

2016 TRB Winter Weather Conference

Innovative uses of Maintenance Decision Support Systems as a Research Tool for analysing Winter Road Salt Usage



Ted Reeler
Meteorological and Oceanographic Services
Amec Foster Wheeler

Amec Foster Wheeler

Meteorologists and Oceanographers
forecasting

Severe Marine and Weather Conditions

including Road Weather Information Systems
which forecasts winter pavement temperatures



Learning Outcomes

1. Road Weather Information Systems (RWIS)

what is the special value of RWIS?

2. Maintenance Decision Support Systems (MDSS)

what is the special value of MDSS?

3. MDSS as a Research Tool

what are the practical uses of MDSS as a research tool?

how is it powerful when used as a research tool?

Road Weather Information Systems

RWIS

A typical RWIS Station



Wind Speed/Direction

30 foot roadside meteorological tower

Relative Humidity/Air Temperature

Barometric Pressure

Snow Depth

Datalogger

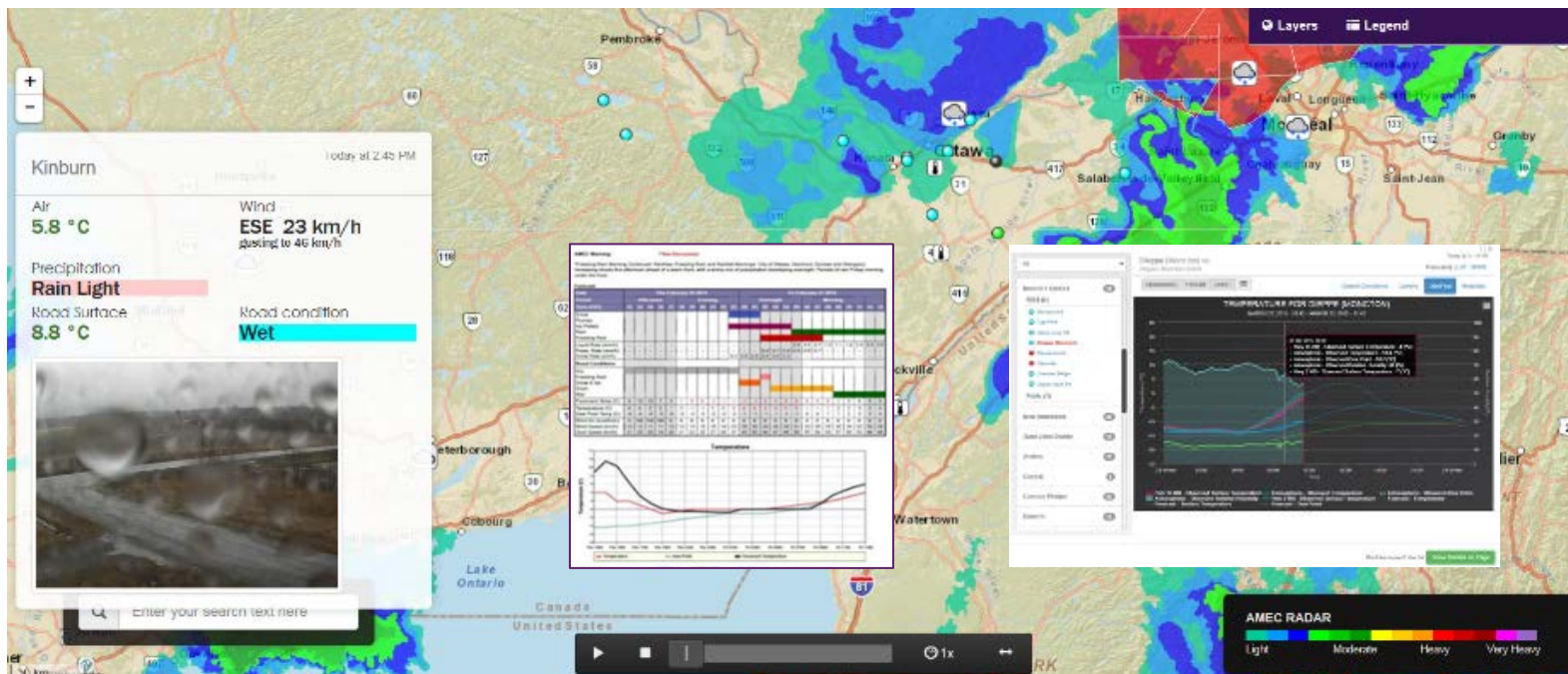
Tipping Bucket Rain Gauge

Road Surface Sensor



A Weather Web Portal showing RWIS data

- Real-Time and forecasted **pavement temperatures** are displayed
- Road Maintenance Crews know when the road will freeze
- Roads made safe through timely plowing and chemicals (salt) application



Maintenance Decision Support System

MDSS

RWIS Systems and MDSS Systems

Road Weather Information Systems (RWIS) is a fairly mature industry

- Pavement Temperature Forecasting
 - when will the road freeze?
 - timely plowing and chemical application (salt)

Maintenance Decision Support Systems (MDSS) becoming more widely used

- analyzes the coming winter storms
 - what treatment should be applied?
 - best application of the Rules of Practice

MDSS origins

- Funded by the FHWA Federal Highway Administration in the USA;
- Released in 2002 by NCAR and 4 other labs and refined since;
- National Centre for Atmospheric Research (NCAR)
- Army Cold Regions Research & Engineering Laboratory (CRREL)
- Massachusetts Institute of Technology (MIT)
- NOAA National Severe Storms Laboratory
- NOAA Forecast Systems Laboratory



What does MDSS really do?

