Project No. 2406C

<<Collaboration with Government Organizations>>

Research on Efficient Accident Prevention Measures Using Artificial Intelligence

Project Leader: Akinori Morimoto, Waseda University

1. Research Overview

1．1 プロジェクトメンバー

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	Rumiko Iwasada	Motor Journalist
	Akihiro Nakamura	Professor, Faculty of Economics, Chuo University
	Hidekatsu Hamaoka	Professor, Graduate School of Science and Technology, Akita University
	Yuka Nakagawa	Professor, Faculty of Law, Chukyo University Lawyer, Nakagawa Law & Management Office
	Nobuaki Takubo	Deputy Director, Research Department, Institute for Traffic Accident Research and Data Analysis (ITARDA)
	Daisuke Kamiya	Associate Professor, Department of Engineering, Faculty of Engineering, University of the Ryukyus
	Kyoko Manaka	Associate Professor, Faculty of Economics, Ryutsu Keizai University
Special Observer	Yoshimi Furukawa	Advisor, International Association of Traffic and Safety Sciences (IATSS) Professor, Professional University of Automotive Engineering
	Jun Teraoku	Chief Engineer, Road Traffic Department, Chubu Branch, Construction Engineering Research Institute Co., Ltd.
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＜Observers＞

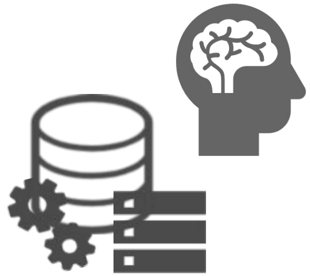
・Takashi Koizumi (Traffic Guidance Division, Traffic Bureau, National Police Agency), Katsuki Masuda (Traffic General Affairs Division, Traffic Department, Tokyo Metropolitan Police Department)
・Nozomu Watanabe, Daiken Suzuki (Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism)
・Atsunori Sugiura, Takuya Aso (Sales Department, Informatix Inc.)
・Emi Satake, Sion Honda (Police Security Solution Division 2, NEC Corporation)
・Hironori Kimura, Yuki Hara (Construction Engineering Research Institute Co., Ltd.)

As of March 2025

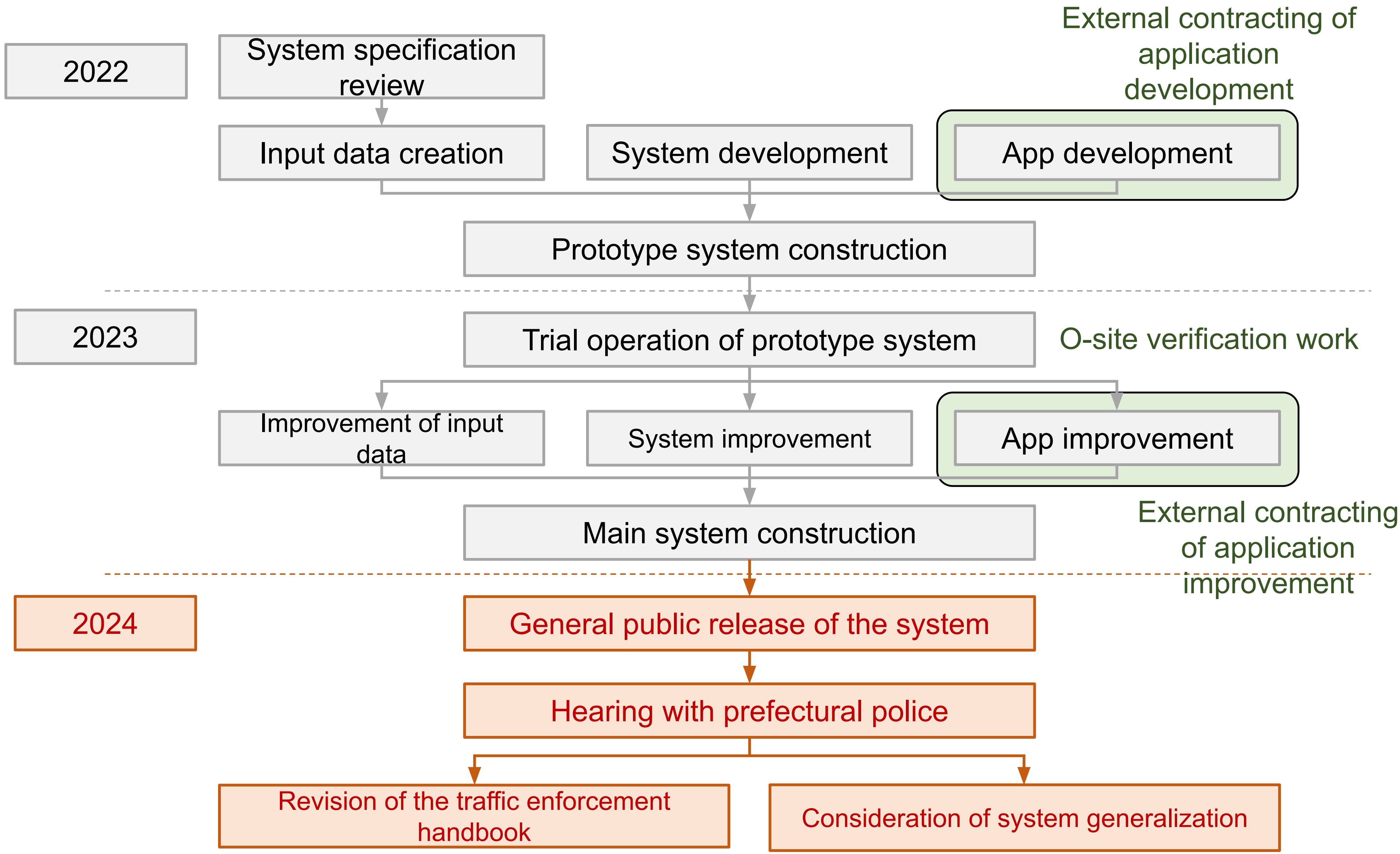
1.2 Background, Objectives, and Expected Effects

- The 11th Basic Traffic Safety Plan identifies "promoting traffic guidance and enforcement to help prevent traffic accidents" as a priority measure.
- The Digital Agency was established in 2021, necessitating standardization and other responses in the field of traffic safety as well.
- IATSS has been publishing the "Traffic Enforcement Handbook" since 2014, providing continuous information to those involved in traffic enforcement.

Develop a basic model that utilizes rapidly advancing artificial intelligence to advance accident prevention measures.



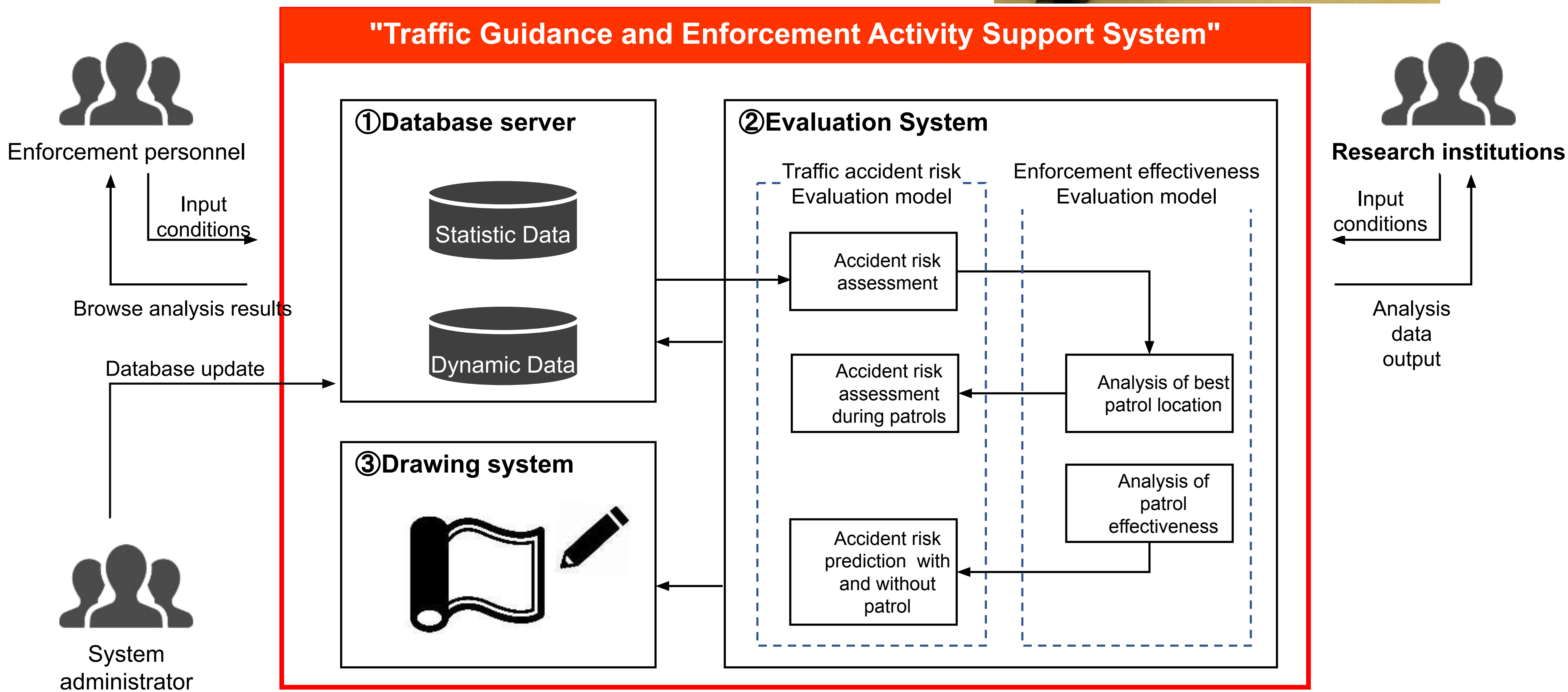
Enable development in diverse regions through the development of general-purpose applications, and consider regionally based countermeasures by accumulating countermeasure effects.


External contracting of application development
2022
System specification review
Input data creation
System development
App development
Prototype system construction
2023
Trial operation of prototype system
O-site verification work
Improvement of input data
System improvement
App improvement
Main system construction
External contracting of application improvement
2024
General public release of the system
Hearing with prefectural police
Revision of the traffic enforcement handbook
Consideration of system generalization

2. Traffic Guidance and Enforcement Activity Support System: General Public Release

2.1 Overview of the Traffic Guidance and Enforcement Activity Support

- A system combining a "traffic accident risk prediction model" and an "enforcement effectiveness evaluation model.“
- Supports the determination of enforcement locations by visualizing the model calculation results in a series.



- The "Traffic Guidance and Enforcement Activity Support System" developed through research up to the previous year has been made publicly available on the International Association of Traffic and Safety Sciences website.
- One organization has applied to have the system data sent to them, and that was completed.

＜IATSS HP　Top Page＞

- A paper on the theoretical aspects of the "Traffic Guidance and Enforcement Activity Support System" was published in IATSS Research (2024).

IATSS Research 48 (2024) 129–135

Contents lists available at ScienceDirect

IATSS Research

journal homepage: www.sciencedirect.com/journal/iatss-research

Overview

History and prospects of traffic enforcement for traffic safety in Japan

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ARTICLE INFO

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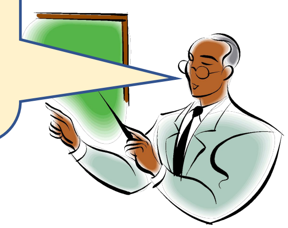
Traffic enforcement
PDCA

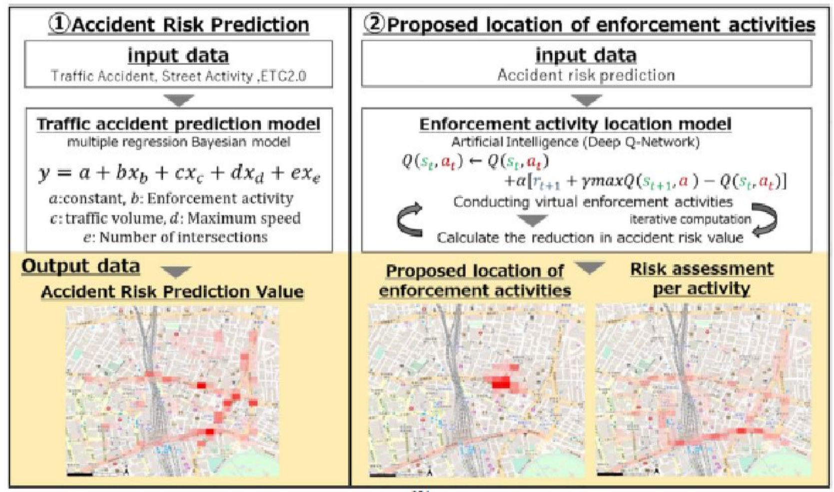
ABSTRACT

Traffic enforcement is one of the 3E's of traffic safety measures. Traffic enforcement has been reported to reduce traffic accidents worldwide; however, significant regional differences exist in its effectiveness. This study summarizes the history of the effects of traffic enforcement on reducing traffic accidents in Japan. In particular, scientific approaches and more efficient enforcement since 2000 have been describ

It introduces the relationship between traffic enforcement and traffic safety in Japan, including historical background and IATSS projects.

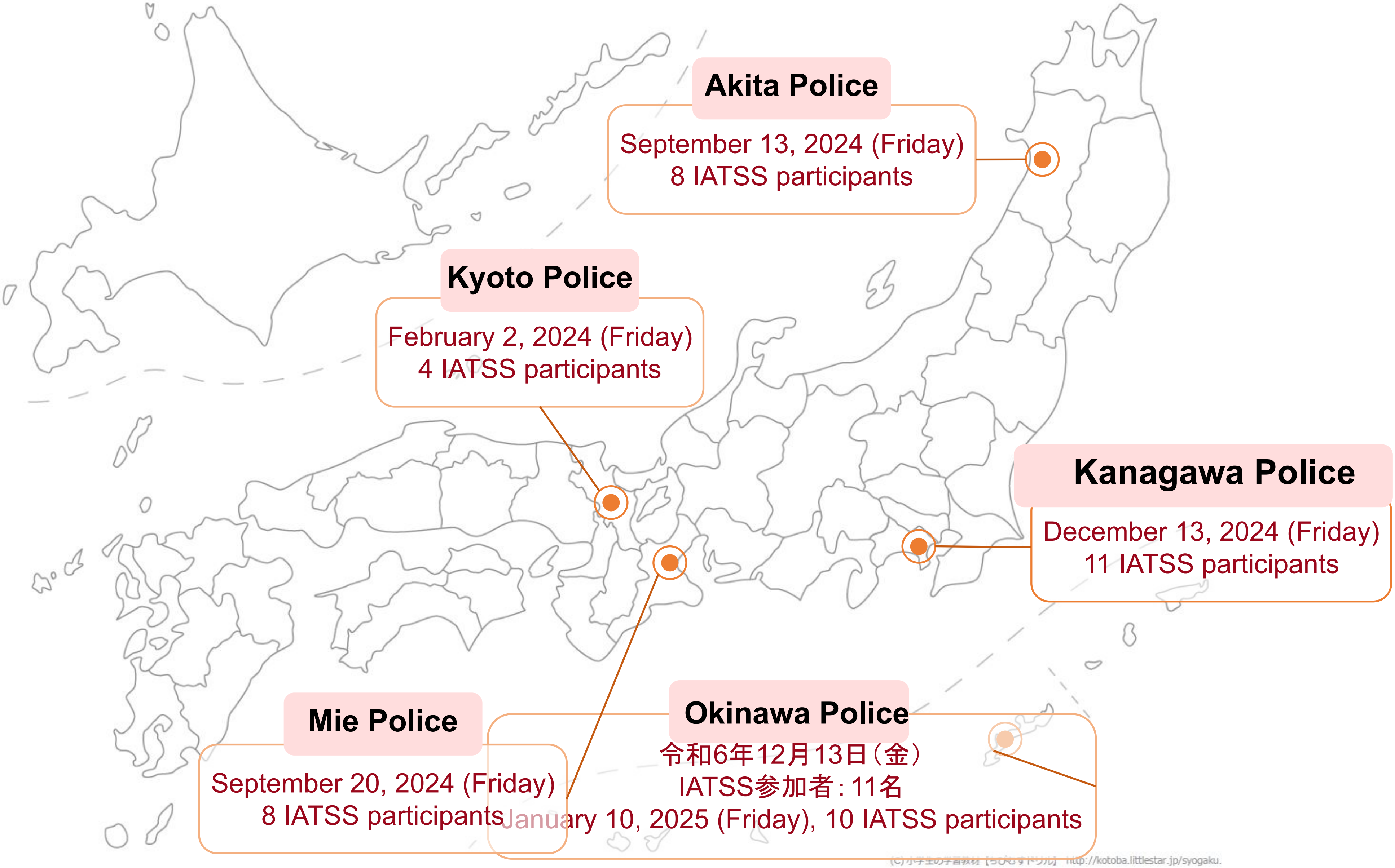


Based on the results of past research on efficient traffic enforcement using AI, a research project on efficient accident prevention measures using AI was started in 2022, with a view toward future practical applications. The goal is to develop a hybrid model that combines a forecasting model based on knowledge gained from conventional statistical methods with an AI-based sequential update model using big data (see Fig. 11).



