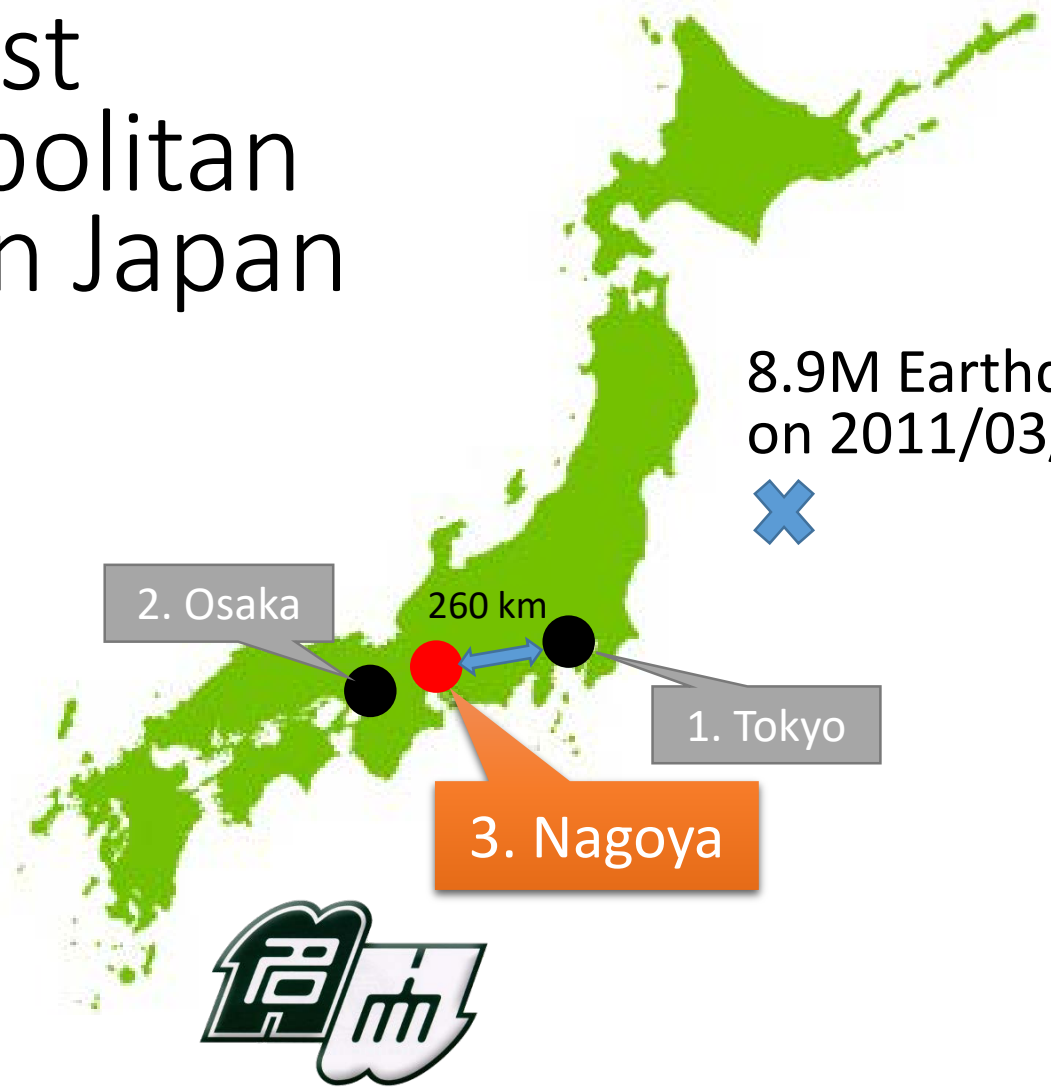
# Unhappy relationship between water and road traffic

## Effects of rainfall and inundation on road traffic

Toshiyuki Yamamoto, Nagoya University

# 3 largest metropolitan areas in Japan


Toshiyuki Yamamoto, Nagoya University

# Outline

- Introduction
- Effect of rainfall on traffic speed: recurrent case
- Effect of inundation by tsunami on road congestion and drownings: non-recurrent case
- On-going research on economic loss by urban flood

