Evaluation of the optimal location of fire stations considering the burden of emergency transport operations and disaster prevention

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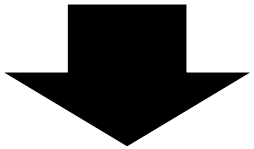
Chapter 1:
Background and purpose

Background in this study (1)

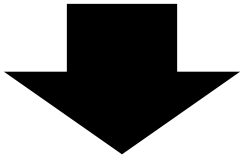
- ***The population of Japan has been declining since 2004.***



- ***However, the number of emergency calls in Japan has been increasing every year, and has about 1.59 times in the past 19 years (from 4.18 million calls in 2000 to 6.64 million calls in 2019) as reasons of aging society, free service by tax, inappropriate use , and lack of hospital etc.***

Background in this study (2)

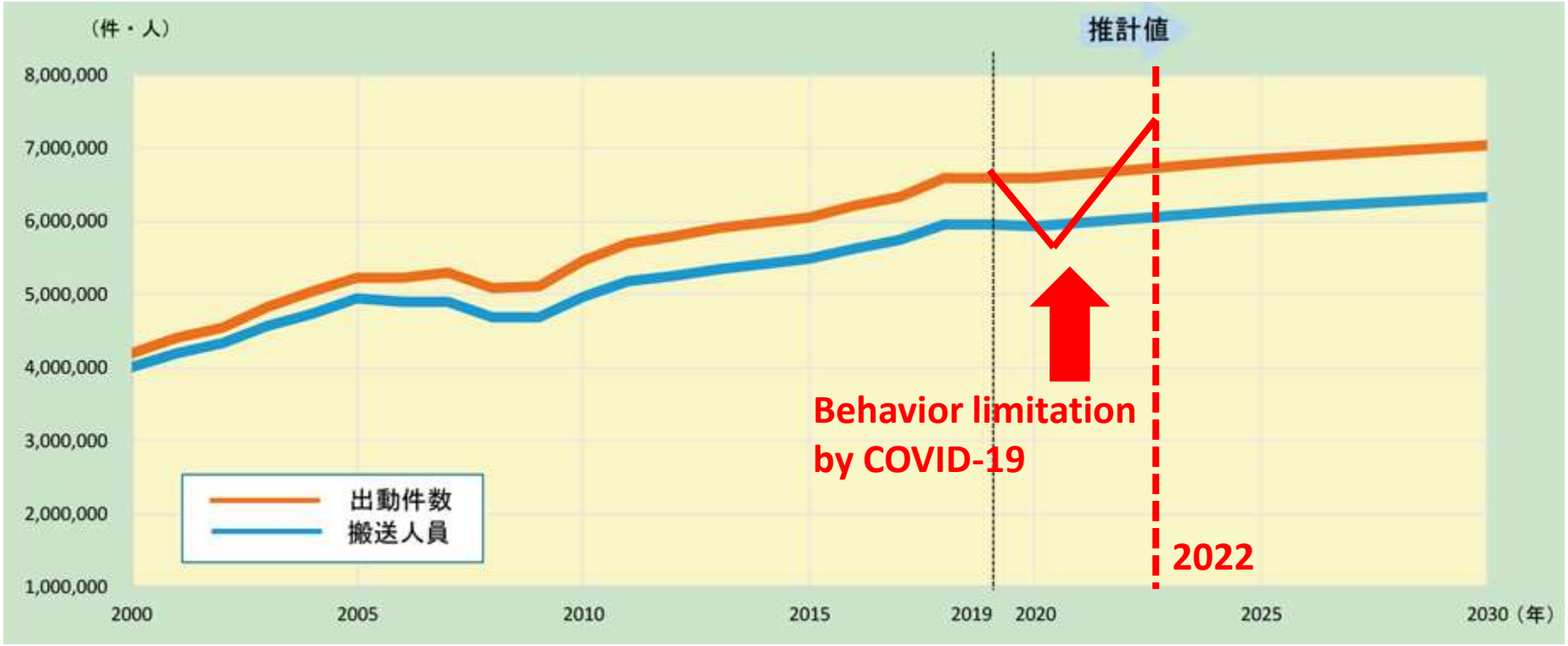
- ***Moreover, the travel time from the fire station to the location requested by the ambulance (dispatch) has increased by 3.2 minutes over the past 20 years (from 6.2 minutes in 2001 to 9.4 minutes in 2021)***
- ***The travel time required to arrive at the hospital has increased by 14.3 minutes over the past 20 years (from 28.5 minutes in 2001 to 42.8 minutes in 2021)***