3. Prefectural Police Hearings

3.1 Hearing Implementation Status



3.2 Hearing Results (Main Opinions and ICT)

Akita Police

Traffic accidents increase in winter (December-February), while enforcement detections decrease

They have a system that displays traffic accident locations and enforcement locations on a map

Kyoto Police

Intersection accidents are the most common due to road structures in Kyoto

They want visualization of accident occurrence status and enforcement activity results

Kanagawa Police

When enforcement numbers were reduced from 2016 to 2018, the number of fatalities increased

They utilize an AI system for traffic monitoring patrol route selection and selection of accident-prone areas

Okinawa Police

Accidents involving foreign tourists (especially from China, Taiwan, and South Korea) are a challenge

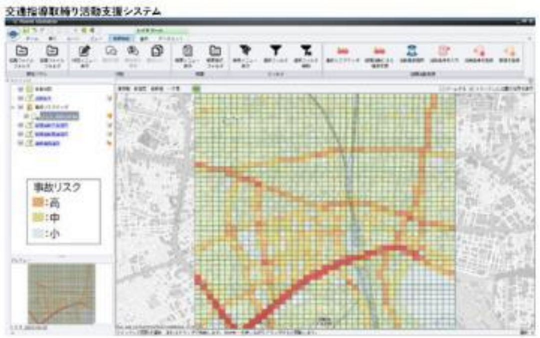
They analyze accident congestion using probe data

Mie Police

In 2024, there were 45 fatal and injury accidents, the lowest in history, and the number of traffic

They have an accident risk AI system at the headquarters and will start full-scale operation soon

３．３ システムの導入可能性



Traffic Guidance and Enforcement Activity Support System

No.	Target	Main Opinion
1	Police A	●Predicting and visualizing the effects of street activities could lead to more focused activities
		●The jurisdiction area is large, and patrol cars also patrol, so it's difficult to conduct street activities at system-proposed locations
2	Police B	●While there is a system within the prefectural police, its usability depends on individual abilities. A system that supports this would be useful
		●It's unclear whether daily system input of street activity records is feasible
3	Police C	●Proposing enforcement activity locations and times alone is innovative and would be helpful if it reduces the effort required for enforcement activity planning
		●It might be difficult for local police station personnel to handle daily data input
4	Police D	●Understanding accident risk is effective and can be utilized for future enforcement
		●It would be better if it could propose risk details (rear-end collisions, intersection accidents, etc.) and activity methods
5	Police E	●There is a sense of routine in selecting activity locations, which could be resolved
		●Adding location characteristics (sunrise, road surface freezing, etc.) would allow consideration of regional characteristics

4. Consideration of System Generalization Based on Hearings

①Accident Risk Prediction Model

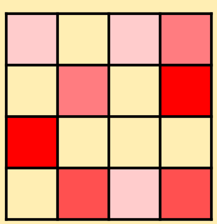
Method: Multiple regression Bayesian

Predicts accident risk values in **50m units per day**

Objective Variable	Accident risk value [cases]
Explan-atory Variable	Enforcement activity value [hours]
	Number of intersections [units]
	Maximum speed [km]
	Traffic volume [vehicles/day]

Output data

Accident risk prediction variable

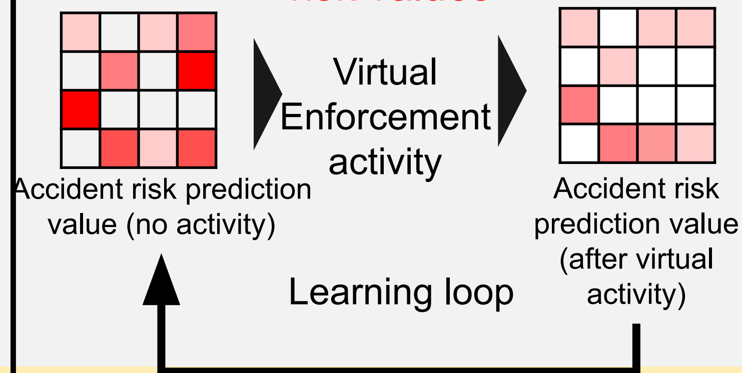


Mesh	PRC*
No.1	0.2
…	…
No.16	0.7

②Enforcement Activity Proposal Model

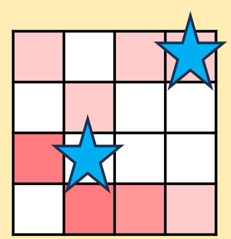
Method：Deep Q-Network

Proposes enforcement activities that **maximize the reduction** in accident risk values



Output data

Optimal street activity location and time



Mesh	Activity time [h]
No.4	2
No.10	1

PRC*=Predicted Risk Value

4.2 Accident Occurrence Risk Prediction Model

- Accident risk is predicted by a multiple regression Bayesian model
- ETC2.0 probe data used as input data is **non-public**

①事故発生リスク予測

入力データ

交通事故　街頭活動　ETC2.0

交通事故予測モデル

重回帰ベイズモデル

$$y = a + bx_b + cx_c + dx_d + ex_e$$

偏回帰係数	a 定数	b 取締り活動値	c 交通量	d 最高速度	e 交差点数
平均μ_i	6.34E-02	-6.92E-03	7.28E-05	3.21E-03	3.30E-02
分散σ_i^2	3.09E-04	5.25E-06	5.27E-10	2.19E-07	1.57E-04

出力データ

事故リスク予測値

Data Content	Source
ETC2.0 probe data	**MLIT**
Street activity data	MPD
Road environment	Open source
Traffic accident data	MPD

Consider alternatives with highly versatile data

Multiple Regression Bayesian Model

A combination of multiple regression models and Bayesian

ベイズ理論基本公式

$$\pi(\theta|D) \propto \pi(\theta) \cdot f(D|\theta)$$

事後分布は事前分布と尤度の積に比例

目標

$$y = a + bx + cu + \cdots + \varepsilon$$

事前分布　尤度

- Probability information can be updated by adding new information to known probabilities
- Data can be updated

$$y = a + bx_b + cx_c + dx_d + ex_e$$

	Accident risk(cases)		Traffic volume (vehicles/day)		Interactions(units)
	Enforcement activity value(h)		Maximum speed(km/h)		Constant term

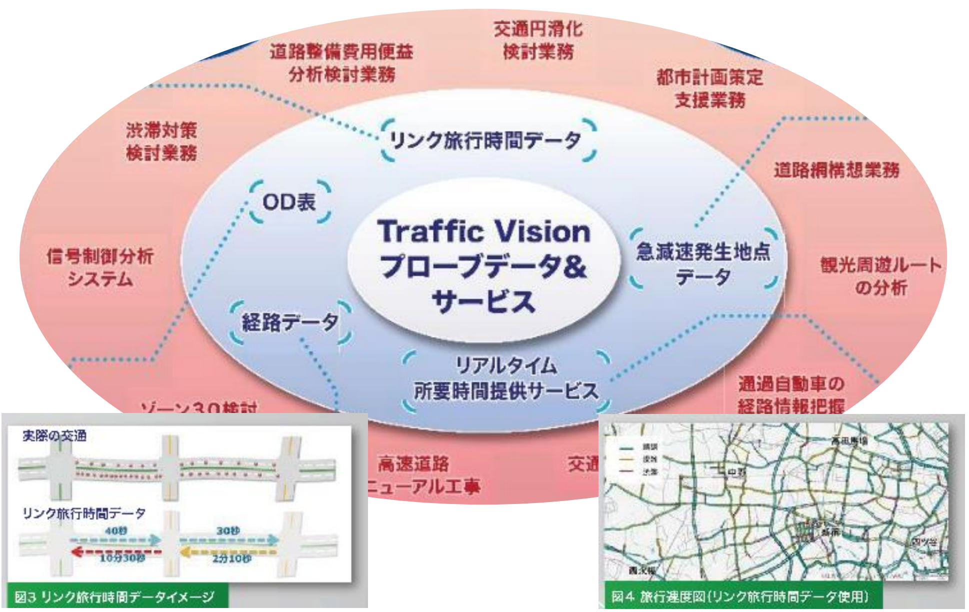
4.3 Examination Method

- Conducted an examination of two publicly available datasets

Automotive Probe Data: (Traffic Vision Probe Data)

・Sales of statistically processed Honda probe data.
・Target data: Honda vehicle travel data excluding commercial and freight vehicles.

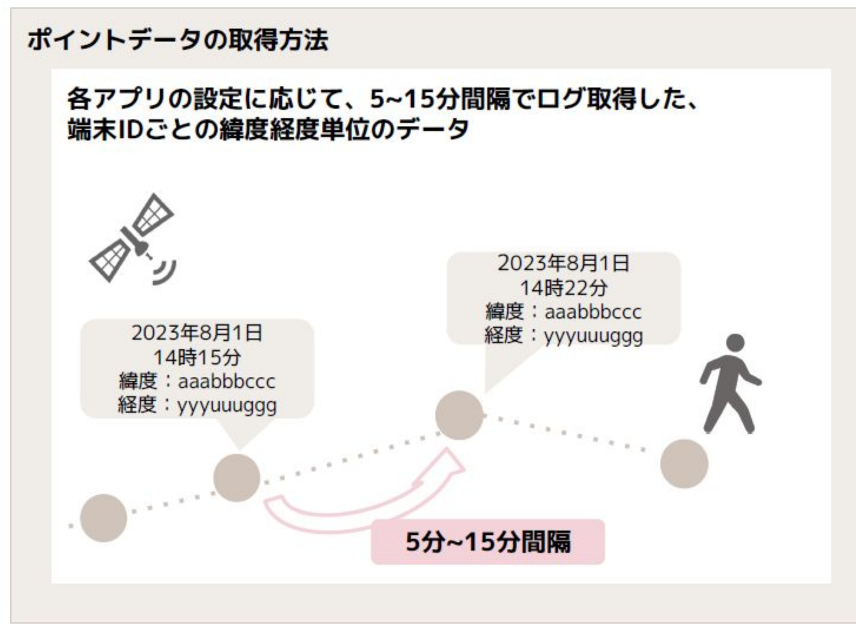
Available data
①Trave time-related
・Link travel time data：Calculates trave time for each road segment from trave data/ Targets roads with a width of 5.5m or more.
②Sudden deceleration-related
・Sudden deceleration occurrence point data (deceleration, occurrence date and time, latitude and longitude)



Mobile Probe Data (Human Flow Data) (Profile Passport)

・Targets users who have granted permission to use location information from partnered smartphone applications (approx. 30 million people).
・ Acquires user location information at 5-15 minute intervals.

Available data
①Point data→movement mean and speed data can also be attached
・data in latitude and longitude unit for each user
②Non-aggregated OD data
・Data organized by origin and destination for each user



4.3 Examination Method

・Compare "traffic volume (data volume)," "travel speed," and "number of sudden deceleration occurrences" for each analysis mesh in each data set to verify the possibility of substitution.

・ The measurement units for each data set are as follows:

Product Name	ETC2.0 Probe Data	Traffic Vision Probe Data	Profile Passport
Data type	Point	Road link	ポイント
traffic volume measurement unit	Every 200m when changing direction by 45°or more	For each DRM road link 5-minute intervals	Every 125 meters (anonymized within a 125m mesh)
Travel speed measurement unit	Every 200 when changing direction by 45°or more	Road link length ÷ average travel time	Every 125 meters (anonymized within a 125m mesh)
Sudden deceleration count measurement unit	Every 200 meters When changing direction by 45° or more When abrupt maneuvers occur	When maneuvers of -0.25G or more occur (point data)	No data on abrupt maneuvers
Remarks	Scaling process based on the installation rate of ETC2.0 onboard units	—	Used only for data with "car" as the means of transportation.

*Transportation categories: bicycle, car, stay, train, walk (5 types)

- For each data set, we will compare 'traffic volume (data volume)', 'travel speed', and 'number of sudden decelerations' for each analysis mesh to verify the possibility of substitution.