# น้ำท่วมระดับไหน ไม่ควรขับลุย

## 5-10 ซม.

ไม่อันตราย
ผ่านได้ทุกคัน

## 10-20 ซม.

ยังปลอดภัย แต่อาจได้ยิน
เสียงน้ำใต้ท้องรถและมีคลื่น
บ้างเวลาขับสวนกัน

## 20-40 ซม.

เริ่มเสี่ยงสำหรับอีโค่คาร์
แต่รถกระบะยังผ่านได้

## 40-60 ซม.

รถเก๋งต้องเลี่ยง
รถกระบะเริ่มเสี่ยง
ควรปิดแอร์ขณะขับ

## 60-80 ซม.

อันตรายต่อรถทุกประเภท
ไม่ชำนาญห้ามลุยเด็ดขาด

## เกิน 80 ซม.

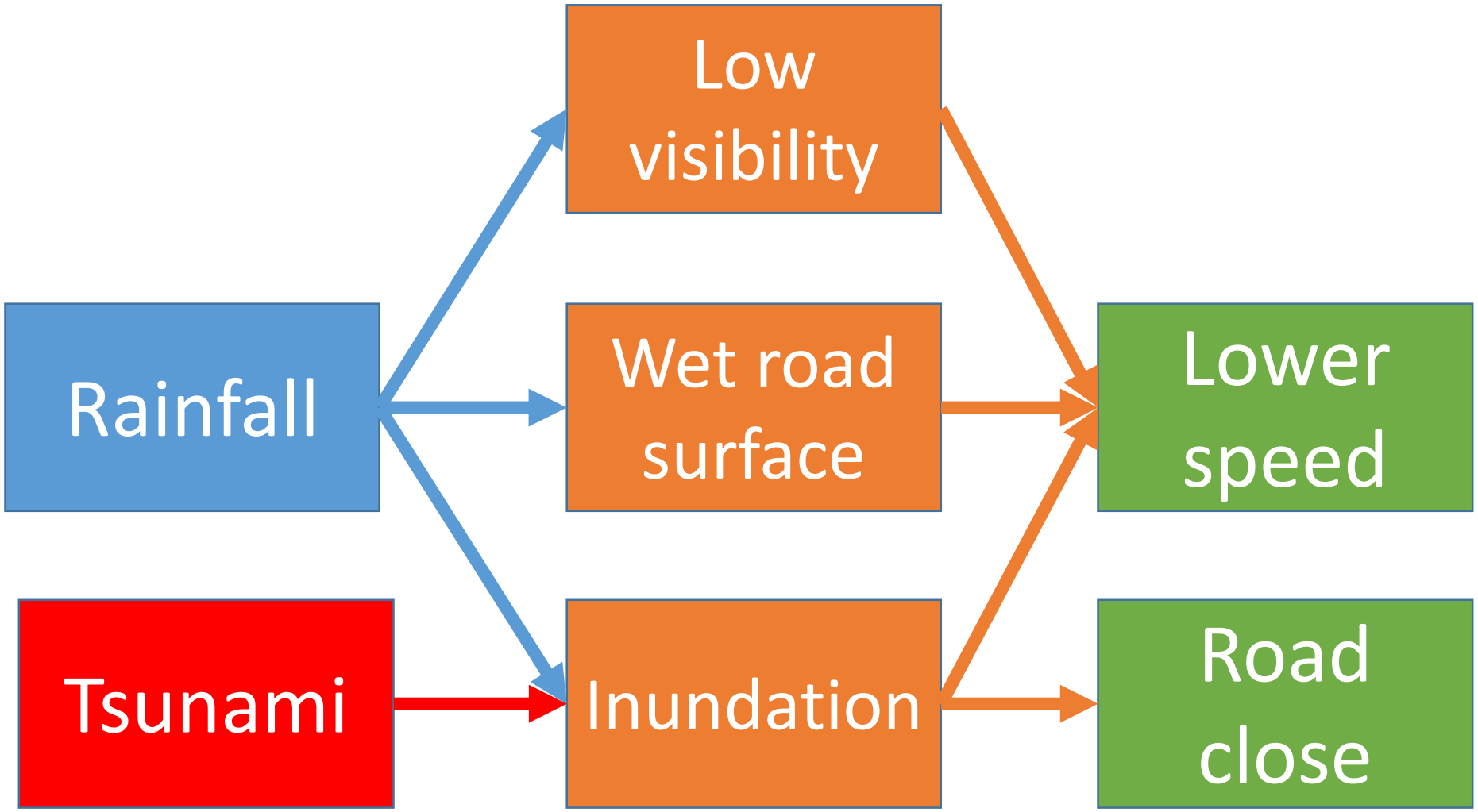
ระดับน้ำสูงสุดเท่าที่รถ
จากโรงงานจะผ่านได้

