



The study on winter road maintenance by applying predicted friction index “GRIP Analysis”

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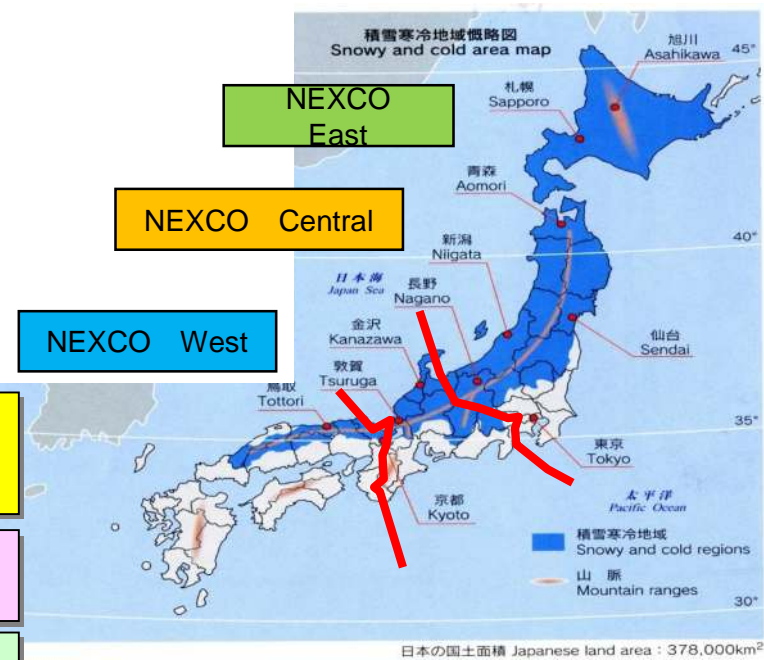


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2. Snow and Ice Management
3. Determining the state of Expressway Surface
4. Verification of GRIP ANALYSYS
5. Advanced Winter Road Management
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1. INTRODUCTION

- 1 . Location ; lies between latitude 30°N and latitude 45°N.
- 2 . Service length ; 8,700 km (March. 2011)
- 3 . Cargo traffic volume ; 47.7% (2005)



Cargo Traffic Volume (per 100 million ton kilometers)

Auto mobile 2,451 (92.3%)	Expressway 1,266 (47.7%)
	the other general road 1,185 (44.6%)
Railway 204 (7.7%)	

Open Extension (kilometer)

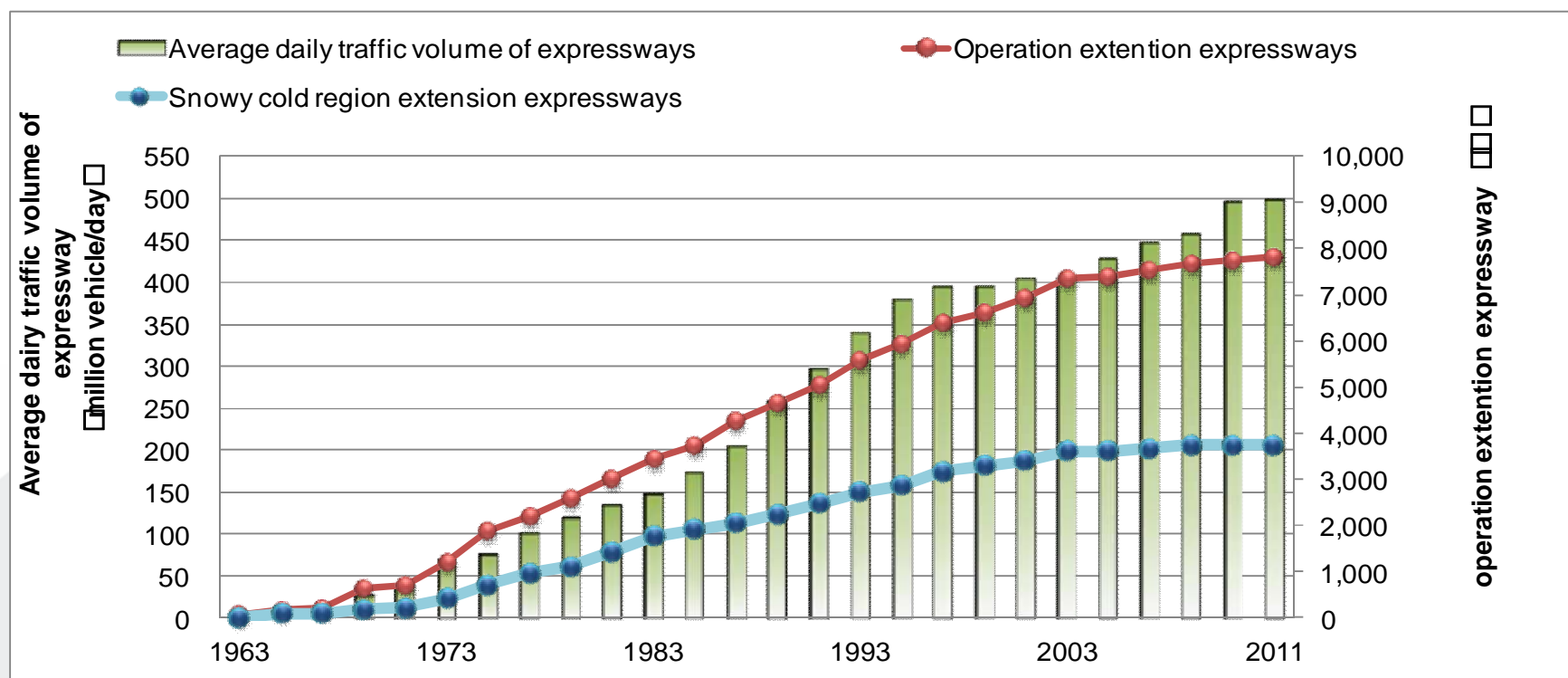
Auto mobile 1,197,008 (97.8%)	Expressway 7,642 (0.6%)
	the other general road 1,189,366 (97.1%)
Railway 27,338 (2.2%)	

