

# ASIA GEOSPATIAL FORUM 2011

## Eco-Friendly Walk Score Calculator Choosing a Place to Live with GIS

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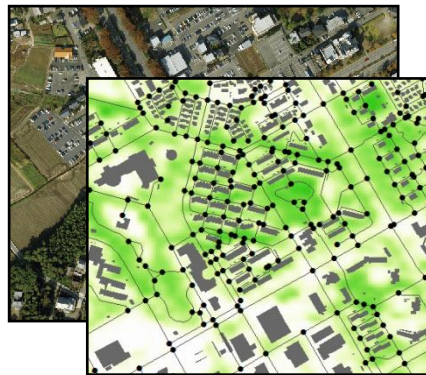
# Objective

Objective of the project



# Objective

To develop **an integrated methodology** (Remote Sensing, GIS and Spatial Web Technology) to model **urban green space walkability**, which enables local residents to **make spatial decision** while their walking on the street or choosing a place to live with GIS.



ALOS-AVNR2  
Building Footprints  
Road Network  
Public Facilities



Spatial Web Technology  
GIS + Internet Technology  
Urban Green Space Walkability Model



Local residents  
decision making  
Find eco-friendly living place  
Find shortest or greenest paths



# Benefit of Urban Green Spaces

Improve Public Mental Health

Increase Social Interaction and Cohesion

Save Country Socioeconomic

Clean Environment



# Improve Public Mental Health

## Improve Public Mental Health

*Studies on the relationship between nature and health*

*Residents of neighborhoods with **abundant green spaces** tended, on average, to enjoy **better general health** ([Maas et al., 2006](#))*

*More often one visits green areas, the **less often one reports sickness from stress** ([Grahn and Stigsdotter, 2003](#))*

*Neighborhood greenness was more strongly associated with **mental health** than it was with physical health ([Sugiyama, 2008](#))*



# Increase Social Interaction and Cohesion

## Increase Social Interaction and Cohesion

*Green spaces (especially parks) play important roles in **social interactions and cohesion***

- *Children can play and build friendship*
- *People can meet and talk each other*
- *Do green exercises together*





# Save Country Socioeconomic and Clean Environment

## Save Country Socioeconomic and Clean Environment

- *Reduce cooling and heating demands*
- *Improve air quality*
- *Reduce storm water runoff*
- *Enrichment of urban biodiversity*
- *Reduce urban heat island effect*
- *More ....*



# Web-GIS: Geospatially Enabled Society

GIS and Internet Technology  
Benefits of Web-GIS for society





# Web-GIS: Geospatially Enabled Society

GIS → GIScience → GIST (Geographical Information Science and Technology)

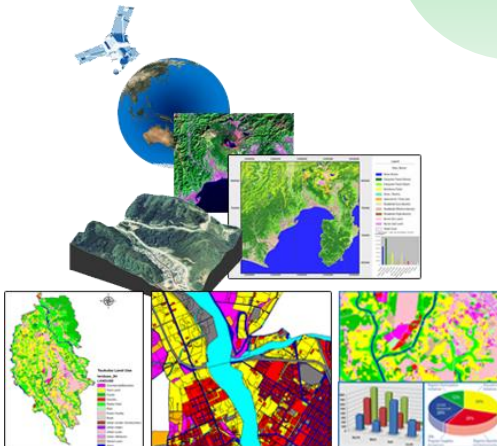
Provide theory and concept  
Enhance spatial analysis  
Improve spatial modeling  
Adequate decision making

**GIS  
GIScience**

**Internet and  
Communication  
Technology**

**Spatial Web  
Technology  
WEB-GIS**

**Development of communication technology**  
*ISDN > ADSL > Wi-Fi access*  
**Development of Hardware**  
*Desktop > Laptop > Netbook > Smartphone*  
**Development of User-friendly Web-GIS**  
*Google Earth, Microsoft Bing Maps, ...*



**GIS is more accessible ....**  
*GIS goes professional to public*  
**Part of our daily lives**  
*Finding closet facility, driving routes, ...*  
**Geospatially enabled society**



