New Wave of Meso-scale Spatial Analysis:
From aggregated thinking to non-aggregated thinking

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Spatial Segregation


**METHODOLOGY**

A GIS approach to estimation of building population

- **Arealometric method**
  \[ \text{Area} = \frac{\text{Building}}{\text{Population}} \times \text{Building} \times \text{Footprint area} \]

- **Volumetric method**
  \[ \text{Volume} = \frac{\text{Building}}{\text{Population}} \times \text{Building} \times \text{Volume} \]

- **Average building height approach**
  \[ \text{Height} = \frac{\text{Building}}{\text{Population}} \times \text{Building} \times \text{Height} \]

- **Total building volume approach**
  \[ \text{Volume} = \frac{\text{Building}}{\text{Population}} \times \text{Building} \times \text{Volume} \]

**ESTIMATION OF BUILDING POPULATION**

Study Area

- Total Census Tracts: 94
- Population: 84,955
- Area: 5,959.13 Hectares
- Place: Part of Tsukuba City

**Reasons:**
- Population integrity
- Heterogeneous landscape
- Rich of geo-information
- Home of University of Tsukuba
List of Data

- **LIDAR**
  Point (Provided by PASCO Corp.)

- **Ortho**
  Spatial resolution = 8cm x 8cm

- **Census Tracts**
  Polygon (Population)

- **Building footprints**
  Polygon (Name, Floors, Block No, ...)

- **iTownpage (NTT)**
  Business information in CSV format

### List of Data Processing

#### Extraction of Building Height and Volume Attribute

**ArcGIS (Zonal Statistic as Table)**

Zonal statistic function summarizes the values of a raster (DHM or DVM) within the zones of another dataset (building footprints) and reports the results to a table.

<table>
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<tr>
<th>Code</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 4</th>
<th>Area 5</th>
<th>Area 6</th>
<th>Area 7</th>
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</table>

### Separation of Residential and Non-Residential Building

**Step 1: Filter by zero census tracts**
- University campus, research centers, ...

**Step 2: Filter by Building Area and Height**
- Surface area < 20 m² and height < 2 m
- Removing cars, bicycle stands, roofs, garbage boxes, porches, etc.

**Step 3: Filter by Public Facilities**
- Financial institutions, governmental organizations, educational organizations, ... (using NTT iTownpage)

**Step 4: Manual Filtering**
- Multi-storey car parking lots, ...
Chapter 3: ESTIMATION OF BUILDING POPULATION

Estimated Building Population

Result and Validation

Online Micro-spatial Population Analysis (µSPA)

http://land.geo.tsukuba.ac.jp/microspa

Utilize GIS estimated building population for micro-spatial analysis

What We Measure

• Building Population
• Facility Locations
• Connectivity networks

Who Can Use

Local residents, business owners, urban planners, potential home buyers, ...

ONLINE MICRO–SPATIAL ANALYSIS

Map Layers and Data Sources

<table>
<thead>
<tr>
<th>Layer Order</th>
<th>Layer Name</th>
<th>Description</th>
<th>Feature</th>
<th>Visibility</th>
<th>Source</th>
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<td>1</td>
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<td>Building footprints with estimated population</td>
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<td>Visible</td>
<td>Zmap-TOWNII</td>
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<td>Visible</td>
<td>Zmap-TOWNII</td>
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</tbody>
</table>

ONLINE MICRO–SPATIAL ANALYSIS

Measurements

How We Measure

• W. Population Mean Center
• W. Facility Mean Center
• Connectivity Mean Center

Spatial Indices

• Population Mean Center Index
• Facility Mean Center Index
• Connectivity Mean Center Index
ONLINE MICRO–SPATIAL ANALYSIS

Measurements

Measurement of Indices

- Population mean center
- Facility mean center
- Connectivity mean center
- User defined point

Indices Measurement

- Population Mean Center Index
- Facility Mean Center Index
- Connectivity Mean Center Index

Index = \( \frac{d}{r} \)

\( d = \) Mean center distance
\( r = \) Circle radius

Value = 0 ~ 1

ONLINE MICRO–SPATIAL ANALYSIS

Map Tools and Analysis Domains

Example of Polygon Tool

ANALYSIS TYPE: Find Location
ANALYSIS TOOL: Polygon
DOMAIN AREA: 683400.22 m²
TOTAL BLDG. POPULATION: 4184
W.BLDG. POP. MEAN CENTER: 23993.29; 7783.57
FACILITY MEAN CENTER: 23887.44; 7917.41
CONNECTIVITY MEAN CENTER: 23983.76; 7741.37

Potential Applications
Local community center allocation
Public facility site sitting ...

ONLINE MICRO–SPATIAL ANALYSIS

Map Tools and Analysis Domains

Example of Line Tool

Local community bus route planning
Traffic noise impact

ONLINE MICRO–SPATIAL ANALYSIS

Map Tools and Analysis Domains

Potential Applications

Improve Accuracy in Micro-spatial Analysis

Planners
Residents

CONCLUSION

Improve Accuracy in Micro-spatial Analysis

Total population inside 200m: 1691
Total population inside 350m: 1443
Total population inside 500m: 884
Total population inside 1000m: 1653
**Conclusion**

Potential Applications

Dasymmetric Mapping

Dasymmetric mapping based on GIS estimated building population

3D Visualization

Applications are numerous ... ... ...

Thank You!