SCATTER
SPRAWLING CITIES AND TRANSPORT: FROM EVALUATION TO RECOMMENDATIONS

Lic. Sc. Kari Lautso/LT Consultants:
The Helsinki case
Contents

1. Methodology: City sprawl assessment/sustainability assessment
2. Helsinki – background
3. Examples of tested policies and their effects on city sprawl and urban sustainability
4. Overall conclusions
1. Methodology: City sprawl assessment/sustainability assessment
Two methods for describing urban sprawl:

• Urban sprawl variables

• Sustainability indicators and indices
## Urban sprawl variables

### Overall mobility
- Average travel time (all modes) \( \text{minutes/trip} \)

### Public transport
- Modal share of public modes \( \% \)
- Passenger-km by public modes \( \text{km/household/a} \)

### Road traffic
- Private vehicle-km \( \text{km/household/a} \)
- Greenhouse gases from transport \( \text{eq.ton/household/a} \)
- Average road traffic speed \( \text{km/h} \)

### Land use
- Inhabitants in urbanised zones \( \# \)
- Employees in urbanised zones \( \# \)

### Accessibilities
- Average home-work travel distance \( \text{kilometres} \)
- Accessibility to city centre \( \text{minutes/trip} \)
- Accessibility to services \( \text{minutes/trip} \)
- Productivity gain from land use \( \% \)
Why sustainability evaluation?

• The phenomenon of city sprawl is illustrated and can be understood through the city sprawl variables.

• The aim of sustainability evaluation is to answer the following questions:
  – Is city sprawl sustainable or not?
  – Is one alternative to fight city sprawl better than another one?
What is sustainability in urban planning context?

Institutional framework

For a city to be sustainable it needs to use resources in an efficient and equitable way within the carrying capacities of the environmental and social systems it is dependent on.
Environmental indicators

Global climate change
  Greenhouse gases from transport

Air pollution
  Acidifying gases from transport
  Volatile organic compounds from transport

Consumption of natural sources
  Consumption of mineral oil products, transport
  Land coverage
  Need for additional new construction

Environmental quality
  Fragmentation of open space
  Quality of open space

Environmental Index
Social indicators…

**Health**
- Exposure to particulate matter from transport in the living environment
- Exposure to nitrogen dioxide from transport in the living environment
- Exposure to traffic noise
- Traffic deaths
- Traffic injuries

**Equity**
- Justice of distribution of economic benefits
- Justice of exposure to particulates
- Justice of exposure to nitrogen dioxides
- Justice of exposure to noise
- Segregation
…Social indicators

Opportunities
- Housing standard
- Vitality of city centre
- Vitality of surrounding region
- Productivity gain from land use

Accessibility
- Total time spent in traffic
- Level of service of public transport and slow modes
- Accessibility to city centre
- Accessibility to services
- Accessibility to open space

Social Index
Economic indicators

- Transport investment costs
- Transport user benefits
- Transport operator benefits
- Government benefits from transport
- Transport investment costs
- Transport external accidents costs
- Transport external emissions costs
- Transport external greenhouse gases
- Transport external noise costs

Economic index: total savings €/inhabitant (NPV)
TOOLS for calculating the indicator values (from PROPOLIS)

Land use and transport models

Illustration

GIS

Evaluation

Economic calculations

Noise Level Differences

2021 000 compared with 2001 000
The evaluation process

- Weights of the themes
- Weights of the indicators
- Alternative scenarios
- The environmental index
2. Helsinki – background
Land use superzones

Surrounding region
- Rural
- Urban

Metropolitan area
- outer parts (suburbs)
- inner parts
- central parts
- city centre
Intercity comparisons

Figure 7.2 Population density in the study areas of Brussels (2001), Helsinki (1999) and Stuttgart (2000)
Projects included in the reference solution

- Radial main roads
  - Short-term improvements €32m
  - Improvements €241m
- Ring Road III
  - Middle section 2 €27m
  - Middle section 1 €109m
- Ring Road IV
  - Western section €31m
- Marja Urban rail line €252m
- Ring Road IV Eastern section €30m
- Public transport
  - Cross-town connections €17m
  - Ring Roads I and III €17m
- Public transport
  - Cross-town connections Pasila level €10m
- Ring Road III Eastern section €34m
- Ring Road I Helsinki and Espoo €147m
- Jokeri Rail Link €109m
- Helsinki metro
  - 2nd line, north €165m
- Helsinki metro
  - 2nd line, south €385m

