



XIII
INTERNATIONAL
WINTER ROAD
CONGRESS

QUÉBEC, FEBRUARY 8 TO 11, 2010



Québec 

SUSTAINABLE WINTER SERVICE FOR ROAD USERS

*A Multilevel Disaggregate Model for
Quantifying the Safety Effect of Winter Road
Maintenance*

Taimur Usman

University of Waterloo, Canada

PhD Student

tusman@engmail.uwaterloo.ca



AGENDA

- Introduction
- Objectives
- Previous Research
- Methodology
- Results and Application
- Conclusions and Future Work

INTRODUCTION: WINTER ROAD SAFETY

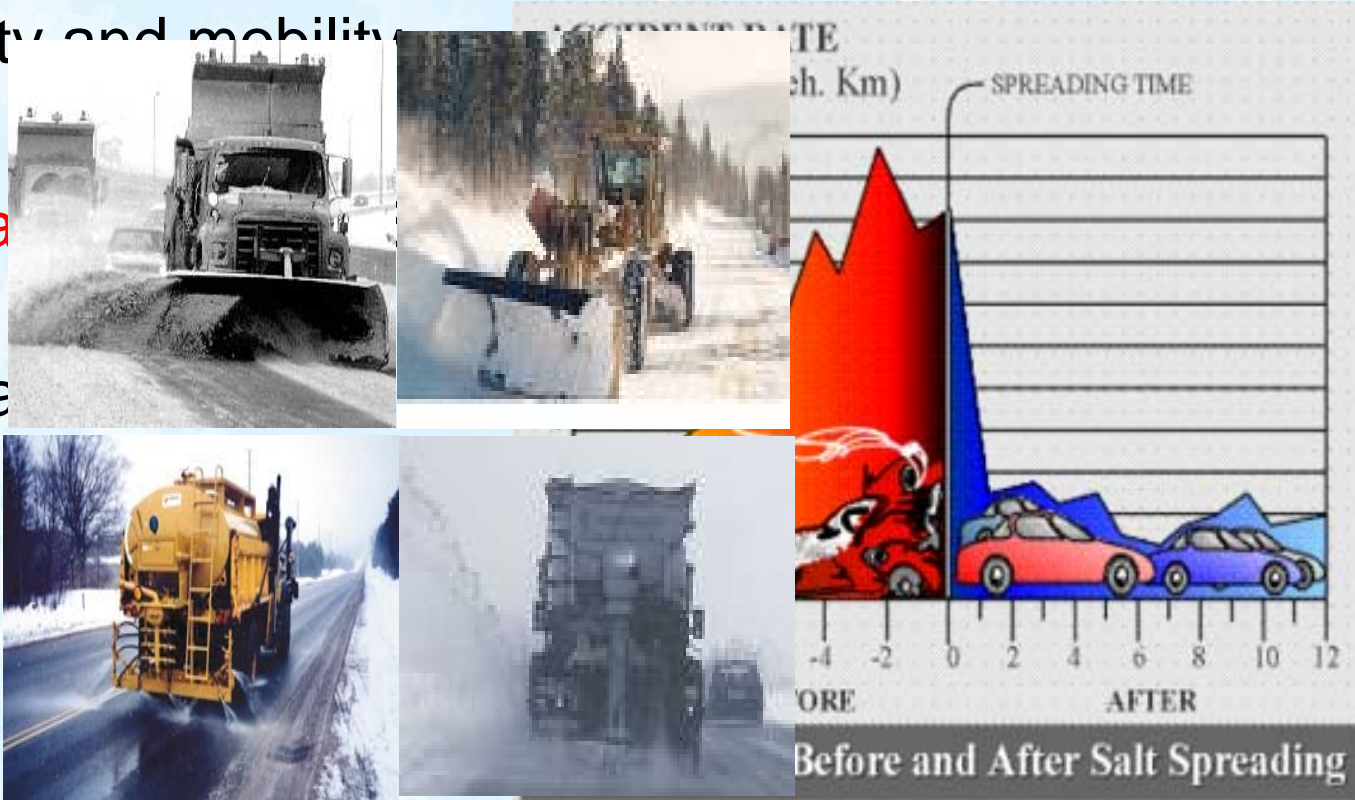
- Average increase in accidents **50 ~ 100%**
- Weather related accident cost in Canada is **\$1.1 billion**



