MDSS SNOW ACCUMULATION PERCENTAGE BASED ON ROAD SEGMENT MAINTENANCE REQUIREMENTS

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This presentation describes a decision support tool implemented in Finland for maintenance supervisors who are in charge of a large heterogeneous road network.

Snow accumulation displays have been a key element of winter maintenance decision support systems from the beginning (1). Typical presentation is a graph for a point location and/or a map that shows the spatial distribution of snow accumulation, as measured in centimetres. These suffice if the end-user is either focusing on a single ploughing route or if all the roads in the area have similar maintenance requirements. The Finnish Transport Agency contracts out winter maintenance and employs supervisors that randomly check the performance of the contractors. During a snowfall event the supervisors face a problem: where to focus surveillance during the event, in order to optimally spend their time. The problem is challenging since one supervisor is responsible for a geographically large area in which there are roads that belong to different winter maintenance road classes. The maintenance requirements per road class include the maximum snow depth allowed during the snowfall and the time after event start at which maintenance actions must begin. For example, a class I highway has a maximum snow depth of 4 cm and an action time of 3 hours while the numbers for a class III road are 10 cm and 6 hours, respectively. The variety in maintenance requirements combined with uneven distribution of snowfall makes it difficult to see where exactly the action thresholds are being triggered at any given time. The solution was to create an hourly updated service where past and future snowfall are consistently presented, not in centimetres, but as a percentage of the maximum allowed snow depth for each road segment.

To create the service, data from multiple sources had to be combined. The Finnish state-owned highway network comprises 78,000 kilometres of roads. The entire highway network was split into one kilometre segments and each segment was assigned to a winter maintenance class. If possible, each segment was additionally assigned to a ploughing route to enable per-route alerts, but this data was not available from all the contractors. The service time-line extends 12 hours into the past and 24 hours into the future. The past snowfall is based on radar and the future snowfall is obtained from an in-house manually edited snow accumulation product. The on-duty meteorologists typically use radar extrapolation for the first hours of the product. During the first 2016-2017 winter season, the service derived past snowfall from radar using a fixed reflectivity-based formula. Even though the formula has been experimentally calibrated using observed snow accumulation in weak wind situations, it was found to be too inaccurate to justify the high level of detail in the service. During the second winter season 2017-2018, a real-time calibration based on hourly precipitation measurements from the Finnish SYNOP stations was implemented. Another refinement based on the first season's experiences was related to radar clutter filtering. Clutter filtering invariably removes some real precipitation and there is a trade-off between the amount of remaining false echoes and the amount of falsely removed precipitation. It was realised that for a service which combines automatic alerts with long accumulation periods, aggressive filtering is needed. To support the service, a custom radar-based snow accumulation product was therefore created based on aggressive filtering and real-time calibration against SYNOP stations.

The user interface of the service allows navigation in time, zooming and panning, and clicking on arbitrary road segments for detailed information. The key feature of the service is a map (Fig. 1.) where the road segment colouring is based on the percentage of maximum snow depth reached. The colouring is based on a traffic light scheme: roads are green if no action is required, then turn yellow when action should have started at 50% of maximum snow depth, and then turn red when the maximum snow depth is reached. This map makes it easy for the supervisors to plan their daily route: they simply need to check where the roads turn red at any given time. To relieve the supervisors of the need to continually monitor the service, email alerts can be subscribed to, based on arbitrarily selected areas.

A separately funded independent study about the snow accumulation accuracy and about the usefulness of the service was performed during the first winter. (2) The study found the service useful for the monitoring of snow accumulation when the target area was large, but found some issues with the actual accumulations. Additionally, test users reported issues that were tracked down to false radar echoes and to the conversion of radar reflectivity to snow depth. The earlier-mentioned improvements implemented during the second winter addressed most of the concerns, and the service has been found useful.

Fig. 1. The snow accumulation percentage map display

Possible future work includes ingestion of live maintenance action data from the contractors' fleets. Such data is already available to some extent, but for this service such data should be available for the entire country. Real-time de-icing and ploughing information would make it meaningful to run a full road maintenance model with ploughing-based snow removal and residual salt modelling. Without comprehensive maintenance data it was deemed sufficient to build the service using only snowfall data. Another possible future improvement is advection-based adjustment of radar measurements (3).

This work was supported by the Finnish Transport Agency. The idea of a service where snow accumulation is presented as a percentage of the maximum allowed snow depth was presented by Pekka Rajala, ELY Centre.

References:

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