

Dynamic microsimulation for modelling household location decision

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Household location modelling

- The UK Department for Transport has commissioned a project as part of longer-term research into the factors underlying the demand for transport and the consequences of transport change.

Overall task is

- To develop a microsimulation - based model of household location and related processes of change.

Objective of the project:

- **to achieve a better understanding of households' residential location behaviour; in particular**
 - achieving a better understanding of the linkages between transport and household location, both generally and as a basis for providing advice on modelling methods for transport planning;
 - forecasting residential location as an input to transport modelling;
 - achieving a better understanding in particular of the factors affecting commuting and commuting distances.

Disaggregate modelling: advantages

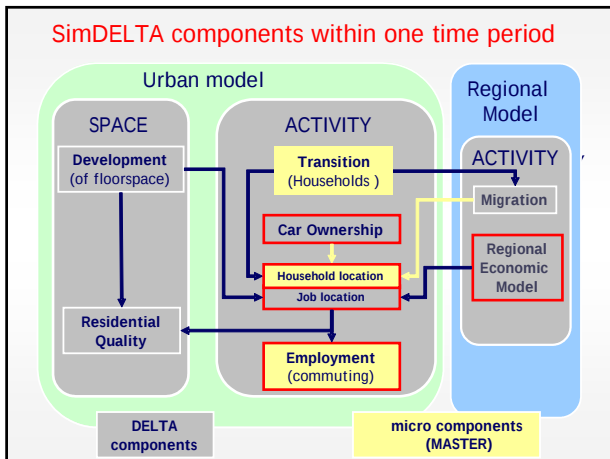
- The **advantages** of developing land use – transport interaction models using disaggregate data are due to these models being based on the same decision-making choices that are present in the real world for both **land** use and travel decisions.
- It may be important to note that they are not necessarily more accurate in the base year validation statistics, since models can be “tweaked” to match observed values, but would be more accurate in the forecast years.

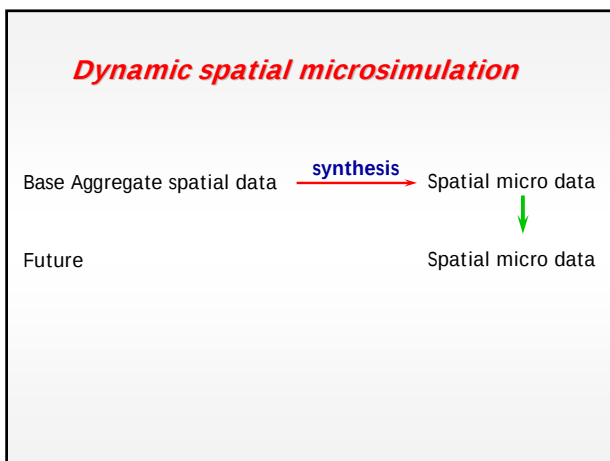
Disaggregate modelling: disadvantages

- Random numbers are used in the process of “deciding” which of the available alternatives the decision-maker will choose, given the calculated probabilities.
- The sequence of random numbers generated depends on the particular method and the initial value of the random number (random number seed). Changing the random number seed produces a different sequence of random numbers, which, in turn, produces different results.

SimDelta model components

- The overall proposal is that **all** of the model components which deal with changes in households and individual household members will be implemented as microsimulation models, **except**
 - longer-distance migration, and
 - car ownership.
- Longer-distance migration has to be treated differently because it has to deal with migration between the microsimulated case study area and the other regions of Great Britain.





- Individual demographics and other changes**
- Ageing
 - Survival
 - Birth/multiple births
 - Enter/re-enter labour market
 - Retire from labour market
 - Update educational status
 - Fix/change occupation
 - Acquire driving licence
 - Lose driving licence
 - Absence from household

Household changes

- Separate
- Form couple or potential couple
- Marry
- Household formation

Household location

- Seek to move
- Housing tenure choice
- Location choice
- Set/adjust asking price for dwelling

Employment

- Seek to change job
- Job (and workplace) choice

In addition the model will take account of

- the transport system, and its impact on accessibility and hence on households – this is of critical interest for DfT;
- changes in the number and distribution of jobs; and
- changes in the supply and characteristics of housing;

but

- the model is **not** expected to deal with feedback from household location to travel demand.

MODELLING AREA

- 1: Bradford and Craven
- 2: Calderdale and Kirklees
- 3: Leeds and Wakefield
- 4: Barnsley, Rotherham, Sheffield, and North East Derbyshire
- 5: Doncaster and Bassetlaw



Modelling area and 2001 local authority boundaries



Thank you for your attention!!!

