

# Compact City Scenarios Based on Resident's Intention in the Small Town

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Shota Tamura  
Takahiro Tanaka  
Daisaku Nishina



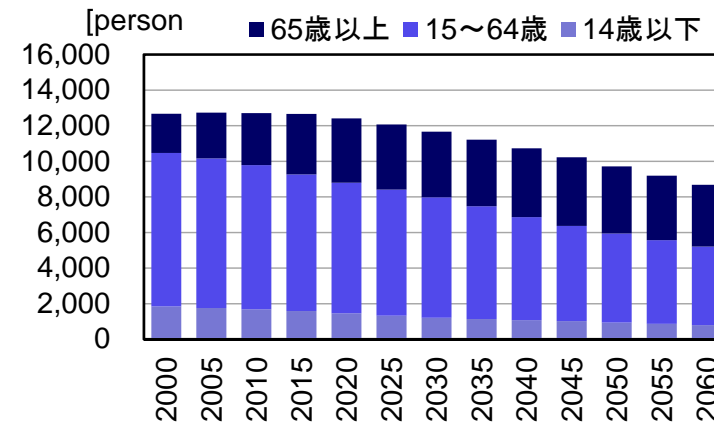
HIROSHIMA UNIVERSITY

# Back ground

Low density



Population change in the future



Depopulation + low density



In recent years, compact city is becoming popular as a suite urban structure for population decreasing society in Japan

# Back ground

environment



cost



Inhabitant

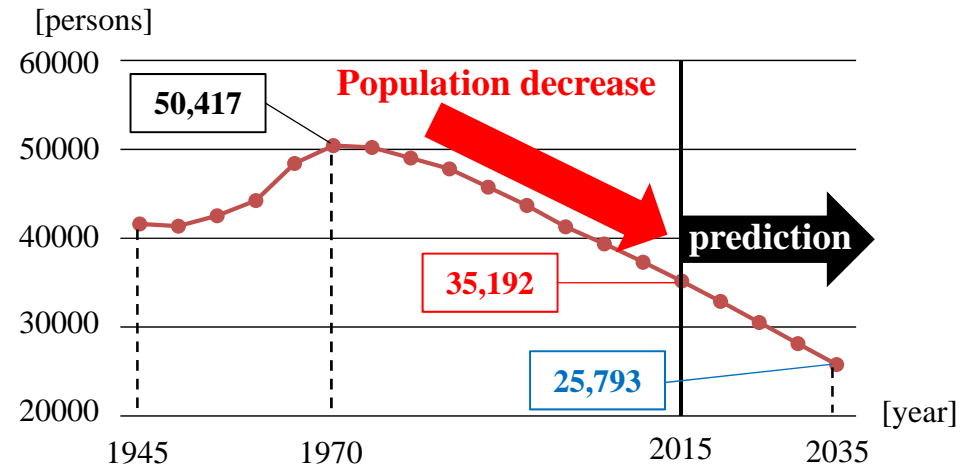
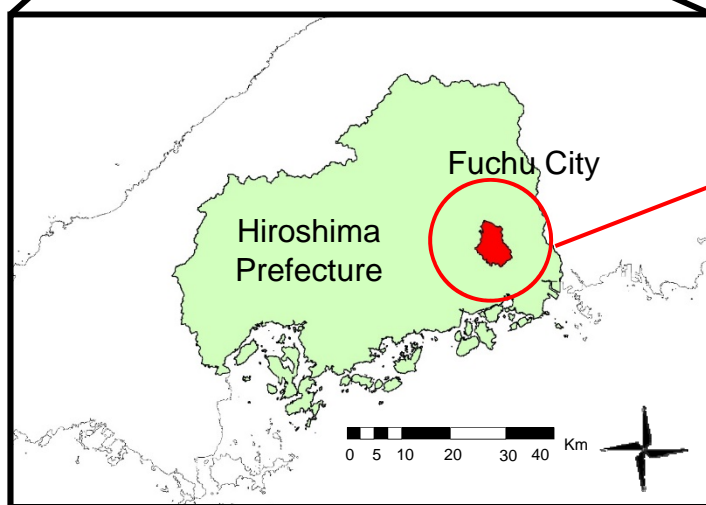
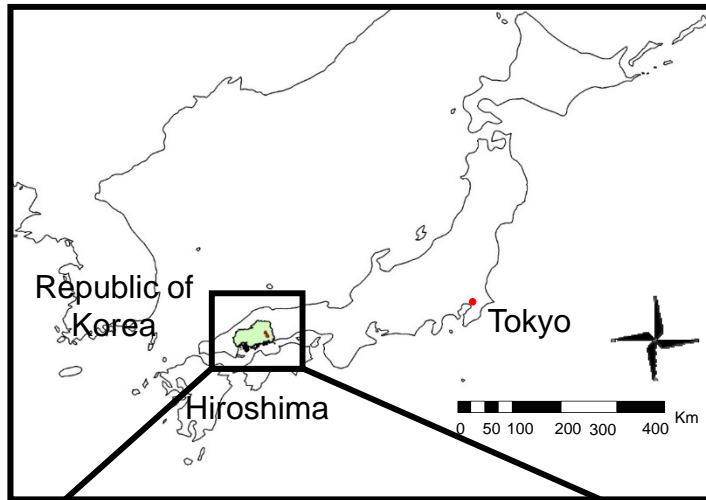


## purpose

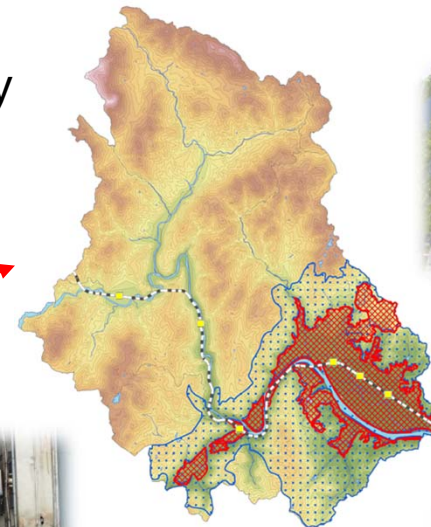
This study aims at building the compact scenarios based on the inhabitant's intention and evaluating them from the viewpoints of CO<sub>2</sub> emissions and infrastructure maintenance costs

# Target area

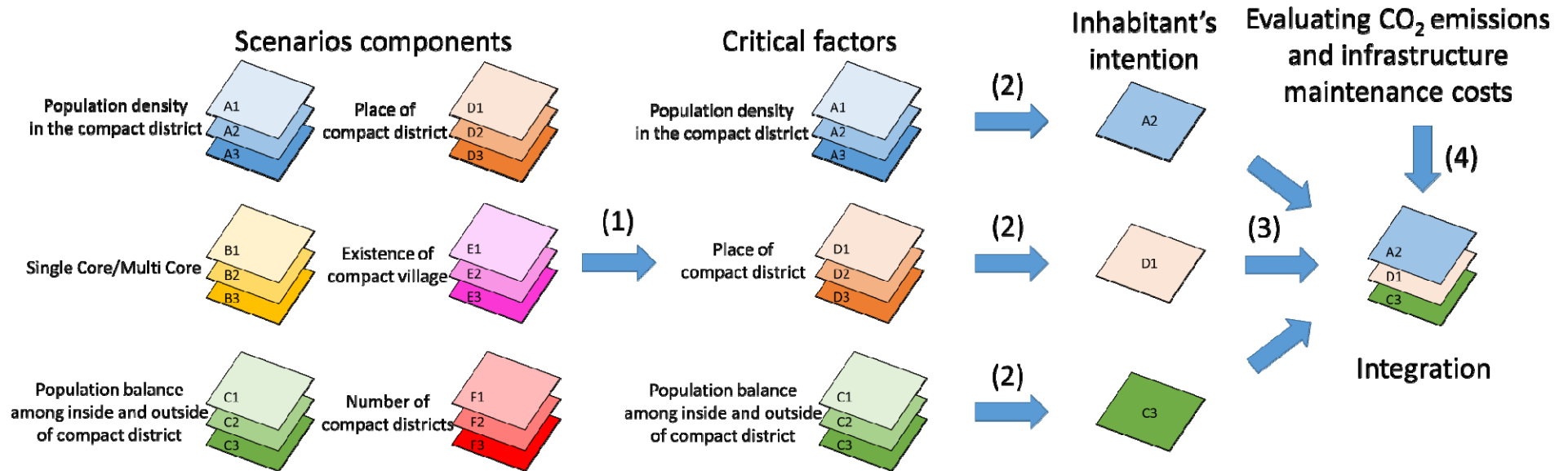
## Fuchu city



## Fuchu City



# Flow of the study



- (1) Extracting the critical factors of the scenarios for CO<sub>2</sub> emissions and infrastructure maintenance costs.
- (2) Examining inhabitant's intention on the critical factors by questionnaire survey.
- (3) Making scenarios based on the questionnaire survey results.
- (4) Evaluating scenarios based on the inhabitant's intention from the viewpoints of CO<sub>2</sub> emissions and infrastructure maintenance costs.

