

THE EFFECT OF AVALANCHE ACCIDENTS ON THE RECORDED AVALANCHE HISTORY AND THE AVALANCHE WORK IN ICELAND

Svanbjörg Helga Haraldsdóttir *
The Icelandic Meteorological Office

ABSTRACT: Avalanche accidents have had a major effect on the development of the avalanche work in Iceland. The revised avalanche history of Flateyri and the data collection is discussed as well as the avalanche history of Neskaupstaður.

In December 1974 catastrophic avalanches in Neskaupstaður killed 12 people, after which the basic work of data collection was performed and maps published with the information. After the accident a committee was established in Neskaupstaður, and a year later a report was finished with plans for a cooperation over the whole country for protections against avalanche danger. It is very similar to what has been developed after the catastrophes in 1995.

In April 1994 an avalanche struck a skiing area and summer cottages in Ísafjörður, killing one person. In January 1995, an avalanche struck Súðavík, killing 14 people. In October of the same year another one fell on the village Flateyri, killing 20 people. The runout distances of these avalanches were all greater than expected according to the methods for making hazard maps at that time. Afterwards some inhabitants of Flateyri emphasized that the avalanche history of Flateyri should be reviewed, since they knew of some unrecorded avalanches.

KEYWORDS: avalanche accidents, avalanche protection, avalanche forecasting.

1. INTRODUCTION

This report begins with a short description of the surroundings of four avalanche towns, where catastrophes occurred in 1974 and 1994-1995. In December 1974 avalanches took the lives of 12 people in Neskaupstaður, in April 1994 one person was killed in an avalanche in Ísafjörður, in January 1995 14 lives were lost in an avalanche in Súðavík and in October 1995 an avalanche took 20 lives in Flateyri. A short description of the relevant catastrophes is given and the resulting work.

2. THE SURROUNDINGS

Iceland lies on the oceanic Atlantic ridge with belts of volcanic activity across the country, such that the geological formations are younger towards the middle than in the east and west.

The Eastfjords as well as the Westfjords are in the old basaltic rock formations, 3-20 million years old, and have been eroded by glaciers during the periods of glaciation. The fjords are

embraced by steep mountains, that reach a height of approximately 600-800 m a.s.l. Plateaux above the slopes exist in most areas in the Westfjords, and huge amounts of drifting snow may be transported on the plateaux and collected in the gullies.

Neskaupstaður (figure 1) is in Austfirðir, the Eastfjords. It lies on the northern coast of Norðfjörður. The mountains reach up to 800 m a.s.l., with passes through them at about 600 m a.s.l. Although avalanches could start almost anywhere in the mountainside above the town, two gullies make the main threat to the inhabited area, i.e. Drangaskarð and Innra Tröllagil. Avalanches with long run out distances fell from them in 1894. The major avalanche cycle this century was in December 1974, when 15 big avalanches were recorded during a period of 2 days.

The three locations of the 1994-1995 avalanche accidents are in the northern part of Vestfirðir, the Westfjords (figures 1 and 2), i.e. Ísafjörður, Súðavík and Flateyri.

Avalanches often fall in the skiing area of Ísafjörður and have sometimes destroyed lifts and huts in the skiing area. Usually they do not reach far, and none have been known before to reach as far as the 1994 avalanche.

* Corresponding author address: Svanbjörg Helga Haraldsdóttir, The Icelandic Meteorological Office, Bústaðavegur 9, 150 Reykjavík, Iceland; tel. (354)-560-0600; fax: (354)-552-8121; email: svana@vedur.is