Source: yellowpages.co.th

# Car surfing on the road in Japan


Source: https://www.youtube.com/watch?v=lGvyK4Louso

# Effects of water on road traffic



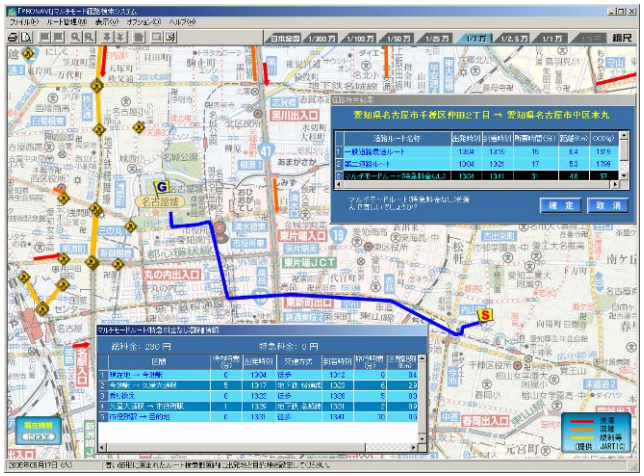
# Effect of rainfall on traffic speed

Wang, L., Yamamoto, T., Miwa, T. and Morikawa, T. (2006): An analysis of effects of rainfall on travel speed at signalized surface road network based on probe vehicle data, Proceedings of ICTTS 2006, Edited by Mao, B., Tian, Z., Gao, Z. and Huang, H., pp. 615-624.

# P-DRGS (Probe-based dynamic route guidance system) project

Probe data collection

Calculation of traffic condition



Traffic information provision

## Probe vehicle:

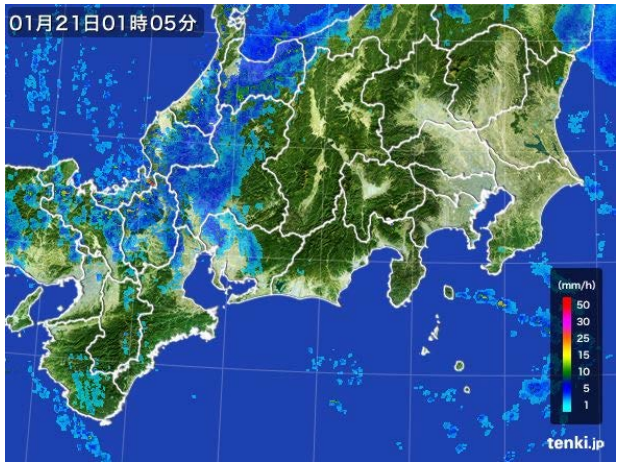
- vehicle with GPS as moving sensor

## Information provision:

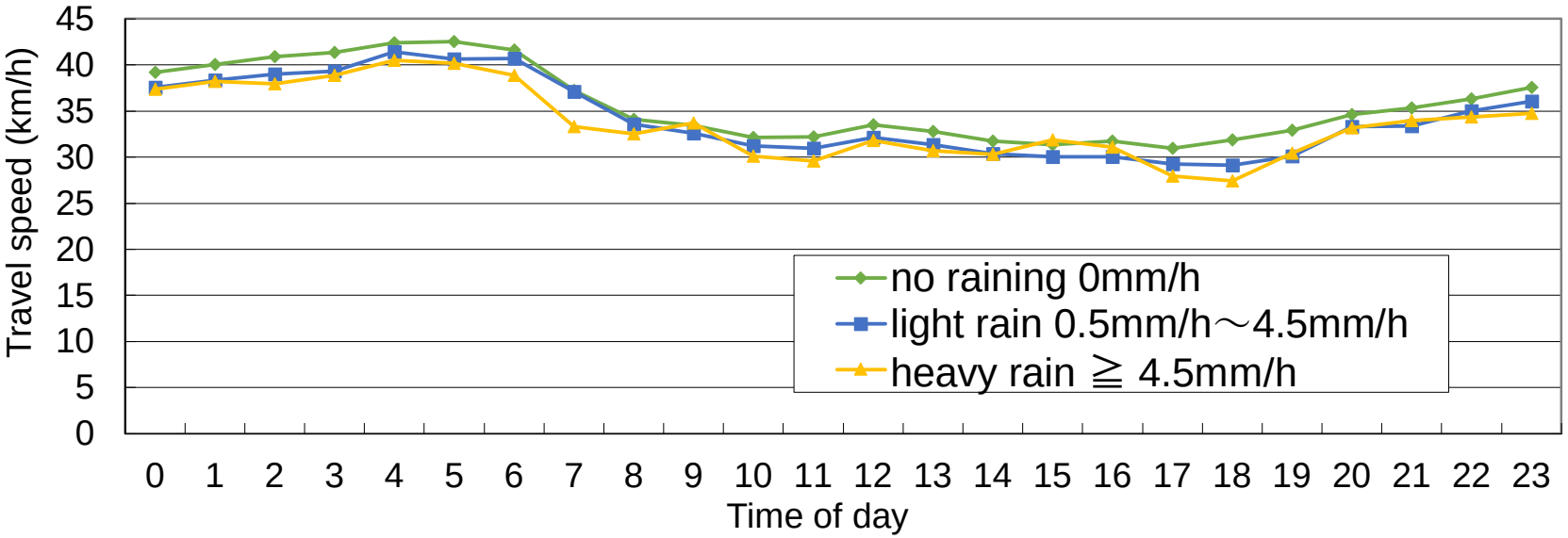
- Personalized multi-mode route guidance
- Real-time traffic management