# Definition of original words

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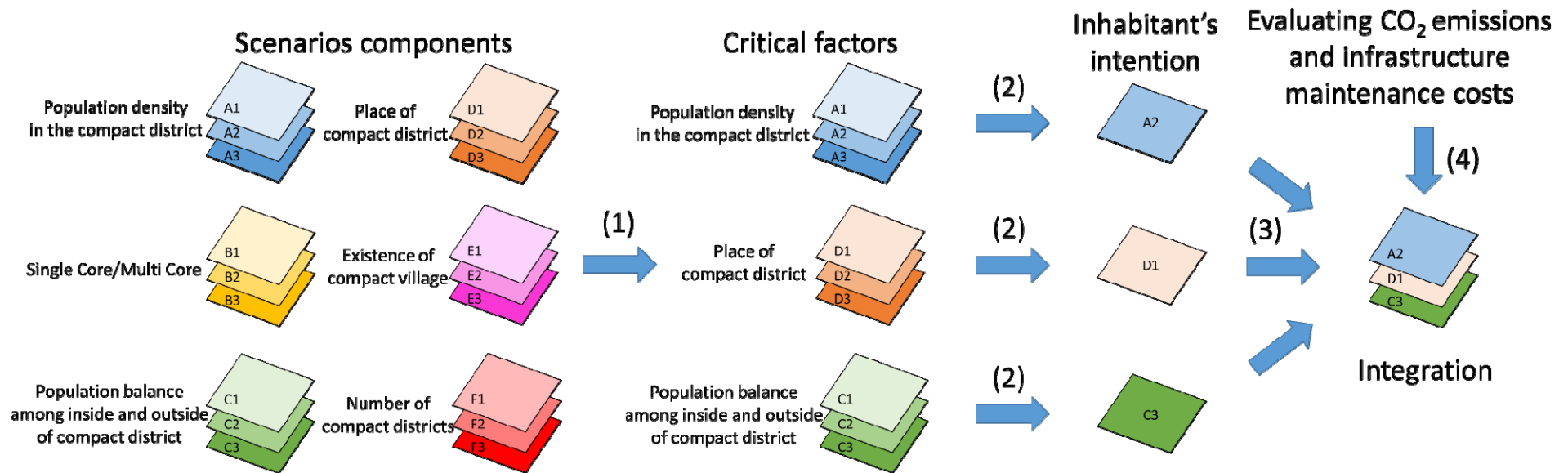
## Scenarios

Scenarios is defined as the spatial distribution of urban land use

## Compact district

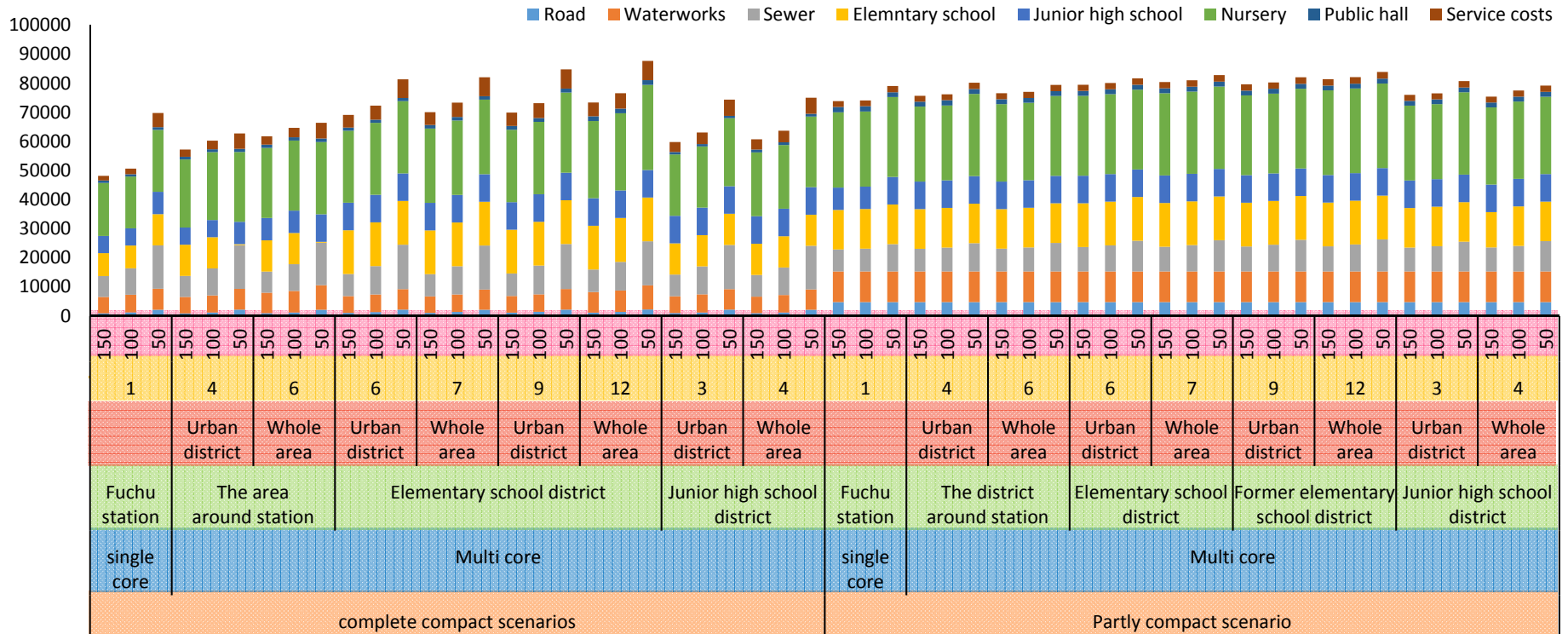
compact district is defined as the district which urban land use is concentrated

# Flow of the study









- (1) Extracting the critical factors of the scenarios for CO<sub>2</sub> emissions and infrastructure maintenance costs.
- (2) Examining inhabitant's intention on the critical factors by questionnaire survey.
- (3) Making scenarios based on the questionnaire survey results.
- (4) Evaluating scenarios based on the inhabitant's intention from the viewpoints of CO<sub>2</sub> emissions and infrastructure maintenance costs.

# Previous study



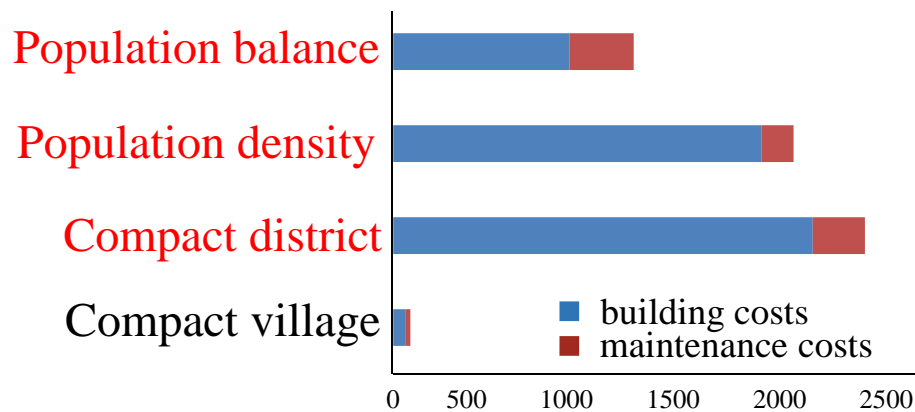
## Scenario factors

-  Population density (50 / 100 / 150 [person/ha])
-  Number of compact district (1 / 3 / 4 / 6 / 7 / 9 / 12)
-  Urban planning area (The whole of target area / urban district )
-  Place of compact district (the area around station/Elementary school district...)
-  Single/Multi core model
-  Population balance (complete compact concentration / partly compact concentration)