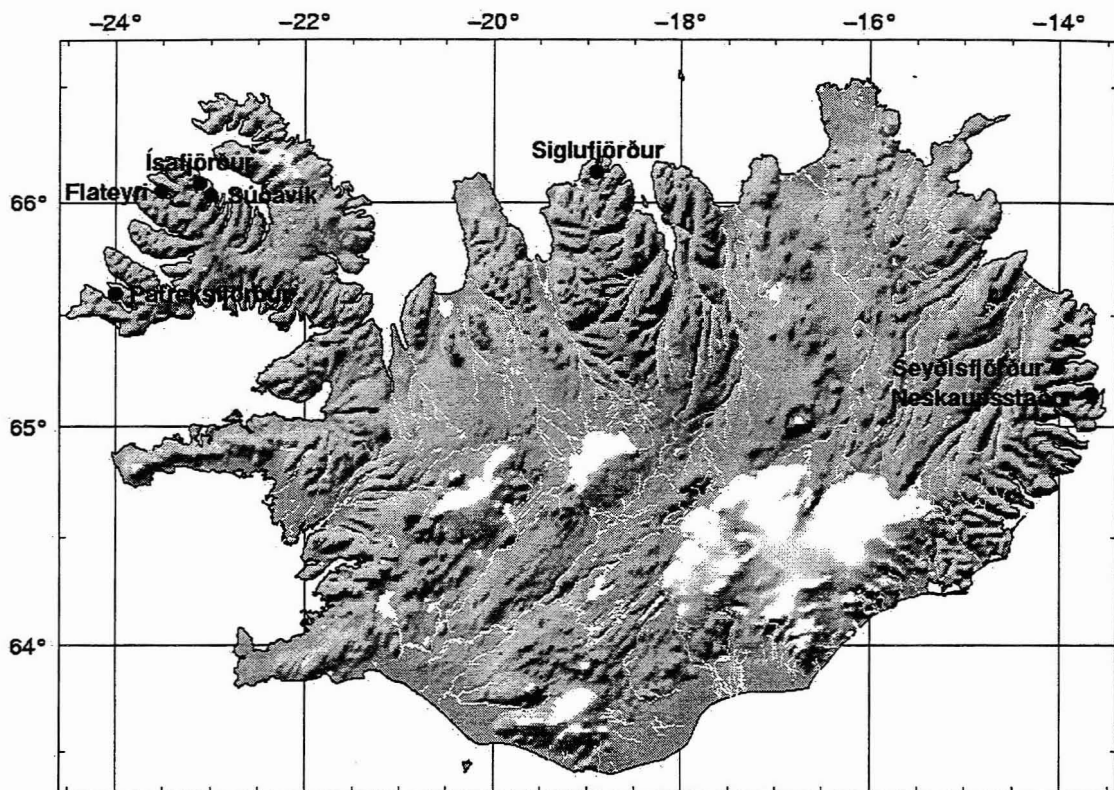


Figure 1. Some avalanche villages and towns in Iceland (Gunnar Guðmundsson).

Súðavík is a fishing village on the coast. On the mountain, Súðavíkurhlíð, above the village, is a plateau. When the wind blows from the NW a ridge on the plateau allows snow to accumulate on the mountain edge above the main part of the old village.

accident in 1995, they have never hit them. Traðargil is a gully that threatens another part of the "old" town, with frequent avalanches.

Another fishing village lying on a small north coast peninsula of Öndarfjörður is Flateyr. Two gullies that threaten the village, are the big bowl shaped gully, Skollahvilt, where the snow collection can be enormous and Innra Bæjargil. Avalanches from Innra Bæjargil have previously hit houses, and avalanches from Skollahvilt have destroyed parts of the graveyard, fences and gardens. The old main road to the village has frequently been closed because of avalanches.

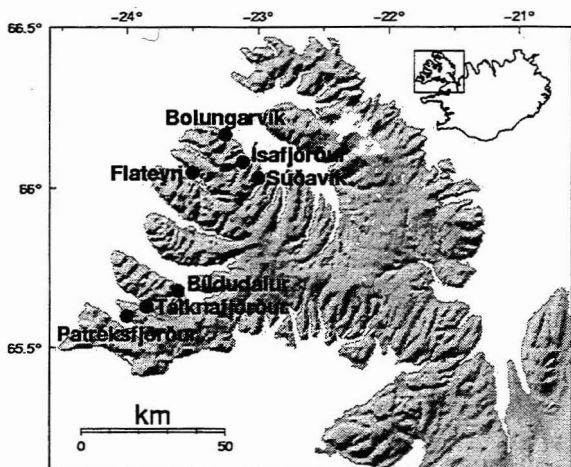


Figure 2. Vestfirðir, the Westfjords, avalanche villages and towns (Gunnar Guðmundsson).

Although avalanches have come close to the houses below Súðavíkurhlíð before the

3. THE AVALANCHE HISTORY

Most of the fishing villages along the coast in Iceland have expanded towards the mountain side during the last half of this century, and in many places up the slope.