# Traffic speed by weather condition

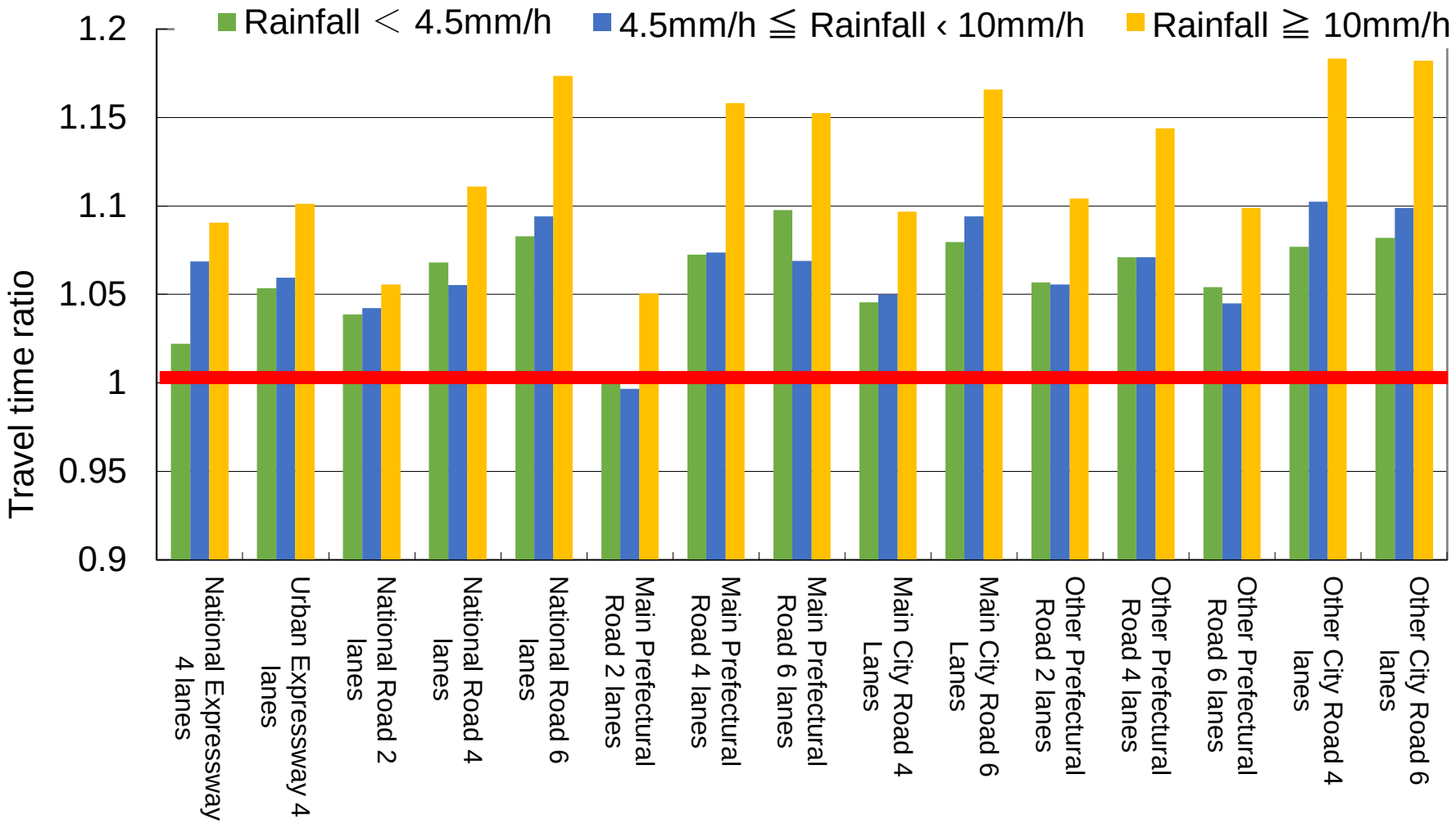
Probe data collection




Precipitation data



# Travel time ratio compared with no rain condition by road type



# Economic loss by travel time increase

- 14,139,000 car trips per day in Nagoya metropolitan area
- 24.5 minutes of average travel time per trip
- 9% increase of average travel time by rainfall
- 2400 JPY/hour (20 USD) of value of travel time saving (MLIT, 2009)

