Effects of information provision on going home behavior and traffic congestion at large-scale disaster: case study of Nagoya Metropolitan area

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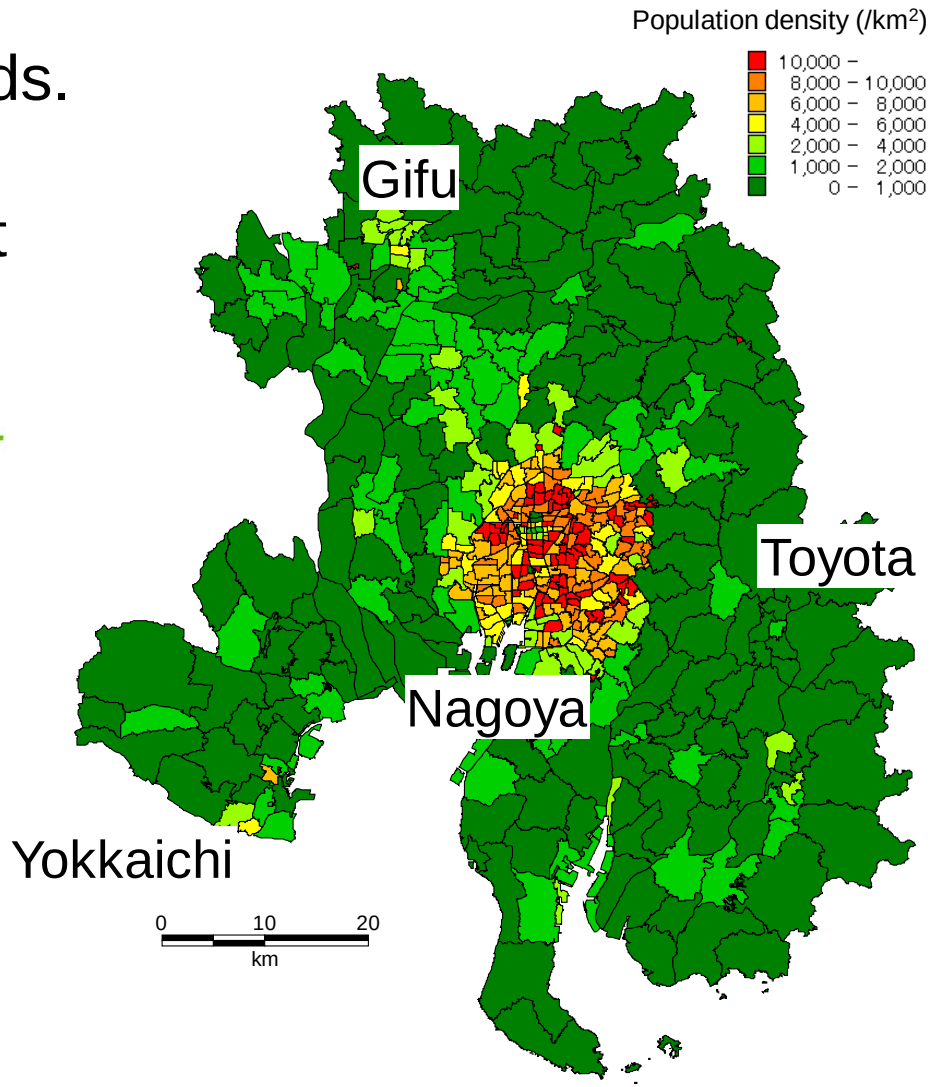
1. Background

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

Information services

- Ordinal telephone network became 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

