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XIII INTERNATIONAL WINTER ROAD CONGRESS

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WORLD ROAD ASSOCIATION
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SUSTAINABLE WINTER SERVICE FOR ROAD USERS

PERFORMANCE MEASUREMENT OF WINTER ROAD MANAGEMENT

Naoto TAKAHASHI

Civil Engineering Research Institute for Cold Region
P.W.R.I., Japan

Deputy Team Leader, Traffic Engineering Research Team

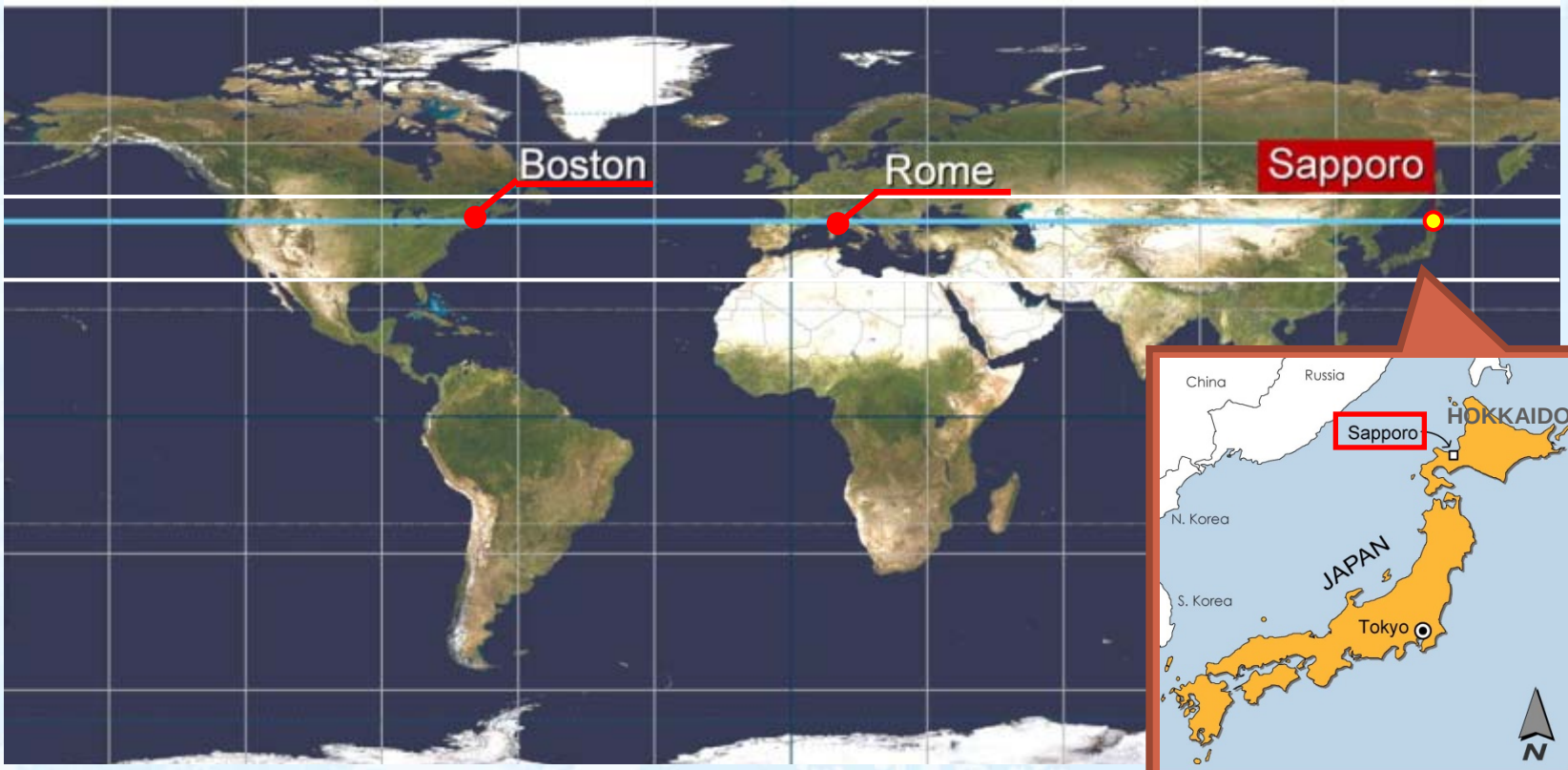
takahashi-n24k@ceri.go.jp

OUTLINE

- Introduction
- Research trends in performance measurement of winter road management
- Performance measurement for winter road management
  - Method of performance measurement
  - Logic model for winter road management
  - Measuring the surface friction
- Trial performance measurement for winter road management
  - Trial for performance measurement
  - The relationship between road surface friction and traffic conditions
- Conclusions and Suggested Research

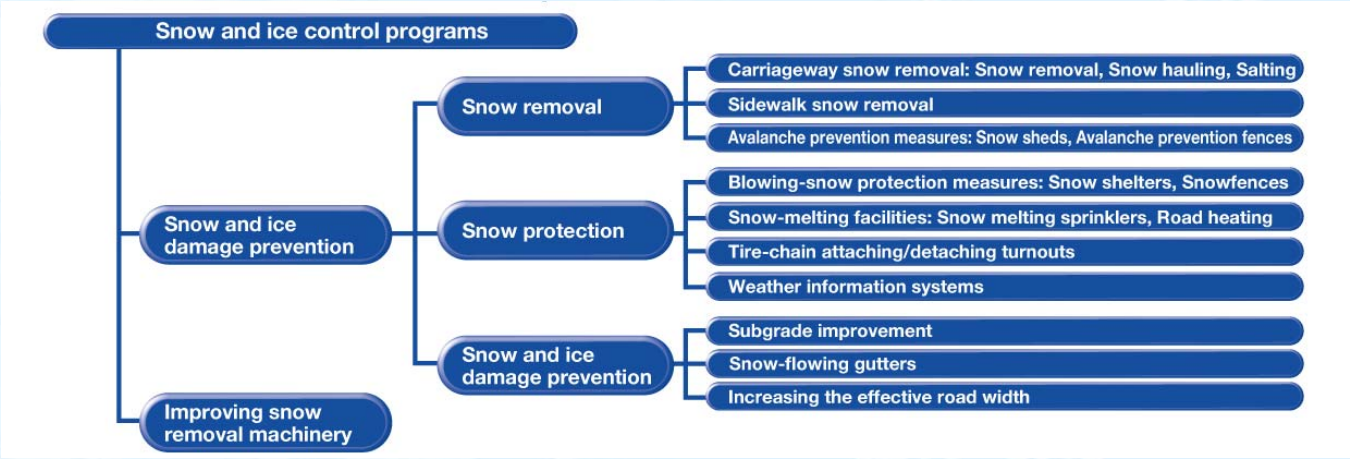
INTRODUCTION

- Japanese Archipelago: Between the Latitudes of 20 and 45 Degrees North
- Hokkaido: Northernmost Major Island of Japan
- Ave. Temp. from Dec. to Mar. is below 0 Degree Celsius
- Ave. annual period of snow cover exceeds 100 days



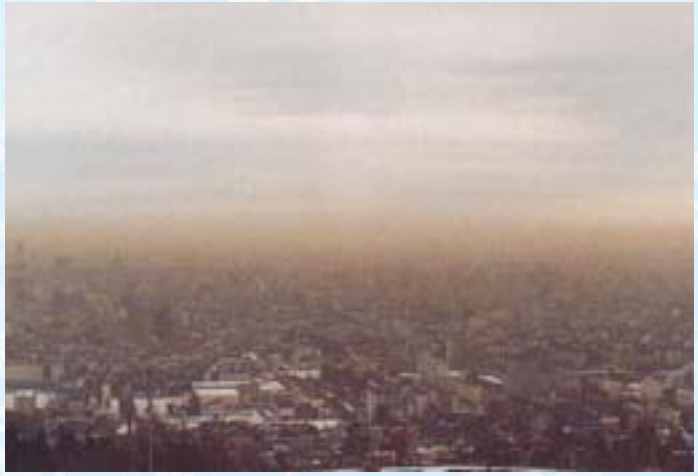
WINTER ROAD MANAGEMENT

- In 1956, The Special Measures Law for Ensuring Road Traffic in Snowy and Cold Areas was enacted to ensure smooth winter traffic.