Legend:
- Phase 1 (before 2010)
- Phase 2 (2010 - 2019)
- Phase 3 (2020 - 2029)
- After 2030
Population and densities in the base forecast

Population and employment:

Relative densities vs 1990:
3. Examples of tested policies and their effects on city sprawl and urban sustainability
Increase speed of current rail services 25%?
In general (big/radial) rail enhancements contribute to sprawl…

113 H – Decrease current rail travel times 30%
...like the reduction of public transport fares

512 H – Decrease public transport fares by 20%

Relocation from HMA

From suburban areas towards centre and from rural areas to urban
Planned Metropolitan Area Rail Investments…
...do not, however, seem to contribute to sprawl

112 H – HMA plan-public transport rail investments, compare with do-nothing:
Land use measures

A-type land-use zones
Pricing land-use seems (also) efficient

311 H – Annual tax (development impact fee) in non urban zones + fiscal incentive (tax reduction) in urban zones

-5000 -5000

-10000 -10000

0 0

5000 5000

-5.0% -5.0%

0.0% 0.0%

5.0% 5.0%

Households

Employees

% 2005 % 2010 % 2015 % 2020

% 2005 % 2010 % 2015 % 2020

% 2005 % 2010 % 2015 % 2020

% 2005 % 2010 % 2015 % 2020

Hel Centre Inner HMA Outer HMA HMA Suburbs Oh Urban Rural

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Policies tested and their sustainability evaluation
**Land use (pricing) policies**

<table>
<thead>
<tr>
<th>Base</th>
<th>Environmental index</th>
<th>Social index</th>
<th>Economic index €/inhabitant</th>
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</thead>
<tbody>
<tr>
<td>000 Base 2001</td>
<td><img src="image" alt="Graph" /></td>
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<tr>
<td>000 Base 2011</td>
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**Land use (pricing) policies**

- 311 DIF 670 euro/a
- 312 DIF 340 euro/a
- 313 DIF 1000 euro/a
- 321 ABC land use regulation for businesses
- 331 ABC land use pricing for businesses

Legend:
- Global climate change
- Air Pollution
- Consumption of natural sources
- Environmental quality
- Health
- Equity
- Opportunity
- Accessibility
Conclusions – land use (pricing) policies

• The changes of the environmental, social and economic sustainability indices are small

• The effects of land pricing policies on
  – overall mobility
  – city sprawl
  – CO2 emissions and
  – accessibilities

are positive
## Transport pricing

### Environmental index

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### Economic index €/inhabitant

- Global climate change
- Air Pollution
- Consumption of natural sources
- Environmental quality
- Health
- Equity
- Opportunity
- Accessibility
Road pricing is efficient in reducing (population) sprawl.

Relocation to HMA

411 H – Car operating costs +50%
Conclusions - transport pricing

• The transport pricing policies perform well environmentally, socially and economically
  – However, lowering PT fares, increasing speed and service have a negative impact on city sprawl indicators
  – Car pricing policies work efficiently against the city sprawl effect

• Combination of car pricing and PT policies have positive effects while also the city sprawl remains at reasonable level
Combinations (car pricing, PT, land use)

### Environmental index

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<tr>
<td>Combinations</td>
<td>811 Comb. 411+512+311</td>
<td>812 Comb. 411+512+331</td>
<td>813 Comb. 411+512+311+331</td>
</tr>
</tbody>
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### Social index

### Economic index €/inhabitant

- Global climate change
- Air Pollution
- Consumption of natural sources
- Opportunity
- Environmental quality
- Health
- Equity
- Accessibility

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SCATTER WORKSHOP, Brussels, November 9th 2004

KARI LAUTSO / LT CONSULTANTS

DG Research
Policy combination 2

\[ 812 \text{H} = 411 \text{(VOC+50\%)} + 512 \text{(fares -20\%)} + 331 \text{(LU pricing)} \]
Conclusions - combinations

• The combination policies are able to simultaneously improve all dimensions of sustainability (compared with the base scenario)
• In some cases they also maintain or improve the current level of sustainability
• The combinations work efficiently against city sprawl but the overall effect remains small compared with the base trends: population and welfare growth.
Conclusions - combinations

- Results of the combination policies in Helsinki:
  - car-km reduction: -14 – 18%
  - PT-km increase: +16 -17%
  - CO2 reduction: -11 – 12%
  - accident reduction: -12 – 14%
  - less exposure to noise and pollutants
  - improved accessibilities
  - less sprawl
  - economic benefits (NPV): +1900€/inh
4. Overall conclusions
Overall conclusions

• The sustainability evaluation showed that most of the tested policies reducing sprawl also improved the three dimensions of sustainability, i.e.