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Static model

- JAVA coded simulated annealing model
- 1991 and 2001 Census and 1991 Small Area Statistics data are used in the process
- Output from simulated annealing contains all the Census variables from the Sample of Anonymised Recors for each member of every household (not all needed)
- Other variables had to be synthetically added, particularly
 - Household incomes
 - Place of work for working individuals

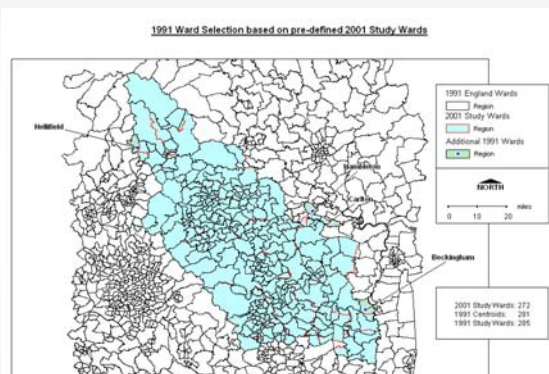
Simulated Annealing Process

- Select Sample of Anonymised Records at random (SAR)
- Compare predicted Small Area Statistics (SAS) tables and real SAS tables
- Cells populated by new SARs
- 'Temperature' controls number of swaps
- If error reduced, retain those records
- Continue until error minimised

1991 Census and 1991 Synthetic databases

LA (whole or part)	Population Model 1991	Population SAS 035	Deviation (%)	Households model/SAS27	Households SAS042	Deviation (%)
Barnsley	218,731	218,556	0.080	87,087	87,091	-0.005
Bassetlaw	98,881	98,779	0.103	39,218	39,230	-0.031
Bolsover	1,917	1,912	0.262	778	778	0.000
Bradford	451,308	451,050	0.057	174,071	174,112	-0.024
Calderdale	189,520	189,444	0.040	77,428	77,444	-0.021
Craven	36,615	36,554	0.167	15,290	15,294	-0.026
Doncaster	285,264	285,022	0.085	112,725	112,737	-0.011
Harrogate	4,344	4,347	-0.069	1,638	1,638	0.000
Kirklees	369,696	369,534	0.044	146,864	146,893	-0.020
Leeds	648,841	648,572	0.041	271,518	271,609	-0.034
North East Derbyshire	46,398	46,397	0.002	18,027	18,027	0.000
Rotherham	249,795	249,692	0.041	97,851	97,866	-0.015
Selby	10,334	10,317	0.165	3,857	3,857	0.000
Sheffield	496,447	496,215	0.047	210,925	210,982	-0.027
Wakefield	307,936	307,765	0.056	123,465	123,483	-0.015
Total	3,416,027	3,414,156	0.055	1,380,742	1,381,041	-0.022

Ward boundary changes



2001 Census and 2001 Synthetic databases

LA (whole or part)	Population Model 2001	Population cas002	Deviation (%)	Households model/KS20	Households cas056	Deviation (%)
Barnsley	218,131	218,070	0.028	92,167	92,161	0.007
Bassetlaw	118,406	119,721	-1.098	49,272	49,315	-0.087
Bolsover	3,025	3,019	0.199	1,254	1,257	-0.239
Bradford	461,376	467,664	-1.345	180,243	180,238	0.003
Calderdale	191,748	192,401	-0.339	80,938	80,937	0.001
Craven	55,643	56,031	-0.692	23,694	23,712	-0.076
Doncaster	286,180	286,863	-0.238	118,696	118,718	-0.019
Harrogate	5,766	5,770	-0.069	2,322	2,326	-0.172
Kirklees	385,836	388,555	-0.700	159,034	159,036	-0.001
Leeds	683,361	688,938	-0.810	290,897	290,891	0.002
North East Derbyshire	45,791	45,815	-0.052	18,982	19,004	-0.116
Rotherham	247,856	248,174	-0.128	102,278	102,313	-0.034
Selby	20,922	20,946	-0.115	8,314	8,244	0.849
Sheffield	507,855	513,235	-1.048	217,620	217,652	-0.015
Wakefield	314,355	315,173	-0.260	132,210	132,224	-0.011
Total	3,546,251	3,570,375	-0.676	1,477,921	1,478,028	-0.007

Examples of households

- *Household 1*
- 1991 Begins married with 2 children, employed, owner-occupier, income £21560
- 1996 Child 1 leaves home – sets up new household with partner
NEW HOUSEHOLD FORMATION HERE (Household new2)
- 1998 Child 2 leaves home, goes to university (leaves the region)
- *Household NEW 2*
- 1996 Household formation – rented accommodation
- 1999 Household marries
- 2000 Relocation to new household as income increases (owner-occupied)