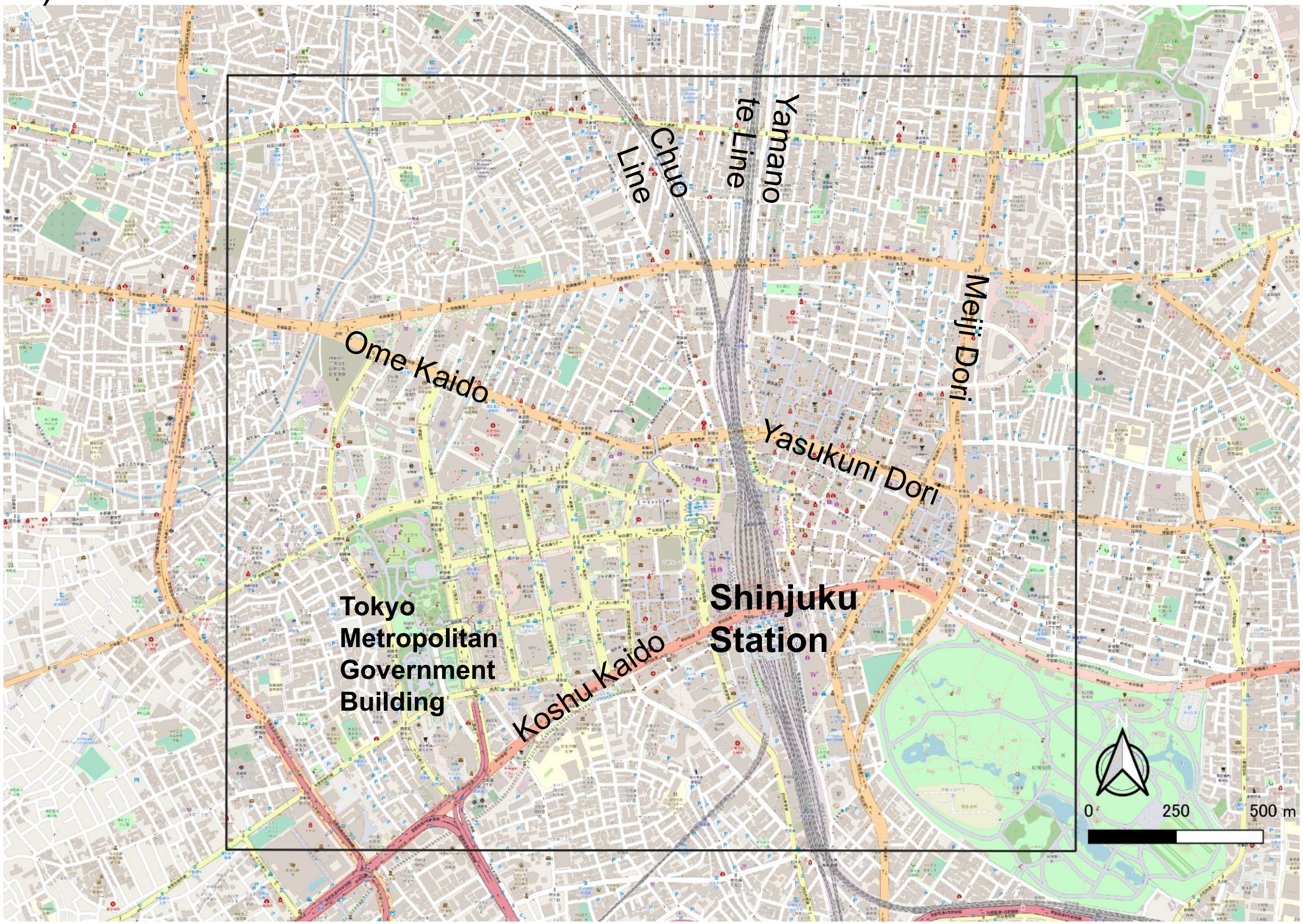
・The calculation method for each data set is as follows

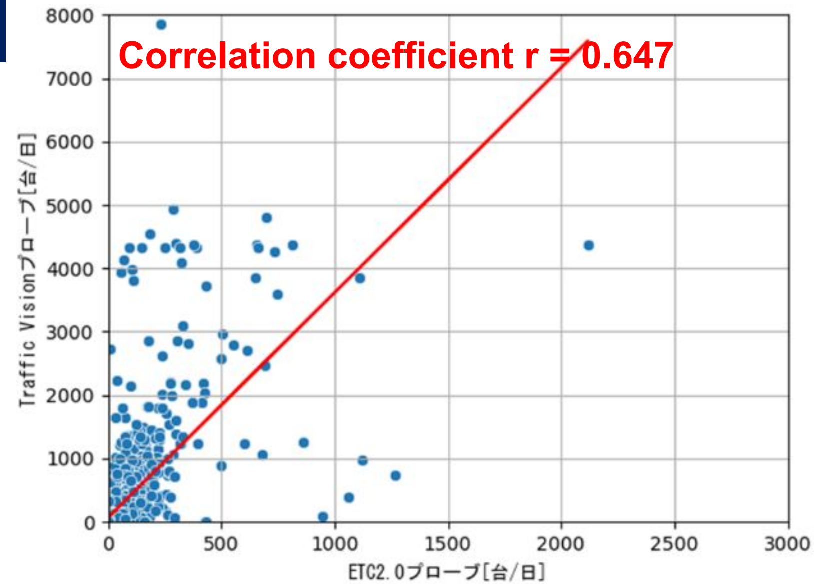
Product Name	ETC2.0 Probe Data	Traffic Vision Probe Data	Profile Passport
Traffic Volume Aggregation Method	Interpolate data with spline curves and aggregate data volume for each analysis mesh	Traffic volume of road links overlapping each analysis mesh. If multiple road links apply, sum the traffic volume of all links	Aggregate data volume for each analysis mesh
Travel Speed Aggregation Method	Interpolate data with spline curves and aggregate the maximum data value for each analysis mesh	Maximum travel speed of road links overlapping each analysis mesh	Aggregate the maximum data value for each analysis mesh
Number of Rapid Decelerations Aggregation Method	Aggregate the number of maneuvers of -0.25G or more for each analysis mesh (excluding -1.00G or more)	Aggregate the number of maneuvers of -0.25G or more for each analysis mesh (excluding -1.00G or more)	—
Remarks	Scaling process based on the installation rate of ETC2.0 onboard units	—	Used only for data with "car" as the means of transportation

*Transportation categories: bicycle, car, stay, train, walk (5 types)

4.4 Target Area for Examination

・Area where trial operation was conducted (Shinjuku Ward, Tokyo, 50m mesh x 2064 units).

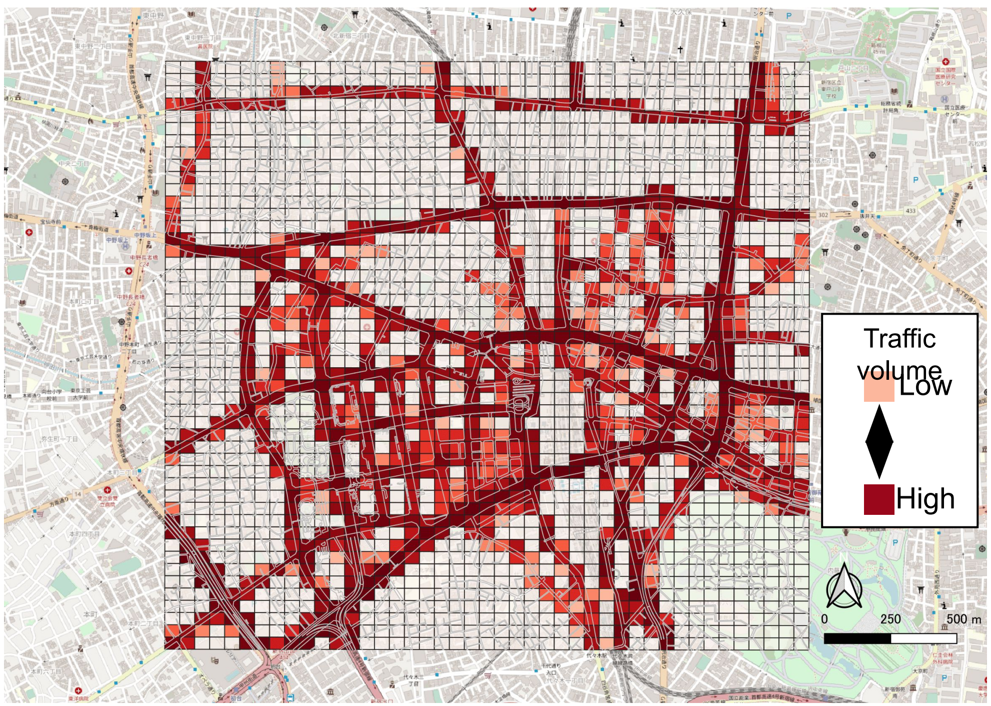




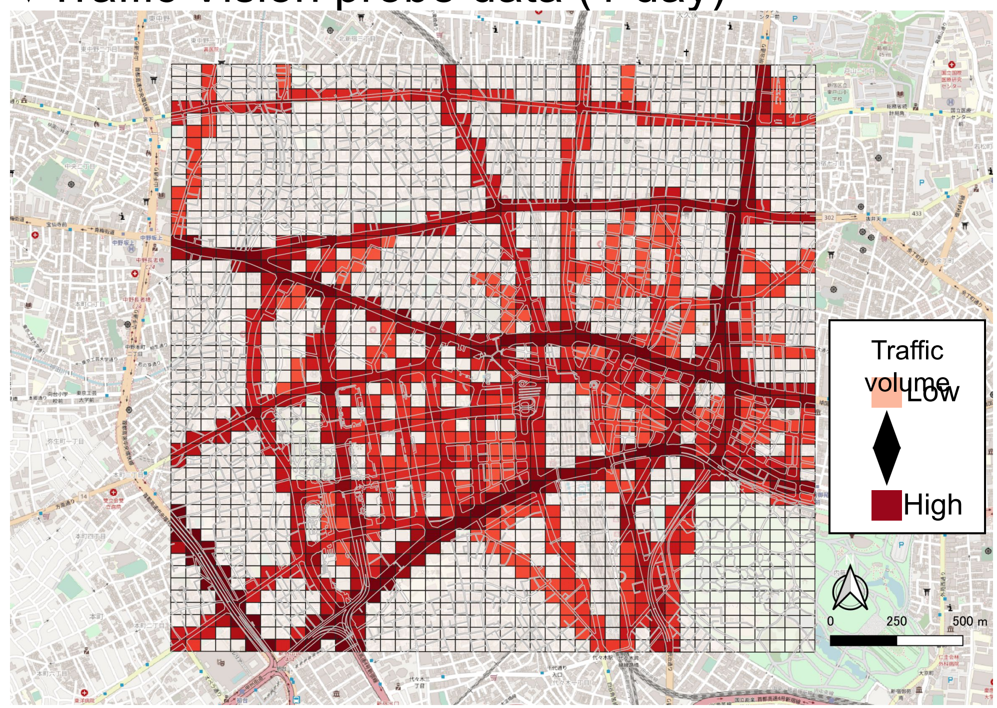
(1) Traffic Vision Probe Data

- Data plotted on roads in both cases
- Traffic Vision has a slightly higher proportion of arterial roads
- Relatively strong correlation (Correlation coefficient r = 0.647)

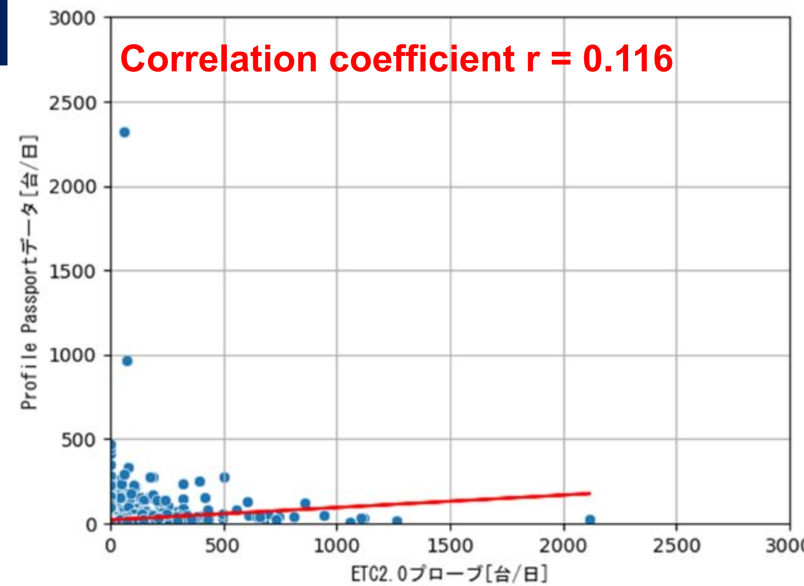
▼ ETC2.0 probe data (1 day)



▼Traffic Vision probe data (1 day)

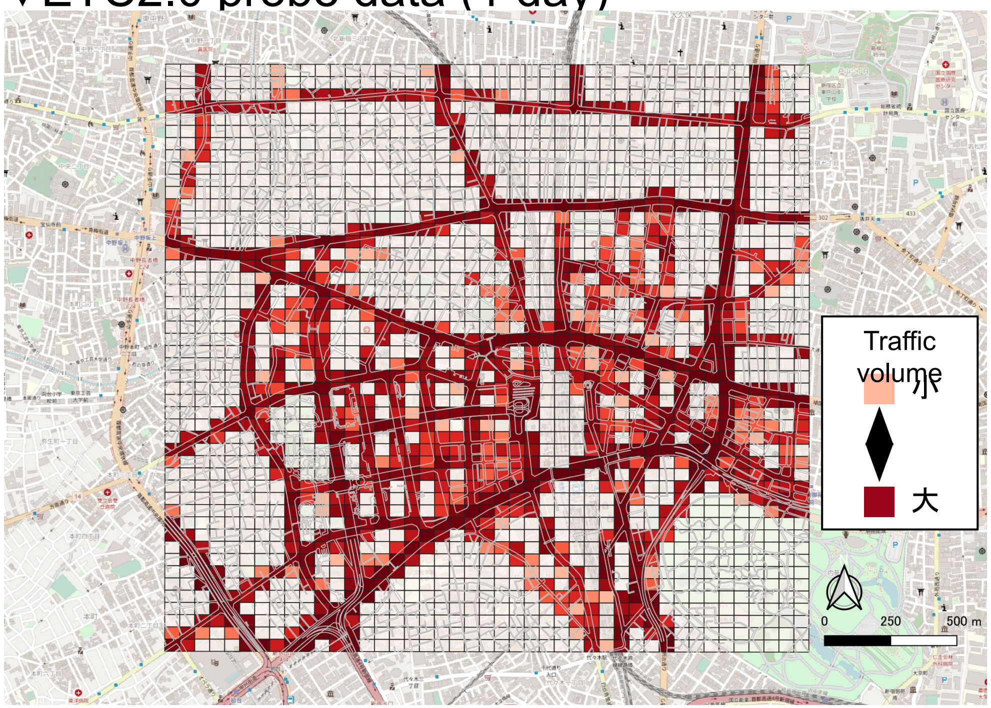


(2) Profile Passport

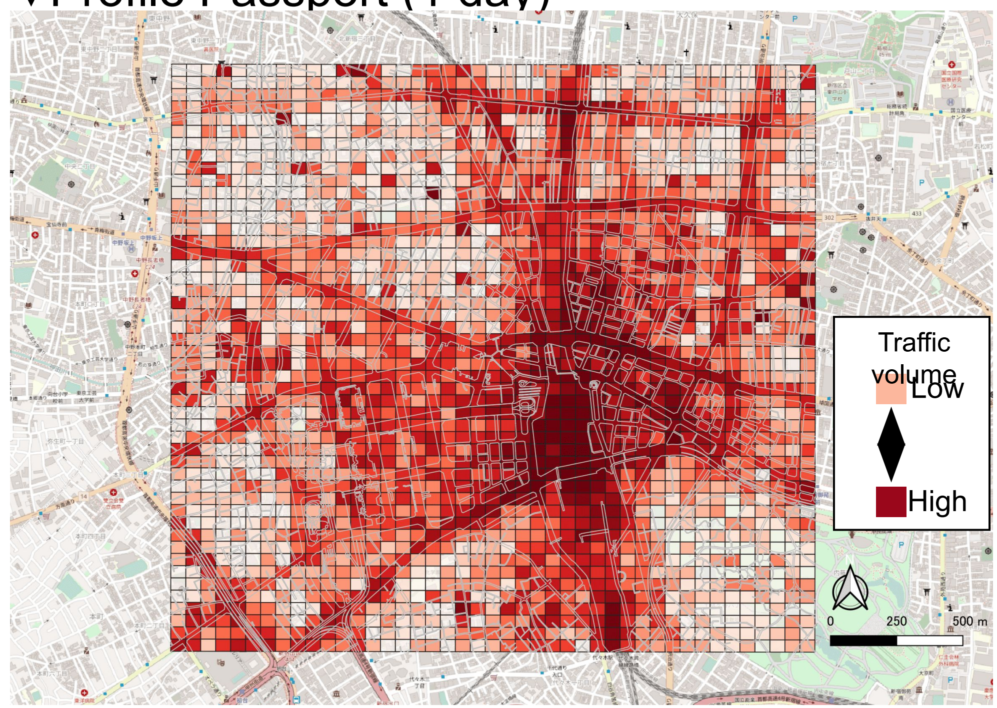


・Profile Passport has plots on arterial roads, but a certain amount of plots outside roads
・Profile Passport has a high proportion of Shinjuku Station and its surrounding areas
・Weak correlation
(correlation coefficient: 0.116)

