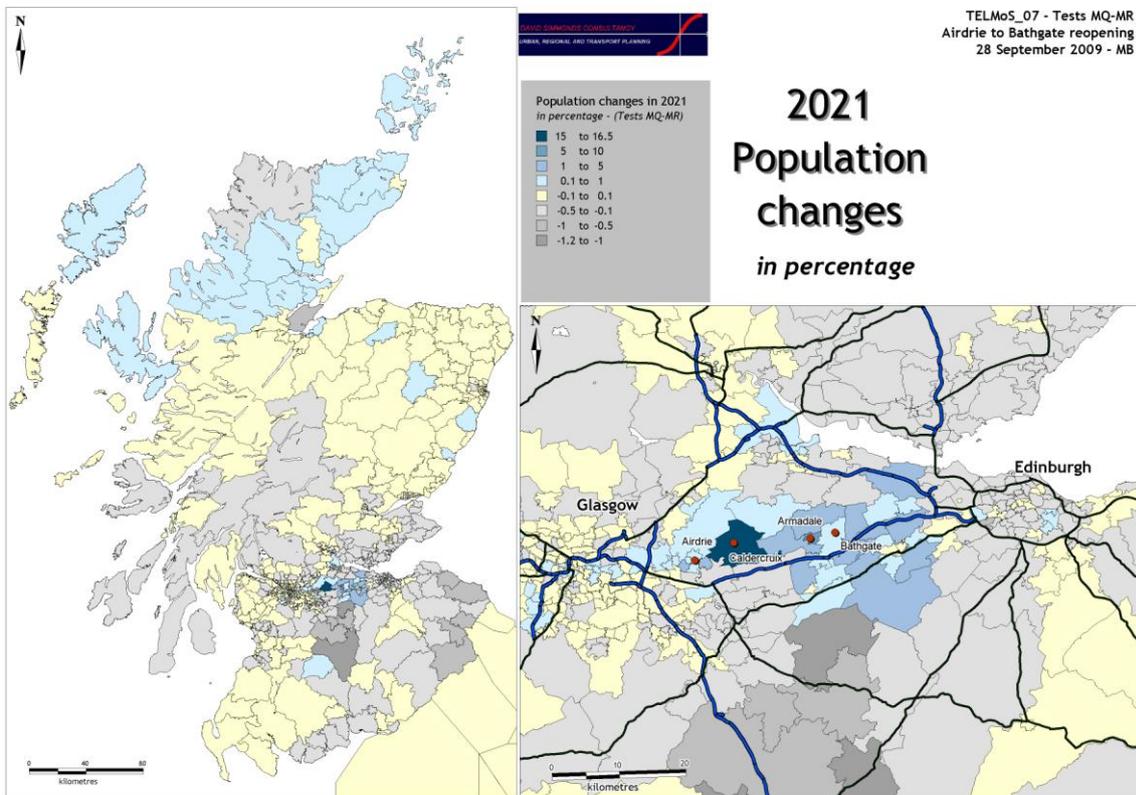


Figure 7.2 Population Change 2021 (Test MQ- Test MR)

7.4.4 The maps show that the positive employment impacts are concentrated in the corridor served by the railway, whilst the positive population impacts tend to spill over into the Livingstone area to the south of Bathgate and the Linlithgow-Winchburgh corridor to the north. Both variables seem to be affected by a certain amount of noise in the model outputs resulting in some local population and employment redistribution in the North and North-East of Scotland.

7.4.5 The build-up of these impacts in the corridors of West Lothian and North Lanarkshire is shown in Figures 7.3 to 7.5.

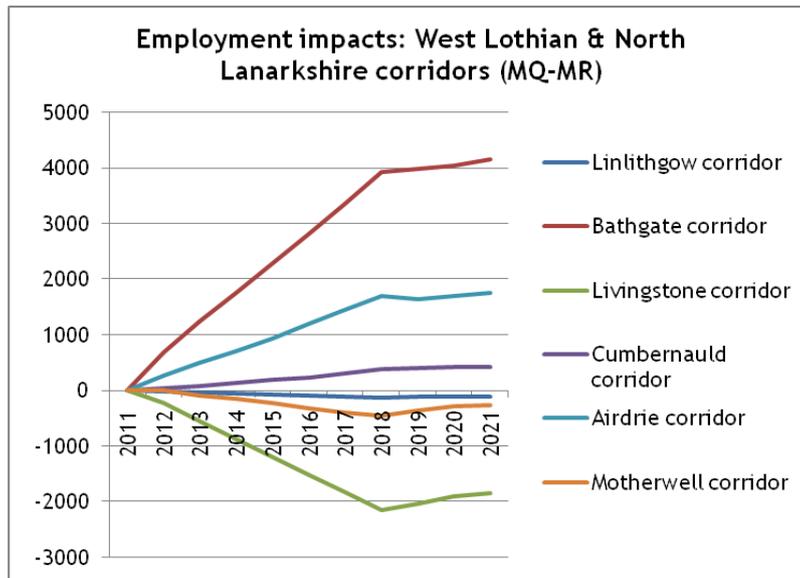


Figure 7.3 Employment Impacts (Test MQ – Test MR)

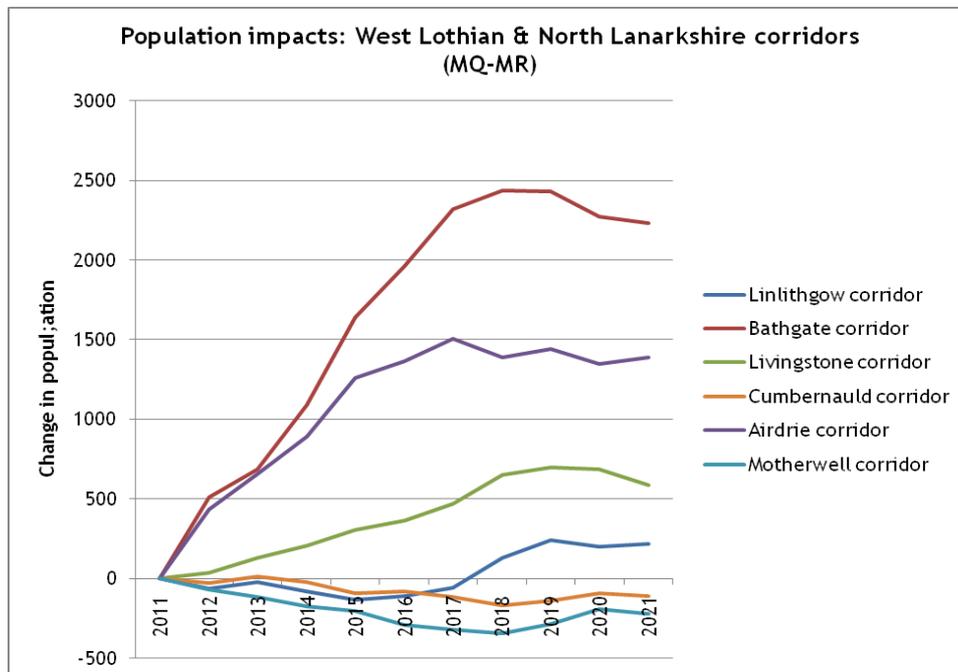


Figure 7.4 Population Impacts (Test MQ – Test MR)

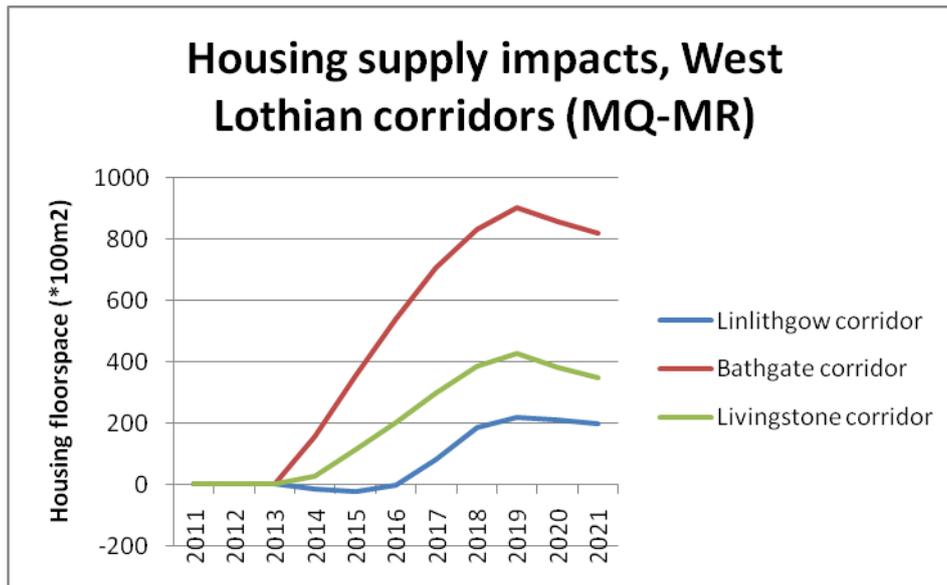


Figure 7.5 Housing Supply Impacts (Test MQ - Test MR)

7.4.6 These graphs show that:

- the employment impacts develop fairly steadily up to 2018, with some further growth after 2018 due to multiplier effects;
- as would be expected, the Bathgate and Airdrie corridors show the largest gains in employment, with a marginal gain in the Cumbernauld corridor and some losses (due to displacement effects) in the other corridors of the two districts;
- the impacts on house-building in West Lothian are significant: by 2019 the population effects are somewhat less steady over time – this is at least partly due to the changes in house-building;
- for population, the Bathgate and Airdrie corridors again show greatest growth, with Livingstone also gaining (even though it loses employment); and
- the population effects all show a tendency to reach a maximum impact after about 8 years and for the impacts then to decline: this is partly due to the housing impacts (see below), but increasing car ownership over time will also tend to dilute the impacts of public transport changes.

7.4.1 By 2019 residential floorspace equivalent to approximately 900 additional dwellings has been built in the Bathgate corridor, a further 400 dwellings' worth in the Livingstone corridor and 200 dwellings' worth in the Linlithgow corridor. There is no scope for additional or earlier development in North Lanarkshire, ie all permissible development is being used each year in the Reference Case, and therefore there are no increases in housing development there.

7.4.2 We estimate that without the housing supply response the population impacts in the West Lothian corridors would be much smaller, and in the Linlithgow corridor they would probably tend to remain slightly negative rather than turning positive in the later years of the decade. We believe this illustrates the value, in terms of understanding the longer-term land-use effects of transport change, of running the model with planning policy inputs that allow scope for additional development if demand increases in a particular area.

- 7.4.3 There is a further issue of how planning policy changes over time. In the present model, the quantities of permissible development are fixed, and hence additional development in one year tends to restrict the amount of development in later years. In practice, development plans are regularly reviewed and it is likely in an area such as West Lothian that the acceleration of development forecast to result from the A2B scheme would lead to further land being allocated for housing (and/or housing densities being increased, and/or sites being identified which could be rebuilt for additional housing) and that would allow the impact of the railway on housing supply to be maintained or even increased in the longer term. The forecast falling-off of the impacts in later years is therefore not inevitable in practice.
- 7.4.4 There is scope for debate as to whether additional land allocations or other planning responses to increase supply should be regarded in the appraisal process as part of the normal response to the transport change or as separate decisions which should be appraised separately.

8 The LUTI Reference Case

8.1 Introduction

8.1.1 This Chapter describes the Land Use and Transport Interaction Model Reference Case. It is the result of a running of TELMoS:07 and TMfS:07 in interactive mode, with planning inputs being passed from TELMoS:07 to TMfS:07 in 2007, 2011, 2016, 2021 and 2031, and costs being passed from the transport model to TELMoS:07 in the same years. The following sections describe the key inputs of this reference case and the model forecasts or outputs.

8.2 Model Inputs – Base Year data

8.2.1 The processes used in assembling the Base Year data are documented in the Model Description Report. This section, along with Appendix 2 provide a summary of the inputs.

8.2.2 Tables A2.1 and A2.2 show the base-year population and number of households by Local Authority area.

8.2.3 Table A2.3 contains a breakdown of households by the twenty household types used within the model. The base year data was derived from specially commissioned Census Tables from GRO(S) and show the numbers of single person, couple and three adult households.

