Weather induced road accidents, winter maintenance and user information

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Abstract

In Northern Europe, Scandinavia and in mountainous areas elsewhere in Europe, a considerable portion of road accidents has adverse weather (e.g. strong winds, snow and ice) as a primary or a contributing cause. In future climate, wind will probably appear as a more serious and frequent threat to road traffic than in present climate. Another consequence of climate change on road traffic is the northward migration of the de-icing zone, which in turn calls for continuous adaption of winter maintenance procedures. Mitigating measures against this accident category may consist of intense winter maintenance, the use of road weather information systems for data collection and early warnings, besides driver education, road surveillance and traffic control. While hazard from reduced road friction due to snow and ice may be eliminated by snow removal and de-icing measures, the effect of strong winds on road traffic are not easily avoided. Forced road closures due to strong winds may have serious impacts on society and should therefore be kept to a minimum. Therefore, knowledge on the relationship between wind exposure and traffic safety should be enhanced. The purpose of the study described here, was to investigate the relationship between traffic safety, weather, user information on road weather and driving conditions and winter maintenance operations. Thanks to the dense network of automatic road weather stations in Iceland, the road user information service and the winter maintenance automatic vehicle location and activity registration, the road accident database can be examined in depth with respect to these issues. For chosen road sections, all weather related road accidents in a given period were cross-linked to the available data described above. Two road sections in Iceland were investigated. The Reykjanesbraut road, connecting the capital area and the airport was chosen for accident analysis with respect to winter maintenance activity and user information delivery. National road no. 1 at Kjalarnes and Hafnarfjall were chosen for wind gust and road surface scrutiny for registered accidents. The relatively short examination period, low traffic volume and small number of accidents yet investigated has not allowed a valid statistical analysis of the results so far. However, it has been demonstrated that the methodology developed herein is likely to give valuable information from processing of larger batches of weather induced incidents later on. The most prominent applications are the optimization of the winter maintenance management system, improvements to road surveillance, road weather monitoring and improved accuracy of user information delivery. Also, statistics on wind gust, surface condition, vehicle category and other relevant parameters for wind induced accidents provide basis for traffic control, early warning policies and driver education for improved road safety at wind-exposed locations.

1. Introduction

1.1 Background

Iceland shares the common climatic challenges of other Nordic countries regarding the road traffic. During winter time, accessibility and safety is compromised by snow and ice conditions and considerable effort is required by the road authorities to maintain acceptable driving conditions, ensuring winter road safety and accessibility. Additionally, strong winds frequently lead to hazardous driving conditions, which get even worse when snow and ice cause reduced road friction.

The whole national transport system for goods and people relies almost exclusively on the performance of the road system due to the fact that no rail system exists in Iceland and coastal shipping is abandoned. Large portion of road accidents in the winter time have reduced winter friction and strong winds as a contributing factor. Mitigating measures against this accident category may consist of intense winter maintenance, the use of road weather information systems for data collection and early warnings, besides driver education, road surveillance and traffic control.

1.2 Objective

The purpose of the research described here, was to investigate the relationship between traffic safety, weather, user information on road weather and driving conditions and winter maintenance operations. The main objective is to demonstrate how continuous analysis of road accident statistics can contribute to improvements to the Winter Management System and to all operations intended to increase road safety with respect to climatic conditions (Figure 1).