:Exhibit:Land Transport Statistics Handbook, Road Traffic census 2005

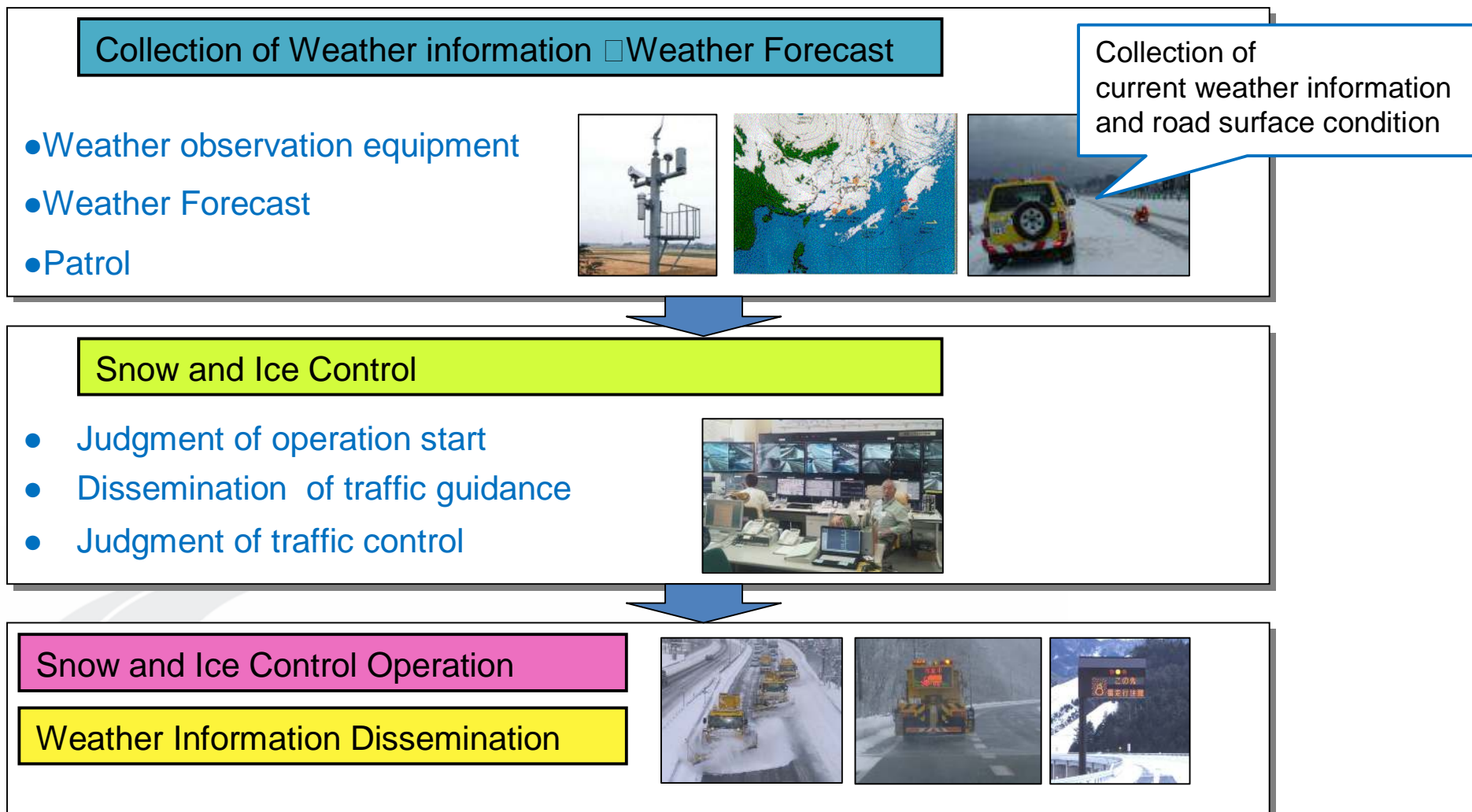
1. INTRODUCTION

4 . Service length (in snow cold region) ; 3,700km

5 . Daily vehicle users ; 5 mil. Vehicles



2. SNOW AND ICE MANAGEMENT



2. SNOW AND ICE MANAGEMENT

Expressway administrator

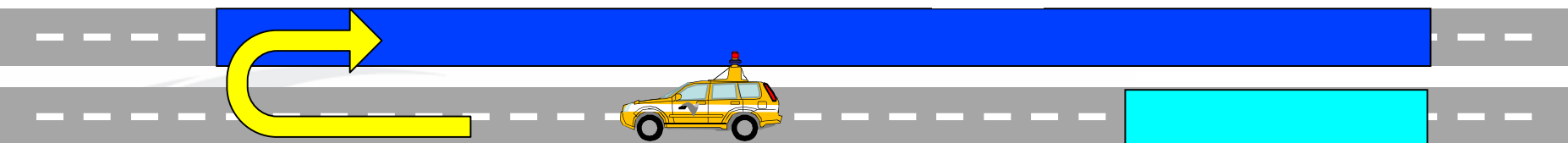
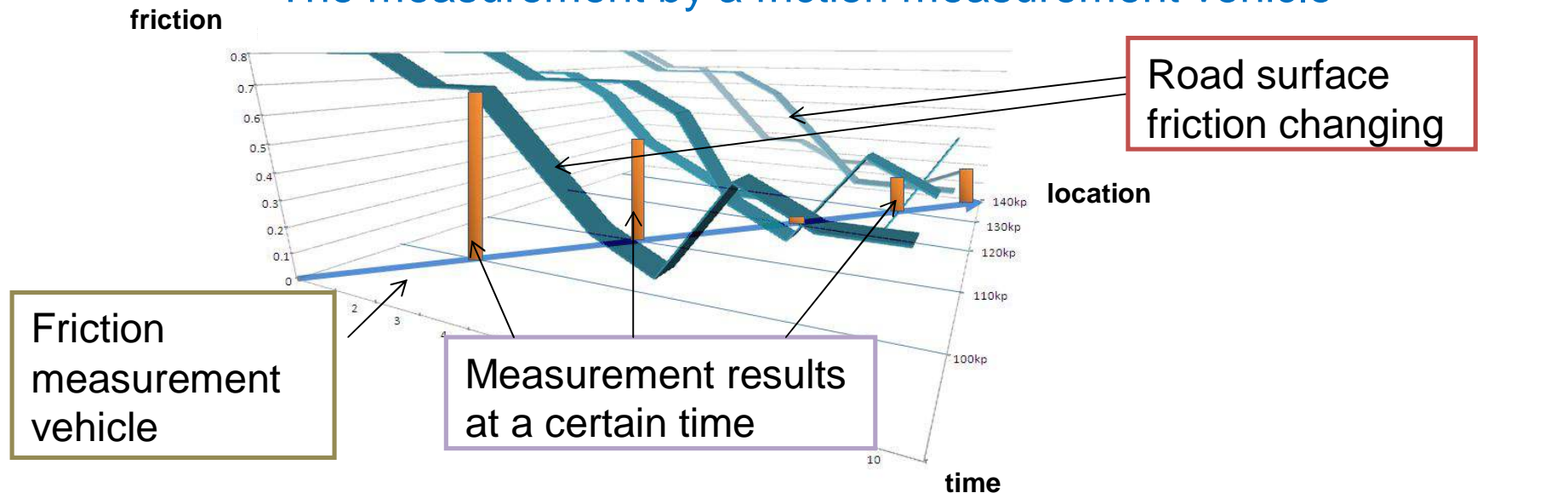
- Judgment by experience varies greatly depending on the staff involved.