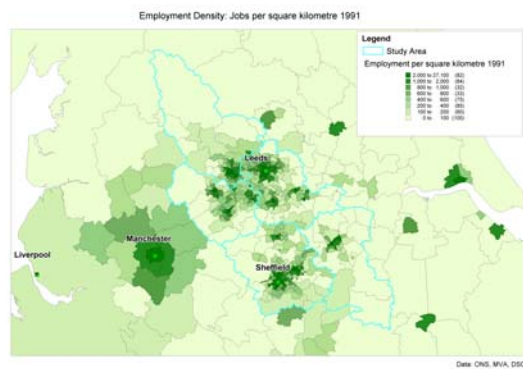
Examples of households

- *Household 3*
- 1991 Married couple with no children: owner-occupied
- 1993 Divorce – male seeks new household in rented accommodation (new household formation)
- 1994 Female finds partner and stays in original dwelling
- 1996 Male finds a new partner – move to owner-occupied
- 1997 Male loses job – moves to unemployed
- 1997 Female remarries – move to bigger dwelling as household income increases
- 1998 Male reemployed
- 2000 Income increases in new male household - seek relocation

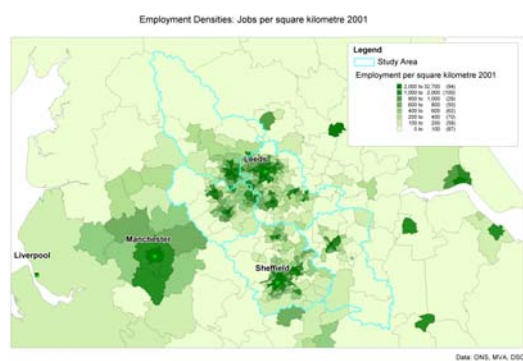
Journey to work

- All simulated individuals are assigned workplaces (at ward level) on the basis of Monte Carlo sampling from probabilities based on the Census journey to work flows
- Currently, the model uses 1991 Census Special Workplace Statistics (SWS)