- ***so the burden of emergency transport operations has increased significantly in recent years.***

Background in this study (3)

- ***According to the White Paper on Fire Fighting, the number of emergency transport operations is expected to continue to increase and exceed 7 million by 2030.***



Background in this study (4)

- ***Shortening the travel time from the fire station to the location requested by the ambulance and required to arrive at the hospital not only reduces the burden of EMS transport operations, but also generates social benefits such as an increase in the lifesaving rate.***
- ***Death by the lack of systems is tragedy.***

- ***We think that it is very important to first quantify and demonstrate the burden of work undertaken by fire departments.***

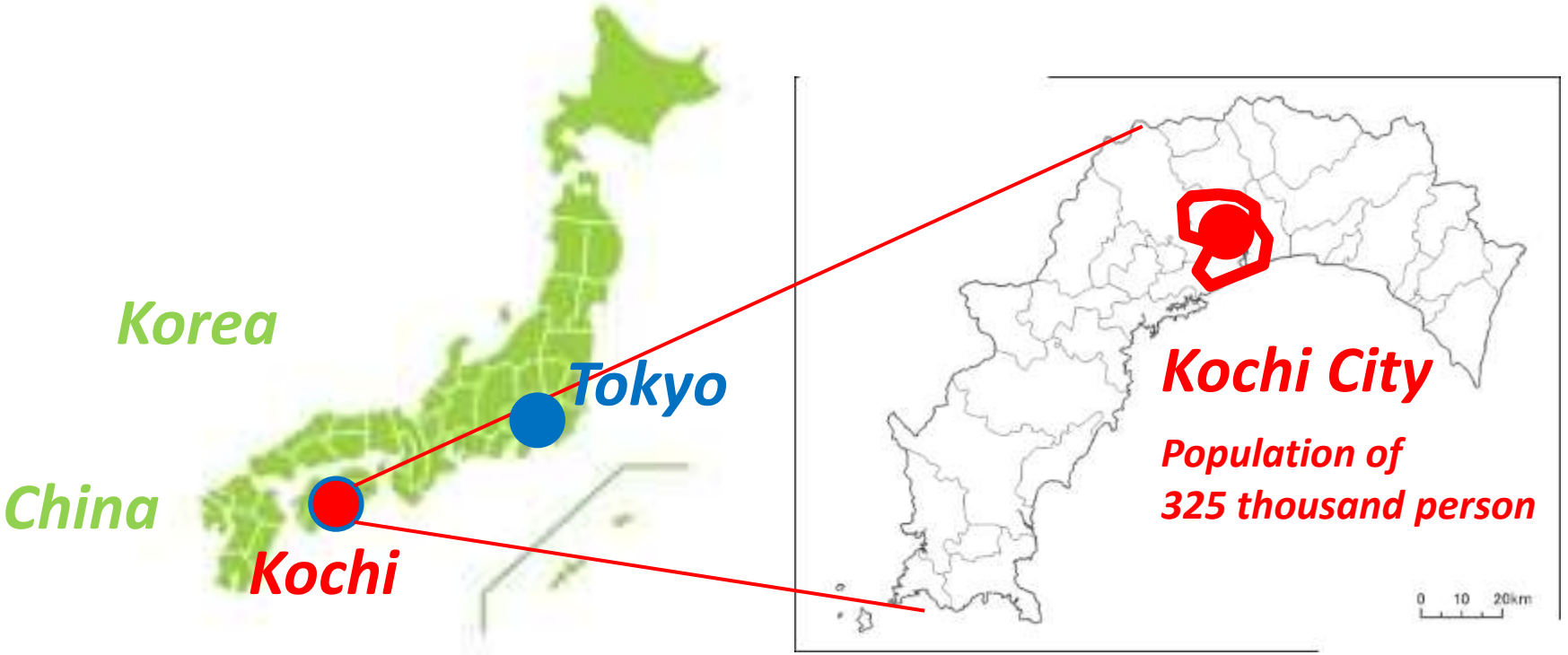
The purpose in this paper

- ***In the case of multiple fire stations, it is important to think quantitatively about how to balance and distribute the work.*** ***This is important from the viewpoint of risk diversification and as well as to maintain the motivation of those who are engaged in the work.***

- ***The purpose of this study is to quantitatively discuss the reallocation of multiple fire stations in the Kochi City Fire Department, minimizing the total travel time of emergency transports.***

Chapter 2:
Methods and data used

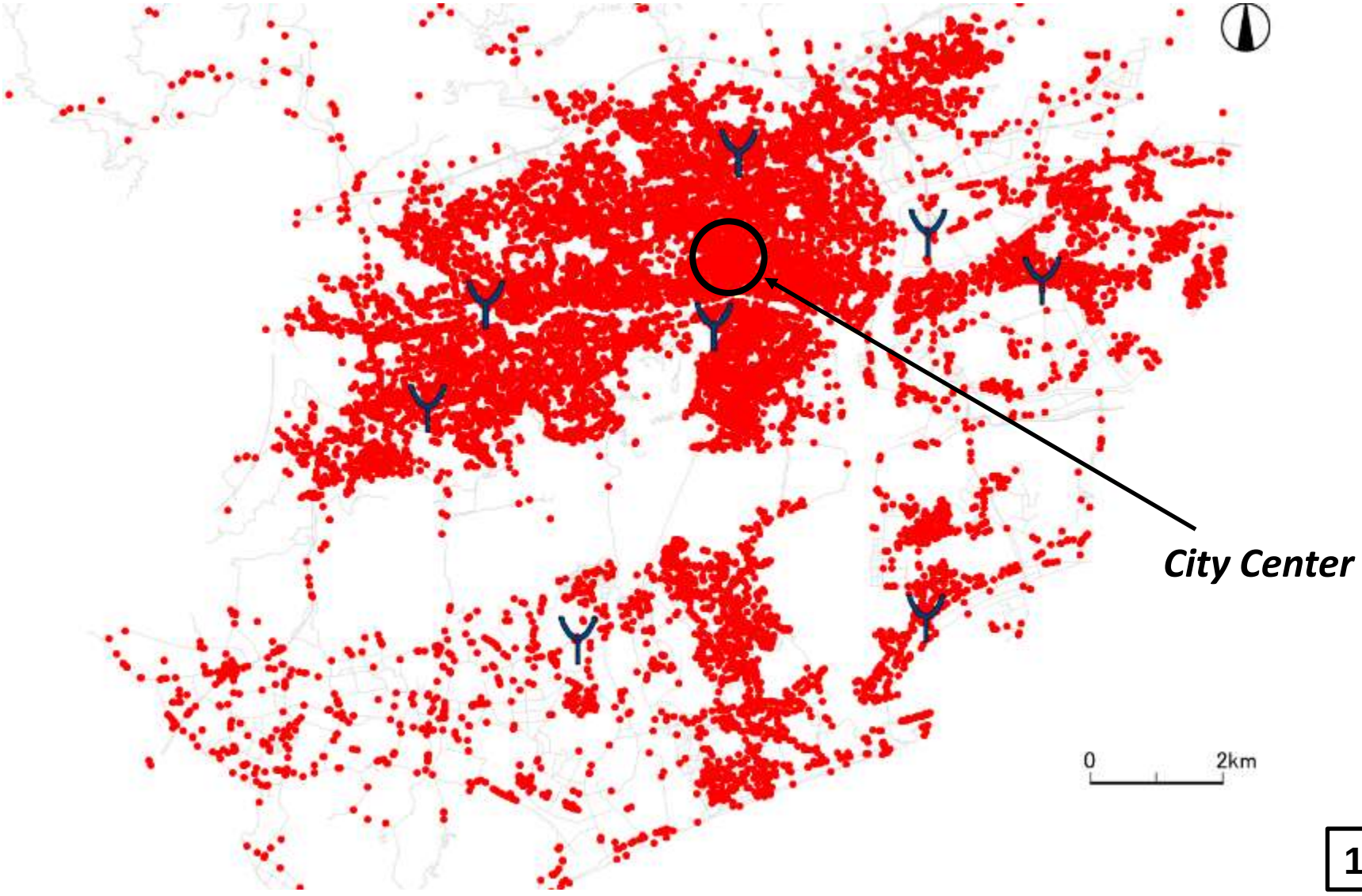
Target Area (Kochi City)



