Two Destructive Avalanches in Iceland

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ABSTRACT

This presentation will be case histories of two avalanche disasters in Iceland in the year 1995, resulting in the death of 34 people. Each avalanche hit a small fishing village, destroying many houses in the middle of the night. On January 16th the village of Sudavik was partly destroyed by an avalanche, killing 14 people, and on October 26th the village of Flateyri was hit, killing 20 people. Those villages are both on the North-West peninsula of Iceland, named Vestfirdir, whose history has during the centuries proved to be very prone to avalanches. Both avalanches happened during severe northerly snowstorms, that caused widespread avalanche activity and damages. Both avalanches went much further than the hazard zone line had indicated, which is also true for 5 other avalanches in the area in the last two years. The size of the accidents and the bad weather had a big effect on the rescue operations, and the rescue efforts were a test for the whole Icelandic rescue system. Those two disasters affected the avalanche warning and protection system in Iceland, which has since been reorganized and strengthened. In the future one of the villages will be protected by defense structures and the other will be moved to a safer place.

INTRODUCTION

Iceland is an island in the middle of the North-Atlantic, around 103,000 km² in size, with a little over 260,000 inhabitants. Most of the settlements are along the coast, on a narrow strip between the sea and the mountains (600-1000 meter high a.s.l. in coastal areas), or in deep valleys extending from the fjords. A landscape made by the glaciers during the last ice-age are in many cases ideal runways for avalanches. Until the 19th century most of the Icelanders lived on small farms, spread all over the country, but then small fishing villages were established along the coast. Most often this was on reefs extending into the fjords, where it was easy to safely land the small fishing boats. In the beginning of the 20th century new technology led to great development in the fishing industry, which caused those villages to grow rapidly. This meant that they extended from the reef up the mountainsides above it and along the narrow coast, often into areas which were not safe from avalanches.

The climate in Iceland is a maritime one, variable, with relatively mild weather, but very changeable. The weather is mostly controlled by pressure lows and fronts, passing NW along the North-Atlantic, resulting in (often sudden) changes in the weather.

From the moment the first settler set his foot on Iceland, in the year 874, avalanches have been a threat. The oldest description of an avalanche accident comes from Sturlungu, one of the old Sagas:

"Snorri had a good stock of sheep and lived in Svinadalur, where now is called Snorrastadir. He drowned in Saelingsdalsa, where now is called Snorravad. Then went Sighvatur Ulfsson, his brother-in-law, to look for him and four men with him and they were hit by an avalanche and all killed."
This was in the year 1118.

From that year, chronicles tells of around 680 fatalities as a result of avalanches, and one can assume that many accidents are missing, specially before the year 1600. Of those 680 fatalities, 164 happened during this century, 107 of them in houses and villages, but 57 on roads and in the backcountry. No other natural hazard has claimed more human lives, except bad weather sinking boats and drowning fishermen. All the earlier accidents were relatively small, since the people lived on small individual farms. After the villages started to form, bigger avalanche accidents followed. 24 people died in Seydisfjordur in the year 1885, 20 people in Hnifsdalur in 1910, 12 people in Neskaupstadur in 1974, 14 people in Sudavik in 1995 and 20 people in Flateyri in 1995.

THE TWO AVALANCHES

On the morning of January 14th 1995 a pressure low could be seen on weather charts, far SW of Iceland. At that time its influence on the weather in Iceland was not certain, but as it came closer the computer forecasts indicated that it would lead to a full force winter storm. On Sunday the 13th the windspeed started to increase, with snowfall and heavy drifting snow. That day a general avalanche warning was issued and people started to evacuate the houses that were within avalanche hazard zones in the villages in northern and western parts of Iceland.

At 6:25 in the morning of January 16th a big avalanche started high in the mountain above the small village of Sudavik (230 inhabitants) in the NW part of Iceland (Figure 1). The avalanche is believed to have started at the mountain edge (elevation of 580 m.a.s.l.), possibly as a collapse of a cornice, but gained size as it ran further down the mountain slope. This is only assumed, since the four day storm that followed the avalanche eliminated all marks of the start of it. The starting zone is expected to have been about 200 meters wide, but further down the avalanche spread out to the width of 430 meters. The total length of the avalanche path was 1,400 meters and the estimated size around 150,000 m³.