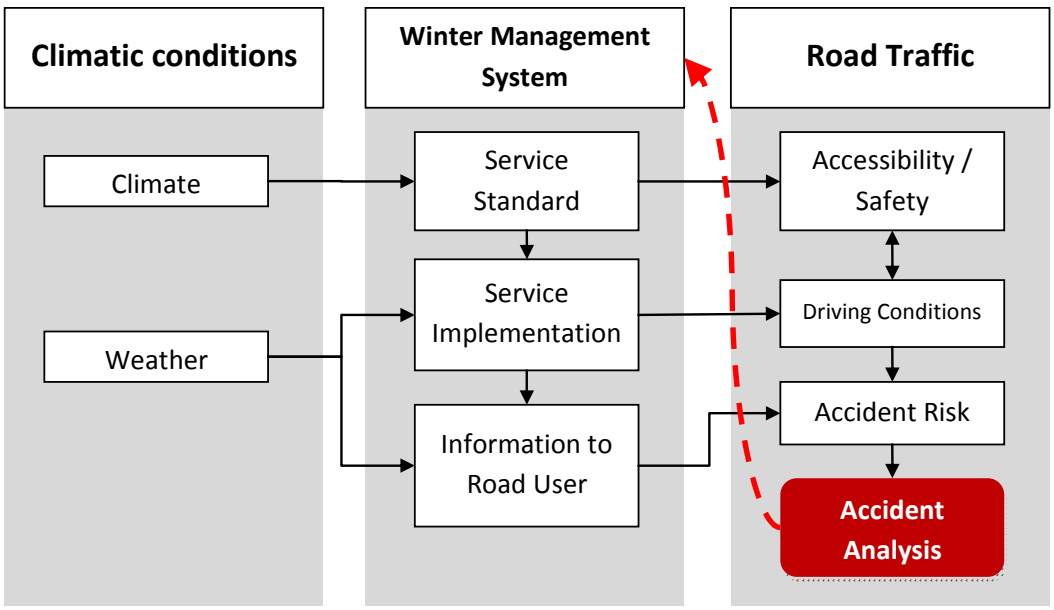

Figure 1. Schematic diagram showing factors influencing road safety due to climatic conditions.

The paper summarises the results from two separate studies; firstly analysis of wind induced accidents on two wind-exposed road sections on national road no.1, on either side of the Hvalfjordur submarine road tunnel near Reykjavik (Thordarson & Snaebjornsson, 2004 and 2006 and Thordarson 2006). The two road sections are Kjalarnes, ADT 6400 and Hafnarfjall,

ADT 3400 (year 2005 figures). That research was done in collaboration between the Icelandic Road Administration (ICERA), Orion Consulting and the Engineering Research Institute, University of Iceland. Secondly, we present results from analysis of accidents due to snow and ice on the Reykjanesbraut road no. 41 (ADT 9500, year 2005 figures) presented in (Thordarson & Olafsson, 2007). In the study, service vehicles equipped with automatic vehicle location (AVL) and activity registration allows for a more precise investigation of the effect of winter service operations on accident risk than previously possible.

2. Results

2.1 Wind induced accidents

The ICERA operates numerous weather stations along the road network. Besides providing real-time monitoring the historical data from the stations is useful for different analysis, including accident analysis. In this study, measured wind data at the time of accident along with description of road surface condition from police accident reports allows in depth analysis of accidents.

Both sites investigated for wind induced accidents are adjacent to mountains that during specific weather conditions are prone to magnifying the wind effects, causing extremely hazardous conditions on the road. On the road near Hafnarfjall, we investigated all wind induced accidents in the period 1995-2001, and in the Kjalarnes area the study period is from 1999 – 2003. At Kjalarnes the chances that the 10 minute mean wind speed exceeds 15 m/s in a single day during the winter is 47%. The highest wind gust can be as high as 2,5 times higher than the mean wind speed, frequently caching drivers off-guard, despite variable message signs indicating the wind speed on the site.

It is well known that vehicle characteristics are important regarding stability during windy conditions. On exposed sites, cross winds acting laterally on the side of the vehicle are commonly as strong as the vehicle velocity induced air-speed, the air pressure acting sideways can thus be high as the drag force in the driving direction . The appearance of the different vehicle categories in the data confirms that the aerodynamic properties of vehicles is an important factor regarding safety on wind exposed sites. Once an accident has happened, the chances that the recorded mean wind speed is 10 m/s or more, are double for high-sided vehicles such as trucks and trailers, than for passenger cars. The following table summarizes the involvement of different vehicle categories in the accidents.

Table 1. Number of vehicles per category involved in all accidents at Hafnarfjall and Kjalarnes study sites and the portion of vehicles in wind-accidents.