▼ETC2.0 probe data (1 day)



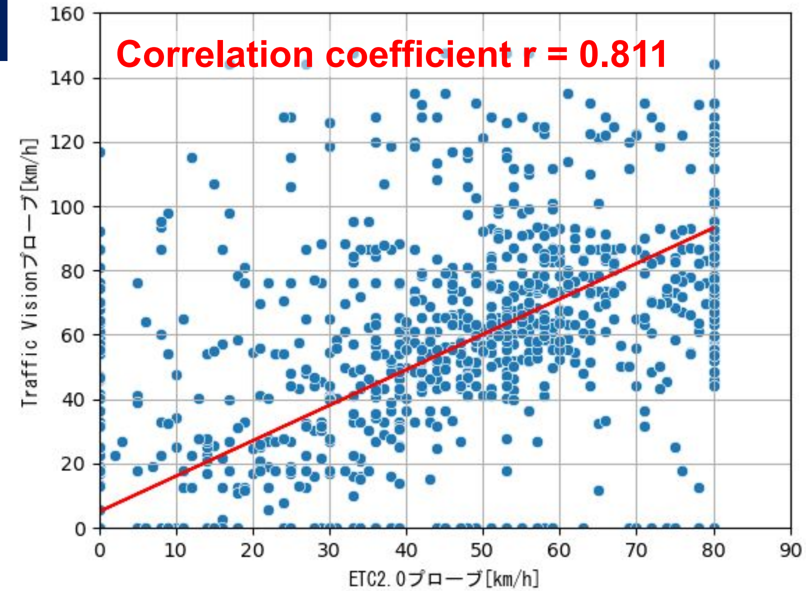
▼Profile Passport (1 day)



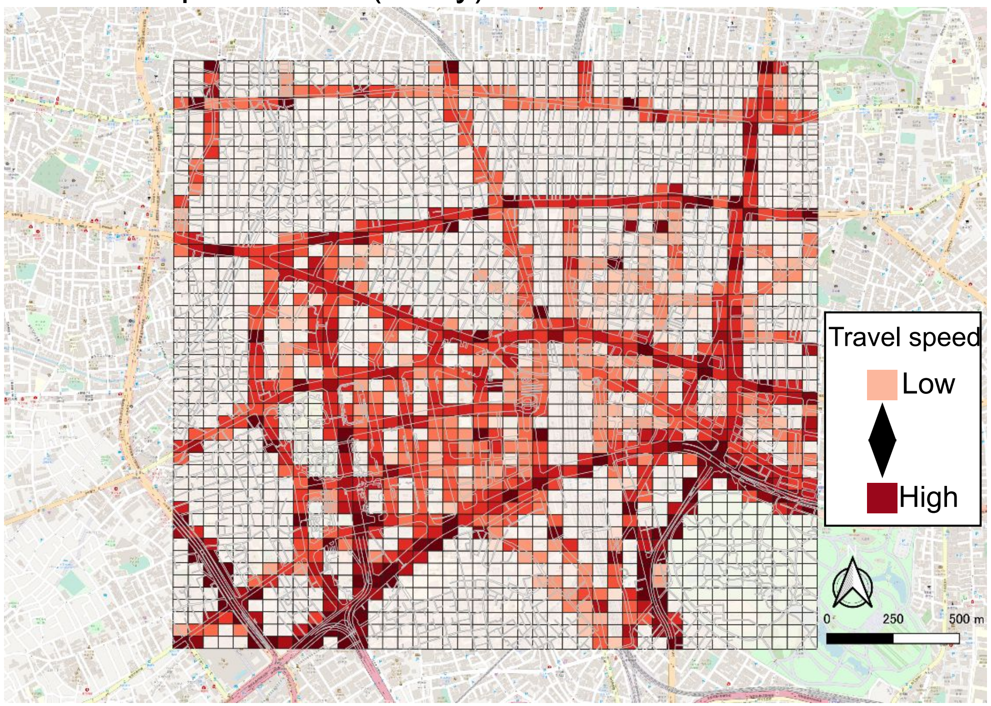
4.5 Examination Results (Travel Speed)

(1) Traffic Vision Probe Data

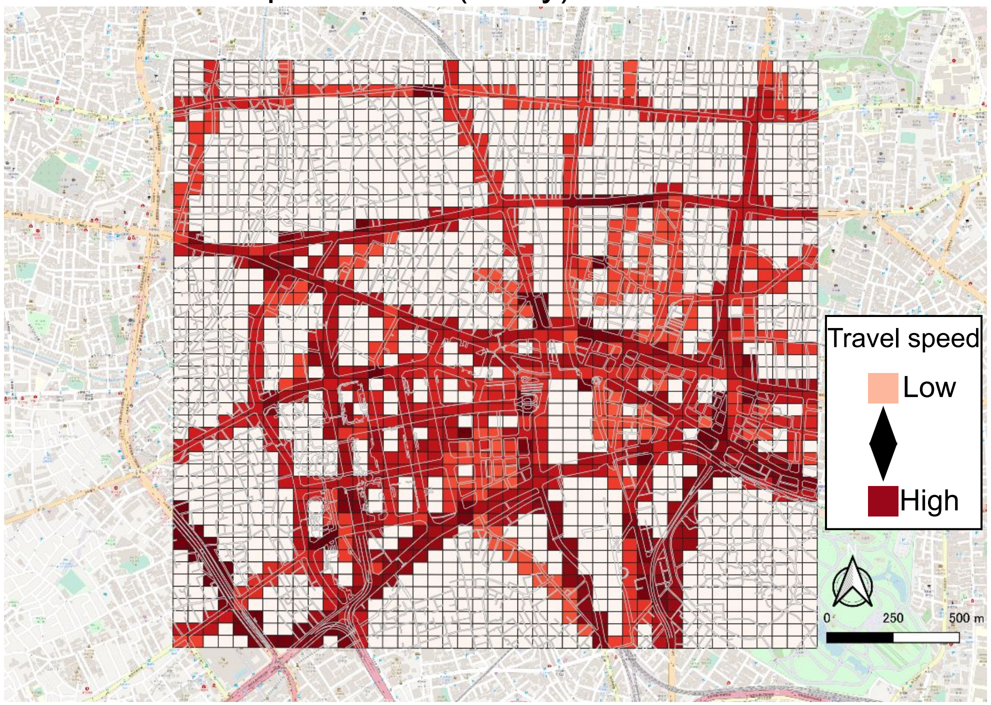
・Data plotted on roads in both cases.
・Traffic Vision has a slightly higher proportion of arterial roads.
・ ETC2.0 probe has more detailed changes.
Strong correlation
(correlation coefficient: 0.811).



▼ETC2.0 probe data (1 day)

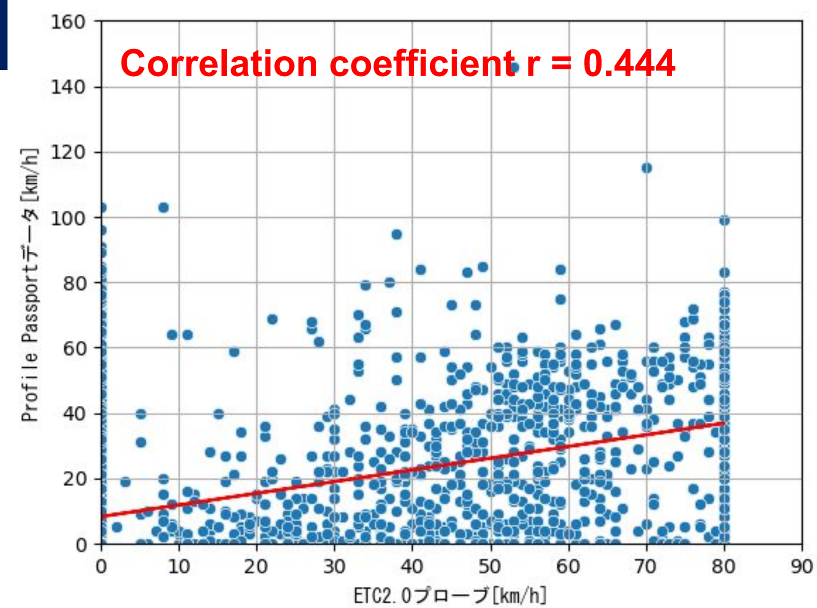


▼Traffic Vision probe data (1 day)

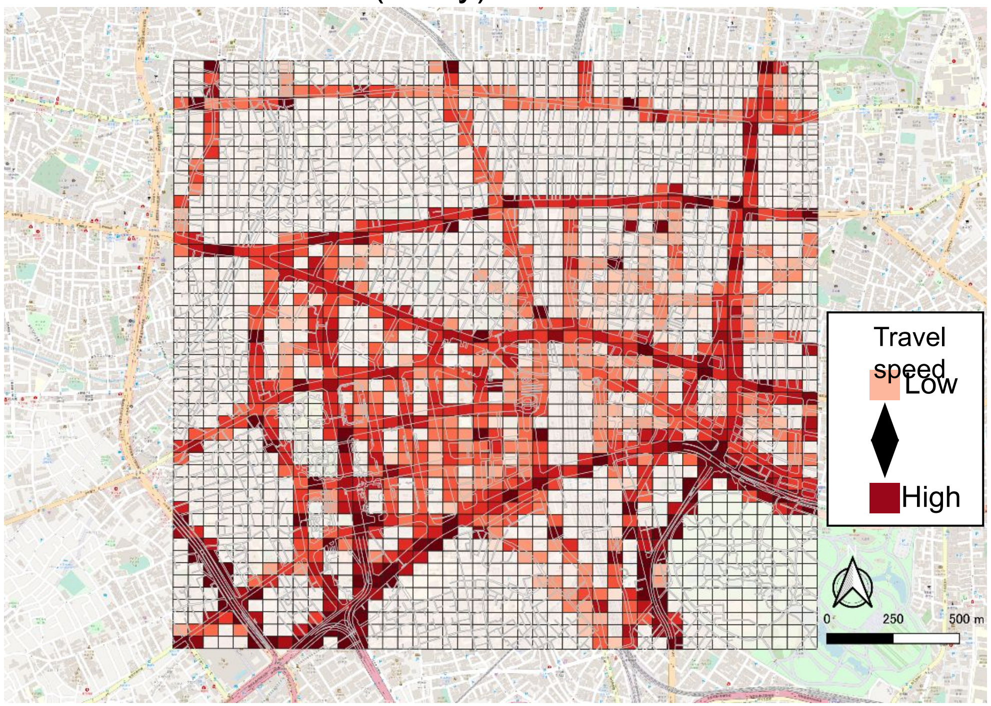


(2) Profile Passport

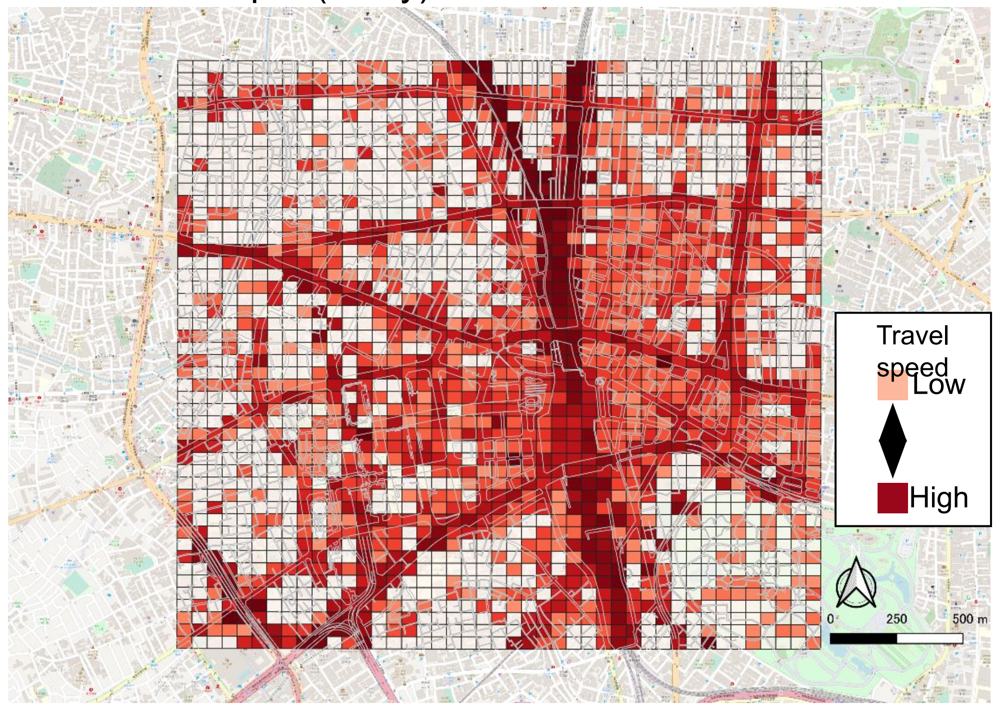
- Profile Passport has plots on arterial roads, but a certain amount of plots outside roads.
- Profile Passport has high travel speeds on railway lines. Possible misidentification of "train" as "car."
- Weak correlation (correlation coefficient: 0.444).



