
Real Simulations for Real Cities: From Computer Gaming to an Infrastructure for Research, Policy and Teaching

Mark Birkin and Martin Clarke
School of Geography
University of Leeds

Content

- City Simulations
- Moses Project
 - Concepts and objectives
 - Methods
 - Evaluation
 - Results
 - Next Steps
- Conclusions

SimCity: Features

- Infrastructure is managed by game-players in order to make cities attractive to their residents
 - Schools, healthcare, emergency services, transportation, ...
 - In accordance with fixed resource budgets
 - Well-managed cities will grow and generate additional resources
 - Poorly-managed cities will wither and lose resources
- Sophisticated user interface allows impact of decisions to be visualised and evaluated
- Behavioural 'rules' are relatively simple but generate complex environments
- Both success and failure are inexpensive and generate useful learning outcomes

Real Cities: Features

- Infrastructure is managed by decision-makers in order to make cities attractive to their residents
 - Schools, healthcare, emergency services, transportation, ...
 - In accordance with fixed resource budgets
 - Well-managed cities will grow and generate additional resources
 - Poorly-managed cities will wither and lose resources
- Some use of 'performance indicators', survey data etc to provide a picture of service effectiveness
 - Much useful information is poorly integrated or difficult to access
- Individual 'rules' are complex and poorly understood, giving rise to highly complex systemic behaviour
- Failure to manage resources effectively is extremely wasteful and poor decisions may take years to remedy

Real Cities: Implications

- Decision-makers need simulation tools in order to understand the impact of plans and policies
 - Evaluate alternative scenarios
 - Draw conclusions from real information
 - Build experience from synthetic learning environments
- Rationale for the Moses project

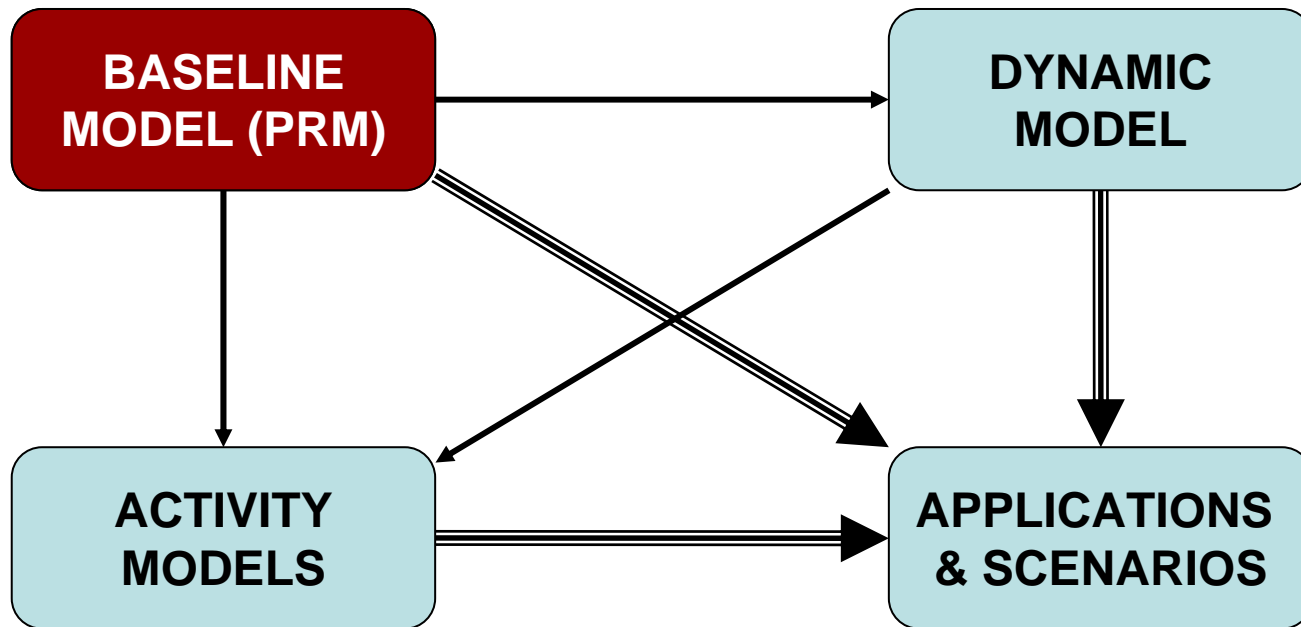
Urban Simulation: The Research Challenge

- Academics and planners have been trying to simulate real cities for 40 years or more
 - Often with inadequate data, insufficient computational resources and weak theories, particularly in relation to dynamics
- Moses seeks to leverage recent developments in e-Science and in the technology of spatial modelling (specifically agent-based simulation) for this purpose

Moses: Project Objectives

- To develop a complete **representation** of the UK population at a very fine spatial scale
- To produce rich, detailed and robust **forecasts** of the future population of the UK
- To investigate **scenarios** which relate demographics to service provision
 - with particular emphasis on policy applications within the health, transport and fiscal policy sectors

Moses: Project Components



Methodology for the PRM

Census tables for zone i

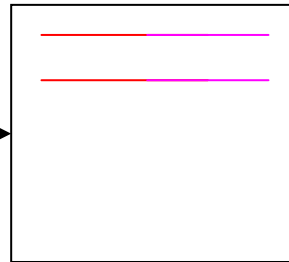
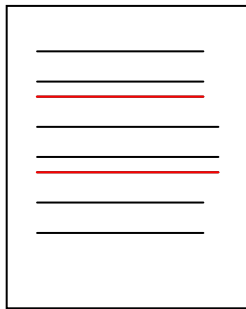


i

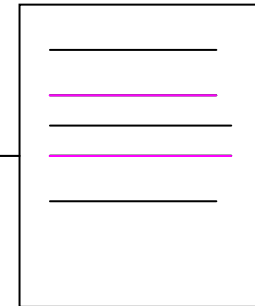
Households					
All households	With no adults in employment		With dependent children		With one or more people with a limiting long term illness
	With dependent children	Without dependent children	All ages	Aged 0-4	
Select all	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Synthetic list for zone i