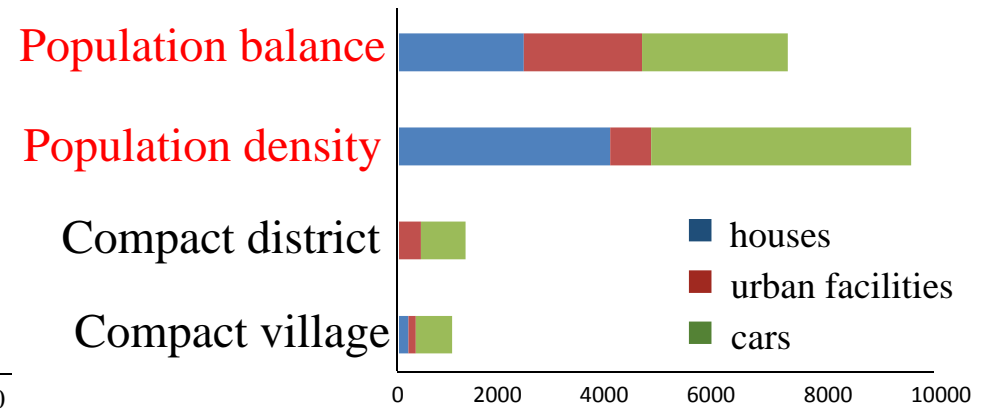


# Critical factors

## Results of quantification method class 1



Contribution of critical factors for infrastructure maintenance costs



Contribution of critical factors for CO<sub>2</sub> emissions



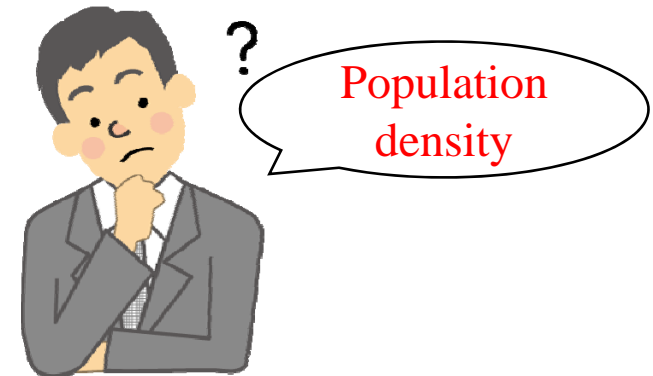
Population balance

Compact district

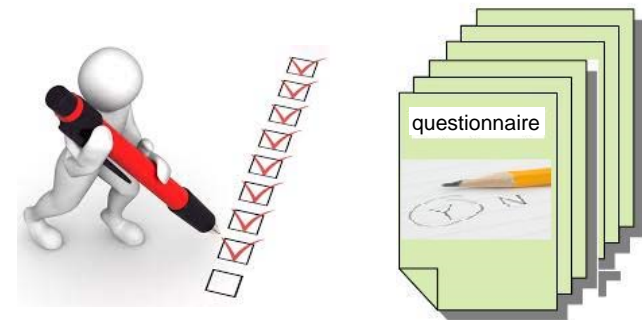
Population density

# Population density

As for the population density, it is thought that most generally inhabitants don't have sense on population density

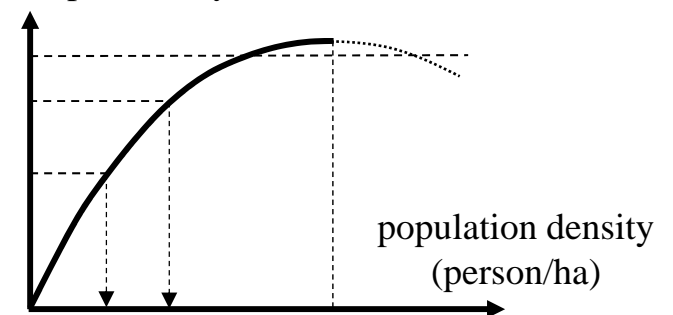


Necessity of some important facilities such as supermarket and clinic are asked in the questionnaire survey.



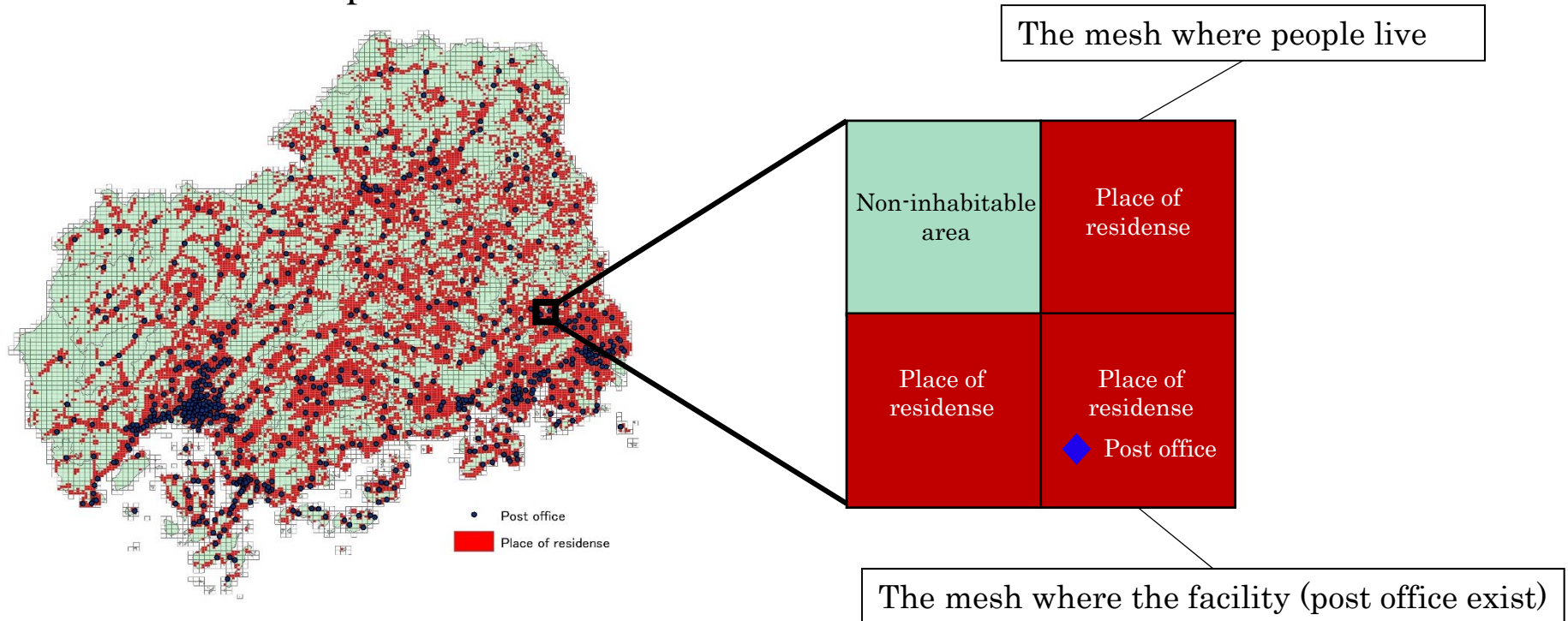
The population densities in surrounding of such facilities are analyzed and cumulative distribution function curve and formula for each facilities are made.

Location probability(%)



# Location probability

Location of post office



$$\text{Location probability(\%)} = \frac{\text{The number of mesh where the facility exist}}{\text{The number of mesh where people live}} \times 100$$