Population of 126 million person

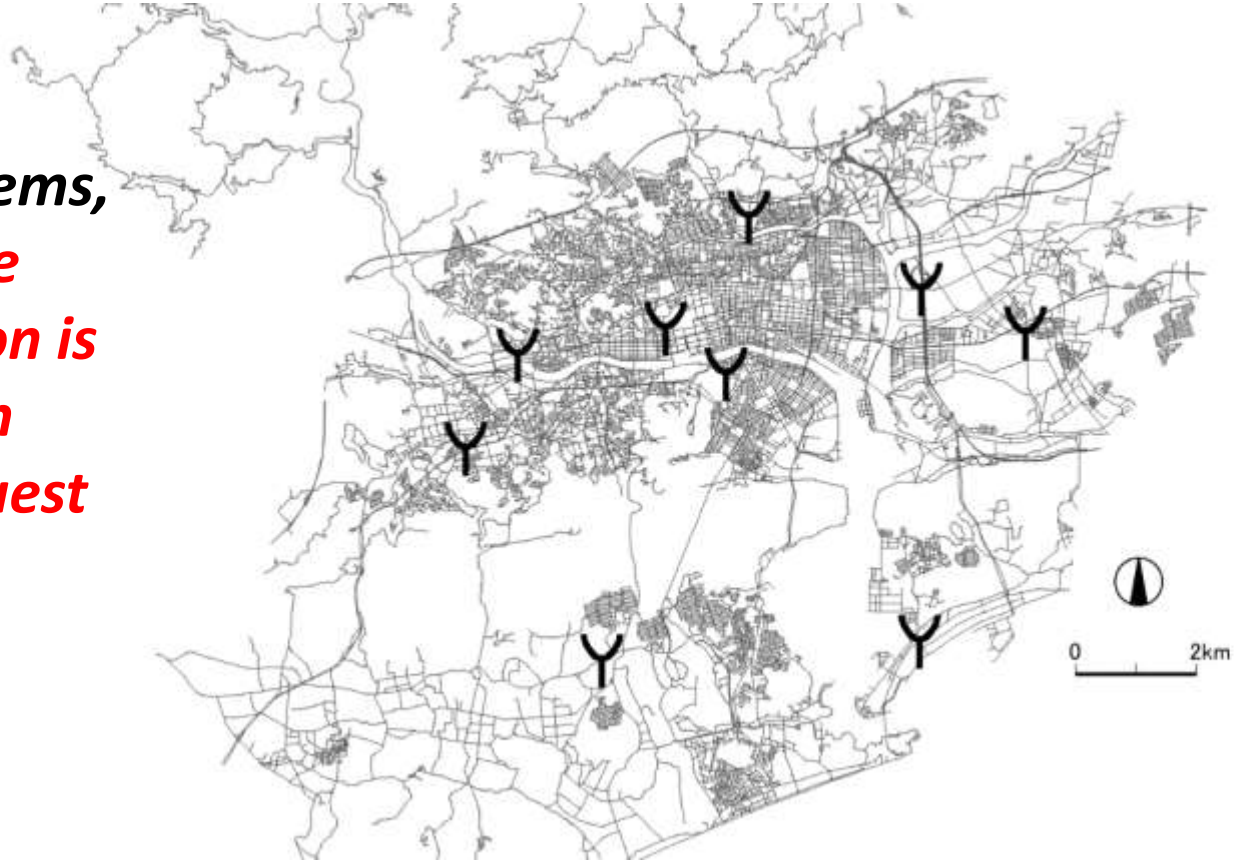
Population of 689 thousand person

Map of the location requested by the ambulance (8 fire stations, 18,655 points)



Map of the road network in Kochi City (174,913 links and 166,095nodes)

- ***By using these constructed calculation systems, we can calculate which fire station is the closest to an ambulance request in Kochi City.***



What is meaning "the total travel time"

- ***The total travel time of emergency transports for the Kochi City Fire Department (8 stations) can be quantitatively evaluated under the ideal situation in which 100% of the nearest emergency response teams can arrive at all sites of an emergency.***

  (Car's capacities are not considered)

