European volcanological supersite in Iceland: a monitoring system and network for the future

Report

D3.4 - Report on feedback of FUTUREVOLC impact from end-users across Europe

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Summary

This report comprises Deliverable 3.4 - Report on feedback of FUTUREVOLC impact from end-users across Europe. The report describes the results of a survey sent out to stakeholders in early 2016; notes from a review meeting of the Scientific Advisory Board of the Icelandic Civil Protection; and notes from the FUTUREVOLC Stakeholder Meeting held in November 2015. The report also contains user instructions for the FUTUREVOLC Catalogue of Icelandic Volcanoes, directed at duty officers, and a graphical expression of the Icelandic Disaster Management System. The main finding is that the FUTUREVOLC project has played a significant role in improving preparedness across sectors and in enabling the near real-time application of science to support societal needs.

Main findings suggest that communication and flow of information about volcanic eruptions in Iceland has improved during the lifespan of the FUTUREVOLC research project. The three recent major eruptions in Iceland, Eyjafjallajökull in 2010, Grímsvötn in 2011, and Bárðarbunga/Holuhraun in 2014-2015, have called for closer cooperation and collaboration between different stakeholders groups across Europe. The science produced by FUTUREVOLC has supported this group of stakeholders as they adjust their planning and preparedness for volcanic eruptions. Our research show that this application of research to societal needs requires a strong investment in multi- and inter disciplinary research, in collaboration between operational science institutes and universities, and in collaboration and cooperation, particularly between scientists and civil protection. Our research also shows that contingency planning is improving in Europe, and that the contingency plans are working well, in all the sectors we looked at, which include Civil Protection, Meteorological Service Providers, Science, Media, Aviation Authority, Air Traffic Control, and Airlines. Science has a major role to play in ensuring effective planning and response across sectors in Europe.

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1 Introduction

1.1 Report Overview

According to the FUTUREVOLC project Description of Work (DoW/Annex I), the deliverable "D3.4 (should) report on feedback of FUTUREVOLC impact from end-users across Europe". The related task 3.4, is defined in the document as to "consult end-users as to the impact of FUTUREVOLC and any outstanding requirements." A further comment describes the process: "questionnaires will be distributed and followed up with discussions to assess the impact of the project in terms of improvements in coordination and knowledge exchange but also to identify 'next-steps'" (Futurevolc Project, 2012).

To meet these requirements the FUTUREVOLC team in work package 3 (WP3) has turned to the stakeholders for answers on how knowledge has been shared during the lifetime of the project, and on how the coordination has been improved. We submitted a new survey to the same stakeholders group that we questioned in 2013, and documented in FUTUREVOLC report D3.1, which gives us a comparison on these issues over the last six years, covering the three major eruptions in Iceland during that time, Eyjafjallajökull in 2010, Grímsvötn in 2011 and Bárðarbunga in 2014-2015[1]. We also participated in the FUTUREVOLC Stakeholders Meeting that took place in Iceland in November 2015. We analysed the feedback from the working groups of that meeting, and there we had the opportunity to speak directly to some of our stakeholders and listen to what they had to say on these issues. We also mounted, in close cooperation with our key partners, a review meeting at the Scientific Advisory Board (SAB) of the Icelandic Civil Protection, where we could ask the scientists directly how they view improvements in coordination and knowledge exchange.

To meet with the requirements of our stakeholders we also include in this report two appendixes, one on the FUTUREVOLC Catalogue of Icelandic Volcanoes and another on the Icelandic disaster management system. As is documented in our D3.3 report, we met with duty officers and administrators of the European Commission Emergency Response Coordination Centre (EC-ERCC) in the spring on 2015 where we reported on the progress of FUTUREVOLC and introduced the Catalogue, which is an online interactive application, that contains real-time and background information on all the 32 Icelandic volcanic systems. In this report we demonstrate in pictures how the catalogue can be used to access this information, including maps, historical summaries, and real-time data. This was done in accordance with a number of requests from our stakeholders to have this kind of information accessible in a convenient format for operators, duty officers.