Household SAR



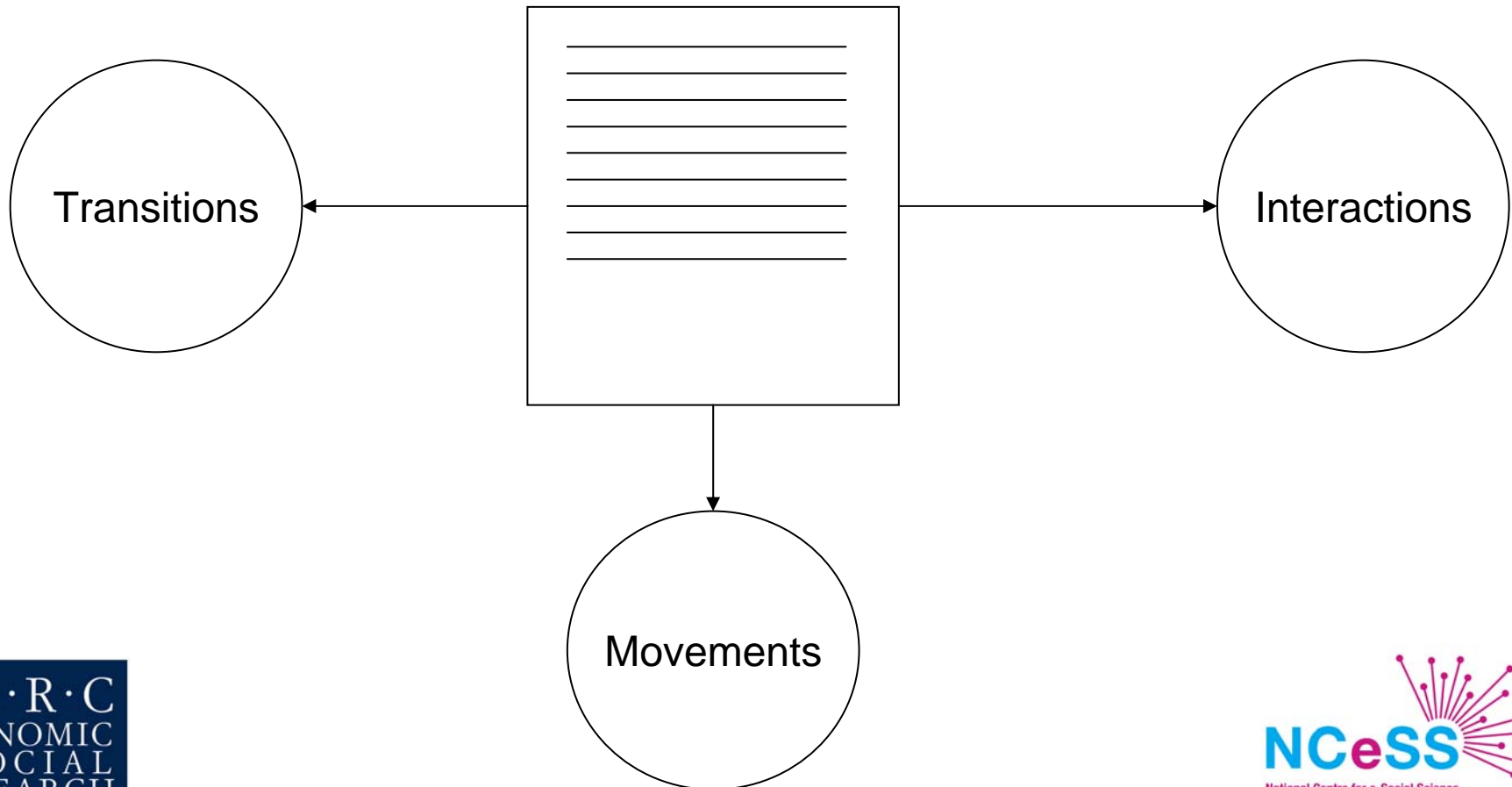
BHPS



Repeat this process for 52 million individuals

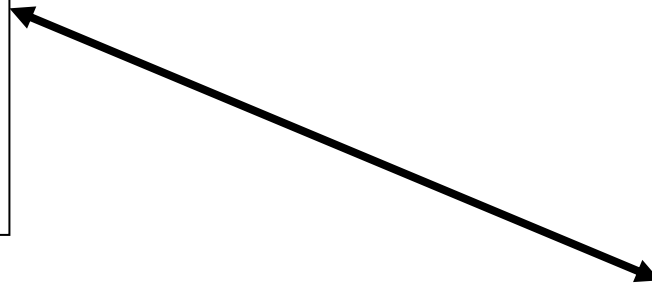
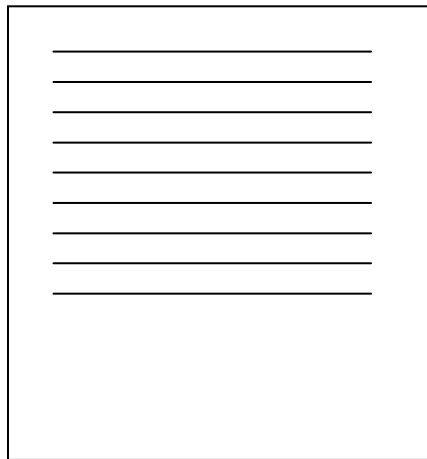
Dynamic modelling