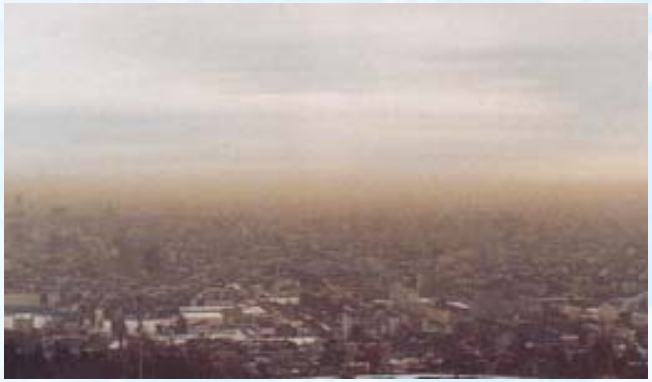
REGULATION OF STUDDED TIRE IN JAPAN

- To improve the performance of tires on snowy, icy roads, the use of *studded tires* (tires with metal studs on the tread surface) started around 1960.
- The studded tires damaged the roads by abrading and rutting them, and the dust from that abrasion caused air pollution.
- Local government ordinances restricting the use of studded tires were issued, and the use of such tires was restricted by law at the beginning of the 1990s.



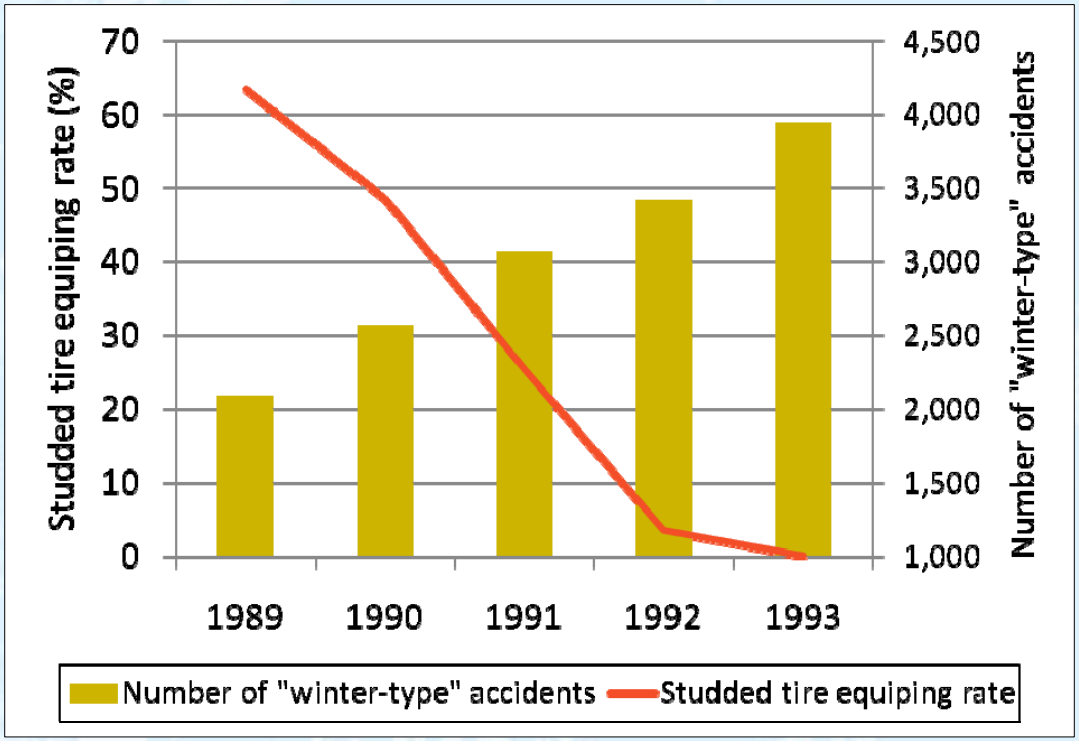
- Restrictions on the use of studded tires considerably improved the living environment.






INFLUENCE OF STUDDED TIRE REGULATION

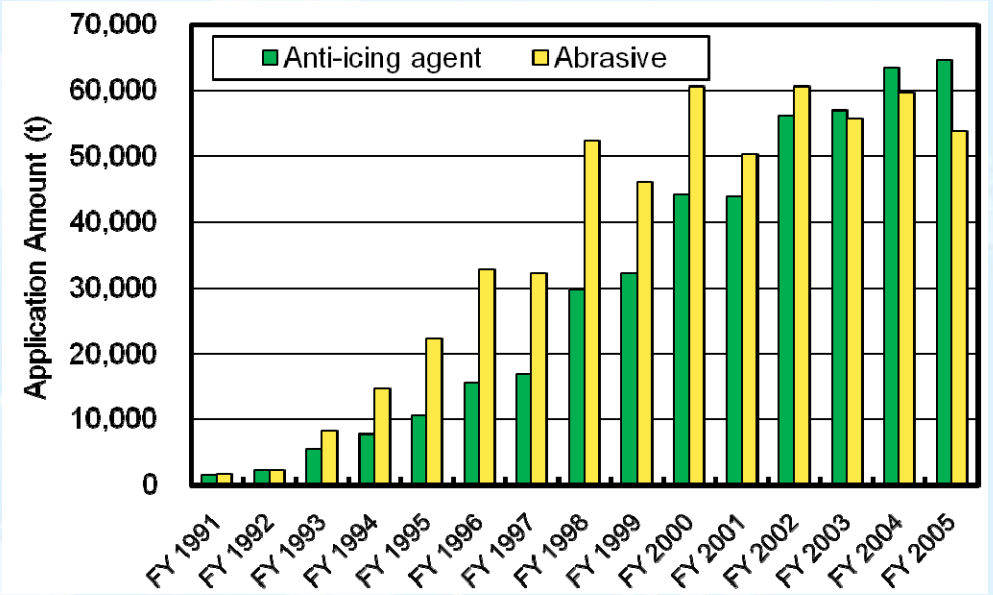
- “Extremely slippery, icy roads” began to appear.
- Increases in the number of “winter-type” traffic accidents and congestion caused by the lowered traveling speed of vehicles, have resulted.



WINTER ROAD MANAGEMENT AFTER THE RESTRICTION

- The amounts of anti-icing agents and anti-skidding materials (abrasives) remarkably increased.
- On the national highways in Hokkaido (6,000 km), the amount of anti-icing agents, which were not being used before studded tire use-restriction, rapidly increased.

Road surface management, particularly measures against icy road surfaces, has become a very important part of winter road management.



ISSUES FOR WINTER ROAD MANAGEMENT AFTER THE RESTRICTION

- Although winter road management has been improved after the regulation of studded tire use, road traffic performance in winter has remained low.
  - Traveling speeds in winter have remained low.
  - Skidding accidents account for 90% of the “winter-type” traffic accidents.