# Eco-friendly Walk Score Calculator

Project Area

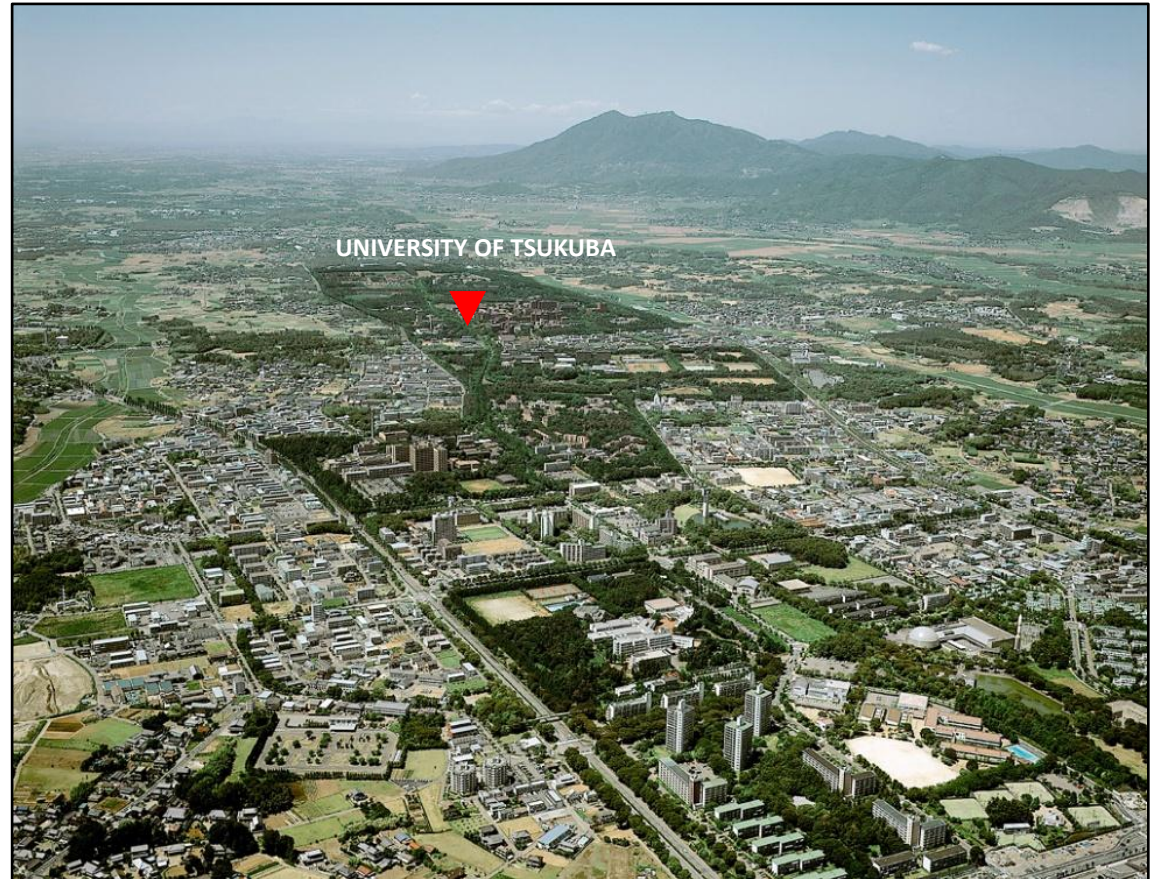
List of Data, Processing and Purposes



## Project Area



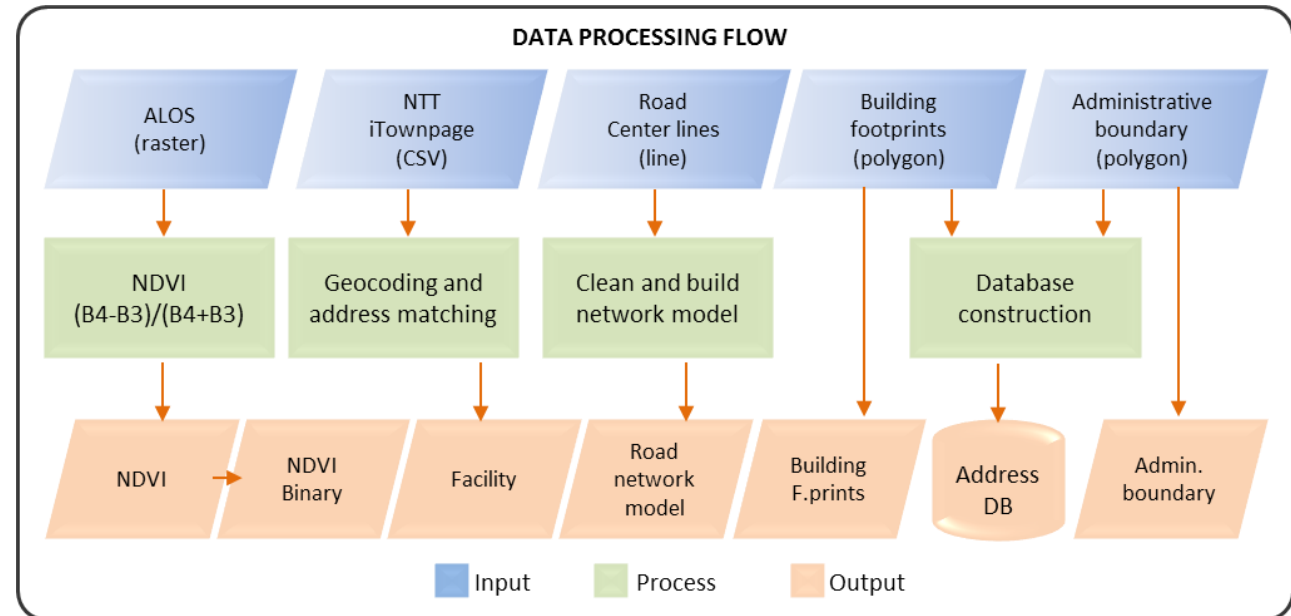
Tsukuba City (45 minutes from Tokyo,  
*Tsukuba Express Train*)  
Research and academic purposes  
Also known as Science City  
Home of: *University of Tsukuba*  
*JAXA, NIES, AIST, .....*  
Area: 284.07 km<sup>2</sup>  
Population: 207,394 (2008)



# List of Data, Processing and Purposes

## List of Data

- ALOS-AVNR2 (JAXA)
- Building Footprint
- Administrative Boundary
- Road Center Line
- NTT iTownpage



**NDVI binary image:** Greenness score calculation

**iTownpage:** Allocation of facility point

**Road center line:** Find shortest and greenest path

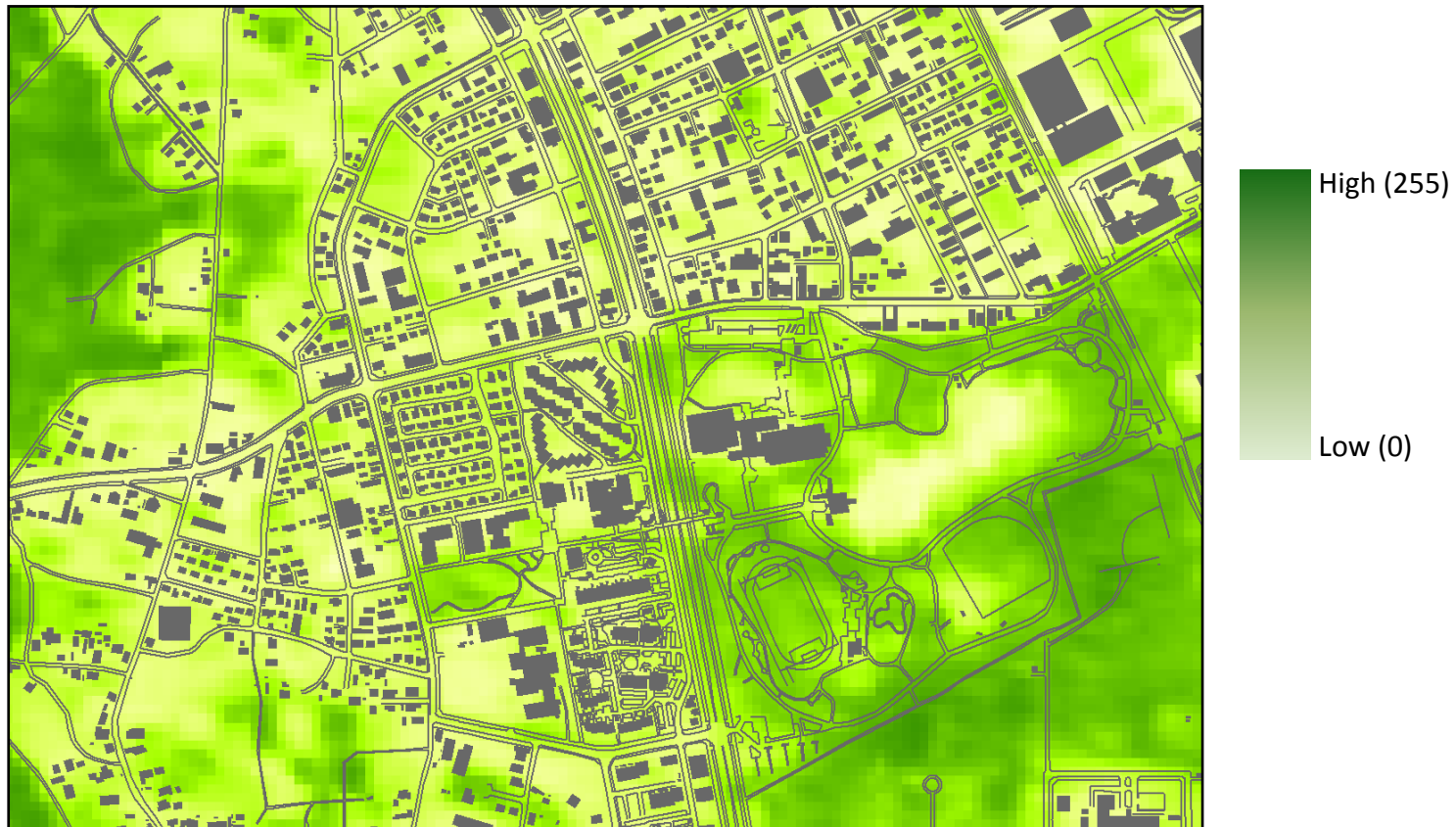
**Building Footprint + Admin. Boundary:** Construct address database