In accordance with these requests we also include in the report an overview of the Icelandic disaster management system in clear and readable graphs or pictures. These charts are produced and published here for respondents that may not always have the time or conditions to read through long reports. This important group needs to act under time pressure and will use maps and charts to explain what is going on, where, and what needs to be done.

[1] The Bárðarbunga event consist of few stages, as has been covered in number of FUTUREVOLC reports, the seismic activity in the Bárðarbunga caldera, the subsidence of Bárðarbunga caldera, the dyke intrusion from the Bárðarbunga caldera to the eruption site in Holuhraun, and the outbreak of the volcanic eruption in Holuhraun, the lava flow in Holuhraun, and the S02 gas emission. The focus of this report is not on these events per se, but on communication between institutions and key stakeholder groups. In the questionnaire we used "Bárðarbunga/Holuhraun 2014-2015" so that the name of the eruption site would be visible. To simplify the terminology we use the term Bárðarbunga 2014-2015 when we refer to event as whole and Holuhraun if we are referring to the eruption site.

1.2 Main Findings

Through the survey we found a strong indication that communication and flow of information during the three recent volcanic eruptions in Iceland are improving. Over 70% of our respondents either thought communication was 'improving' or 'improving significantly'. Although the three eruptions differ greatly in a number of ways, where the Eyjafjallajökull 2010 eruption had the most impact across Europe, due to dispersion of ash, the short lived eruption in Grímsvötn in 2011 also had impact on aviation traffic and there was potential hazard in the Bárðarbunga crisis that eruption might break out under ice, resulting in ash dispersion. These eruptions called for an attention from all of the repliers but due to the long lived eruption in Holuhraun the interest of the proceeding deceased with time. Results from the surveys show that 88% of the non-Icelandic respondents were aware of the eruption, while only 42% of the same group did not know that the eruption had lasted until February 2015.

The survey also indicates that the flow of precursory information, or information about development in the Icelandic volcanoes that possibly lead to eruption, is also improving. The period of unrest leading up to the Bárðarbunga eruption, from the 15th – 30th of August 2015, was a unique in that it was so well-monitored as a result of the FUTUREVOLC project. Precursory information are now being disseminated more systematically and proactively than before, which may explain some of the media attention on the issue. Another factor is the Eyjafjallajökull eruption that made Icelandic volcanic hazard well known in the European context.

The survey also indicates that all sectors have been improving their contingency plans during the lifespan of FUTUREVOLC and more agencies in all sectors now have a special section on volcanic risk in their contingency plans. We also establish that these contingency plans are working, according to our respondents. All sectors are also using a wider variety of media to reach the general public and to disseminate information. Social media is now in the arsenal of all the sectors but was almost exclusively used by the airlines in the Eyjafjallajökull eruption.

Our respondents are using data and information produced by the FUTUREVOLC project or from its main partners to produce information for their own agencies and national governments and giving advice to decision-makers in their countries. Knowing the quality of information, having access to information about Icelandic volcanoes and knowing the status of ongoing volcanic eruptions are therefore vital to this group and it is encouraging to see that 78% of our respondents believe that they had enough information to give a good advice to their decision-makers.

2 The Questionnaire

A survey was sent out to the same email list that received the FUTUREVOLC survey in the summer of 2013 and was documented in FUTUREVOLC Deliverable D3.1 (Heiðarsson, Loughlin, Witham, & Barsotti, 2014). In total 1375 invitations were sent out on February 16th 2016 and reminders were sent on the 1st March and 8th March. In total 225 responded to the survey.

The survey was designed to be a follow-up survey to the one in 2013 and therefore a number of the questions are identical to the 2013 questions while other questions are focused on the recent eruption in Bárðarbunga but in a way that they can be used in comparison to the eruptions in Eyjafjallajökull in 2010 and Grímsvötn in 2011. On the issue of method and literature we refer to the D3.1 report. The 2016 survey is shorter and simpler than the one in 2013. We did not design a special questionnaire for each of the stakeholder groups and we limited the number of questions so respondents would not have to spend more than 15 minutes to answer all the questions.

In total the survey consisted of 37 questions but no responder would have to answer them all due to follow up questions on specific issues. In comparison the 2013 questionnaire had 11 general questions for all the sectors and then between 40 and 50 questions for each sector, bringing the total number of questions to over 300.