## 1.247 billion JPY (10M USD)?!

# Effect of inundation by tsunami on road congestion and drownings

Partly supported by Grant-in-Aid for Scientific Research (26220906) from MEXT & JSPS

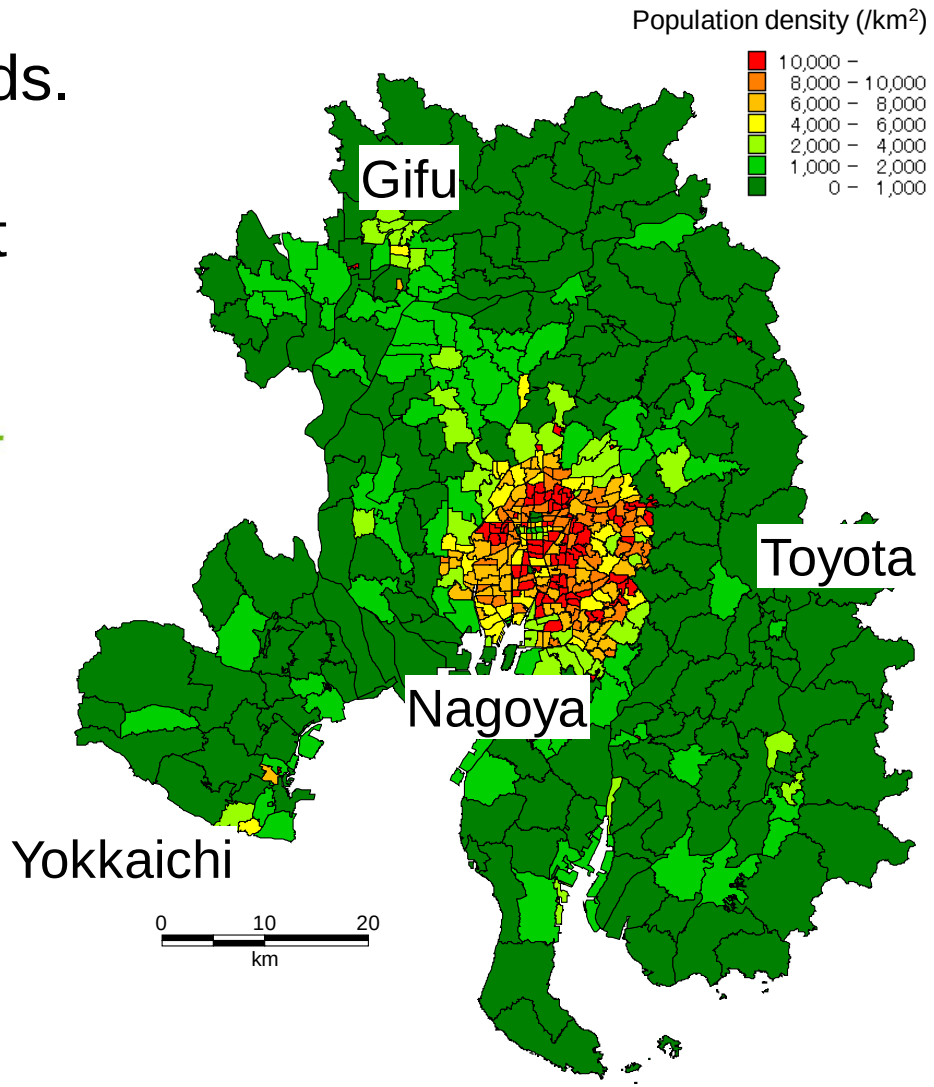
Yamamoto, T., Sugiyama, Y., Kanamori, R. and Hiroi, Y. (2015): Analysis of the effects of information provision on going home behavior and traffic congestion at large-scale disaster: Case study of Nagoya metropolitan area, Presented at 3rd International Conference on Evacuation Modeling and Management, Tainan, Taiwan, June 01-03.