Avalanches were usually not recorded if they did not injure people or life stock, or damage property. Therefore some unrecorded avalanches may have fallen on areas which are now inhabited. Information most recently collected is on avalanches that have not injured people or damaged anything, but are

remembered in connection with some other events.

The complete avalanche history will never be possible, but recording as much knowledge about it as available and being aware of the limitations should assist in the future work of protections and research.

4. NESKAUPSTAÐUR 1974

On December 20th 1974 two avalanches killed 12 people in Neskaupstaður. Avalanches fell from almost all of the mountainside above the town during a cycle of 2 days. The snowfall was intensive prior to them. A strong wind blew in the mountains according to the pressure gradient seen on weather maps at the IMO. The wind was also strong offshore, as described by a man whom the avalanche took out to the ocean. The town, however, was on the leeward side of the mountain. The first avalanche struck on Dec. 19th, but no one saw it, due to low visibility in the heavy snowfall.

The last avalanche killing people in the area struck two farms in 1885. Another one fell on a farm 1894, but then everyone was rescued. Because of the length of time between avalanche accidents, avalanche danger has not been at the top of people's minds.

4.1. The avalanche history of Neskaupstaður

When the weather cleared up for a while on Dec. 22nd, Hjörleifur Guttormsson, a biologist working as a teacher in Neskaupstaður, started recording, photographing, and collecting information about the avalanches. He wrote an article about the accident (1975) and continued working as a snow observer for the remaining winter. He collected information about past avalanches as well and avalanche maps were drawn. The avalanche history of Neskaupstaður at the IMO is based on his work (Svanbjörg Helga Haraldsdóttir 1997).

4.2. An avalanche committee

An avalanche committee was established in Neskaupstaður in 1975 and the above mentioned Hjörleifur Guttormsson was the chairman. This committee worked to determine an official response to the avalanche danger. A year later its work was finished with a publication of recommendations for future work and a list of 32 published items such as letters, announcements and reports.

Below is a shortened version of the committee's ten recommendations.

1. Emphasis should be placed on hiring a permanent snow observer.
2. The civil guard should prepare and maintain an evacuation plan.
3. The zoning for homes and working environment should never be in areas of avalanche risk. Avalanche risk maps (red, blue, yellow and white zones) should be made according to the rules that were valid in other countries (Swiss and Norway).
4. Protection measures should be constructed gradually according to expert's advice. Experts' opinions on risk and advice about protection measures had been obtained during the year of the committee's work.
5. Permission to build in risk areas with existing buildings should be denied, until protections had been built.
6. The rights of the inhabitants with regard to the recommended actions should be introduced.
7. The inhabitants should be informed about avalanches and their danger and the main actions planned by the authorities.
8. Cooperation with the authorities and civil guards nationwide was recommended with respect to protections of all kinds against avalanches.
9. The danger caused by rock falls and mud flows in the area should be considered in protection design.
10. These matters should be dealt with in a way that made the safety of the inhabitants as good as possible and with a support from the authorities of the country.

In addition to hiring a snow observer, poles were set up along the mountainside to be able to locate avalanches and sites of observations. Since then, snow observations have been performed in Neskaupstaður.

The committee made general guidelines and suggested a nation wide cooperation. The suggestions are quite similar to the working procedures following the accidents in the Westfjords that are now in practice.

5. THE THREE CATASTROPHES 1994-1995

The three catastrophic avalanches in the Westfjords that occurred during three winters in the years 1994 and 1995 have had a major influence on avalanche work in Iceland. All of these avalanches had longer run out distances than thought possible in those areas. The three

avalanches fell during the night on people sleeping in their houses.

Only a short review about the catastrophic avalanches will be given here since the avalanches in Súðavík and Flateyri have been introduced previously in English (Jón Gunnar Egilsson 1996 and Svanbjörg Helga Haraldsdóttir 1998 b).

5.1. Ísafjörður May 5th 1994

The first catastrophe was in Tungudalur May 5th 1994. The avalanche fell outside of the town of Ísafjörður, in an area where evacuation would not have been considered. As often before it fell across the skiing area, then continued across a minor slope and down a steeper one into the valley Tungudalur. The avalanche destroyed 40 summer cottages and killed one person. This was just after Easter and most of the people who had been staying in the cottages had only recently left. Only 4 remained that night.