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

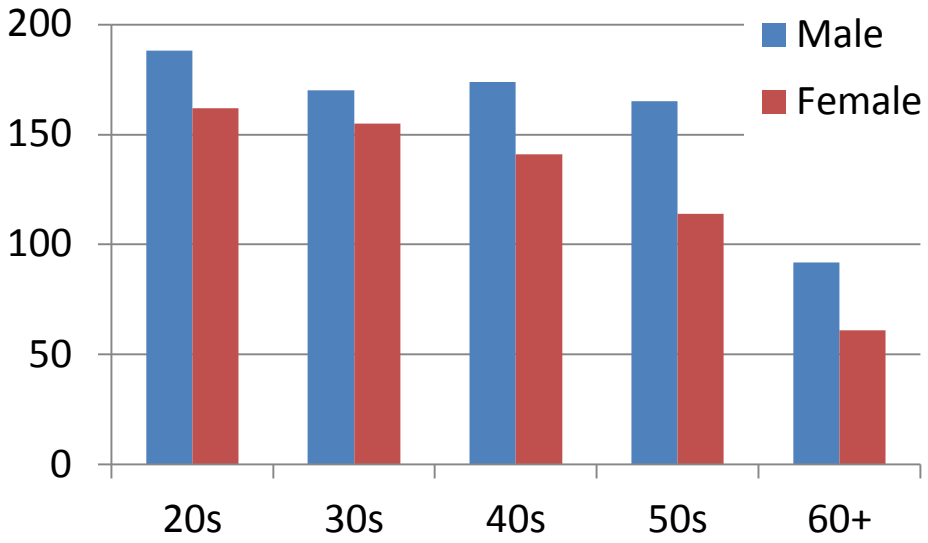
Meso-scopic traffic simulation of going home trips

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

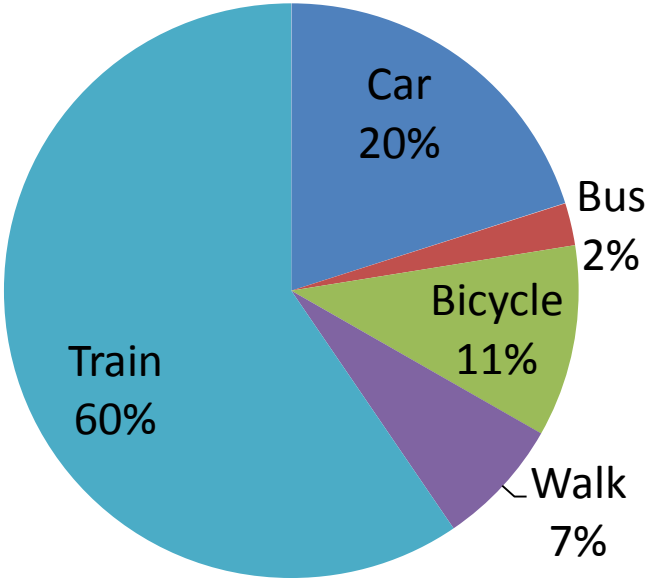
Mode choice analysis at the Great East Japan Earthquake

