Avalanches on Icelandic roads

Geir Sigurðsson[1]*, Harpa Grímsdóttir[2] and Magni Hreinn Jónsson[2]

[1] Icelandic Road and Coastal Administration, Dagverðardal, IS-400 Ísafjörður, [2] ICELAND Icelandic Meteorological Office, Bústaðavegi 9, IS-150 Reykjavík, ICELAND
**Corresponding author, e-mail: geir.sigurdsson (at) vegagerdin.is*

1. ABSTRACT

The Icelandic Meteorological Office (IMO) and the Icelandic Road and Coastal Administration (IRCA) have worked together on avalanche issues for roads since 2011. IMO has delivered daily avalanche forecasts for specific roads since 2013, as a service to IRCA.

The forecast is one of the tools IRCA uses to make decisions on openings and closures of the roads, to issue warnings or send information to travellers. A system for disseminating information to road users has been developed, and road users can sign up to receive text messages in their mobile phones regarding the avalanche situation on the roads. The information is not only about openings and closures but also on possible upcoming danger and avalanche warnings during periods when the road is still open.

2. INTRODUCTION

The history of road construction in Iceland is brief, especially in rural areas. In the areas where the risk of avalanches is the highest, road construction is very difficult due to steep mountain slopes. This is especially the case in the Westfjords, part of the North and in the Eastfjords. Many of the roads in these areas were not opened until 1950−1970. Roads with heavy snow were not always cleared and, therefore, closed for a large part of the winter. It wasn't until after 1960 that snow removal on roads started to any extent.

For a long time, the responsibility and supervision regarding avalanches and avalanche danger rested on the shoulders of the supervisor for each area. The supervisors achieved good experience, got to know the circumstances well and led successful careers in general. It became known what sort of weather would be likely to lead to avalanches in each area and at which point, after the weather calmed, it was safe to be back on the roads. Many roads, where avalanches are likely to occur, lie in or under steep slopes with many avalanche paths threatening a short stretch of the road. Commonly, many avalanches occur within a short period of time.

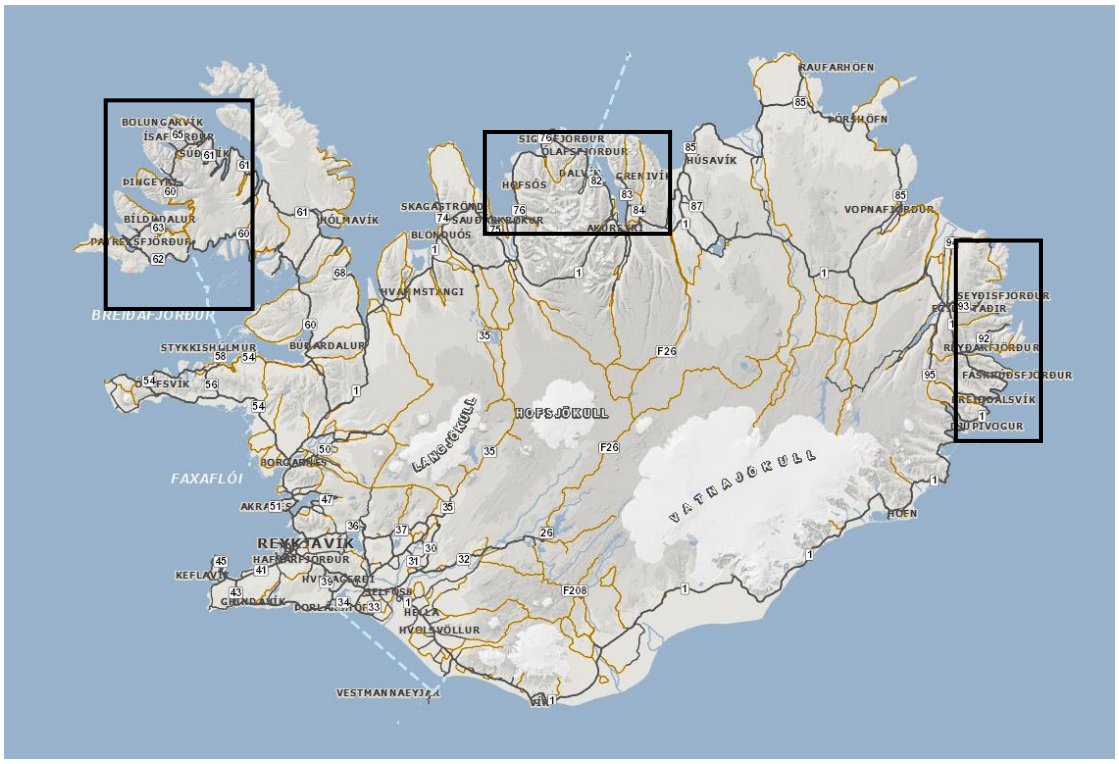

Figure 1. Three areas in Iceland where avalanches on roads are most frequent.