- ***This means that changes in total travel time of emergency transports can also be quantitatively evaluated when the location of fire stations changes due to reorganization or consolidation of fire stations.***

Chapter 3:
Analysis and Results

Targeting the analysis (the relocation of Misato station)

- ***We evaluated the optimal allocation of fire stations from the viewpoints of emergency transport workload and disaster prevention considering the relocation of the Misato station of the Kochi City Fire Department.***

Why the relocation of Misato station is important?

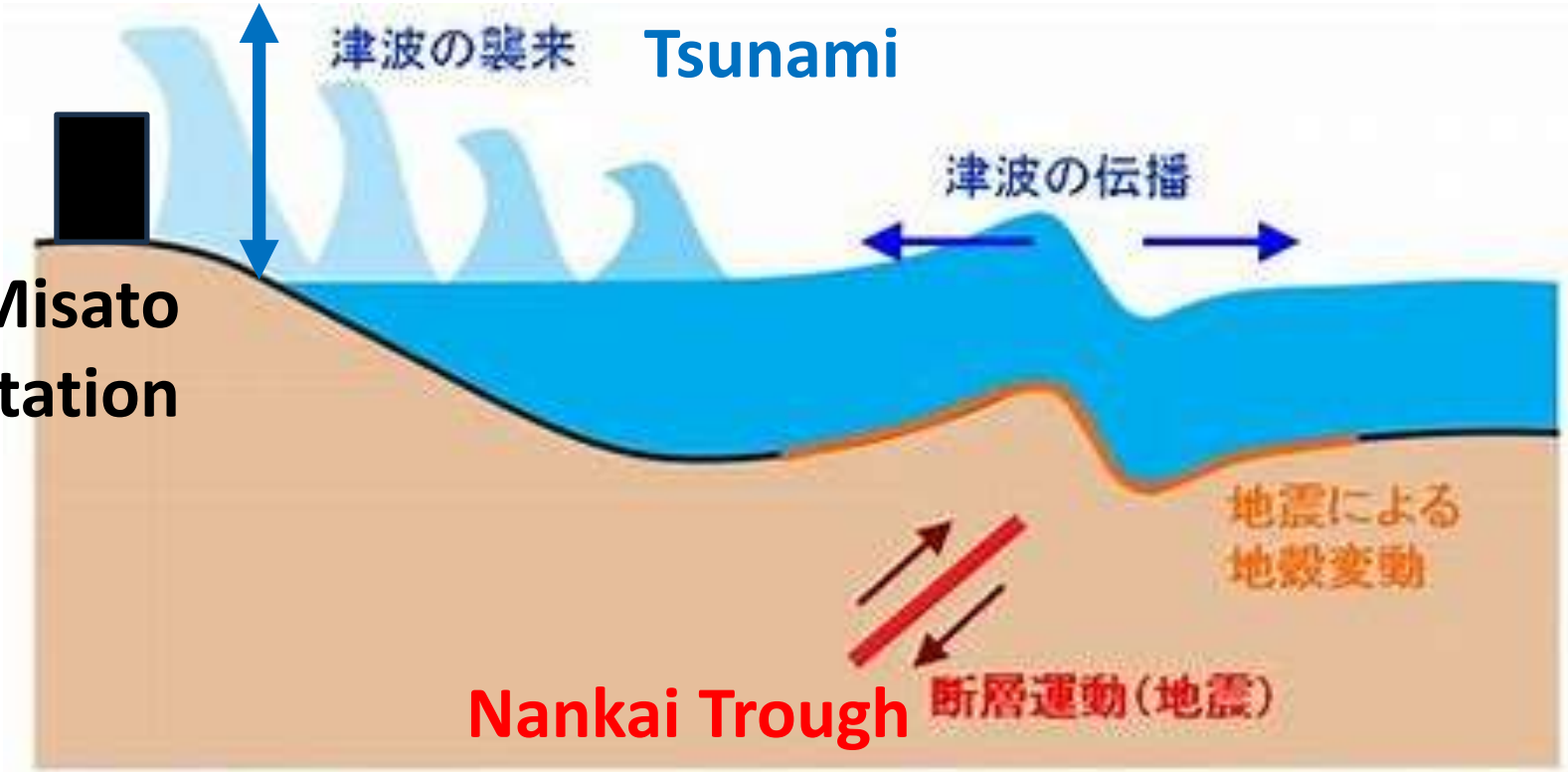
- ***In the event of a Nankai Trough earthquake, a tsunami is expected to reach Kochi City within 30 to 60 minutes, resulting in flooding and damage to a widespread area.***