• Reduced sprawl means increased sustainability (exception: PT improvements may sustainable but may add to city sprawl)
Conclusions

• The best policies were the combinations of car pricing, PT fare reductions and land use policies
• They had positive impacts on most of the city sprawl variables and simultaneously improved all the three dimensions of sustainability
Thank you for your attention!
Base trends vs. policy combination 813
### Indicators of Work package 5: basic indicators for simulation results

#### Helsinki case city

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Base 2001</th>
<th>Present</th>
<th>Base 2021</th>
<th>Present</th>
<th>Diff. in % units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall mobility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average travel time (all modes)</td>
<td>minutes</td>
<td>29.8</td>
<td>29.2</td>
<td>-0.5%</td>
<td>0.0%</td>
<td>-0.3%</td>
</tr>
<tr>
<td><strong>Public transport</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modal share of modes</td>
<td>%</td>
<td>44.1</td>
<td>42.3</td>
<td>-1.4%</td>
<td>-1.4%</td>
<td>0.2</td>
</tr>
<tr>
<td>Passenger-km by public modes</td>
<td>km/inhabitant/a</td>
<td>5232</td>
<td>5734</td>
<td>-5.1%</td>
<td>-4.2%</td>
<td>-0.6%</td>
</tr>
<tr>
<td><strong>Road traffic</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private vehicle-km</td>
<td>km/inhabitant/a</td>
<td>2451</td>
<td>2930</td>
<td>-6.7%</td>
<td>-1.4%</td>
<td>-4.9%</td>
</tr>
<tr>
<td>Greenhouse gases from transport</td>
<td>eq.ton/inhabitant/a</td>
<td>1.41</td>
<td>1.78</td>
<td>-1.6%</td>
<td>-0.9%</td>
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<tr>
<td><strong>Land use</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households in core metropolitan area</td>
<td>#</td>
<td>265432</td>
<td>304320</td>
<td>0.1%</td>
<td>0.0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Employees in core metropolitan area</td>
<td>#</td>
<td>392807</td>
<td>499005</td>
<td>-0.2%</td>
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<tr>
<td><strong>Accessibilities</strong></td>
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</tr>
<tr>
<td>Average home-work travel distance</td>
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<td>16.2</td>
<td>15.0</td>
<td>-0.7%</td>
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<tr>
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<td>%</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.5%</td>
<td>0.4</td>
<td>-1.1</td>
</tr>
</tbody>
</table>

**Legend:**
- **Present:** Indicates the current year's data.
- **Base 2021:** Expected data for the base year 2021.
- **Do not invest:** Impact of not investing in transport infrastructure.
- **Only car investments:** Impact of investing only in car infrastructure.
- **Only PT investments:** Impact of investing only in public transport infrastructure.
- **All reference investments:** Impact of investing in all reference infrastructure.
- **Develop orbital connections of PT:** Impact of developing orbital connections of public transport.
## Indicators of Work package 5: basic indicators for simulation results

<table>
<thead>
<tr>
<th>Helsinki case city</th>
<th>2001</th>
<th>000</th>
<th>211</th>
<th>212</th>
<th>213</th>
<th>214</th>
<th>215</th>
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<tr>
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**Notes:**
- **Present** and **Base** columns represent current scenarios.
- **New town alternatives** columns represent future scenarios in different towns.
- HMA stands for Human Mobility Analysis.
### Indicators of Work package 5: basic indicators for simulation results

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<table>
<thead>
<tr>
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HMA: diff. in % units
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<td>512</td>
<td></td>
<td></td>
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#### Overall mobility
- Average travel time (all modes) minutes: 29.8 (present) 29.2 (base 2021) -5.1% -3.5% 5.1%