▼ETC2.0 Probe Data(1 day)

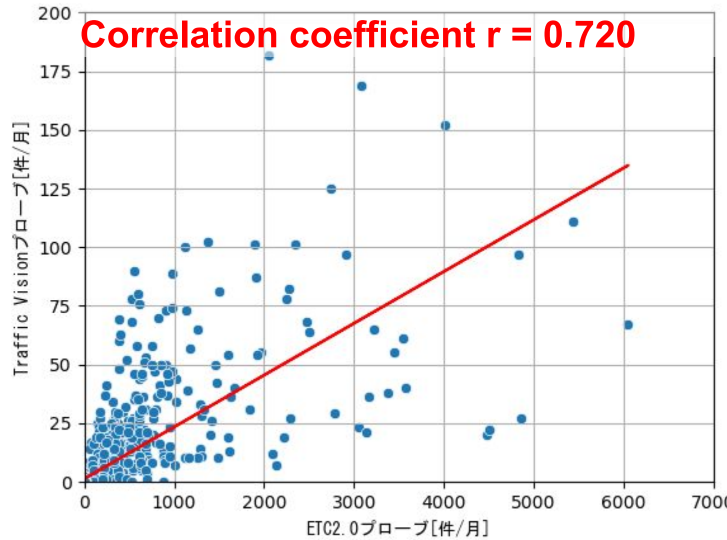


▼Profile Passport(1 day)

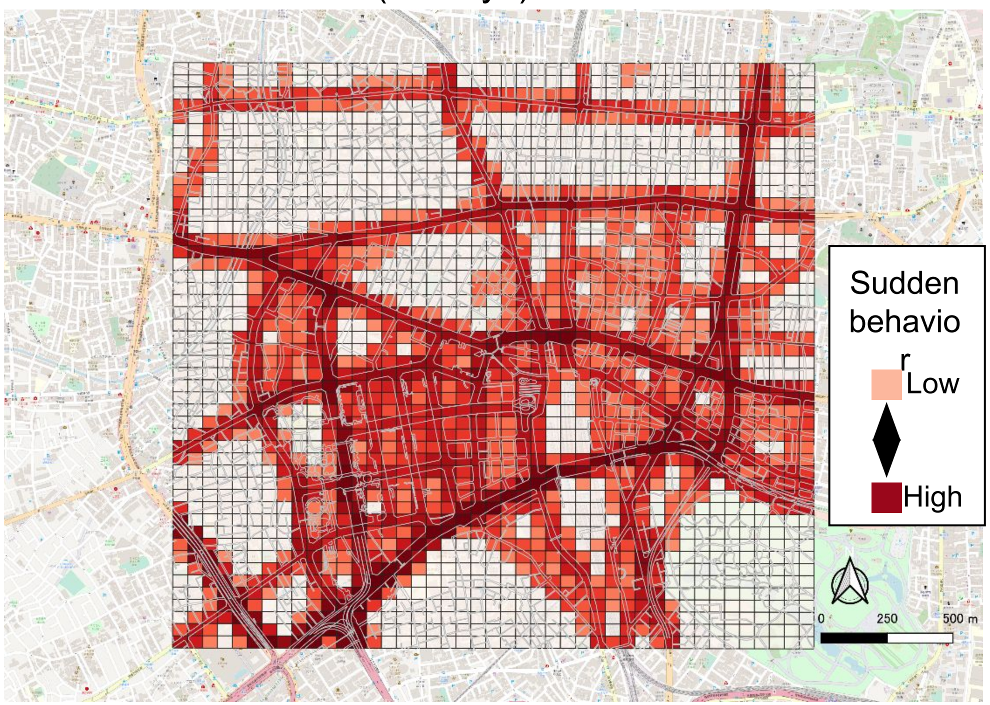


(1) Traffic Vision Probe Data

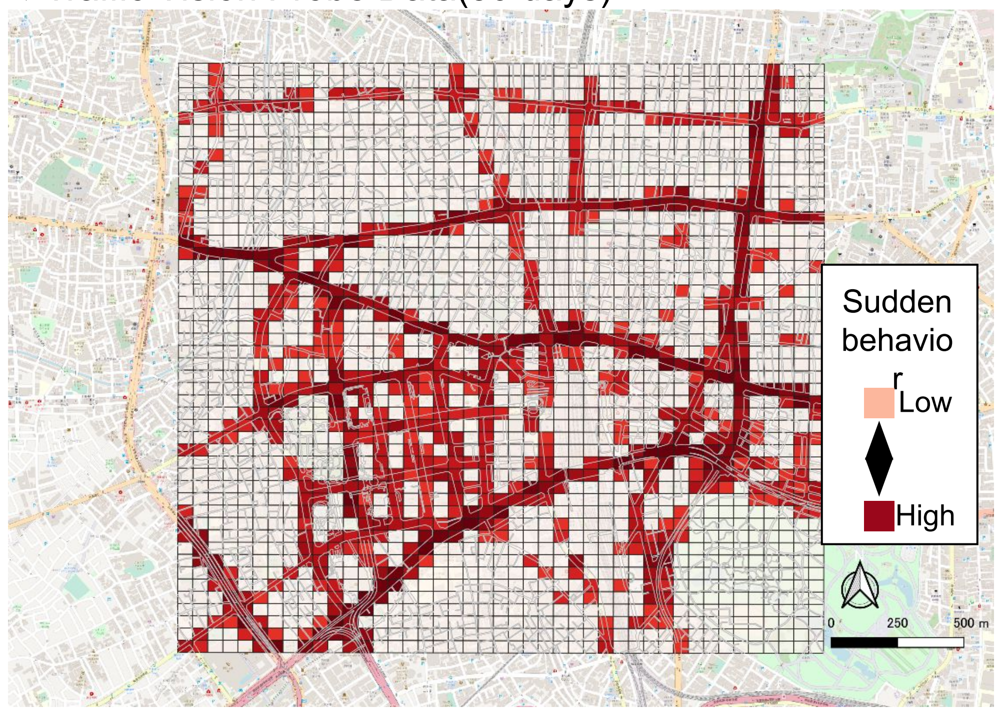
・Data plotted on roads in both cases.
・Traffic Vision has a slightly higher proportion of arterial roads.
・ETC2.0 includes data from narrow streets and building parking lots.
・ Strong correlation (correlation coefficient: 0.720).



▼ETC2.0 Probe Data (30 days)



▼Traffic Vision Probe Data(30 days)



5. Revision of the Traffic Enforcement Handbook

5.1 Overview of the Revision

Research Study Project 1 (2010-2012)
"Research on Traffic Safety
and Traffic Enforcement"
2013 "Traffic Enforcement Handbook"

Research Study Project 2 (2015-2016)
Added and reorganized research results
2017 "Traffic Enforcement Handbook" revised edition issued.

Update of existing content

+

- Addition of the "Traffic Guidance and Enforcement Activity Support System" using artificial intelligence
- Specifications and usage methods of the developed model

Chapter	Title	Revision Content
Chapter 1	Characteristics of Traffic Enforcement	No change
Chapter 2	Relationship Between Traffic Enforcement and Traffic Accidents	No change
Chapter 3	Regional Differences in Traffic Enforcement	No change
Chapter 4	Characteristics of Traffic Violations	No change
Chapter 5	Impact of Traffic Enforcement on Driver Awareness	**Updated content of "Safety Awareness by Showing Traffic Street Activities"**
Chapter 6	Towards Traffic Enforcement that Suppresses Accidents	**Newly added the following two items:** **・Classification of traffic accidents based on differences in enforcement effectiveness** **・Differences in enforcement effectiveness by accident type**
Chapter 7	Efficient Accident Prevention Measures Using ICT	**Based on the results of this research, the following seven items are included:** **・What is artificial intelligence?** **・Transition of traffic safety research using artificial intelligence** **・Example 1 of traffic accident prediction model using artificial intelligence** **・Example 2 of traffic accident prediction model using artificial intelligence** **・Model constructed by the International Association of Traffic and Safety Sciences** **・Overview of the traffic enforcement activity support system** **・Introduction of how to use the traffic enforcement activity support system**

5.3 Revision Details

（1）Cover Image

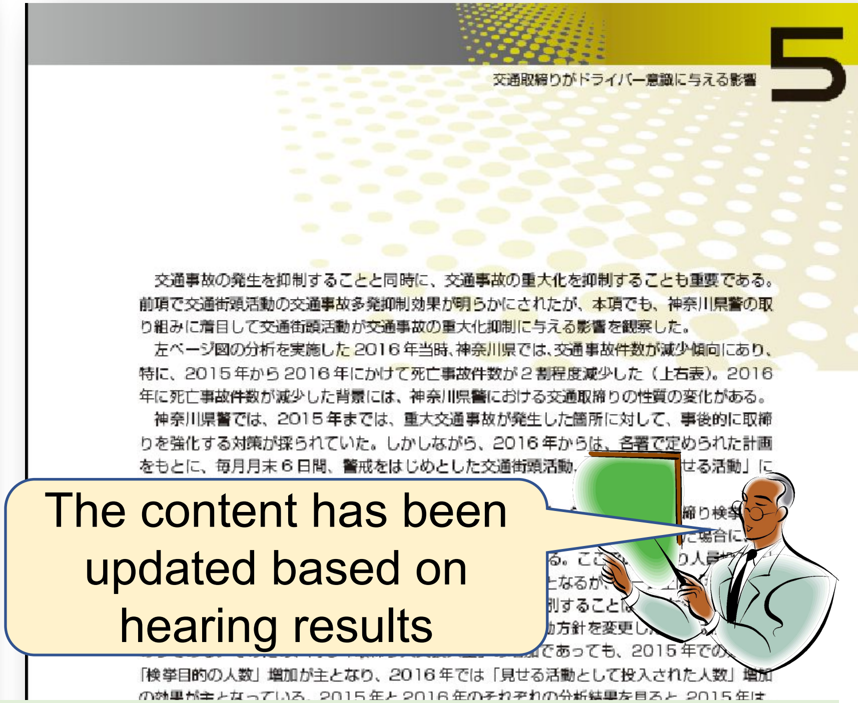
（2）Updated Content of Chapter 5

交通街頭活動を見せることによる安全喚起

取締り検挙人数、取締り人員投入量をそれぞれ 100 人増やした場合に、
発生する交通事故が重大化する確率の変化

		2015	2016
事故件数		28,313件	27,091件
内訳	死亡事故	178件	136件
	重傷事故	1,220件	1,310件
	軽傷事故	26,915件	25,645件

検挙を中心とした取締り人員投入量を増加しても、効果は期待できなかった（2015 年）。



交通取締りがドライバー意識に与える影響

5

交通事故の発生を抑制することと同時に、交通事故の重大化を抑制することも重要である。前項で交通街頭活動の交通事故多発抑制効果が明らかにされたが、本項でも、神奈川県警の取り組みに着目して交通街頭活動が交通事故の重大化抑制に与える影響を観察した。

左ページ図の分析を実施した 2016 年当時、神奈川県では、交通事故件数が減少傾向にあり、特に、2015 年から 2016 年にかけて死亡事故件数が 2 割程度減少した（上右表）。2016 年に死亡事故件数が減少した背景には、神奈川県警における交通取締りの性質の変化がある。

神奈川県警では、2015 年までは、重大交通事故が発生した箇所に対して、事後的に取締りを強化する対策が採られていた。しかしながら、2016 年からは、各署で定められた計画をもとに、毎月月末 6 日間、警戒をはじめとした交通街頭活動、……せる活動」に……

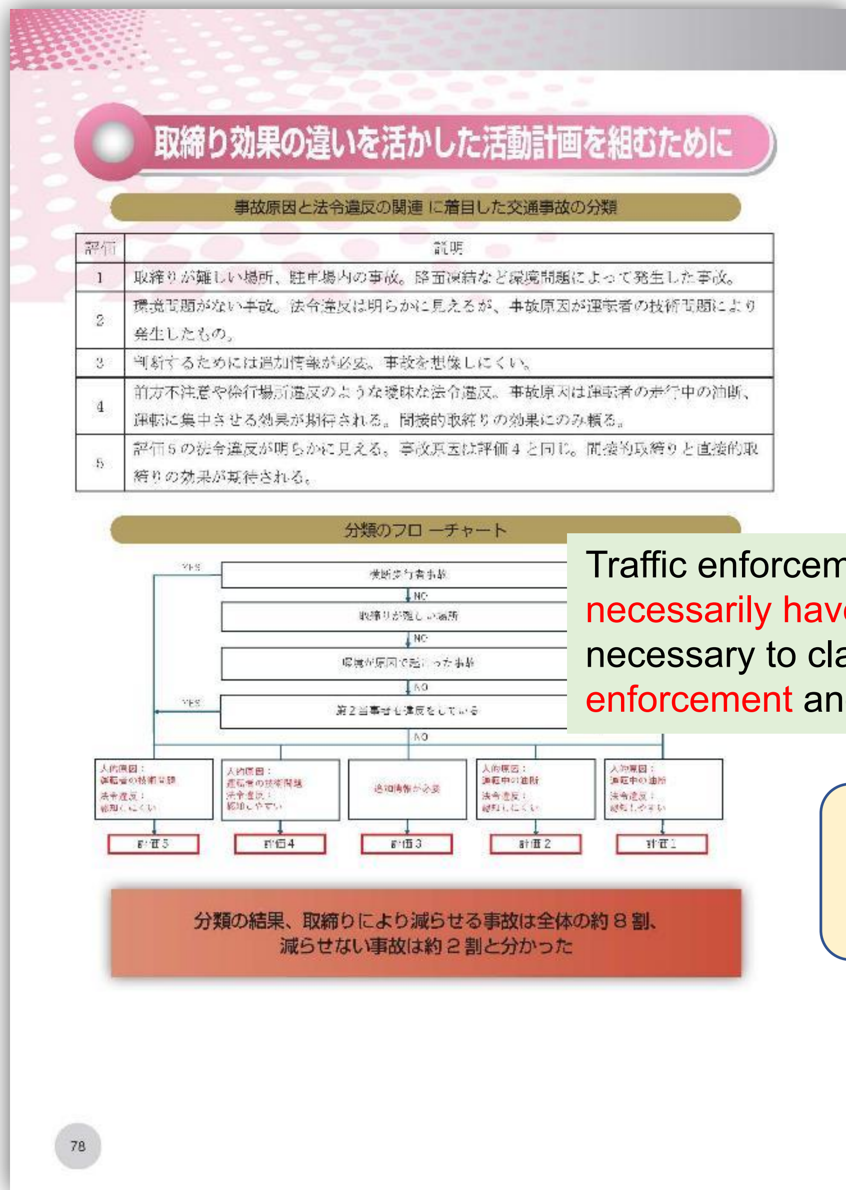
……「検挙目的の人数」増加が主となり、2016 年では「見せる活動として投入された人数」増加……

The content has been updated based on hearing results

While it can be observed that showing traffic street activities in this way has the effect of suppressing the severity of traffic accidents, the decline in fatal accidents has shown a marked tendency to bottom out in recent years. Even looking at the figures from the Kanagawa Prefectural Police (below), the number of traffic accident fatalities, which had been on a downward trend, reached 162 in 2018, and apart from the recent COVID-19 pandemic, the number of fatal accidents shows a tendency to bottom out. This suggests that the effect of 'showing activities' is difficult to continue to raise drivers' traffic safety awareness without a certain level of arrests. The Kanagawa Prefectural Police has also adopted a policy of aiming to reduce traffic accidents while continuing to exert the effect of showing traffic street activities and giving consideration to the accident prevention effect of arrests in recent years.

From the above, it can be seen that not only arrests and direct guidance of drivers who commit traffic violations but also traffic street activities focused on warning can raise drivers' awareness of safe driving and be an effective traffic safety measure. A measure that combines direct guidance and traffic street activities in a balanced manner would be effective.