# Location probability

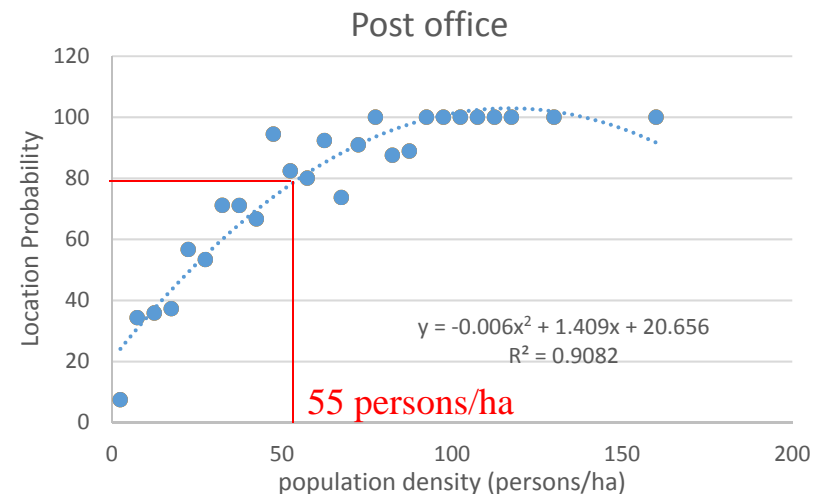
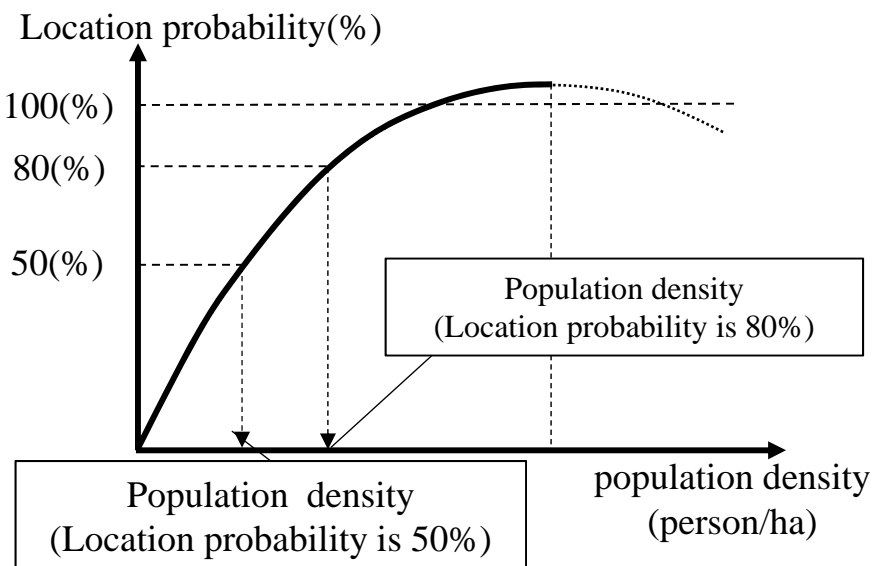
0~5 (persons/ha) Location probability =  $\frac{140}{4649} \times 100 = 3.0114\%$

5~10 (persons/ha) Location probability =  $\frac{90}{312} \times 100 = 28.8461\%$

Number of the mesh having post office  
(population density 5-10)

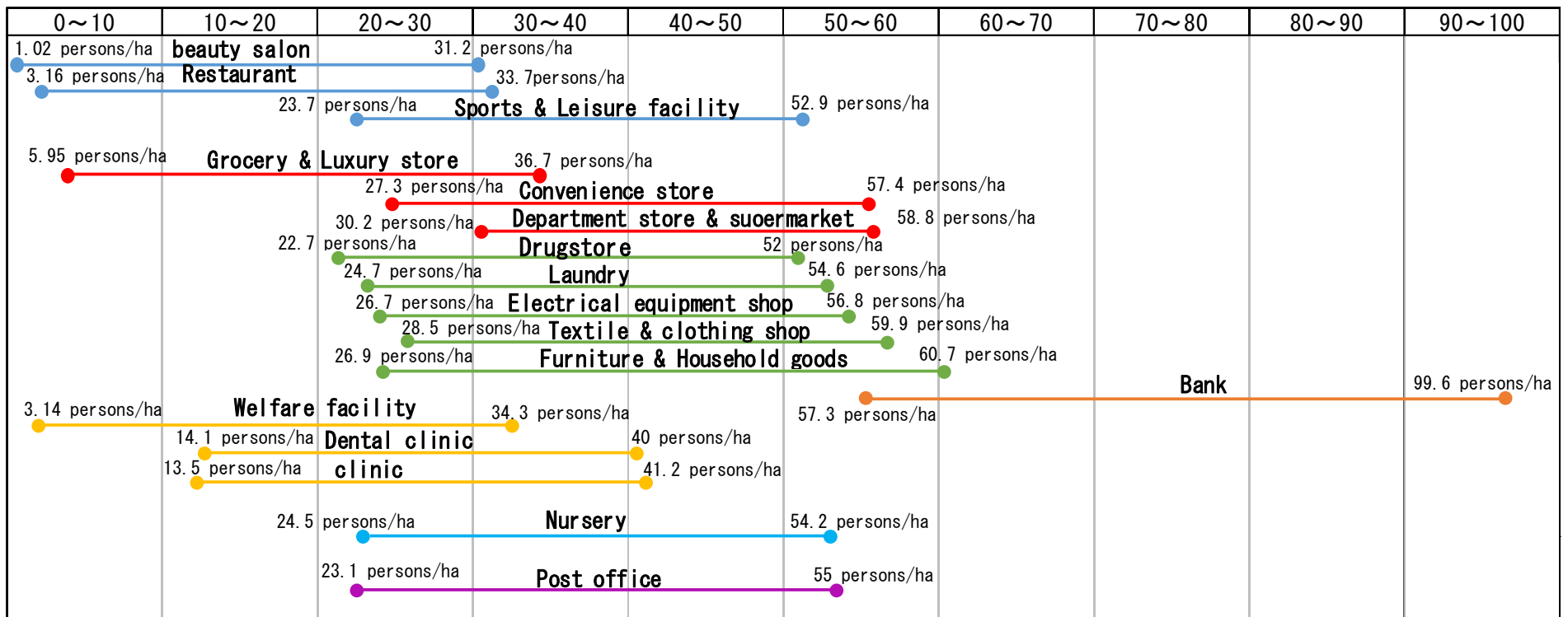
Number of the mesh having post office  
(population density 5-10)

120~125 (persons/ha) Location probability =  $\frac{3}{3} \times 100 = 100\%$



# Location probability

## Population density in the surrounding of facilities



# Questionnaire survey

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## Outline of questionnaire survey

### Critical factors

Population balance

Compact district

Population density

### Questions for making scenarios to inhabitant

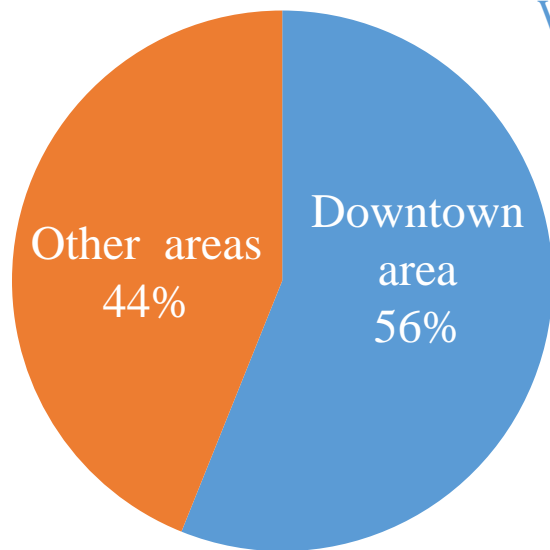
**Which area will you want to live in the future?  
(downtown area or suburb)**

**what facility should be centrally located in the  
future?**

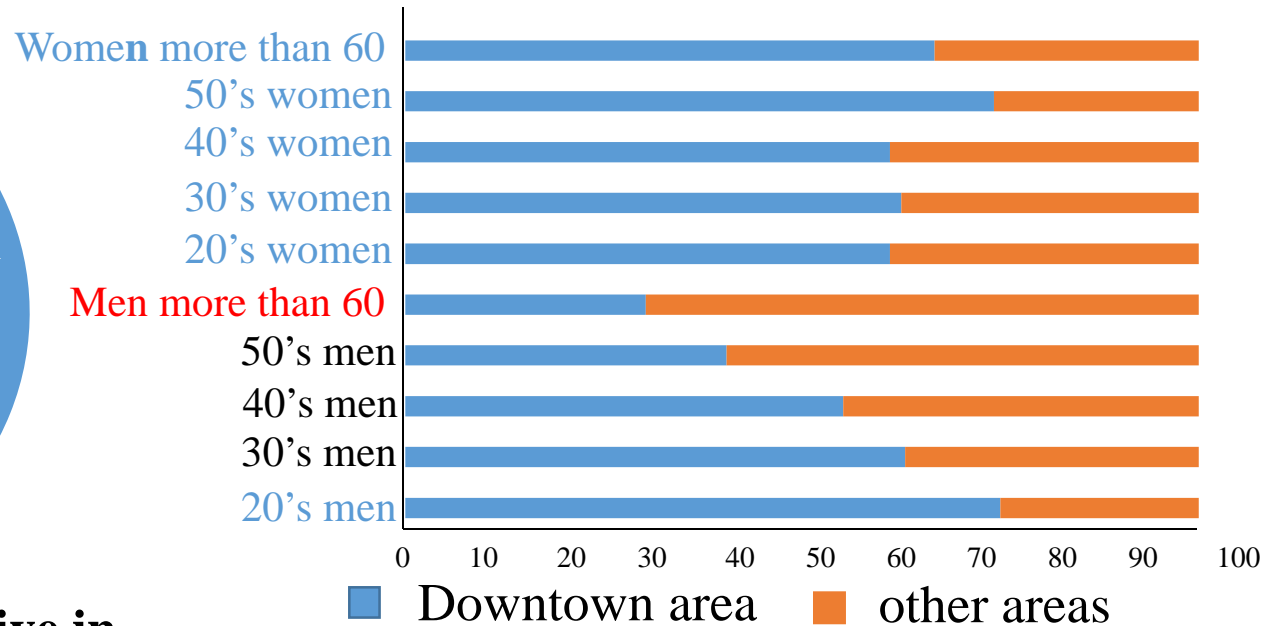
**What facility do you want to have in compact  
district in the future?**