8.2.4 Table A2.4 shows a disaggregation of employment by activity type for each of the twenty-seven employment activities modelled within TELMoS:07. Table A2.5 then describes the total employment by Local Authority area.

8.2.5 Tables A2.6-A2.12 show the amount of floorspace for each of the land-use types modelled, again at Local Authority area level, whilst Tables A2.13-A2.16 describe the occupancy rates for the four main land-use types : residential, retail, office and industry.

8.2.6 Finally Tables A2.17-A2.19 show the numbers of people in households with no car, one car and two or more cars, for each Local Authority area.

8.3 Model Inputs – Planning Policy Inputs

8.3.1 Planning Policy Inputs reflect the plans and policies of the Local Planning Authorities. They are based upon a series of consultations with the Local Planning Authorities within Scotland. They are shown in Tables A3.1 to A3.7 in Appendix 3.

8.3.2 Within the LUTI test run we have assumed that all commitments, planning permissions and allocations that are planned to be available for development in the period 2011 will be built. This is on the basis that there is likely to be a high degree of certainty about plans and proposals and the bringing forward of land for development in the near future. Beyond 2011, the planning policy inputs are entered as permissible development. This floorspace is available for development if there is sufficient demand.

8.3.3 Figures 8.1 to 8.8 show the amounts of development within each Local Authority area for exogenous and permissible development for the main four land uses that are modelled within the model: residential, retail, office and employment floorspace. Note that each dot on the maps represents a quantity of floorspace within the zone, not a specific development.

Residential floorspace

TELMoS:07
Test JA - 12 May 2009

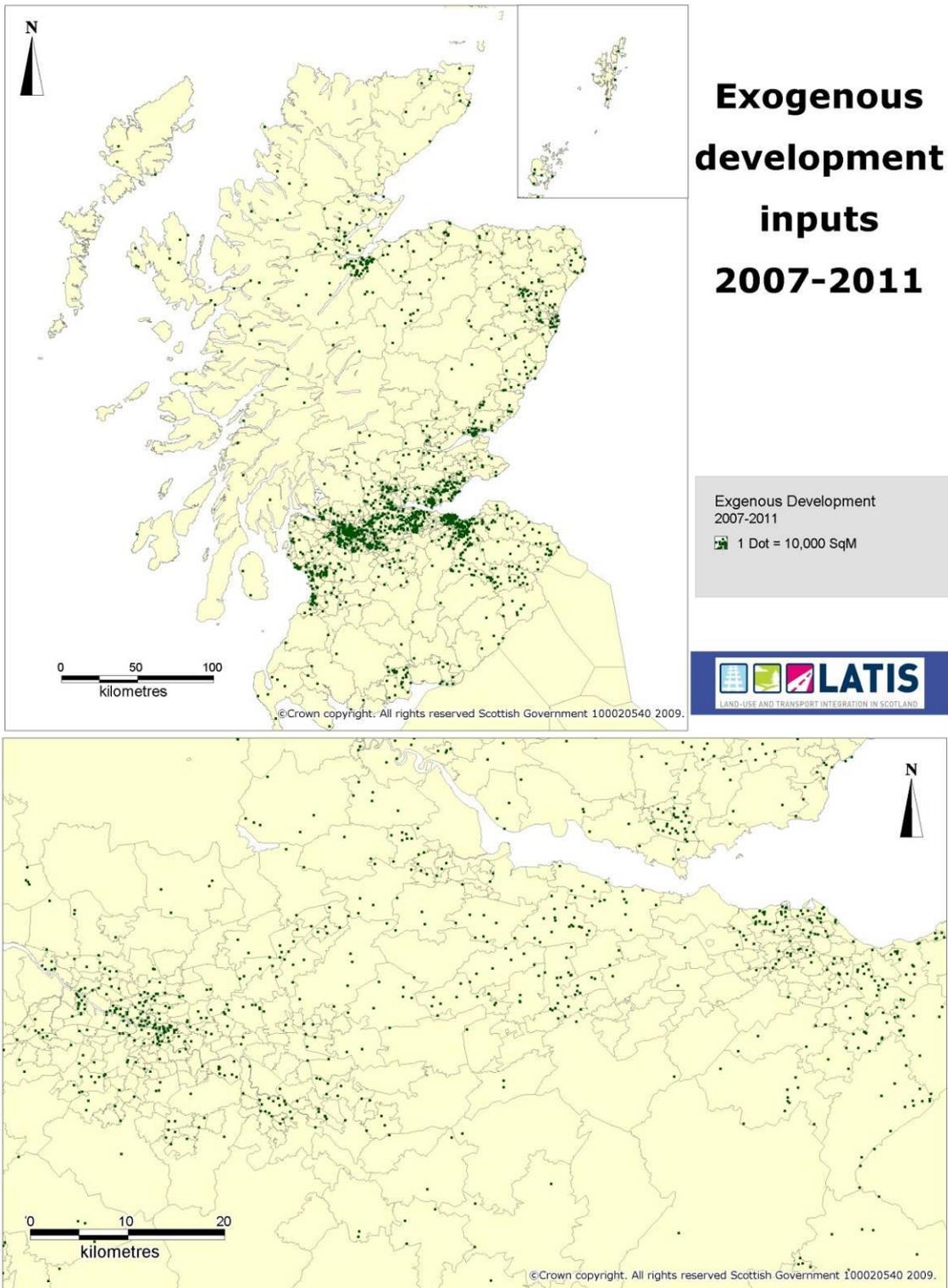


Figure 8.1 Exogenous Development 2007-2011 (square metres)

Residential floorspace

c1.42.07 TELMoS_07
Test JA - 12 May 2009

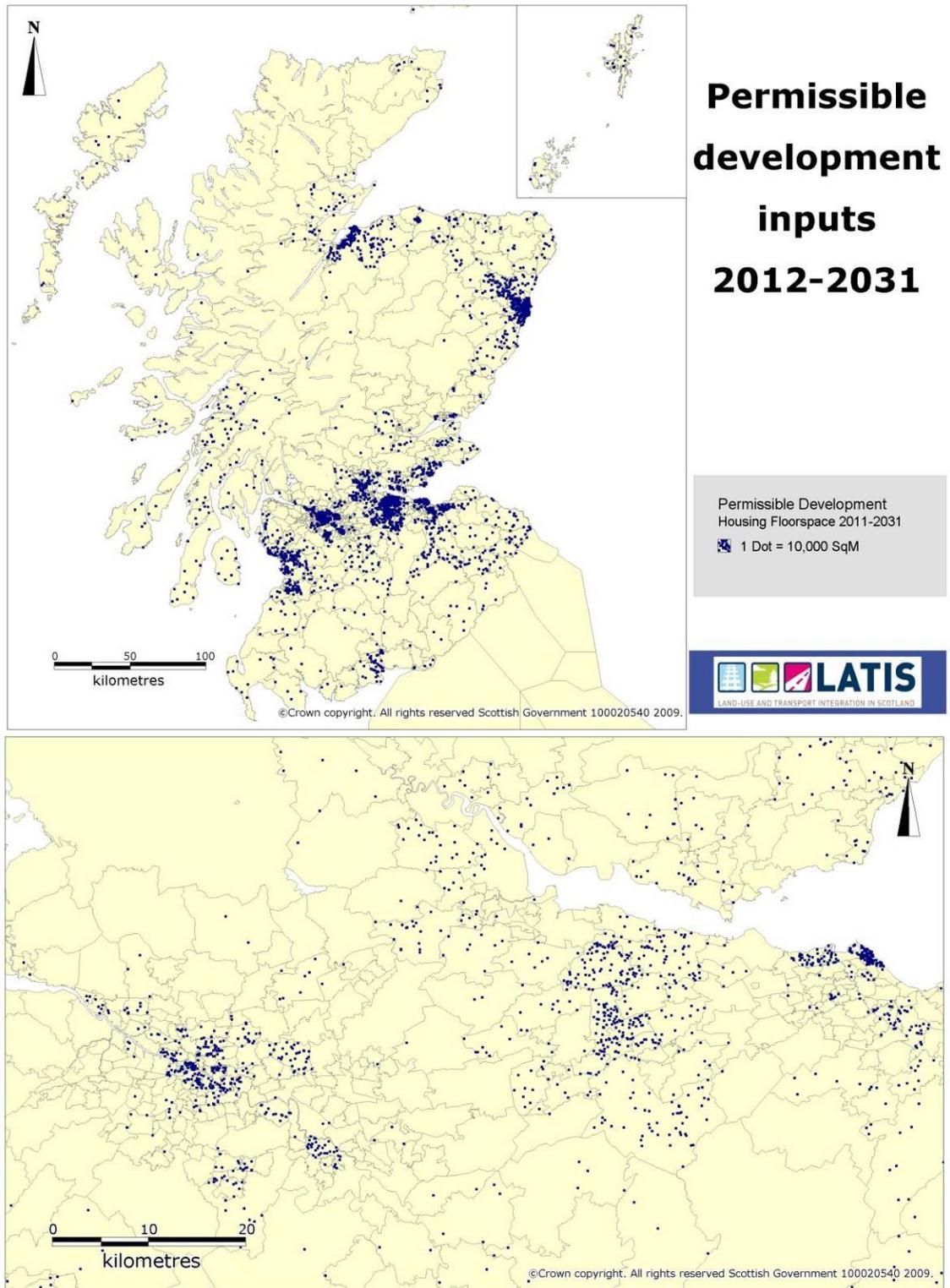


Figure 8.2 Permissive Residential Development 2012-2031 (square metres)

Retail floorspace

TELMoS:07
Test JA - 12 May 2009

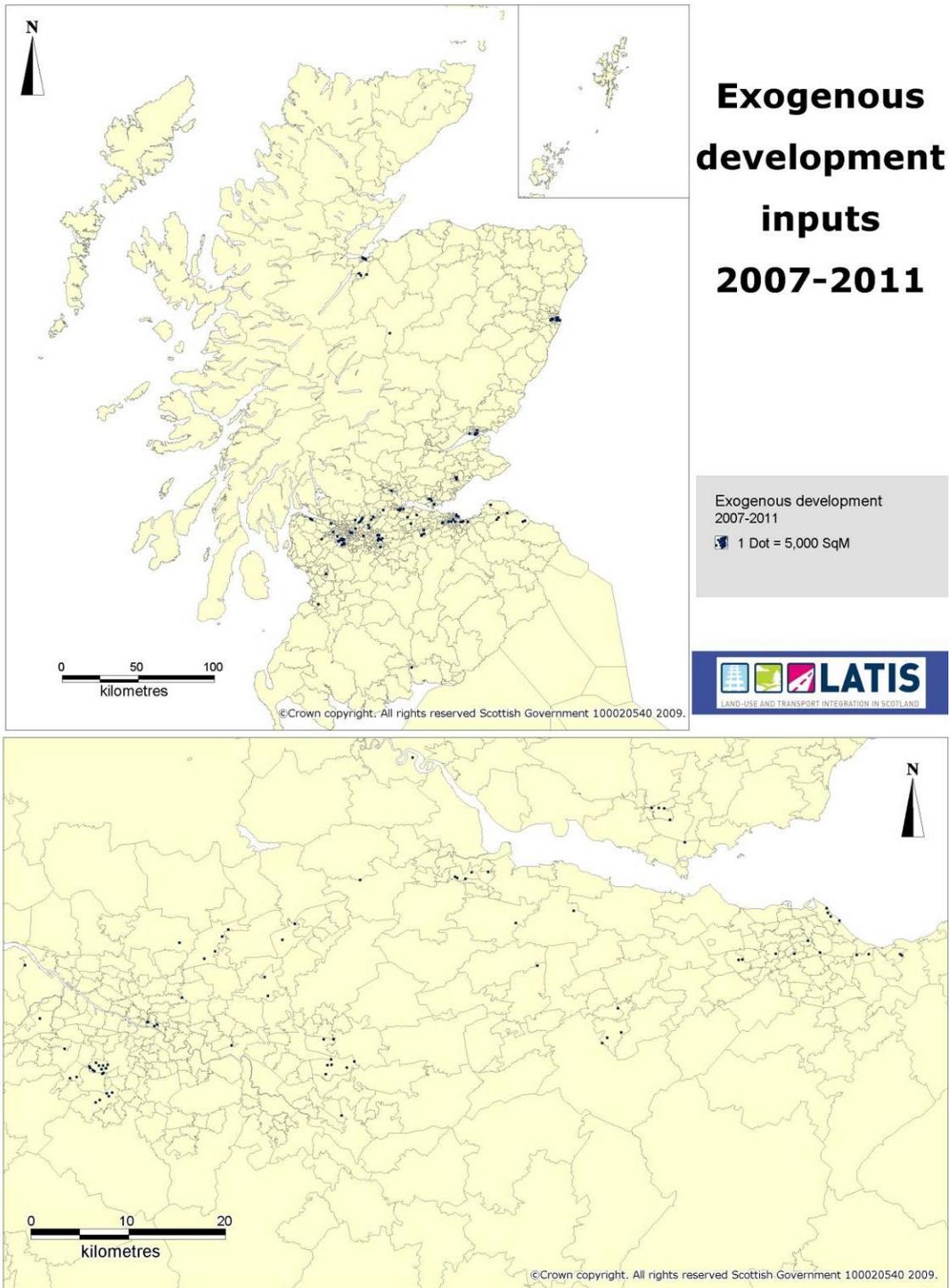


Figure 8.3 Exogenous Retail Development 2007-2011 (square metres)