Different types of mitigation have been used to reduce risk on roads in Iceland. One of the main solutions is to widen channels beside the roads to make room for the snow. Often a steel bulkhead is installed as well to reduce the number of avalanches reaching the road. In some cases, dangerous roads have been replaced by a tunnel.

Figure 2. Steel bulkhead by the road below Óshlíð between Bolungarvík and Hnífsdalur.

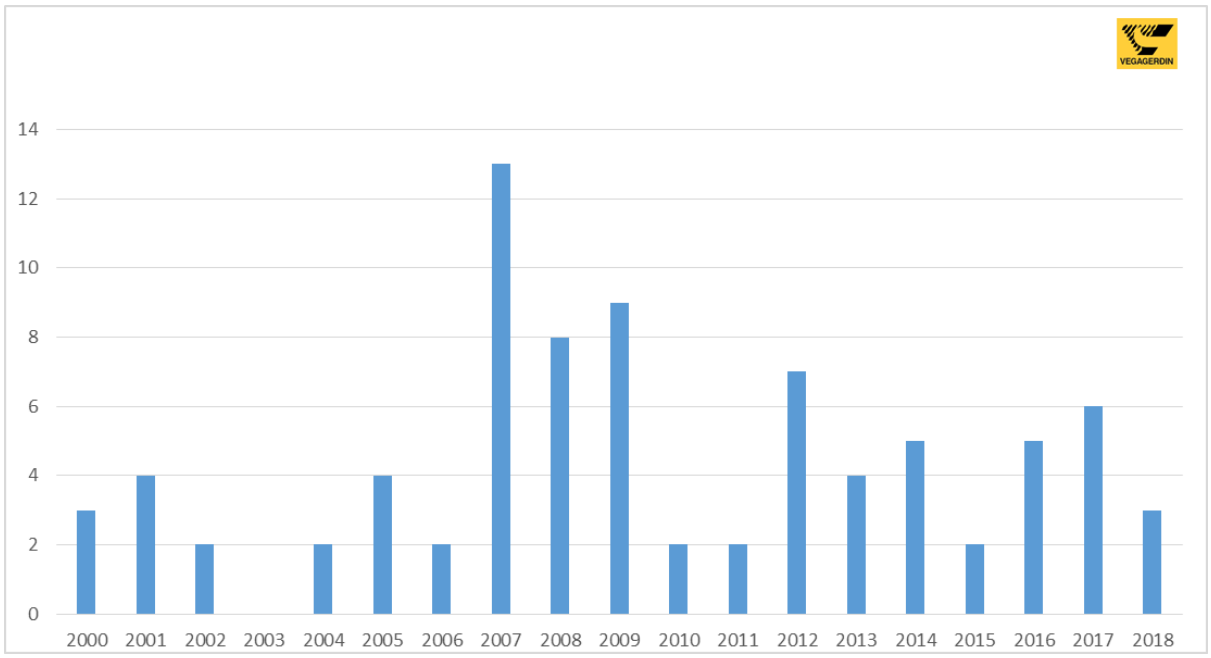

Figure 3. Number of accidents where vehicles encountered avalanches or rockfall, 2000−2018.