(3) Added Content of Chapter 6 (Example)



取締り効果の違いを活かした活動計画を組むために

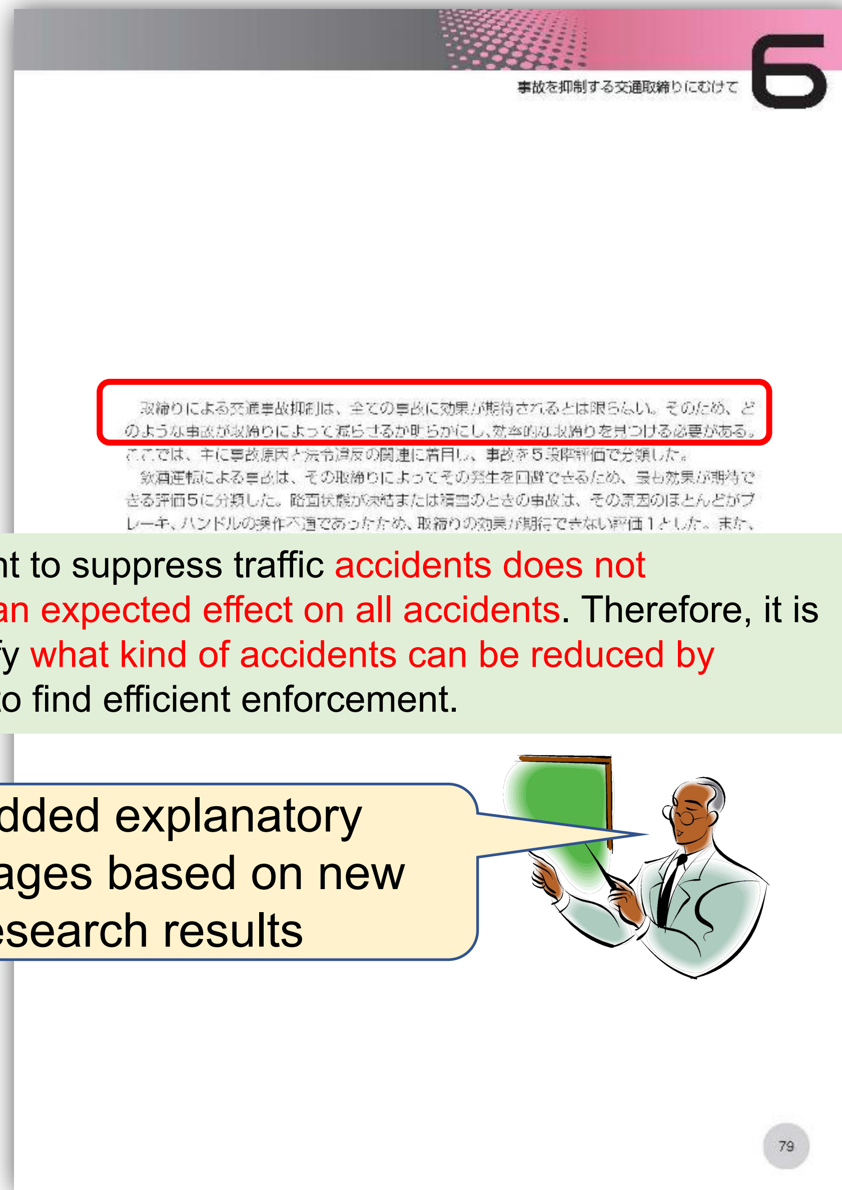
事故原因と法令違反の関連 に着目した交通事故の分類

評価	説明
1	取締りが難しい場所、駐車場内の事故。路面凍結など環境問題によって発生した事故。
2	環境問題がない事故。法令違反は明らかに見えるが、事故原因が運転者の技術問題により発生したもの。
3	判断するためには追加情報が必要。事故を想像しにくい。
4	前方不注意や徐行場所違反のような曖昧な法令違反。事故原因は運転者の走行中の油断、運転に集中させる効果が期待される。間接的取締りの効果にのみ頼る。
5	評価5の法令違反が明らかに見える。事故原因は評価4と同じ。間接的取締りと直接的取締りの効果が期待される。

分類のフローチャート

分類の結果、取締りにより減らせる事故は全体の約８割、
減らせない事故は約２割と分かった

78



事故を抑制する交通取締りにむけて 6

取締りによる交通事故抑制は、全ての事故に効果が期待されるとは限らない。そのため、どのような事故が取締りによって減らせるか明らかにし、効率的な取締りを見つける必要がある。ここでは、主に事故原因と法令違反の関連に着目し、事故を5段階評価で分類した。

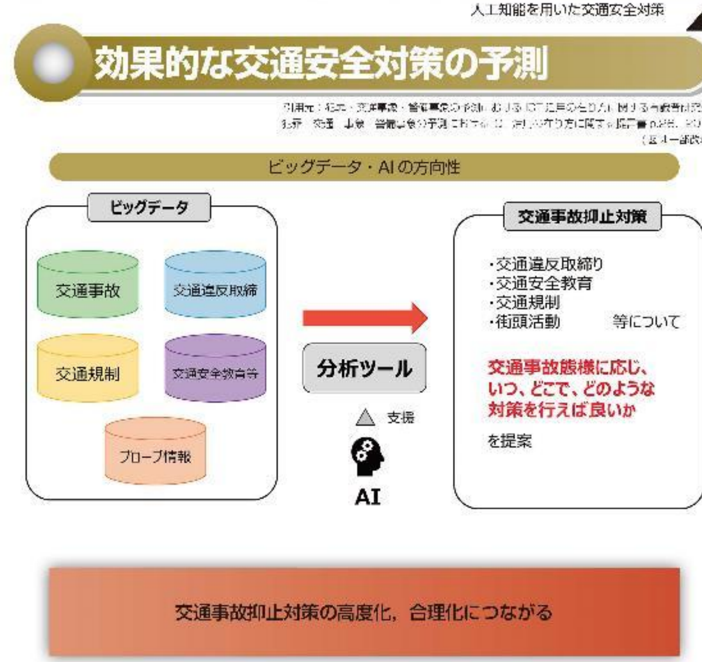
飲酒運転による事故は、その取締りによってその発生を回避できるため、最も効果が期待できる評価5に分類した。路面状態が凍結または積雪のときの事故は、その原因のほとんどがブレーキ、ハンドルの操作不適であったため、取締りの効果が期待できない評価1とした。また、

79

Traffic enforcement to suppress traffic accidents does not necessarily have an expected effect on all accidents. Therefore, it is necessary to clarify what kind of accidents can be reduced by enforcement and to find efficient enforcement.

Added explanatory pages based on new research results

(1) Effective Traffic Safety Measures

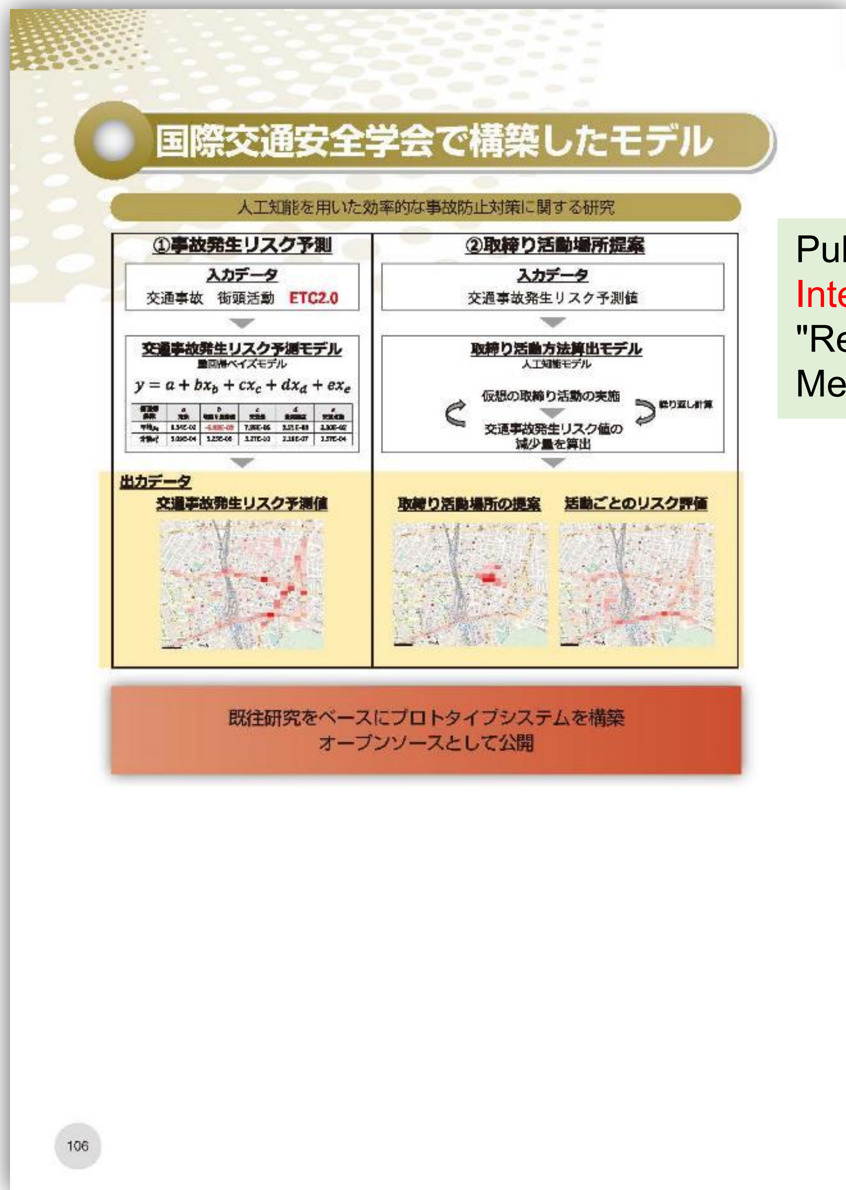


交通安全対策については、事故、違反、規制、街頭活動、民間が保有する情報等のデータを組み合わせたＧＩＳを活用し、事故発生箇所と取締り箇所の位置関係、事故の内容等を警察職員が分析し、交通配置や交通取締り、あるいは道路標識などの交通規制見直し等を行っているのが現状である。

そこで、ＡＩを活用した分析により、様々なタイミングで交通事故の発生を抑止するための必要な対策を予測し、提示するシステムがあれば、限られた人員を必要な時間帯に必要な場所に効果的に配置することができ、交通事故の発生を抑止できるほか、これまで個々の警察職員が時間をかけて分析していた業務の省力化にもつながるものと思われる。

97

(2) Overview of the IATSS Model



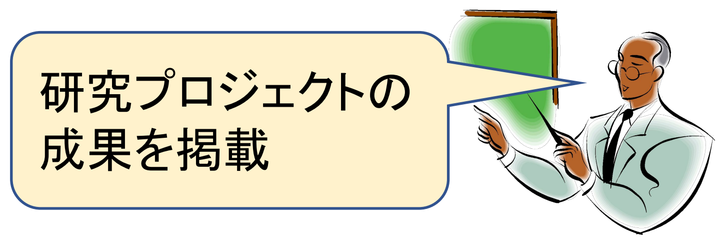
7 人工知能を用いた交通安全対策

Published the results of research projects conducted by the International Association of Traffic and Safety Sciences: "Research Project on Efficient Traffic Accident Prevention Measures Using Artificial Intelligence (2022-2024)

て研究成果を整理しつつ、今後の実用化に向けて、人工知能を用いた効率的な交通事故防止対策に関する研究プロジェクト（2022年～2024年）が国際交通安全学会で実施された。

このモデルの特徴は、従来の統計手法から得た知見を活かした予測モデルと、ビッグデータを用いた人工知能による逐次更新モデルを組み合わせたハイブリッド型のモデルを構築していることである（左図参照）。

本モデルは、交通事故や取締り活動などのデータをもとに、交通事故を抑止する効率的な取締り活動場所の提案が可能である。

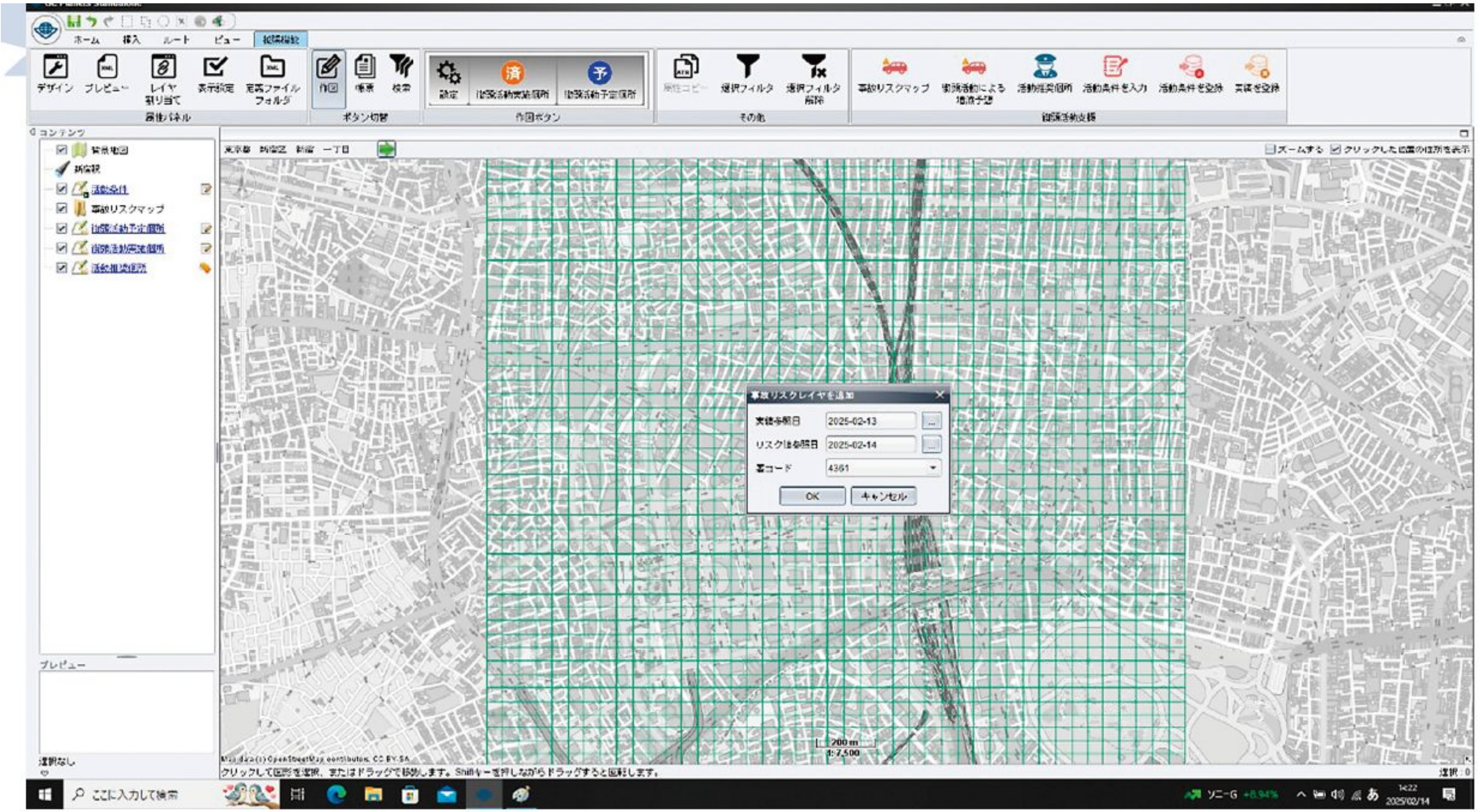


107

(3) System Description 1

[Step 1」Input area and date/time for which you want to conduct enforcement activities

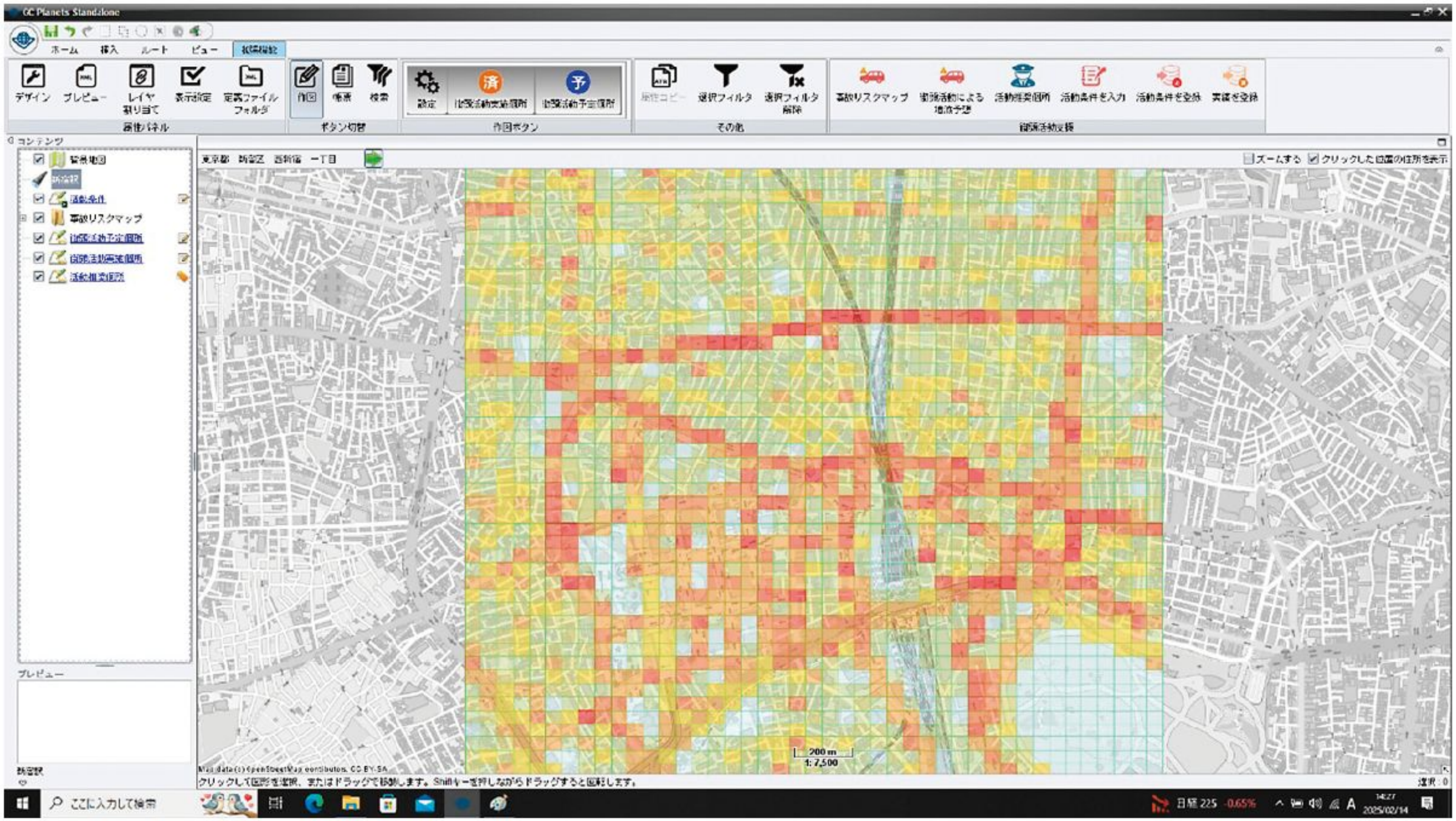
●Input the jurisdictional area (local police station unit) and date/time for which you want to conduct enforcement activities.