The avalanche hit 17 buildings in the village and ran far beyond the avalanche hazard zone line. All of those buildings, except two, were homes and at that time there were 48 people in them, all asleep. Only 3 of those houses were within the avalanche hazard zone, but had not been evacuated at that time. The force of the avalanche was enough to totally wipe out some of the houses, but other were damaged, some severely and others less so. Of those 48 people, 21 people got out the avalanche on their own

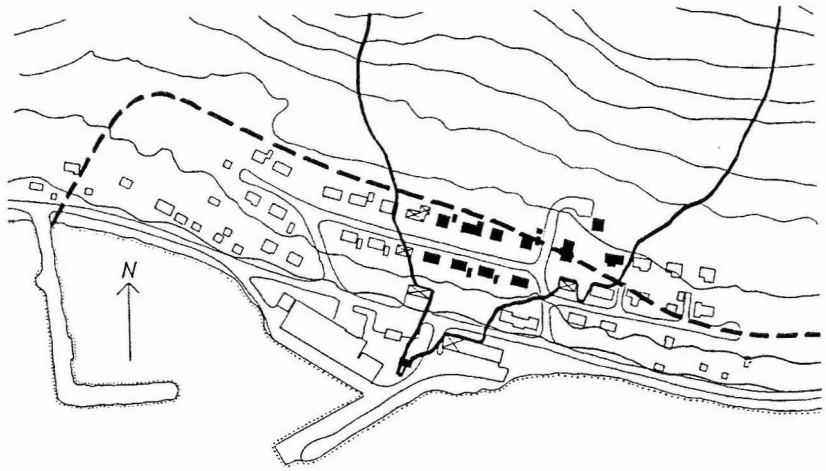

Figure 1 - Sudavik

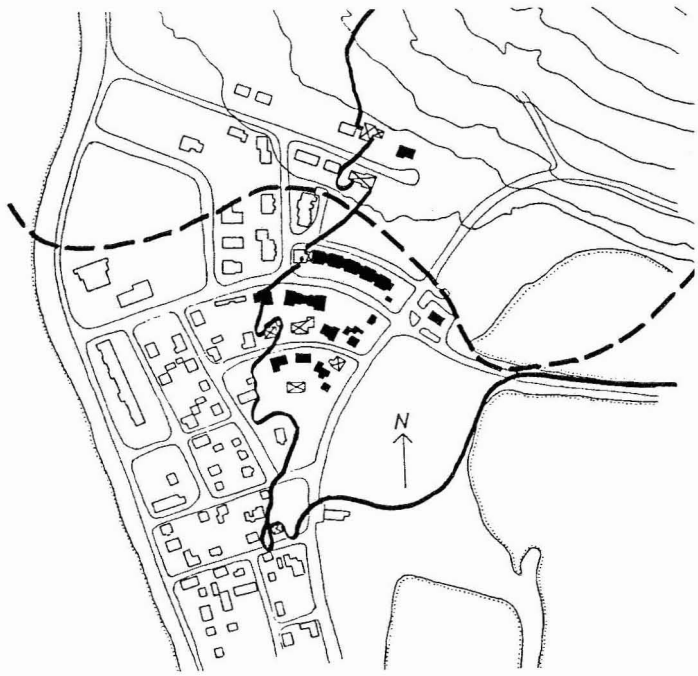

Figure 2 - Flateyri

Avalanche boundaries

Avalanche hazard zone line

Destroyed buildings

Damaged buildings

or assisted by their neighbors, 7 were locked in their houses (but not burried in snow). 20 people were missing and of them 6 were rescued by locals and the rescue teams.

Since this happened during a severe snow storm all rescue efforts were extremely difficult. Adding to that the fact that at such latitude the daylight in January is only a few hours, made the conditions even worse. Of course the first response came from the survivors in Sudavik and the small local rescue team, but one of the first things the head of the village council did was to call for all available assistance from the nearby town of Isafjordur. All roads to Sudavik were closed at that time due to snow and extreme avalanche danger, and it was impossible to use airplanes or rescue helicopters. The only way to get to Sudavik was by ship, but that was difficult in such a weather, wind of force 10-12 and heavy seas. The first 52 rescuers from Isafjordur came to Sudavik at 9:50, three and a half hours after the accident (normal driving time is 20 minutes), equipped with avalanche rescue gear and avalanche dogs. They started immediately to search with the locals, but the bad weather and the extent of the accident made all rescue operations extremely difficult. A limited number of rescue transceivers also affected the number of people that could search at any time. All the inhabitants of Sudavik had been moved to the fish processing plant, close to the harbour, and from there all rescue operations were organized. The sheriff at Isafjordur soon contacted the National Civil Protection in Reykjavik asking for all available help, nationwide. From Reykjavik two ships, a coast guard vessel and a fishing trawler, were sent with specially trained rescuers, and fishing trawlers started to collect rescue personnel from other villages in Vestfirdir and other parts of Iceland, to take them to the accident site. The weather affected the speed of the ships, and even made two of them run into some troubles, so they had to be assisted by other ships. Later the second group of rescuers were transported from Isafjordur to Sudavik, and at the same time the people of Sudavik were taken back to "nearby" Isafjordur. All this happened in a severe weather conditions, and more avalanches came down, hitting houses in Sudavik and Isafjordur (in an evacuated area). The rescue personnel from Reykjavík arrived 35 hours after the first call for assistance was made. The last survivors was found 15 and 23 hours after the avalanche fell, and the last victim was located after 39 hours.