# Inhabitant intention

## Population balance



**Intention of the place to live in the future**



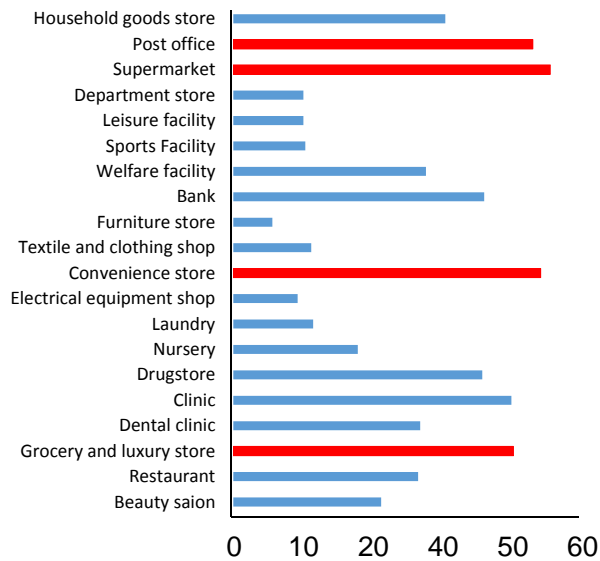
**Difference of sex and age**

	Major inhabitant	Elderly men	Women and younger men
<b>Downtown area</b>	56 %	31 %	65 %
<b>Outside of downtown area</b>	44 %	69 %	35 %

# Inhabitant intention

## Necessary of the facilities

Major inhabitant



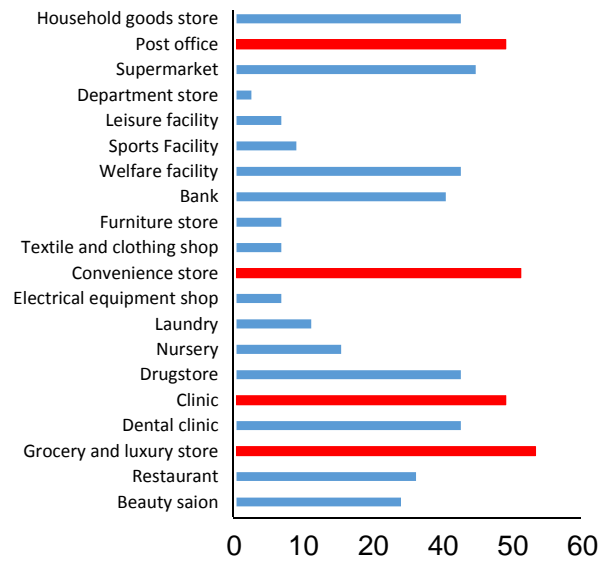
Post office

Supermarket

Convenience store

Grocery and luxury store

Elderly men



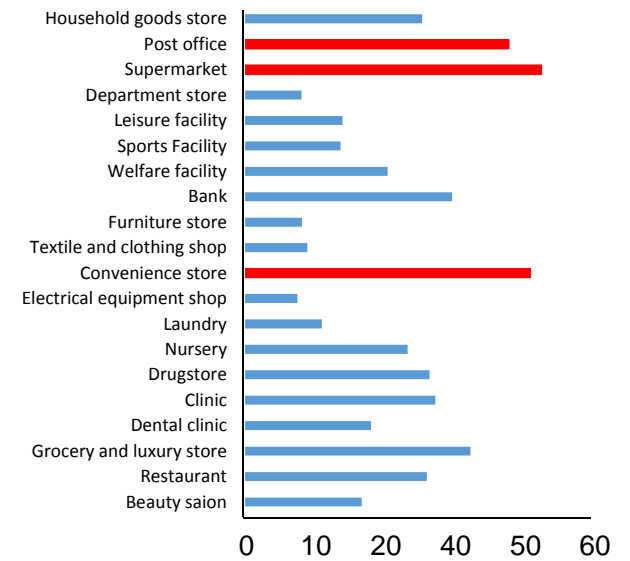
Post office

Convenience store

Clinic

Grocery and luxury store

Women and younger men



Post office

Supermarket

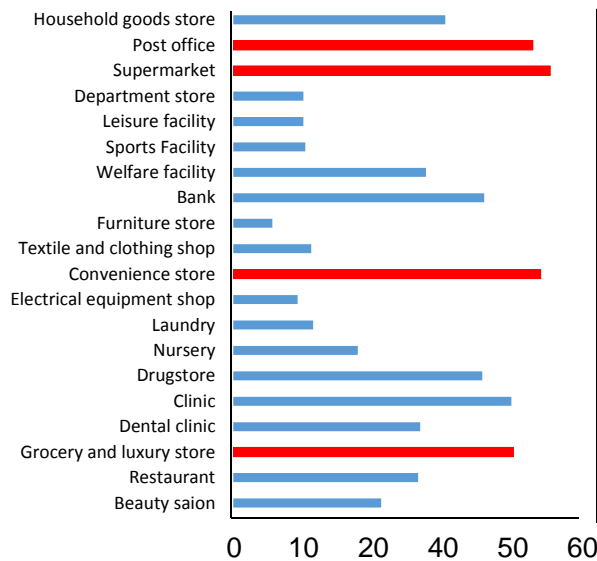
Convenience store



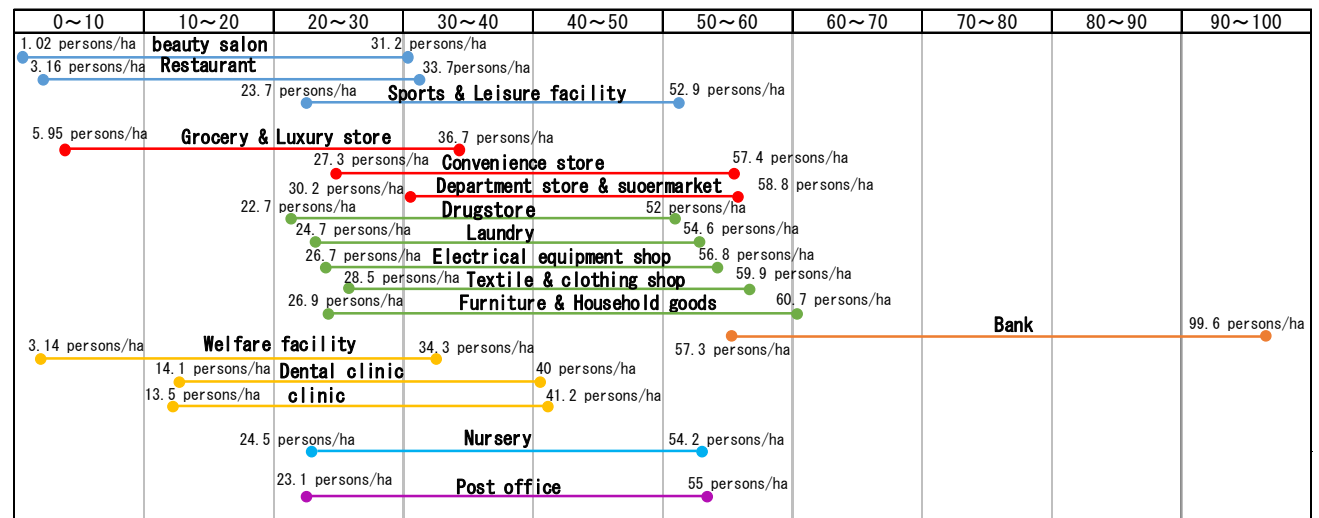
# Inhabitant intention

## Necessary of the facilities

Major inhabitant



Population density in the surrounding of facilities



Post office

55 (persons/ha)