An Accident occurred on Icy road

INTRODUCTION: WINTER ROAD MAINTENANCE

- Improve safety and mobility
- Cost
 - \$ 1 billion/year
 - 100 million in
 - Environmental



Hanbali, 1992

OBJECTIVES

- Develop methodology and models for quantifying the safety benefit of winter road maintenance

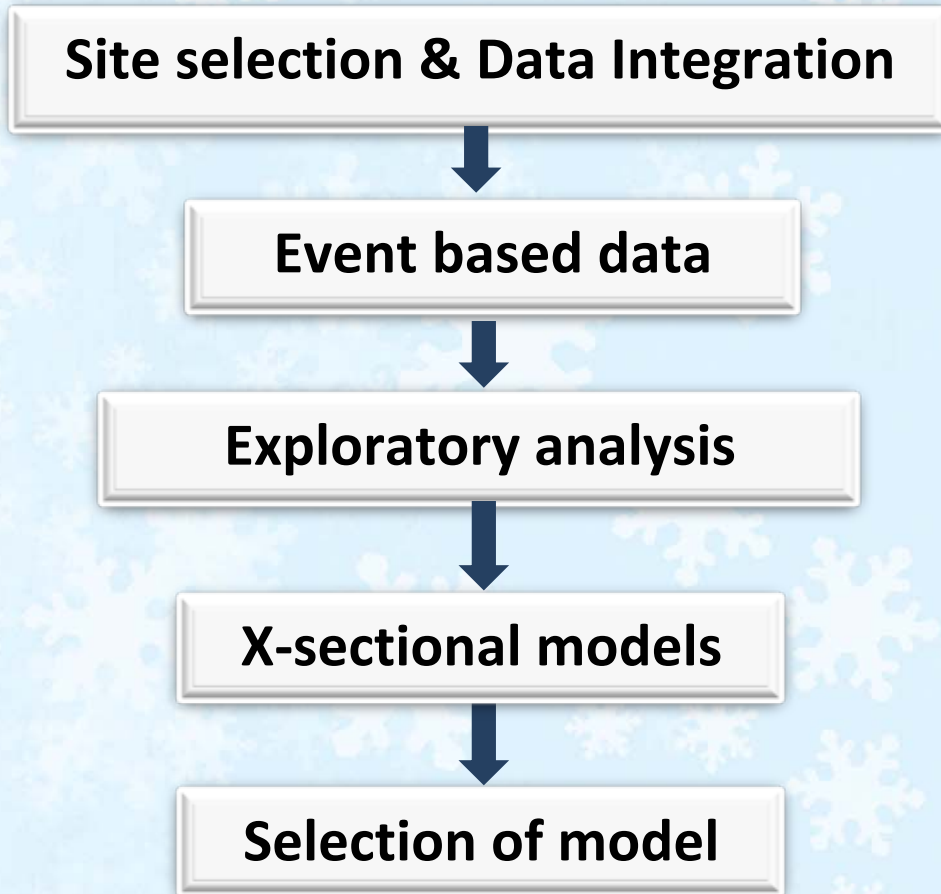
LIMITATIONS OF PAST RESEARCH

- Mostly focused on the relationship between weather and road safety without considering winter road maintenance
- Mostly considered large analysis units – both spatially (e.g. whole city, network) and/or temporally (e.g. whole year, season, day)