## List of Data, Processing and Purposes

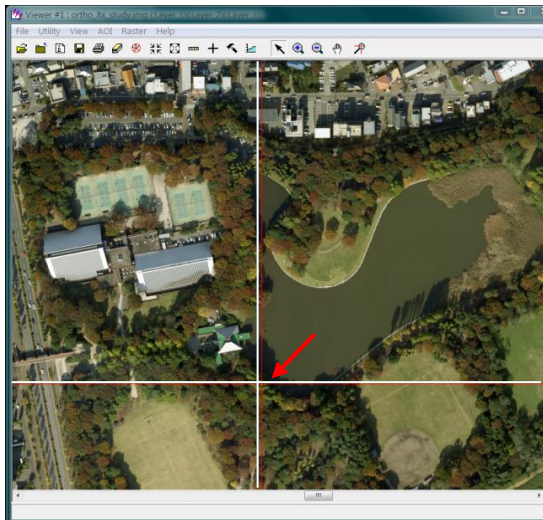
**ALOS-AVNR2 NDVI intensity image** (DN = 0 – 255) at 10m spatial resolution



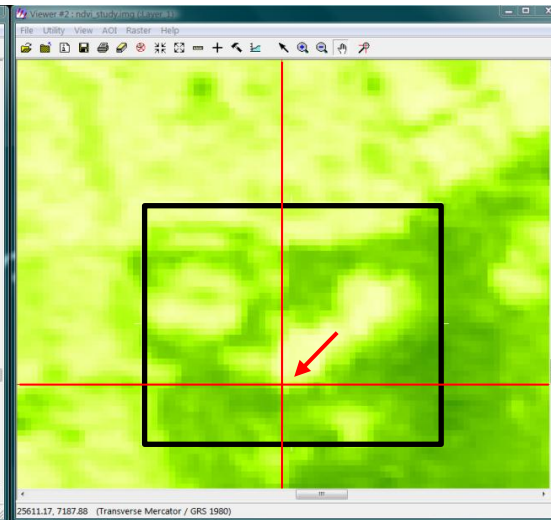


# List of Data, Processing and Purposes

RGB True Color Ortho-image (67cm)



ALOS AVNIR-2 NDVI (5m)

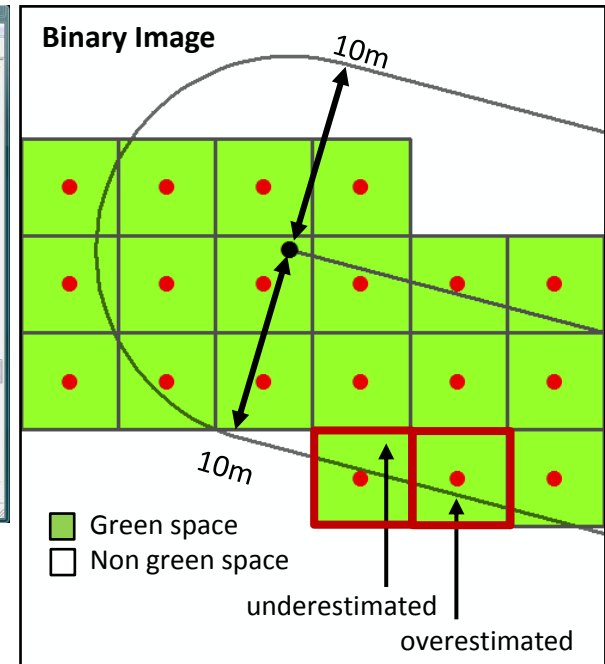
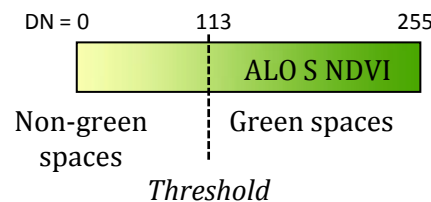