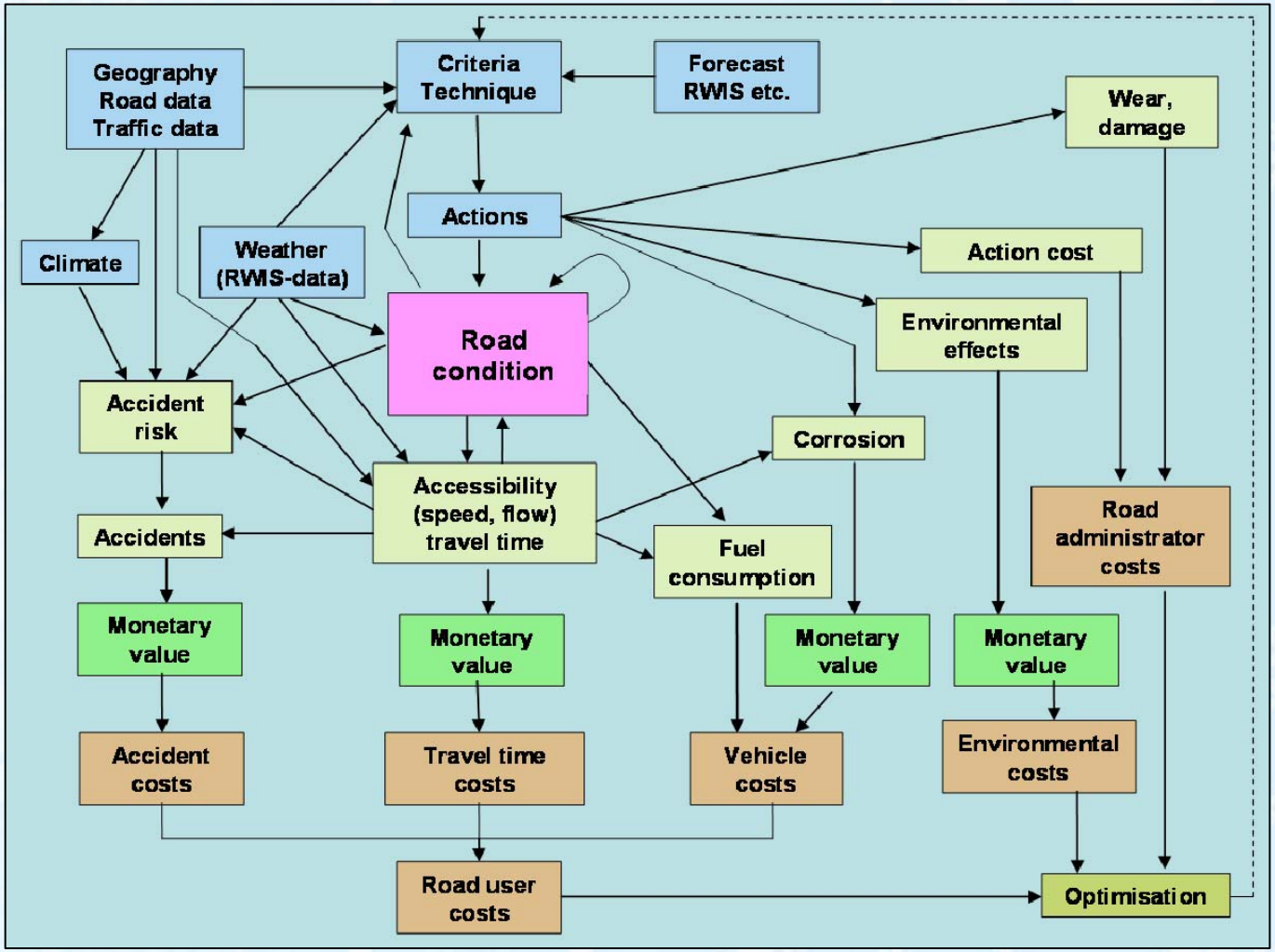
To improve the performance of winter road traffic under budget constraints and environmental concerns over the use of anti-icing agents, there is a need for accurate and efficient winter road management.

RESEARCH TRENDS IN PERFORMANCE MEASUREMENT OF WINTER ROAD MANAGEMENT

- In Japan, performance measurement has been used in measuring economic effects as a part of public project evaluation and in evaluating each program of a public project.
- Road administration organizations have been striving to improve their activities more effective, efficient & transparent.
  - placing importance on the perspectives of citizens.
  - employing a management system, "Plan-Do-Check-Act" cycles.
    - quantitative indicators are preset (Plan),
    - policies and projects are implemented (Do),
    - performance is evaluated (Check), and
    - the evaluation is reflected in the future management (Act) .
- A few studies have addressed performance measurement and evaluation for winter road management.

“WINTER MODEL”

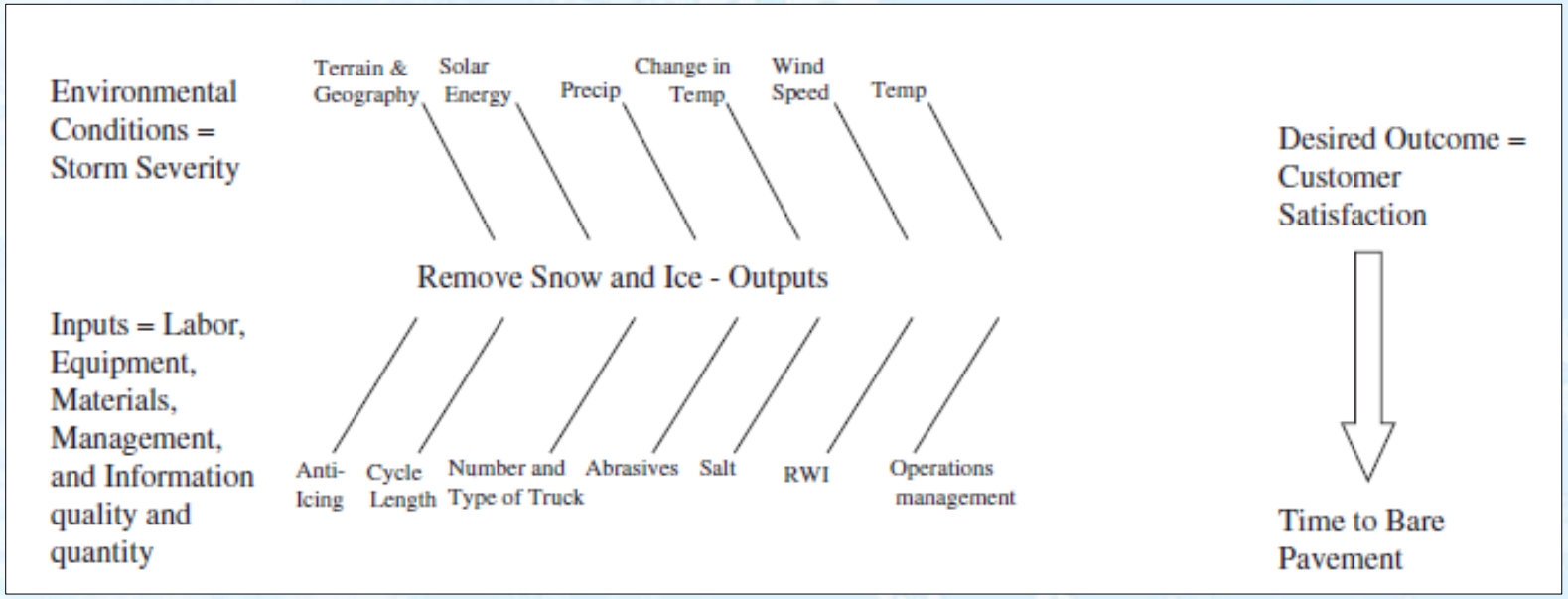
- Sweden has developed Winter Model.
  - optimizing winter road management



Source: Carl-Gustaf Wallman (2004). The Winter Model: A Winter Maintenance Management System, Transportation Research Circular Number E-C063, pp83-94, Transportation Research Board

RELATIONSHIP BETWEEN INPUTS, OUTPUTS, AND OUTCOMES

- United States has surveyed and reported performance measures for snow and ice control operations.
- The report shows that performance measurement for winter road management categorized in three areas: inputs, outputs, and outcomes.