	All vehicles involved in accidents	Vehicles in accidents with wind > 10 m/s	
Passenger cars	248	69	28%
Busses	6	2	33%
Heavy goods vehicles	43	18	42%
Trailers (any size)	22	14	64%
Others	34	7	21%
Sum	353	110	31%

The interaction of road surface condition and wind gust also plays an important role concerning road safety. Our analysis revealed that wet road surface during rain, or slippery road due to snow and ice lowers the critical wind gust strength. However numerous accidents are recorded on a bare, dry road surface but the wind gust is usually higher in those cases. Also, accident types vary according road surface conditions, dry road wind accidents are more often caused by vehicles rolling over, while vehicles skidding of the road is more common during wet or slippery conditions.

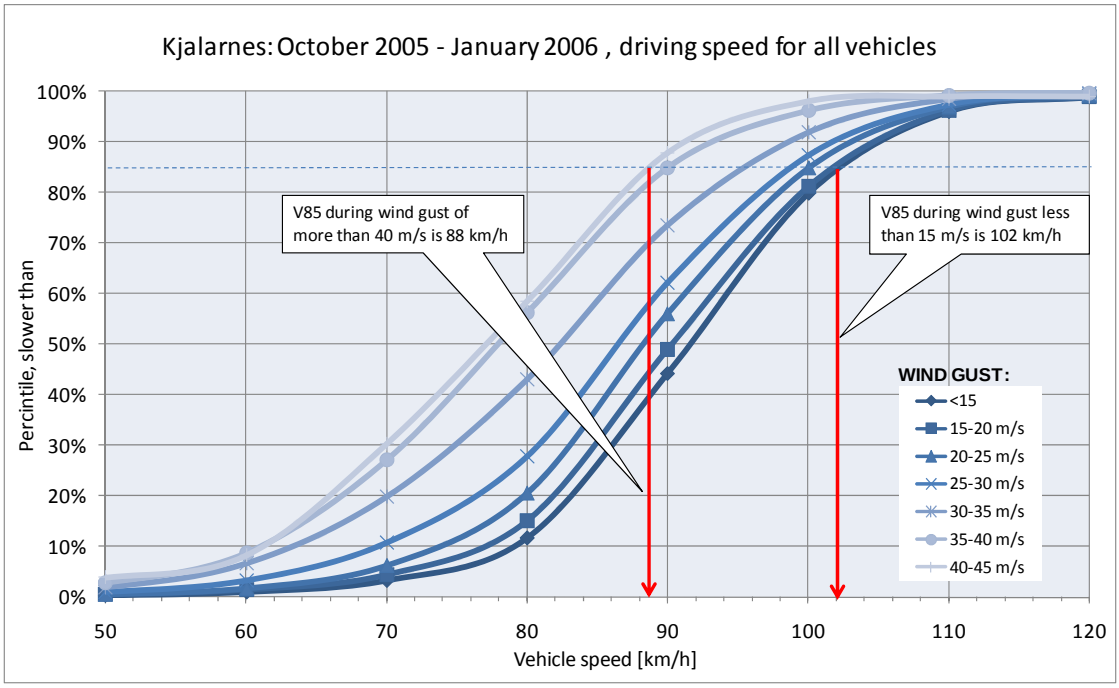

Figure 2. Actual measured vehicle speed distribution during different wind conditions. The results indicate that during extremely high wind speeds (gust > 40 m/s) V85 in only lowered from 102 km/h to 88 km/h.

In accidents happening at mean wind speeds lower than 10 m/s at Kjalarnes, 85% of the drivers state that their driving speed was 89 km/h or lower (V85 = 89 km/h). When the mean wind speed is higher than 10 m/s, 85% of drivers involved in accidents estimate their driving speed as 78 km/h. Thanks to the pavement mounted traffic sensors, V85 is easily calculated (Figure 2) and sorted according to the recorded wind speed in a nearby weather station. For the winter 2005 to 2006, on Kjalarnes, this exercise reveals that V85 is close to 102 km/h when the maximum wind gust is lower than 15 m/s. When the wind gust is 40 m/s (78 knots or 144 km/h), V85 is reduced to 88 km/h.