Retail floorspace

c1.42.07 TELMoS_07
Test JA - 12 May 2009

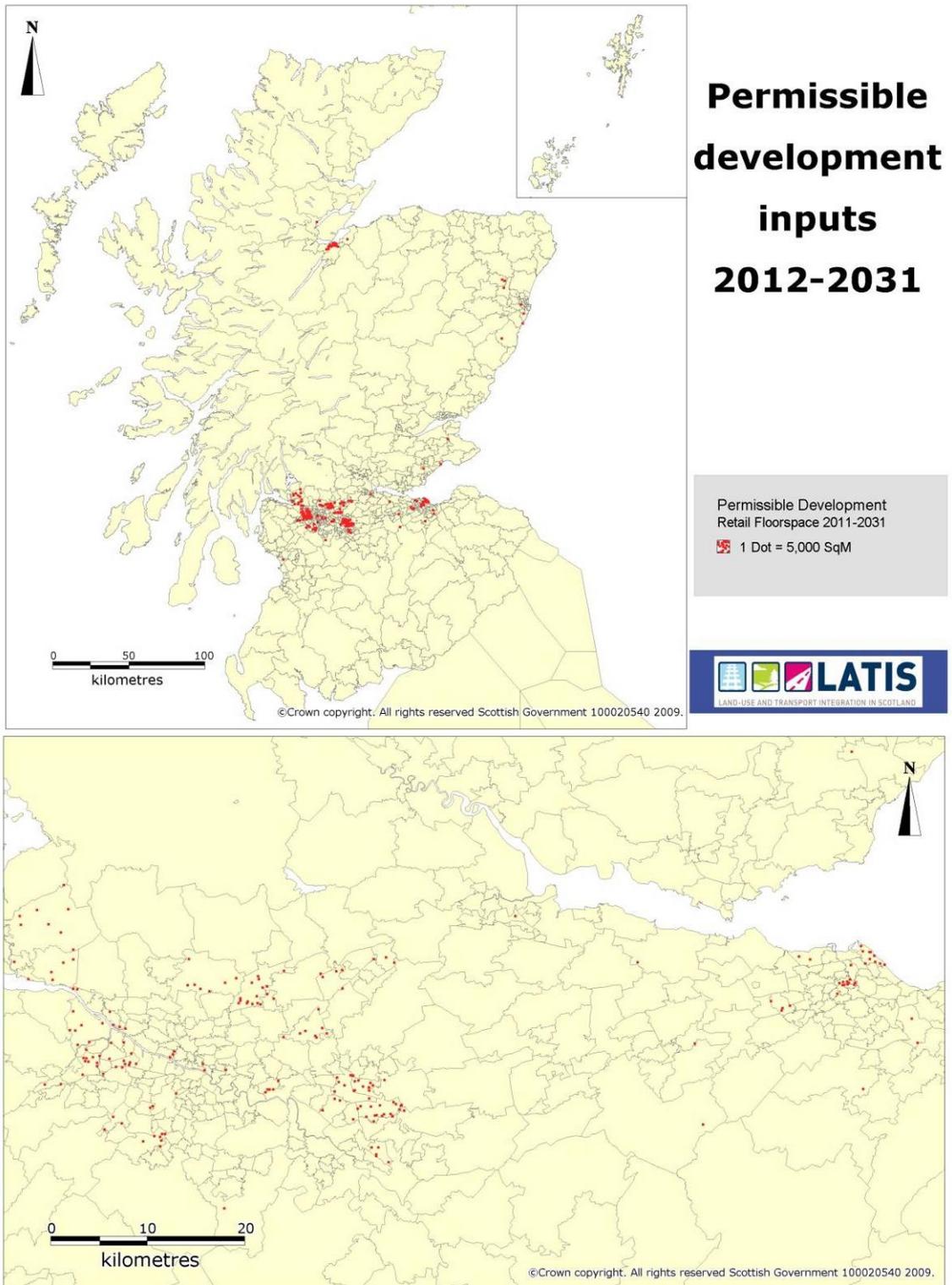


Figure 8.4 Permissive Retail Development 2012-2031 (square metres)

Office floorspace

TELMoS:07
Test JA - 12 May 2009

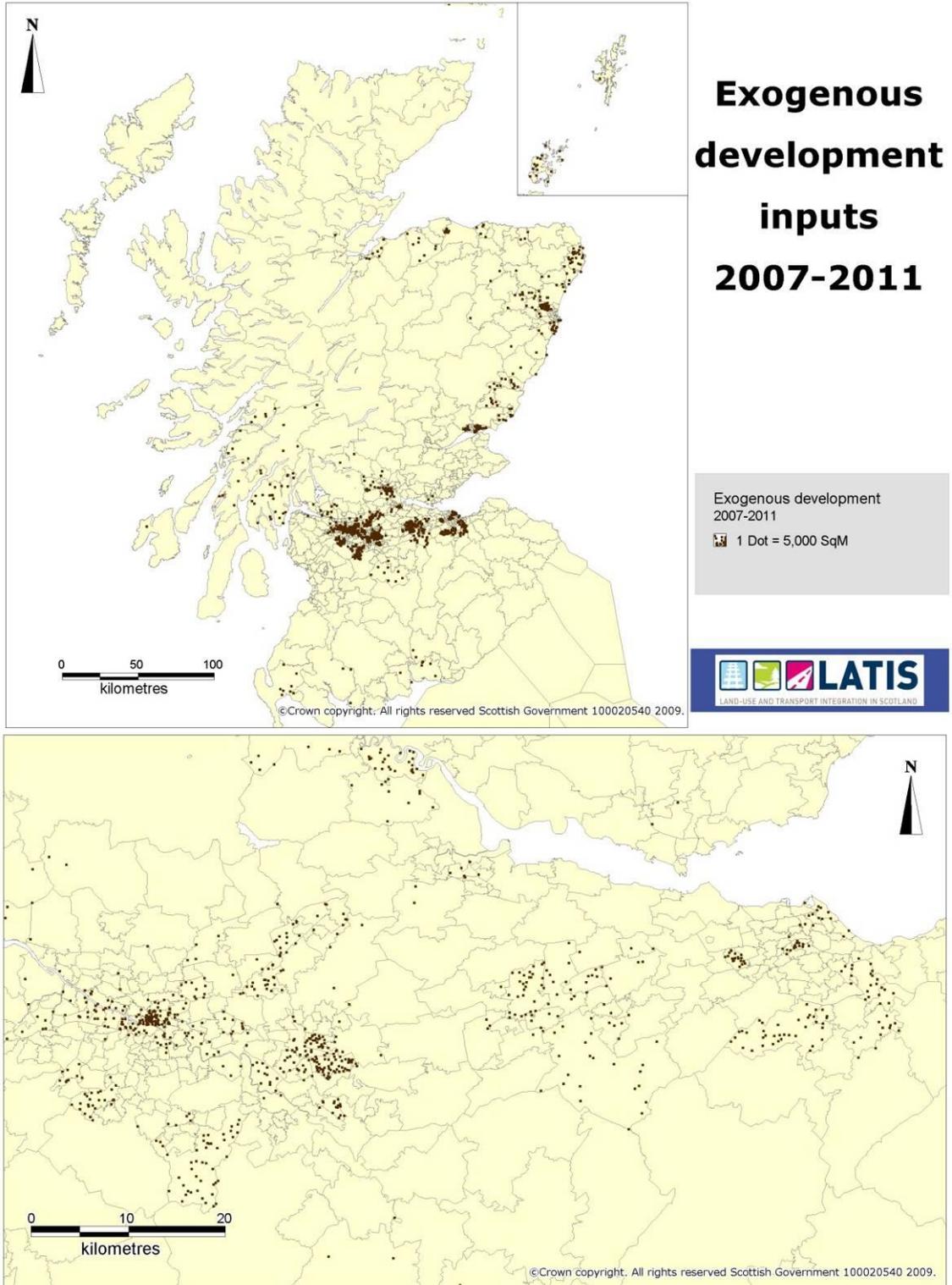


Figure 8.5 Exogenous Office Development Inputs 2007 – 2011 (square metres)

Office floorspace

c1.42.07 TELMoS_07
Test JA - 12 May 2009

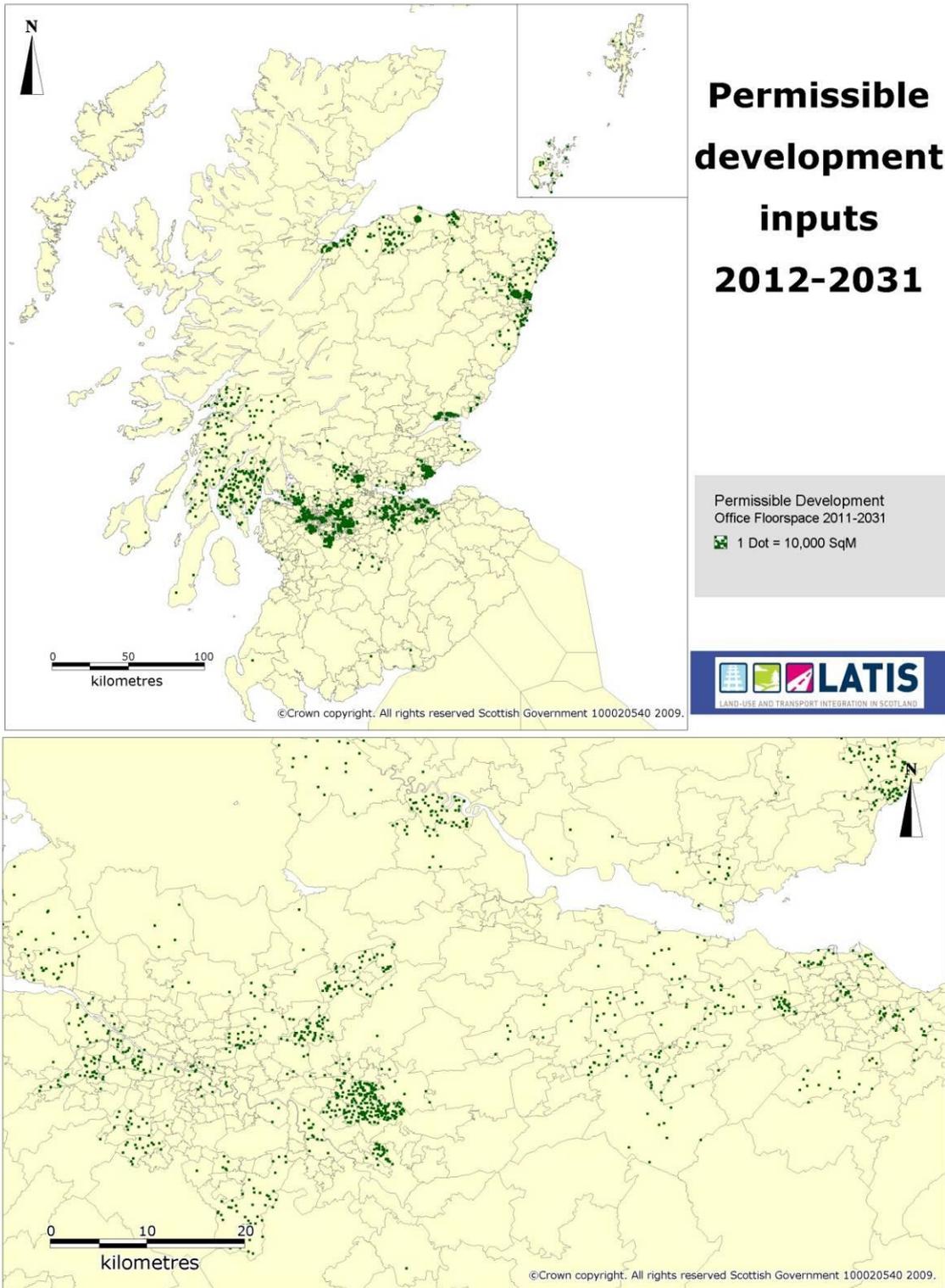


Figure 8.6 Permissible Office Development Inputs 2012 – 2031 (square metres)