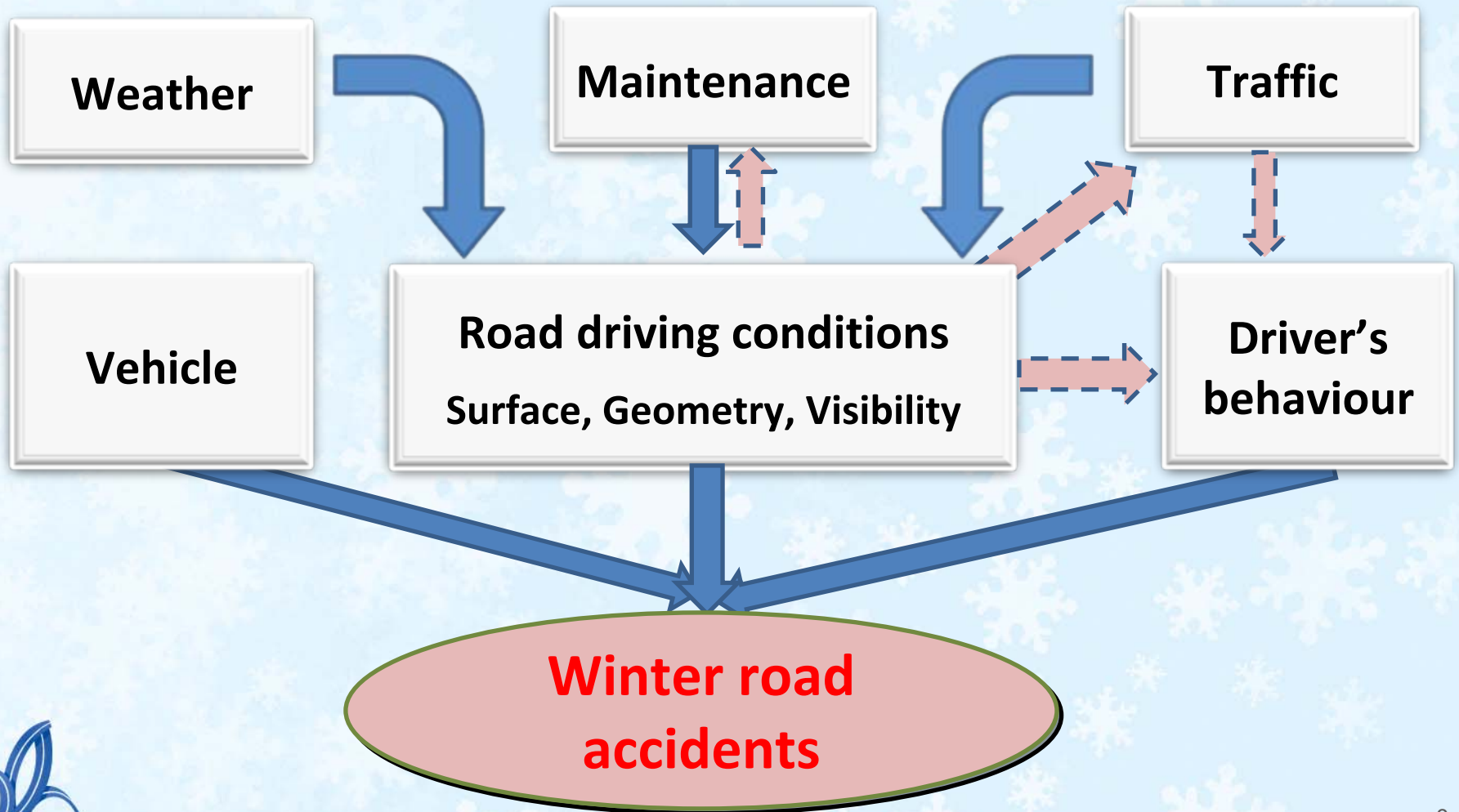
PROPOSED METHODOLOGY

- Conduct a statistical analysis on the relationship between winter road maintenance and safety
- Key Considerations:
 - Spatial and temporal unit?
 - Factors?
 - Modeling approach?