Source: NCHRP Project 6-17 (2007). Performance Measures for Snow and Ice Control Operations, NCHRP Web-Only Document #136, http://trb.org/news/blurb/blurb_detail.asp?id=10053.

PERFORMANCE MEASUREMENT FOR WINTER ROAD MANAGEMENT

Method of performance measurement

- Logic model was employed.
- Describe the logical flow of elements necessary for performance measurement as a diagram with inputs, activities, outputs and outcomes flows.
- Makes it possible to visually understand the relationships between the elements.
- Logical tracking from the initial inputs to the end products makes it possible to formulate a systematic policy and determine each outcome toward achieving the final goal.

LOGIC MODEL FOR WINTER ROAD MANAGEMENT

Inputs

- Budget for winter road management
- Equipment (that used for winter road management)
- Personnel (public office personnel, contractors, workers)

Activities

- Implementation of winter road management operations

Outputs

- Number of deployments (patrol and spreading fleets)
- Spreading amount of anti-icing agents

Outcomes

Intermediate Outcome

- Friction (quantitative indicator of road surface condition)

End Outcome

- Winter traffic conditions (travel speed, traffic volume, capacity)
- Winter-type accidents (number and occurrence rate)
- Reliability of travel time (decrease and variance)
- Customer satisfaction (number of complaints, ease of driving)

"OUTCOME" OF WINTER ROAD MANAGEMENT

- *Intermediate outcome*: "an outcome that is expected to lead to a desired end goal, but is not an 'end goal' in itself."
- *End outcome*: results of programs that are implemented.

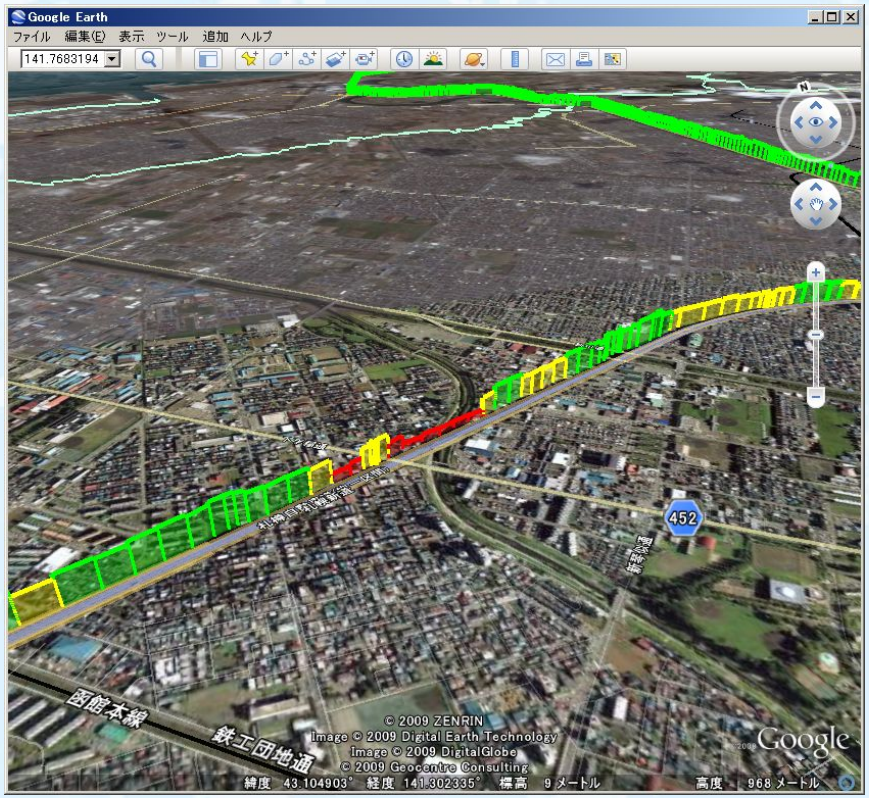
- The purpose of winter road management is to provide a safe, convenient road traffic environment to the road users by improving the road surface conditions.
  - Road surface friction, which is a direct result of winter road management, was employed as the intermediate outcome.
  - Traffic conditions, which are measurable in the form of road traffic data and satisfaction, were employed as the end outcomes.

MEASURING THE SURFACE FRICTION

“Continuous Friction Tester (CFT)”

- Determine the Halliday Friction Number (HFN) for the road surface by using the measuring wheel attached to the rear of the vehicle while driving, which makes it possible to measure the road surface friction continuously.

Continuous Friction Tester



Measurement result on Google Earth

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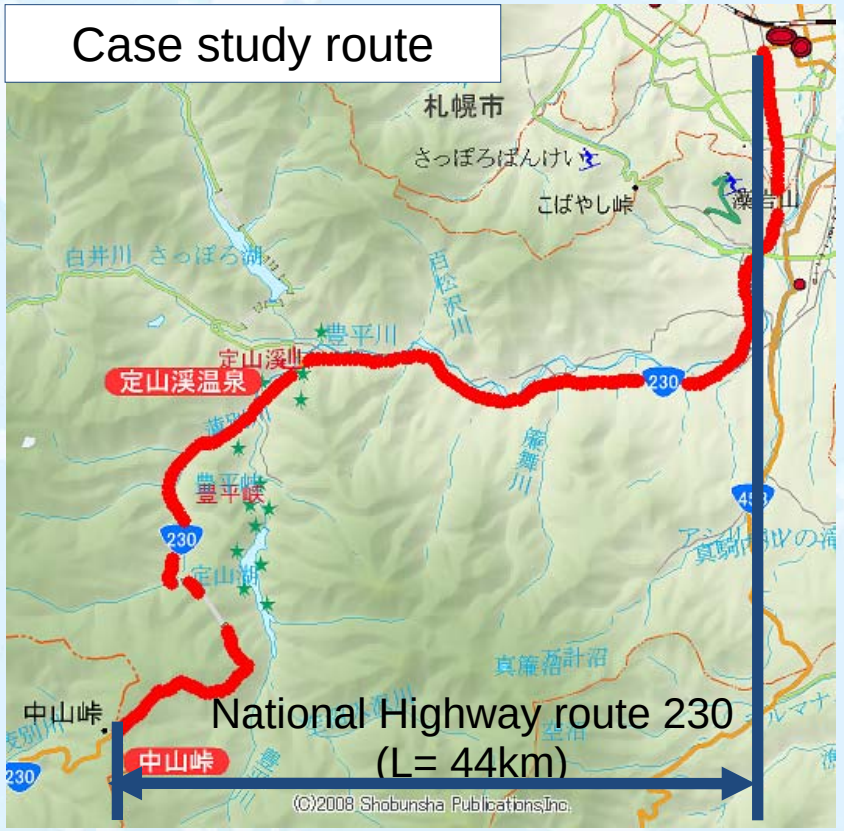
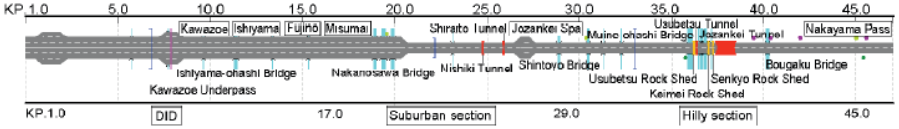
TRIAL PERFORMANCE MEASUREMENT FOR WINTER ROAD MANAGEMENT

- Monitoring of the road surface friction using the CFT for national highways in Sapporo started in the winter of 2007.
- A case study route is National Highway 230 (44km).