Synthetic list for zone i



Activity modelling

Synthetic list for zone i



Service provision
at location j

Figure 1. Architecture of the Population Reconstruction Model

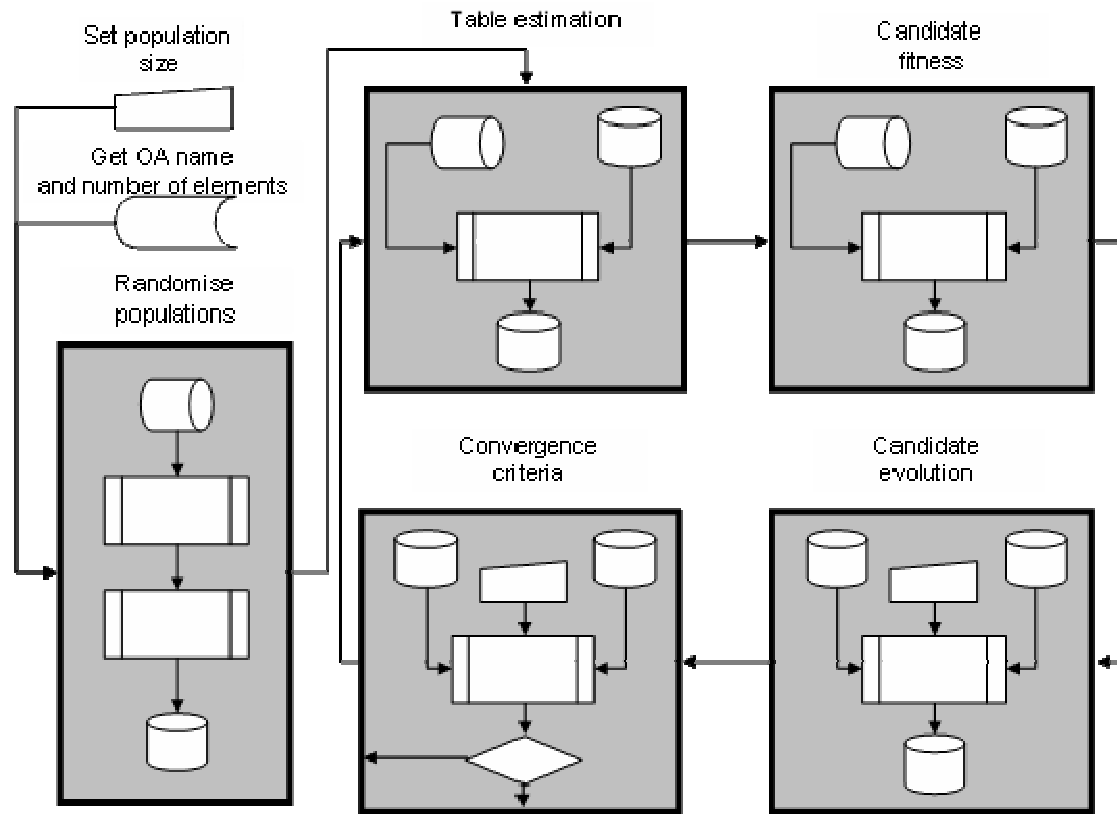


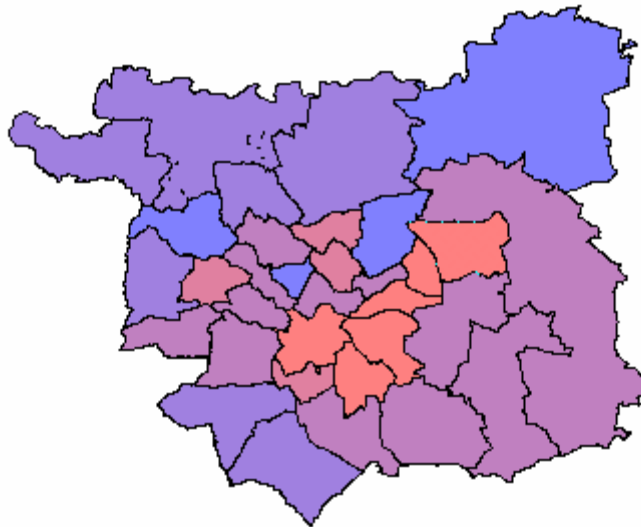
Table I Results from the PRM (Version 1)

Attribute	IoD	Type	Attribute	IoD	Type	Attribute	IoD	Type
White	0.04	V	Semi-Detached	0.11	O	Unemployed	0.20	V
Males	0.04	V	Public Transport	0.11	V	Married	0.21	O
Full-time	0.06	V	Married	0.11	V	Single	0.21	V
25-44	0.06	C	Married	0.11	V	16-24	0.22	C
part-time	0.08	V	Own Vehicle	0.12	V	Rank	0.20	O
65+	0.07	C	No Quals	0.13	V	Detached	0.20	O
Long-term I	0.07	O	Over-Occupied	0.14	O	Mixed	0.20	V
15-64	0.07	C	Professional	0.14	V	Lease	0.20	V
Co-habiting	0.07	V	Wish	0.16	V	Other	0.11	V
Life medical	0.08	V	Age 65+ dependent	0.17	V	Asian	0.46	V
Lease 2	0.09	V	Terminated	0.17	O	Black/Asian	0.48	V
Lease 1	0.09	V				Black	0.52	V
Under 16s	0.09	C						

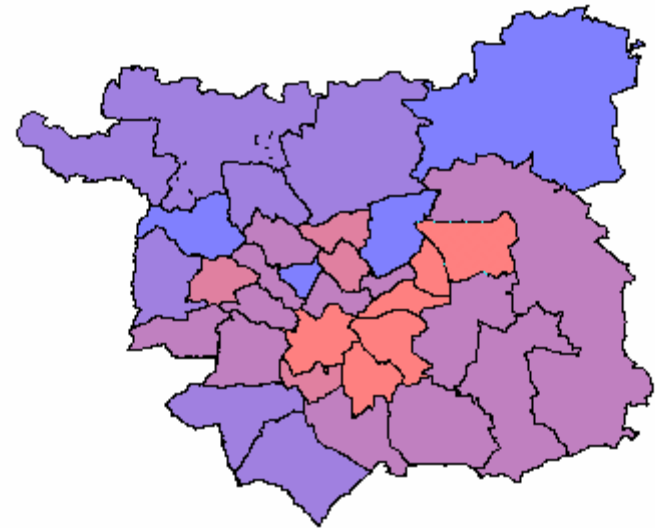
Note:
 IoDs of 0.05 or lower (row) & 0.5 or higher (col) indicate perfect correspondence; all other IoDs indicate imperfect correspondence.
 Attribute types are constrained (C), optimized (O) and missing (V). For discussion, see text.

Health Status (Optimised)

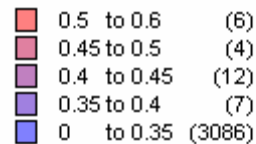
Actual



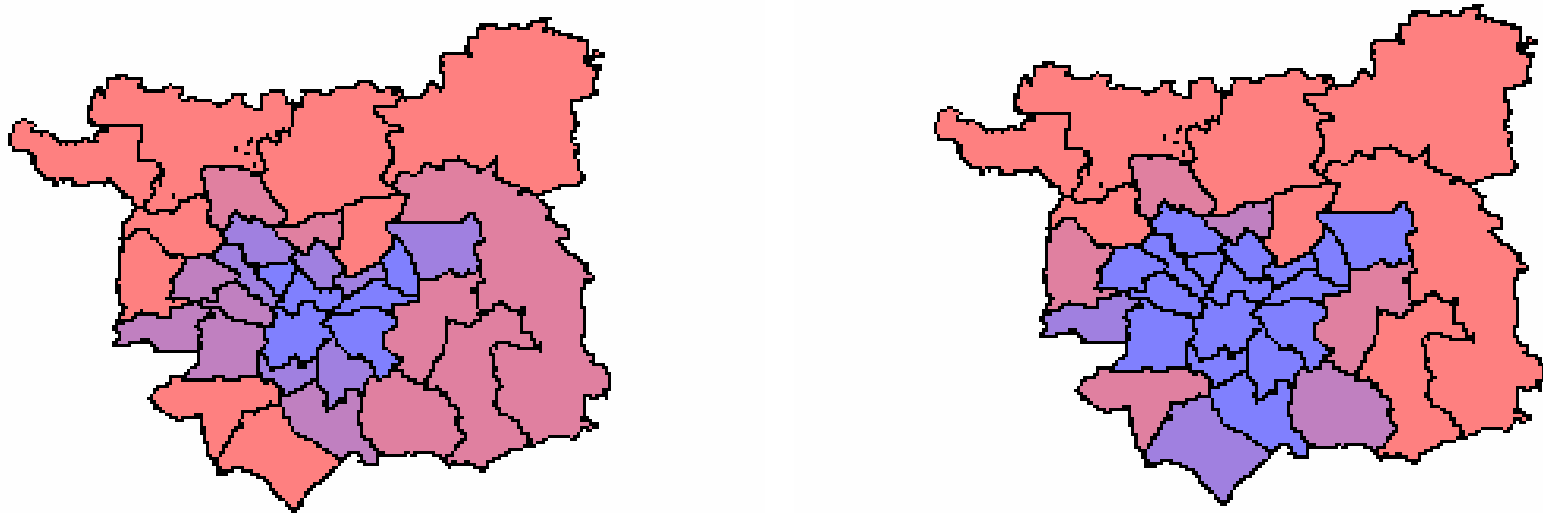
Model



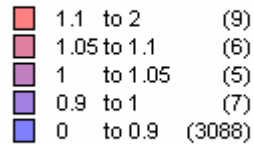
leeds_wards by health



Car ownership (Co-varying)



leeds_wards by carmod



Issues with Version 1

- Scope (households versus communal establishments)
- Constraints
- Data sources (HSAR vs ISAR)
- Geography (SCAM)
- Household dynamics
- Algorithm/ methodology

