



Analysis of commuters unable to get home and traffic congestion at large-scale disaster in Nagoya metropolitan area

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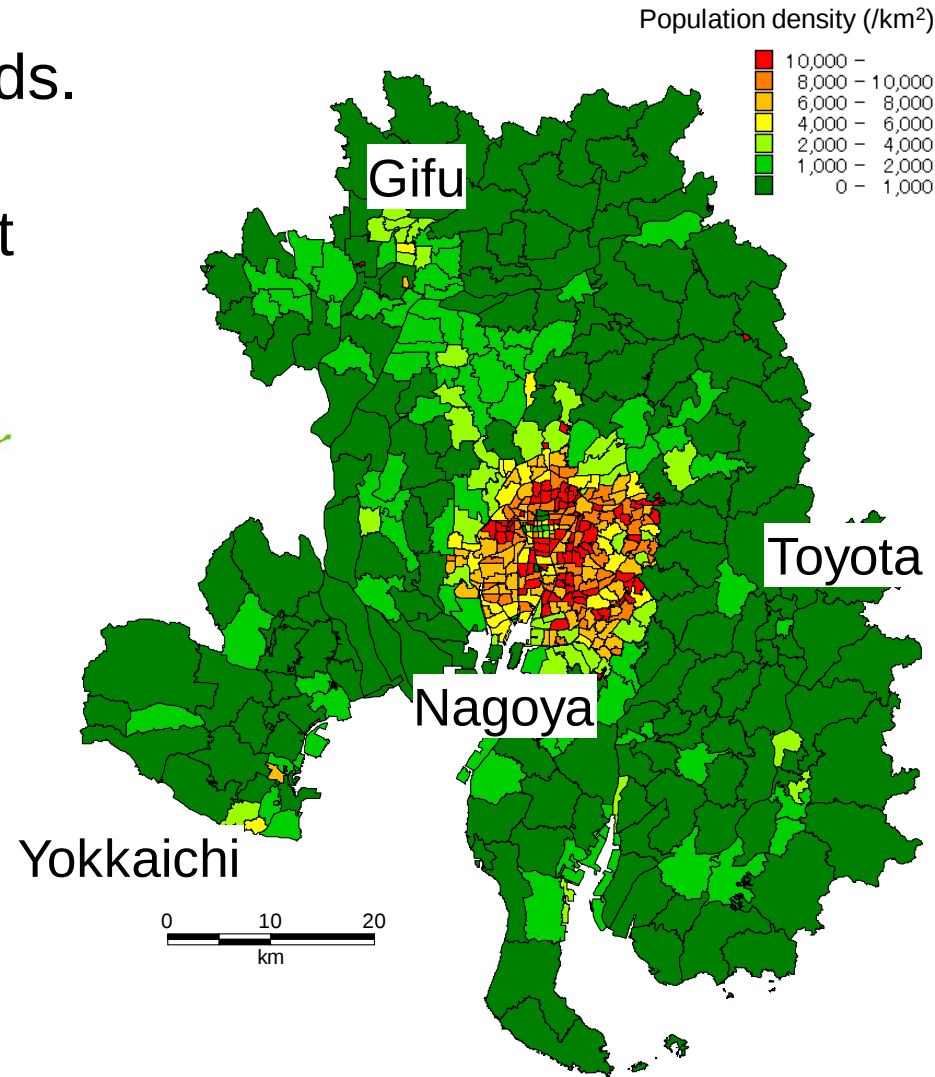
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1. Background

Japan has experienced many earthquakes, typhoons and floods.

Big earthquakes periodically hit Nagoya metropolitan area

- M7.9 in 1605
- M8.6 in 1707
- M8.4 in 1854
- M7.9 in 1944



Next one is anticipated in 30 years with 88% probability

1. Background

The Great East Japan Earthquake occurred on March 11, 2011.

In Tokyo Metropolitan area,

- Over 5 million peoples were unable to get home
- More than 80% started going home
- 24% drove home



Traffic jam on March 11, 2011
in Tokyo Metropolitan area

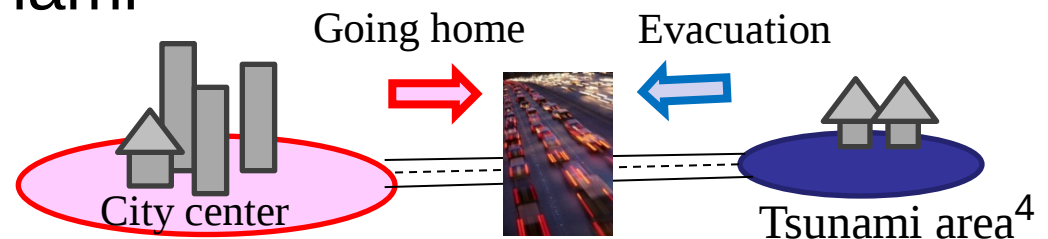
2. Objectives

Size of refugees unable to get home and traffic congestion are estimated, and the effects of information services are evaluated for the next earthquake at Nagoya Met.

