Urban Simulation Model

The implications of simulated growth scenarios for investment, service delivery, land use demand and governance in city regions

Louis Waldeck
3 September 2014
Presentation to DST
Financial & Fiscal Commission:
Capital + recurrent investment of R350 billion per annum (2012) in 6 metros (~ 10% of SA GDP)

Source: Nelson Mandela Bay Metro Urban Network Strategy
Simulating the future

Simulate spatial growth patterns 30 years into the future, to better understand:

– Future **demand for infrastructure, facilities and services** such as water, electricity, sanitation, schools, clinics and hospitals.

Risk free means of assessing the likely outcome of major policy decisions:

– Ideal for development and refinement of Capital Investment and Spatial Development Frameworks
– Reflecting on the potential impact and market uptake of specific investments such as mass transit
A model of the urban system

Developers provide stock of housing and floor space for business. They maximise profit through same return on investment calculation as real-world developers.

Government provides road and mass transit networks.

Households choose where they live, where they work and how they commute.

Government controls physical development of city by virtue of rights associated with land.

Jobs serve as proxy for businesses.

Developers provide stock of housing and floor space for business. They maximise profit through same return on investment calculation as real-world developers.

Government controls physical development of city by virtue of rights associated with land.

Adapted from Waddell, 2005
The software

**UrbanSim (Open Source)**

Based on discrete choice theory: Simulates the choices made by various agents

- For example the probability of a household agent buying a particular house
- Sub-models allow for different behaviour of different income groups

**Open Trip Planner (Open Source)**

Used to determine lowest cost trips

- Considering all available modes of transport, distance limited walking and cycling, private vehicles, minibus taxis and mass transit
Data required

From a variety of data sources:

**Control Totals**
- Households by income, age, children, cars ...
- Employment by Standard Industry Classification

**Synthetic population**
- From 10% sample of enumerator forms from census and control totals for sub places and main places

**Land and buildings**
- Cadastral parcels (~2 300 000)
- Classify by typology of ~50 classes derived from Knowledge Factory
- Type of building and market value

**Other**
- Environmentally sensitive, undermined, dolomitic areas ...
- Developments in the pipeline ...

**Study area**
Example results

Cities of eThekwini and Nelson Mandela Bay
UrbanSim tracks profile of households/jobs associated with each development template.

Massive potential for projecting consumption patterns of municipal services: Water, energy, waste water, solid waste, public transport, libraries, revenue, ...
eThekweni mass transit scenario 2001 - 2030

Based on total HPPTN area

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Households</th>
<th>Area (ha)</th>
<th>Gross density (hu/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Scenario</td>
<td>555 779</td>
<td>73 618</td>
<td>7.5</td>
</tr>
<tr>
<td>Blue Sky Scenario</td>
<td>595 238</td>
<td>73 618</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Based on area of residential land uses in HPPTN

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Households</th>
<th>Area (ha)</th>
<th>Gross density (hu/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Scenario 2030</td>
<td>555 779</td>
<td>63 192</td>
<td>8.8</td>
</tr>
<tr>
<td>Blue Sky Scenario 2030</td>
<td>595 238</td>
<td>63 192</td>
<td>9.4</td>
</tr>
</tbody>
</table>

All development 2008 - 2030 inside HPPTN

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Households</th>
<th>Area (ha)</th>
<th>Gross density (hu/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All development</td>
<td>742 778</td>
<td>63 192</td>
<td>11.8</td>
</tr>
</tbody>
</table>
Jobs that can be reached < R40 pd
Innovations required
Sparse data

2M: Pearl Strings
Closely related to the Upper Crust, the Pearl Strings are crowning lifetimes of achievement with refined, slightly understated style — in fact, they may well be frowned on flash. While their incomes are only outstripped by those of the Upper Crust, properties

25M: Chakalaka
Chakalaka clusters (named after a spicy vegetable relish/dish developed in the townships of Gauteng) were meant to be orderly locations — much like the eKasi clusters, however, all open spaces in this cluster have been cramped full with a wide assortment of shacks and structures. The result is a lively community that is,

26M: Poor Neighbours
The residents of the Poor Neighbours cluster, too, have outgrown the old 'matchbox' houses originally built in the area. As a result, the cluster is typified by numerous shack dwellings erected amongst the permanent structures or nearby. Dwellings are basically standard four-room or three-room
Excellent resemblance despite GTI map representing total shacks rather than growth in shacks between 2001 and 2007.
Excellent results also obtained in Nelson Mandela Bay
Outcomes
DST investment

- Used to establish a **capability**:
  - Unique in SA (GCRO Occasional Paper 6)
  - Available to metros to guide major infrastructure investment decisions (10% GDP)
  - Compact cities benefit the poor (FFC). Now based on OpenTripPlanner to better model access to public transportation

- **Process**
  - Collaboratively with metros
  - Greater than means of individual metros. Not possible without DST investment
  - Takes many years to develop trust in new technologies and to gain traction
Traction and uptake

- NMBM: Long Term Financial Sustainability Strategy
- City of Tshwane: Capital Investment Framework
- GPDRT modelling centre
  Possible future home when Transportation Authority established to oversee integrated transport planning for Gauteng metros
- Being evaluated by DRDLR to forecast land-use change for implementation of SPLUMA
- Putting the I back into IDP
  Unintended consequences
Thank you

3D extensions being released