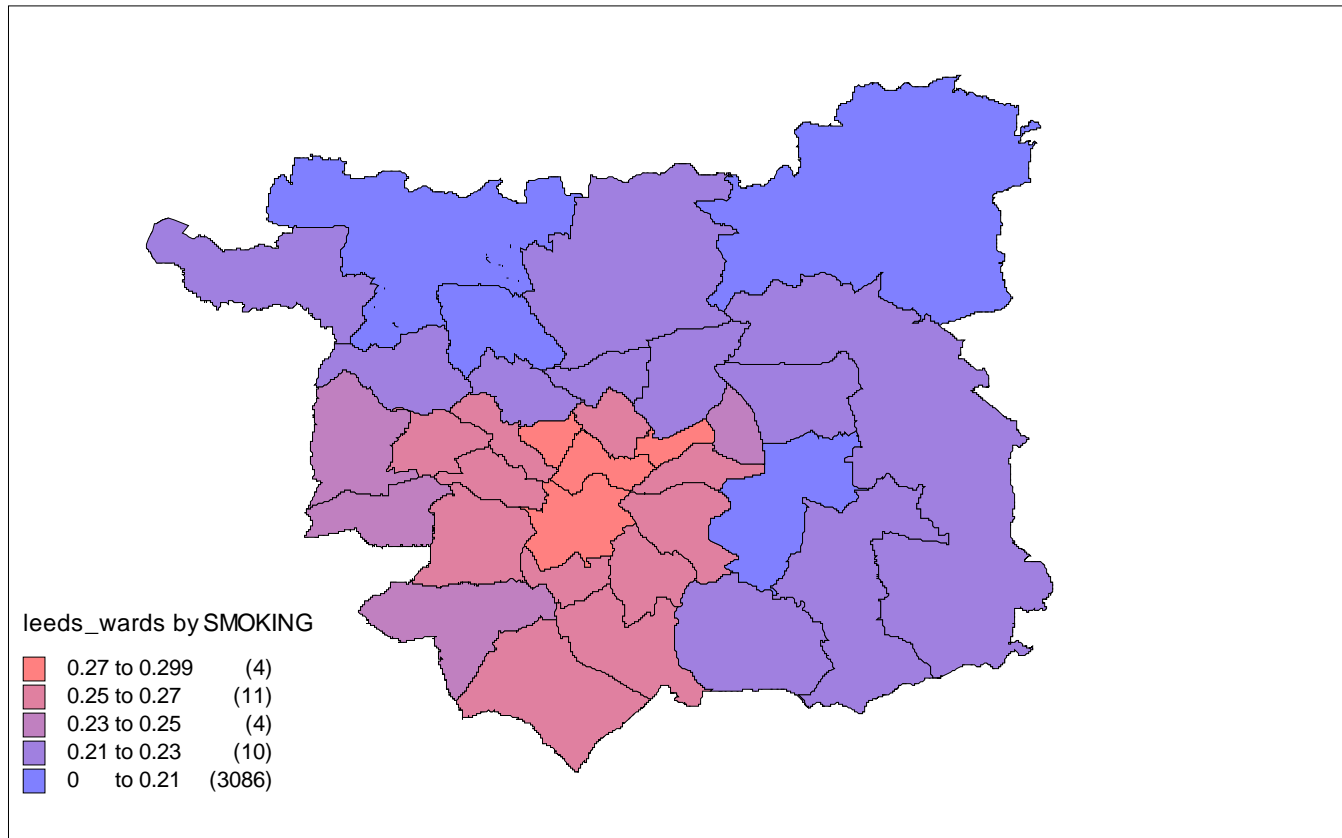
Note on model versions

	Model 1	Model 2
Spatial Scale	OA	Ward
Data source	ISAR	HSAR
Dynamics	Embedded	Separated
Algorithm	GA	IPF
Effectiveness	Disappointing	Very encouraging