# 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,

- More than 80% started going home
- 24% drove home

- Over 5 million peoples were unable to get home

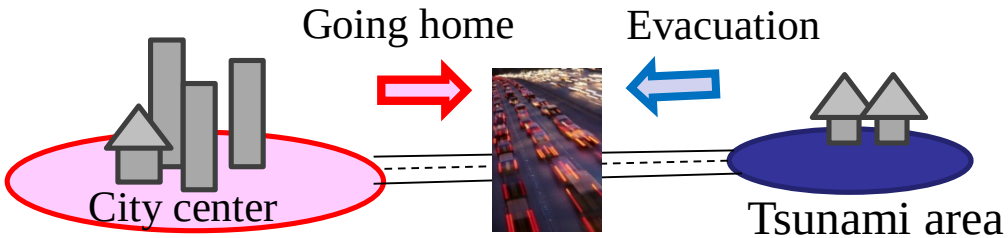
Traffic jam on March 11, 2011 in Tokyo Metropolitan area

# 2. Objectives

To estimate size of refugees unable to get home, traffic congestion and drownings at the next big earthquake hitting Nagoya

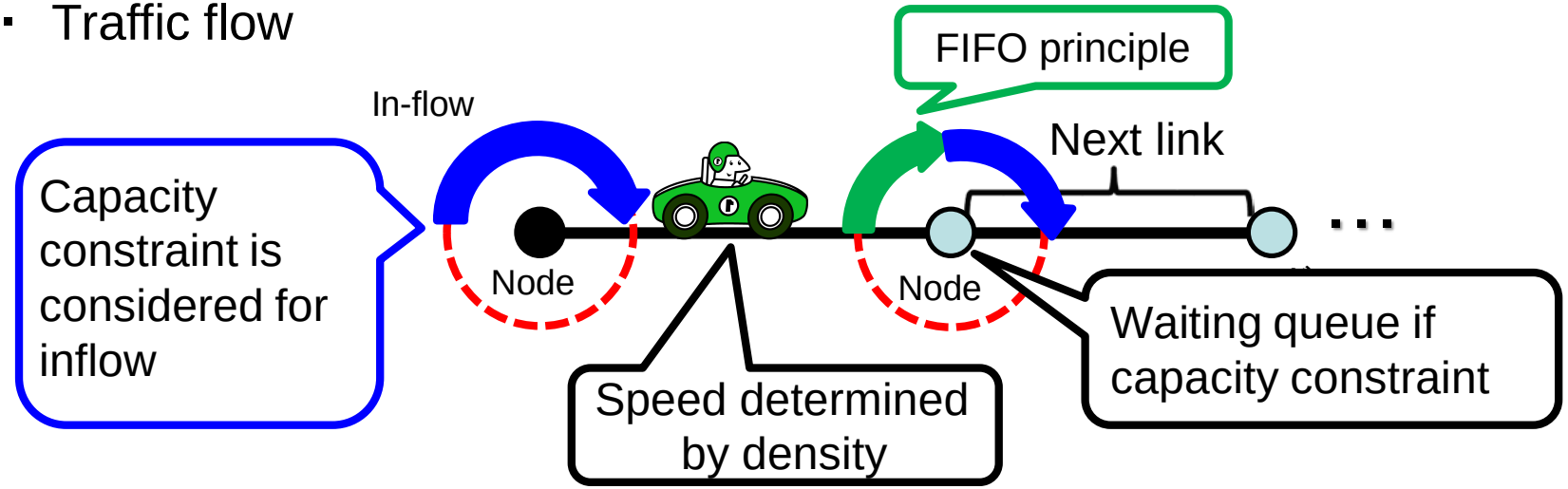
Key points:

- Excess car demand returning home
- Conflict between going home and evacuation from anticipated Tsunami