- Inputs: budget & equipments for winter road management.
- Outputs: amount of anti-icing agent spread.
- Intermediate outcome: The road surface friction (HFN).
- End outcomes : travel speed, winter-type accidents.

Data on the route: Length: 44 km, number of lanes: 4 – 6, density of signaled intersections: 4.2 intersections/km, bridge length: 2,254 m, number of tunnels: 4 (combined length of 1,507 m), length with permeable pavement: 17.8 km, number of sections installed with road heating: 1

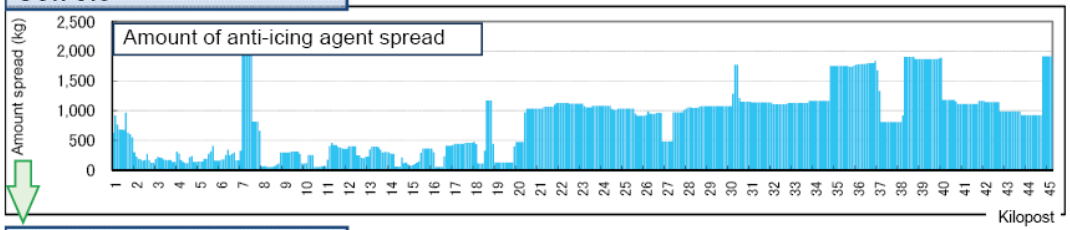


Purpose: To improve safety, convenience and reliability of winter road traffic.
Goal: To secure winter road surface friction of xx (HFN) or higher.

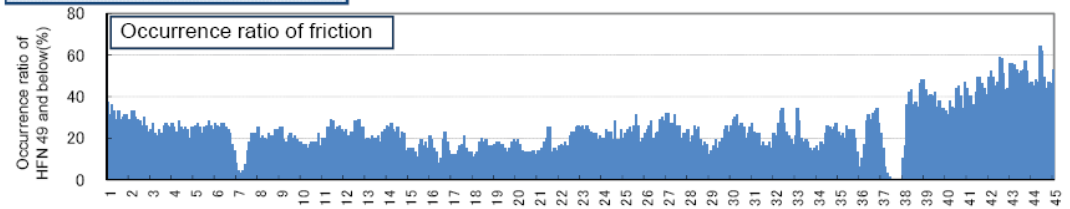
INPUTS

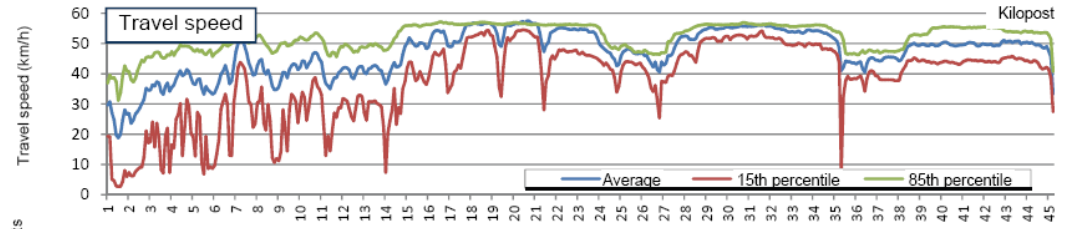
- Budgets (Unit: thousand yen) : Snow hauling: 107,395, planned snow removal and supplemental work: 58,060, spreading of anti-icing agent: 64,601
  Note: The figures were calculated based on the work records.
- Equipment (incl. facilities): Two snow removal stations, 16 work vehicles (for snow removal and spreading works)

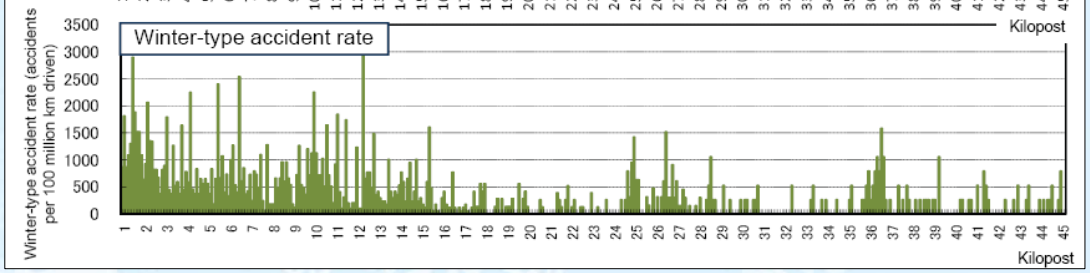
OUTPUTS



OUTCOMES







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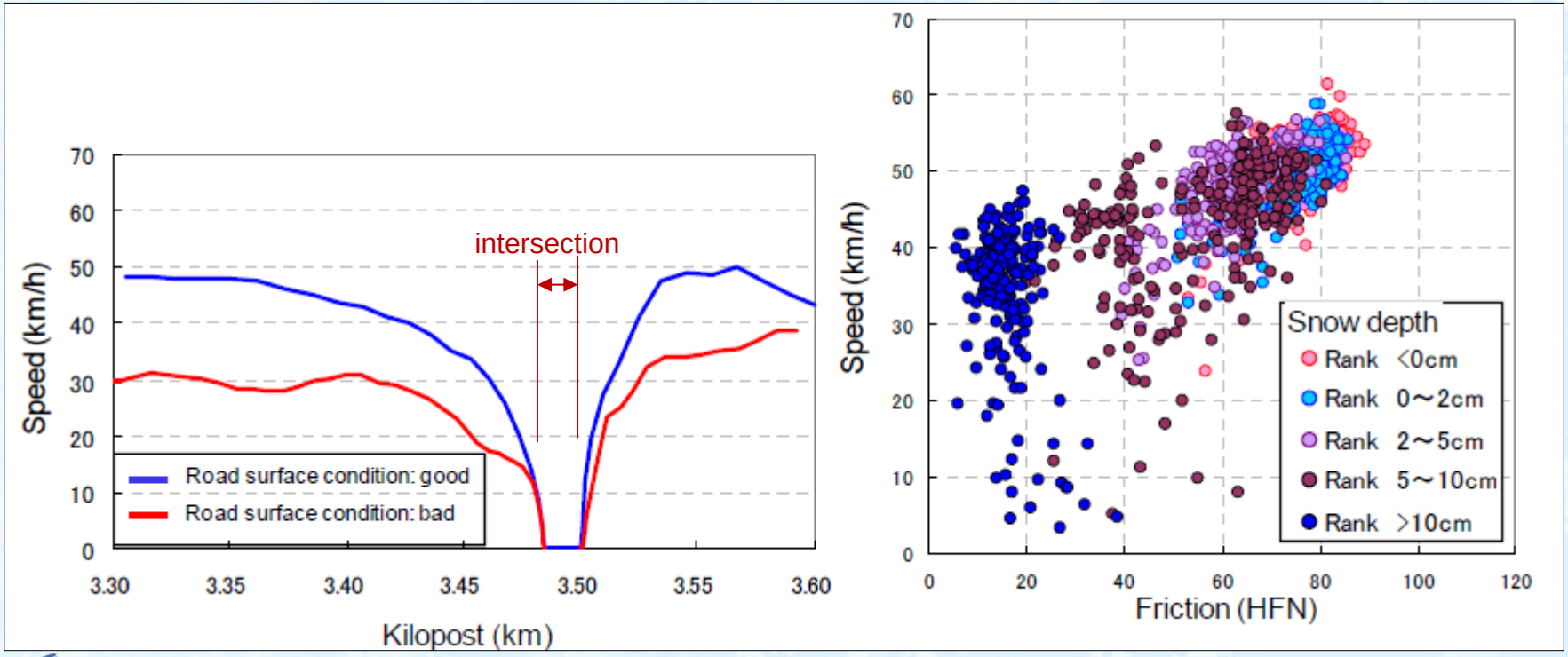
THE RELATIONSHIP BETWEEN ROAD SURFACE FRICTION AND TRAFFIC CONDITIONS