Industrial floorspace

TELMoS:07
Test JA - 12 May 2009

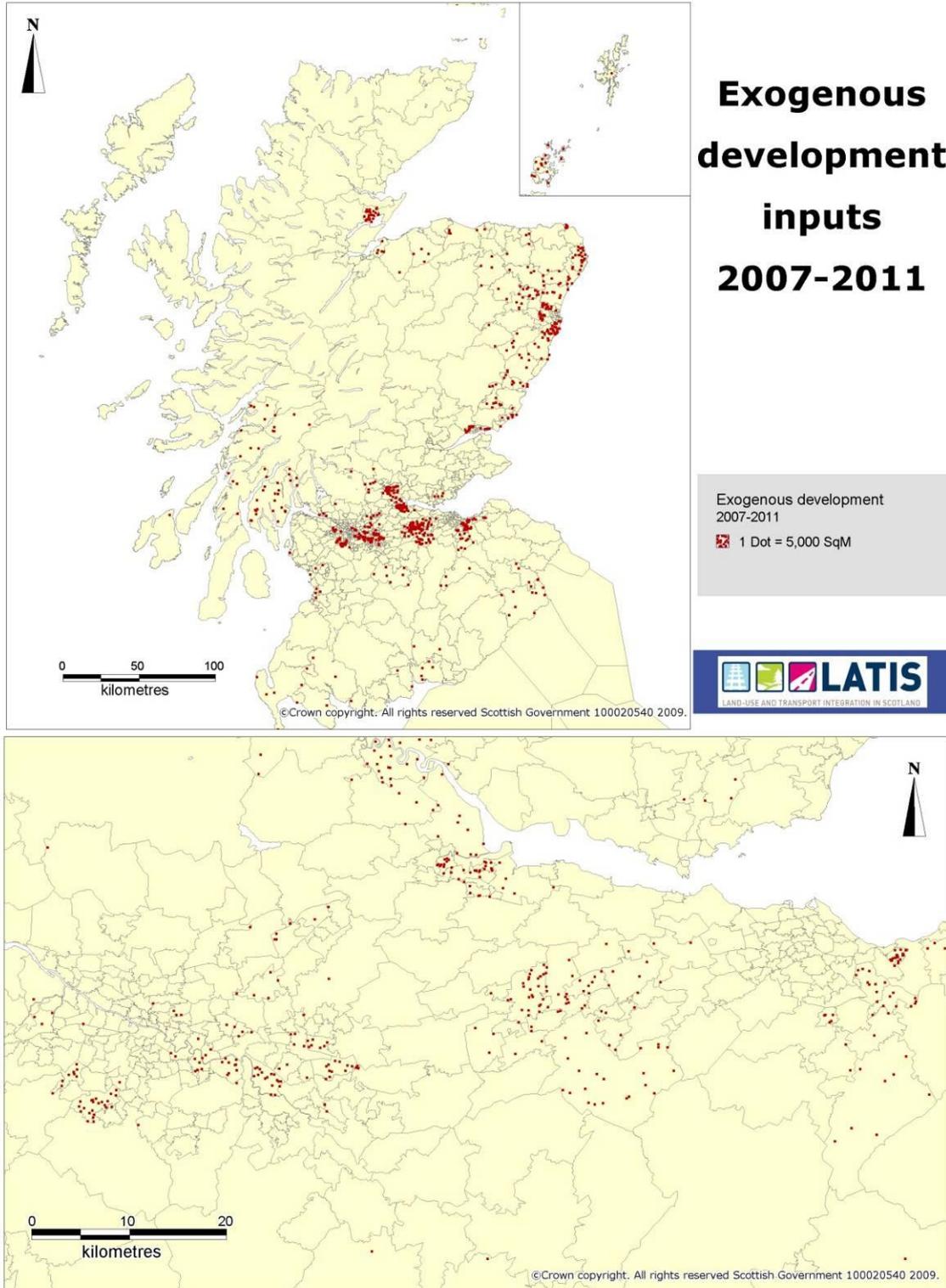


Figure 8.7 Exogenous Industrial Development 2007-2011 (square metres)

Industrial floorspace

c1.42.07 TELMoS_07
Test JA - 12 May 2009

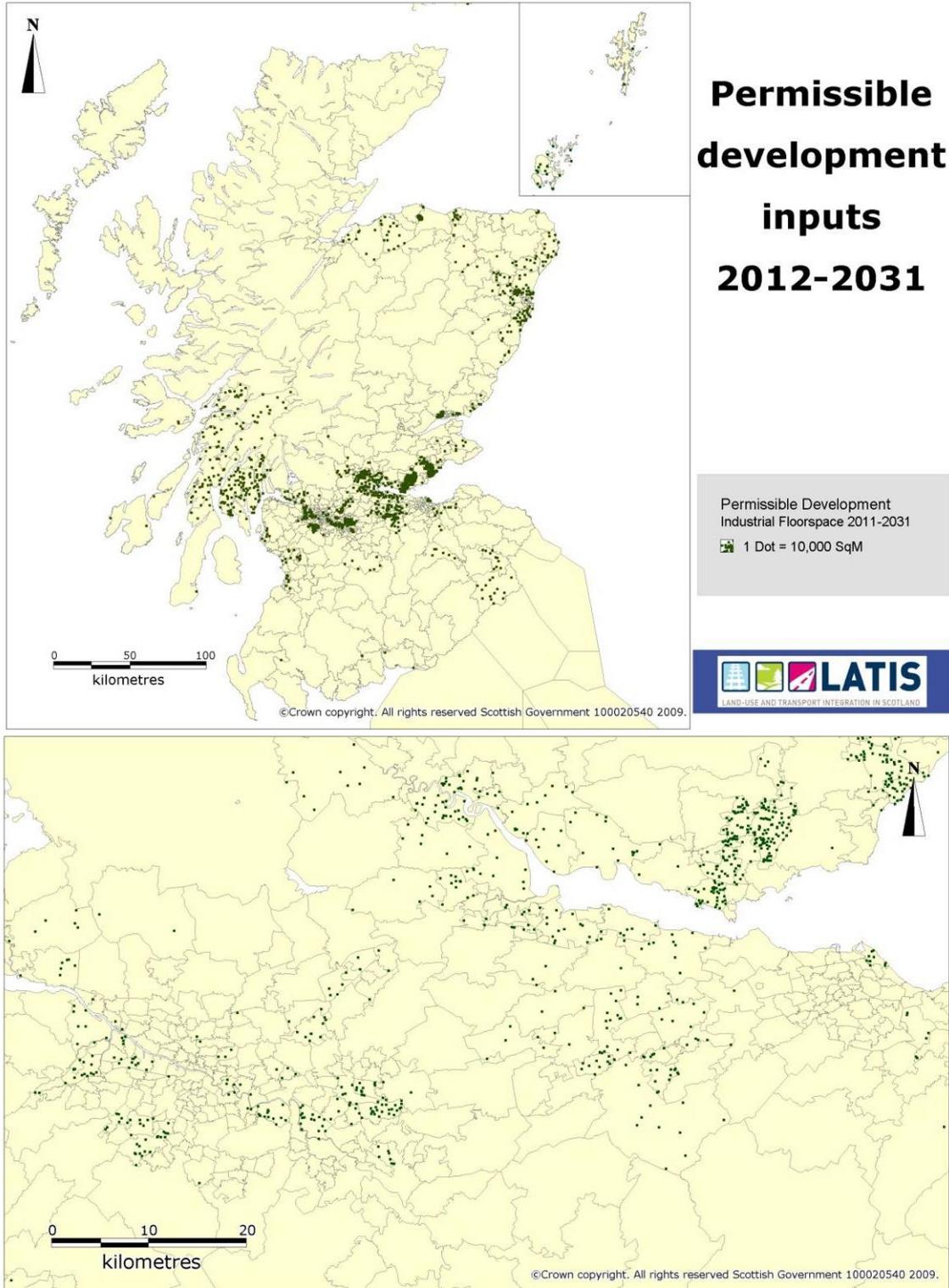


Figure 8.8 Permissive Industrial Development 2012-2031 (square metres)

8.4 Model Inputs – Demographic Scenario

8.4.1 The demographic model within TELMoS_07 has been adjusted so that the totals of households and population reflect the population growth implicit within GRO(S)'s 2006-based national population forecasts for the period to 2021. Note: the GRO(S) figures are targets which TELMoS aims to reproduce by modelling household change over time.

8.4.2 For the period 2001-7, constraints are used to control the numbers of households locating in each zone in line with estimates based on Mid-Year Estimates of population. From 2008 onwards, no constraints are applied, nor is there any local adjustment of demographic change: the distribution of households and population within Scotland are entirely forecast by the model.

8.4.3 GRO(S)'s national forecasts are shown in Figure 8.9. To summarise:

- **Total Population** increases from 5.04 million in 2007 to 5.19 million in 2021 and 5.22 in 2031;
- The number of **Children** decreases from 915,200 in 2007 to 889,700 in 2021 and 856,500 in 2031;
- The **working-age population** decreases from 3.2 million in 2007 to 3.1 million in 2021 and 3.0 million in 2031; and
- The number of people of **retirement age** increases from 0.9 million in 2007 to 1.2 million in 2021 and 1.4 million in 2031.

8.4.4 The definitions for children, working age and retirees used by GRO(S) differ slightly from those used within TELMoS:07. Adjustments are made to reflect this.

8.4.5 Figure 8.10 shows the goodness of fit between these GRO(S) forecasts and the population forecasts within TELMoS:07.

8.4.6 The number of children within the TELMoS:07 scenario is marginally greater than the GRO(S) projections in the periods 2006-2015 and 2028-2031. This reflects the variable rate of annual change in the GRO(S) projections, with high rates of annual change in some years and lower rates in others. Within TELMoS:07 constant coefficients for the modelled demographic processes are used throughout the forecast period.

8.4.7 As part of the process of ensuring a good fit to the GRO(S) forecasts, adjustments have been made to the levels of in-migration.