In terms of nationality, the majority (36%) of the respondents are Icelandic and 34% of the respondents work in Iceland. In comparison 32% of the respondents in the 2013 survey were Icelandic. Of other European nations the United Kingdom comprised 10%, Sweden 5%, Italy, Norway and Germany had 4%, Denmark 3%, Netherlands, Czech Republic, Latvia and the United States all had 2%. In total 225 individuals from 34 nations replied to the survey.

On the gender issue, we still have a large male majority or 77% versus 23% female, the same ratio as in 2013. The age of the respondents is slightly higher than in 2013, understandable given that it's the same group, but again the largest group is between 40 and 60 years old. The level of education is also the same, and again quite high with 73% holding a university degree.

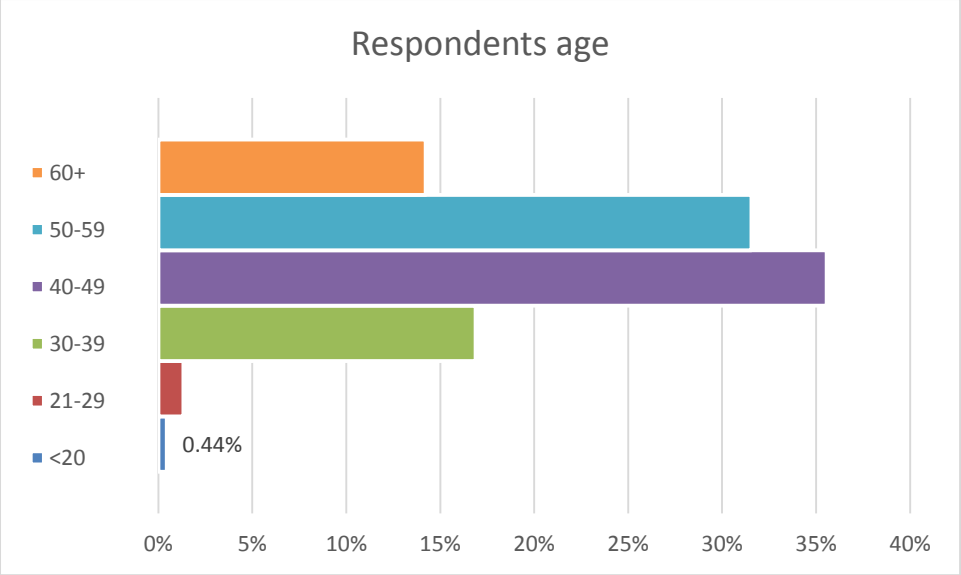

Figure 1 Question 4: Respondents age

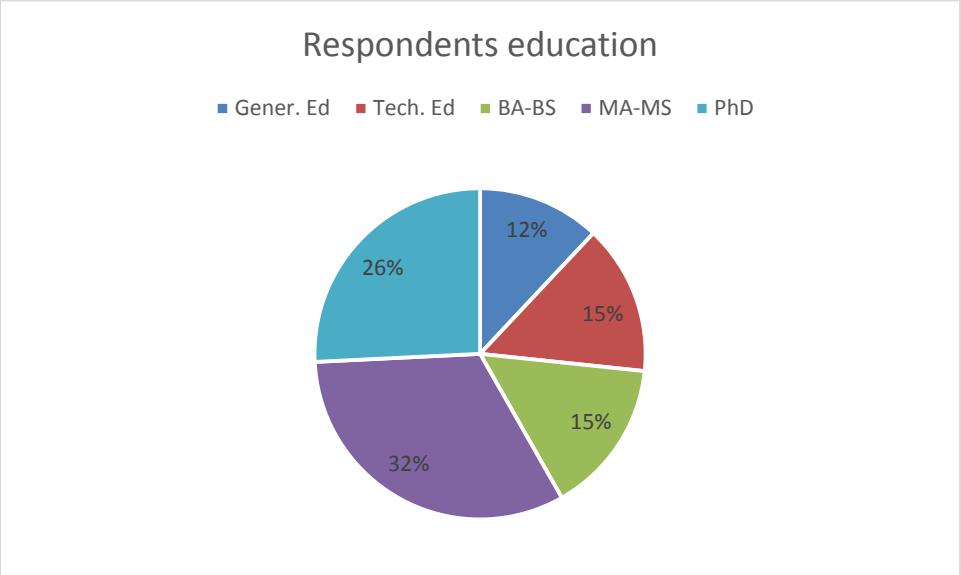

Figure 2 Question 5: Respondents level of education

On the issue of professional rank the respondents group has been climbing the career ladder, with 51% holding executive or department manager positions compared with 43% in 2013.