- Continuous measurement of the road surface friction made it possible to describe the flow of winter road management.
- However, continuous friction measurement is not enough for performance measurement of winter road management.
- To measure and evaluate the performance of winter road management, it is necessary to clarify the relationships between inputs, outputs and outcomes.
- In the following we show the result of analysis in order to clarify the relationship between the friction as the intermediate outcome and the traffic characteristics as the end outcome, both of which are obtained from the collected data.

FRICTION AND TRAVEL SPEED

- Slow travel speed and slow stopping and starting speed affect the traffic flow on that route.
- The worse are the road surface conditions in winter, the more the reliability of travel time is impaired.



Left: Change in travel speed at an intersection
Right: Relationship between friction and travel speed

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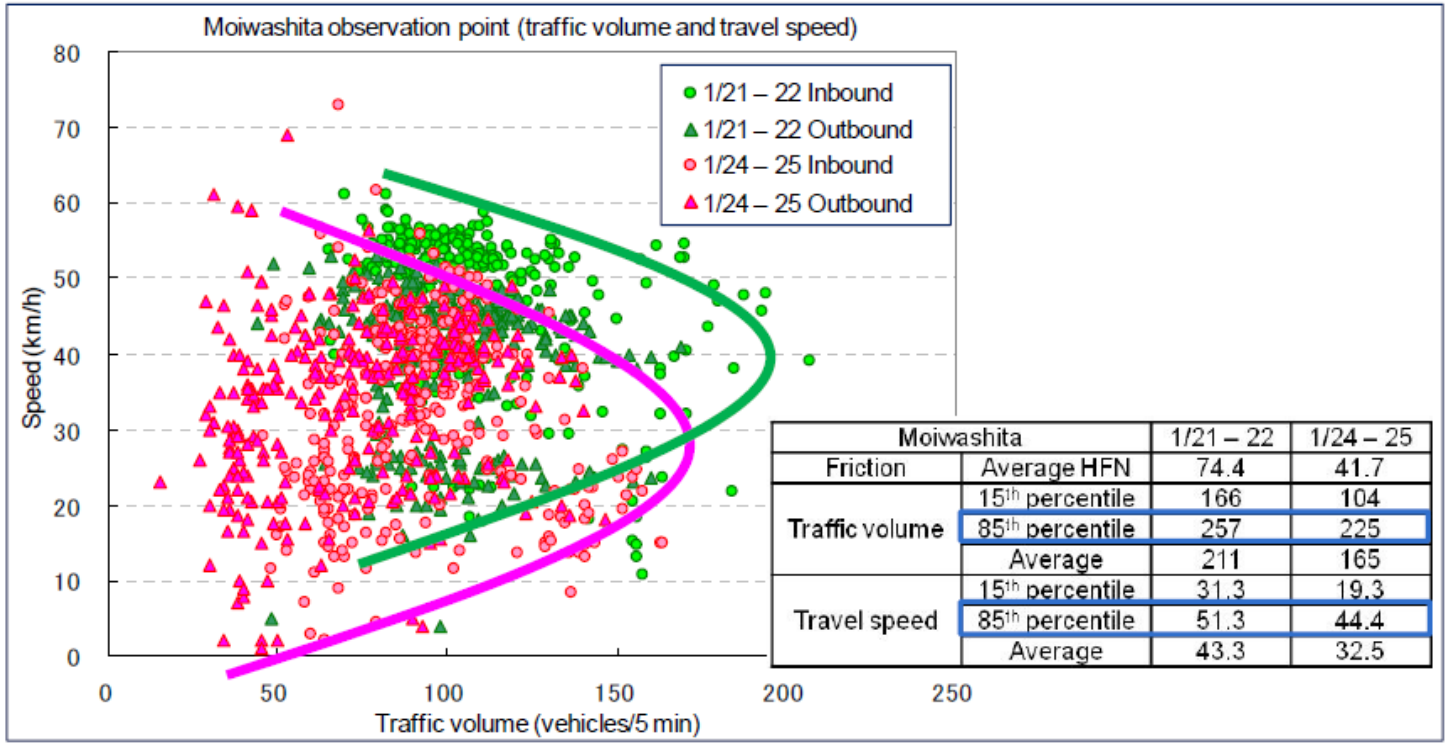
FRICTION AND TRAFFIC FLOW

- Decrease in the friction value results not only in decreases in the travel speed but also in decreases in the traffic capacity.
- Ave. friction decreased from 74.4 on Jan. 21 and 22, to 41.7 on Jan. 24 and 25. The traffic volume showed a 22% decrease and the travel speed showed a 25% decrease.