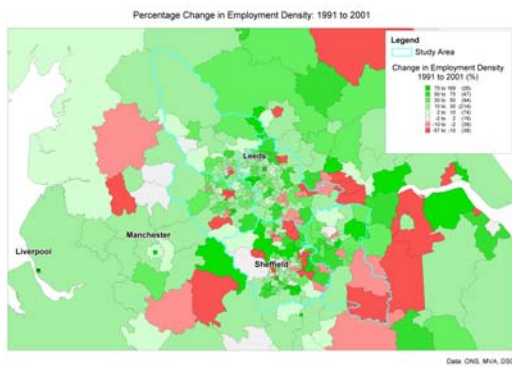
Employment data 1991



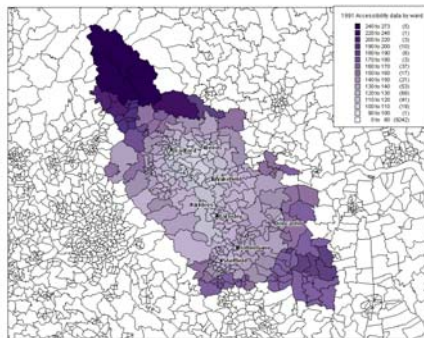
Employment data 2001



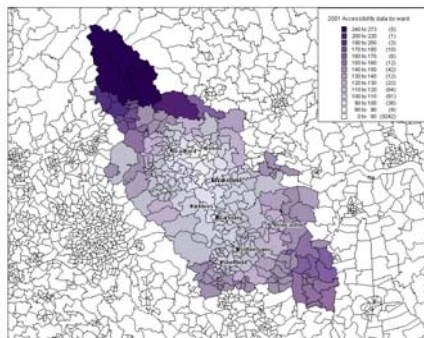
Difference in employment 2001-1991



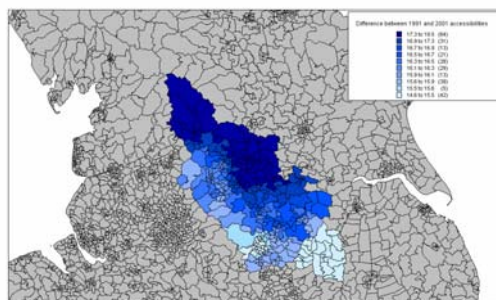
Accessibility to work values for 1991



Accessibility to work values for 2001



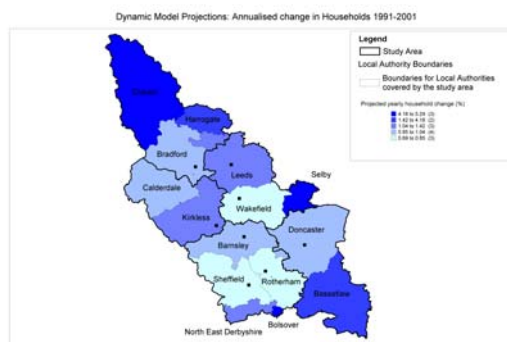
Change in accessibility



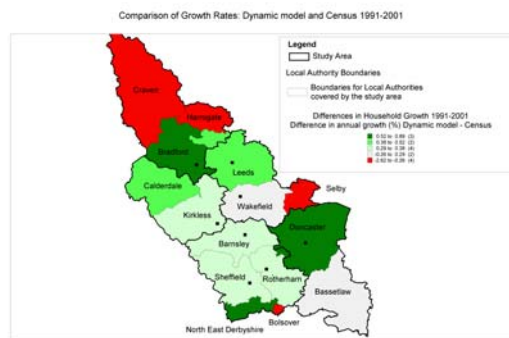
Preliminary dynamic model outputs

Local authority	Actual 1991	Projected 2001	Actual 2001	Projected - observed	Projected rate of change	Actual rate of change	Difference (projected - actual)
Barnsley	87,091	94,881	92,161	2,720	0.9%	0.6%	0.3%
Bassetlaw	39,230	49,360	49,315	45	2.3%	2.3%	0.0%
Bolsover	778	1226	1257	-31	4.7%	4.9%	-0.3%
Bradford	174,112	190,684	180,238	10,446	0.9%	0.3%	0.6%
Calderdale	77,444	84,322	80,937	3,385	0.9%	0.4%	0.4%
Craven	15,294	23,036	23,712	-676	4.2%	4.5%	-0.3%
Doncaster	112,737	125,018	118,718	6,300	1.0%	0.5%	0.5%
Harrogate	1,638	1,934	2,326	-392	1.7%	3.6%	-1.9%
Kirklees	146,893	164,322	159,036	5,286	1.1%	0.8%	0.3%
Leeds	271,609	302,767	290,891	11,876	1.1%	0.7%	0.4%
North East Derbyshire	18,027	20,748	19,004	1,744	1.4%	0.5%	0.9%
Rotherham	97,866	105,362	102,313	3,049	0.7%	0.4%	0.3%
Selby	3,857	6,453	8,244	-1,791	5.3%	7.9%	-2.6%
Sheffield	210,982	226,003	217,652	8,351	0.7%	0.3%	0.4%
Wakefield	123,483	134,221	132,224	1,997	0.8%	0.7%	0.2%
Total/Average	1,381,041	1,530,337	1,478,028	52,309	1.0%	0.7%	0.4%

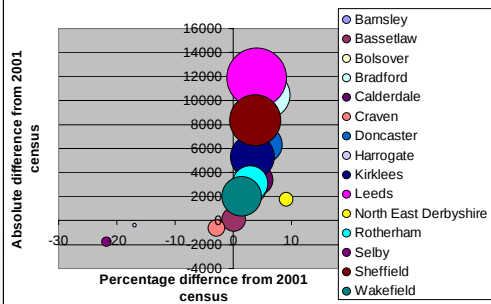
Dynamic model projections



Comparison of growth rates



Absolute and percentage differences in Households, 2001 Dynamic model output and 2001 Census, Local Authorities scaled in proportion to households in Census



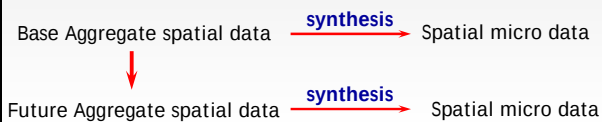
More statistics

	Households	Births	Deaths
Average	1433921.2	47133.2	36405.6
St. deviation	414.753178	279.4874	219.889293
Min	1433635	46729	36153
Max	1434643	47481	36752
max-min	1008	752	599
dev/average %	0.028924405	0.592974	0.60399853
(max-min)/average %	0.07029675	1.595478	1.64535127

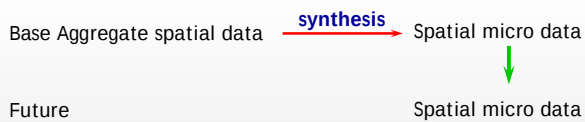
More statistics: birth by age of female

	Age <20	20-24	25-29
Average	2265	12418.8	17154
deviation	52.3116	103.5577	76.6746
min	2201	12277	17051
max	2345	12513	17237
max-min	144	236	186
dev/average %	2.3096	0.8339	0.4469
(max-min)/average %	6.3576	1.9003	1.08423

Static spatial microsimulation



Dynamic spatial microsimulation



Propensity to change house

- Calculated for every household by person per room ratio
- Estimated the migration rates for wholly moving households on the basis of migration information from the BHPS

Tenure types

- Owner occupier households
- Privately renting households
- Households renting from Local Authority or Housing Association

Tenure change modelling is performed on the basis of transition rates, which are calculated using corresponding variables in the British Household Panel Survey, to evaluate each simulated household for change in tenure status