Figure 3 Question 6: Professional rank

In question 7 the respondents are divided into the sectors used in the 2013 survey. The number have slightly changed but the general trend is the same. The civil protection and government sector is largest with 26% compared to 31% in 2013. Both the meteorological and the science sectors are slightly larger than in 2013, as is the aviation administration. Airlines and air traffic control are on the other hand a bit smaller. Again the media sector is the smallest one and will need to be researched with different methods to online questionnaires.

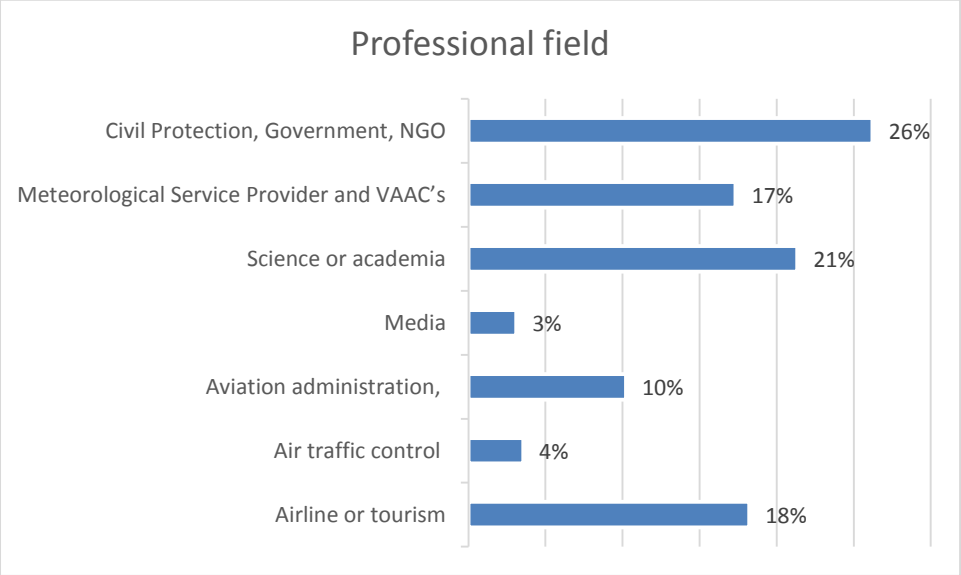

Figure 4 Question 7: In what field or profession are you working?

In question 8 we asked about the nature of the answer; are you answering on behalf of your agency, as a staff member who only speaks for himself, as an independent specialist or something else. In Figure 5 we see the answers broken down according to sectors, showing a very similar pattern to 2013. A good proportion of civil protection and government, meteorological service providers (MSP), aviation administration and airline participants responded on behalf of their agencies (40%) while the science sector and air traffic control gave personal answers.