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



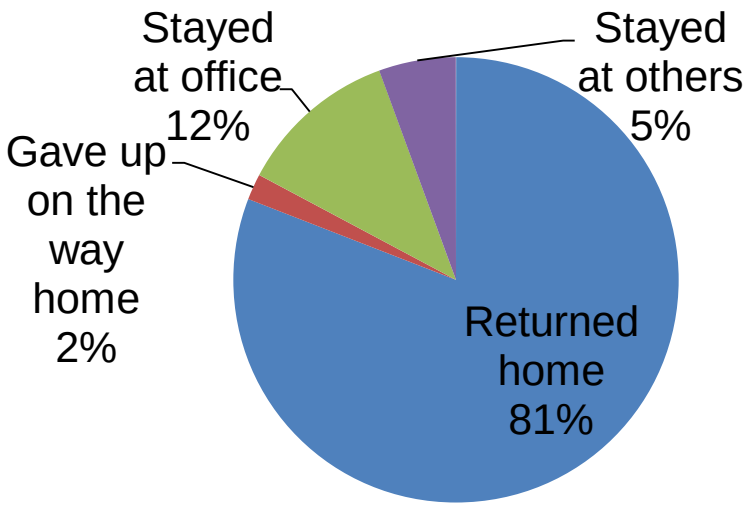
Age distribution by gender



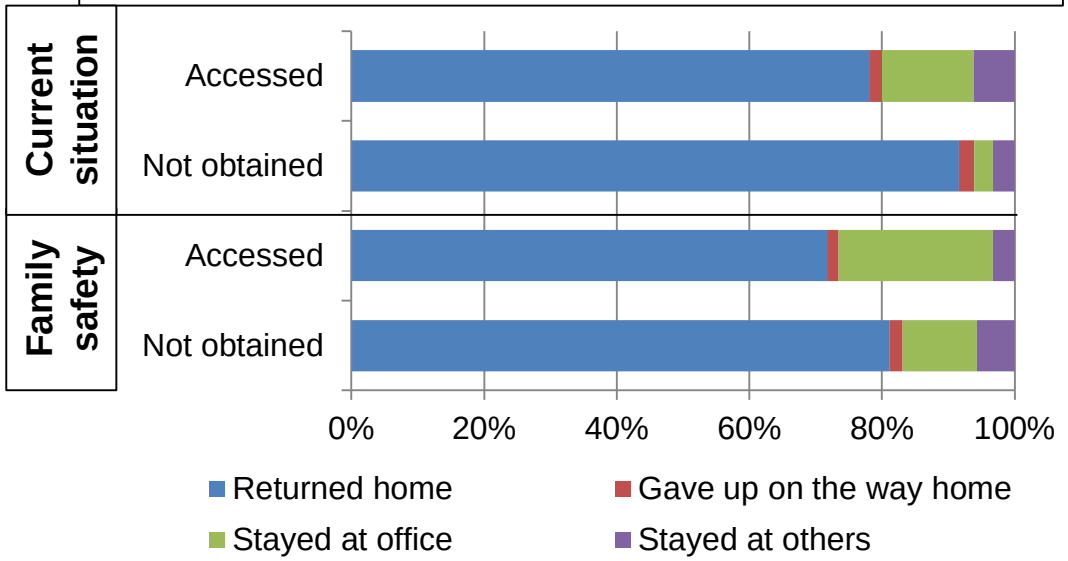
Daily commute mode

5. Survey results

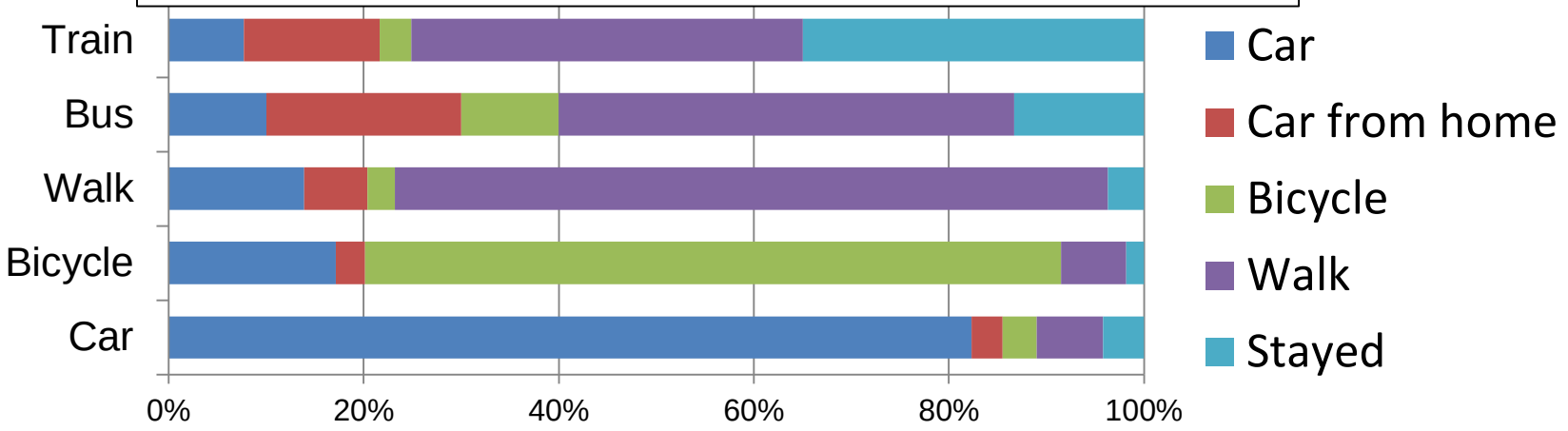
Going home behavior



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

Choice set

	Car	Car from home	Bicycle	Walk	Stayed