– Current situation, family safety

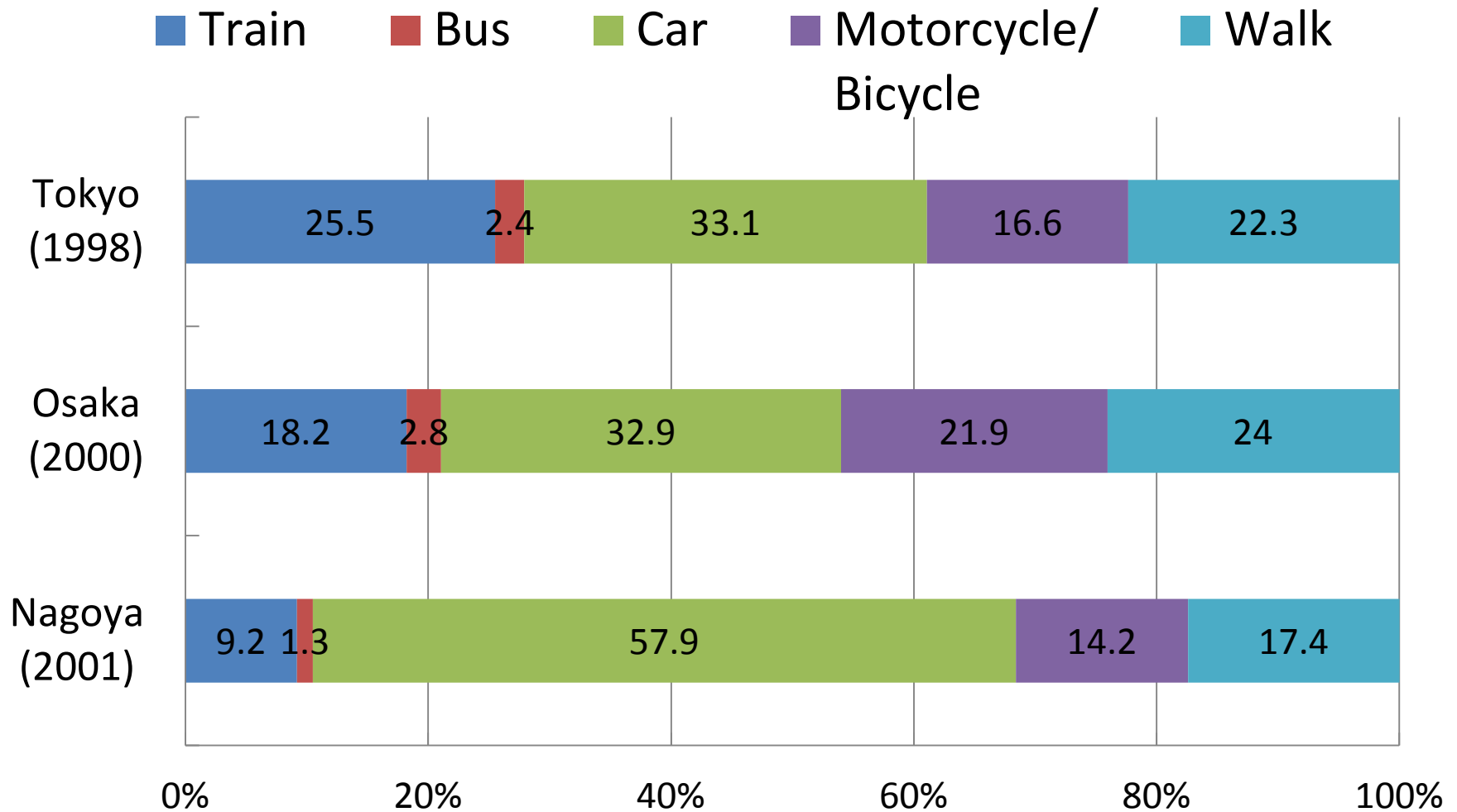
Key points:

- Car demand resulting from higher share in daily trips
- Confusion between going home and evacuation from anticipated Tsunami



- Ordinal telephone network got busy and unreliable at the disaster
- Reliable information service at the disaster
 - Specially designed for emergency period to leave and retrieve a message to/from family member at the designated phone number

Mode share at 3 largest metropolitan areas in Japan



3. Research flow



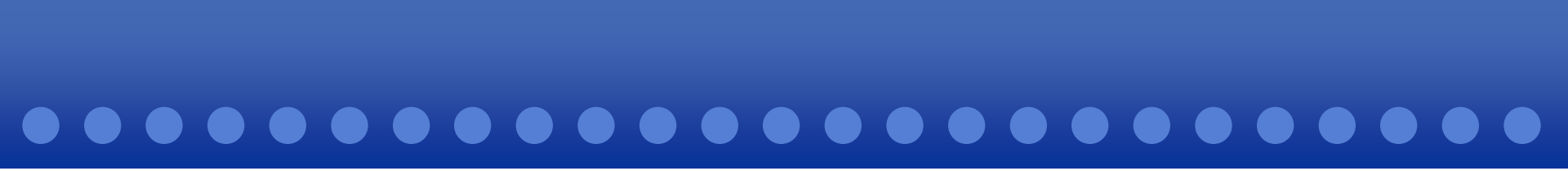
Mode choice analysis at the Great East Japan Earthquake

- Development of mode choice model considering the effects of information services
- Demand for going home trips is estimated at Nagoya metropolitan area



Meso-scope traffic simulation of going home trips

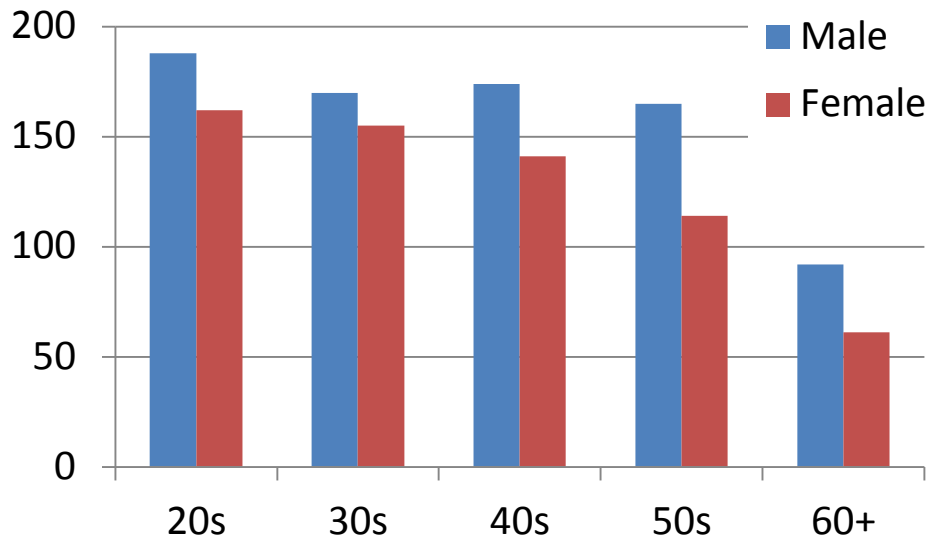
- Stochastic/deterministic route choice behavior with/without real-time traffic information
- Degraded road network and evacuation from Tsunami are considered



