Avalanche and landslide hazard zoning committees in Iceland

Fjóla Guðrún Sigtryggsdóttir[1]* and Gunnar Guðni Tómasson[2]

[1] *NTNU, Department of Civil and Environmental Engineering, Trondheim, Norway*
[2] *Landsvirkjun, Iceland*
**Corresponding author, e-mail: fjola.g.sigtryggsdottir (at) ntnu.no*

ABSTRACT

In Iceland, landslides and avalanches have resulted in catastrophic consequences with loss of lives as well as economical losses. After two tragic events in 1995, an act on protective measures against avalanches and landslides was passed in 1997, revised in 2000 and followed up with the issue of a regulation. The regulation embraces hazard zoning, classification and utilisation of hazards zones, as well as preparation of provisional hazard zoning. These require an assessment of the risk associated with snow avalanches and landslides in communities where such have fallen on or near settled areas, or where the threat of this can be deduced from the topographical and meteorological conditions. Furthermore, a Hazard Zoning Committee (HZC) is to be assigned for each specific case. The HZC shall decide, in consultation with the local authority, which areas the hazards zoning shall cover, and subsequently request the Icelandic Meteorological Office to carry out the hazards zoning. This paper outlines the responsibility of the HZC as mandated by the laws. Furthermore, it provides an overview of the extent of work carried out by the different committees in conjunction with hazard zoning of altogether 23 urban areas/communities, since the first committee was established in the year 2000.

1. INTRODUCTION

In Iceland, mass movements, mainly snow avalanches, have resulted in catastrophic consequences with loss of lives as well as economical losses. Several catastrophic events have occurred in recent decades in East- and West-Iceland, mainly in villages by fjords dominated by steep mountain sides. After two catastrophic avalanches at Flateyri and Súðavík in West-Iceland in 1995, a governmental fund, the Icelandic Avalanche Fund, was strengthened considerably. Furthermore, an Act on Protective Measures against Avalanches and landslides was passed in 1997 (Alþingi, 1997) (referred to in the following as the Act), revised in the year 2000 and followed up with the issue of a regulation on hazard zoning due to snow and landslide (Umhverfisráðuneytið, 2000) (referred to in the following as the Regulation). The aim of the Act is to prevent damage to property and persons resulting from avalanches and landslides.

The Act and the Regulation embrace collection and process of data on avalanches and landslides, measurements of snowpack properties and research regarding avalanche dangers, hazard zoning, classification and utilisation of hazards zones, as well as preparation of provisional hazard zoning. These require an assessment of the risk associated with snow avalanches and landslides in communities where such threat lies in the topographical and meteorological conditions. Furthermore, a Hazard Zoning Committee (HZC) is to be assigned for each specific case. This paper will outline the responsibility of the HZC committees as

mandated by the laws by summarizing the framework given by the Act and Regulation. Furthermore, report on the work that has been carried out in conjunction with hazard zoning of, to this date, 23 urban areas/communities, since the first HZC committee was established in the year 2000.

2. FRAMEWORK

The local authorities in communities threatened by snow- or landslide shall according to the Act have the initiative to request the Minister for the Environment (referred to as the Minister in the following) for an assessment of the risk involved. Following such a request the Minister appoints a Hazard Zoning Committee (HZC) of four members. The HZC is to direct the preparation of a hazard zoning in the community requesting the assessment. Two of the HZC members are nominated by the local authorities, while the Minister appoints two without nomination. One of those appointed without nomination shall, according to the Act, be the Chairman of the committee and cast the deciding vote in case of a tie vote. The Regulation additionally requires the other person without nomination, to be a Specialist with expert knowledge of snow- and landslide danger.

The HZC shall direct the preparation of the hazard zoning and decide, in consultation with the local authority, which areas the hazards zoning shall cover. Furthermore, the HZC shall request the Icelandic Meteorological Office (IMO) to carry out the hazards zoning and conclude a contract with the IMO in this regard.

The hazard zoning must be based on the following data collection: maps of the area, extensive documentation on snow- and landslides in the area, investigation of weather conditions, examination of local settlement history and on-site inspection (Umhverfisráðuneytið, 2000) (the Regulation). The IMO is by law (Alþingi, 1997) (the Act) responsible for collecting and processing data on avalanches and avalanche danger. Thus, in most cases the work of the IMO relating to the data collection and hazard assessment has started and been ongoing for some time before the HZC is appointed by the Minister.