The LUTI Reference Case

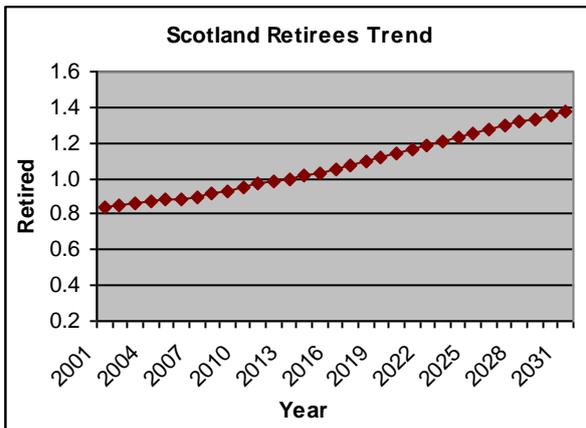
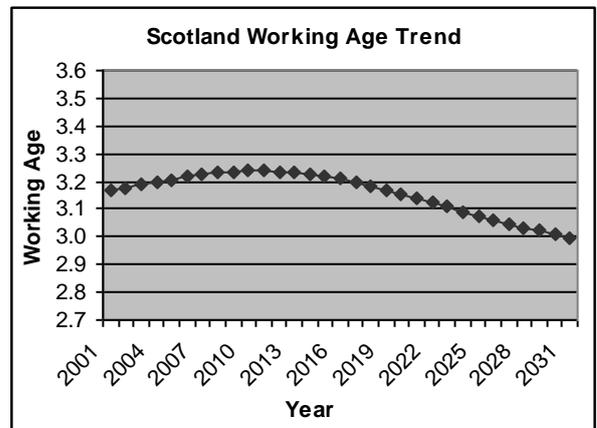
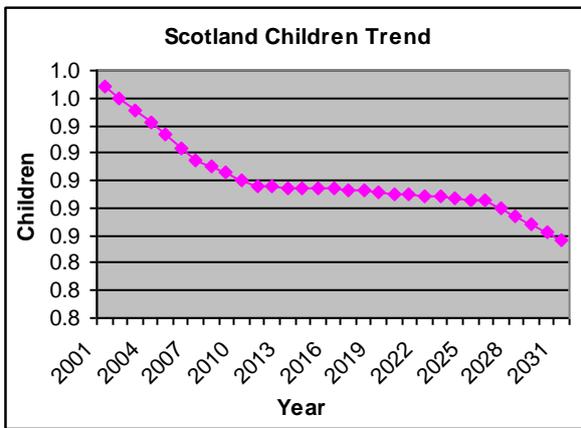
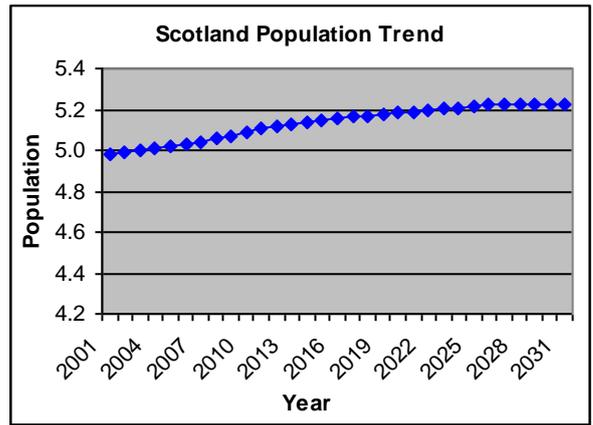
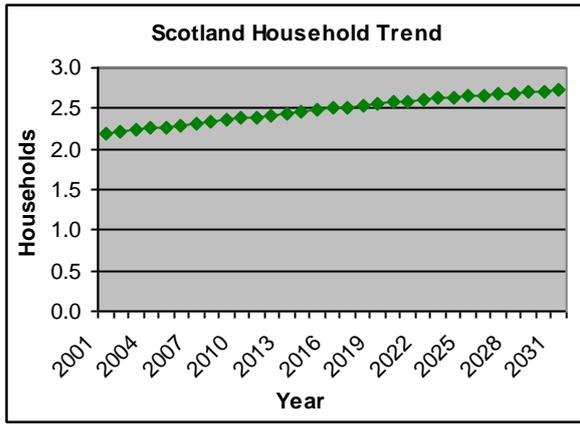


Figure 8.9 GROS forecasts

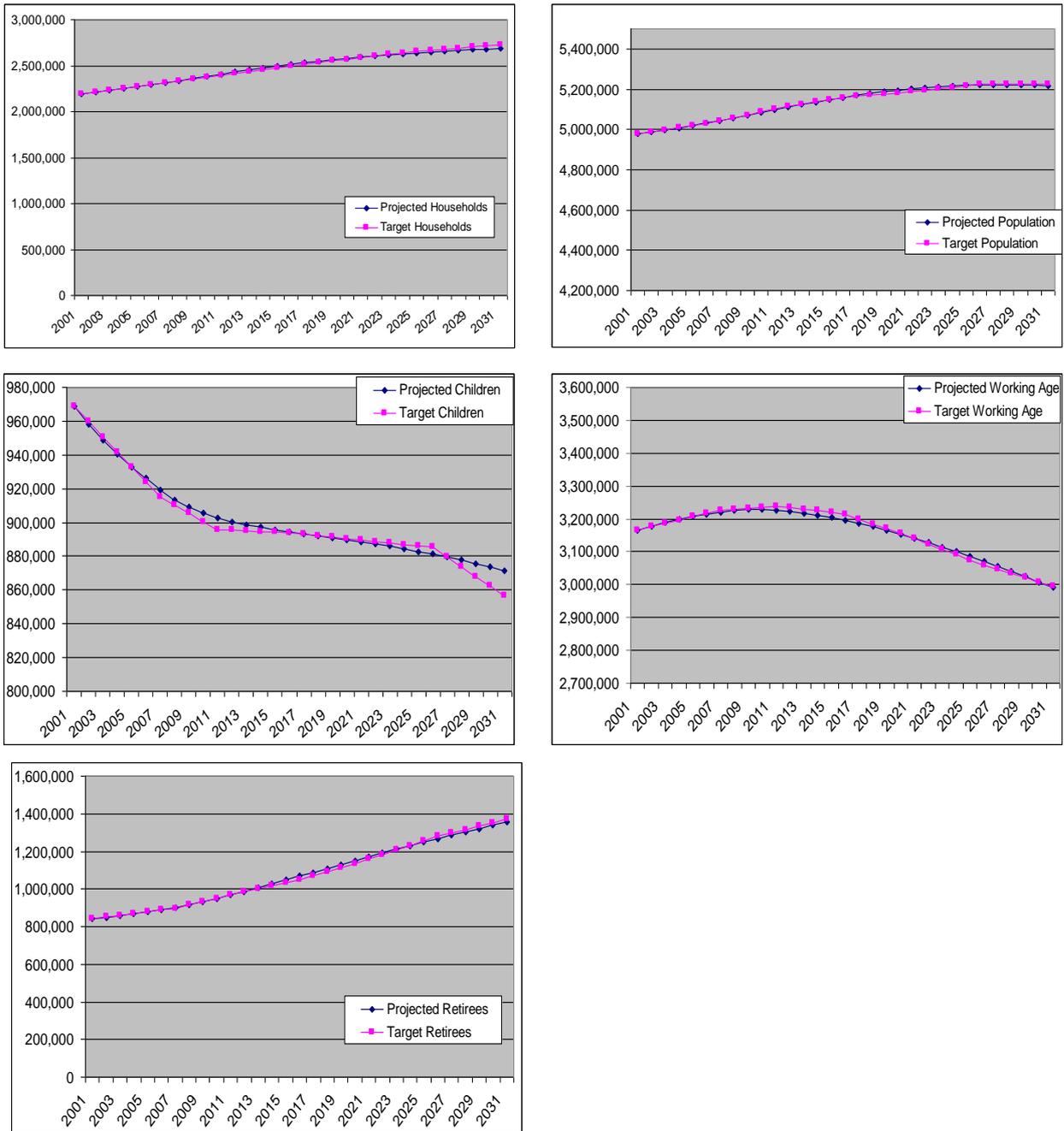


Figure 8.10 Comparison of GROS population forecasts and the TELMoS scenario

8.5 Model Inputs – Economic Scenario

- 8.5.1 The economic strategy has been estimated so as to reproduce levels of national economic growth that are consistent with externally generated forecasts and assumptions.
- 8.5.2 For the period to 2022, the strategy reproduces the rates of growth contained with the economic forecasts used in Transport Scotland’s Strategic Transport Project Review.

8.5.3 For the period beyond 2022, the following assumptions have been made:

- a growth rate of 1.9% per capita per annum;
- a constant rate of growth across all sectors of the economy. As the input-output coefficients (defining the relationships between the various sectors of the Scottish economy) are assumed to be constant, the growth will therefore be driven by growth in final demand; and
- a growth in productivity of 1.9%. This implies the employment growth will be in proportion to population growth.

8.5.4 The post-2022 assumptions reflect the guidance of Transport Scotland and are consistent with economic performance over the past 30 years. These assumptions do not figure directly in the forecasts to 2021, but are will be used in extended TELMoS:07 forecasts to 2031 (hence the reference to them in this report).

8.5.5 Tables 8.1 and 8.2 show the levels of growth in Gross Value Added and employment that are forecast when applying the economic scenario.

Table 8.1 Economic Scenario - Assumptions on GVA by Sector

	2007	2012	2017	2022	2027	2032
101: Agriculture, Forestry and Fishing	1,173.2	1,024.3	1,072.0	1,183.4	1,300.2	1,428.5
102: Mining	1,461.7	1,276.2	1,337.5	1,476.3	1,621.9	1,782.0
103: Manufacturing	12,735.5	10,630.5	10,815.2	11,820.8	12,987.3	14,268.9
104: Energy and water	2,008.8	1,753.8	1,823.9	2,013.4	2,212.1	2,430.4
105: Construction	4,823.1	4,836.4	5,196.4	5,535.9	6,082.2	6,682.4
106: Distribution and catering	12,554.3	12,709.0	15,092.1	17,188.5	18,884.6	20,748.2
107: Transport and communications	6,169.5	6,339.4	7,382.4	8,446.8	9,280.3	10,196.1
108: Finance and business	18,241.1	19,769.9	23,822.3	27,891.0	30,643.2	33,667.1
109: Public Administration	18,073.9	18,826.5	20,701.2	22,150.8	24,336.7	26,738.2
110: Other Services	892.3	910.7	1,015.5	1,111.5	1,221.2	1,341.7

Table 8.2 Economic Scenario - Employment by Sector

	2,007	2,012	2,017	2,022	2,027	2,032
101: Agriculture, Forestry and Fishing	44,823	39,134	32,450	28,560	28,563	28,566
102: Mining	23,201	20,256	16,810	14,794	14,795	14,797
103: Manufacturing	213,596	178,292	143,973	124,295	124,308	124,320
104: Energy and water	18,483	16,137	13,345	11,745	11,746	11,747
105: Construction	161,136	161,580	161,929	162,264	162,280	162,296
106: Distribution and catering	417,007	422,145	426,716	431,996	432,039	432,082
107: Transport and communications	161,669	166,121	168,644	170,605	170,622	170,639
108: Finance and business	425,027	460,649	494,173	518,383	518,435	518,487
109: Public Administration	678,786	707,054	735,883	756,241	756,316	756,392
110: Other Services	124,898	127,479	128,238	129,115	129,128	129,141
Total	2,270,633	2,300,859	2,324,179	2,350,020	2,350,260	2,350,499

8.6 Model outputs – population

8.6.1 The population of Scotland increases from 5.10 million in 2007 to 5.25 million in 2031. This represents a 2.9% increase. This increase, of approximately 150,000 is consistent with the increase in GROS's forecasts. Table 8.3 shows the total population forecasts for Scotland.

Table 8.3 Population Forecasts for Scotland

	2007	2011	2016	2021	2026	2031
Children	922,231	911,303	907,043	903,940	898,673	890,445
Adults (non retired)	3,258,457	3,267,805	3,240,981	3,188,614	3,120,510	3,042,328
Retired	921,095	976,029	1,064,932	1,157,522	1,244,136	1,320,259
Total	5,101,783	5,155,137	5,212,956	5,250,076	5,263,318	5,253,033

8.6.2 Tables A2.1 and A2.2 in Appendix 2 describes the population and household change at local authority level. This shows a variable pattern across Scotland with increases in population in Edinburgh and the Lothians, decreases in locations ranging from parts of Strathclyde (though not Glasgow City) and the Tactrans areas to more rural areas.

8.6.3 Figures 8.11 to 8.15 map the change at zone level across Scotland for the total population and then for the four sub-divisions of this figure namely children, working adults, non-working adults and retired adults.