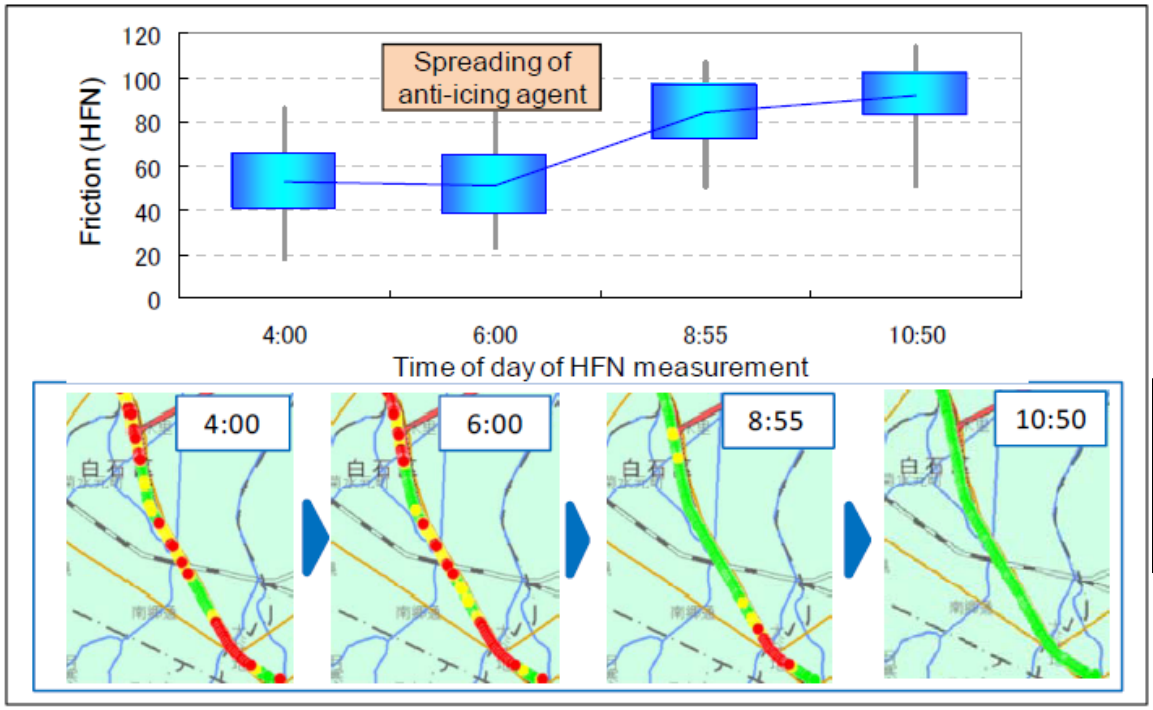


Moiwashita		1/21 – 22	1/24 – 25
Friction	Average HFN	74.4	41.7
Traffic volume	15th percentile	166	104
	85th percentile	257	225
	Average	211	165
Travel speed	15th percentile	31.3	19.3
	85th percentile	51.3	44.4
	Average	43.3	32.5

Average friction measured by CFT, traffic volume and travel speed measured at a fixed observation point

FRICTION IMPROVEMENT BY WINTER ROAD MANAGEMENT

- The ave. friction value was 50 at 06:00, before the spreading of anti-icing agent, rose to HFN 80 at 09:00.
- These data support the need for the spreading of anti-icing agents and the effectiveness of anti-icing agents in improving the road surface condition.



Friction before and after the spreading of anti-icing agent

CLUSIONS AND SUGGESTED RESEARCH

Study on setting standards and indicators (Outcomes)

- Set appropriate standards & to determine the priorities of the set standard items.
- Examine & determine what shall be the outcomes, how to measure them, what shall be the standard values for such outcomes & which outcome shall be prioritized.

Clarifying the relationships between inputs, outputs, and outcomes (intermediate outcome, end outcome)

- Necessary to clarify the casual relationship between inputs, outputs, and outcomes in winter road management by collecting additional data on weather, winter road surface friction and related road management data.

THANK YOU FOR YOUR ATTENTION!

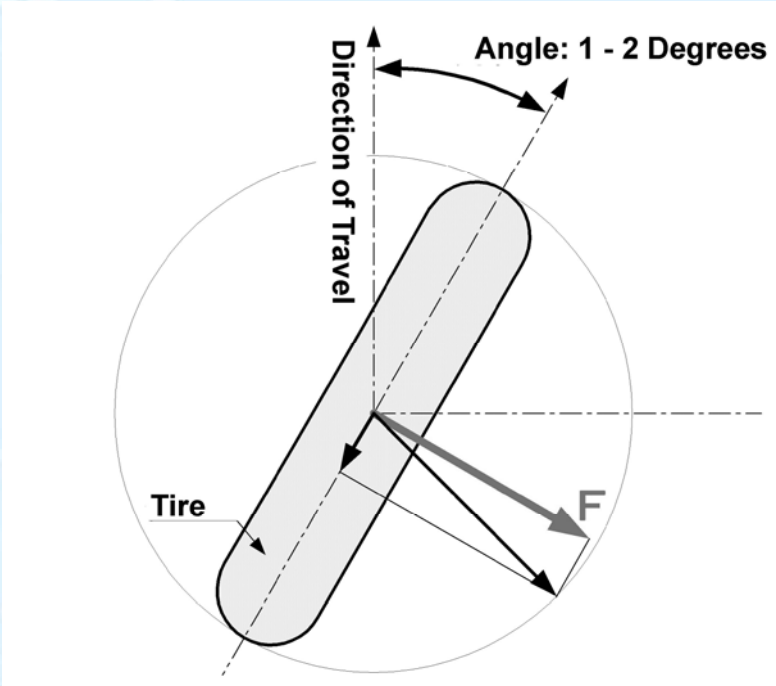
Naoto TAKAHASHI,

Civil Engineering Research Institute for cold region

takahashi-n24k@ceri.go.jp

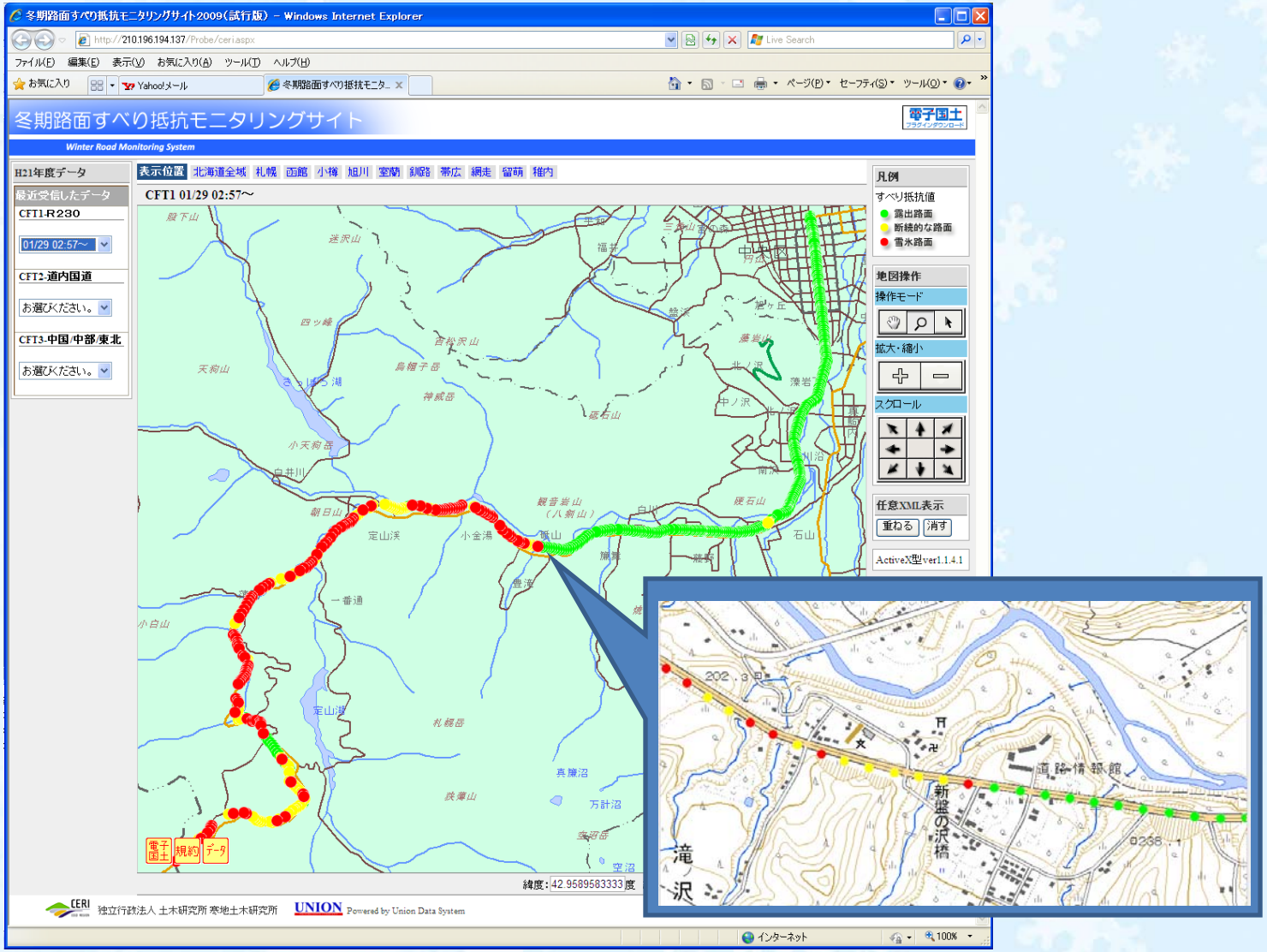
PRINCIPLE OF MEASUREMENT

- CFT calculates friction value by measuring the axial force created by installing a test tire 1-2 degrees off axis from the direction of travel
- The friction value computed by the tester is called “Halliday Friction Number (HFN),” which is originally determined by this device’s designer, and this HFN scale usually varies in 0-100.