When the IMO has completed a proposal for the hazard zoning, the local authority, in consultation with the HZC, is responsible for advertising and arranging the presentation of this at an open meeting in the local community (see the Regulation). Usually, a flyer is prepared in conjunction with the open meeting, containing relevant information and summary from the hazard zoning, including a small map. The hazard zoning and the basis of this is usually presented by the IMO specialists conducting the assessment. After the presentation, the hazard zoning and associated report is to be available to the public for four weeks at the office of the local authority (see the Regulation). During this period, comments and questions may come from the public, which the HZC usually answers in consultation with the IMO and the local authorities. Furthermore, the report may be revised to make some points clearer in light of the comments and questions.

At the end of the four week open public access to the hazard zoning, the HZC sends this to the Minister for the Environment for attestation. The hazard zoning enters into force upon publication in the Official Journal of Iceland (Stjórnartíðindi).

3. HAZARD ZONING COMMITTEES

3.1 Overview and urgency of hazard zoning

The inhabited areas threatened by avalanches are mostly located close to the coast in western, northern and eastern Iceland. These areas were prioritized in the time line set for the hazard zoning (See Figure 1). Furthermore, the Regulation (Umhverfisráðuneytið, 2000) issued in 2000 had temporary provisions requiring that the HZC assigned for certain ten centres of populations to conclude the hazard zoning no later than the end of the year 2001. The centres of population given this urgency were the following: Bíldudalur, Bolungarvík, Eskifjörður, Ísafjörður including Hnífsdalur, Neskaupsstaður, Ólafsvík, Patreksfjörður, Seyðisfjörður and Siglufjörður. However, the HZC for these places were appointed in the time period 2000 to 2003, and thus obviously the specified deadline could not be adhered to. Still, these places were prioritised and the first ones to have a hazard zoning attested.

Figure 1. Centers of population threatened by avalanches and for which historical data along with population density indicated the highest associated risk. (Figure from Jóhannesson and Arnalds, 2001). These centers of population (with the exception of Flateyri and Súðavík) were given an urgency in the hazard zoning procedure by the Regulation issued in 2000 (Umhverfisráðuneytið, 2000).

The first two HZC were assigned in the year 2000 for Neskaupstaður and Eskifjörður, the open meeting was held in 2001 and the hazard zoning attested in 2002. In 2002, the hazard zoning for four of the ten (effectively nine considering that Hnífsdalur is a part of Ísafjörður) prioritized centres of populations entered into force. In 2004 all of these had a hazard zoning attested and into force, the last ones being Ólafsvík and Bíldudalur.

Notably, the villages Flateyri and Súðavík were not listed in the temporary provisions of the Regulation. But after the tragedies in 1995, measures were taken to reduce the avalanche risk. In Flateyri, avalanche protection measures were installed, and in Súðavík, the populated area within the hazard zone was relocated. Nevertheless, a HZC was assigned for these places, Flateyri and Súðavík, respectively in 2003 and 2004 with the hazard zoning in force in 2004 and 2005. By 2007, HZC had been assigned for all populated areas in North-, East- and West Iceland severely threatened by avalanches. In the years that followed, HZC were assigned for areas with a lower risk relating to avalanches and or landslides.

3.2 Appointed Hazard Zoning Committees

Altogether twenty-three HZC have been appointed in the period from the year 2000 to 2013. The two members of the HZC nominated by the local authorities are inevitable represented by different persons. However, a certain stability has been in the appointment of the Chairman and the Specialist. Gunnar Guðni Tómasson has been a member of all the HZC appointed, the Chairman of fifteen of these and the Specialist in eight. Snjólfur Ólafsson has been the Chairman in eight of the committees and the Specialist in thirteen. Fjóla Guðrún Sigtryggsdóttir has been appointed as the Specialist in the last two HZC appointed. Thus, of the twenty-three HZC, twenty-one have had the same two persons appointed as the Chairman and/or the Specialist, and the same person has been in all HZC either has Chairman or a Specialist. This arrangement has ensured consistency in the work of the HZC.

3.3 Work of the HZC and attested hazard zoning

The location of the twenty-three populated areas that have had a hazard zoning attested within the framework of the Act and Regulation, is given in Figure 2. Additionally, Figure 3 gives an overview of the apparent comparative urgency given to the hazard zoning, assuming that this is represented by the year of appointment of a HZC for the location specified. The urgency relates to the potential associated risk identified from historical data, topography, climate, and the population of the respective areas.