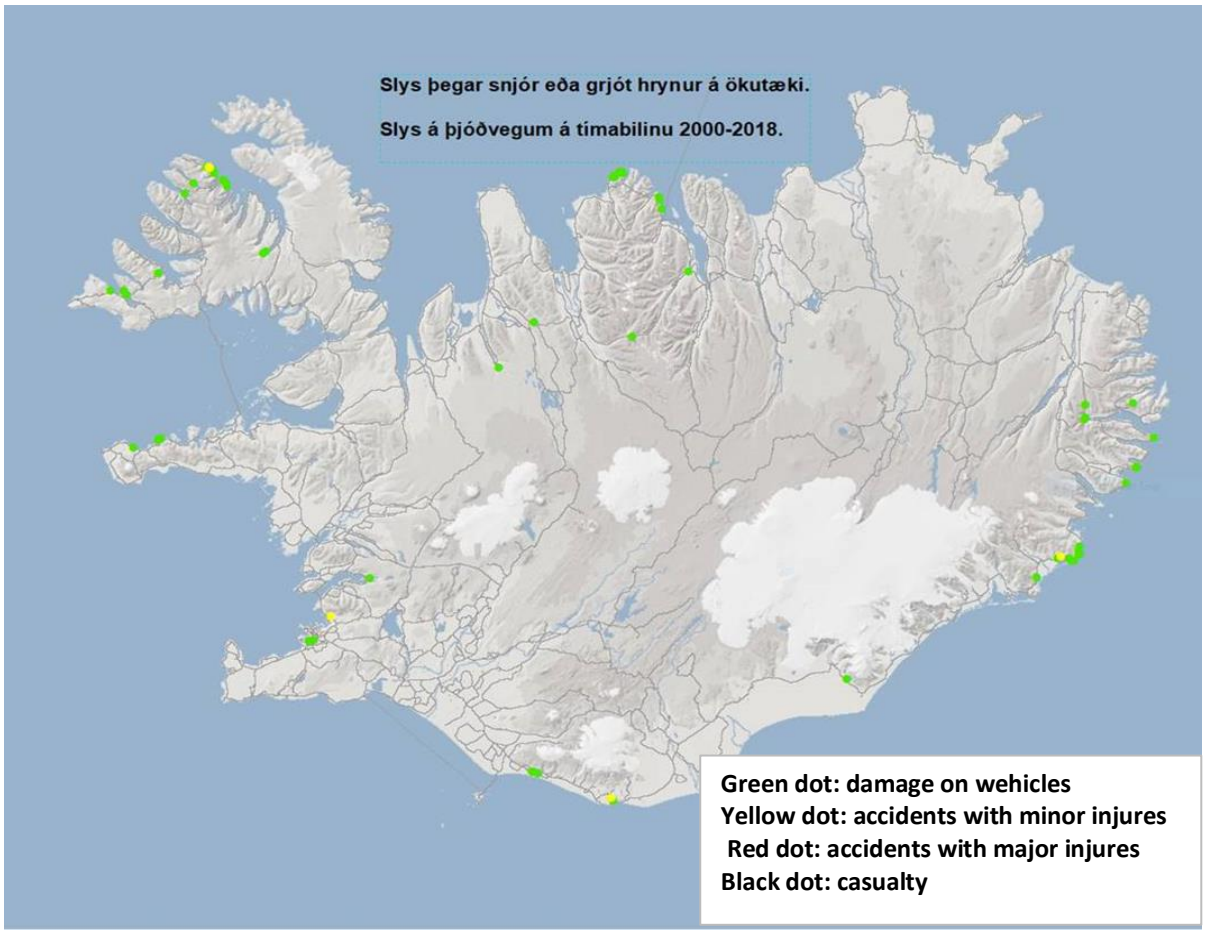

Figure 4. Locations where accidents where vehicles encounter avalanches or rockfall on Icelandic roads, 2000−2018.

2.1 Records on avalanches and statistical analyses.

The Icelandic Road and Coastal Administration (IRCA) has kept records on avalanches on roads since 1975. The avalanche danger was evaluated informally and typically a road was not closed due to avalanche danger until at least one or two avalanches had overrun the road. In the year 2011, the IRCA and the IMO started developing more formal avalanche forecasts for selected road stretches as well as a system for disseminating information to road users. This was through the Nordic collaboration project SNAPS (Snow, Ice and Avalanche Applications) that was partly funded by the EU Northern Periphery Programme.

At the IMO, statistical analyses were done on avalanche- and weather records for the roads 61 Súðavíkurhlíð and 82 Ólafsfjarðarvegur (Jónsson and others, 2014; Jónsson and Brynjólfsson 2015). Similar analysis is planned for road 64 Flateyrarvegur in 2019. The results are an important input for formal avalanche forecasting for these roads that started in 2013 as a service to the ICRA. Today, the IMO makes daily avalanche forecasts for four road stretches and less formal warnings are also issued for two more roads when the danger is estimated high. The roads in question are marked on the map in figure 2.

Figure 5 1. Súðavíkurhlíð, 2. Ólafsfjarðarvegur, 6. Flateyrarvegur: daily avalanche forecast and information service with text messages.

3. Siglufjarðarvegur: daily avalanche forecast.

4. Dalsmynni, 5. Ljósavatnsskarð: avalanche warning when the danger is considered high.

The IRCA, in cooperation with the local police, closes roads during periods of high danger and informs travellers of possible avalanche danger. For three of the roads people can sign up to

receive text messages from the IRCA in their mobile phones regarding the avalanche situation on the road.

In addition to the avalanche forecast from the IMO it is important for the IRCA to have local supervisors to assess the situation and help making decisions based on the forecast as well as other factors such as visibility, road conditions, traffic etc.