Supermarket

58.8 (persons/ha)

Convenience store

57.4 (persons/ha)

Grocery and luxury store

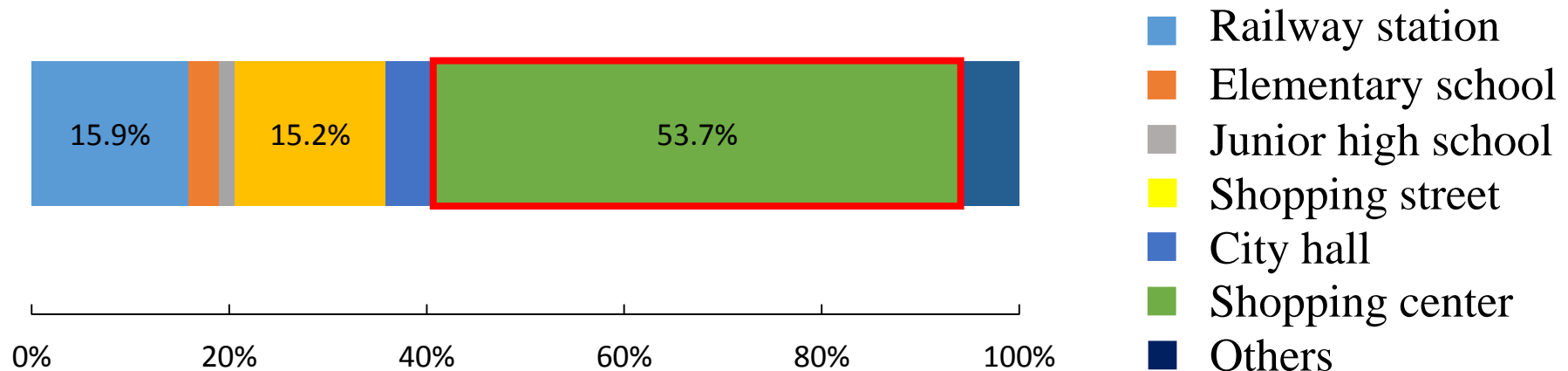
36.7 (persons/ha)

Compact district population density is average of these population

51.9 (persons/ha)

# Inhabitant intention

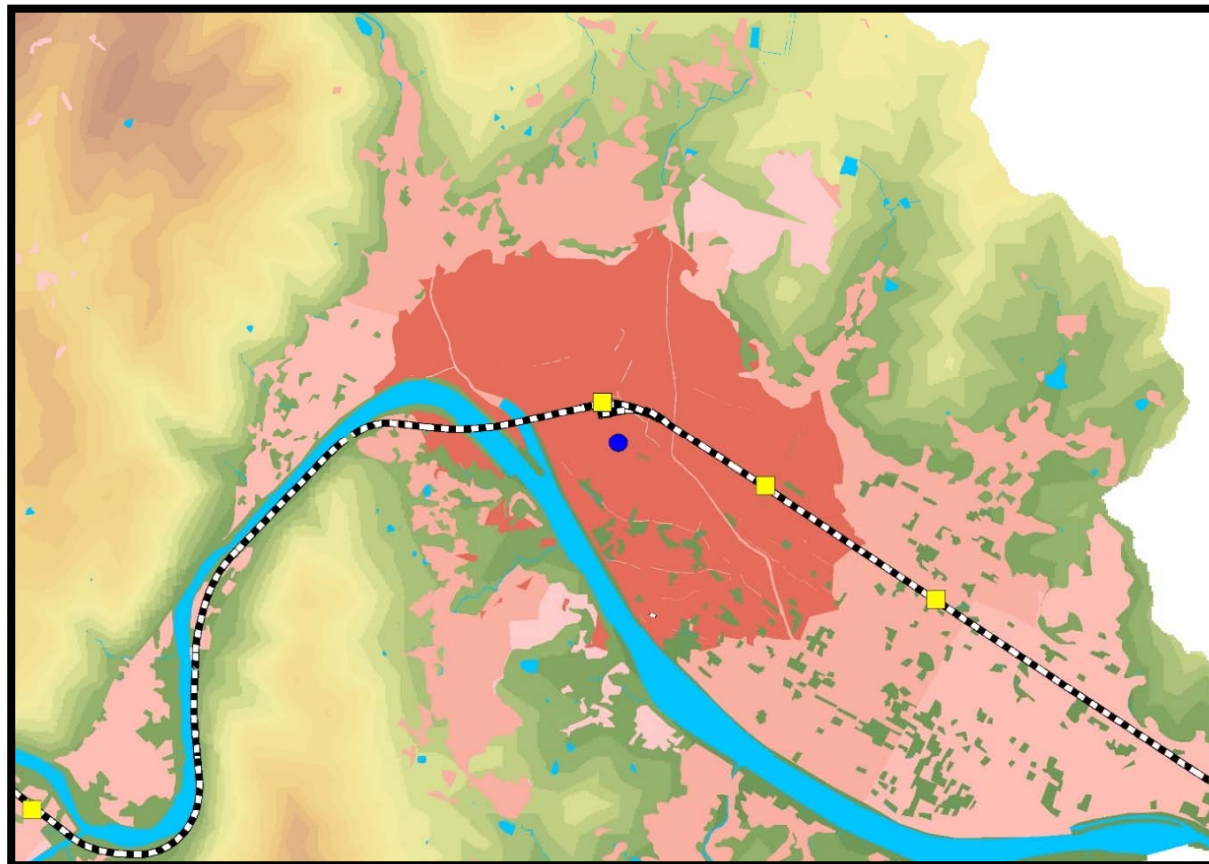
## Center place of compact district



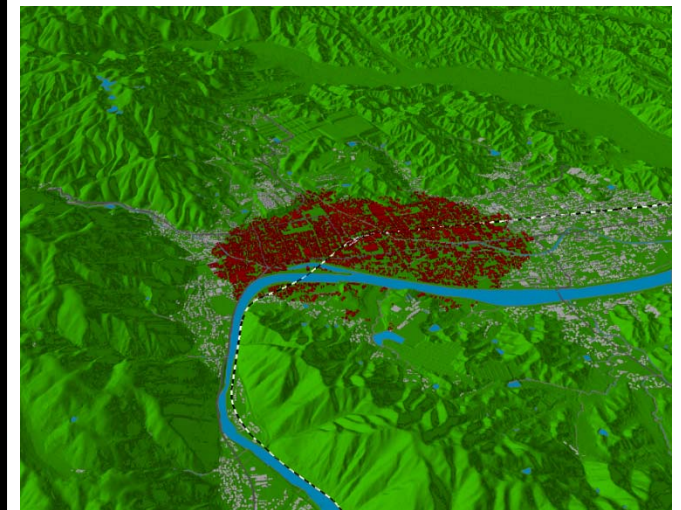
**Shopping center is preferable**

# Scenario based on inhabitant intentions

## Scenario1 making from major inhabitant intention



Compact district population density	52(persons/ha)
Population	
Compact district	14,444 persons (56%)
Suburb	11,349 persons (44%)