5.2. Súðavík January 16th 1995

The second catastrophe occurred in Súðavík on January 16th 1995. An avalanche killed 14 people. It happened during a severe snow storm that lasted for days after the avalanche fell making the rescue work extremely difficult and dangerous. The run out zone was far of the avalanche hazard zones defined at that time so evacuation would not have saved any lives. An avalanche from Traðargil later fell, hitting more houses in another part of the town, that had already been evacuated. Then yet another avalanche from Traðargil fell even further than the previous one. Avalanches fell from many other gullies and mountainsides during the avalanche cycle (Jón Gunnar Egilsson 1995).

5.3. Flateyri October 26th 1995

The third catastrophe to be mentioned here occurred when an avalanche fell from Skollahvilft on Flateyri October 26th 1995 killing 20 people. This avalanche also occurred during a severe snow storm, but early in the winter. The warm, humid air from the south meeting the cold air from Greenland produced heavy snowfall in the mountains. The strong northerly winds and heavy precipitation led to enormous snow accumulation in Skollahvilft during a short period of time.

5.4. The avalanche history of Flateyri

Some of the gaps in the avalanche history of Flateyri have been filled in after the accident in October 1995. Inhabitants from Flateyri asked the IMO to collect information on avalanches there, since they knew of some that were not already recorded. People are concerned and many have assisted in the work by giving interviews. Some new information has been uncovered about unrecorded avalanches.

The avalanche history of Flateyri was first published in 1989 at the IMO. The recorded avalanches were 18, 7 from Skollahvilft and 4 from Innra Bæjargil, and the rest from the surrounding gullies. In Aug. 1995 an internal report was published, and there the recorded avalanches were 34.

The recorded avalanches are now 61, of which 9 avalanches have fallen after the preliminary edition in 1995. A total of 24 avalanches are now recorded from Skollahvilft and 17 from Innra Bæjargil. Of those from Skollahvilft 4 avalanches went further than recorded in the first edition.

6. CHANGE OF LAW AND THE IMO

After the Súðavík avalanche plans were made for funding and putting effort into protection against avalanche danger. After the Flateyri avalanche, it became a top priority by the authorities.

As a result of a new law passed in parliament, the role of the Icelandic Meteorological Office, IMO, changed in December 1995. The institute continues to watch over avalanche danger and additionally was given the responsibility of ordering evacuations in case of avalanche danger. It also is responsible for making hazard maps and guides in the design of avalanche protection measures.

Previous to the avalanche accidents the authorities in each village were responsible for evacuation due to avalanche danger.

7. THE IMO - PROJECTS

Before the accident occurred in Súðavík 2 people were working in the avalanche section of the IMO. Now there are 9.

7.1. The avalanche watch and evacuation

As the above indicates the work at the IMO has changed much during a period of almost 3 years. A special watch over avalanche danger in

avalanche towns is exercised during the winter months (figures 1 and 2). Snow observers work as employees of the IMO in all of these towns.

A group from the avalanche section at the IMO formed a plan for the watch as introduced in ISSW'96 (Magnús Már Magnússon 1996). Since then the plan has been adjusted in light of experience gained during avalanche danger periods.

The IMO snow observers in each town keep in touch with the avalanche watch in Reykjavík. Together with a meteorologist they estimate the possibility of danger.

Evacuation plans were made in cooperation with the local authorities in the spring 1996 and reports published with evacuation maps (IMO 1996). The plans were introduced to the local people with brochures and meetings.

If evacuation is considered to be necessary it is decided in cooperation with the local authorities

7.2. Protections

A report with suggestions on avalanche protection measures and estimation of their costs for all of the avalanche endangered towns was made in 1996 (Tómas Jóhannesson et. al. 1996).

A short overview of the work done in the villages and towns of the accidents mentioned above is given below.

After the destruction in Tungudalur, Ísafjörður, summer cottages have been built there again. The conditions for the reconstruction of the cottages were that they would not be used during the winter time.