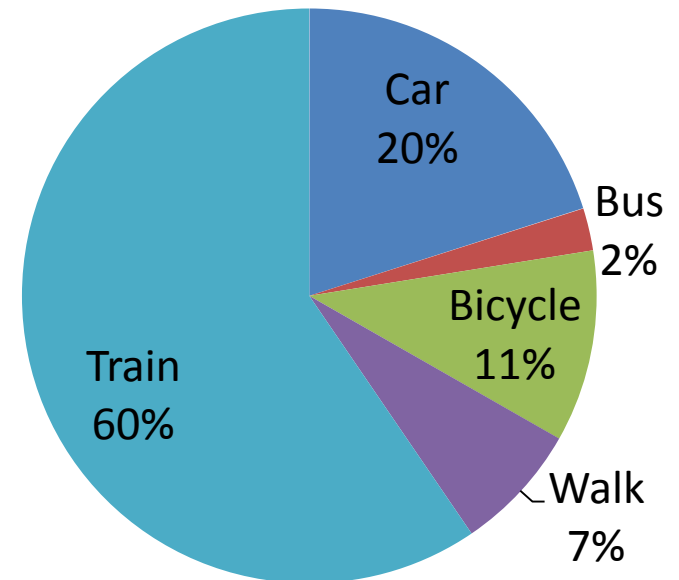
Mode choice analysis at the Great East Japan Earthquake

4. internet survey on the Great East Japan Earthquake

- Investigators: Univ. of Tokyo, Toyo Univ. and Survey Research Center
- Survey period: 2011/03/25 to 03/28
- Survey area: Tokyo Metropolitan (Tokyo, Kanagawa, Saitama & Chiba)
- Respondents: 20+ yrs. old who were away from home at the Quake
- Method: internet survey with panels
- Sample size: 1,915 out of 2,026 responses
- Questionnaires: Going home behavior & information access at the Quake