But therefore, there is no quantitative index for whether the operations are too early or too late.

- Spreading anti-icing in order to maintain the best possible road surface has a tendency to increase the amount of rock salt used.
- Since it is unclear whether the operation is enough, snow-removal is repeated as much as possible so that the state of a road surface may be kept as safe as possible.
- Even if the conditions on a road get worse (except for the case of freezing), many cases are difficult for expressway administrator to make a judgment to Road closed.

3. DETERMINING THE STATE OF EXPRESSWAY SURFACE

The measurement by a friction measurement vehicle

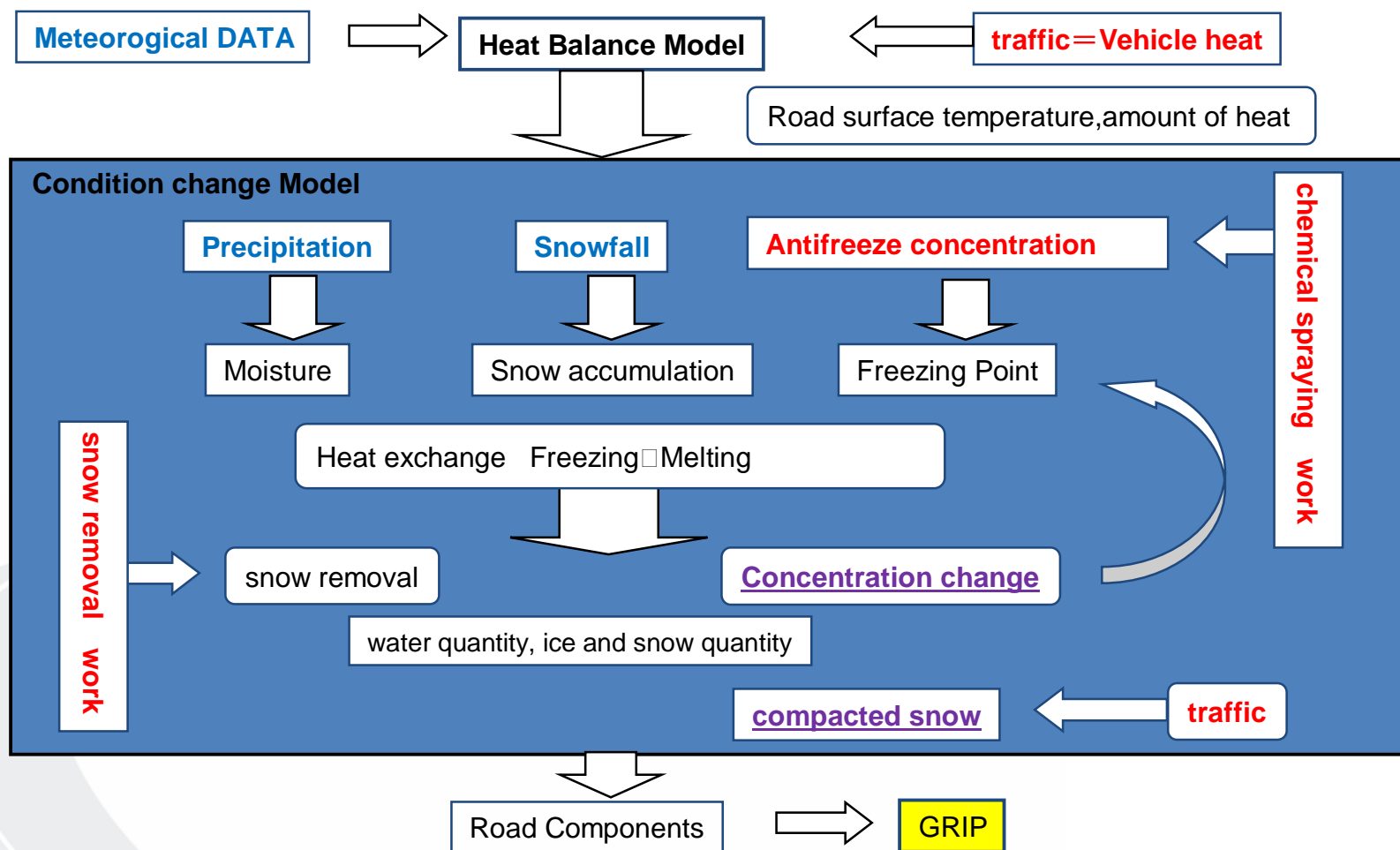


Takes a long time to measurement of road surface (yellow colored portion)
Friction is changed immediately by snowfall ,etc . (red colored portion)

We need Friction data All location! Every time! ➡ USE “GRIP Analysis”