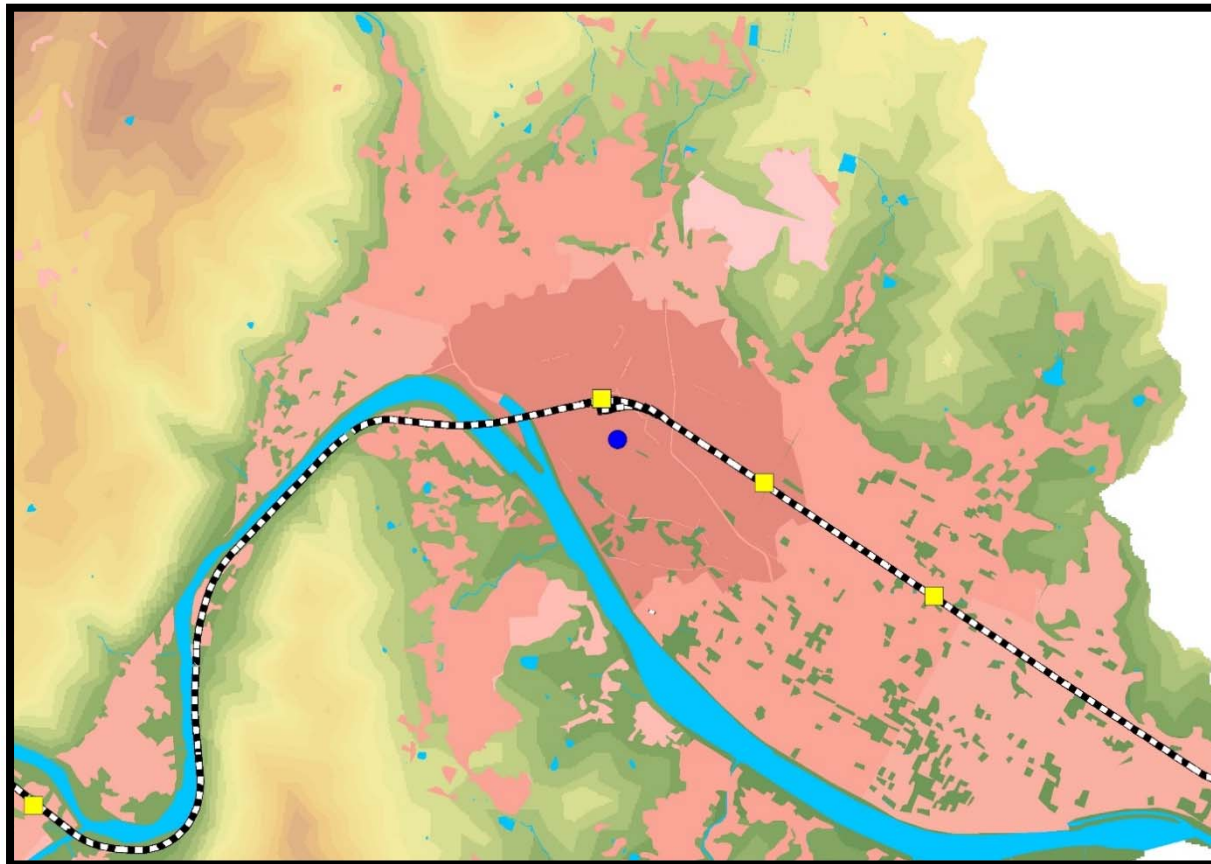


0 10 20 30 40 50 60  
 Population density (persons/ha)

 Shopping center  
 Station  
 Rail road

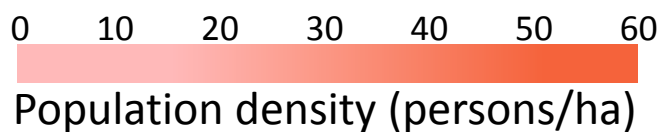
# Scenario based on inhabitant intentions

## Scenario2 respecting the life in the suburb



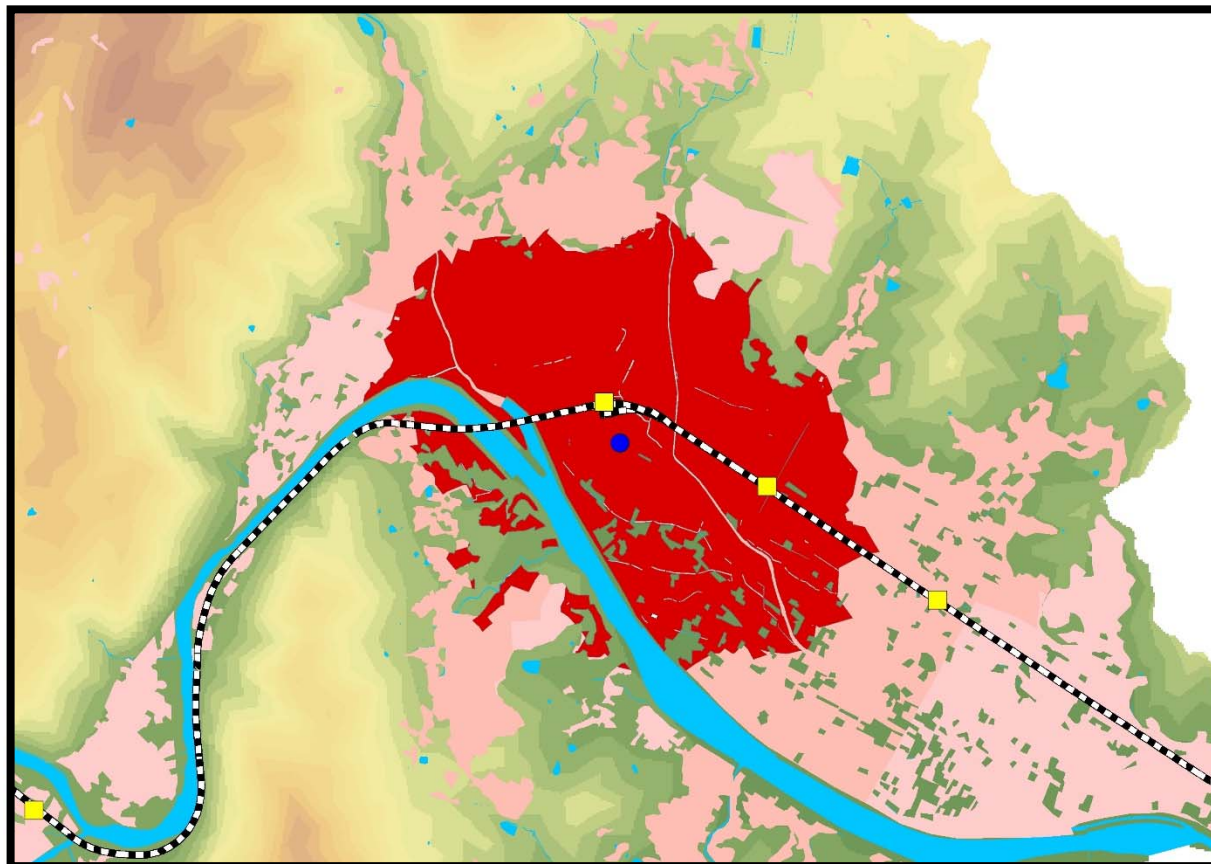
Compact district population density 47.6(persons/ha)

Population  
 Compact district 7,790 persons (31%)  
 Suburb 18,003 persons (69%)



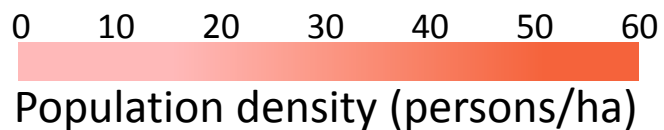
# Scenario based on inhabitant intentions

## Scenario3 Respecting the life in the compact district



Compact district population density 57.2(persons/ha)

Population  
 Compact district 16,766 persons (56%)  
 Suburb 9,027 persons (44%)



# Scenario evaluation

## Urban infrastructure costs

Urban infrastructure  
development costs

+

Urban infrastructure  
maintenance costs

## Target of urban infrastructure

1. Public hall
2. Waterworks
3. Sewer
4. Elementary school
5. Junior high school
6. Nursey
7. Road
8. Development costs

These infrastructures are considered to be  
affected by urban structure change

# Scenario evaluation

## The methods of estimating urban infrastructure costs

Making the estimation formula by actual data concerning urban infrastructure in Fuchu city



Evaluating scenarios from view points of urban infrastructure development and maintenance

### Ex. Elementary school

Development costs (yen) = maintenance floor area (m<sup>2</sup>) × 188,093(yen/m<sup>2</sup>)

Maintenance costs (yen) =  $\sum_{i=1}^n K_i$  (yen) + L<sub>i</sub> (yen)

K<sub>i</sub> : Service costs of all elementary school in the scenario

L<sub>i</sub> : labor costs of all elementary school in the scenario

# Scenario evaluation

## CO<sub>2</sub> emissions

Cars



Urban facilities



Houses



These infrastructures are considered to be affected by urban structure change



# Scenario evaluation

## CO<sub>2</sub> emissions from cars

CO<sub>2</sub> emission from cars used by inhabitants in Fuchu and surrounding area are examined by person trips survey.