The avalanche had claimed the lives of 14 people, including 8 children. It had also totally destroyed part of the village.

On October 24th 1995 a pressure low approached Iceland from the SSE. The front from that low crossed Iceland, resulting in a severe winter storm, specially in the NW part of the country. The weather itself was not so unusual, but the timing was, so early in the winter. This low was followed by another one traveling along similar course. Those two lows resulted in a severe winter storm that lasted for more than 48 hours in northern part of Iceland. When this was forecasted a general avalanche warning was given, and people in northern and western part of Iceland started to evacuate the houses that were within the avalanche hazard zones. On October 25th an avalanche hit and damaged severely the garbage burning plant in Isafjordur, confirming the worries about avalanche danger.

At 3.55 in the morning of October 26th 1995 a big slab avalanche was released in the Skollahvilft bowl, high above the village of Flateyri (379 inhabitants) in the NW part of Iceland (Figure 2). The avalanche started just below the edge of the plateau, at 650 m.a.s.l. and the fracture line was up to 3.9 meters thick. The total volume of the avalanche was estimated to be close to 500,000 m^3, and the total length was 2,100 meters. The widest part of the avalanche was 500 meters and debris was up to 4 meters thick.

The avalanche went much further than the avalanche hazard zone line, and in total 29 buildings were hit, 26 of them houses. Of those 29 buildings, 17 were destroyed or damaged beyond repair. Only 3 of those houses were within the avalanche danger zone, and had been evacuated after the general avalanche warning had been issued, two days earlier. In those houses at that time there were 45 people, all of them asleep. Of those 45, 21 escaped or were soon assisted by neighbours and four were dug out after the rescue had been organized.

The rescue operations were almost a copy of the one in Sudavik, 10 months earlier, except that the weather was not as bad nor did it last as long. The first response was naturally from the people of Flateyri and the small local rescue team. A call for all available help was made to the sheriffs office in Isafjordur, which then alerted the National Civil Protection in Reykjavík for multiagency/multiarea assistance. The rescue teams from Isafjordur started their trip to Flateyri by driving through a new road tunnel, still under construction, but due to extreme avalanche danger had to be taken by a small fishing boat the last kilometers to Flateyri. They came to Flateyri at 9:30, almost six hours after the accident had happen (normal driving time is 30 minutes), and started immediately to search with the locals. Avalanche dogs were used to indicate where something was buried, and people with probes and shovels would then dig in and cut open the house debris. As in the Sudavik incident, rescue personnel were sent with ships from Reykjavík and other towns and villages. They also used helicopters and airplanes to get as close to the accident site as the weather permitted, and then onward with ships. During the day the weather improved and at 13:13 the Coast Guard helicopter managed to land at Flateyri with specialized rescue personnel and avalanche dogs onboard. It was soon followed by other helicopters, bringing in more rescuers. After the experience in Sudavik, rescue personnel were much better prepared for the search and rescue work in Flateyri. Most of the rescuers had been themselves in Sudavik, and there was even the same On-Scene-Commander directing both operations. The last victim was found after 36 hours, and it was estimated that during that search, 7-8,000 m^3 of snow had been hand-shoveled.

The avalanche had claimed the lives of 20 people, including 3 small children. It had also destroyed part of the village.

WHAT DID WE LEARN FROM ALL THIS?

PREVENTION:

Catastrophic avalanches in Iceland occur during bad weather. They can be forecasted and people evacuated out of danger. The observation and warning system for the whole country has been reorganized and strengthened.