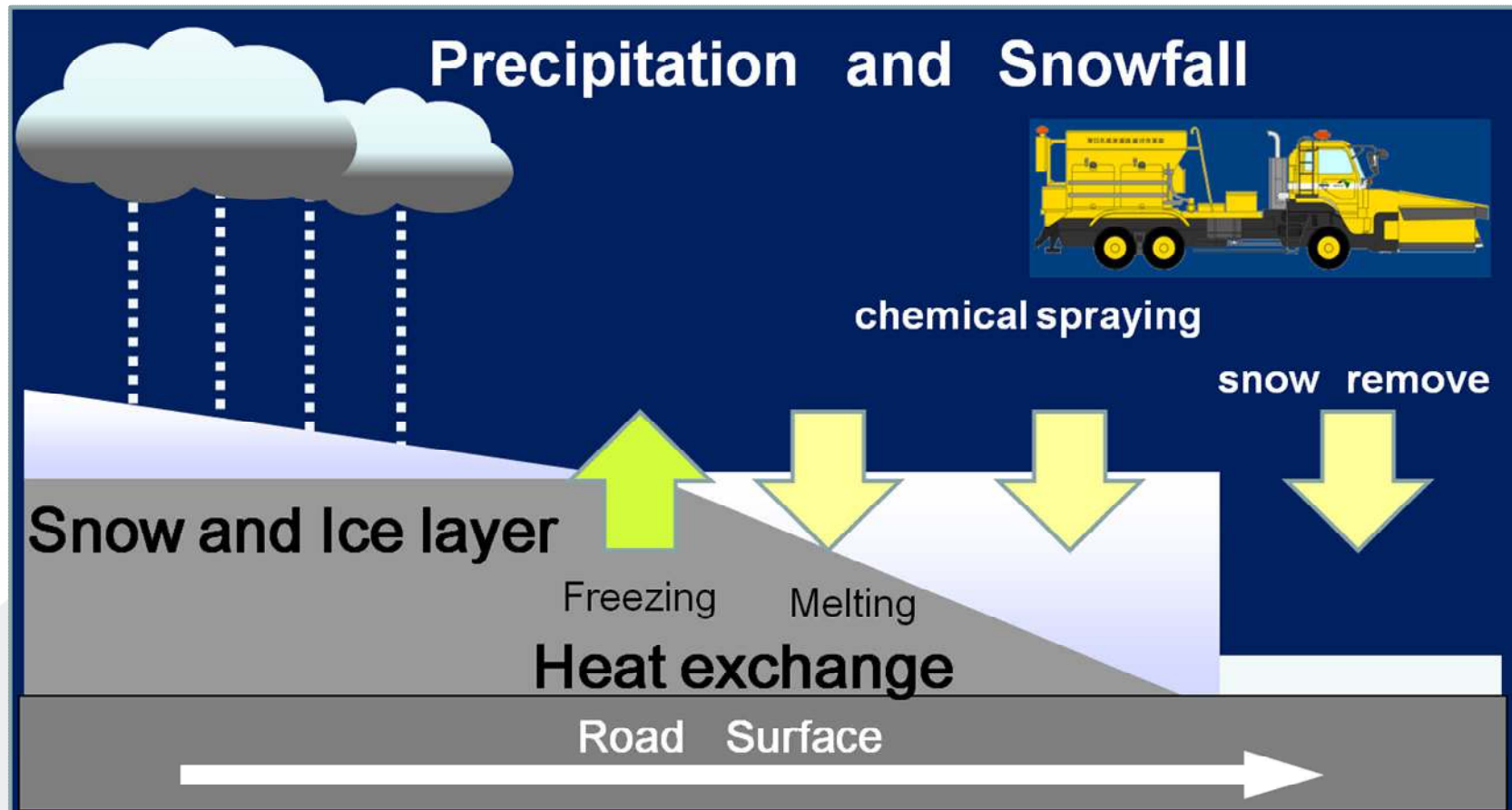
3. DETERMINING THE STATE OF EXPRESSWAY SURFACE

Forecast flow chart “GRIP Analysis”



3. DETERMINING THE STATE OF EXPRESSWAY SURFACE

Road components change model



3. DETERMINING THE STATE OF EXPRESSWAY SURFACE

Proprietary innovations in this flow chart:

- The weather, a road surface conditions, and GRIP Analysis are integrated.
- Snow management operations are reflected.
- Observational data is reflected in real time.
- Supposition reflection of traffic conditions.
- It corresponds to changes and prediction of the weather situations.
- Not a point but a line performs analysis and prediction, aimed at supporting operations.
- Supposition of real time usage.
- Supposition of evaluation and feedback of road surface management level and operations results in real time usage.

4. VERIFICATION OF GRIP ANALYSYS

- Observation
by Remote Road Surface State Sensor
- Observation
by Remote Road Surface State Sensor Installed to a Vehicle