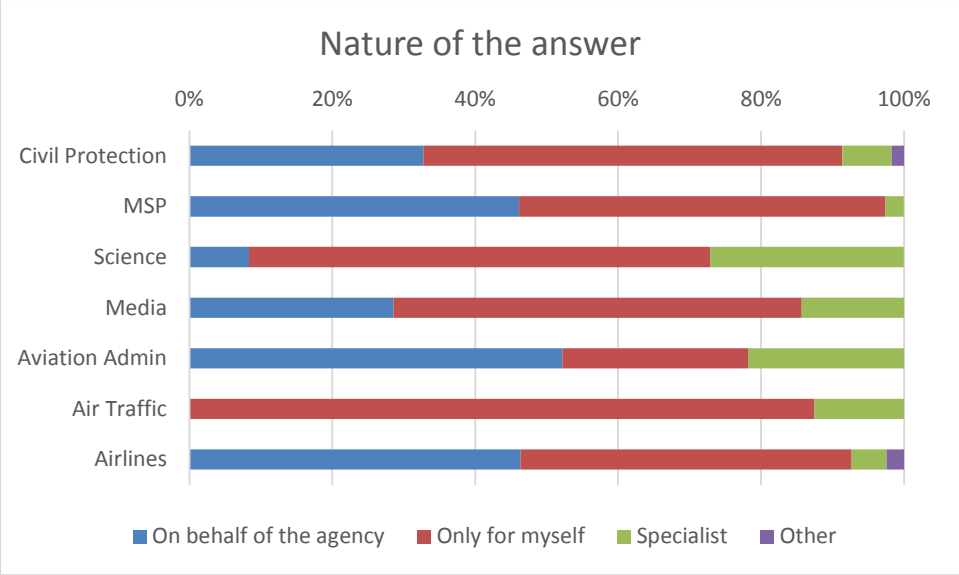

Figure 5 Question 8: Nature of the answer. Are you answering these questions as?

In question 9 we asked if the respondents were aware of the Bárðarbunga eruption. The responses confirm that the eruption got far less attention than the eruptions in 2010 and 2011. The Eyjafjallajökull eruption, in 2010, was understandably in its own league among volcanic eruptions in Iceland regarding volcanic ash and its effect on aviation.

It turns out that even in this group of professionals 8% was not aware of the Bárðarbunga eruption, and if we only look at responses from outside of Iceland 12% did not know about the eruption.

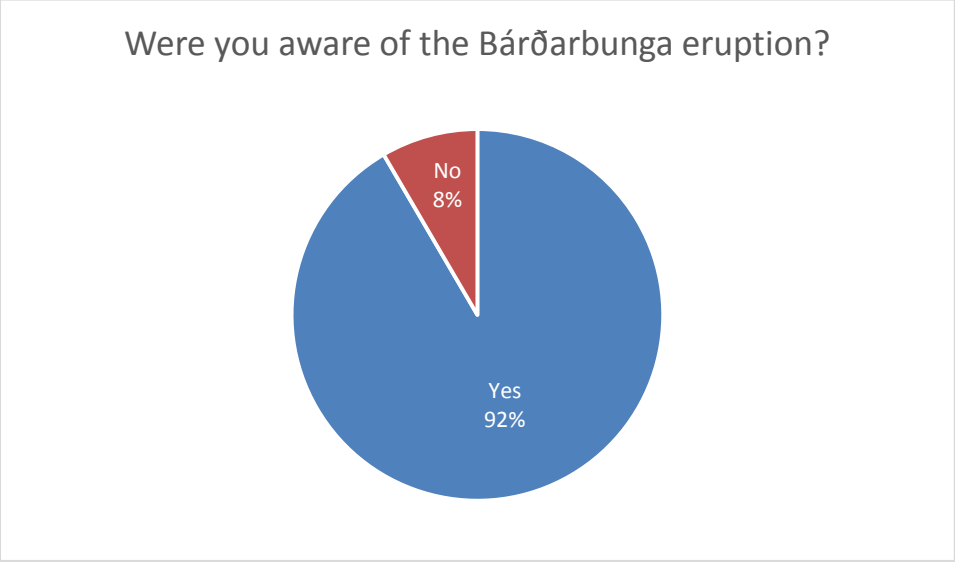

Figure 6 Question 9: Were you aware of the Bárðarbunga/Holuhraun eruption in Iceland that started in August 2014?

Question 10 was only answered by those who answered question 9 with a '*yes*', they were aware of the Bárðarbunga eruption. Of those 39% had heard of the eruption through the media, 25% through Icelandic Met Office (IMO), 12% through the London VAAC, 11% selected the '*other*' option, and 8% the Icelandic Civil Protection.