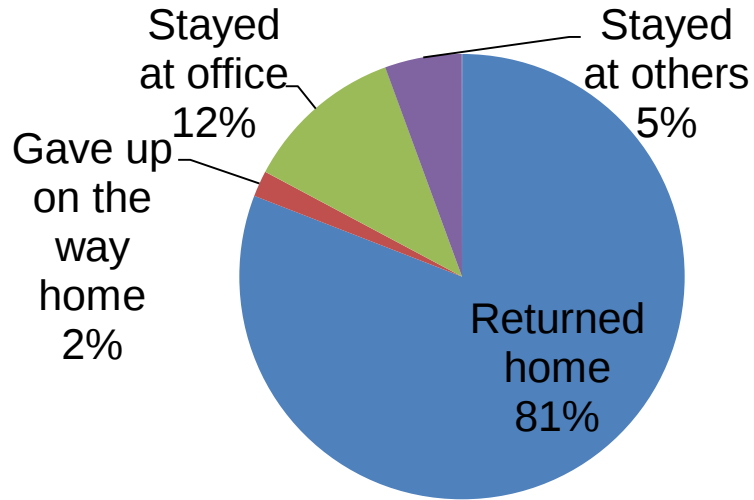
Age distribution by gender



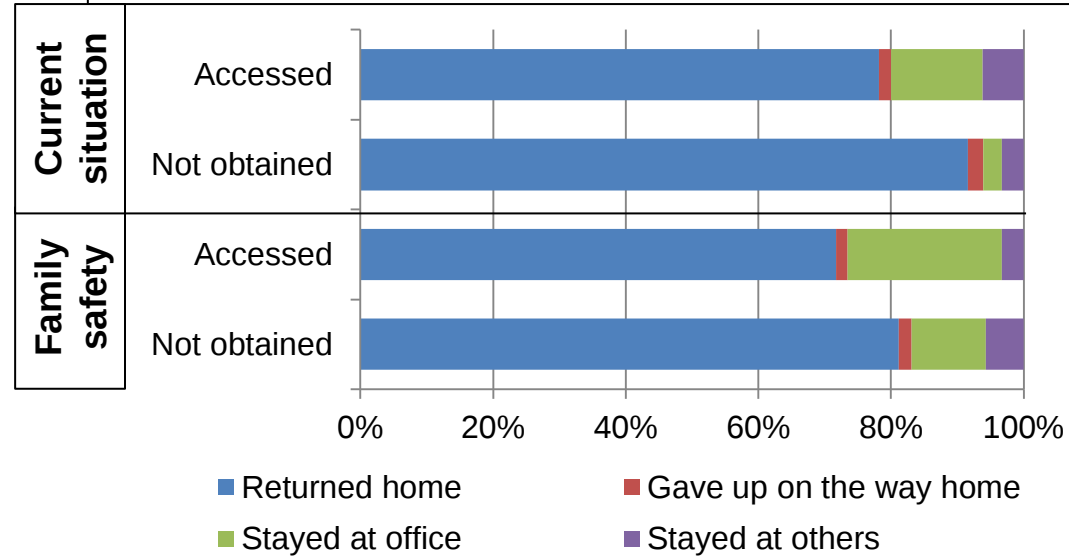
Daily commute mode

5. Survey results

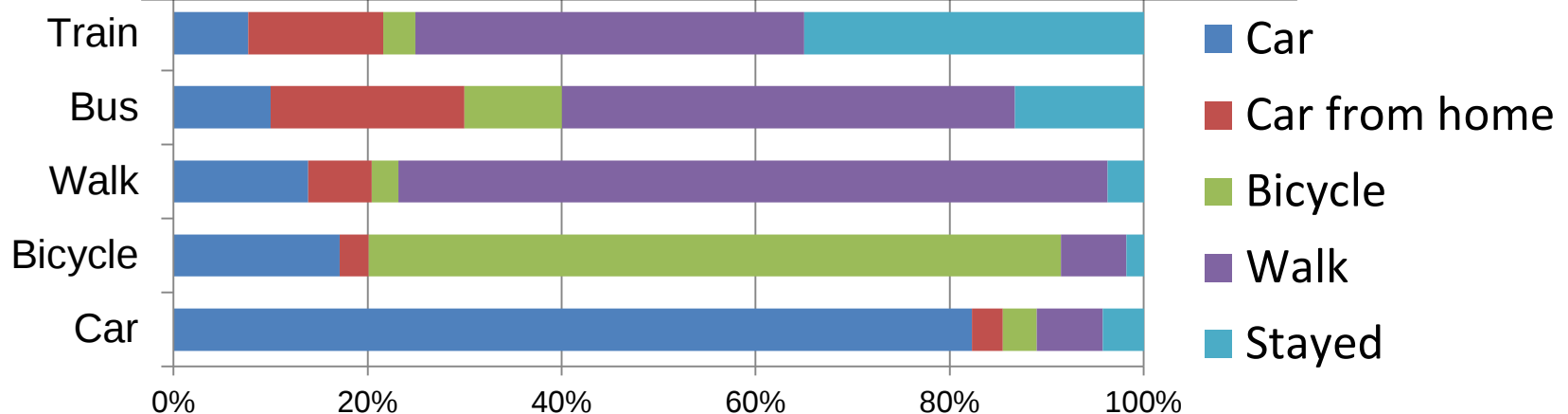
Going home behavior



Going home behavior by info. access



Going home behavior by daily commute mode



6. Mode choice model of going home

- Car and bicycle availability is considered for commuters, but no information for non-commuters
- Train and bus are excluded from the alternatives

MNL for commuters

- Car (available only for car commuter)
- Car from home
- Bicycle (available only for bicycle commuter)
- Walk
- Stayed (not going home)

MNL for non-commuters

- Car from home
- Walk
- Stayed (not going home)

Captive use if available

- Car
- Bicycle

7. Estimation results of mode choice model

MNL for commuters

	Alternative	Coef
Constant	Car	7.18**
Constant	From home	7.66**
Constant	Bicycle	7.88**
Constant	Walk	6.26**
Male	From home	-0.742**
Full-time worker	From home	-0.536**
Ln(Distance to home)	Walk	-0.909**
Ln(Distance to home)	Stayed	1.31**
Train commuter	Walk	1.46**
Ln(Age)	From home	-0.787**
Access to current situation	Stayed	1.14**
Access to family safety	Stayed	0.917*
Sample size		1318
Adjusted rho-squared		0.407

MNL for non-commuters

	Alternative	Coef
Constant	From home	10.19**
Constant	Walk	4.69**
Male	Stayed	-1.39
Ln(Distance to home)	From home	-0.864**
Ln(Distance to home)	Stayed	1.20**
Ln(Age)	From home	-2.14**
Access to current situation	Stayed	1.82*
Sample size		172
Adjusted rho-squared		0.488

Access to information encourages to stay (avoid going home)