4. VERIFICATION OF GRIP ANALYSYS

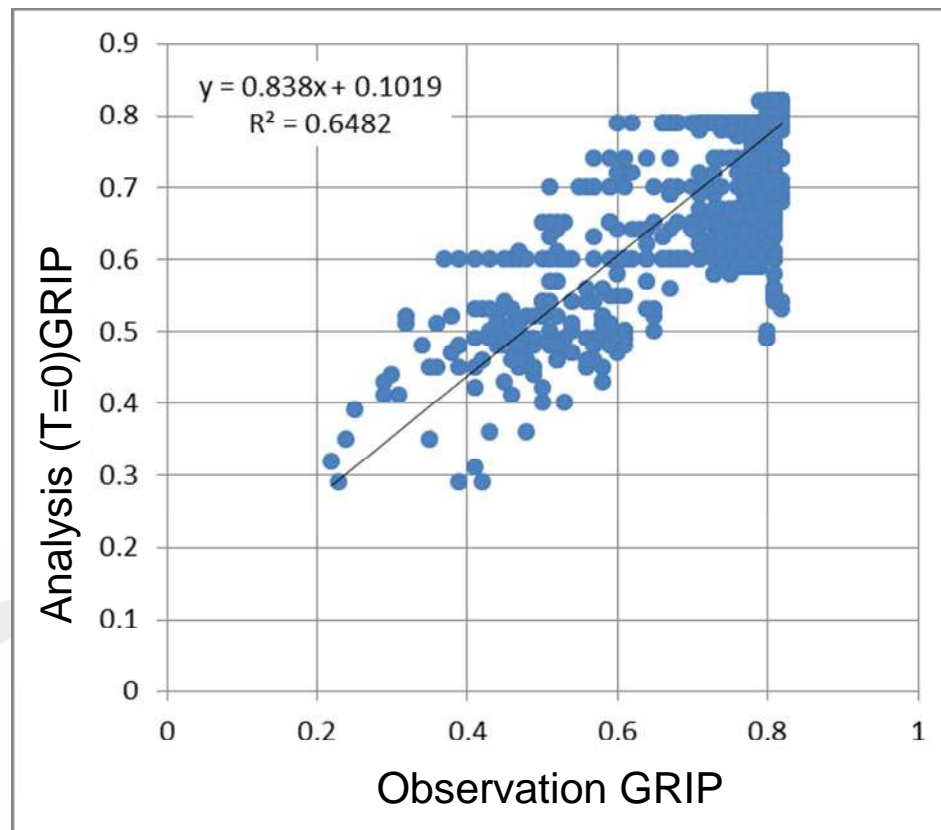
- Analysis
Condition change Model

CONDITION	GRIP
dry	0.8~1.0
wet	0.6~0.8
snow	0.1~0.8
slushy	0.4~0.8
ice	0.0~0.2



4. VERIFICATION OF GRIP ANALYSYS

Comparison of GRIP Analysis and Observation GRIP



※Data comparison SANJO

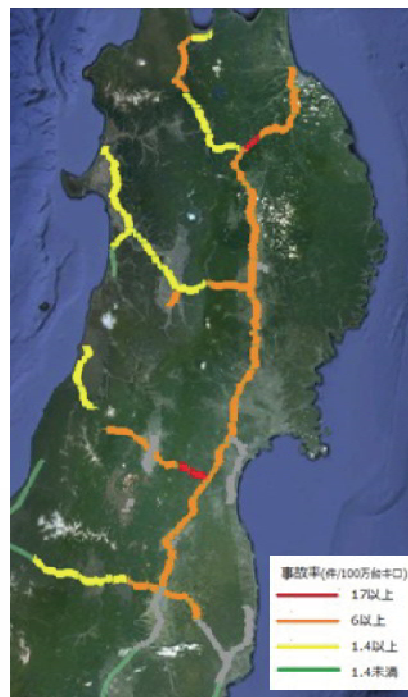
GRIP Analysis and Observation GRIP are correlated.

4. VERIFICATION OF GRIP ANALYSYS

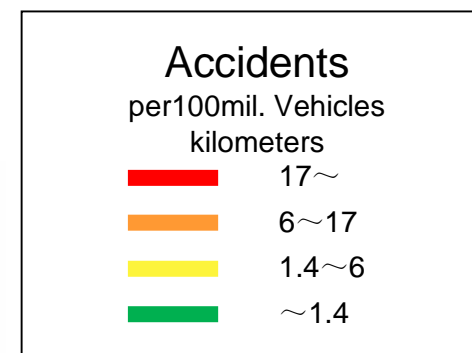
Relationship between traffic accidents and road condition
(Calculated value of the GRIP Analysis)



Safe condition Accident Map
GRIP Analysis (0.6~)



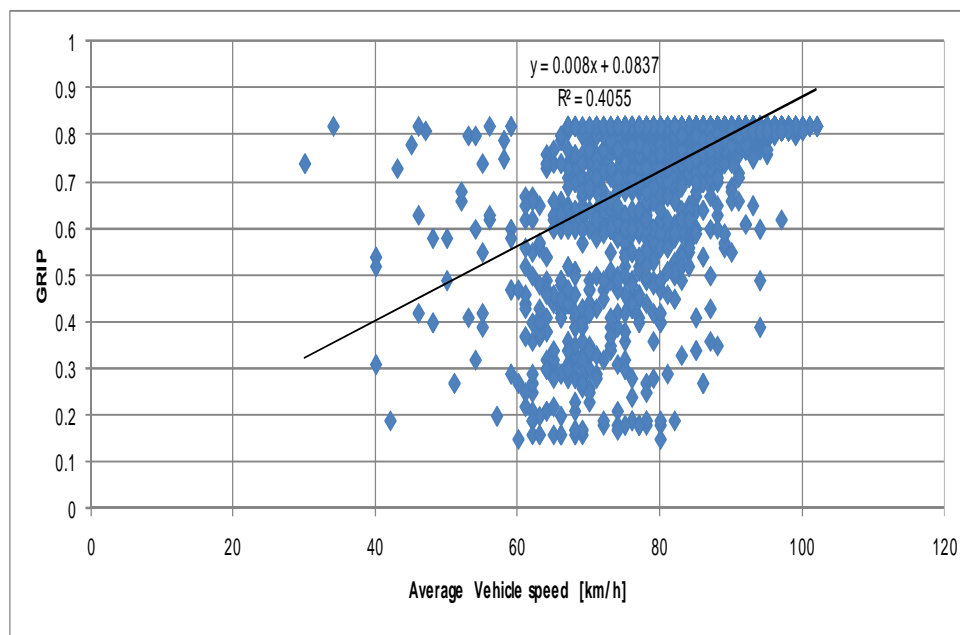
Negative condition Accident Map
GRIP Analysis (0.2~0.4)



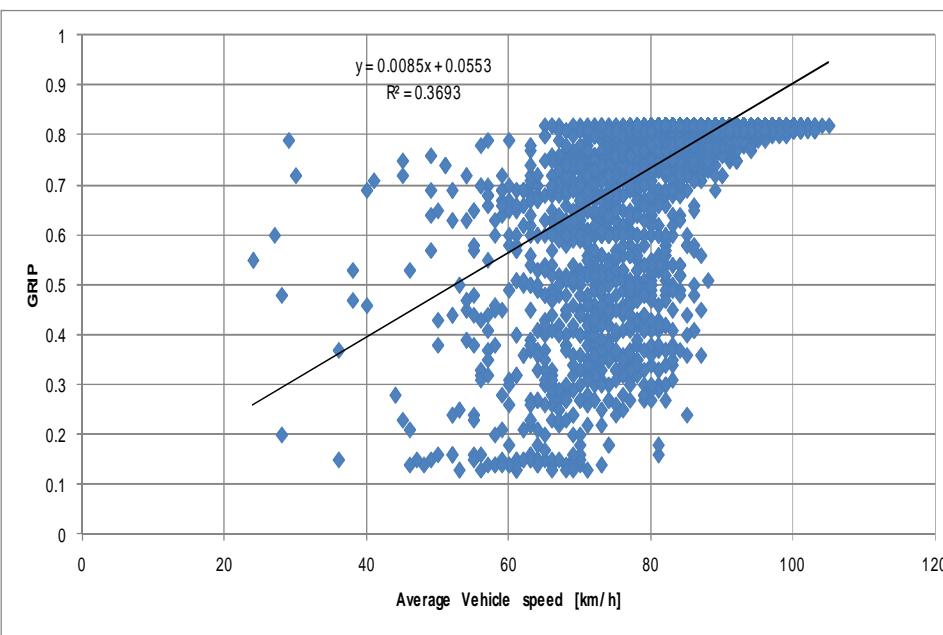
Traffic accidents is relevance to the road condition.