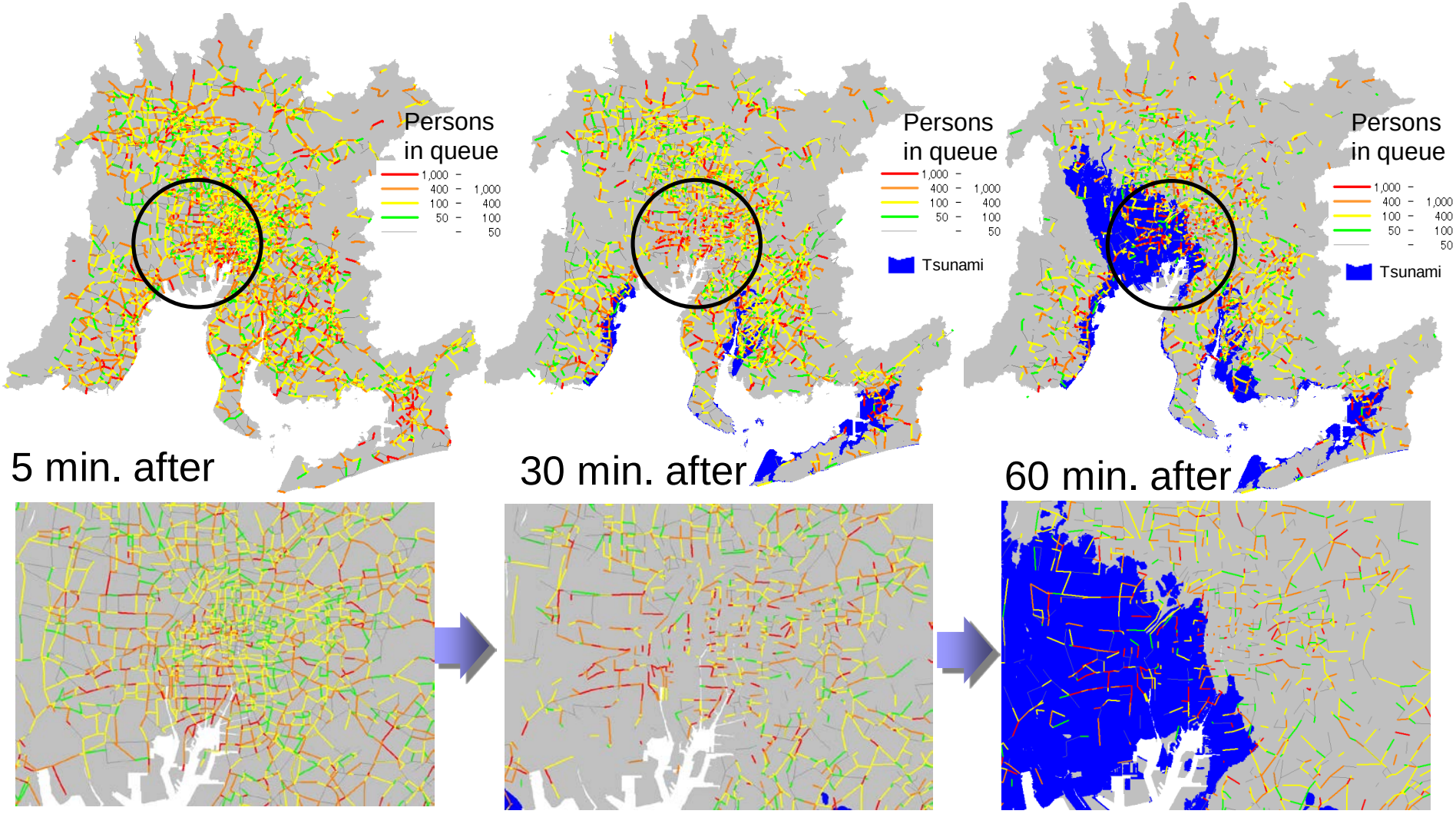


# 9. Traffic simulation of going home trips

- Assumed earthquake: Occurred at noon in weekday
- Timing of trip: Start going home immediately 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



# 10. Results of simulation

- Base case
  - Stochastic route choice under current situation
  - No information access
- Information access case (current situation and family safety)
  - 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 flooded** | 438,000 | 382,000 |

# On-going research on economic loss by urban flood

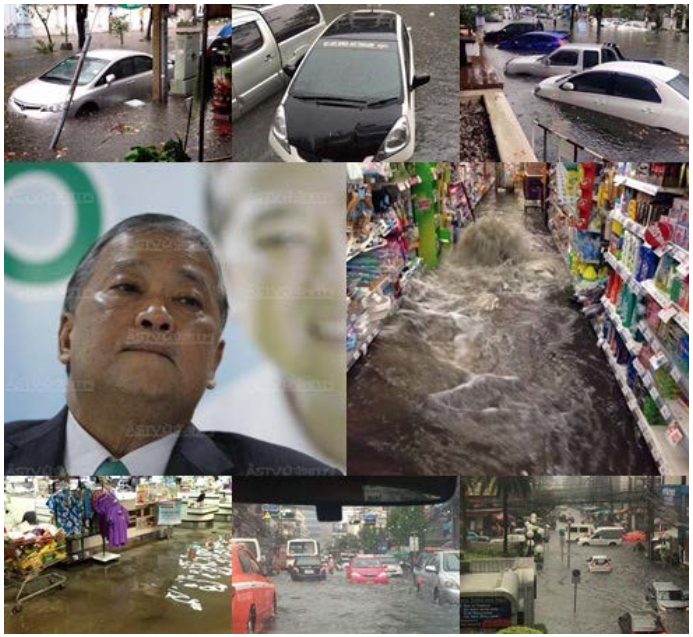
"Advancing co-design of integrated strategies with adaptation to climate change in Thailand (ADAP-T)" supported by JICA/JST