8. Estimation of going home behavior at Nagoya met.

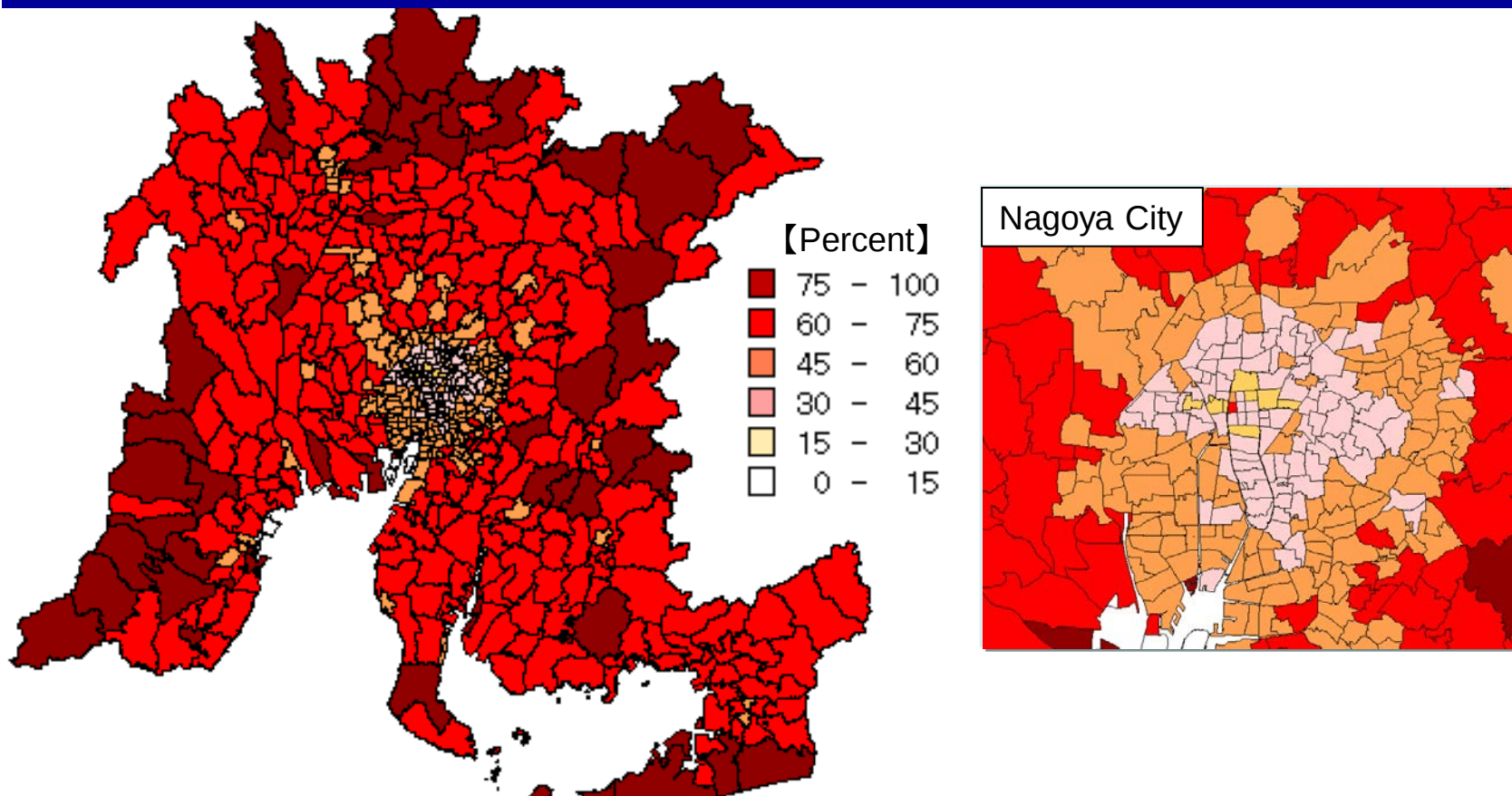


- 5.96M people away from home at noon in Nagoya metropolitan area
- Effects of information access are estimated

Family safety	Current situation	Car	Car from home	Bicycle	Walk	Stayed
Not obtained	Not obtained	2,973,000	855,000	598,000	1,436,000	252,000
Accessed	Not obtained	2,908,000	794,000	595,000	1,349,000	466,000
Not obtained	Accessed	2,883,000	768,000	594,000	1,298,000	569,000
Accessed	Accessed	2,723,000	678,000	587,000	1,169,000	955,000

8. Estimation of going home behavior at Nagoya met.

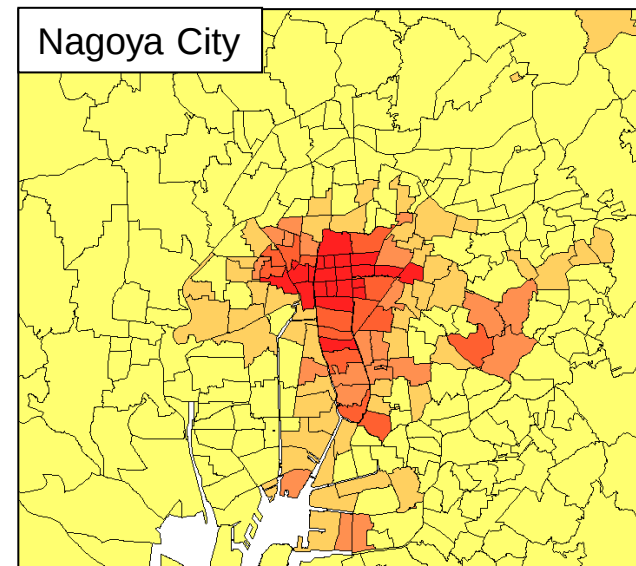
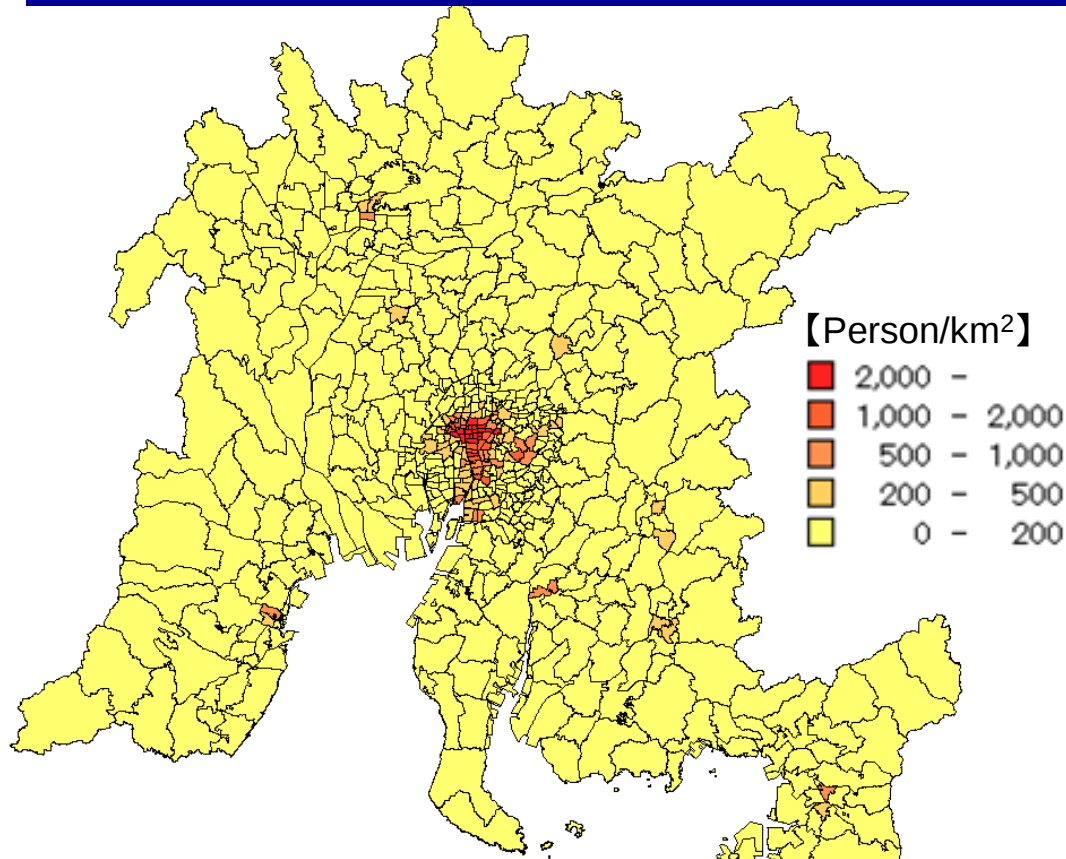
Mode share of car & car from home w/o information access by home zone