Avalanches can go much further than the current avalanche hazard zone lines indicates. In addition to those two avalanches, 5 other avalanches have gone beyond the hazard zone lines. At the moment work is being done to make new rules for avalanche hazard zoning in Iceland. Until new avalanche zoning has been made for each village and town, evacuation will be done according to new evacuation maps that were made last winter (which includes big margin for errors).

The risk for people living in those avalanche prone areas is too high to be acceptable. An evacuation plan is only a temporary solution, but work has started on protecting all inhabitants living in houses within avalanche hazard zones (part of it is of course new avalanche zoning). For Sudavik avalanche protection was very expensive, so instead all the houses were bought by the State Avalanche Fund, and the village is being rebuilt in a safer area, less than 1 km from the old place. Work has begun on constructing big deflecting dams above Flateyri.

Most of the houses at the edge of the debris were not strong enough to withstand even a small load from the avalanches, but so far nothing has been done to set rules for strengthening houses close to avalanche hazard zones nor has any research been started to solve such technical problems.

RESCUE:

Big avalanches, that hit built-up areas, most often happen during bad weather. In such conditions the roads are most likely closed and it is impossible to use rescue helicopters. Therefore it is vital that avalanche rescue capability is available in each and every town and village in avalanche areas, at all times. Locals will have to take care of rescue operations during the first hours, which is the time that most victims can be rescued alive. All rescue teams in Iceland have been training hard for avalanche rescue and more avalanche dogs are being trained, as a result of those two avalanches.

Avalanche dogs are the most powerful and effective method for locating avalanche victims (not wearing transceivers). Therefore it is very important to get several trained dogs (as they get exhausted very quickly under such contitions) to the accident site as soon as possible. Even so, the dogs may not be able to locate all the victims and even give many false indications (there are many possible and long airways in avalanche debris in built-up areas), so many people equipped with probes and shovel have to be available and trained for avalanche work.

Often search and rescue after such a big accident is performed in a heavy snowstorm with low visibility, preventing an avalanche lookout above the accident site. As a result the rescue personnel themselves are in constant danger from further avalanches and at all times a fully equipped back-up rescue team has to be kept at a safe place, close to the search area.

There seem to be no theories predicting where victims will end up in the debris of an avalanches after it has passed houses. Special "detectives" should be selected as soon as possible to assist the search leader to select the most likely search areas. Their only job is to hunt for any clues in the debris that can give an indication of the location of a victim. In the debris of an avalanche that has hit built-up areas there will be many items to investigate and study. This is a demanding and difficult task, and those men should not have any other obligations during the search.

When using untrained volunteers in rescue operations involving a catastrophic avalanche, great care has to be taken of their welfare and abilities. They will not all able to do the necessary hard work under such a difficult conditions, even though they have volunteered to do so, and want to do it. Even so volunteers are an important source of assistance in such a big incidents, specially in small communities and in the beginning of the rescue operations.

In a big avalanche, like these two, it is important to have enough rescue equipment available for the rescuers, such as; avalanche transceivers (not only one per rescue team member, but many extra for those who will assist), avalanche probes (many will break during the operations), shovels (good, steel made, and even they will break) and equipment for urban search and rescue (to go through house debris).

DATA COLLECTING:

After such an avalanche it is very vital to collect as much data as possible. Later it will be possible to use this valuable data for research on avalanches and avalanche accidents. This has to be done as soon as possible and by people with experience in avalanche work. Such a big accident will have much psychological effect on the persons collecting the data and there is a great possibility that some important information will not be detected and registered. After walking through a destroyed village and knowing what has happened there, it is very hard to set the mind on something else. As a result ones mind is upset and things don't happen very logically and quickly. Therefore it is very important to give the persons responsible for collecting such data plenty of time on location, and free them from other duties in the meantime, such as avalanche forecasting, media interviews and meetings (and from our experience there will be a lot of meetings the first days after such an event). It is also important to have more than one person doing this job, because one can see what others are missing. Plenty of time, a good camera, a lot of films, an open mind, an eye for details and a notebook are the most vital tools to carry along on such a task.

CONCLUSIONS

Each and every avalanche accident is a lesson. A lesson that can extend our knowledge and understanding of this dangerous enemy. The price for such a lesson is much to often much to high, a human live. Therefore it is our duty to learn as much as possible from each and every avalanche accident, because after all, knowledge and understanding are the only weapons we will ever get to fight the avalanches.