4. VERIFICATION OF GRIP ANALYSIS

Survey of GRIP and Average vehicle speed



Average vehicle speed, observed
GRIP (daytime)

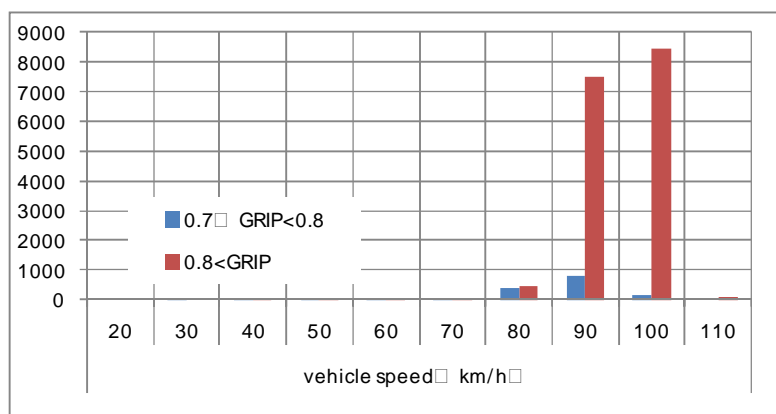


Average vehicle speed, observed
GRIP (night)

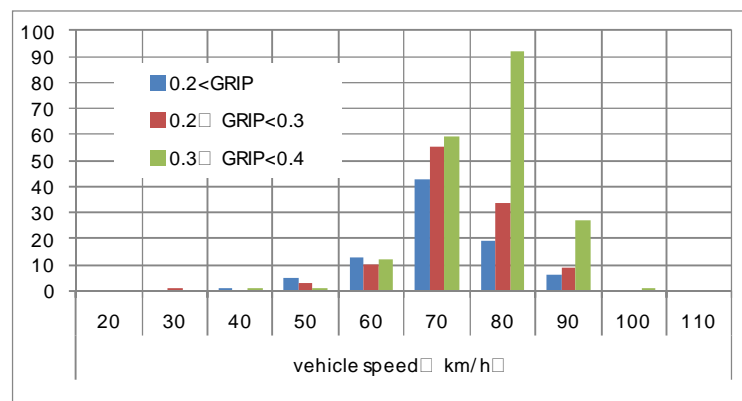
The GRIP and average vehicle speeds would not be proportional.

4. VERIFICATION OF GRIP ANALYSYS

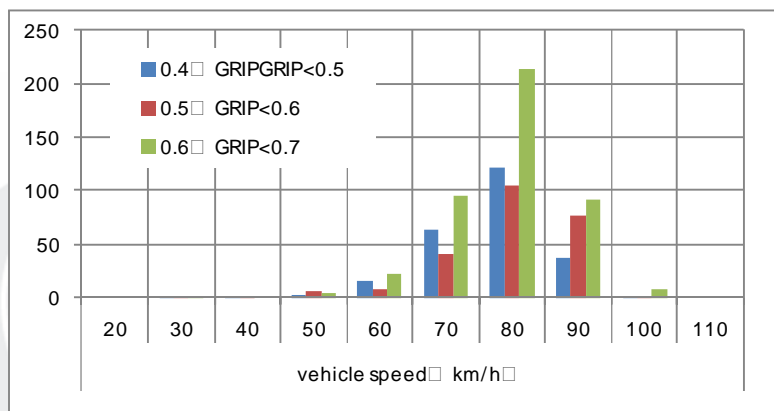
Distribution of Average vehicle speeds and GRIP



Average vehicle speed, volume of vehicle (GRIP 0.7-0.8)



Average vehicle speed, volume of vehicle (GRIP 0.2-0.4)



Average vehicle speed, volume of vehicle (GRIP 0.4-0.7)

The relationship of the GRIP and average vehicle speeds needs to be examined in more detail.

5. ADVANCED WINTER ROAD MANAGEMENT

Correlation with the road surface condition

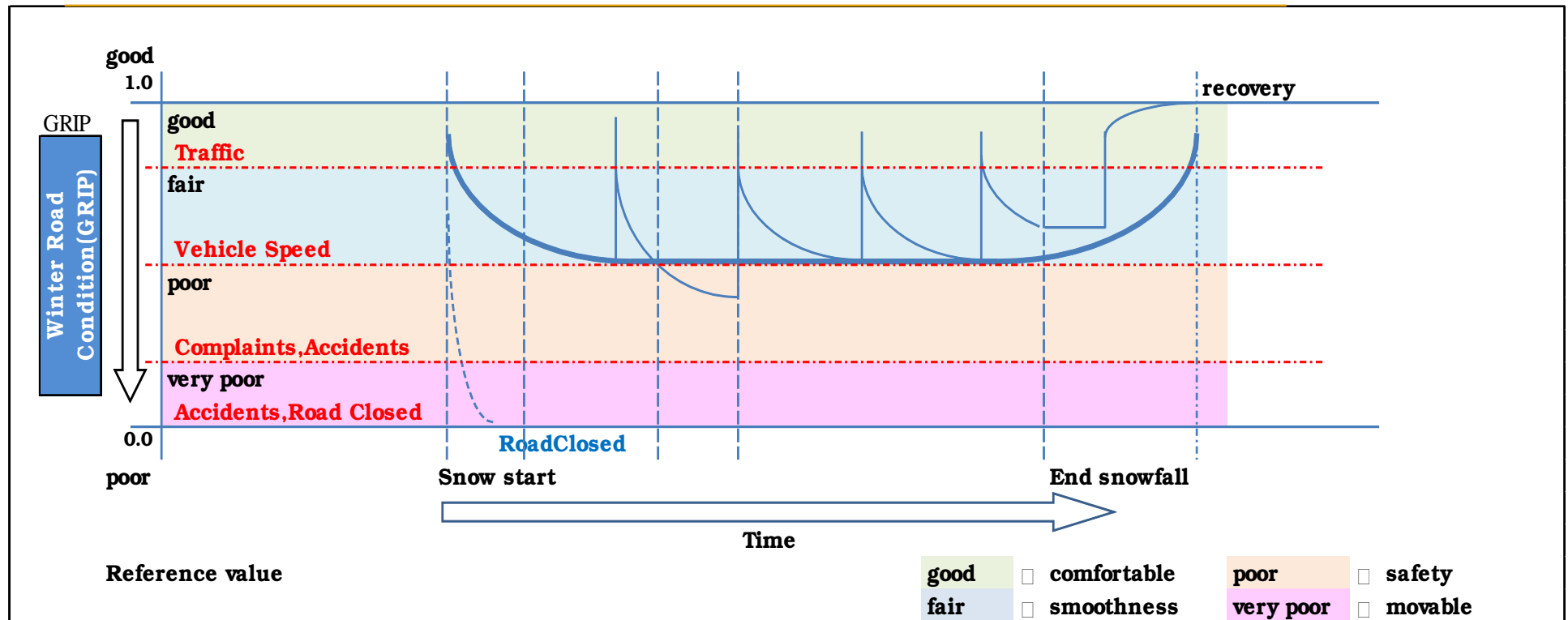
- Skid resistance
- Traffic accidents
- Average vehicle speeds
- Appearance time of snow and ice surface