## Green spaces

Forest, paddy fields and grass lands

## Non-Green Spaces

Bare lands, water surface, roads and building footprints

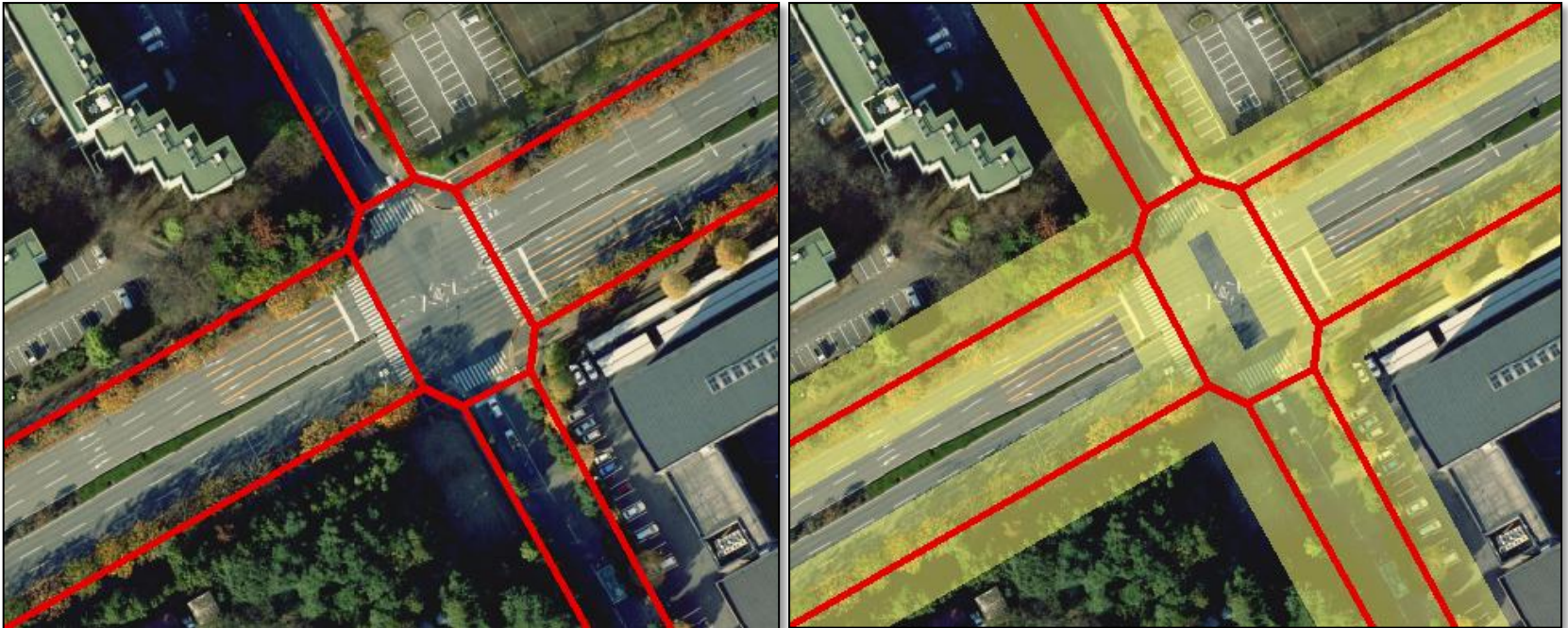


Resampled to 5m

To improve between raster and vector analysis

Convert to binary image (DN = 0 – 1)

## List of Data, Processing and Purposes



Building a GIS Road Network Data Model



# List of Data, Processing and Purposes

**Building Footprint:** *To construct address database*

**Administrative Boundary:** *To construct address database*

GET SCORE BY ADDRESS

Kasuga 3 Chome    10-16    Go

350    Buffer Distance (m)

*Example:*

***Japanese addressing system (Block System)***

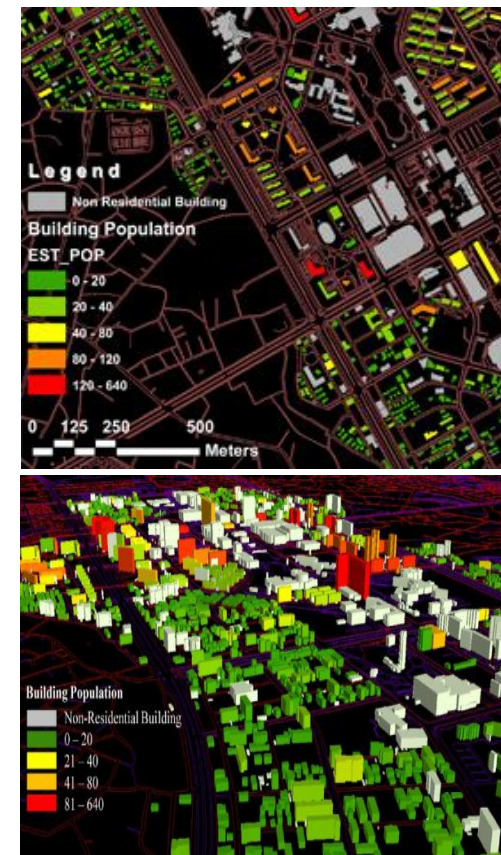
*Kasuga 3-10-16, Tsukuba, Ibaraki, Japan 305-0821*

***Western or other countries (Linear System)***

*701 Lee Street Suite 680, Des Plaines, IL, 60016*

*500 Dover Street, City Hall, Singapore*

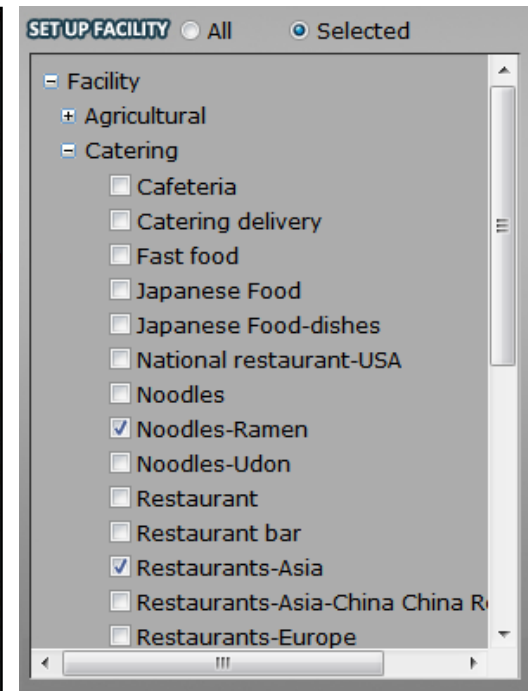
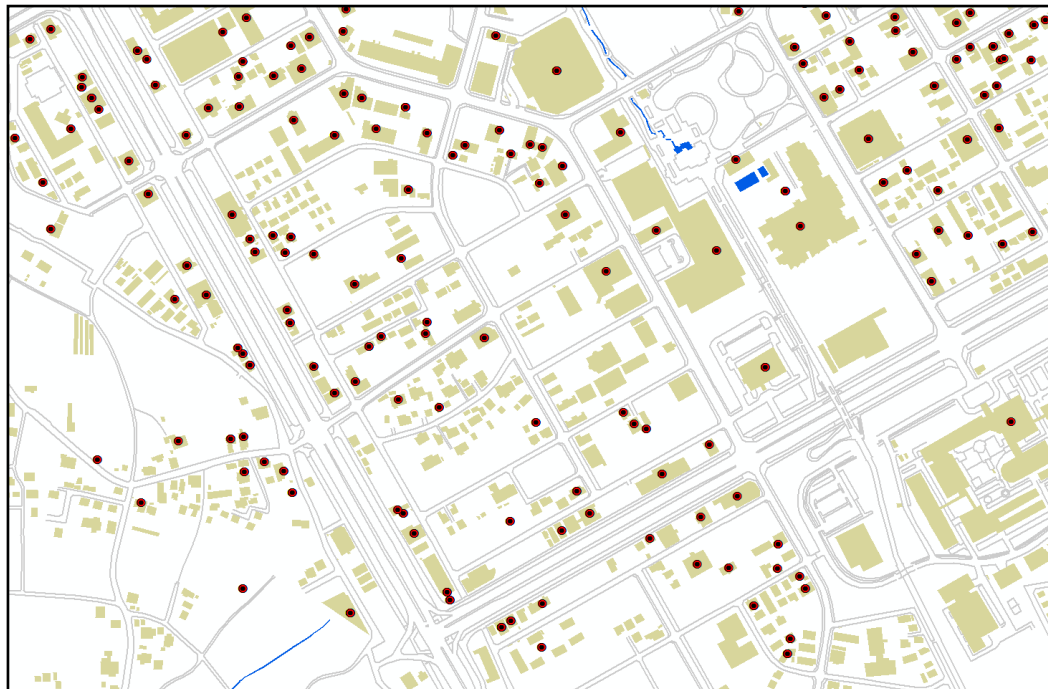
*Building foot prints data are useful for building population estimation by integration with number of floors information or building height derived from LIDAR data (Lwin and Murayama, 2009, 2010)*



