Evaluating Walkability through Neighborhood Environment using GIS: A Case Study in Tokyo Metropolitan Area

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Introduction

- Neighborhood environment for daily walking behavior has attracted highly academic attention in recent years because plenty of evidence have shown that ideal neighborhood environment can promote residents' daily walking behavior;
- Neighborhood walkability is an index to evaluate how friendly the built environment is to the occurrence of people's walking behavior;
- The main purpose of this study is to evaluate walkability in Tokyo Metropolitan Area (TMA) and prove good walkability in neighborhoods promotes daily walking behavior.

Methodology

Multi-criteria Evaluation (MCE)

Five indices listed below were selected for the evaluation. Equal weights were given to each criterion. The weights of BSD and RSA were 0.125 as they were considered together as the public transportation facilities.
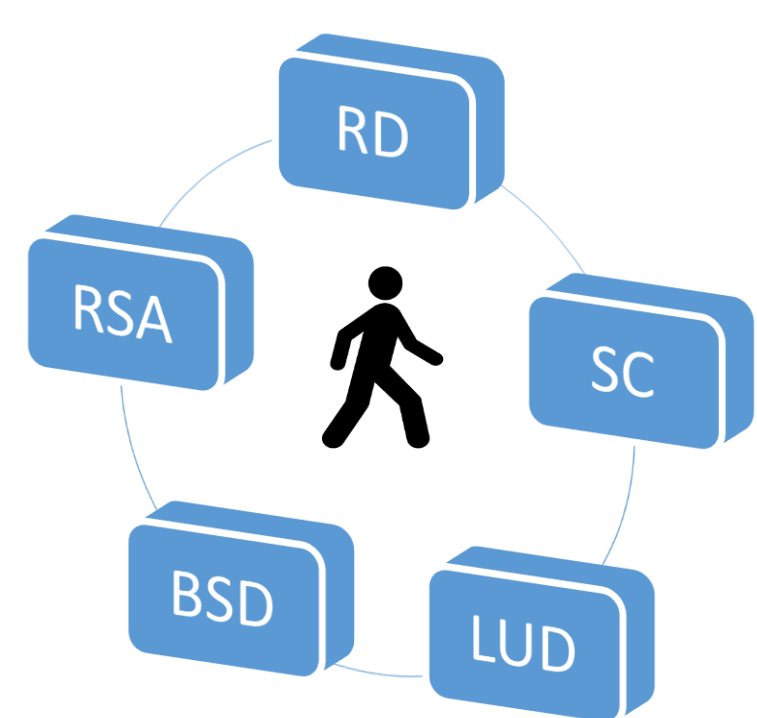

Index Selection
RD (weight: 0.25) — Residential Density (count of residential buildings)
SC (weight: 0.25) — Street Connectivity (count of intersections)
LUD (weight: 0.25) — Land Use Diversity (mixed degree of land use)
BSD (weight: 0.125) — Bus Stops Density (count of bus stops)
RSA (weight: 0.125) — Railway Station Accessibility (distance to the closest railway station)
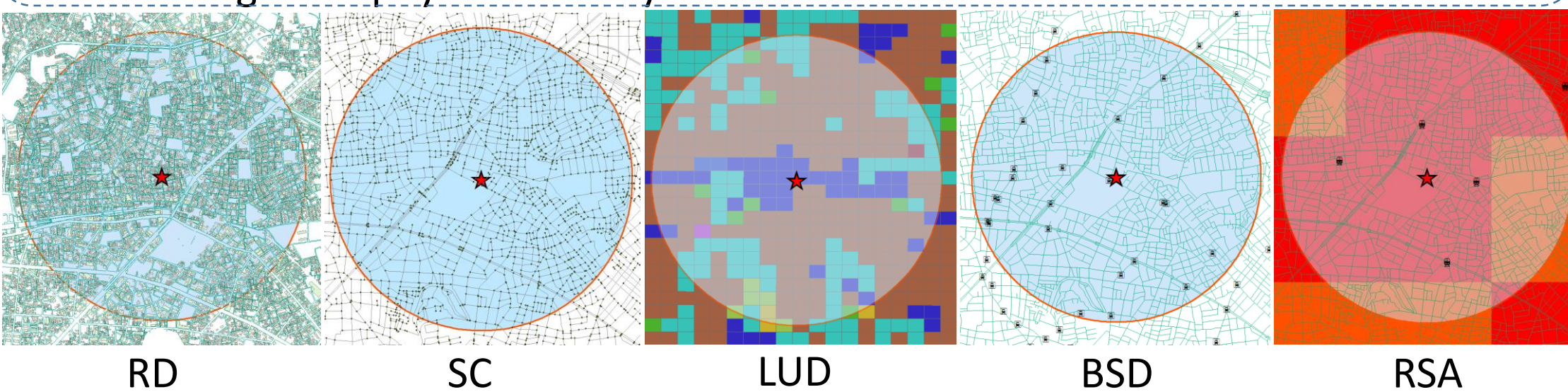
Data Used