Consensus building !

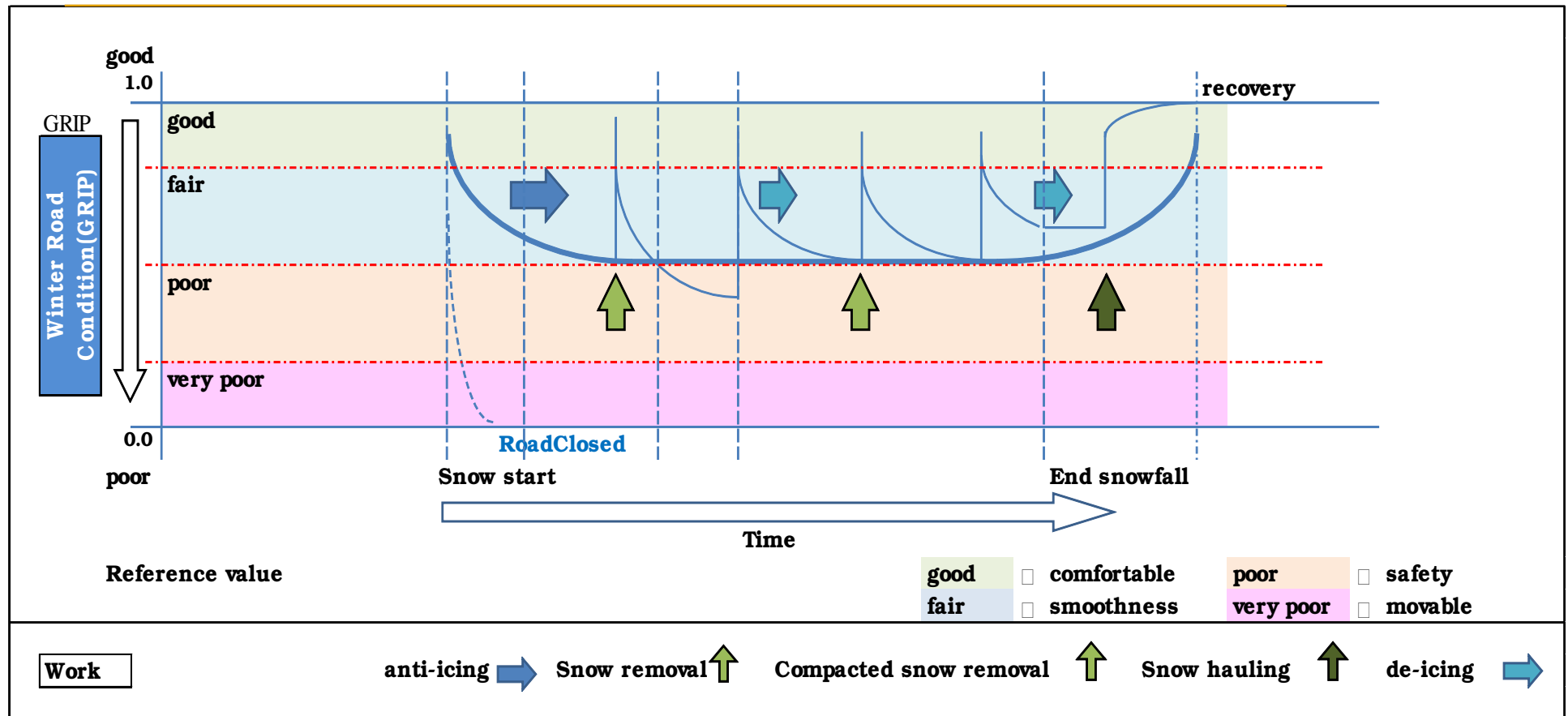
(users) (traffic administrator) (expressway administrator)