Provides Treatment Recommendations for winter roads

- What?
- When?
- How Much?

- Predicts when you should plow to remove snow according to your Rules of Practice
- Predicts when to apply chemicals, what chemicals and how much so the water on the road will not refreeze
- Shows the expected improvement in road conditions if treatment is applied

MDSS integrates:

- Numerical weather predictions models
- Road weather forecast system
- Road temperature algorithm
- Road chemical concentration algorithm
- Road mobility algorithm
- **Rules of Practice** logic (specific to the road maintainer)

MDSS Treatment Suggestions

Baddeck
From: St Anns Intersection
To: Baddeck

Table Chart Show old forecasts MDSS Summary

Time NST	Temp (°C)	Precip Rate (mm)	Snow (cm)	Plow	Apply Chems	Chemicals	Original	Net	Blowing snow	Road	Weather
Nov 27, 2014 09:30	3.3	3.00		No	No		70	70	OK	Marginal	Marginal
Nov 27, 2014 08:30	1.8	1.90		No	No		70	70	OK	Marginal	OK
Nov 27, 2014 07:30	1.5	3.10		No	No		70	70	OK	Marginal	Marginal
Nov 27, 2014 06:30	1.6	4.80	0.58	No	No		60	60	OK	Marginal	Marginal
Nov 27, 2014 05:30	1.4	3.90	0.60	No	No		60	60	OK	Marginal	Marginal
Nov 27, 2014 04:30	0.9	2.40	0.60	No	No		60	60	OK	Marginal	OK
Nov 27, 2014 03:30	0.3	2.80	0.60	No	No		60	60	OK	Marginal	OK
Nov 27, 2014 02:30		2.40	0.60	No	No		60	60	OK	Marginal	Extreme
Nov 27, 2014 01:30	-0.2	2.20		Yes	Yes	55 kg/(lane*km) DRY NAACL	60	70	OK	Marginal	Extreme
Nov 27, 2014 00:30		2.10	0.60	No	No		60	60	Extreme	Marginal	OK
Nov 26, 2014 23:30		1.90	0.52	No	No		60	60	Poor	Marginal	Poor
Nov 26, 2014 22:30	0.9	1.20		No	No		70	70	OK	Marginal	Marginal
Nov 26, 2014 21:30	3.8	0.80		No	No		70	70	OK	Marginal	Extreme
Nov 26, 2014 20:30	4.1	0.40		No	No		70	70	OK	Marginal	OK
Nov 26, 2014 19:30	4.4			Yes	Yes	95 kg/(lane*km) DRY NAACL	100	100	OK	OK	OK

MDSS as a Research Tool

Using MDSS to assess past salt usage

Use MDSS to process past seasons;

- using weather and RWIS data;
- applying specific Rules of Practice;
- generating recommended treatments;
- for each winter storm over the season.



Compare the results with actual treatments that took place;

- Are reasonable quantities are being used in practice?

2014

The City of Ottawa was able to assess the impacts over past seasons of:

- Salt Usage
- Environment
- Costs

Using MDSS to assess the impact of Rules of Practice

If you change the Rules of Practice

- Pre treatments;
- Snow accumulation before plowing;
- Chemical type and rate rules;
- Route timing and turn-around times;

How is road maintenance affected

- salt usage;
- time spent clearing roads;
- maximum possible length of runs;
- cost of maintenance.

2015/2016

Ministry of Transportation of Ontario

MTO is able to:

- explore Rules of Practice
- measure Winter Severity



MDSS Factors

MDSS analyses and tracks;

- road temperature;
- snow on the road;
- snow precipitation rate;
- available liquid on the road;
- road type;
- traffic volumes;
- weather conditions;
- road conditions; and
- mobility on the road.



Note that:

- road maintenance crews measure time to regain bare pavement; while
- MDSS measures how much liquid equivalent remains on the road.

MDSS Analysis Methodology

Methodology:

- select multiple test areas;
- select multiple seasons;
- get MDSS running according to the specific rules of practice;
- validate that its behavior makes sense;
- then run it consistently:
 - over different storms;
 - in different seasons;
 - over different parts of the province;
- explore the sensitivity as you increase or decrease certain parameters;
- explore the differences for large storms and small storms;
- explore the differences for a normal season and an extreme season.

MDSS Practical Considerations

In reality there are **important real world factors** which are difficult to program:

- forecast uncertainty;
- safety margins are applied in practice;
- maintenance crews know troublesome roads and dangerous intersections.

MDSS has **assumptions in its algorithms** (for example):

- try to minimize the salt application (not necessarily the fuel and labour spent);
- wait until there is chemical failure before re-applying;

MDSS enables **consistency of practice** to be applied

- can turn anecdotal comparisons into **measurable quantities**;
 - in different storms; and
 - in different seasons; and
 - over different geographic areas.

Learning Outcomes

1. Road Weather Information Systems special value?
models and predicts when the roads will freeze
2. Maintenance Decision Support Systems (MDSS) special value?
recommends when and how to treat winter roads
3. MDSS as a Research Tool – what are the practical uses?
assess salt usage
predict impact of changing winter road maintenance Rules of Practice
4. MDSS as a Research Tool – how is it powerful?
consistency in processing different storms, in different regions over different seasons



Thank You

Ted Reeler P.Eng.
Associate Consultant, Met-Ocean Services
Amec Foster Wheeler Environment & Infrastructure
Ottawa, Ontario, Canada
613-727-0658 ext. 2365
ted.reeler@amecfw.com