- People Flow Data of Tokyo in year 2008 (self-reported data to calculate resident's walking time)
- National Land Numerical Information
- Open Street Map (road network)
- Zenrin Data of Tokyo Metropolitan Area (year 2008/2009)

Flow Chart
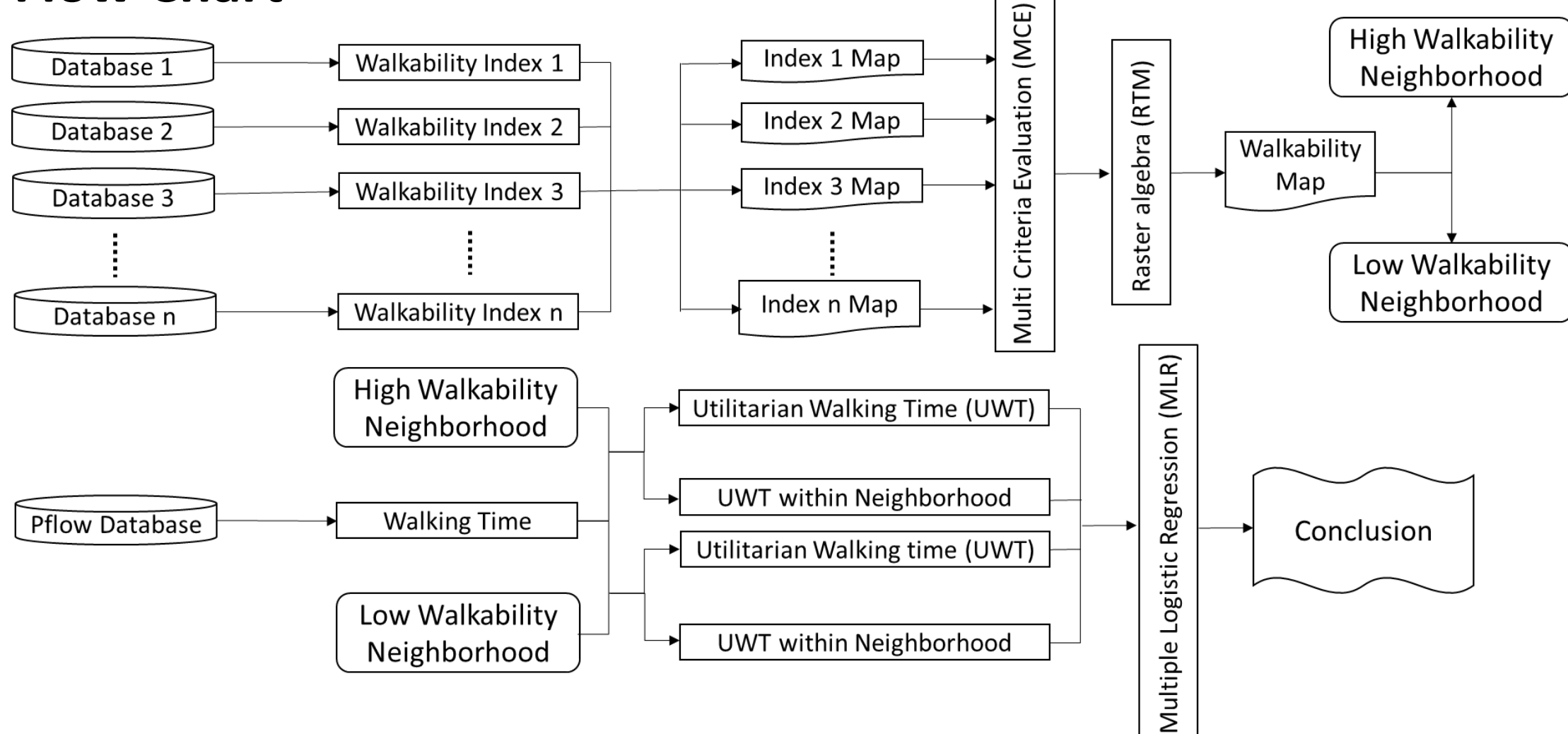
Neighborhood Scale: 1 km buffer

The area with a distance less than 1 km to the residence was defined as each person's neighborhood. Previous studies have shown that neighborhood environment attributes within 1 km home buffers are positively associated with moderate-vigorous physical activity in the buffer.

