First Technical meeting on Human Settlements Indicators for SDGs
Naivasha, Kenya from 13 to 17 February 2017

Techniques for measuring Street Connectivity

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Introduction

• Well connected street network
  – Many short links / numerous intersections.
  – Few cul-de-sacs.
  – Balance between the street network length and the streets width.

• Benefits
  – Encourages walking and cycling
  – Better infrastructures and public services
  – More efficient public transport
  – Less use of individual transport
  – Less traffic jams
  – Less pollution
  – More livable cities
Introduction

• Some connectivity Indicators
  – Land Allocated to Streets (%)
  – Street Density (Km/Km2)
  – Intersection Density (#int/Km2)
  – Average Block Size (Hec)
  – Walkability Ratio
Introduction

• Street Connectivity benchmark (CPI Methodological Guide)

  - Land Allocated to Streets: 36%
  - Street Density (Km/Km2): 20 Km/Km2
  - Intersection Density (#int/Km2): 100 int/Km2
Methodology

1. Delimitation of the Built-up Area
2. Sampling
3. Calculation of aggregated metrics
4. Assessment of the degree of confidence
5. Calculation of disaggregated metrics and aggregated metrics excluding Open Space

1 Based on the methodology used in Angel et al., Atlas of Urban Expansion, Lincoln Institute of Land Policy, 2012.

1. Delimitation of the Built-up Area

- Definition of “city footprint” given in “Atlas of Urban Expansion” (Angel et al., Lincoln Institute of Land Policy, 2012): The total area occupied by the built-up area of the city and its urbanized open space
  - Built-up areas
    - Urban
    - Suburban
    - Rural
  - Urbanized Open Spaces
    - Fringe open space
    - Captured open space
1. Delimitation of the Built-up Area

- City Footprint boundary
- Rural Area (D<10%)
- Suburban Area (50%>D>10%)
- Urban Area (D>50%)
1. Delimitation of the Built-up Area
1. Delimitation of the Built-up Area
2. Sampling

- Halton sequence (quasi-random set of points)
- 10 Hectares circles
3. Calculation of aggregated metrics

• Digitization of block boundaries
  – Block space vs Street Space
  – Street Space:
    • Main purpose (current or potential) is mobility
    • Public Right of Way
    • It includes:
      – Carriage ways
      – One car park line on each side if the road
      – Sidewalks
      – Bike paths
      – Traffic islands
      – Median strips and green areas in the center of boulevards
      – Tram ways
3. Calculation of aggregated metrics

- Digitization of block boundaries
3. Calculation of aggregated metrics

- Digitization of block boundaries
3. Calculation of aggregated metrics

- Digitization of street medians
3. Calculation of aggregated metrics

- Digitization of street medians
3. Calculation of aggregated metrics

- Formulas

<table>
<thead>
<tr>
<th>Metric</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Allocated to Streets</td>
<td>$LAS_{agg} = 100\left(1 - \frac{\text{Blocks Total Area}}{\text{Locales Total Area}}\right)$</td>
</tr>
<tr>
<td>Street Density</td>
<td>$SD_{agg} = \frac{\text{Streets Total Length} \cdot 1E{-3}}{\text{Locales Total Area} \cdot 1E{-6}}$</td>
</tr>
<tr>
<td>Intersection Density</td>
<td>$ID_{agg} = \frac{\text{Total Number of Intersections}}{\text{Locales Total Area} \cdot 1E{-6}}$</td>
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</table>
4. Assessment of the degree of confidence

- Digitization of an Initial set of 40 locales
- Calculation of metrics: Average values Degree of Confidence
- Digitization of 10 more locales
- Reached a high Degree of Confidence?
  - NO: Digitization of 10 more locales
  - YES: Stop Digitization
5. Calculation of disaggregated metrics and aggregated metrics excluding Open Space

- Variables
  - Land Use
    - Open Space
    - Non-Residential
    - Residential
      - Atomistic / organic (not laid-out)
      - Informal
      - Formal
      - Housing Project
  - Plot coverage
    - High
    - Medium
    - Low
5. Calculation of disaggregated metrics and aggregated metrics excluding Open Space

- Digitization of dividing lines
5. Calculation of disaggregated metrics and aggregated metrics excluding Open Space

- **Formulas**

<table>
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<th>Metric Description</th>
<th>Formula</th>
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</thead>
<tbody>
<tr>
<td>Land Allocated to Streets</td>
<td>$LAS_{\text{disagg}} = 100 \left( 1 - \frac{\text{Blocks Total Area in the category}}{\text{Dividings Total Area in the category}} \right)$</td>
</tr>
<tr>
<td>Street Density</td>
<td>$SD_{\text{disagg}} = \frac{\text{Streets Total Length in the category} \cdot \left( \frac{1}{2} \right) \cdot 1E-3}{\text{Dividings Total Area in the category} \cdot 1E-6}$</td>
</tr>
<tr>
<td>Intersection Density</td>
<td>$ID_{\text{disagg}} = \frac{\text{Total Number of Intersections in the category}}{\text{Dividings Total Area in the category} \cdot 1E-6}$</td>
</tr>
</tbody>
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Thank you for your attention!
References

• The relevance of street patterns and public space in urban areas, Nairobi: UN-Habitat, 2013.

• Streets as Public Spaces and Drivers of Urban Prosperity, Nairobi: UN-Habitat, 2013.

  http://www.lincolninst.edu/publications/books/atlas-urban-expansion

  http://www.atlasofurbanexpansion.org