8.6.4 Figure 8.16 shows the change in the number of households by zone over the forecast period 2007-2021.

Population changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

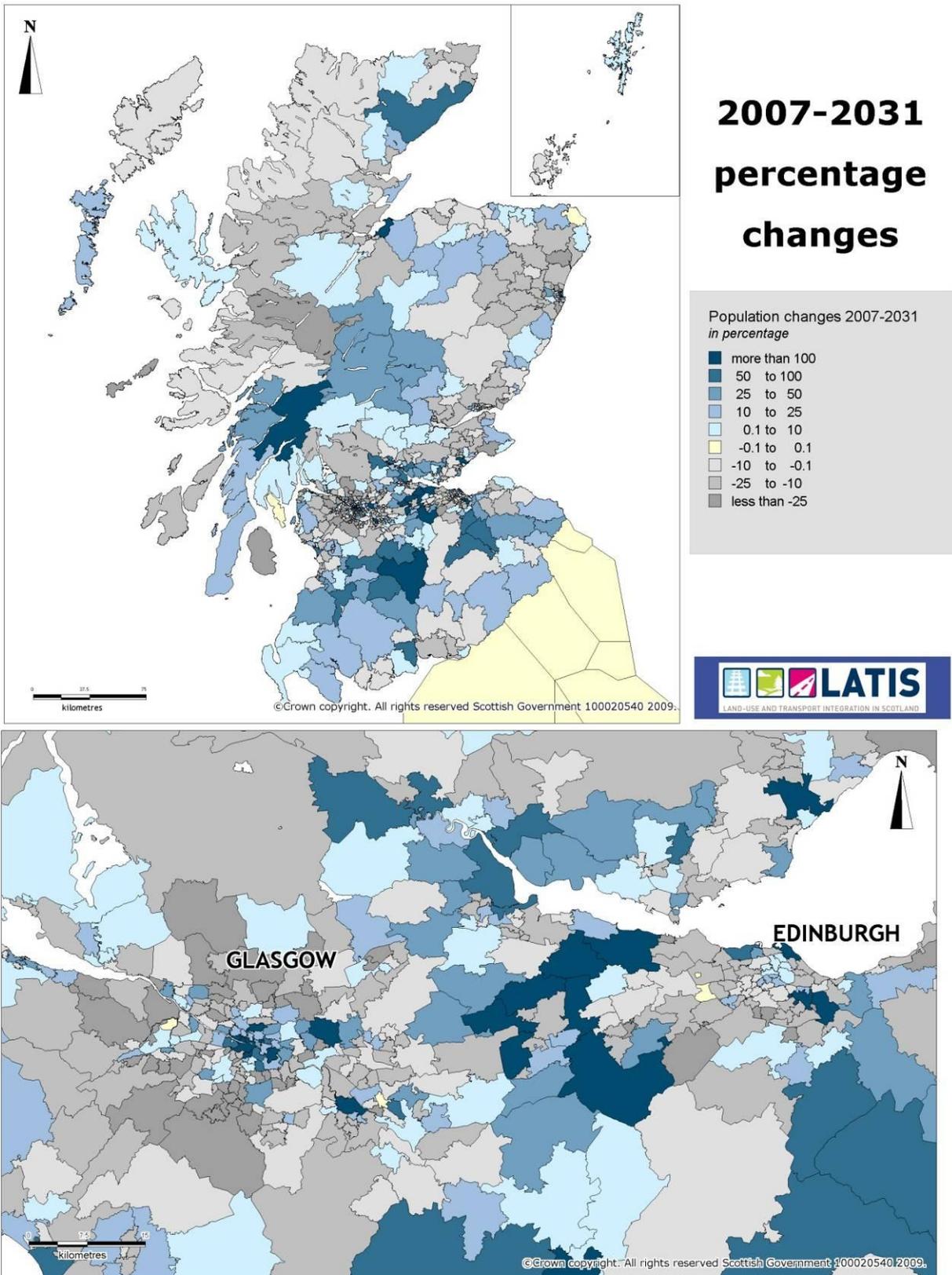


Figure 8.11 Population Change 2007-2031 (LUTI reference case)

Children changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

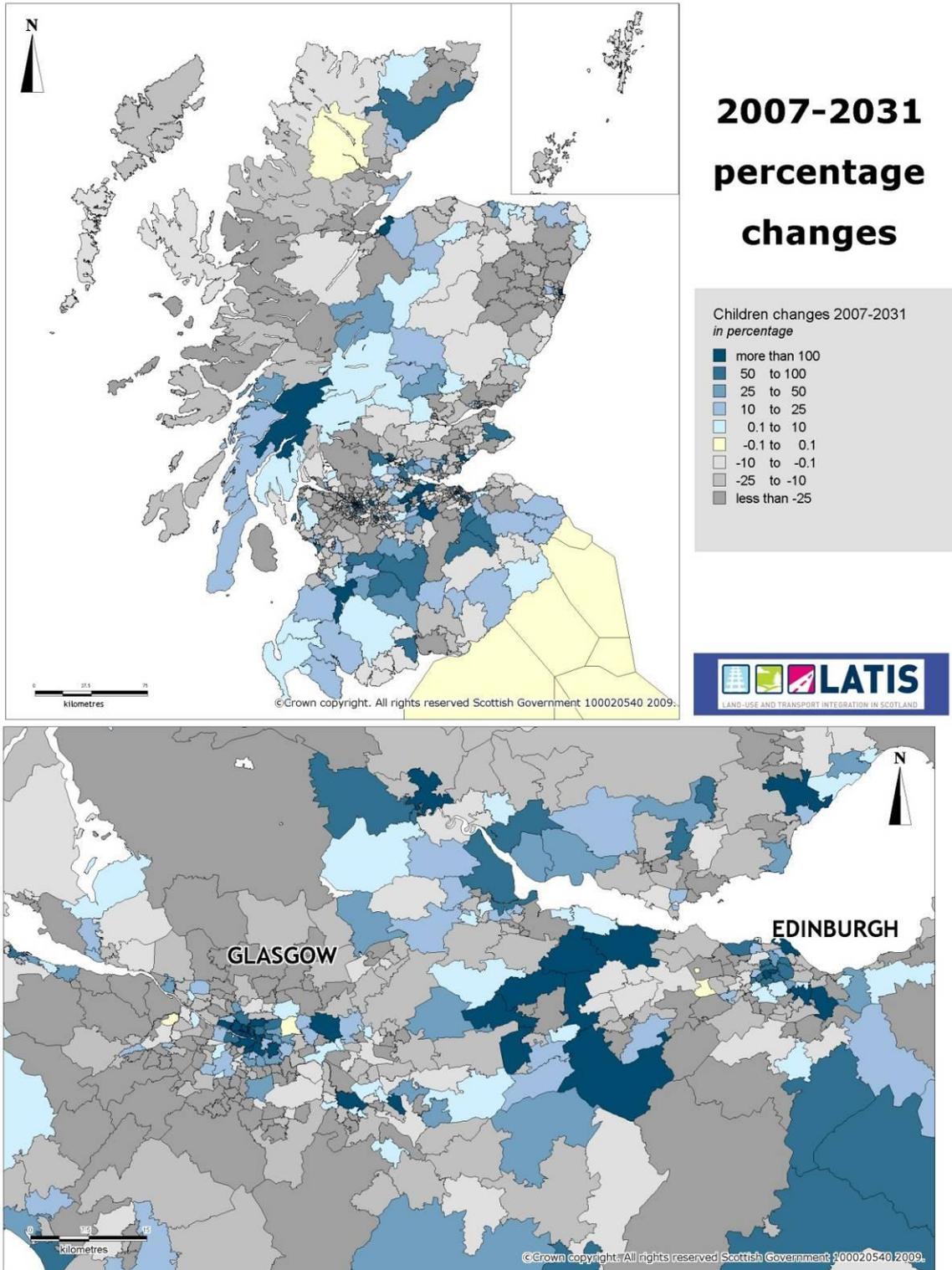


Figure 8.12 Change in number of children 2007-2031 (LUTI Reference case)

Resident workers changes

c1.42.07 TELMoS_07

Test JA - 13 May 2009

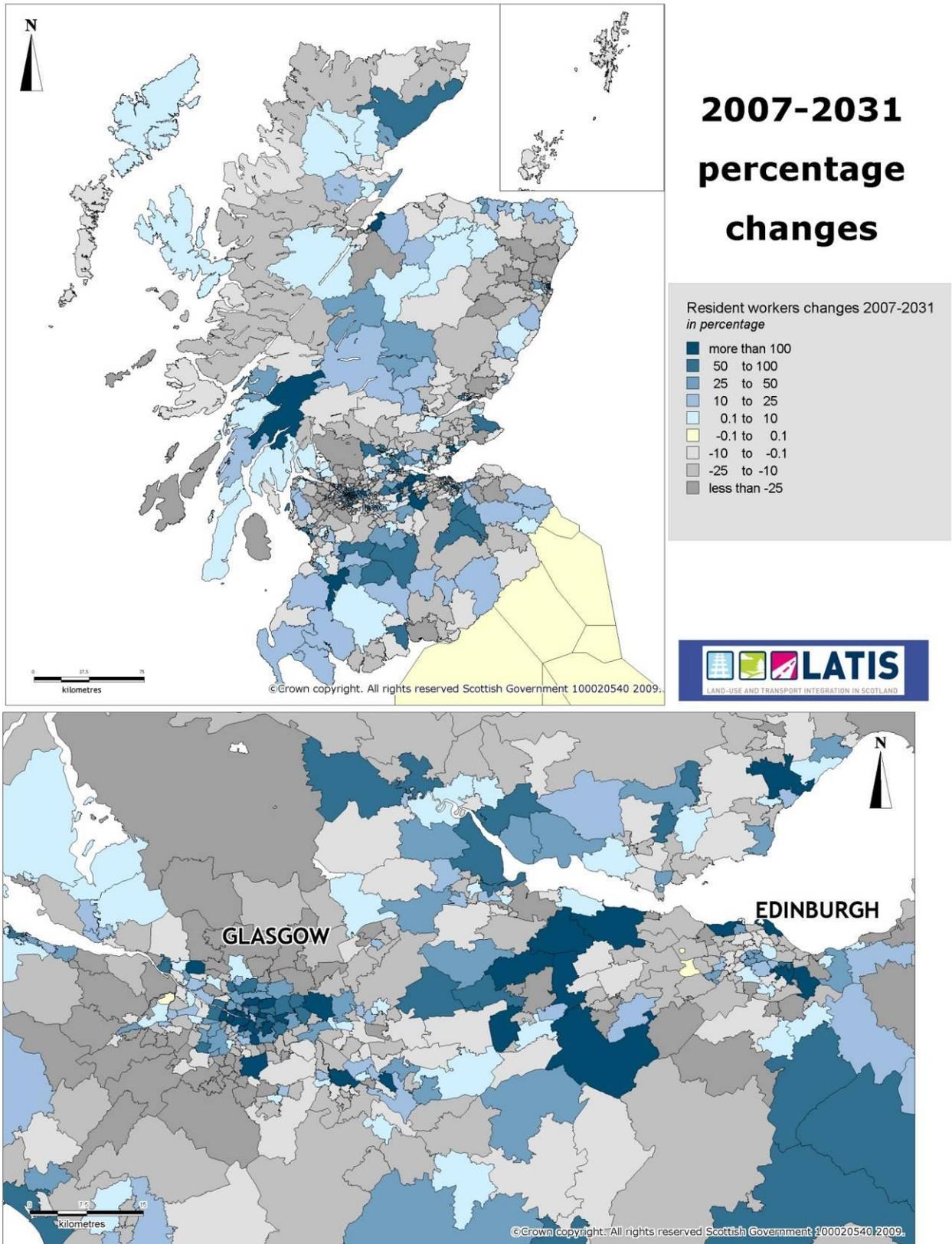


Figure 8.13 Change in resident workers 2007-2031 (LUTI Reference case)