MODELING PROCESS



FACTORS INFLUENCING WINTER ROAD SAFETY



SELECTION OF STUDY SITES

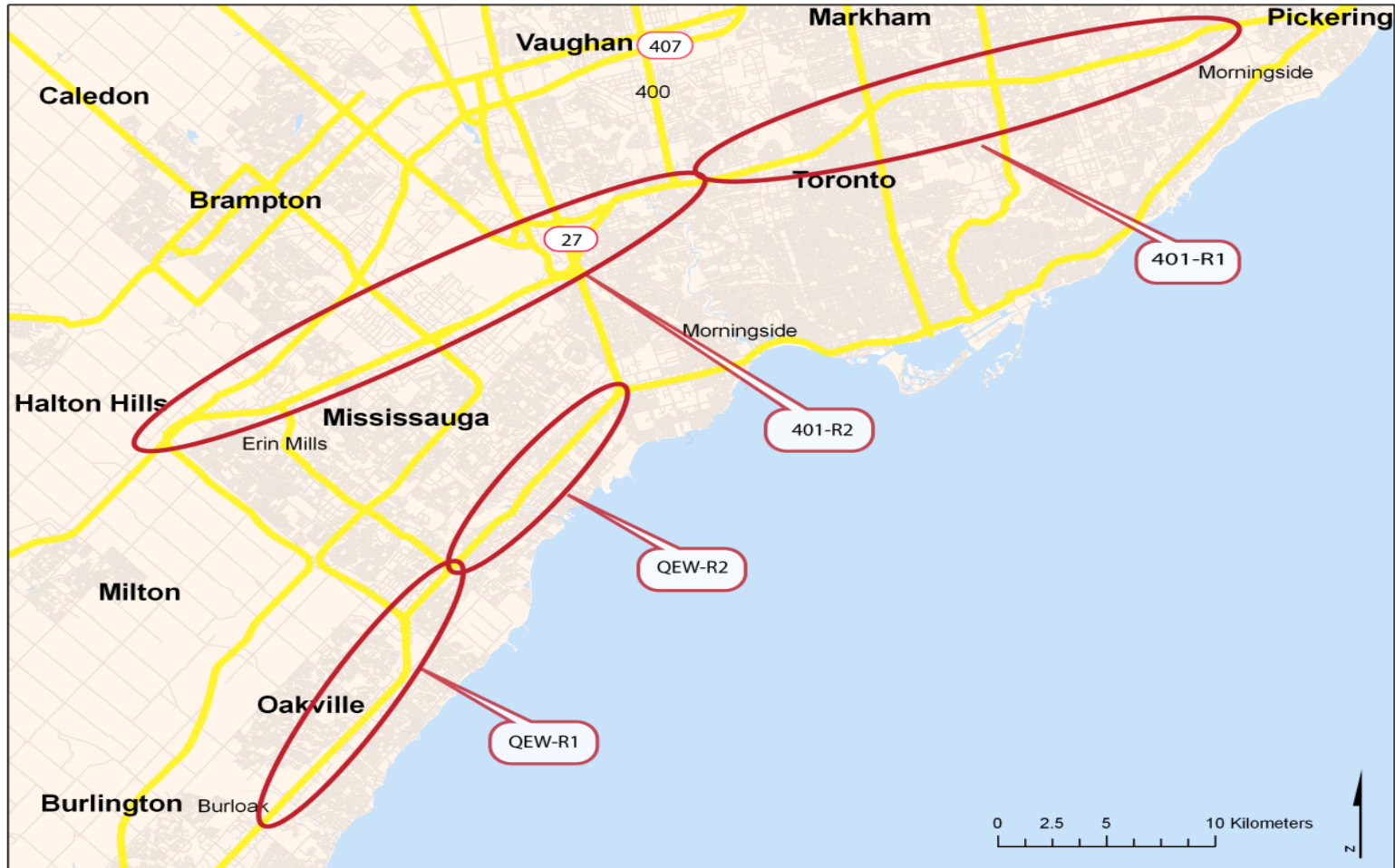


Limite provinciale /
provinciale boundary /
national boundary /
internationale

Scale / Échelle
100 0 100 200 300
km km

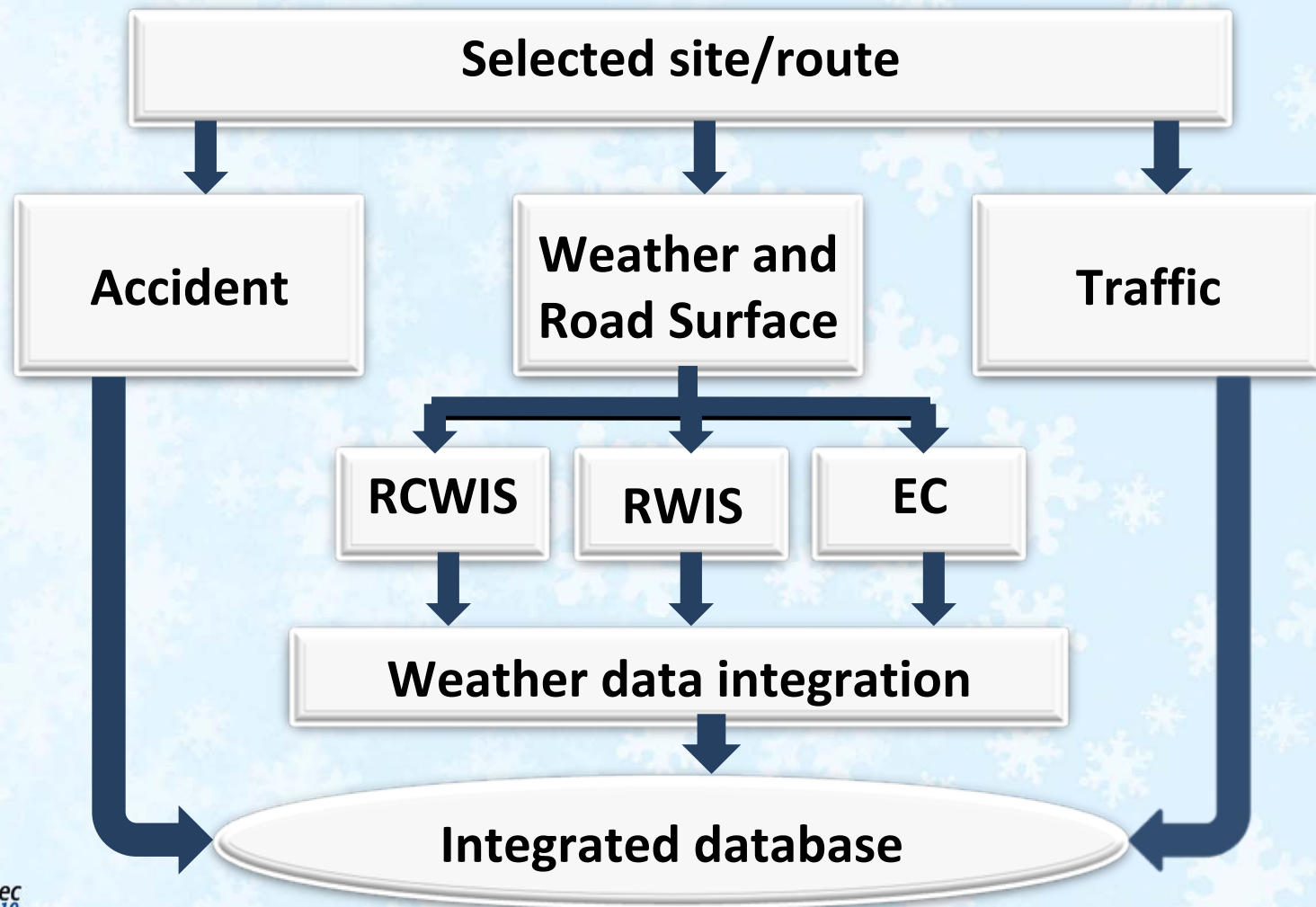
© 2000 Her Majesty the Queen in Right of Canada, Natural Resources Canada.
Sa Majesté la Reine du chef du Canada, Ressources naturelles Canada.

STUDY SITES



Projection: NAD 1983 MTM 10

DATA COLLECTION AND INTEGRATION



ROAD SURFACE CONDITION (RSC) DATA

- Descriptive and categorical:
- 160 sub-classes



RSC REPRESENTATION SCHEMES

- Aggregate the classes into a smaller number of categories
- Convert the categorical RSC into a scalar variable such as Road Surface Condition Index (RSI)

HOURLY-BASED CROSS SECTIONAL ANALYSIS

- Between-events and within event accident variation?
- Model type:
 - Poisson Lognormal model

MODELLING STEPS

- Exploratory data analysis
- Calibration of Models
- Selection of Model

VARIABLES CONSIDERED

- Total number of accidents in an hour as the dependent variable
- Dummy variables for time trend
- Weather variables
- Maintenance & average road surface conditions in an hour
- Traffic Volume in MVKm

MODELING RESULTS

Variable	Coeff	Sig
Intercept	-3.566	0.000
visibility (km)	-0.030	0.000
S2E1	-0.409	0.000
S2E2	0.000	
Wind speed (Km/Hr)	0.008	0.043
Air temperature	-0.038	0.000
hourly Ppt (mm)	0.050	0.004
RSC	-0.670	0.000
Ln exposure	0.218	0.000
401 – R1	2.705	0.000
401 – R2	1.795	0.000
QEW – R1	-0.235	0.589
QEW – R1	0.000	
LL	-3122.863	

