Approaches to Modelling Urban Land Use Change in Response to Residential and other Pressures

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Conway’s Game of Life

A basic ‘cellular automaton’ invented by the Cambridge mathematician John Conway.

2-D *cellular space* consisting of identical cells

*neighbourhood* (Moore)

- cells are in 1 of 2 *states*:
  - dead,  
  - or alive

state changes due to *transition rules*:
- live cell stays alive if 2 or 3 of its neighbours are alive, otherwise it dies.
- dead cell will come to life if it has 3 live neighbours.
Cities as emergent properties

Organic growth
Pan-European Urban growth modelling for IPCC-SRES scenarios

- a) A1, b) A2, c) B1 d) B2
- Urban area for aggregate (NUTS2) regions based on (change in) population and GDP
- Spatial distribution (10’ grid) based on neighbourhood rules, accessibility, attractiveness of the coast, ...


Figure 2. Alternative urban maps for the future, based on the four SRES (Special Report on Emission Scenarios) scenarios: (a) A1FI, (b) A2, (c) B1, and (d) B2. Plotted is the increase in the percentage of land use over the period 2000–80.
Urbanisation in Cincinnati

- Cellular automata
- Neighbourhood rules
- Push-pull factors between land use types

Residential housing in East Anglia: going beyond graphical representation to include agency in decision making

- Agent-Based Modelling (ABM) of residential household locations
- Exploring the increasing pressures of population growth and demographic (profile) change on the East Anglian landscape - especially the coastline
- Empirically-grounded model - ONS statistics at the level of lower super output areas (LSOAs)
- LSOAs have a minimum population of 1000 inhabitants (mean 1500) with 1425 spatial units in EA
- Analysis using PCA and cluster analysis
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**Legend**

- LSOA_EA_clust12_4fact
- <all other values>
- clust_ward_12.CLUSTER
- <Null>

- 1 = HA6 - ... - HA7
- 2 = ... - HA3/6 - HA7
- 3 = ... - HA3/4/6
- 4 = HA7 - ... - HA3/6
- 5 = HA5 - HA4 - ...
- 6 = ... - HA5/7 - ...
- 7 = HA3/4 - HA2 - ...
- 8 = HA2 - HA3 - ...
- 9 = ... - HA2/5 - HA4
- 10 = HA3 - HA1/2 - HA4
- 11 = ... - HA3 - HA1/2
- 12 = HA1 - ... - HA5/7

**Household agent location preferences**

- isolated student: HA1
- single person: HA2
- couple: HA3
- couple with dep. children: HA4
- single-parent family: HA5
- couple with non-dep. children: HA6
- all retired: HA7

14% 20% 39% 25%
cities suburbs periurban & rural coast
Socio-economic scenario modelling of urban growth in Europe (EU28+2):

The RUG model (Regional Urban Growth model), as part of the dynamic Integrated Assessment Model (dIAP)

a) Demographic change only
b) Demographic and societal change*

* based on residential location choices

Modelling urban growth for socio-economic scenarios

Urban areas are mapped as a % of the land area in each 10^6 cell. Comparisons to the baseline are expressed as an absolute difference. White areas were not modelled.

Fig. 6 The projected change, from baseline, in artificial surface extent (as a percentage of the 10^6 cell land area) by 2100 under four different socioeconomic scenarios. Darker colours are associated with greater artificial surface expansion.

The role of land use planning: urban patterns in Europe

Randstad (Netherlands): compact/aggregated

Brussels (Belgium): dispersed

South of Dijon (France): intermediate
Land use planning in East Anglia: institutional actors

- Stakeholder mapping
Conceptual model of the UK planning process

Top-down (Type 1: “policy developers”)

Environmental organisations

Governmental organisations

Property developers

Built environment (Type 2: “implementors”)

Community forums

Infrastructure provision

Cultural/natural heritage

Bottom-up: (Type 3 “lobbyists”)
Concluding remarks

- Many modelling methods exist at different geographic scales
- Most urban land use models are based on drivers of:
  - economics (wealth),
  - population growth,
  - demographic (profile) change,
  - societal preference (for residential locations),
  - spatial planning policy
- Methods based on agency provide opportunities to capture the complex behaviour of individual households when making residential location choices
Any questions?