5. ADVANCED WINTER ROAD MANAGEMENT



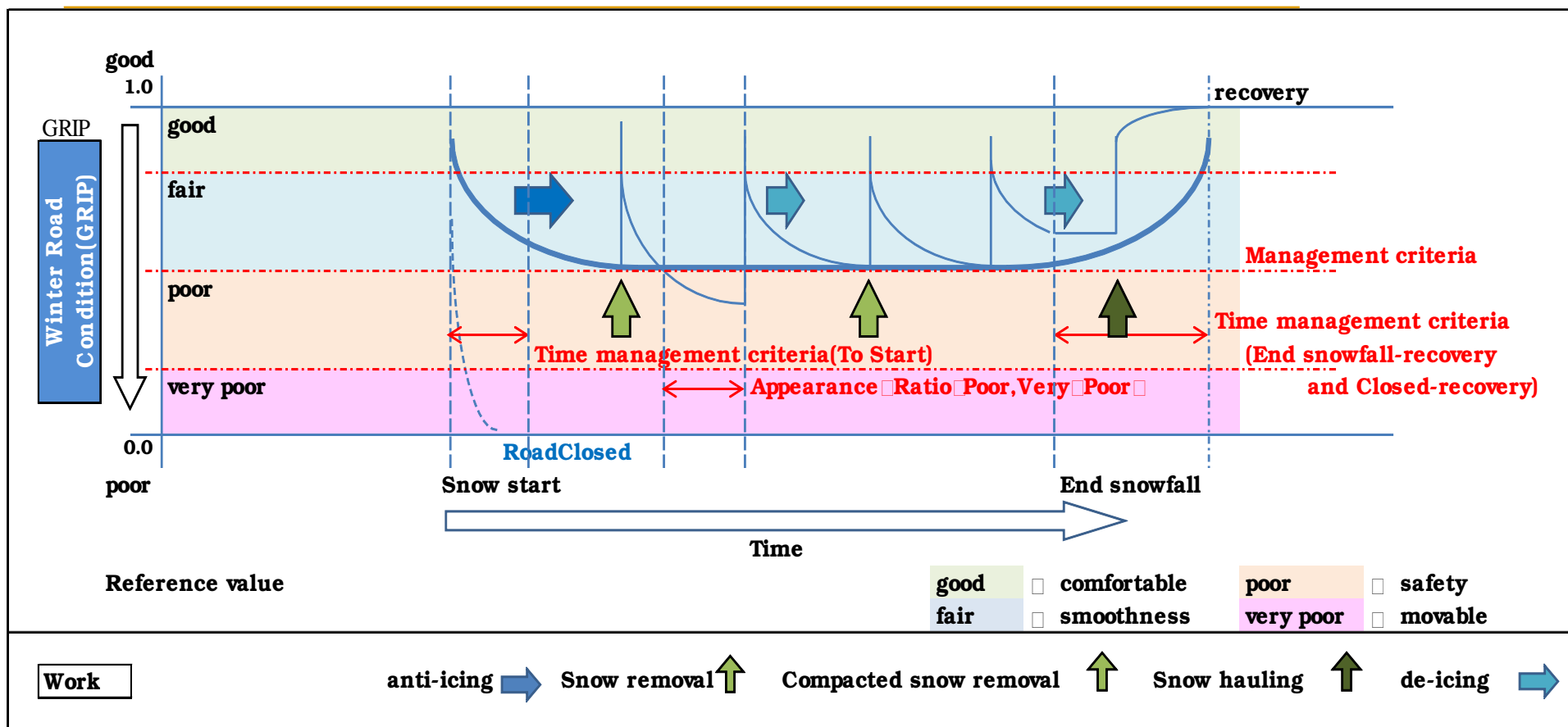
It is planning creating the road surface management index from correlation with the number of traffic accidents, a driving speed, the number of traffic stop time, and sliding friction.

5. ADVANCED WINTER ROAD MANAGEMENT



Expressway administrator manages the snow/ice removal operation in order to keep a level of “Desirable road condition”.

5. ADVANCED WINTER ROAD MANAGEMENT



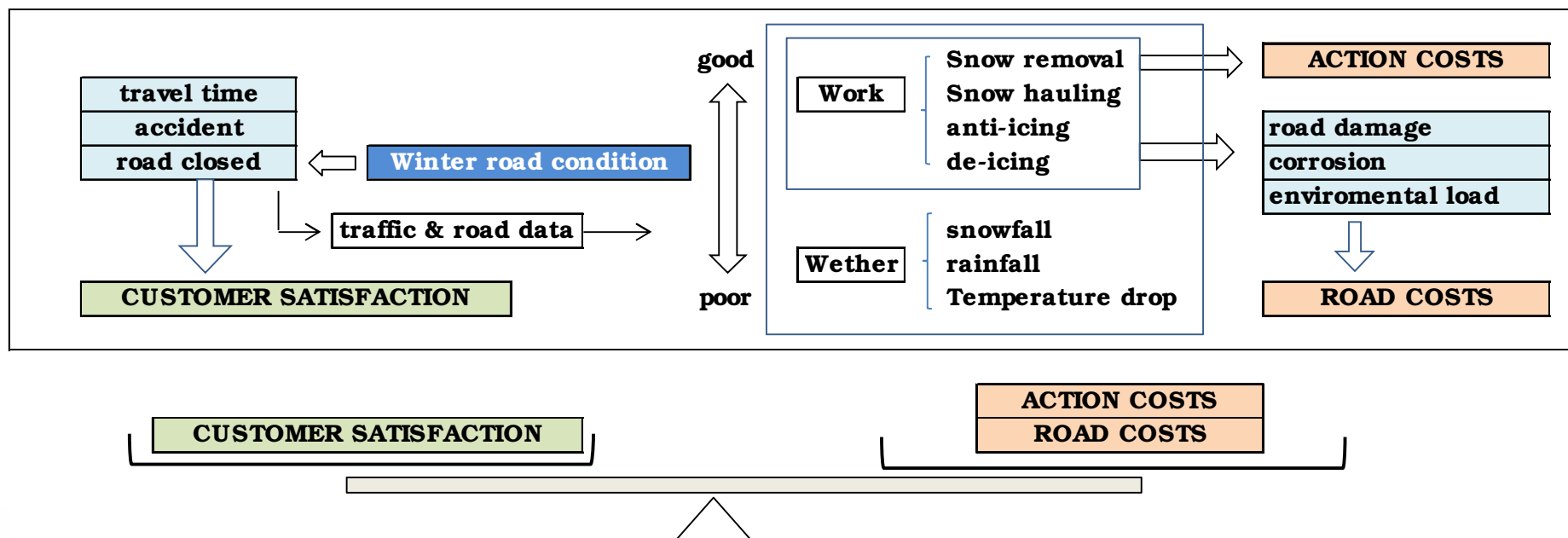
Evaluate in

The time from a snowfall start to snow/ice removal operation start

The appearance ratio of an deteriorated road surface

The time from the end of snowfall to road service condition recovery

6. CONCLUSION



Quantifies “Desirable road condition” and “Hazardous road condition”

There are possibilities for evaluating the cost-benefits of snow/ice countermeasure operations.

END

Thank you!