# List of Data, Processing and Purposes

## NTT iTOWNPAGE (Nippon Telegraph & Telephone Corp.)

*Internet TownPage which includes: Business name, address, category, sub-category, business contents, phone number, URL, etc., in CSV Comma Separated Value format*



*To find available and desire facility locations*

# Measurement Modes

Get Score by Address or User Defined Point

Get Score by Walking Route (Smart Eco-path Finder)





# Get Score by Address or User Defined Point

**1**

GET SCORE BY ADDRESS

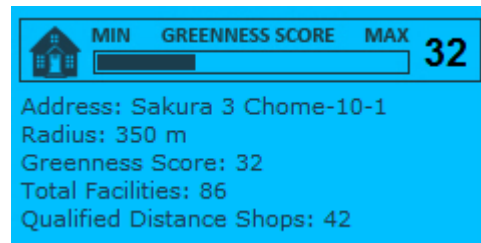
Sakura 3 Chome 10-1

350 Buffer Distance (m)

**2**

- ☒ Fast food
- ☒ Japanese Food
- ☒ Japanese Food-dishes
- ☒ National restaurant-USA
- ☒ Noodles
- ☒ Noodles-Ramen
- ☐ Noodles-Udon
- ☒ Restaurant

## RESULT



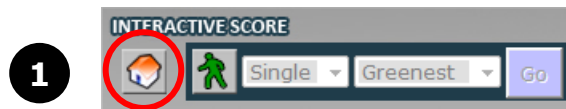
$$\text{Greenness Score} = (\text{GA} / \text{CA}) * 100$$

\*Qualified Distance:  
Network distance <= User defined radius

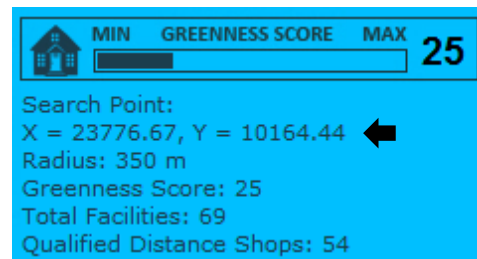
For local residence



# Get Score by Address or User Defined Point



## RESULT



$$\text{Greenness Score} = (\text{GA} / \text{CA}) * 100$$

\*Qualified Distance:

Network distance <= User defined radius



For potential home buyers



# Get Score by Walking Route (Smart Eco-path Finder)

**Intended to:** *Mobile GIS users*

**Focused on:**

- How to utilize urban green spaces with GIST (GIScience & Technology)?*
- How to evaluate neighborhood environmental quality with GIST?*
- How to find **shortest paths** for shopping with GIST?*
- How to find **greenest paths** for walking with GIST?*

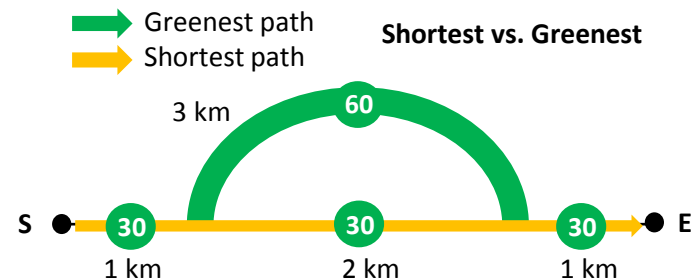
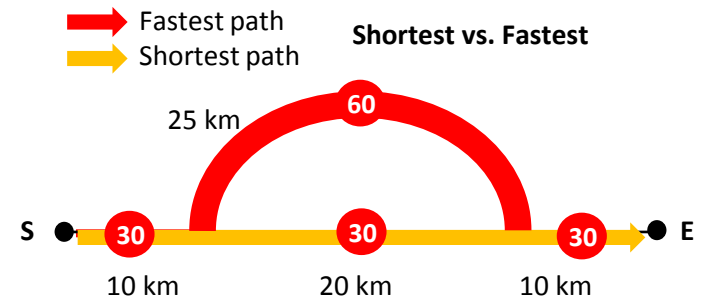
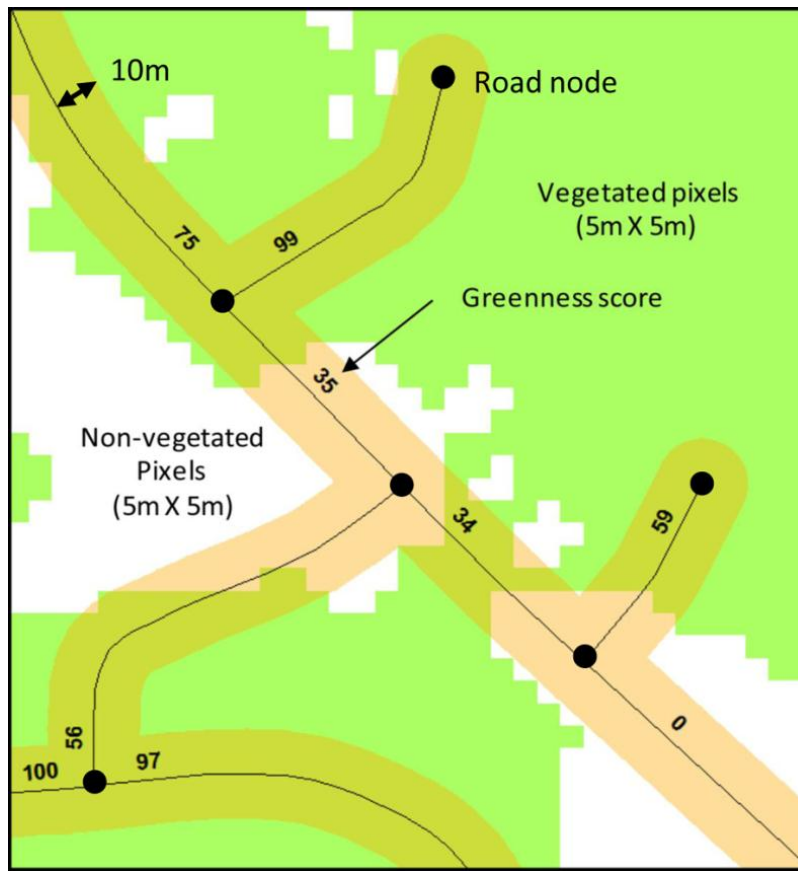