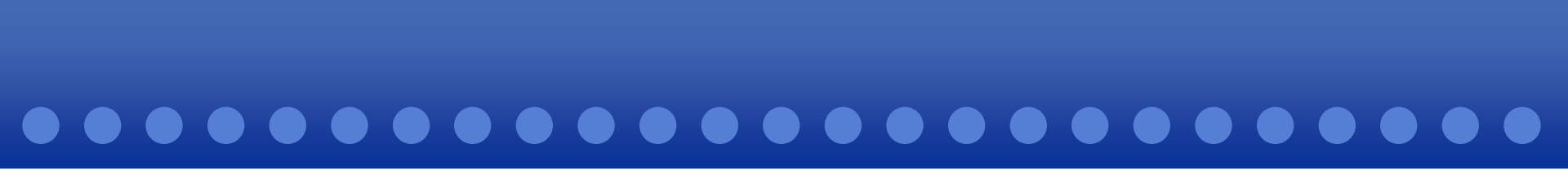
Less than 30% in Nagoya City and more car trips to suburbs

8. Estimation of going home behavior at Nagoya met.

Stayers density w/o information access by staying zone



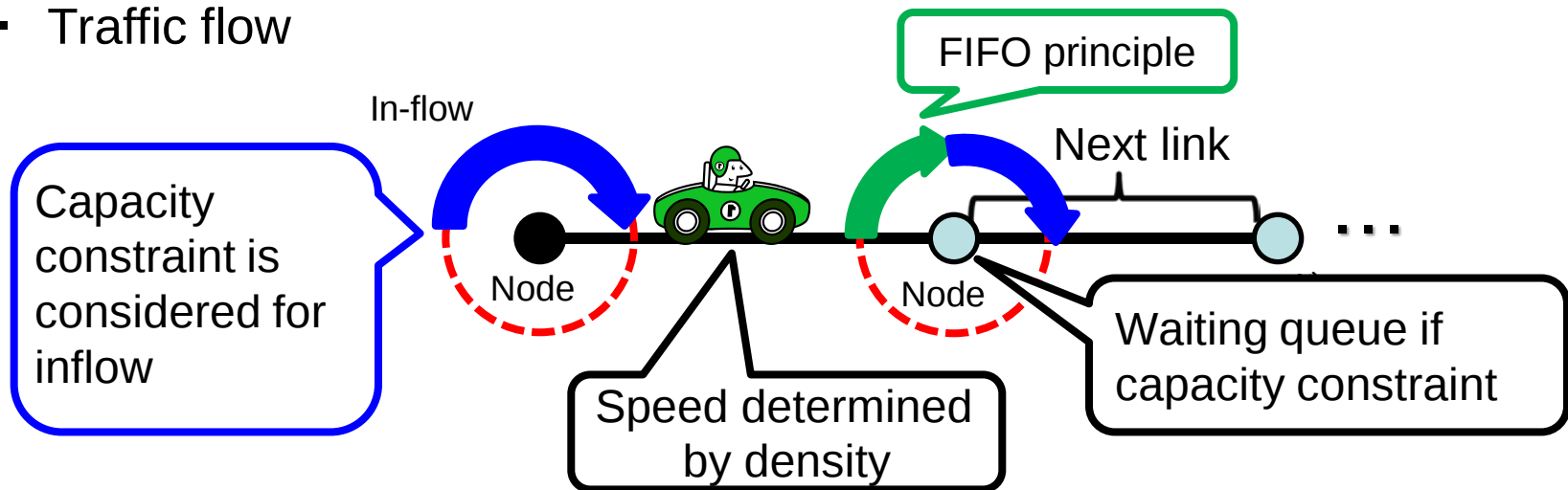
More than 2,000 persons/km² at CBD



Meso-scope traffic simulation of going home trips

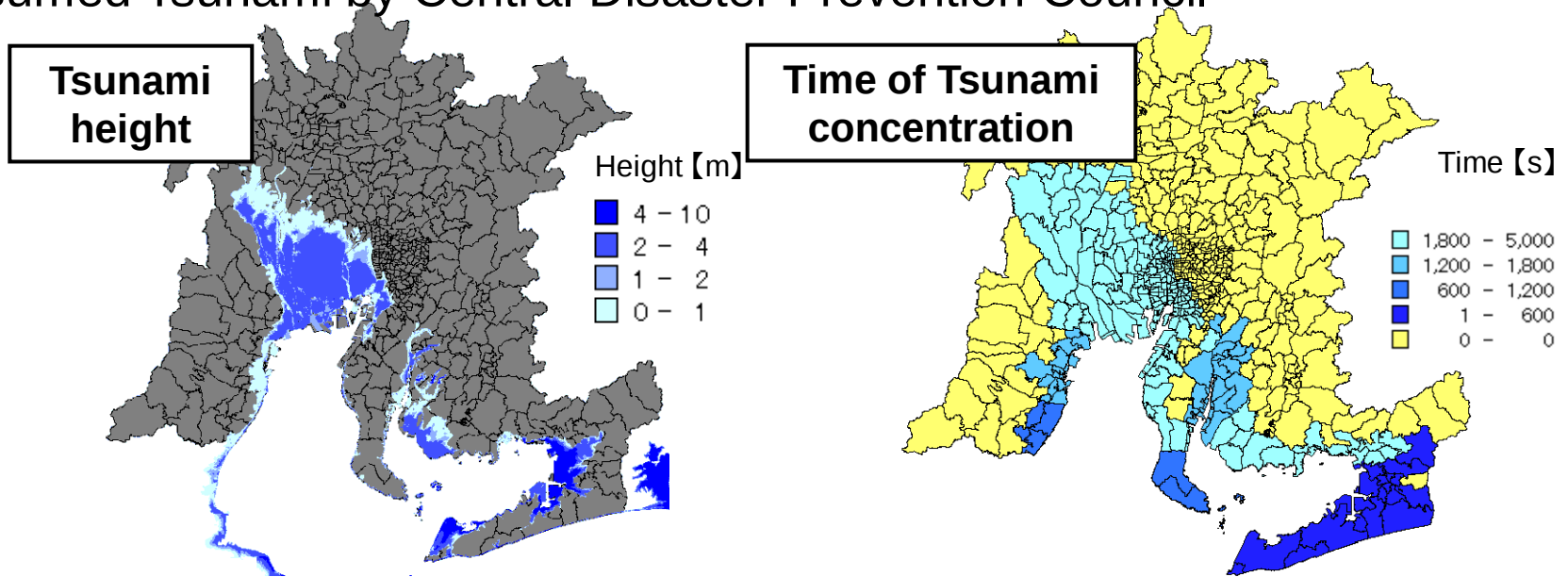
9. Traffic simulation of going home trips