- ***The Misato station, which is expected to suffer tsunami damage, is not subject to renewal or reorganization, and relocation of the Misato station is now an urgent issue.***

Nankai Trough earthquake

Tsunami and the damage

10m, 30-60 minutes



Conditions of relocating Misato station

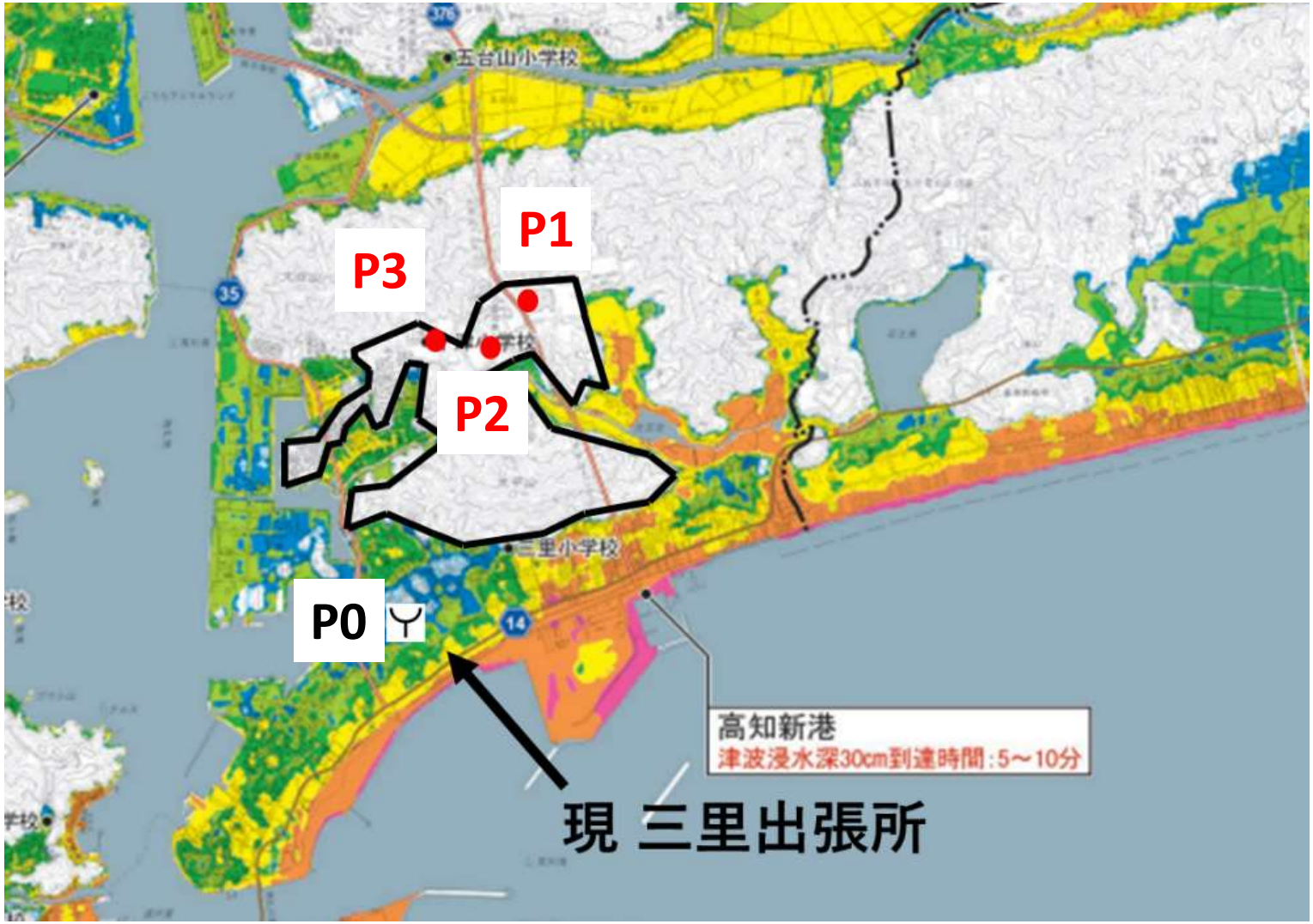
1. ***Although they were not expected to be flooded in tsunami , mountainous areas where fire stations could not be built were excluded.***
2. ***Based on an interview with the Kochi City Fire Department, the standard area needed to construct a fire station is more than 2,000 m2.***
3. ***As a result, three potential relocation sites(P1,P2,P3) that satisfy the above two conditions were selected:***

P1 (near the entrance of the Kochi Medical Center)

P2 (near the entrance of Nozomigaoka)

P3 (near the east side of Totsu Elementary School).

Map of Misato station(P0) and three candidates' stations(P1,P2,P3)



Calculations

- ***The total travel times from the fire station of the Kochi City Fire Department to all emergency stations at the three potential relocation sites (P1, P2, and P3) and the current Misato station (P0) were calculated using the established calculation system.***

Results

- ***The total travel time from the current Misato station (P0) was the shortest at 145,036 minutes, followed by P1 at 147,216 minutes, P2 at 147,660 minutes, and P3 at 147,876 minutes.***
- ***However, the current Misato sub-branch station (P0) is at risk of tsunami-related flooding in the event of a Nankai Trough earthquake, so P1 (near the intersection at the entrance of the Kochi Medical Center), which is the smallest among the three candidates, was selected as the optimal site for relocation of the current Misato station.***

Chapter 4:
Conclusion and future tasks

Conclusion

- ***We evaluated the optimal allocation of fire stations from the viewpoints of emergency transport workload and disaster prevention considering the relocation of the Misato station of the Kochi City Fire Department.***

- ***P1 (near the entrance of the Kochi Medical Center) was selected as the optimal site for relocation of the current Misato station, in terms of minimizing the total travel time of emergency transports(147,216 minutes/18,655 emergency transports).***

Future tasks

- ***Car's capacities need to be considered.***

I deeply appreciate
your attending
to reviewer and audience.