**Shortest  
Vs.  
Greenest  
Path Analysis**

**Shortest:** shopping activity  
**Greenest:** for doing green exercise



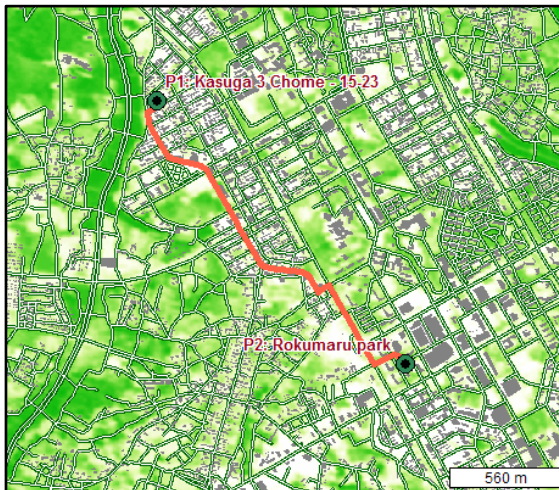
# Get Score by Walking Route (Smart Eco-path Finder)



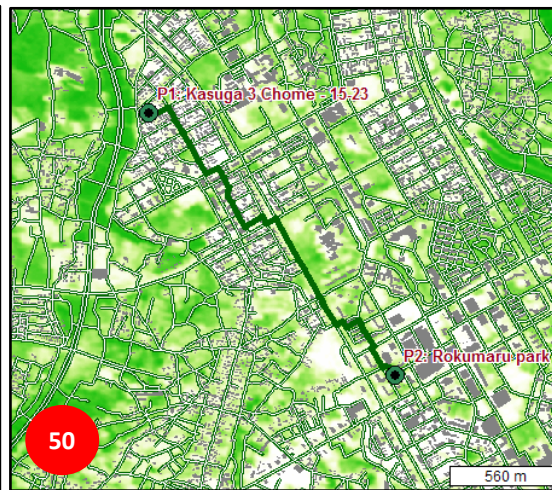


# Get Score by Walking Route (Smart Eco-path Finder)

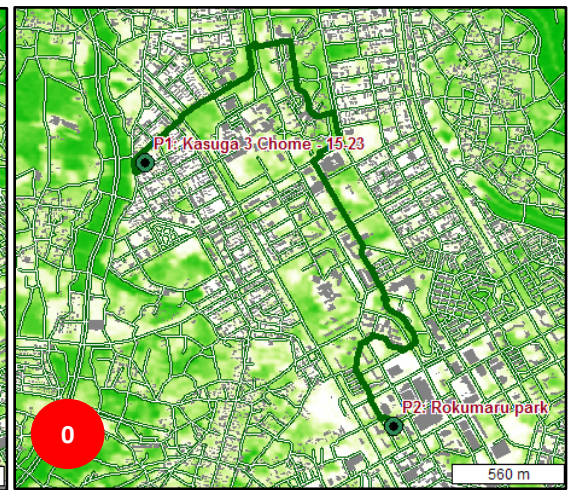
Set up: Greenness Score Limitation/Threshold (Optional)



Route Information: Shortest  
P1-P2: 2.16Km (G.Score: 21)



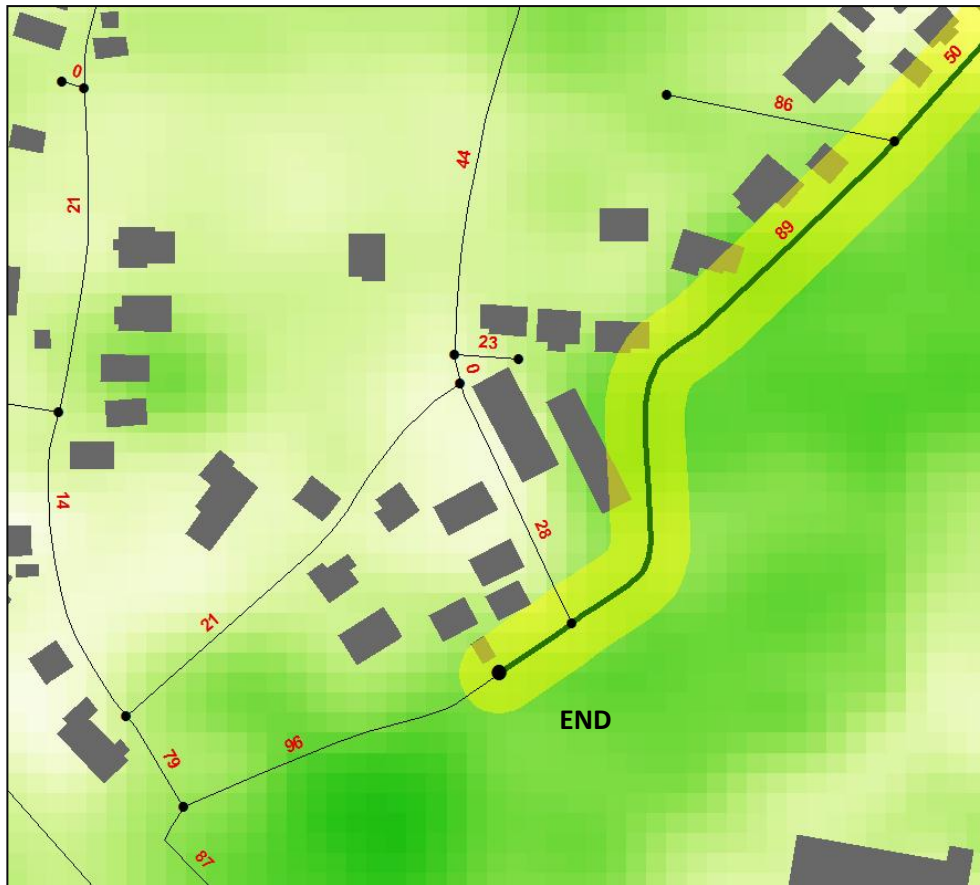
Route Information: Greenest  
P1-P2: 2.26Km (G.Score: 27)