RD   SC   LUD   BSD   RSA

Results

Evaluation Result & Reality

Walkability Map of TMA   **Utilitarian Walking Time Map of TMA**

Utilitarian walking: walk to reach a place for further behavior. One selection among all the methods for movement (e.g. Walk, Bicycle, Bus, Vehicle, etc.).

Classification of area based on walkability (walk score)

Category	Walk Score	Max UWT	Mean UWT	Count
High Walkable Area	4 – 5	82	24.9	535
Medium High Walkable Area	3 – 4	62	22.2	961
Medium Walkable Area	2 – 3	182	17.1	1410
Medium Low Walkable Area	1 – 2	144	11.7	1560
Low Walkable Area	0 – 1	152	9.6	1288

Note: UWT = Utilitarian Walking Time (in minute)

Resident's Movement in High Walkable Area

Resident's Movement in Low Walkable Area

Comparison of Daily Walking Behavior

	Walkability	Mean Walking Time (min)	Standard Deviation (min)	MWT in 1 km Neighborhood (min)	Ratio
High Walkable Area	4.7	30.0	24.5	19.9	66.3%
Low Walkable Area	0.3	2.5	7.0	0.6	24.0%

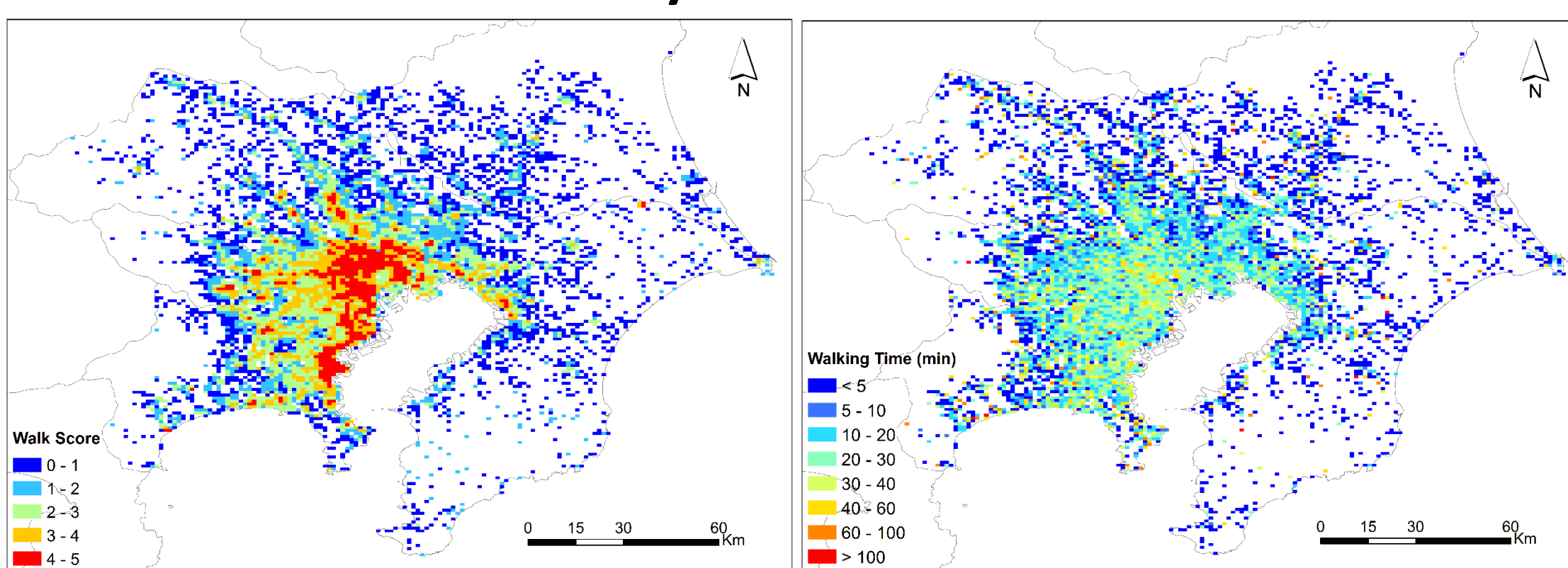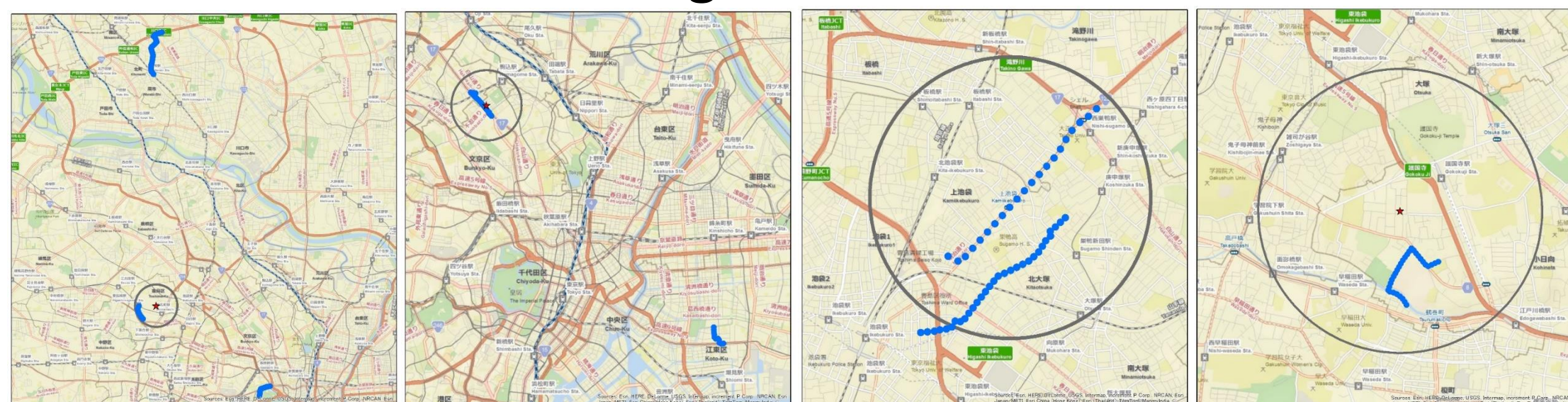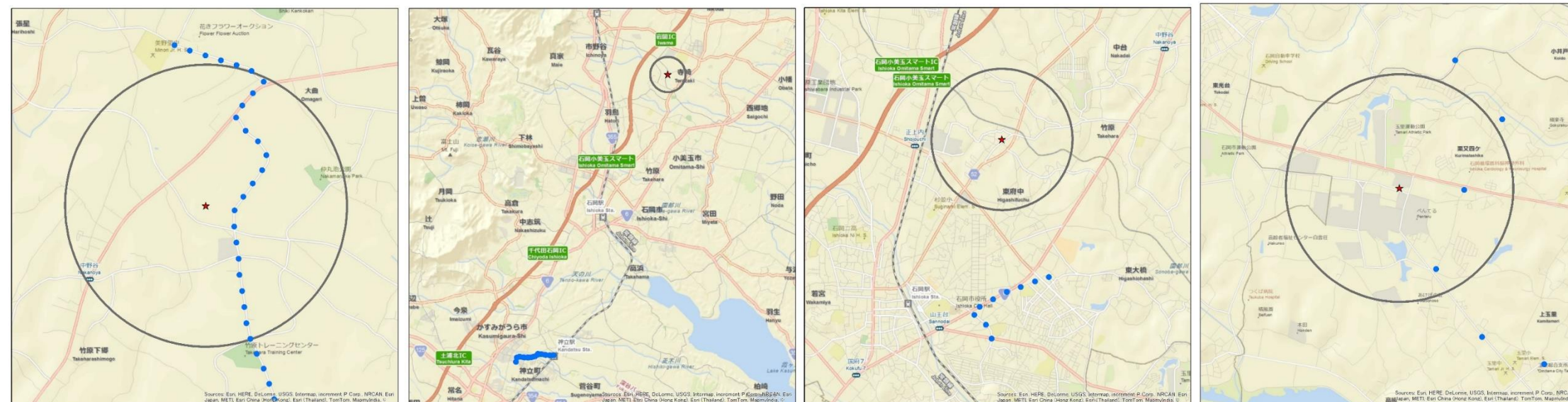Note: 200 samples from each study site were selected.

Discussion and Conclusion

- Residential Density (RD), Street Connectivity (SC), Land Use Diversity (LUD), Bus Stops Density (BSD) and Railway Station Accessibility (RSA) were necessary factors for evaluating walkability in TMA;
- According to the results from this analysis with selected attributes, central areas in Tokyo tended to have higher walkability and residents there spent more time on daily walking;
- Residents in high walkability areas tended to walk more within the neighborhood scale while residents in low walkability areas, except for the relatively lower walking time, tended to walk outside the neighborhood scale.