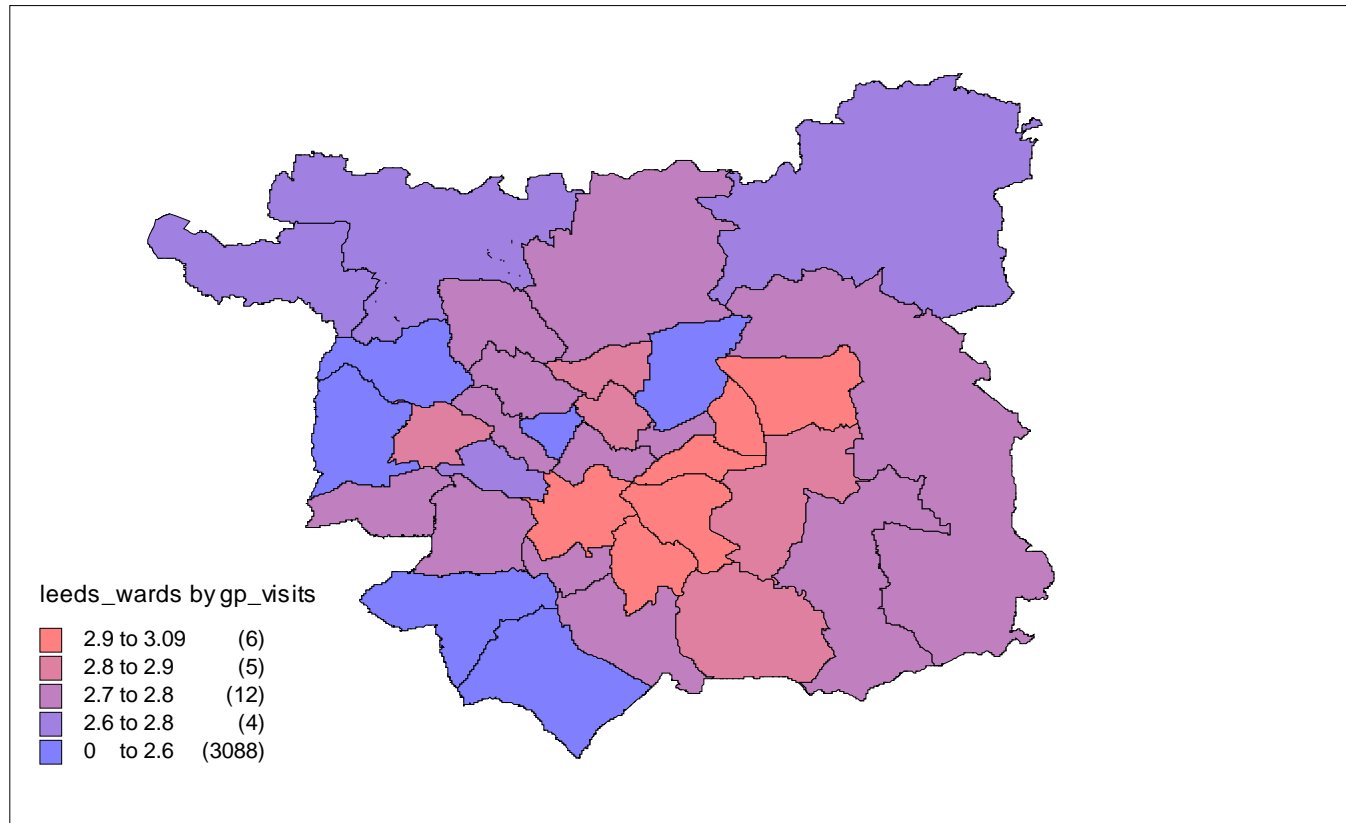
Indicative Results

- Results combine health care content from BHPS with small area demographics from the census
- Demonstrate robustness/ plausibility of model outcomes
- Stimulate further discussion and debate about application scenarios