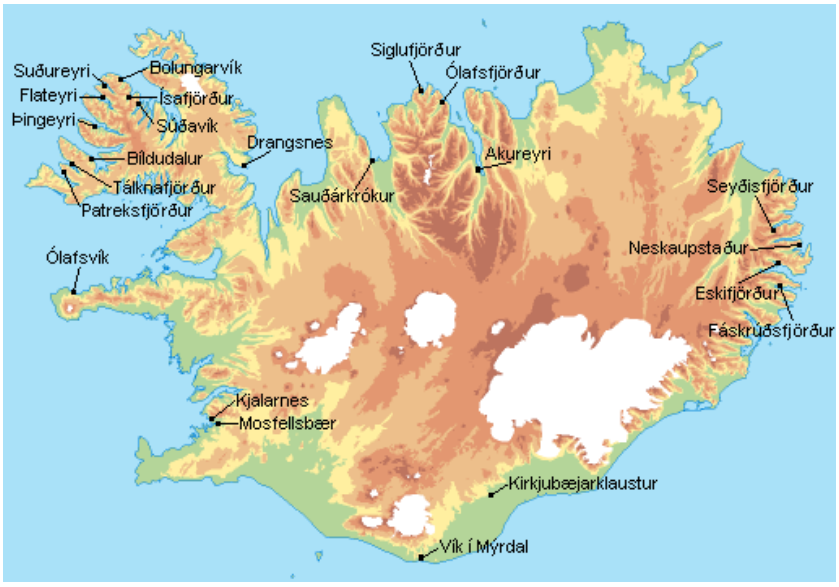

Figure 2 Populated areas for which a hazard zoning has been attested and entered into force. (Figure from IMO: https://www.vedur.is/ofanflod/haettumat/).

An overview of the work conducted by the different HZC is provided in Figure 4. The figure presents timeline and gives for each year the number of HZC appointed as well as the number of attested hazard zoning. The appointment of the HZC marks the initiation of the work relating to the hazard zoning, while the attestation marks the end of the committee's work. The urgency of the early hazard zoning as described above in section 3.1 can be realized from the Figure 4,

with a peak in the number of HZC appointed in the year 2003, and a steady number of attested hazard zonings in the years 2002 through 2005 or about three to four per year in that period.

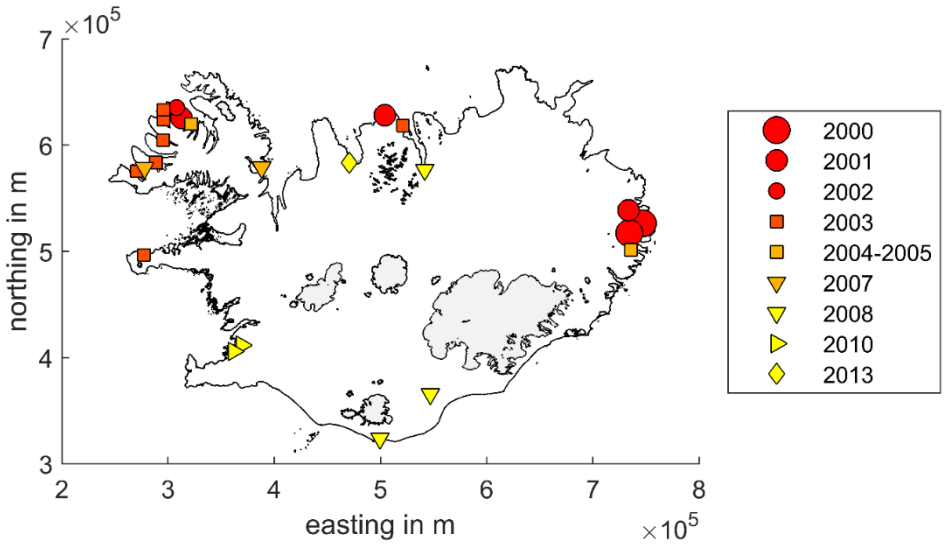

Figure 3 Location of places with hazard zoning in force. The comparative urgency of the hazard zoning is apparent from the year of Hazard Zoning Committee appointment. The most urgent hazard zoning was initiated in the period 2000 to 2003.