5.4 Revision Details (Newly Established: Traffic Safety Measures Using Artificial Intelligence)

（3）System Description 2

[Step 2] Display current traffic accident risk on a map.
●Display the current traffic accident risk in the jurisdictional area and date/time input in Step 1 on the screen in a map and check the locations with high risk.

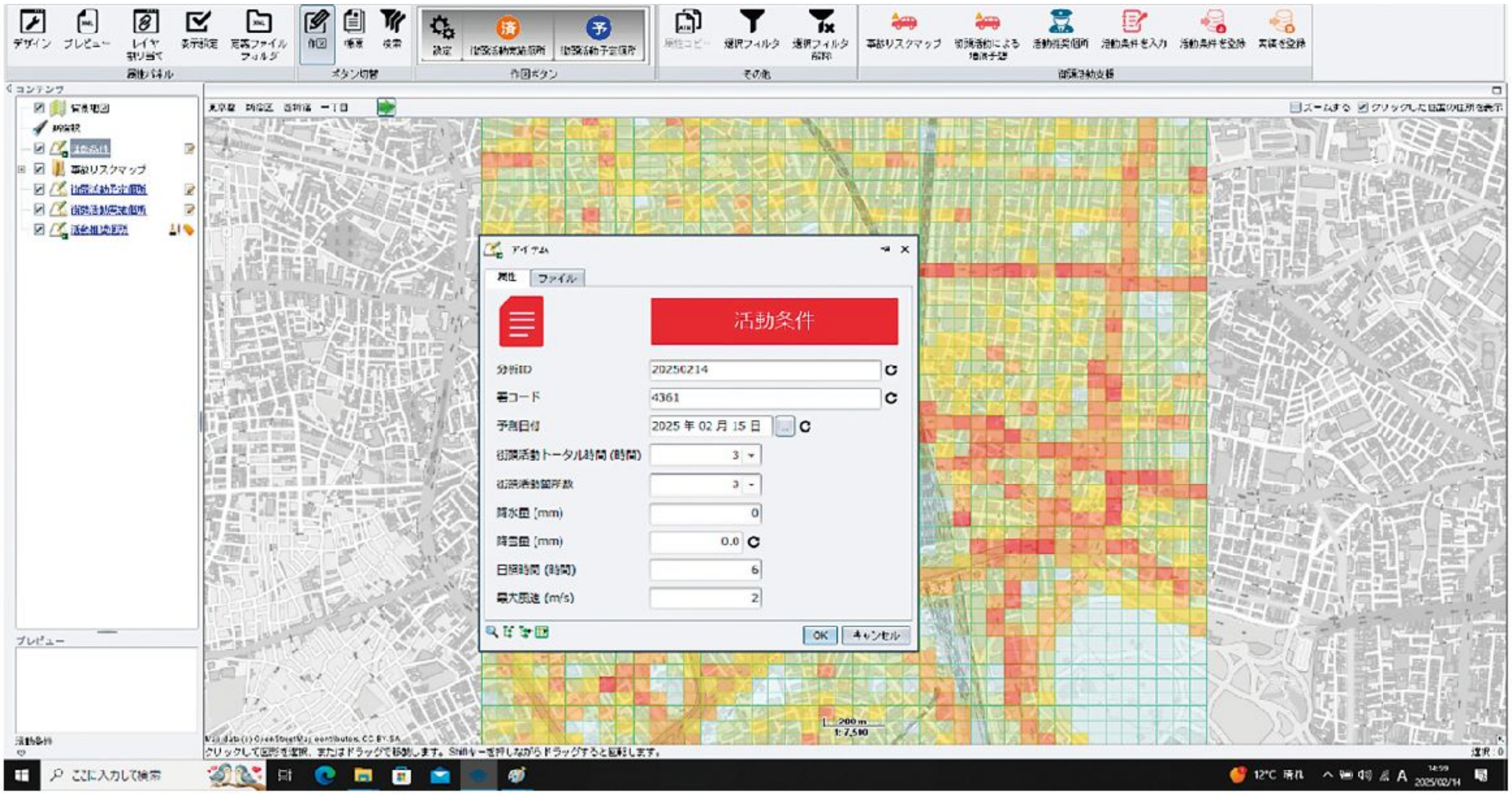


(3) System Description 3

[Step 3] Input activity conditions for the enforcement activity day.

●Input the activity conditions for the day of enforcement activity (number of activity hours, number of street activity locations, precipitation, snowfall, sunshine hours, maximum wind speed) with reference to the weather forecast.

* Necessary information can be obtained from online weather forecast information (Japan Weather Association website, etc.)

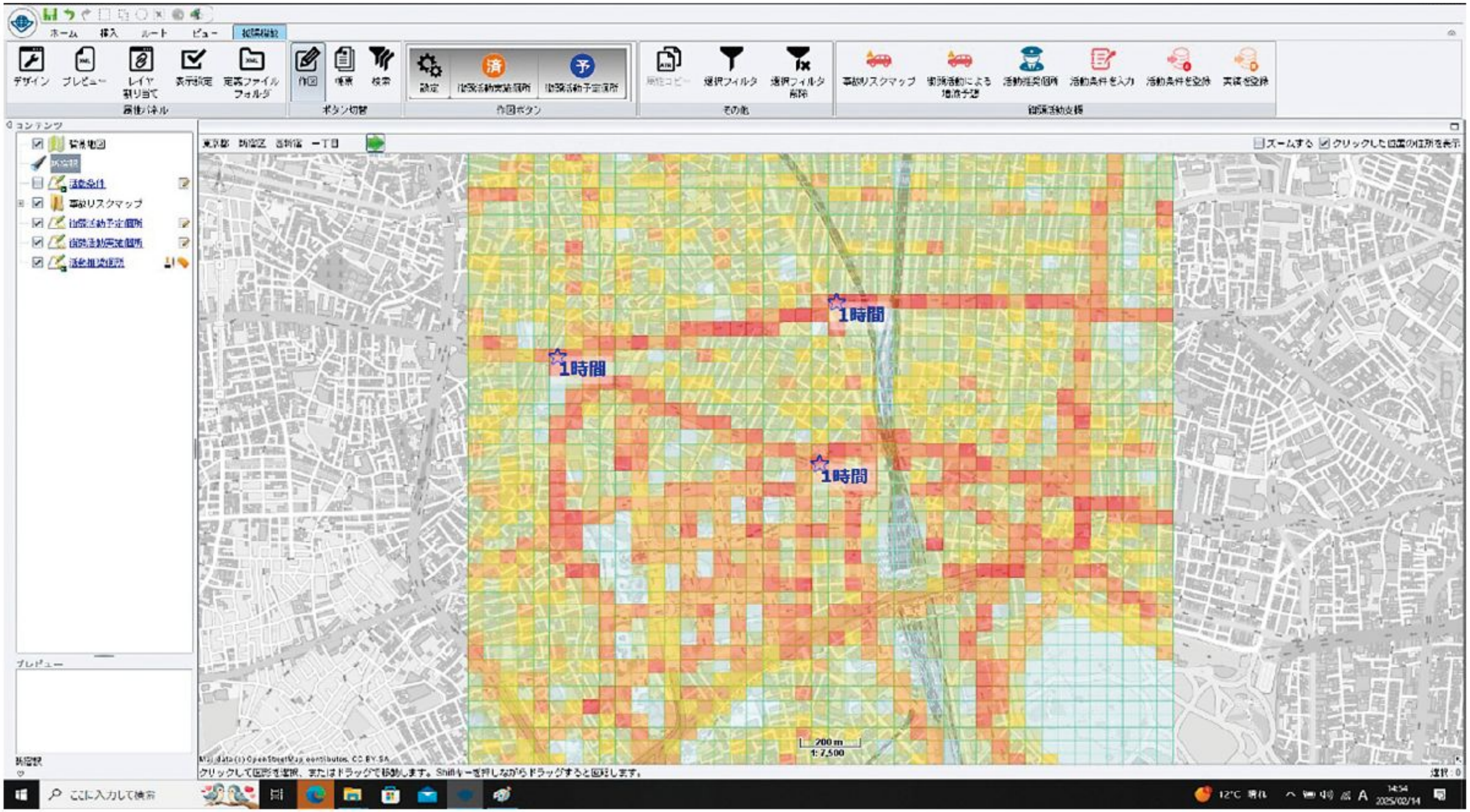


5.4 Revision Details (Newly Established: Traffic Safety Measures Using Artificial Intelligence)

（3）System Description 4

[Step 4] The system proposes optimal enforcement activity locations.

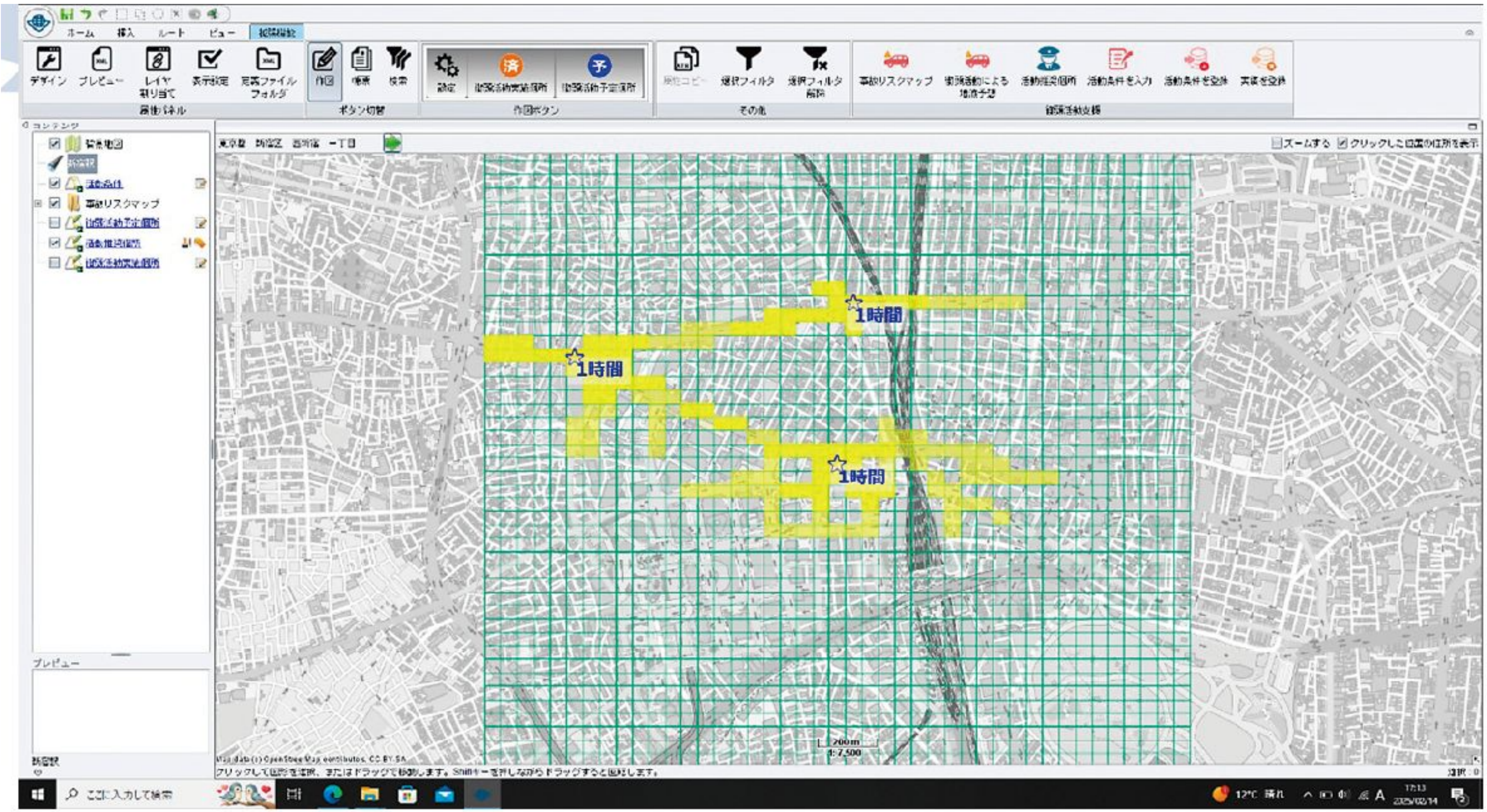
●Based on the activity conditions in Step 3, have the system calculate the traffic accident risk when enforcement activities are conducted. Furthermore, based on the calculation results, have the system propose the optimal enforcement activity locations.



（3）System Description 5

[Step 5] Calculate and map the enforcement effect when conducted at system-proposed locations.