#### Public transport
- Modal share of modes %: 44.1 (present) 42.3 (base 2021) 0.8 3.4 4.5
- Passenger-km by public modes km/inhabitant/a: 5232 (present) 5734 (base 2021) -0.8% 6.2% 14.8%

#### Road traffic
- Private vehicle-km km/inhabitant/a: 2451 (present) 2930 (base 2021) -17.4% -35.9% 0.9%
- Greenhouse gases from transport eq.ton/inhabitant/a: 1.41 (present) 1.78 (base 2021) -11.8% -25.1% 0.0%

#### Land use
- Households in core metropolitan area #: 265432 (present) 304320 (base 2021) 1.7% 3.0% -2.3%
- Employees in core metropolitan area #: 392807 (present) 499005 (base 2021) 0.0% -1.9% 0.2%

#### Accessibilities
- Average home-work travel distance kilometres: 16.2 (present) 15.0 (base 2021) -13.8% -3.9% 16.4%
- Accessibility to city centre minutes/trip: 29.3 (present) 29.8 (base 2021) -2.7% -6.7% -1.7%
- Accessibility to services minutes/trip: 27.7 (present) 28.2 (base 2021) -2.3% -3.2% 1.7%
- Productivity gain from land use %: 0.0 (HMA) 0.0 (diff. in % units) 1.0 -0.6 0.4
### Indicators of Work package 5: basic indicators for simulation results

#### Helsinki case city

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Present</th>
<th>Base 2021</th>
<th>Comb. 411+512+311</th>
<th>Comb. 411+512+331</th>
<th>Comb. 411+512+311+331</th>
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<tbody>
<tr>
<td><strong>Overall mobility</strong></td>
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<tr>
<td>Average travel time (all modes)</td>
<td>minutes</td>
<td>29.8</td>
<td>29.2</td>
<td>0.8%</td>
<td>1.1%</td>
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<tr>
<td><strong>Public transport</strong></td>
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<tr>
<td>Modal share of modes</td>
<td>%</td>
<td>44.1</td>
<td>42.3</td>
<td>6.1</td>
<td>12.3</td>
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<tr>
<td>Passenger-km by public modes</td>
<td>km/inhabitant/a</td>
<td>5232</td>
<td>5734</td>
<td>16.8%</td>
<td>16.9%</td>
<td>16.2%</td>
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<tr>
<td><strong>Road traffic</strong></td>
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<tr>
<td>Private vehicle-km</td>
<td>km/inhabitant/a</td>
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<td>2930</td>
<td>-16.1%</td>
<td>-15.9%</td>
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<tr>
<td>Greenhouse gases from transport</td>
<td>eq. ton/inhabitant/a</td>
<td>1.41</td>
<td>1.78</td>
<td>-10.7%</td>
<td>-10.6%</td>
<td>-12.0%</td>
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<tr>
<td><strong>Land use</strong></td>
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</tr>
<tr>
<td>Households in core metropolitan area</td>
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<tr>
<td>Employees in core metropolitan area</td>
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<td>0.8%</td>
<td>1.2%</td>
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<tr>
<td><strong>Accessibilities</strong></td>
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</tr>
<tr>
<td>Average home-work travel distance</td>
<td>kilometres</td>
<td>16.2</td>
<td>15.0</td>
<td>0.5%</td>
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<td>-0.3%</td>
</tr>
<tr>
<td>Accessibility to city centre</td>
<td>minutes/trip</td>
<td>29.3</td>
<td>29.8</td>
<td>-2.1%</td>
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<td>Accessibility to services</td>
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<td>28.2</td>
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<td>0.1%</td>
<td>-0.1%</td>
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<tr>
<td>Productivity gain from land use</td>
<td>%</td>
<td>0.0</td>
<td>0.0</td>
<td>0.3</td>
<td>0.4</td>
<td>0.7</td>
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</table>

**Less cars**

**Less sprawl**

**better accessibilities**
Pricing policies:
There is an optimum for car pricing and PT fares

The Economic index in different car pricing policies

The Economic index in different public transport pricing policies
New town alternatives