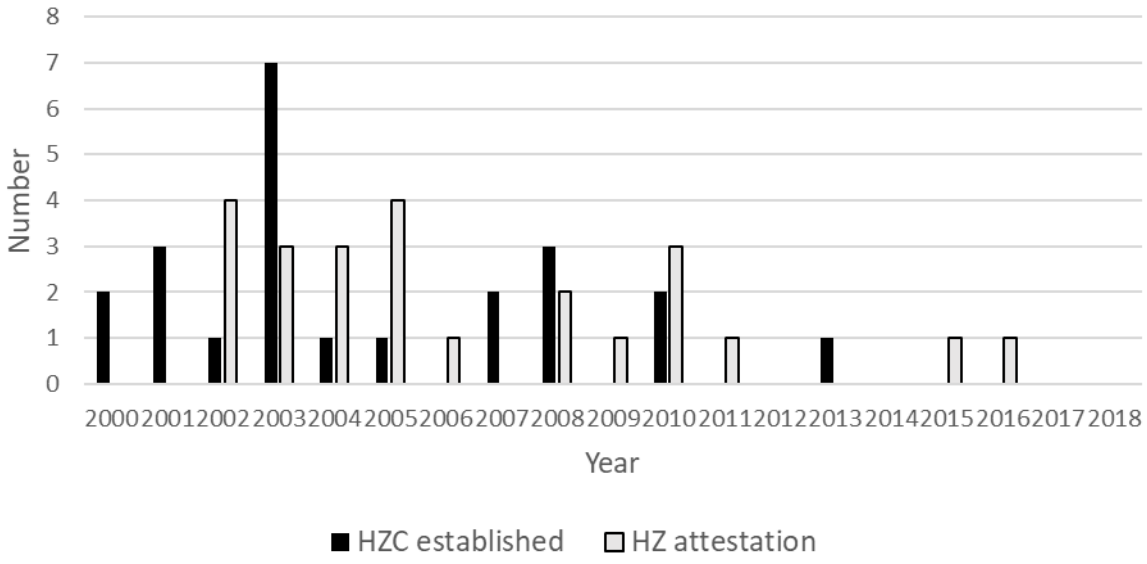

Figure 4 Timeline showing for each year the number of hazard zoning committees appointed and the number of attested hazard zoning.

The work of each HZC from appointment to attested hazard zoning, typically spans one to two years. An exception to this is the five year period for the hazard zoning of the Kjalarnes area at the outskirts of Reykjavík City. The area in question is scarcely populated and revision of the Act was required for clarification relating to this, hence the delay.

The intensity of the work carried out, since the first HSC till the last appointed hitherto, has been uneven and from Figure 4 three periods can be roughly identified in this regard. The first and most intensive period relating to the work overseen by the HZC initiates with the first committees assigned in the year 2000 and extends throughout 2006. During this period the most urgent hazard zoning was carried out and attested. The second period from 2007 to 2011 was of moderate intensity, while the third and last period was the least intensive and embraces the work overseen by the last two HZC appointed and spans from 2010 to 2016.

The information used to create Figures 3 and 4 was extracted from the hazard assessment reports available at the website of the IMO (IMO, 2001 to 2016) for the locations given in Figure 2.

4. CONCLUDING SUMMARY

The Act and Regulations for the hazard zoning of populated areas threatened by avalanches and landslide has provided an important framework for the hazard assessment and zoning conducted in twenty-three communities. Consistency in the work has been ensured, on one hand with the appointment of the same one or two persons as the members of the four-person Hazard Zoning Committee overseeing the work, and on the other by requiring the HZC to conclude a contract with the Iceland Meteorological Office (IMO) on carrying out the hazard assessment. Furthermore, the two members of the HZC nominated by the local authorities have been important for local knowledge and communication. The work overseen by the HZC and carried out by the IMO is clearly presented on the website of the IMO, where all the hazard assessment reports as well as the attested hazard zoning can be assessed. Successful execution of the hazard zoning is largely attributed to the work of the experts and specialists at IMO.

ACKNOWLEDGEMENT

The contribution of IMO in the hazard assessments and hazard zoning is acknowledged, as well as the work of Snjólfur Ólafsson as a member of twenty-one hazard zoning committees, either as a specialist or chairman. Furthermore, the contribution of the many HZC members nominated by the local authorities is acknowledged.

REFERENCES

Alþingi, 1997. Act on Protective Measures Against Avalanches and Landslides, No.49, 24 May 1997.

Iceland Meteorological Office (IMO) (2001 to 2016), Hazard assessment reports available at IMO website https://www.vedur.is/ofanflod/haettumat/ for the locations in given in Figure 2.

Jóhannesson, T., Arnalds, Þ., 2001. Accidents and economic damage due to snow avalanches and landslides in Iceland. Jökull, 50, 81- 94.

Umhverfisráðuneytið (Ministry for the Environment). 2000. Reglugerð um hættumat vegna ofanflóða, flokkun og nýtingu hættusvæða og gerð bráðabirgðahættumats.