2.2 Accidents due to slippery winter road surface

The number of winter-accidents on the Reykjanesbraut road that are registered in the Road Traffic Directorate Accident-Database for the observation period (that is for September 2004-april 2005 and September 2005- March 2006) is 53. A winter-accident has been defined here as an accident where according to police reports, the cause is bad road conditions or the road conditions have been described as slippery, icy or with snow. Of those 53 accidents, 35 are categorized as single vehicle running of the road.

Figure 3 shows three examples of the 53 analysed accidents. Published information on road surface condition is shown for the last four hours before the accident and two hours after the accident. The information on road condition is accessible through website, text-TV and automatic telephone service, besides that road surface temperature and air temperature are indicated on a variable message sign by the road.

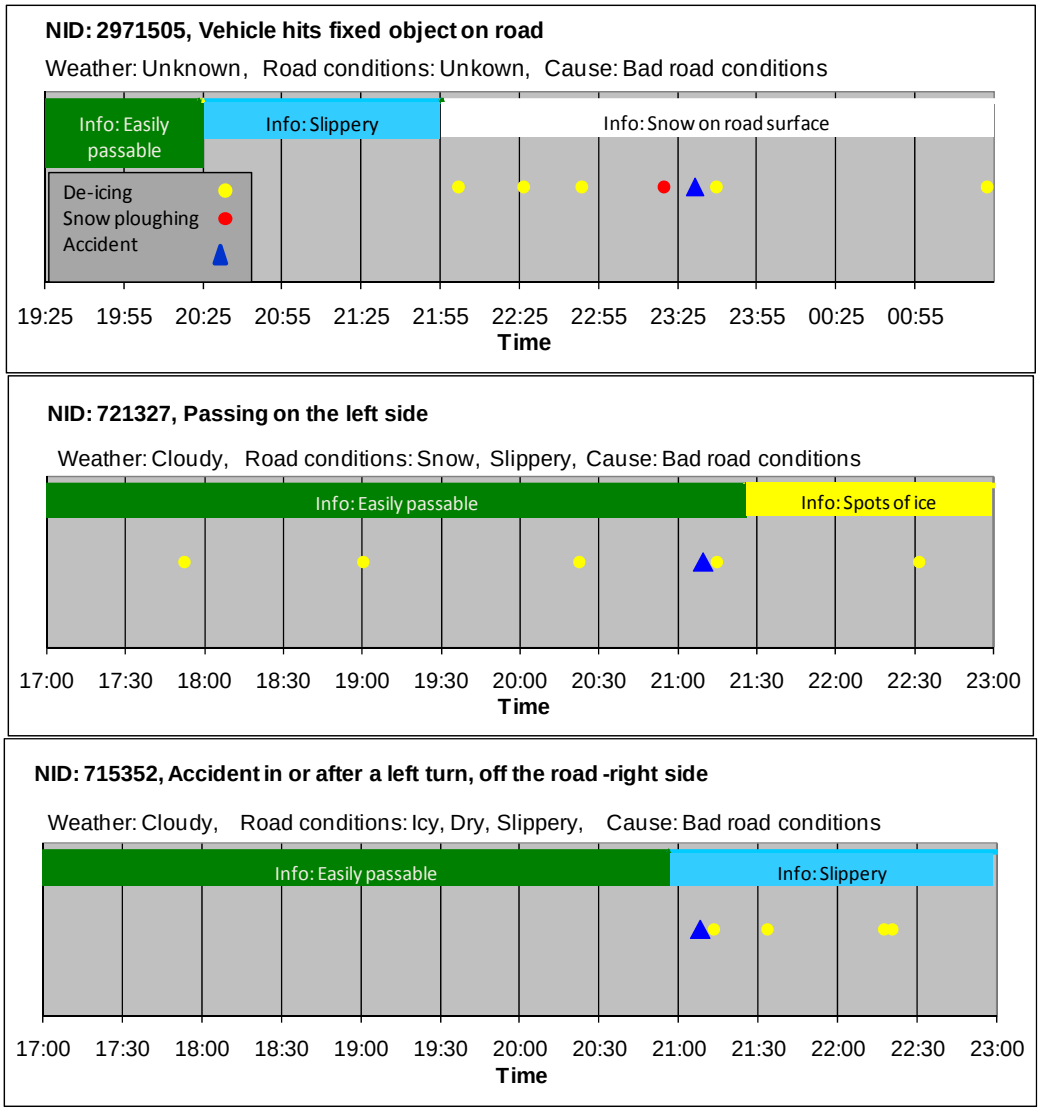

Figure 3. Examples of timeline diagrams showing winter maintenance activity, time of accident and the history of published information on driving conditions before and after the accident. The yellow spots indicate de-icing operation on the actual road section, while red spots indicate snow ploughing. The time of accident is marked with a blue triangle.

Analysis of the information submitted by the road authorities on driving conditions at the time of each accident shows that in 24 cases the label indicates “easily passable”, that means no signs of reduced road friction due to snow or ice is to be expected. However, according to police reports the road conditions are evaluated as slippery for all the 53 accidents defined as “winter accidents”. Approximately 10 % of the daily winter traffic on the study site is during the night (from 24:00 until 07:00), but 23 % of the winter accidents happened during the night. The submitted information is “easily passable” for 67 % of the night-time accidents and 39 % for the accidents happening in the day time. This is summarized in the following table.

Table 2. Winter traffic, accidents and imprecise information submission during day and night.

		Night (24:00 – 07:00)		Day (07:00-24:00)	
Daily winter traffic	8000	800	10 %	7200	90 %
Winter Accidents	53	12	23 %	41	77 %
Submitted info on road condition is “easily passable”	24	8	67 %	16	39 %