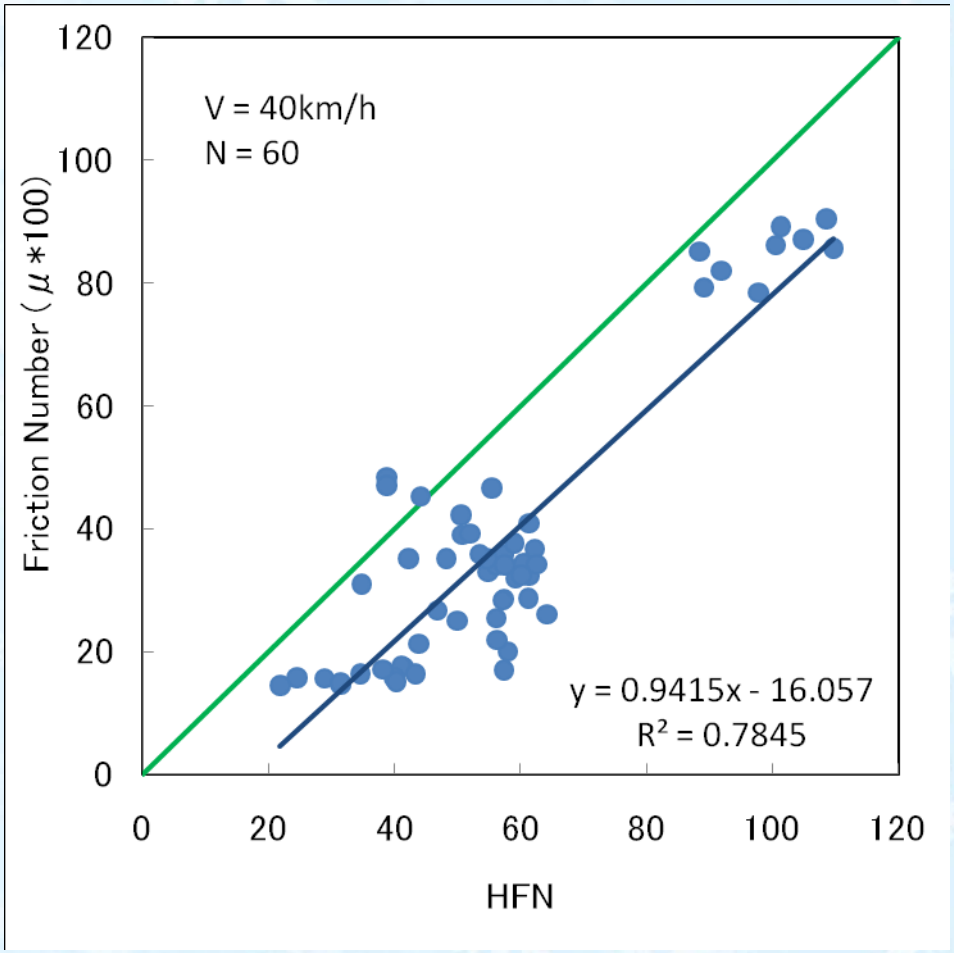


INFORMATION SERVICE FOR ROAD ADMINISTRATORS

- Information on road surface friction through the Internet



RELATIONSHIP BETWEEN HFN & FRICTION COEFFICIENT



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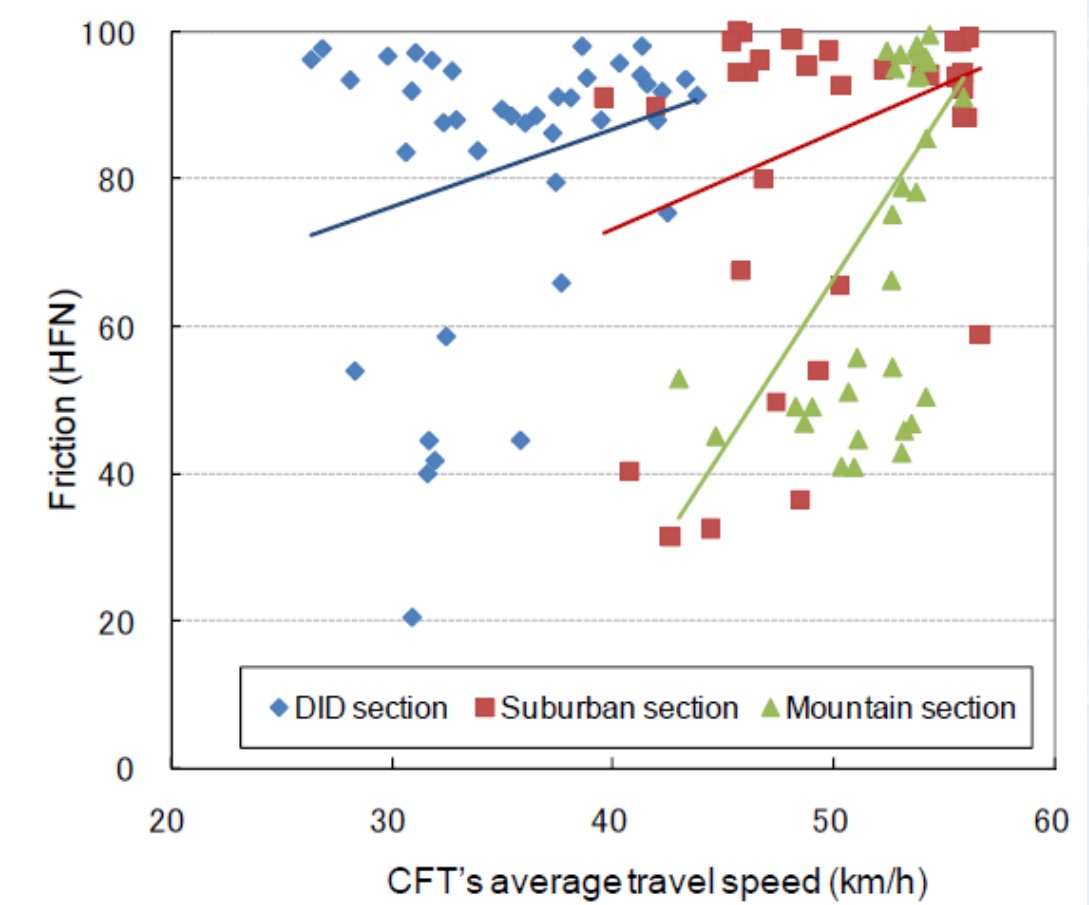
FRICTION AND TRAFFIC ACCIDENTS

- DID section: even though the variation in the friction is great the ave. travel speed is low, which results in a high rate of light injury accidents.
- In contrast, the rates of serious and fatal accidents are high in the mountainous area, which can be attributed to the high travel speeds in that area despite its low HFN.



Average HFN vs. average travel speed