- Assumed earthquake: Occurred at noon in weekday
- Timing of trip: Going home at once after the quake
Evacuation from Tsunami at 5 min. after the quake
- Degraded road network: One lane closure for multiple lane roads
Decreased capacity for one lane roads
Unable to use expressways
- Traffic flow



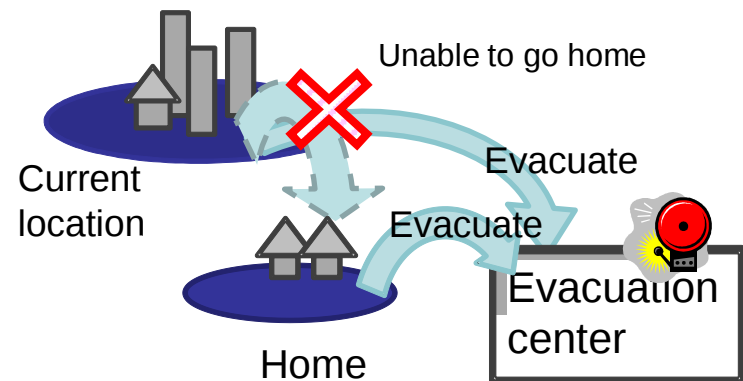
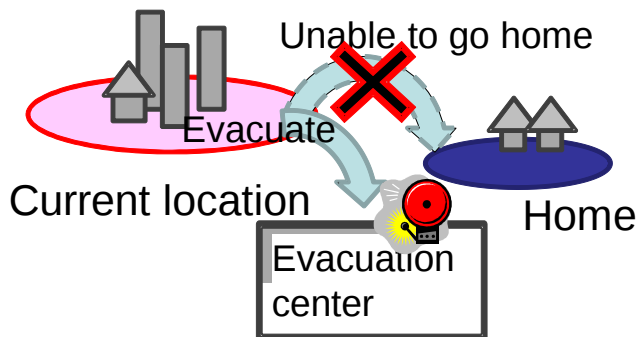
9. Traffic simulation of going home trips

Assumed Tsunami by Central Disaster Prevention Council



【Evacuees】 At home: 1.2M, Away from home: 1.4M

Assumed behavior related Tsunami



9. Traffic simulation of going home trips

- Base case
 - Stochastic route choice under current situation
 - No information access
- Normalcy bias case (false recognition)
 - Stochastic route choice under ordinary situation (false recognition)
- Real-time traffic information case
 - Shortest path choice under current situation
- Information access case
 - Reduced trips by information access

