## Estimating Winter Weather Road Restoration Time using Outsourced Traffic Data: Three Case Studies in Maryland

August 2014, NRITS Branson, MO

**Elham Sharifi** Stanley E. Young Thomas H. Jacobs Steven M. Rochon

# Nickan Kevan Sadr



• Born July 15

### Introduction

- Objective: Examine the I-95 VPP data to determine if the speed and travel time data can be used as a basis to calculate winter weather road restoration performance measures.
- Specifically by identifying the time required to restore the roadway to normal operating conditions.
- A candidate algorithm based on reduction of speed and change in confidence score within the VPP has been proposed.
- The algorithm is evaluated during three known snow events.

### Literature Review

- The most common performance measure for winter weather operations used by most DOTs is 'time to bare pavement'.
- With improvements in technology, traffic data can be used to find the time when traffic is back to normal.
- MnDOT: Speed, flow, and density collected by loop detectors used to determine when traffic patterns return to normal and it is an estimate for the 'bare-lane-regain time'. They identify two common speed recovery patterns :
  - > Only affected by the road condition.
  - > Affected by both the road condition and the traffic-flow.
- MnDOT algorithm incorporates a sophisticated procedure that incorporates data smoothing, quantization, and identification of times of significant changes in speed in order to characterize and measure the return to normal operation.

### Literature Review

- The Ohio DOT has a program called "Snow & Ice Recovery Evaluator" Their data source for traffic is INRIX, and for weather is RWIS. Their basic algorithm is:
  - Starts when at least 5% of the routes have speeds below 10mph from historical speeds and at least 25% of RWIS sensors report snow or ice.
  - Ends when less than 25% of the RWIS sensors are showing snow or ice and wind speed is less than 15 mph.
  - If another snow event starts in less than one hour, the two events are combined.
  - Speeds recover when less than 5% of routes have speeds below 10 mph from historical speeds.
  - Different scores are assigned to different recovery times. If the recovery time is less than 3 hours they score it as 100%.
  - > The score of different winter weather events are averaged for each
  - district monthly.

### Literature Review

Michigan DOT: The steps in their algorithm to find the performance measure (regain time) of winter weather events are:

- The starting and ending time of the winter storm determined by the operations engineer/ maintenance personnel.
- > If another storm begins within 2 hours, the events are combined.
- > Traffic data is based on 10 minute average data from RITIS.
- If the segment consists of several TMC's, the average speed and average historical speed is calculated.
- Whenever the average speed rises to within 5 mph of average historical speed for at least one hour, normal operations have been regained.
- Michigan's goal is to regain normal speeds in 2 hours or less, 80% of the time for winter weather events.

### Developing the Algorithm

- A candidate algorithm based on reduction of speed and change in confidence score within the VPP has been proposed and tested.
- The algorithm was developed by analyzing the data for hurricane Sandy and then it was evaluated and refined by applying on two additional case studies.

#### The case studies include:

- Hurricane Sandy impact on I-68 in Western Maryland (Oct 29<sup>th</sup> and Oct 30<sup>th</sup>, 2012)
- Snow event impact on I-695 (Jan 26th and Jan 27th, 2011)
- Snow event impact on MD-100 (Feb 13<sup>th</sup> and Feb 14<sup>th</sup>, 2013)

### Hurricane Sandy Impact on I-68 in Western Maryland

- Started on Oct, 29th, 2012 and continued to Oct, 30th, 2012.
- Most of the areas in Maryland faced with heavy winds and rains but in western Maryland some snow has been reported.
- One of the areas that experienced heavy snow was I-68 in western Maryland, received between 24 and 30 inches of snow.

#### Location of the Selected Segment on I-68

- One segment
- Between MD-42 / Exit 4 intersection and US-219 / Exit 14 intersection
- ✤ Eastbound with 9.2 miles length.



#### Analyzing Confidence Score 30

- The first step is identifying the normal variation in the confidence score within the VPP data.
- It reflects whether the system has sufficient base level traffic data.
- A confidence score of 30 indicates that the data are driven by actual field observations, whereas a score of 10 or 20 reflects the data is based primarily on historical data.
- When traffic volume diminishes, the probability of having significant base level data for real-time traffic information also diminishes.
- The hourly average confidence score on October 29th and 30th are contrasted against the typical weekday average confidence score.