Principle Investigator: Prof. Taikan Oki, University of Tokyo

# “Advancing co-design of integrated strategies with adaptation to climate change in Thailand (ADAP-T)” supported by JICA/JST

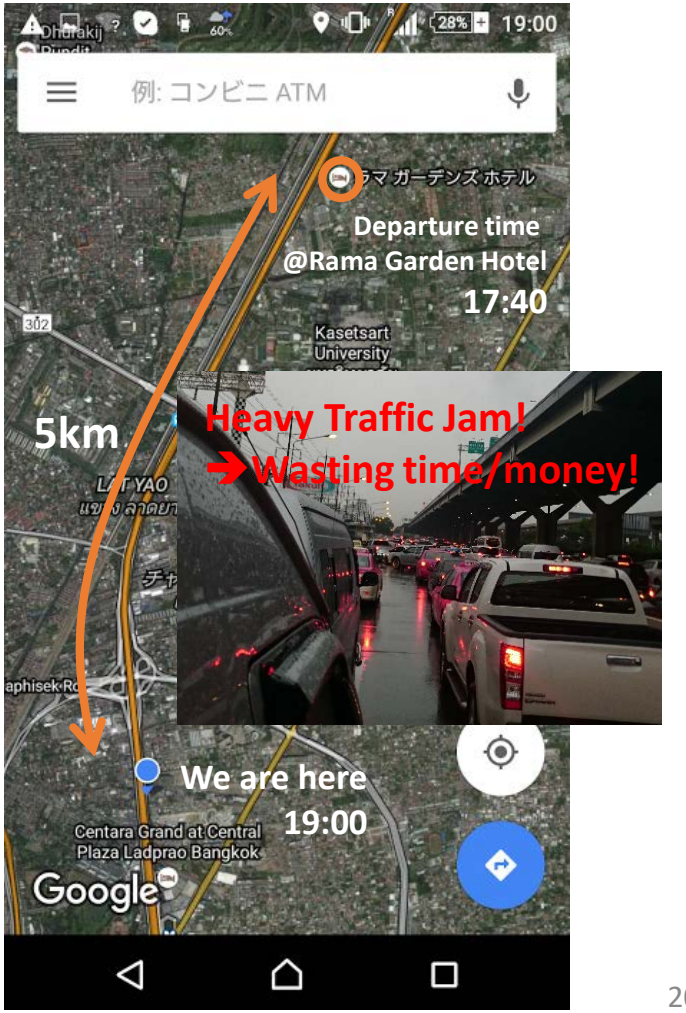
## Topic: Urban Flood caused by Heavy Rainfall in Bangkok

by Prof. Shinichiro Nakamura, Nagoya University



March 24, 2015, heavy rainfall

Heavy rainfall on 13th July 2016




**How much is economic loss due to urban flood in Bangkok?**

# Research flow

**G1**

**G2**

**a) Database**

Historical precipitation, precipitation under CC

Drainage map, historical flood

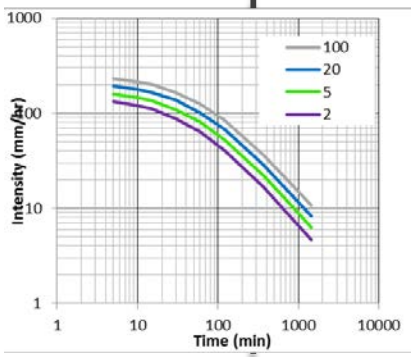
Transportation network, person trip, value of time

**b) Model Development**

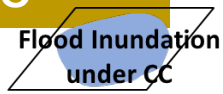
Forecast rainfall under CC

Flood and drainage system model

Transportation network model




**c) Urban flood map under CC**





**d) Urban flood risk related traffic**

**Overall goal in 5 years**

**e) Evaluate adaptation measures**

**f) Appropriate adaptation approaches for BKK**