Non-workers changes

c1.42.07 TELMoS_07

Test JA - 13 May 2009

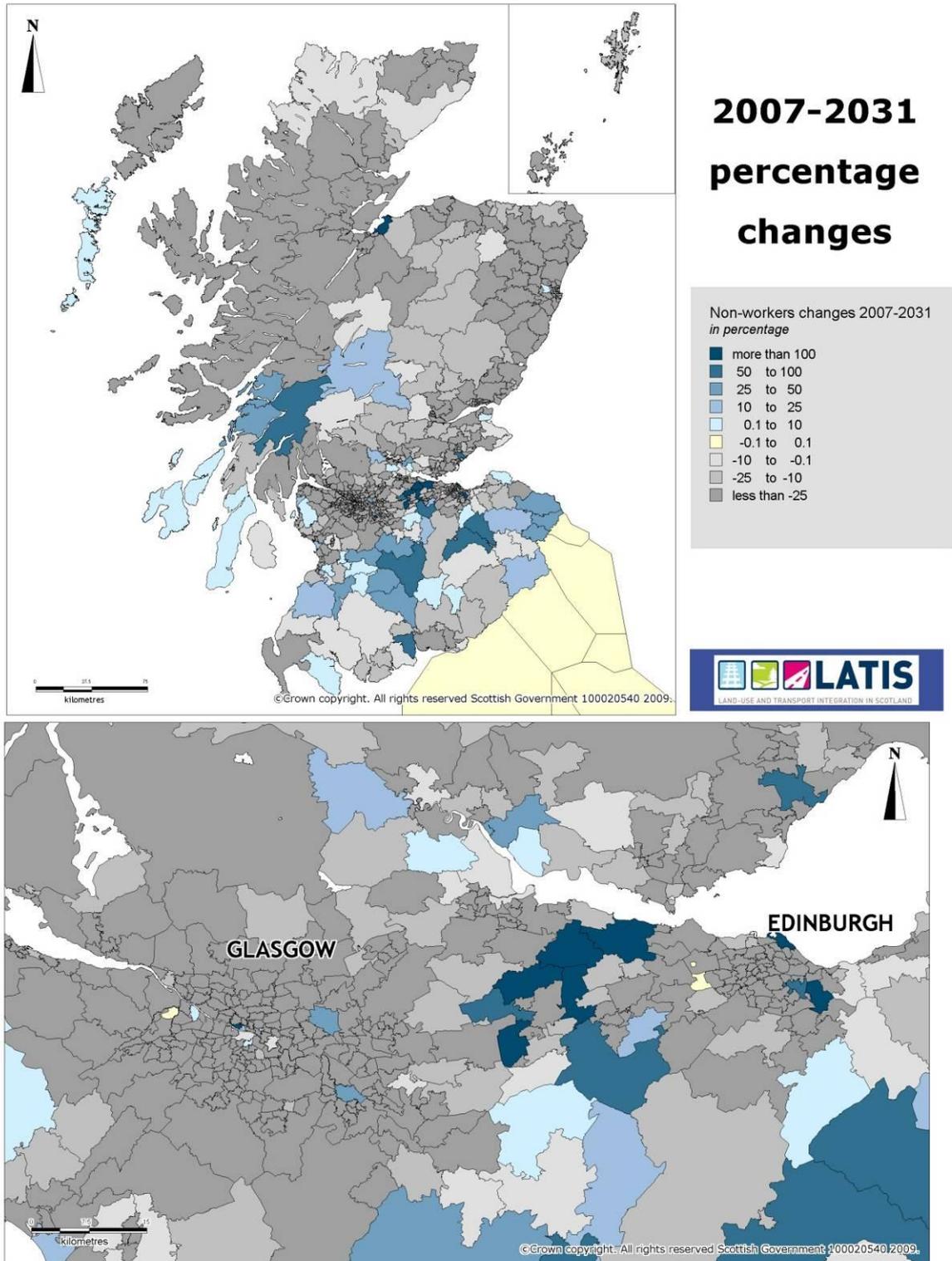


Figure 8.14 Change in non-workers 2007-2031 (LUTI Reference case)

Retired changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

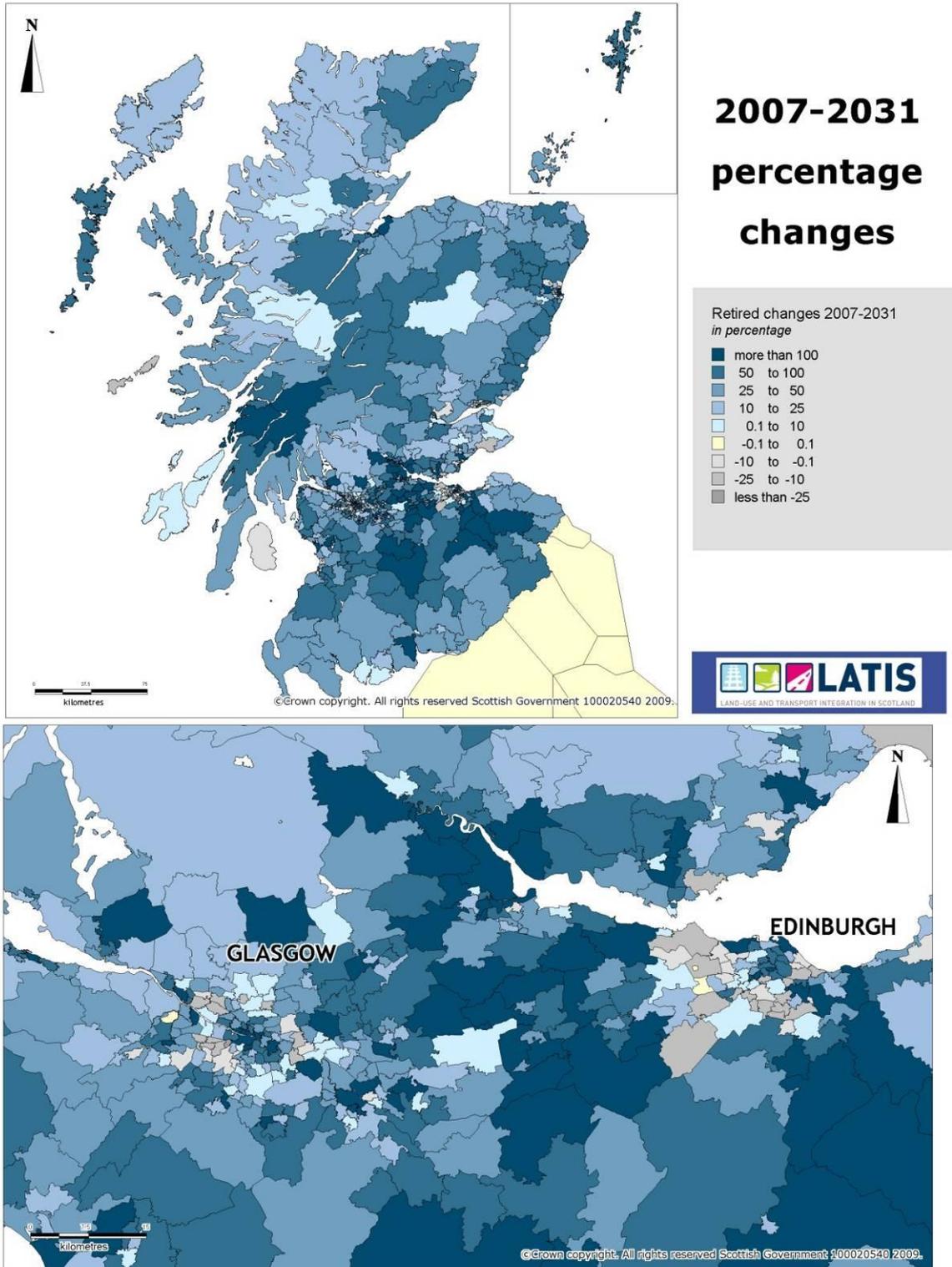


Figure 8.15 Change in retired persons 2007-2031 (LUTI Reference case)

Household changes

c1.42.07 TELMoS_07

Test JA - 13 May 2009

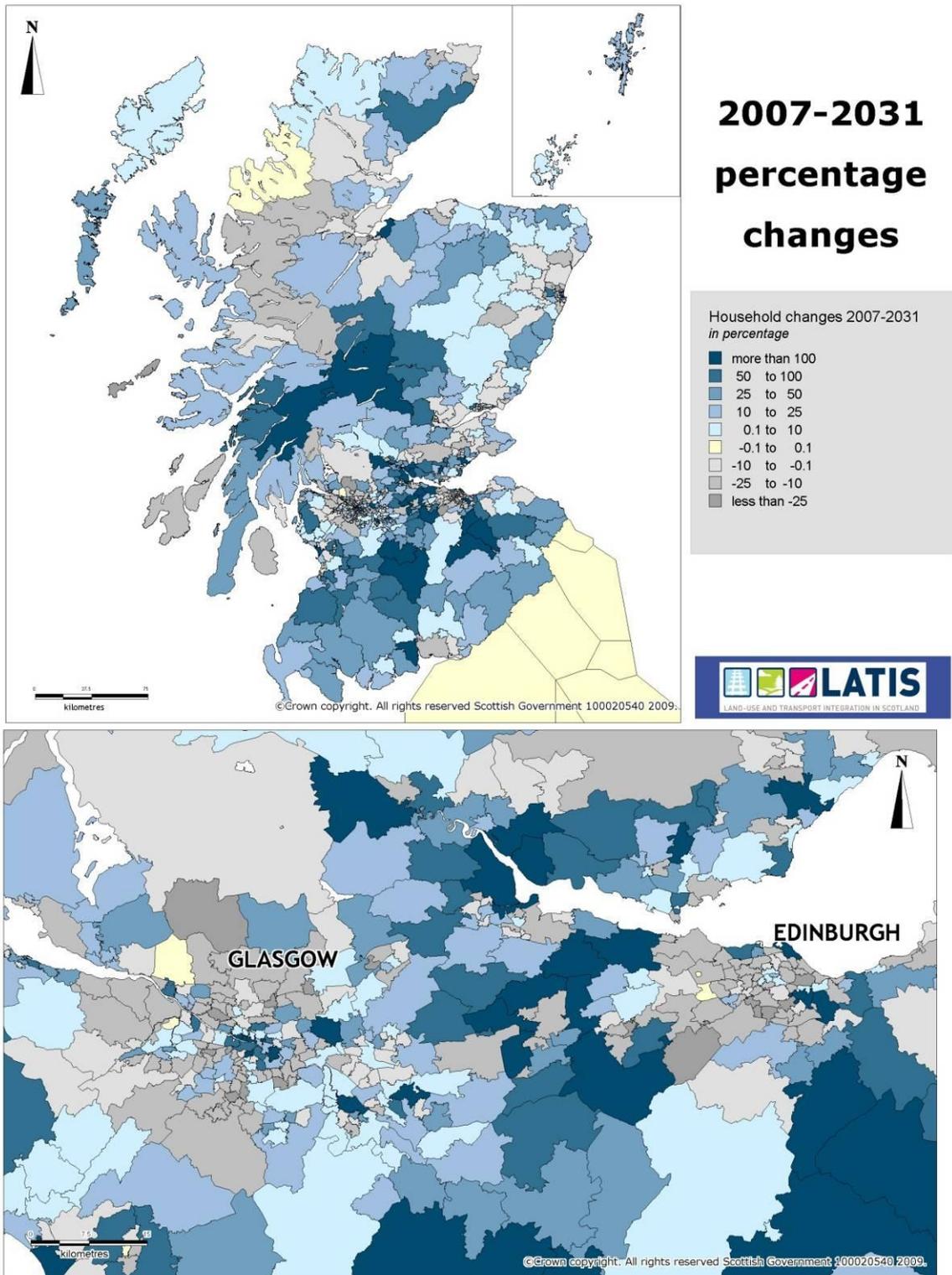


Figure 8.16 Change in total number of households 2007-2031

8.7 Model outputs – economy

8.7.1 Tables A2.21 to A2.23 show the levels of Production, Gross Value Added and Capacity by sector for Scotland. These outputs are consistent with the economic scenario. Figure 8.17 maps the change in employment at zone level for the forecast period to 2031.