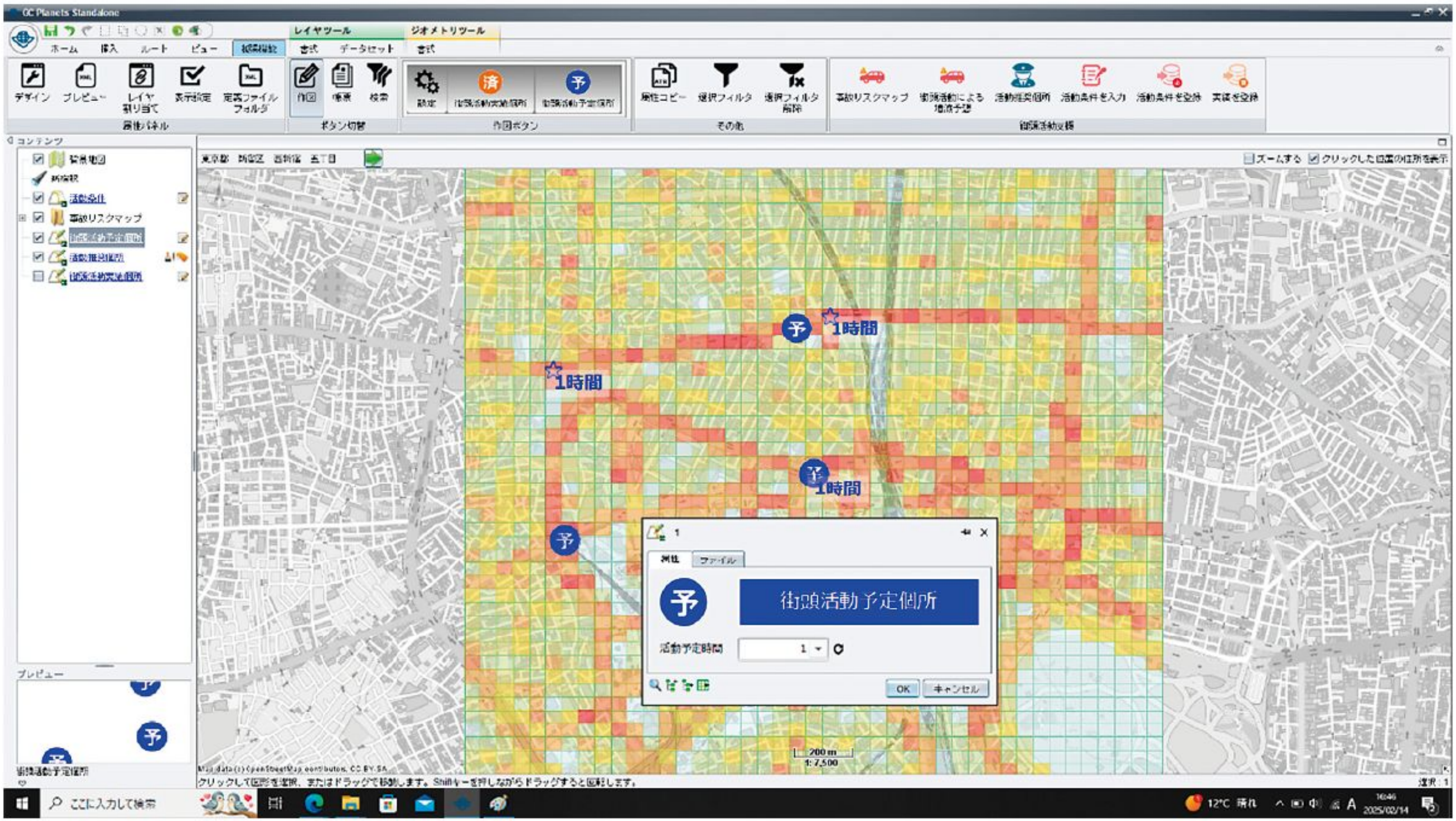
●Based on the current traffic accident risk Step 2, calculate the reduction effect of traffic accident risk when enforcement activities are conducted at the enforcement activity locations proposed by the system and display it on a map.



(3) System Description 6

[Step 6] Set the planned locations for enforcement activities.

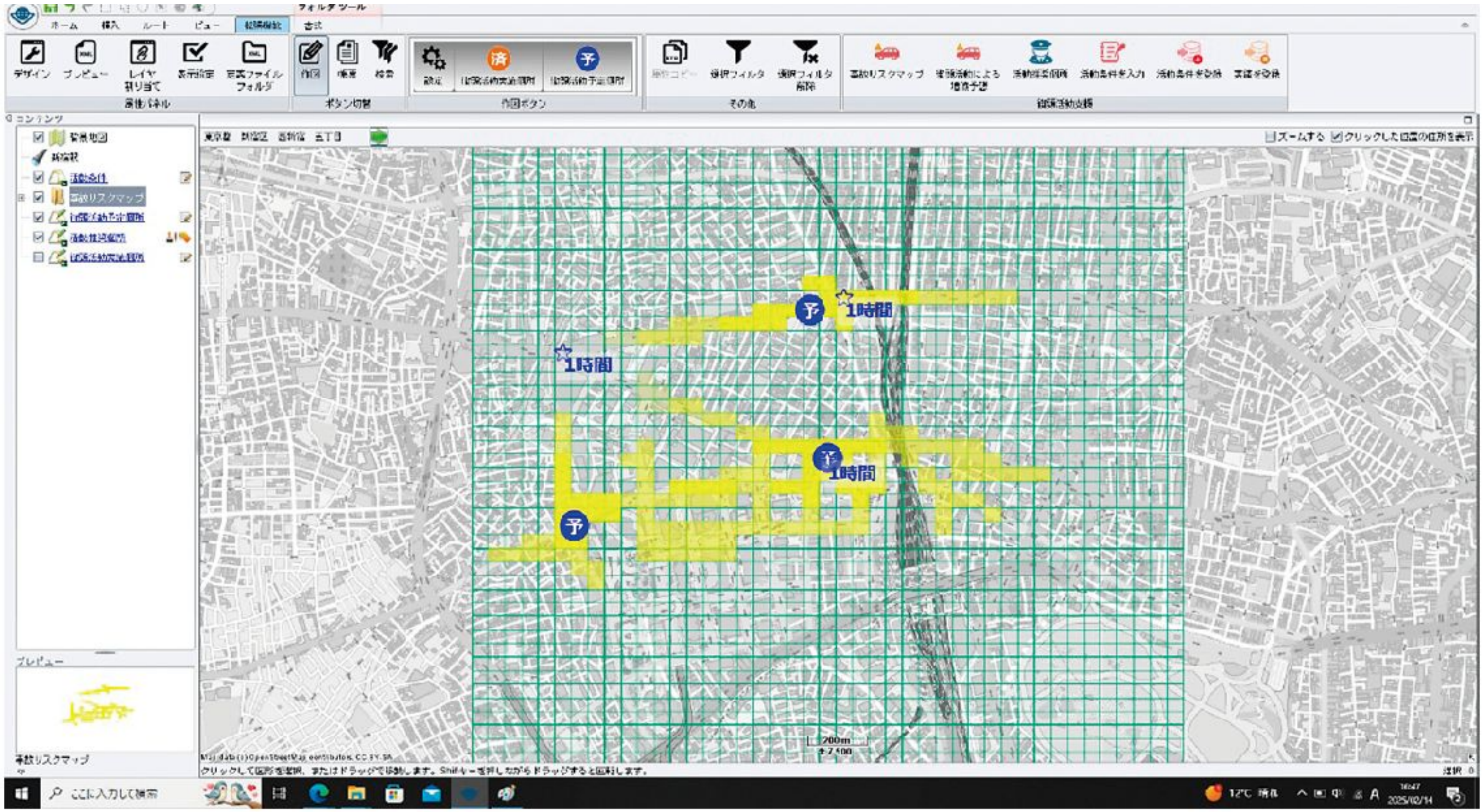
●With reference to the enforcement activity locations proposed by the system, set the planned locations for conducting enforcement activities.



(3) System Description 7

[Step 7] Calculate and map the enforcement effect when conducted at planned locations.

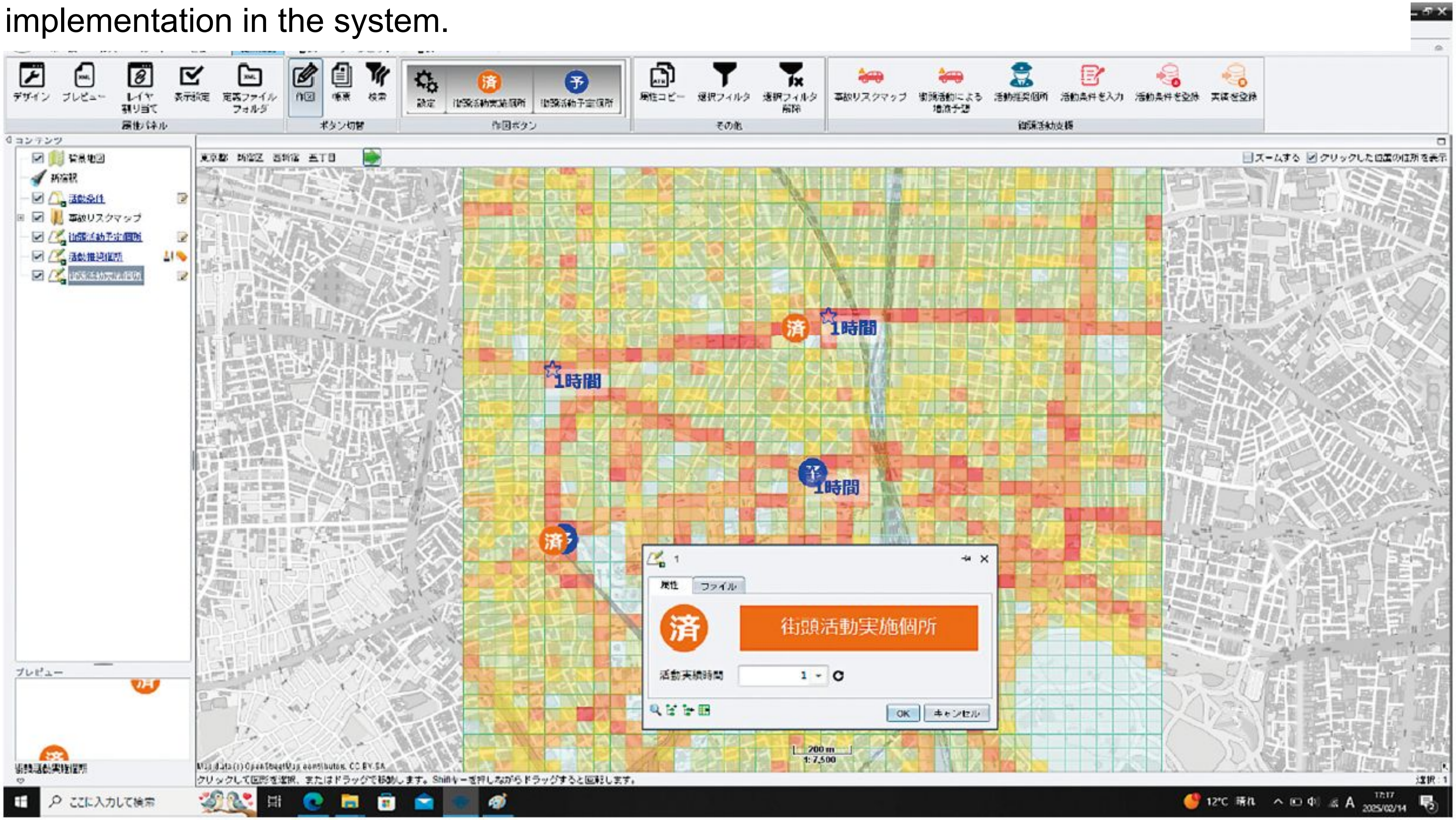
●Based on the current traffic accident risk Step 2, calculate the reduction effect of traffic accident risk when enforcement activities are conducted at the planned enforcement locations and display it on a map. Here, the risk reduction effects of multiple candidate cases can be compared. Based on these results, finally determine the enforcement activity locations.



(3) System Description 8

[Step 8] After conducting enforcement activities, register the actual locations and times of implementation.

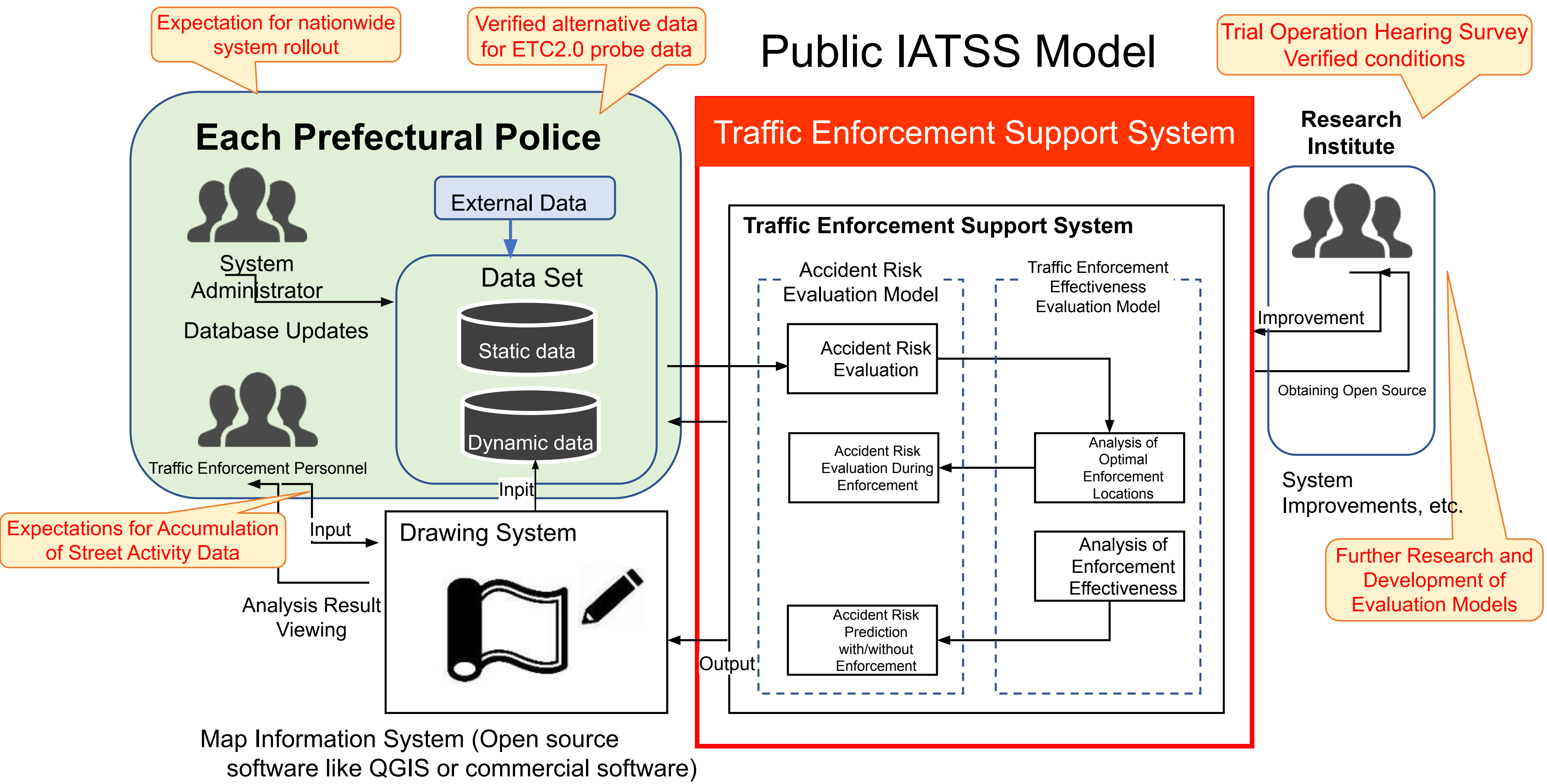
●After actually conducting enforcement activities, register the locations and times of implementation in the system.



6. Summary of Research

6. Summary of Research

・Based on the results of trial operation of the constructed system and hearing surveys, the conditions were verified.
・It was found that there are differences in the data held and available data among the prefectural police departments.
・In the future, it is expected that the system will be deployed nationwide through improvements to the evaluation model, improvements in system versatility, and accumulation of data.



 42

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