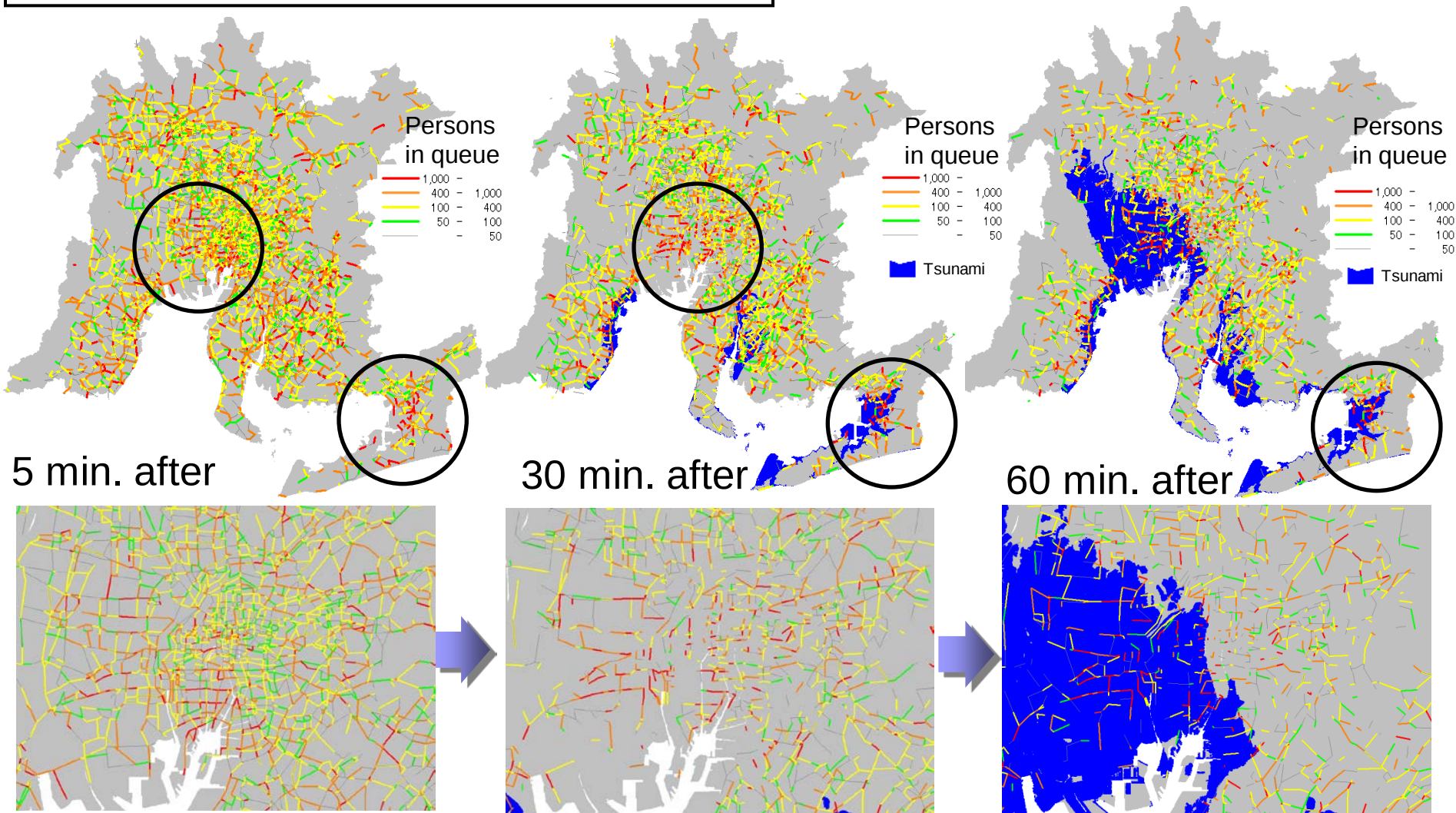
10. Results of simulation

	Base case	Normalcy bias	Real-time traffic info.
Returned home after 4 hrs.	2,371,000 (74%)	2,232,000 (70%)	2,536,000 (79%)
Unable to evacuate before Tsunami concentration	438,000	426,000	210,000

	No degraded network	Evacuation delay by 30 min.	Info. access
Returned home after 4 hrs.	2,502,000 (78%)	2,409,000 (75%)	2,230,000 (78%)
Unable to evacuate before Tsunami concentration	395,000	514,000	382,000

10. Results of simulation

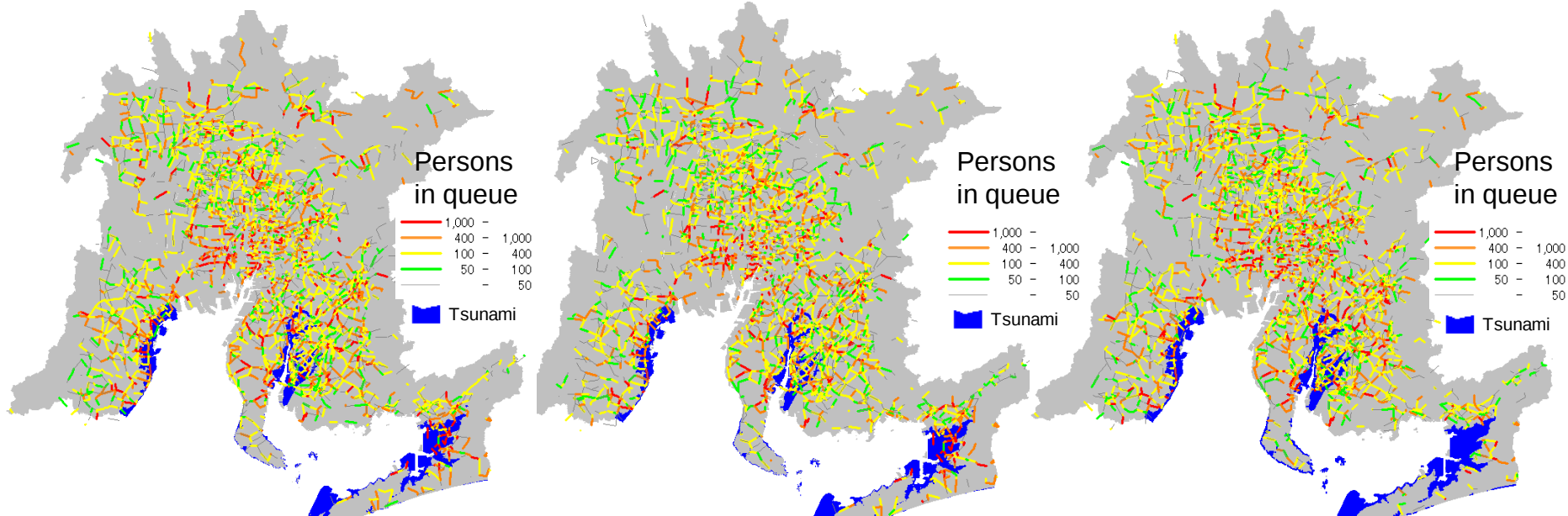
Waiting queues at base case



Confusion between going home and evacuation

10. Results of simulation

Traffic congestions after 30 min.



Base case

Information access case

Real-time traffic information



Reduced congestions by information access and real-time traffic information

11. Conclusions

Findings

- ❑ 0.7M peoples can be reduced from going home trips by information services on current situation and family safety
- ❑ Reduced demand by information services increases the number of people able to evacuate before Tsunami concentration by 50,000
- ❑ Real-time traffic info. helps faster returning home and evacuees from Tsunami

Future research topics

- ❑ Consideration of buildings height for realistic evacuation scenario
- ❑ Congestion of pedestrian traffic
- ❑ Psychological aspects of behavior: dependency to others and group behavior