Employment changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

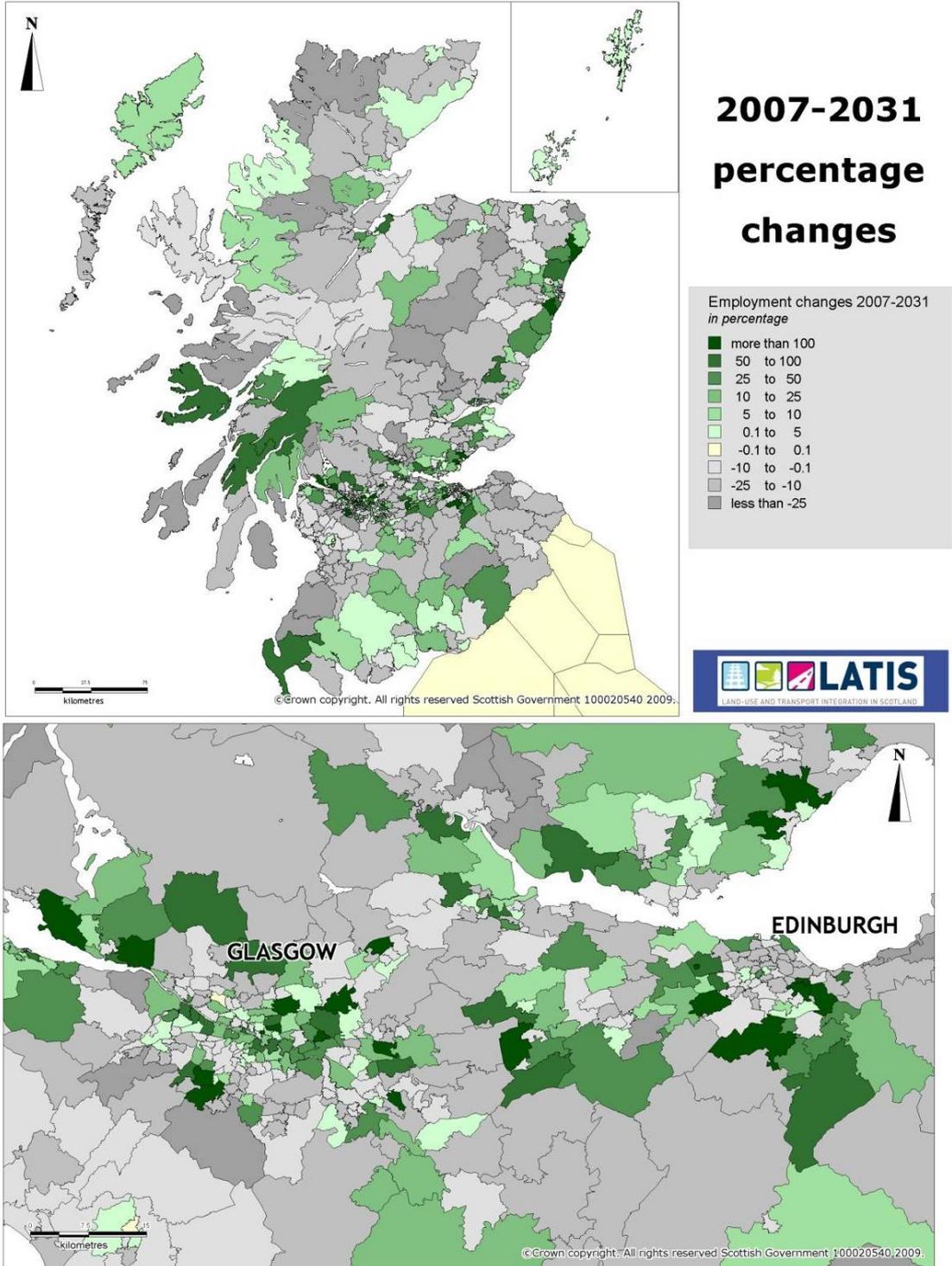


Figure 8.17 Changes in employment 2007-2031 (Reference Case)

8.8 Model Outputs – Floorspace

8.8.1 Tables A2.6 to Tables A2.12 describe the changes in floorspace, at Local Authority Level, for the seven land uses that are modelled within TELMoS:07. Figures 8.18 and 8.19 show the change in occupied residential and employment floorspace.

Residential floorspace changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

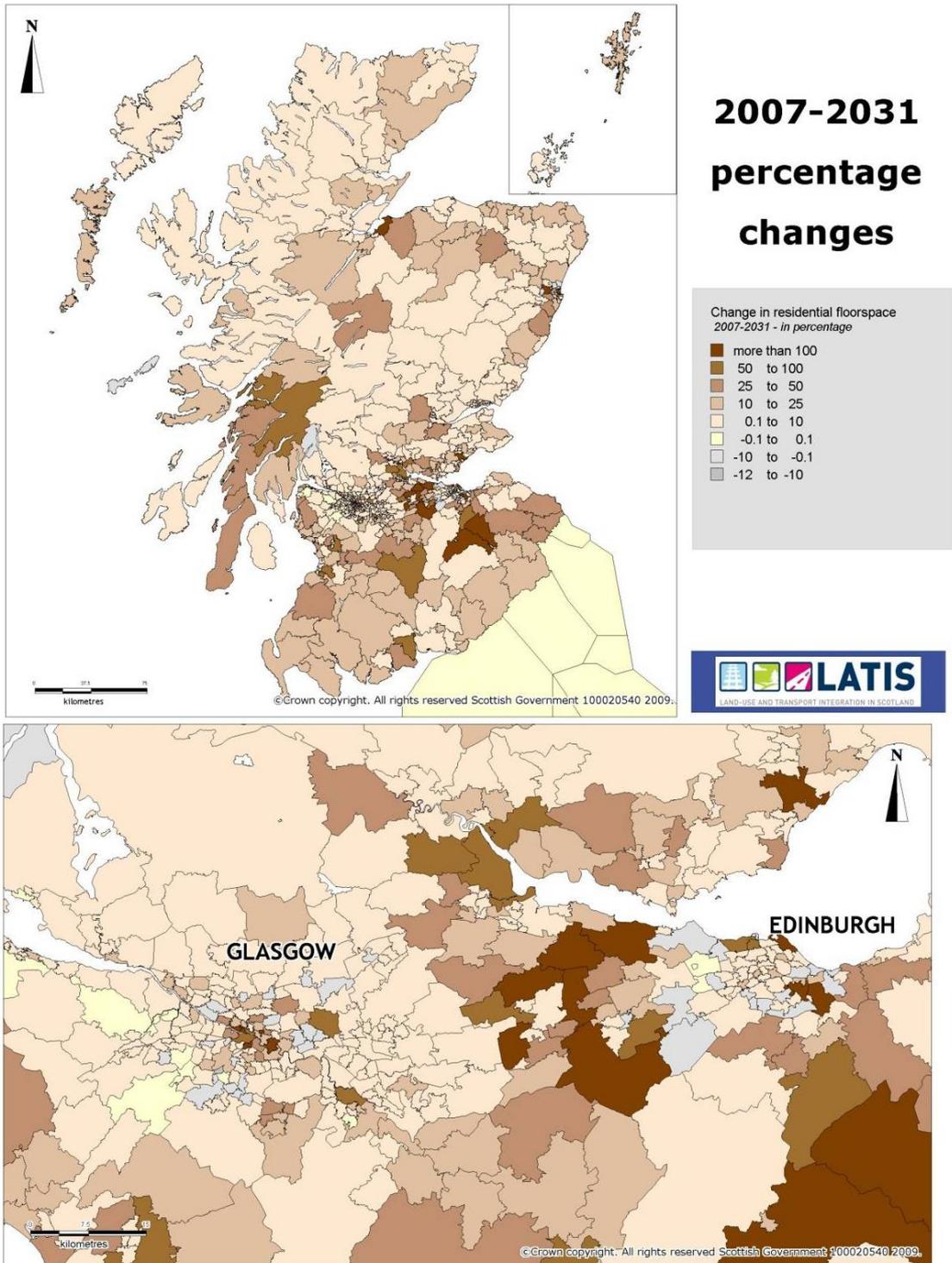


Figure 8.18 Change in residential floorspace 2007-2031

Commercial floorspace changes

c1.42.07 TELMoS_07
Test JA - 13 May 2009

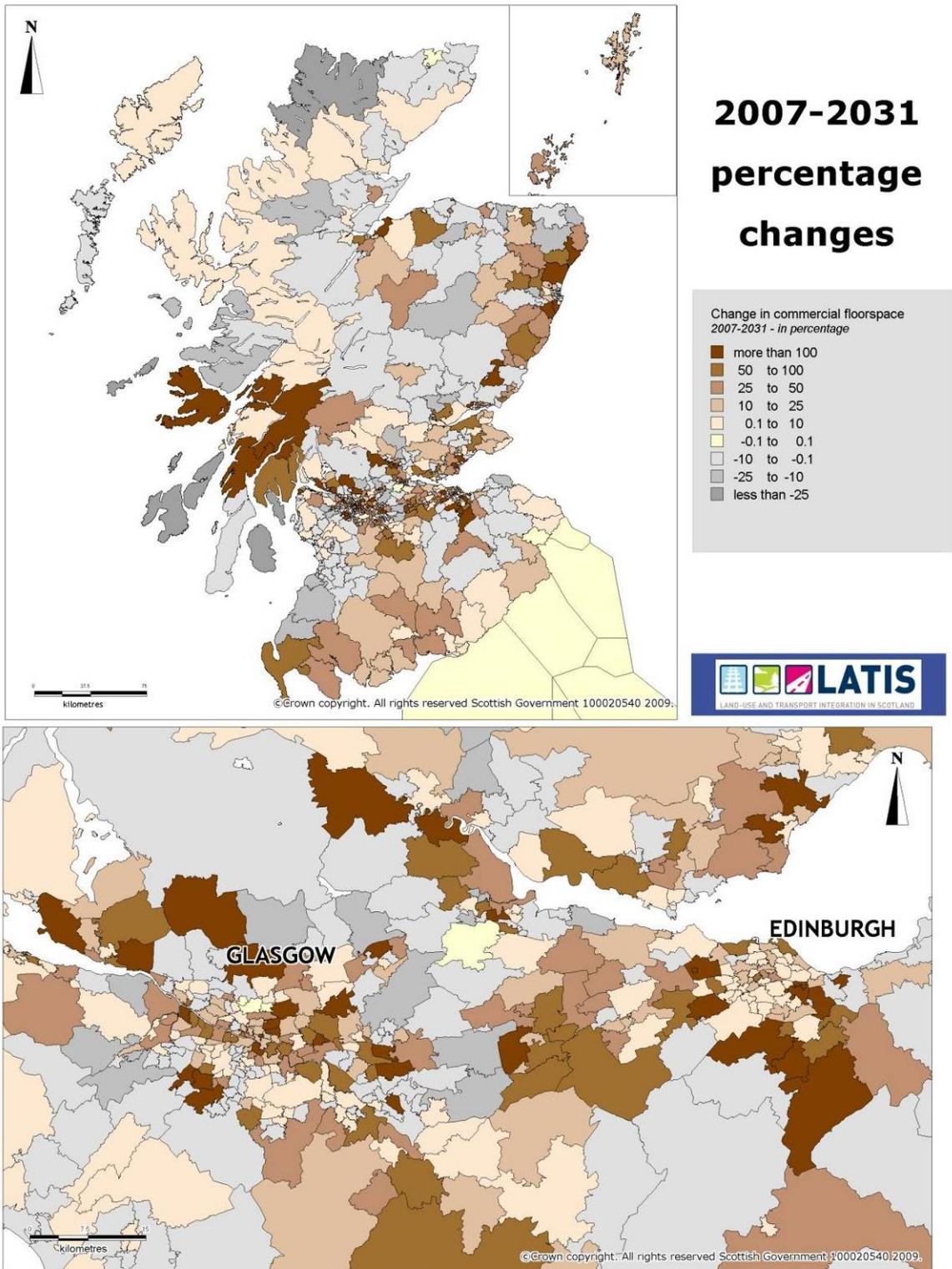


Figure 8.19 Change in occupied employment floorspace 2007-2031

8.8.2 The key points are:

- There is a 10% increase in residential floorspace over the period from 2007-2021. This reflects the planning policy inputs to the model. The largest percentage increases in are within West Lothian (53%) and Midlothian (19%), where there are planning policy inputs of around 48,300 and 13,800 dwellings respectively. The lowest percentage increases are within East Renfrewshire, North Lanarkshire and Inverclyde where increases of around 1% are forecast;
- There is a 19% increase in retail floorspace. Most of this occurs within the period from 2007-2011 when all planning policy inputs are treated as exogenous. There are declines in retail floorspace in several local authority areas including Angus, Argyll and Bute, North Ayrshire and Clackmannanshire;
- There is a 29% increase in office floorspace. Again most of this occurs within the period from 2007-2011; and
- There is a 7.7% increase in industrial floorspace across Scotland.

8.9 Model Outputs – take up of planning permissions

8.9.1 Table A1.20 in Appendix 1 shows the un-used planning policy inputs in 2021 for the four main land uses. These comprise the land and floorspace identified for development by the local planning authorities that have not been taken up and floorspace that may come forward through the demolition process, where floorspace is demolished and an equivalent amount of floorspace is made available for development (or re-development). The process of 're-cycling' demolished floorspace is only applied to the retail, office and industrial floorspace.

8.10 Model Outputs – Activities

- 8.10.1 Tables A3.3 and A3.4 in the appendix 3 show the changes in the Household activities and Employment activities at a national level.
- 8.10.2 In terms of the household activities the most significant increases are amongst the single adult households.
- 8.10.3 In terms of the employment activities (table A3.4) there are declines in the number of jobs within the primary, utilities and manufacturing sectors (Activities 31-40) and increases in the service activities (Activities 41-58).