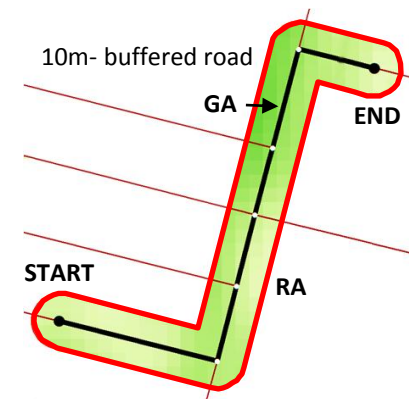
Route Information: Greenest  
P1-P2: 4.04Km (G.Score: 58)



# Get Score by Walking Route (Smart Eco-path Finder)



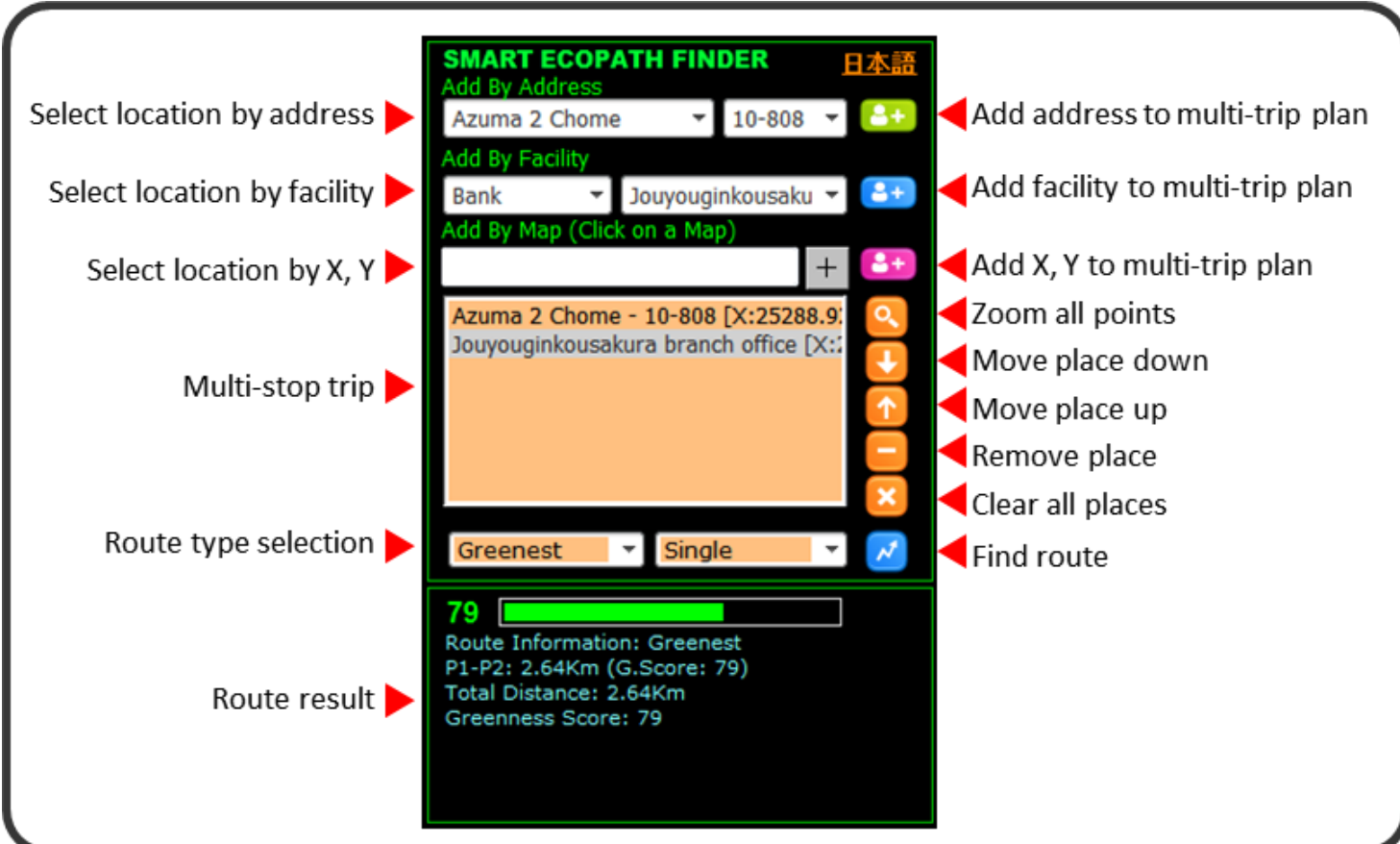
## Route greenness score



Average greenness score by walking route

$$\text{Average Greenness Score} = (GA / RA) * 100$$

# Get Score by Walking Route (Smart Eco-path Finder)



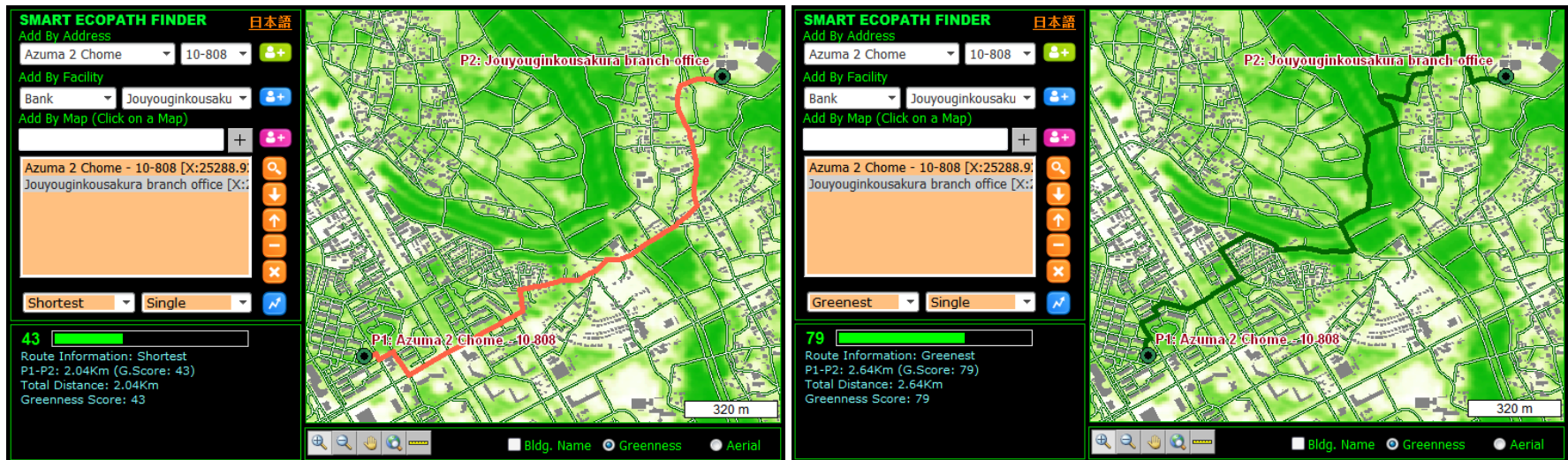
The screenshot shows the SMART ECOPATH FINDER interface with the following components and annotations:

- Select location by address** (points to the "Add By Address" section):
  - Input: "Azuma 2 Chome" and "10-808"
  - Annotation: "Add address to multi-trip plan" (points to the green "+" button)
- Select location by facility** (points to the "Add By Facility" section):
  - Input: "Bank" and "Jouyouginkousaku"
  - Annotation: "Add facility to multi-trip plan" (points to the blue "+" button)
- Select location by X, Y** (points to the "Add By Map" section):
  - Input: Empty fields
  - Annotation: "Add X, Y to multi-trip plan" (points to the pink "+" button)
- Multi-stop trip** (points to the map area):
  - Map shows: "Azuma 2 Chome - 10-808 [X:25288.9; Y:12345.6]" and "Jouyouginkousakura branch office [X:25288.9; Y:12345.6]"
  - Annotations:
    - "Zoom all points" (points to the magnifying glass icon)
    - "Move place down" (points to the down arrow icon)
    - "Move place up" (points to the up arrow icon)
    - "Remove place" (points to the minus icon)
    - "Clear all places" (points to the "X" icon)
- Route type selection** (points to the "Greenest" and "Single" dropdowns):
  - Selection: "Greenest" and "Single"
  - Annotation: "Find route" (points to the blue route icon)
- Route result** (points to the bottom section):
  - Score: 79 (with a green progress bar)
  - Route Information: Greenest
  - P1-P2: 2.64Km (G.Score: 79)
  - Total Distance: 2.64Km
  - Greenness Score: 79



# Get Score by Walking Route (Smart Eco-path Finder)

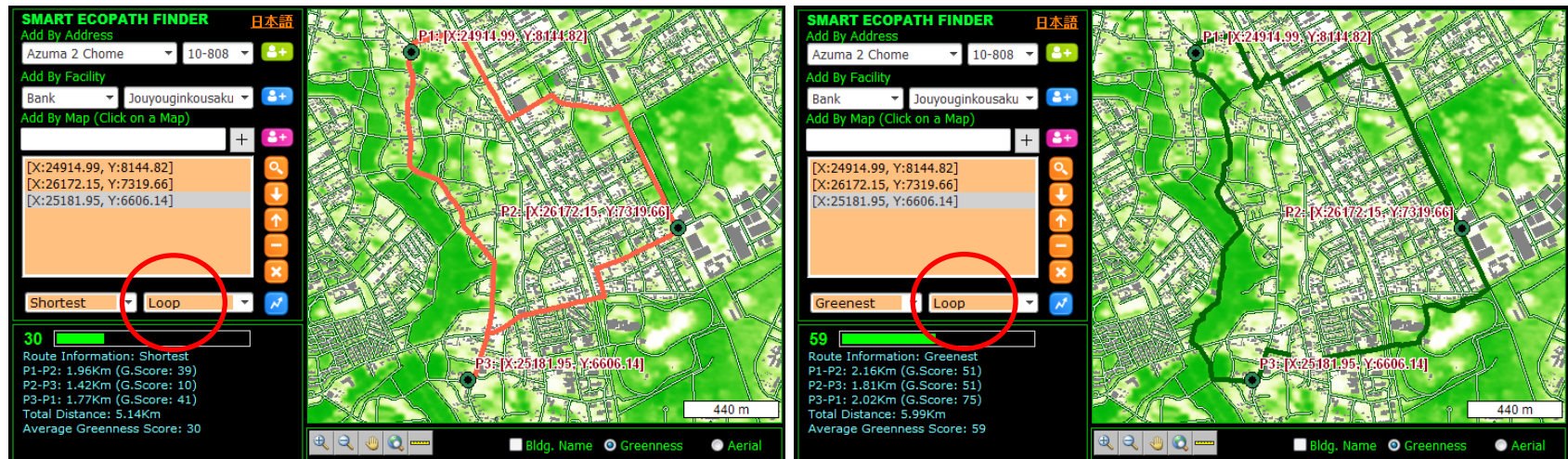
## Single Trip Planning



## Shortest vs. Greenest

# Get Score by Walking Route (Smart Eco-path Finder)

## Multi-stop Trip Planning



Shortest vs. Greenest





# Get Score by Walking Route (Smart Eco-path Finder)



**SMART ECOPATH FINDER** 日本語

Add By Address  
Azuma 2 Chome 10-808

Add By Facility  
Bank Jouyouginkousaku

Add By Map (Click on a Map)  
[X:26783.38, Y:5857.95]  
[X:25464.25, Y:8618.37]

Greenest Single

76  
Route Information: Greenest  
P1-P2: 3.26Km (G.Score: 76)  
Total Distance: 3.26Km  
Greenness Score: 76

40 m

Bldg. Name Greenness **Aerial**

Provide aerial imagery for real-world visualization



# Conclusion

Urban green spaces are important for **human mental health** improvement, **social cohesion**, reduce urban heat island effect, improve air quality, perform green exercises and **saving energy** by reduce cooling and heating demands.

**GIST (GIScience and Technology)** provides identification of green spaces, calculation of **greenness score and route path analysis** to improve local residents decision making.

Modern **spatial web technology (Web-GIS)** provides **more accessible** to a much **wider audience** than traditional GIS. The general public can now directly access spatial information and see the analysis results through their web browsers without any installation of GIS software. The system itself is **reusable and updatable**.



# Thank You

**MAKE IT UNIQUE  
KEEP IT SIMPLE**



Division of Spatial Information Science, Graduate School of Life and Environmental Sciences, University of Tsukuba



URL: <http://land.geo.tsukuba.ac.jp/ecowalkscore> (Choosing a place to live with GIS)

URL: <http://land.geo.tsukuba.ac.jp/ecowalker> (Smart Eco-path Finder)

**Read more:** Lwin, K. K., & Murayama, Y., (2011), Modelling of Urban Green Space Walkability: Eco-friendly Walk Score Calculator, *Computers, Environment and Urban Systems*, 35(5):408–420.