Car commuter	○	○	×	○	○
Bicycle commuter	×	○	○	○	○
Other commuter	×	○	×	○	○
Non-commuter*	×	○	×	○	○

*Non-commuter visiting by car or bicycle is assumed as captive

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.

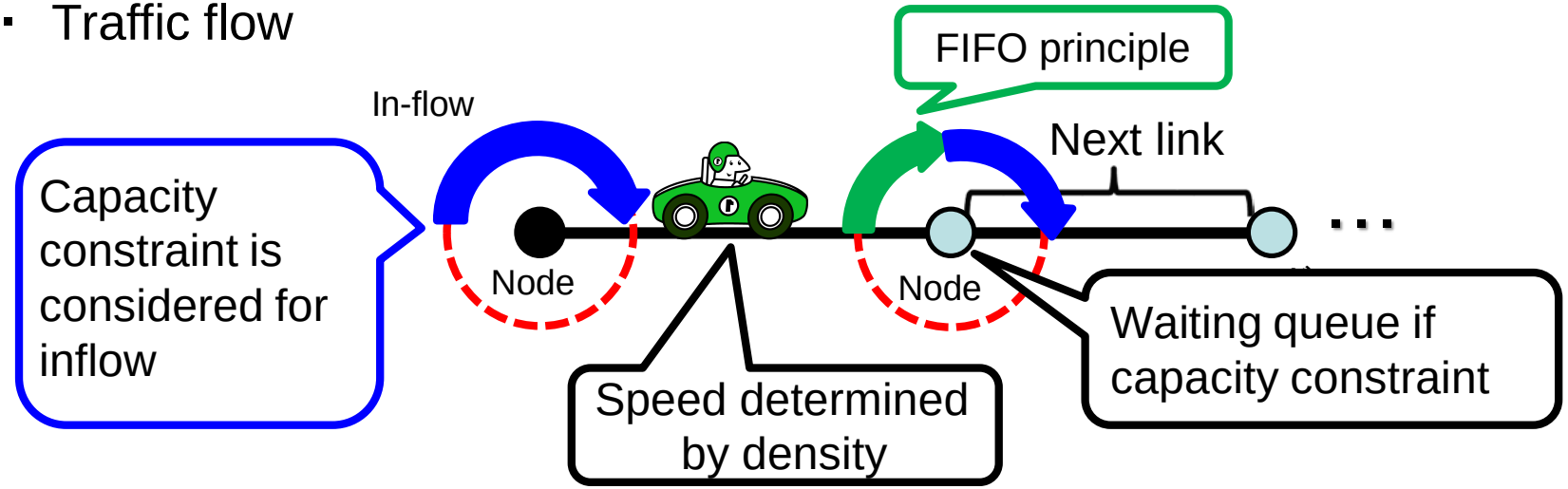
- 5.96M people away from home at noon in Nagoya metropolitan area
- Effects of information access are estimated