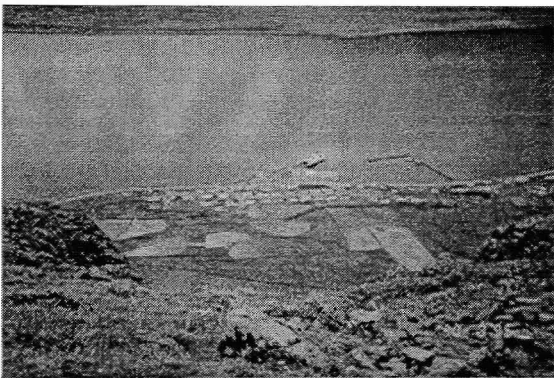


Figure 3. The "old" Súðavík in August 1995 (Svanbjörg Helga Haraldsdóttir).

The main part of the village in Súðavík (figure 3) has been moved after the avalanche accident. The old houses were bought by the

authorities and new ones have been built in a different area considered to be safe.

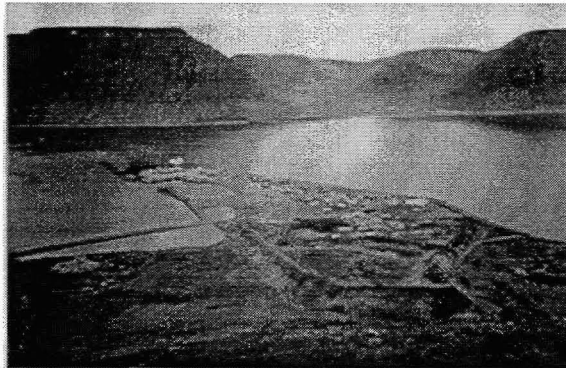


Figure 4. Flateyri, the deflecting dams in August 1998 (Svanbjörg Helga Haraldsdóttir).

In Flateyri two deflecting dams have been built to protect against avalanches from the two gullies. The dams are connected at the top and farther down the slope is a catching dam (fig. 4). Together the three of them form the shape of A (Flosi Sigurðsson 1998).



Figure 5. A part of Neskaupstaður in September 1995. Drangaskarð left of the middle (Svanbjörg Helga Haraldsdóttir).

Suggested avalanche measures have been developed for Neskaupstaður (Gunnar Guðni Tómasson 1998). The town is on the coast, and the densely populated area stretches over 2.5 km. An industrial area is farther to the west. A large part of the town is in an avalanche risk area, and records exist of both dry and wet avalanches. Mud flows and rock falls threaten the town as well. A good solution is difficult to come by.

Building a catching dam below Drangaskarð (figure 5) will probably be the first action in the construction work. It is currently undergoing an environmental impact evaluation.

Deflecting dams would cut the town into small parts and supporting structures make an

expensive solution, as structures would need to be extensive. The quality of the rocks in the starting zones may also make such structures impractical.

7.3. Definition of risk, new methods

The definition of the methods used to estimate the risk were completely reviewed after the accidents. Models were readjusted or reformed and regulations about risk zone definition are almost finished. Adjusting to new methods must be done with care.

A test project on avalanche risk estimation in Seyðisfjörður is being worked on in cooperation with foreign experts. The methods of NGI in Norway, the Austrian methods and the Icelandic methods are compared.

7.4. Research

Some research programs have been initiated. Magnús Már Magnússon (1998) will give an overview of those in his paper, and Gilbert Guyomarc'h et al. (1998) introduce a paper on research of the wind in mountainous regions performed in cooperation with the IMO.

8. THE FUTURE

It is important to use the experience after accidents like those above to make plans for the future both with regards to rescue work and protections. It must not be forgotten that even if the weather is good for years or decades, the threat remains, and we must be prepared.

We will continue with the avalanche work already in progress. Protection measures against avalanches are being built, so gradually it will be safer to live in the avalanche towns. Even when protections structures are completed future observation of snow cover and the weather outlook is vital to warn against the avalanche danger. Protections can only reduce risk and will never be able to provide complete safety. It is extremely important to be aware of the remaining risk.

Gradually people have seen that avalanches can strike where there is no previous history of them. With realizing the possibility of danger that knowledge can be used to protect against it.

To educate people about avalanches and the signs of avalanche danger is very important for the well being of the inhabitants in the areas of avalanche danger as well as the people travelling and enjoying outdoors winter sports.

9. ACKNOWLEDGEMENTS

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