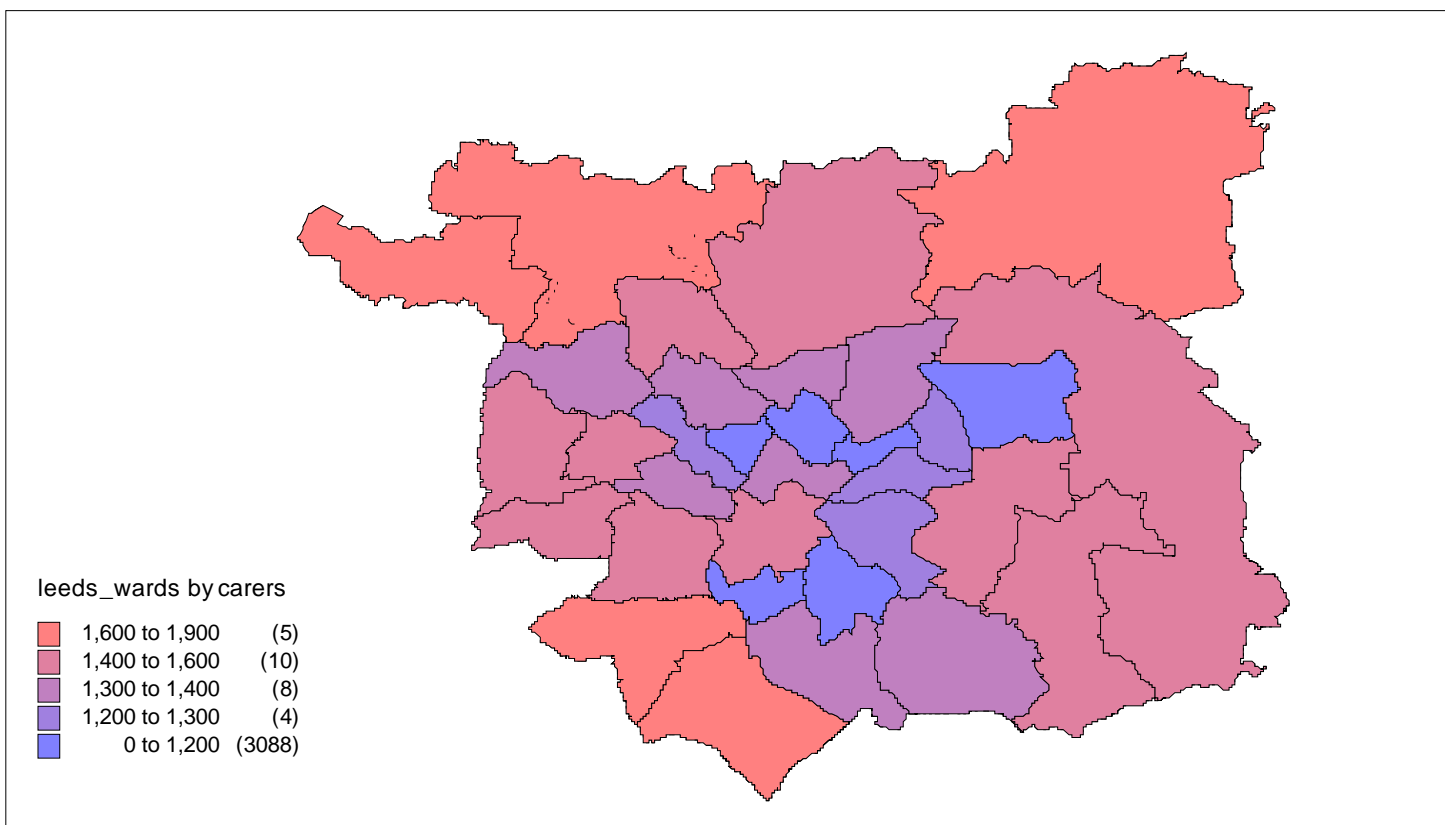
Smoking



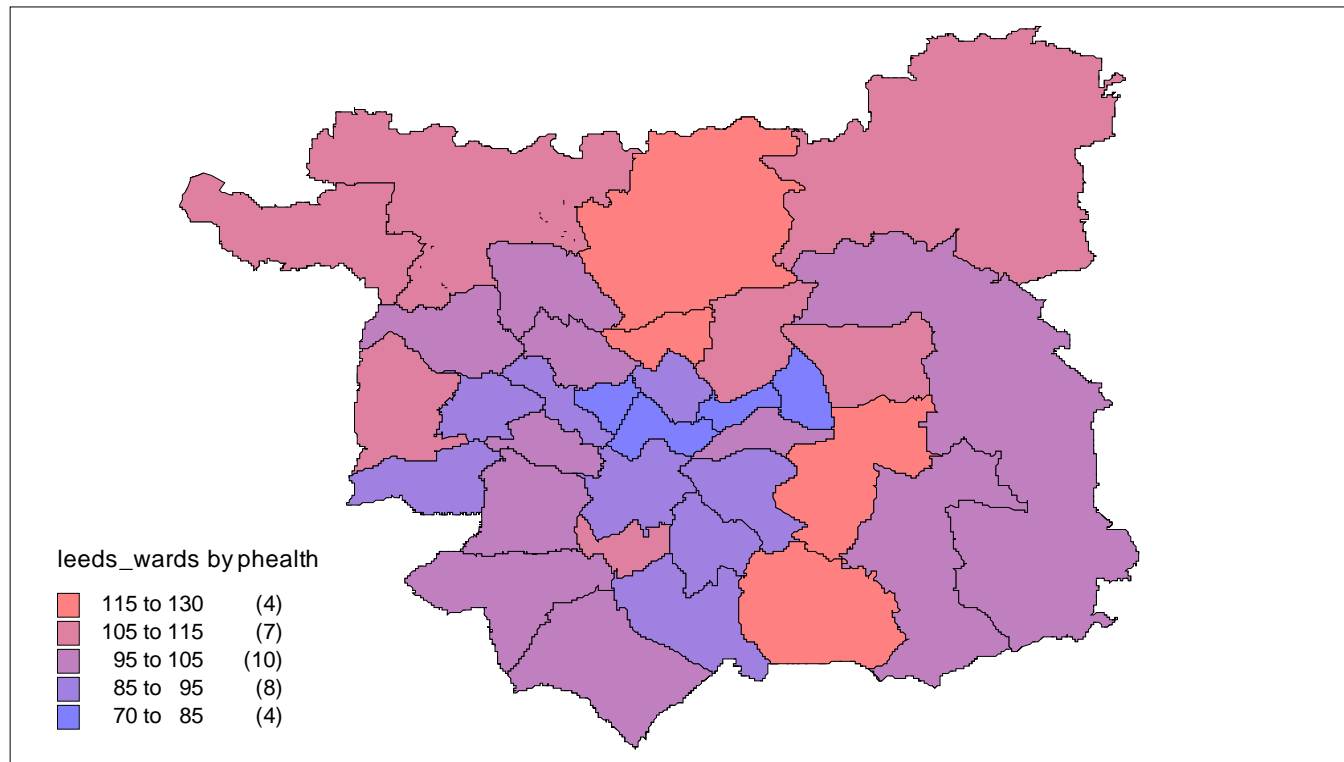
Visits to GP



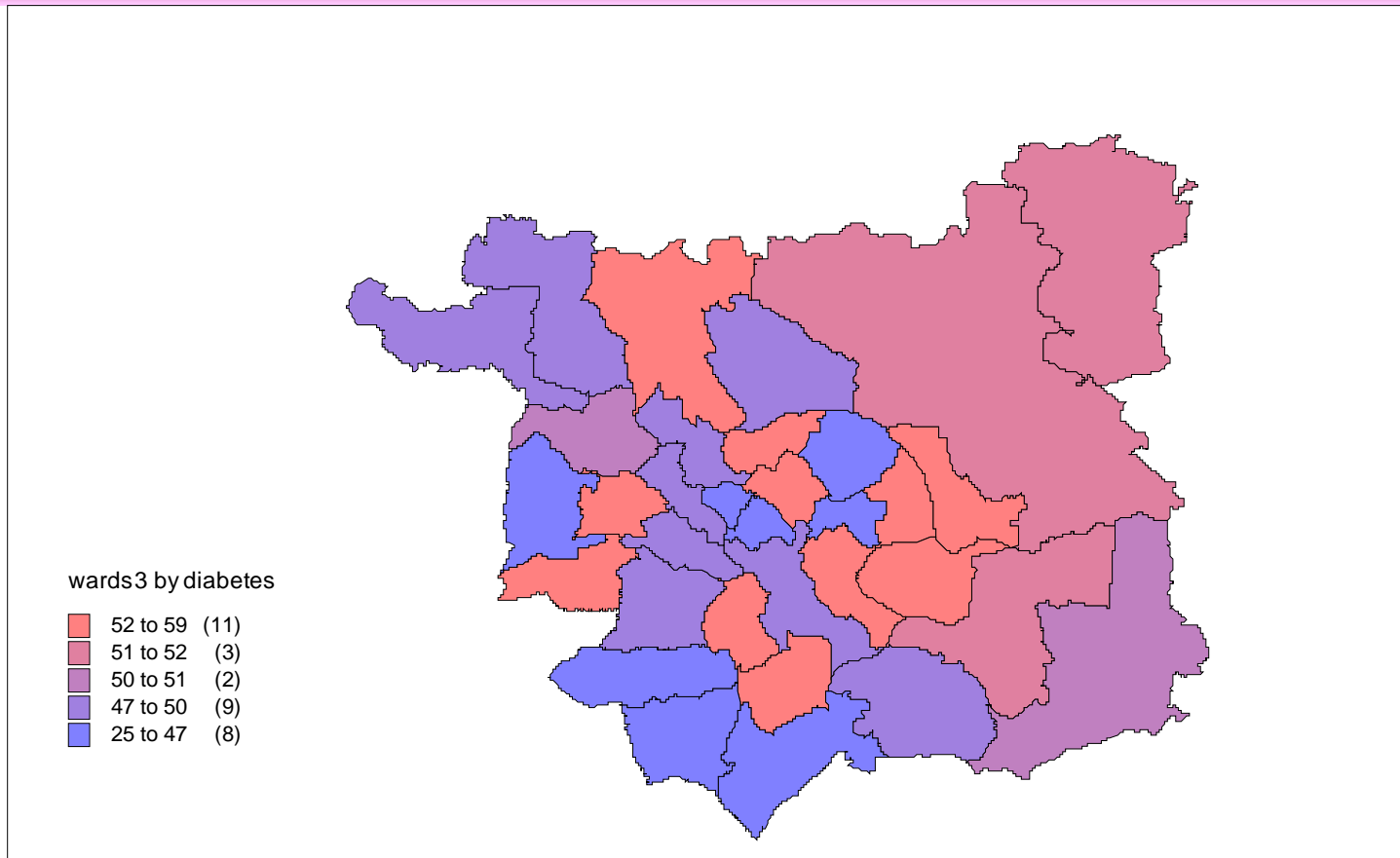
Carers



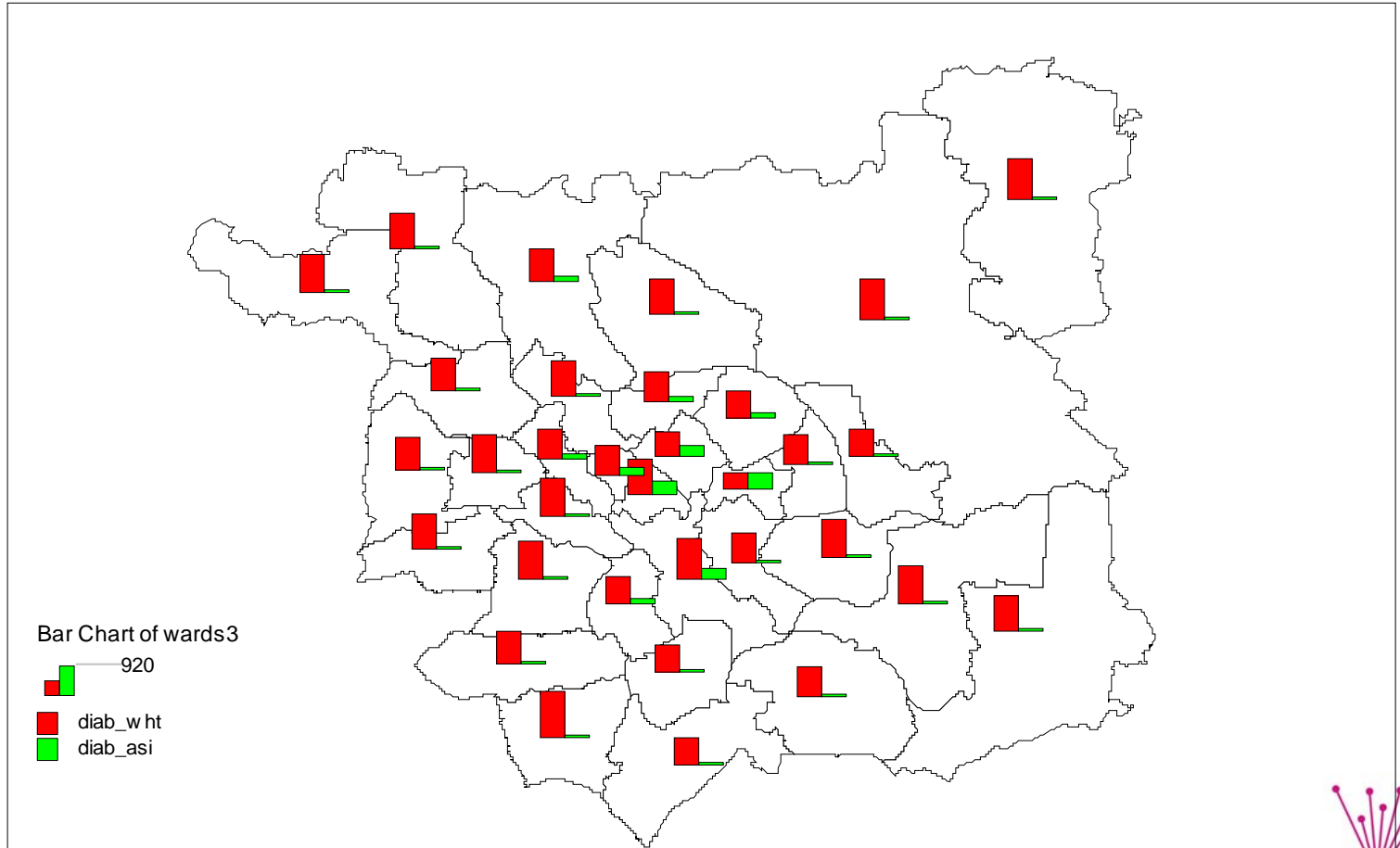
Private Health Care



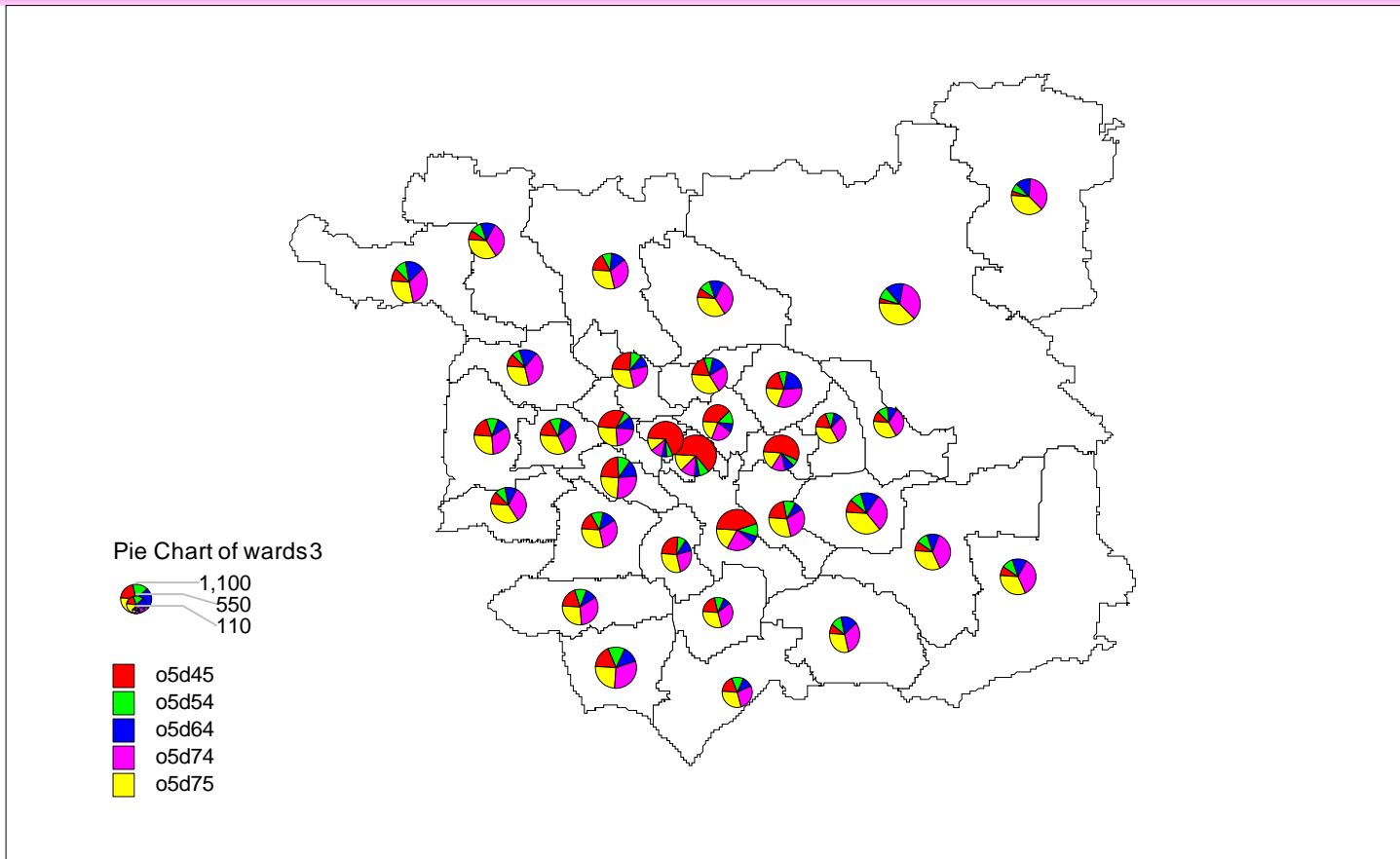
Diabetes



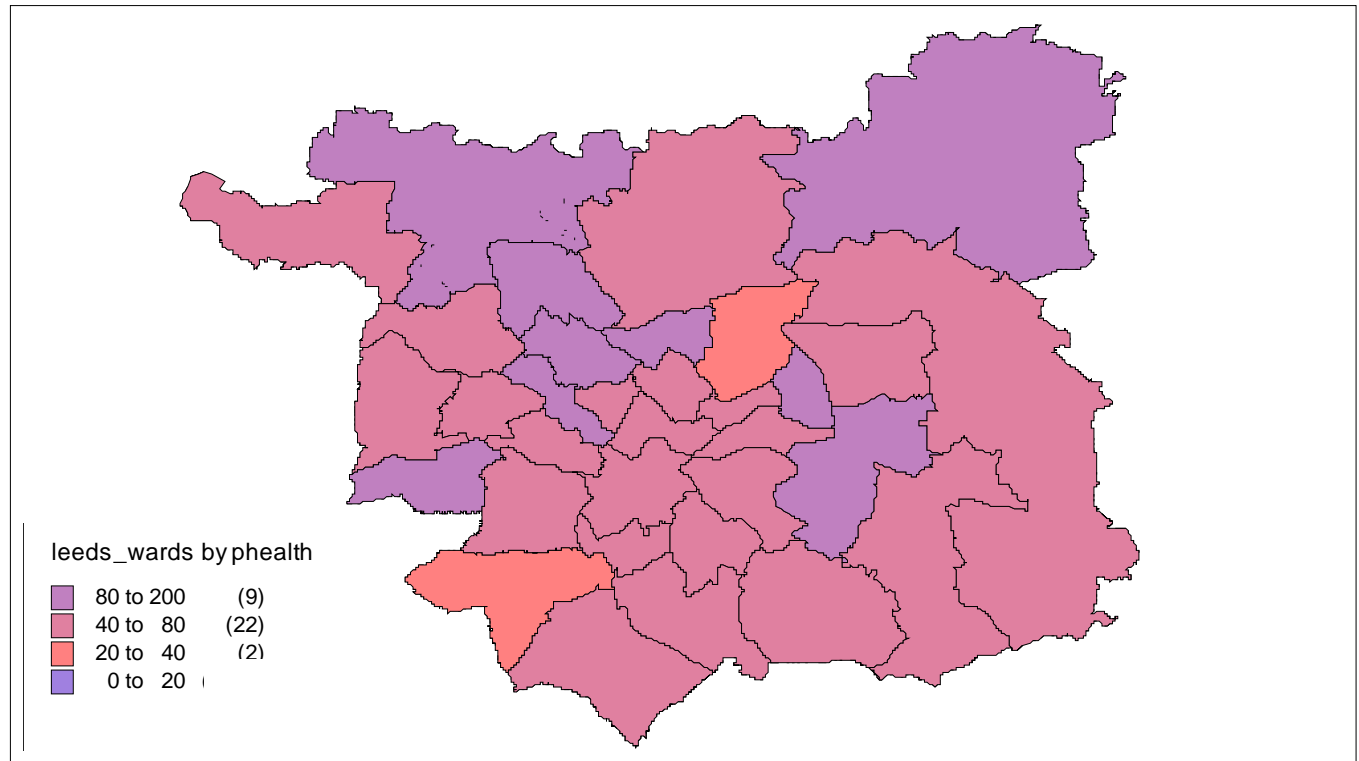
Diabetes



Diabetes 2005



Diabetes 2030



Moses: Application to Policy Issues

- The future balance between primary, community and hospital services
 - The 'prevention agenda'
 - Location of services
 - Current and future gaps in services, eg for older people
- Impact of changes in demand for services, eg diabetes, stroke
- Exploration of relationships between formal and informal support networks

Moses Portal