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

Meso-scopic traffic simulation of going home trips

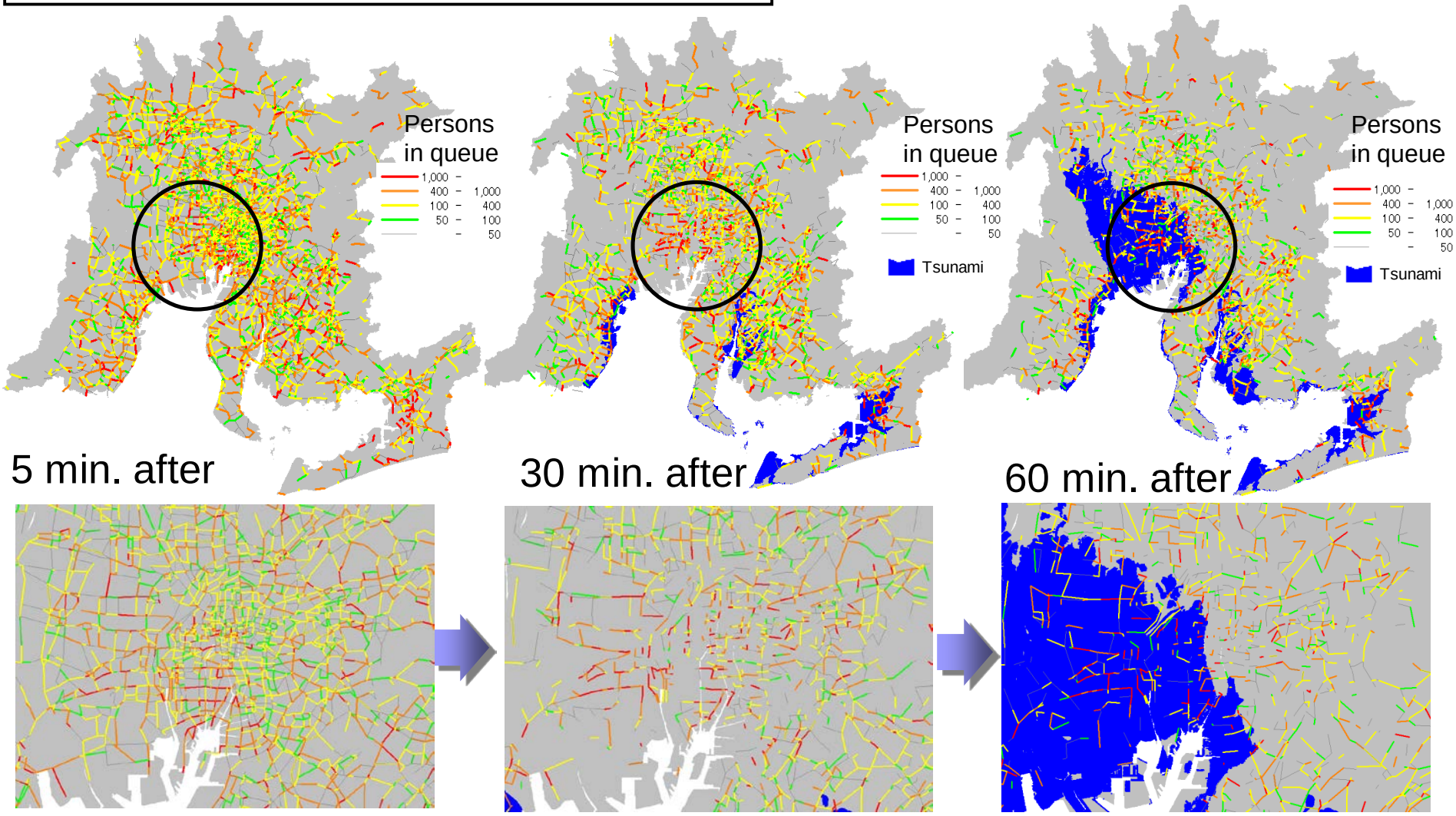
9. Traffic simulation of going home trips

- 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



10. Results of simulation

Waiting queues at base case



Confusion between going home and evacuation

10. Results of simulation

- Base case
  - Stochastic route choice under current situation
  - No information access
- Information access case
  - Reduced trips by information access

	Base case	Info. access
Returned home in 4 hrs.	2,371,000 (74%)	2,230,000 (78%)
Unable to evacuate before Tsunami concentration	438,000	382,000

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

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