3. AVALANCHE FORECAST

Avalanche forecasts for four road stretches are made daily at IMO as a service to IRCA. Four predefined danger levels are used for the forecast. Three of them state the current danger level while danger level 2 warns about upcoming avalanche danger. The danger levels are based on the estimated probability of avalanches hitting the road:

1. No/minor avalanche danger within the next 24 hours (<10% probability probability for an avalanche to reach the road).
2. Possible avalanche danger within the next 24 hours.
3. Considerable avalanche danger (10−40% probability for an avalanche to reach the road).
4. High avalanche danger (more than 40% probability probability for an avalanche to reach the road).

The forecast is recorded into a database at the IMO every day. When the danger level is 2 or higher an e-mail is sent to the ICRA.

Figure 6. Clearing of road 60 Hrafnseyrarheiði. A recently fallen avalanche is clearly seen. Workers are assessing the snow conditions ahead.

4. INFORMATION DISSEMINATION ON AVALANCHE DANGER

The IRCA receives the avalanche forecast from the IMO and decides on roads closures and information to road users on upcoming or current avalanche hazard. For some of the roads, people can sign up to receive text messages in their mobile phones regarding the avalanche situation on the road. Information about avalanche hazard on roads can also be displayed on map on IRCA's website that shows road conditions in the whole country.

Four predefined types of text messages are sent (underlined text is mutable):

A. Ólafsfjarðarvegur: Avalanche is possible later today, Saturday.

B. Ólafsfjarðarvegur: Avalanche: Warning phase is declared today, Saturday at xx o'clock.

C. Ólafsfjarðarvegur: Avalanche: Alert phase is declared today Saturday at xx o'clock. Road closed.

D. Ólafsfjarðarvegur: Avalanche: Alert phase is cancelled Saturday at xx o'clock. Road is open.

Thus, the roads are not just open or closed, more levels are defined. A warning phase is used when there is danger of avalanches, but the road has not been closed. It is not considered feasible to close the roads every time there is some chance of avalanches hitting the road. The idea with the warning phase is to inform road travellers, helping them to evaluate conditions and make decisions. This should reduce traffic on the roads during periods of avalanche danger. Road maintenance workers use full caution while clearing the road and the one carrying out the clearing is often accompanied by an escort or he/she must be in radio contact with his supervisors at all times.

Alert phase is used when avalanches have already fallen, and/or the risk of avalanches is considered great. The roads are closed during alert phase.

A formal survey has not been carried out amongst road users on the experience with the text message system, however, the general feedback is very positive. Road users are happy with better information and use this information to make risk reducing decisions for themselves. When a person receives message A and intends to drive the road in the next hours, he or she can postpone the journey or go before danger arises. People who receive message B can simply cancel trips that are not absolutely necessary. This reduces road traffic and hence the overall risk.

Table 1 shows the number of people that receive the text messages. It can be assumed that a great portion of commuters on those roads receives information about avalanche danger.

Table 2. Number of people that receive text messages for the two road sections and average daily winter traffic.

Road	Road users on SMS list	Traffic pr. winter day
61 Súðavíkurhlíð	200	325
82 Ólafsfjarðarvegur	400	443
64 Flateyrarvegur	160	149

Figure 7. Clearing of an avalanche on road 61 at Óshlíð. The road was replaced by a tunnel in 2010.

5. CONCLUSION

Avalanche danger is a problem at many roads in Iceland. In some cases, the roads lie along steep mountainsides with several avalanche paths. Different types of permanent mitigation have been used to reduce risk for the most dangerous roads. In recent years, the road authorities and the Icelandic Meteorological Office have collaborated on formal avalanche forecasts for roads as well as a system for disseminating information on avalanche danger to road users. Avalanche forecasts from the IMO works towards more systematic decisions on road closures and warning issues. The goal with the avalanche service for road users is to reduce the risk for road travellers without reducing the effectiveness of the road system too much. The warnings should reduce traffic when avalanche danger is increased but roads are still open. Those who need to travel are not stopped but others can choose to cancel or postpone trips may decide to do so.

6. REFERENCES

Jónsson, M. H., Brynjólfsson, S., 2015. *Samband veðurs og snjóflóða á Ólafsfjarðarvegi* [*The relationship between weather and snow avalanches on the road to Ólafsjörður*]. Icelandic Meteorological Office, Technical Report 2015-002.

Jónsson, M. H., Grímsdóttir. H., Breien, H., Kristensen, K., Zeinali. 2014. *SNAPS Work package 2: Weather and avalanches*. Icelandic Meteorological Office, Technical Report.

Eiríksson, G. *Roads and Avalanches*, 2008. The Icelandic Public Road Administration, Technical Report.