- Low-level (tactical) decisions
- High-level (strategic) decisions

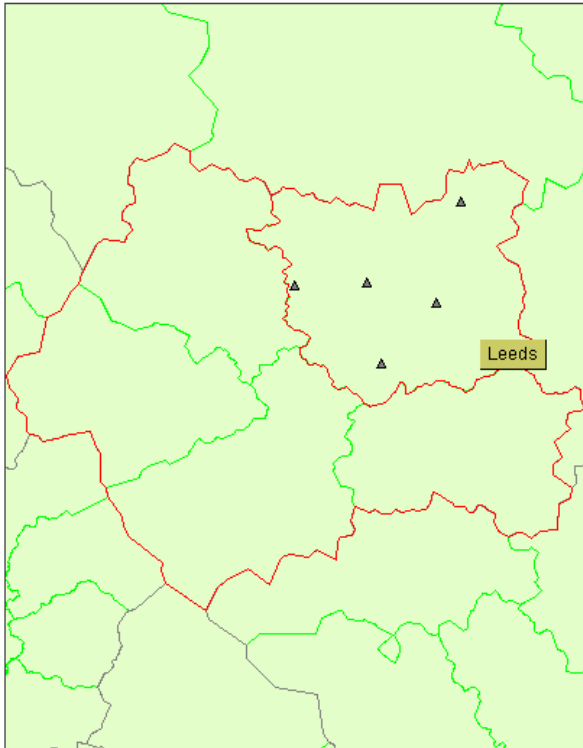
Low-level (Hydra)

HYDRA Health Care Planning Support System | University of Leeds, 2004

Service is NOT available for Scotland

1. Locate a county using the tree below or by clicking on the map:

- Lincolnshire
- Merseyside
- Mid Glamorgan
- Norfolk
- North Yorkshire
- Northamptonshire
- Northumberland
- Nottinghamshire
- Outer London
- Oxfordshire
- Powys
- Shropshire
- Somerset
- South Glamorgan
- South Yorkshire
- Staffordshire
- Suffolk
- Surrey
- Tyne and Wear
- Warwickshire
- West Glamorgan
- West Midlands
- West Sussex
- West Yorkshire



2. Choose Model Parameters:
(a) Select age ranges:

Minimum Female Age: Maximum Female Age:

Minimum Male Age: Maximum Male Age:

(b) Enter Minimum and Maximum number of surgeries:

Minimum: Maximum:

3. Enter 'run' name to save current input choices:

Here are your results.

You can map their locations by selecting the number of surgeries you ran the model for from the list below.

- 1
- 2
- 3
- 4
- 5

Reset Zoom Pan



Moses – Next Steps & Conclusions

- Moses creates a sophisticated representation of the current and future population of the UK and its behaviour
- UK baseline now available (except Scotland!)
- Dynamic model ('toy' version) (September)
- Grid demonstrator – SC06 (November)
- We are actively seeking engagement with policy communities which recognise the potential value of our approach