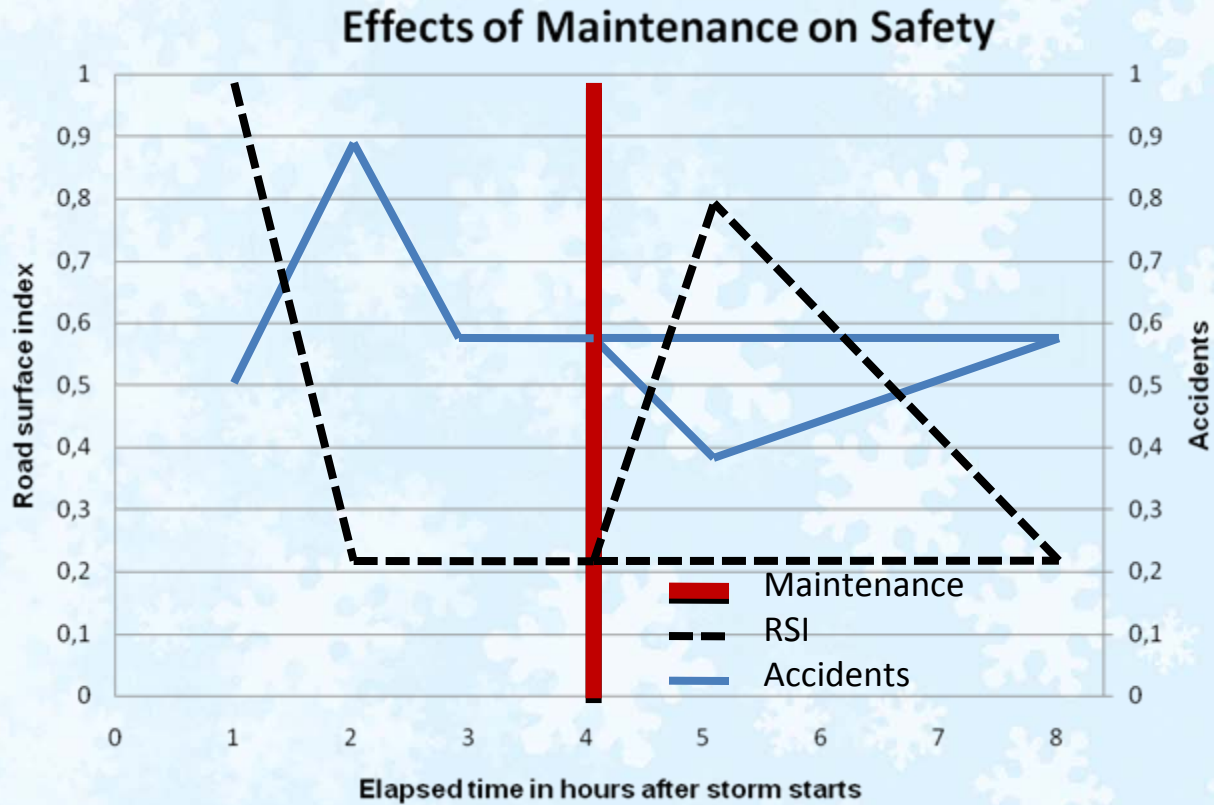
APPLICATION

- Patrol route considered = 401 – R1
- Traffic flow rate = 10,000 veh/hr (through out the event)
- Event duration = 8 hours
- Visibility = 4 Km
- Precipitation = 20 mm/hr
- Wind speed = 15 Km/hr
- Air temperature = -5 C

APPLICATION

- At the start of the event, the road surface is bare and dry with a RSI of 1.0 for the first hour.
- Due to precipitation, RSI drops (linearly) to 0.2 at the start of the second hour and it remains at this level until the end of the 4th hour.
- A ploughing and salting operation is completed at the 5th hour which brings the RSC back to bare-wet state with a RSI of 0.8
- Due to the combined effect of precipitation, residual salt and traffic, the RSI is assumed to decrease linearly to a value of 0.2 in the eighth hour.

APPLICATION



CONCLUSIONS

- Model: Linking road surface condition to safety
- Methodology: operational level, Level of aggregation
- Applications: cost-benefit analysis, traveler information system

FUTURE WORK

- Covering mix of sites
- New model structures
- Severity analysis

ACKNOWLEDGEMENT

- Higher Education Commission, Pakistan
- Ministry of Transportation, Ontario
 - Highway Infrastructure and Innovation Funding Program (HIIFP).
- Environment Canada

Thanks