### Method

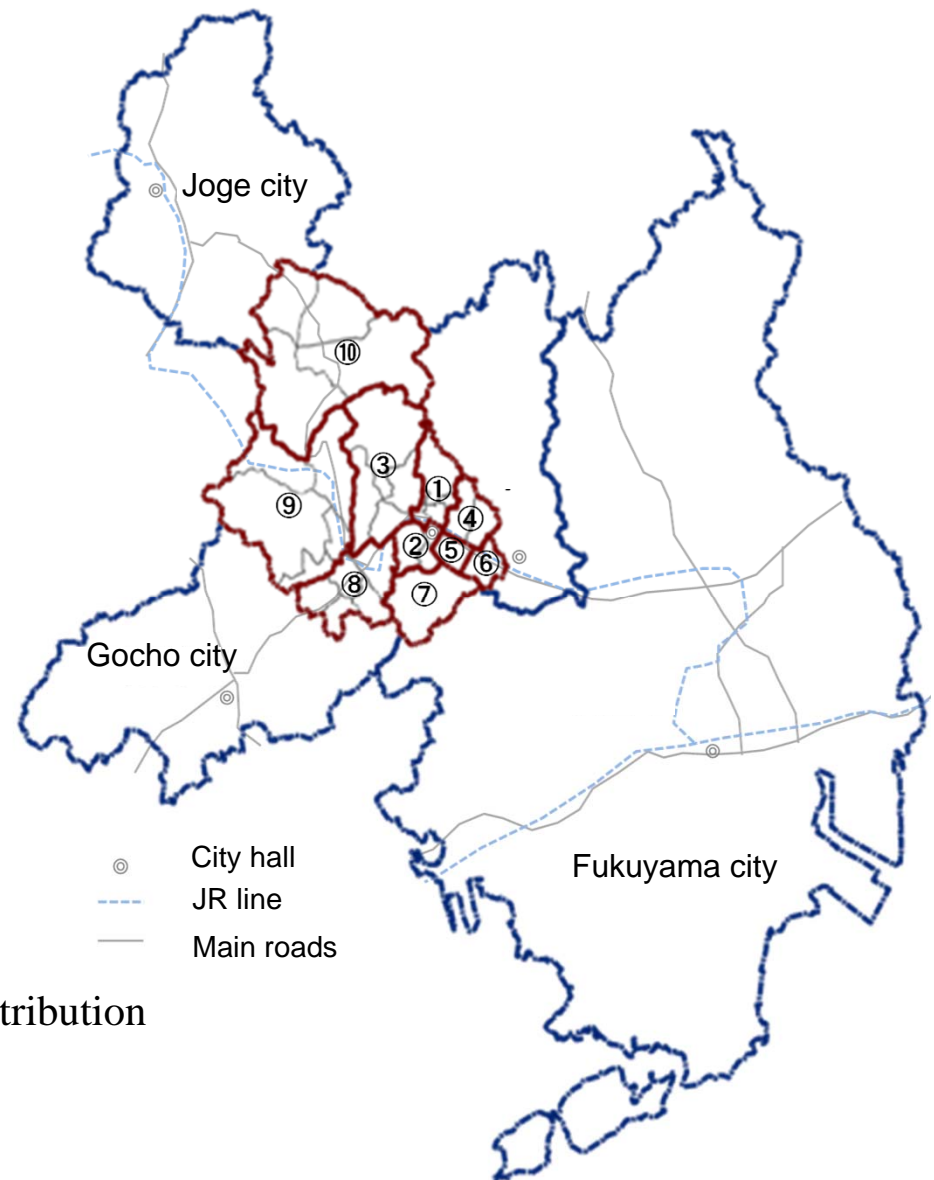
CO<sub>2</sub> emissions are calculated by multiplying the number of moving cars among each area by their movement distances and CO<sub>2</sub> emissions per units of distances.

$$L = \sum T_{od} \times K_{od} \times M_v$$

L: CO<sub>2</sub> emissions (t-CO<sub>2</sub>)     $T_{od}$ : traffic density distribution

$K_{od}$ : distance between with each area (km)

$M_v$ : unit of CO<sub>2</sub> emission from cars types



# Scenario evaluation

## CO<sub>2</sub> emissions from facilities

CO<sub>2</sub> emissions are calculated by multiplying amounts or costs of development and maintenance by actual data in Fuchu city or unit of CO<sub>2</sub> emission extracted from reference.

### Ex. Elementary school

- CO<sub>2</sub> emission from development

$$\text{development cost} \times \frac{3.649[\text{kg-CO}_2/\text{thousands yen}]}{\text{unit of CO}_2 \text{ emissions per development costs based on the value of reference}}$$

- CO<sub>2</sub> emission from maintenance

$$\text{number of class} \times \frac{12.31[\text{t-CO}_2/\text{class}]}{\text{unit of CO}_2 \text{ emissions calculated by usage of electric power, gas and oil amount in elementary school}}$$

# Scenario evaluation

## CO<sub>2</sub> emissions from houses

CO<sub>2</sub> emissions from air-conditioner, CO<sub>2</sub> emissions from construction, repair, renewal and scrap and CO<sub>2</sub> emissions from using common area in apartment are calculated for each scenario.

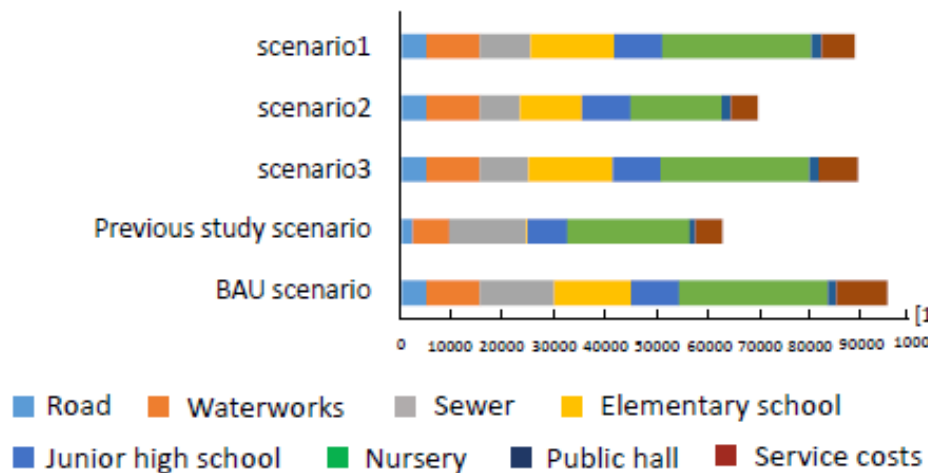
### Method

CO<sub>2</sub> emissions from houses are calculated by the number of detached house and apartments by each unit of CO<sub>2</sub> emissions.

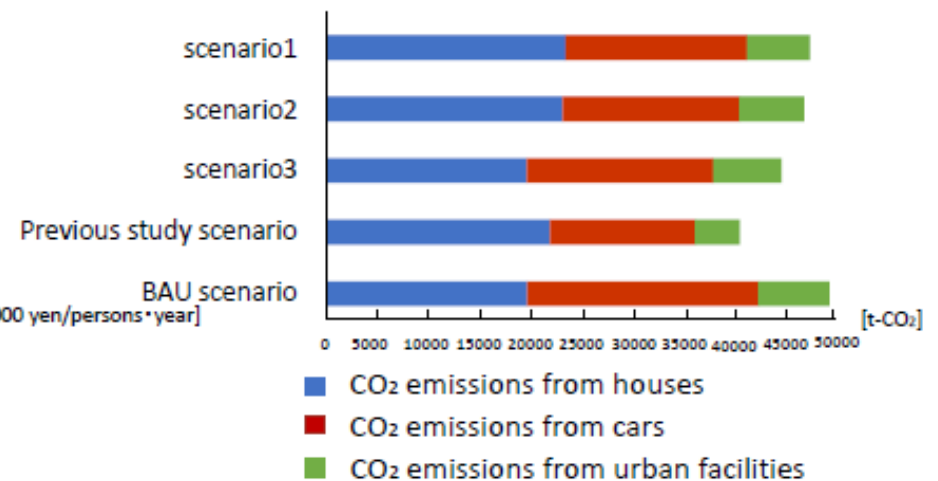
	Detached house	apartment
Air-conditioner	The number of building × 0.65 [t-CO <sub>2</sub> /building]	The number of building × 10.92 [t-CO <sub>2</sub> /building]
Construction	The number of building × 1.12 [t-CO <sub>2</sub> /building]	The number of building × 42.68 [t-CO <sub>2</sub> /building]
Repair/Renewal	The number of building × 0.23 [t-CO <sub>2</sub> /building]	The number of building × 16.65 [t-CO <sub>2</sub> /building]
Scrap	The number of building × 0.15 [t-CO <sub>2</sub> /building]	The number of building × 10.78 [t-CO <sub>2</sub> /building]
Common area	—	The number of building × 14.10 [t-CO <sub>2</sub> /building]

# Scenario evaluation

## Results



Annual infrastructure maintenance costs per person



Annual CO2 emissions

## conclusion

All three scenarios are more efficient in both CO<sub>2</sub> emissions and infrastructure maintenance costs than BAU scenario. It can be said that the scenario based on the inhabitant's intention may also have effects.