#### Hourly Percentage of Score 30 for Sandy Storm Days and a Typical Weekday



#### Speed, Historical Speed, Percentage of Real Time Score 30, Percentage of Typical Day Score 30



Score 30

Score 30 on Typical Weekdays

Based on
15 Minute
Intervals

### **Further Analysis**

Lack of real time probe data makes the reported speed unreliable.

This problem happens because VPP suite also uses any data with Score 20 or 10 in its speed calculations

To alleviate this problem, a 15 minute running average was calculated using only real time data. The 15 minute rolling horizon is assessed every minute.

#### Speed, Historical Speed, Percentage of Real Time Score 30, Percentage of Typical Day Score 30



Based on
15 Minute
Rolling Horizon
for Each Minute

Using Only Real Time Data

#### Winter Road Restoration Time Algorithm

Based on the Speed and Confidence reported in VPP:

- 1) Establish a speed thresholds based on historical data.
- 2) Establish a confidence threshold based on historical.
- 3) Use 15 minute rolling horizon for calculation of speed and percentage of score 30 for each minute. The speed calculation should be only based on real time speeds.
- Beginning: When the percentage of score 30 drops below 40% of reference confidence at nights or below 80% of reference confidence at days or speed drops below 50% of reference speed for at least 30 minutes.

#### Winter Road Restoration Time Algorithm

- 5) If the drop in speed is the only cause of the beginning point and the speed is dropping continuously until it hits the 50% of the reference speed, the beginning time should be reported when speed drops below 80% of reference speed.
- 6) Ending: When the percentage of score 30 rises above 40% of reference confidence at nights or above 80% of reference confidence at days and speed rises above 50% of reference speed for at least 1 hour.
- 7) If in the ending of the event, the speed is continuously increasing; the ending point of the event should be reported as when the speed rises above 80% of reference speed.
- 8) The time difference between the beginning and end of the winter weather event establishes the restoration time.

### **Restoration Time on I-68**



Interval for Winter Road Restoration Time	Beginning Time	Ending Time	Duration
1	21:53	36:13	14:20

#### Case Study-2: Snow Event Impact on I-695

- A winter storm hit the Washington and Baltimore metropolitan areas on Wednesday, January 26th, 2011.
- The storm came in two waves: The first one came in northern Maryland in the early morning. The second one was a stronger wave that hit the region late Wednesday afternoon and evening and brought heavy snow to most of the region.
- There were so many reports of commuters delayed for 5 to 10 hours to get home from work while others abandoned their vehicles.
- The Baltimore beltway which is the area under investigation received between 9 and 10 inches of snowfall during this event.

#### Location of the Segment on I-695

- One segment
- Counterclockwise Direction on Northwest of I-695
- ✤ From I-83, exit 24 to I-795, exit 19
- **♦** 5.9 Miles



#### Speed, Historical Speed, Percentage of Real Time Score 30, Percentage of Typical Day Score 30



### **Restoration Time on I-695**



Interval for Winter Road Restoration Time	Beginning Time	Ending Time	Duration
1	17:32	25:00	7:28

#### Case Study-3: Snow Event Impact on MD-100 in Anne Arundel County

- On Feb 13<sup>th</sup> around 5:30 PM, snow started on MD-100 and it lasted until around 0:30 AM on Feb 14<sup>th</sup>.
- Congestion was reported on MD-100 in Anne Arundel County.
- ✤ A 6.4 mile segment on eastbound of MD-100 was analyzed.



#### Speed, Historical Speed, Percentage of Real Time Score 30, Percentage of Typical Day Score 30



### **Restoration Time on MD-100**



Interval for Winter Road Restoration Time	Beginning Time	Ending Time	Duration
1	24:47	26:37	1:50
2	30:28	31:!6	0:48

#### Lessons Learned / Take-Aways

- The proposed algorithm can detect unusual activity related to a winter weather, but it may be difficult to distinguish between a weather event and a major incident.
- Use other sources to determine the beginning and ending of the weather event (using traffic alone is difficult)
- Outsourced traffic feeds can be used to determine 'returnto-normal' time. However .....
  - Speed alone is insufficient, volume must be considered.
  - Score is used as a surrogate for volume
  - \*What is the speed if no-one is on the road?
  - Overnight hours will be problematic

### Cont.

- Severe weather is more critical to rural areas
- As more state access and use outsourced probe data, such views/analysis may become standardized and offthe-shelf
- Probe data providers may soon provide volume estimates to assist in determining 'normal' traffic

# **Questions?**