Modifying Winter Service Performance Criteria Using a Storm Severity Index – ID 32

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- Challenge of measuring performance of winter services in real-time
- Different storms require different responses
- Using the same level of service for all storms may result in huge variations in effort
- Is it possible to modify level of service as a function of storm severity?
- How?
- Conclusions

Outline

- While post-storm performance measures can be a good quality control measure…
- They are too late to allow service providers to adjust their actions if they are not meeting performance goals
- How can we measure performance in real-time?

The Challenge

- 5 cm of snow is different from 5 cm of freezing rain
  - Strategies
  - Level of effort
  - External factors
- How do we incorporate this difference into our performance measures?

Different Storms, Different Responses

- Keep requirements the same, but adjust time to achieve (i.e. instead of six hours, allow 8)
- Do not modify at all – may be suitable if storms are relatively uniform
- Scale the response according to storm severity – requires a performance measure that is scalable

Incorporate Storm Severity - Methods

Storm Severity Index

- Nixon and Qiu, 2005
- Uses 6 variables
  - Precipitation type, pavement temperature in-storm, wind condition in-storm, pre-storm behavior, post-storm wind speed, post-storm temperature trend
- Provides value between 0 and 1 where 1 is most severe.

$$SSI = \left[\frac{1}{b} \left[\left(ST * Ti * Wi \right) + Bi + Tp + Wp - a \right] \right]^{0.5}$$

ST = storm type (light snow, heavy snow, freezing rain etc.)
Ti = in-storm temperature range
Wi = in-storm wind condition
Bi = early storm behavior (rain or no rain)
Tp = post-storm temperature range
Wp = post=storm wind condition
a, b = normalizing parameters

The Index

- We know that vehicle speeds, and other traffic parameters (e.g. capacity) reduce when there is winter weather
- So, in theory, reduction in speed can be a measure of winter service performance
- The greater the reduction in speed, the greater the impact of the winter weather
- In two “identical” storms, different speed reductions would imply different road conditions (and thus level of service)

A Scalable Performance Measure

- The degree of speed reduction is a function of road types
- 2 lane rural highways are different from 6 lane motorways (Qiu and Nixon, 2009)
- Ignore situations where roads are closed (i.e. average speed = 0)
  - Mostly due to either crashes or low/zero visibility anyway
- Historical data suggests the worst speed reductions observed are in the 30 – 50 kph range
- Use the worst speed reduction for a road type as a normalizing parameter

The Scale of Speed Reductions

- Storm with an index value of 0.6
- Road type where worst expected speed reduction is 45 kph
- If observed speed reduction from "normal" is less than (45 * 0.6) then OK
- If greater, not OK
- "Normal speed" = historical normal for that road in good weather on that day/date at that time

An Example

- Average speeds can be measured and reported in real-time
- Real-time indication of effectiveness of winter service actions
- Ability to correct if not adequate (or if too many resources applied)

Benefits

- Measuring performance in real-time allows service to be adjusted to meet targets more effectively
- Need to adjust for severity of storm
- Combination of index and maximum speed reduction allows development of target speed for in-storm conditions
- Provides real-time measure of performance, and thus real-time adaptation of service if required

Conclusions