<table>
<thead>
<tr>
<th></th>
<th>Environmental index</th>
<th>Social index</th>
<th>Economic index €/inhabitant</th>
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<tbody>
<tr>
<td><strong>Base</strong></td>
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<td></td>
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<tr>
<td>000 Base 2011</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>000 Base 2021</td>
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<td><strong>New town alternatives</strong></td>
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<td>212 Marja-Vanta</td>
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<td>213 Keski-Pasila</td>
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<td>215 Matinkylä</td>
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</tbody>
</table>

Global climate change
Air Pollution
Consumption of natural sources
Environmental quality
Health
Equity
Opportunity
Accessibility
Conclusions – New town alternatives

• The overall differences are environmentally, socially and economically small between the alternative locations

• Pasila, the most central alternative, with best PT and road connections has also the highest increase in overall mobility
Objectives: What are the current trends - what do we try to achieve?

- Continuation of existing policies
- Do nothing
- Goal
Urban sprawl assessment

- **CO2**
  - 1: Do Nothing
  - 2: PT oriented land use
  - 3: Car cost +75%
  - 4: PT speed +5%, fare -20%
  - 5: Combination 3 and 4
  - 6: Combination 2, 3 and 4

- **Car mileage**
- **Average travel time**
- **Inhabitants in urban zones**
- **Employees in urban zones**

- **Modal share - PT**
- **Modal share - car**
Sustainability evaluation

Environmental index

Social index

Economic index

1 Do Nothing
2 PT oriented land use
3 Car cost +75%
4 PT speed +5%, fare -20%
5 Combination 3 and 4
6 Combination 2, 3 and 4
### Investment policies

#### Environmental index

<table>
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<tr>
<th>Base</th>
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<th>000 Base 2011</th>
<th>000 Base 2021</th>
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<tbody>
<tr>
<td>Investment policies</td>
<td>001 Do not invest</td>
<td>002 Only car investments</td>
<td>003 Only PT investments</td>
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</table>

#### Social index

#### Economic index €/inhabitant

- Global climate change
- Air Pollution
- Consumption of natural sources
- Opportunity
- Environmental quality
- Accessibility
Conclusions – Investment policies

• The effect on environmental and social sustainability is small

• Transport investments (both PT and road) tend to, in many cases:
  – increase kilometres travelled
  – increase the average travel time
  – increase CO2 emissions
  – decrease accessibilities
Car costs +75% - Land use changes

Population

Employment

Relative change

EM214

5...2.5...5
0.5...2.5
-0.5...0.5
-2.5...-0.5
-5...-2.5
...

Absolute change

EM214

5000...
2500...
0...
-2500...
-5000...
...

Relative change (%)

EM214

5...2.5...5
0.5...2.5
-0.5...0.5
-2.5...-0.5
-5...-2.5
...

Absolute change

EM214

5000...
2500...
0...
-2500...
-5000...
...

Population Employment
Indicators are defined to measure each dimension of sustainability (PROPOLIS). The indicator themes are:

**ENVIRONMENTAL**
- Global climate change
- Air pollution
- Consumption of natural sources
- Environmental quality

**SOCIAL**
- Health
- Equity
- Opportunities
- Accessibility and traffic

**ECONOMIC**
- Total net benefit from transport
Example: Noise levels and exposure to noise
PT-fares –60% - Land use changes

Population

Employment

Population

Employment

Relative change (%)

Absolute change

Relative change (%)

Absolute change
Car costs +75%, PT speed/service +5%, PT fare –20%

Population

Employment

<table>
<thead>
<tr>
<th>Absolute change</th>
<th>Relative change (%)</th>
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<tbody>
<tr>
<td>5000 – 2500</td>
<td>5.0 – 2.5</td>
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<tr>
<td>2500 – 500</td>
<td>2.5 – 5.0</td>
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<tr>
<td>0 – 750</td>
<td>0.5 – 2.5</td>
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<tr>
<td>0 – 250</td>
<td>0.5 – 0.5</td>
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<tr>
<td>0 – 250</td>
<td>-0.5 – 2.5</td>
</tr>
<tr>
<td>-250 – 500</td>
<td>-2.5 – 5.0</td>
</tr>
<tr>
<td>-500 – 0</td>
<td>-5.0 – 0.5</td>
</tr>
<tr>
<td>-750 – 2500</td>
<td>-2.5 – 0.5</td>
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