In 11 cases, no de-icing or ploughing was done during the last 4 hours before the accident but within two hours after the accident, similar to the bottom diagram in Figure 3.

3. Conclusions

The frequent appearance of heavy goods vehicles in the wind accident statistics is recently being tackled by major transport companies and insurance companies. Based on weather forecast and real time monitoring by automatic weather stations, recommendations are issued to drivers. However, private passenger car drivers hauling any kind of trailers (e.g. horse transport, snow scooter trailers, mobile holiday homes etc.) need to be aware of the risk caused by strong winds.

A higher driving speed can increases the overall aerodynamic forces on the vehicle. By reducing the driving speed during extremely windy conditions, drivers not only reduce the risk of accidents finding place but also increase their chances of correcting the course in time should the vehicle come out of control. Drivers need to be educated on the importance of reducing driving speed during extremely windy conditions. This is especially important when travelling close to mountains, where unexpected wind gust may occur.

The results from the study on accidents due to slippery winter road surface, suggest that road condition monitoring an surveillance could be intensified in order to improve the accuracy of the published information on driving conditions. This is especially true during the night. Preventive treatment of the road is important to reduce the risk of ice forming on the road. The use of advanced systems in weather forecasting and monitoring along with staff education and improved procedures is expected to improve the winter traffic safety. The ICERA has an ambitious vision for the ongoing deployment of information technology for the benefits of winter road accessibility and safety.

4. Acknowledgements

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5. References

1. Thordarson, S. & Snæbjörnsson, J. (2004, 2006). *Traffic accidents and wind conditions, parts I & II*. Reports for ICERA and The Icelandic Board for Road Traffic Safety Research. (In Icelandic).
2. Thordarson, S. & Olafsson, B. (2007). *The influence of road winter maintenance and user information on traffic safety*. Report for the Icelandic Road Aministration.
3. Thordarson, S. (2006). ‘Traffic safety on wind-exposed roads in Iceland’. *Nordic Road and Transport Research*, No. 2, pp. 14-15.