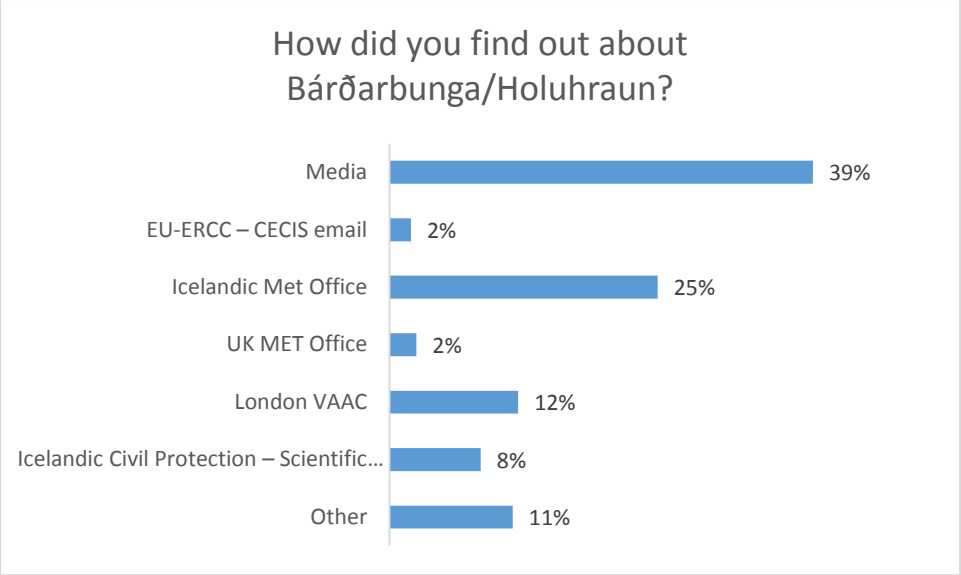

Figure 7 Question 10: How did you find out about the Bárðarbunga/Holuhraun eruption that started in August 2014?

All respondents received question 11, "*Were you aware that the eruption did not finish until February 2015?*" 27% of the respondents did not know that the eruption had lasted so long. Given the fact that over 98% of the Icelandic respondents answered 'yes' we see that around 42% of the respondents outside Iceland did not know that the eruption lasted until February 2015. Again, we are only talking to professionals in this survey, but the numbers indicate that most people do not follow events unless they are affected by them.

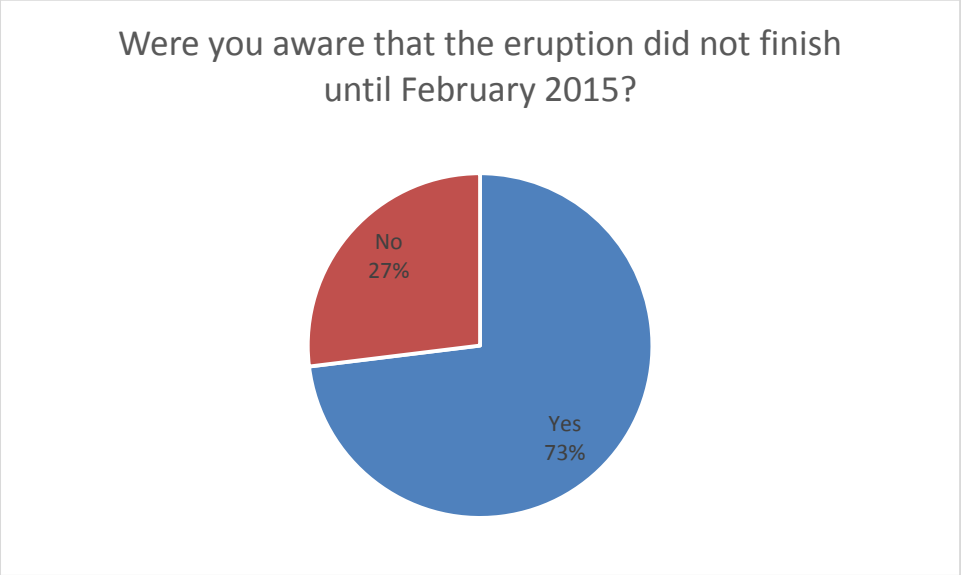

Figure 8 Question 11: Were you aware that the Bárðarbunga/Holuhraun eruption did not finish until February 2015?

The subsequent questions, 12-15, were focused on professional advancement. In question 12 we see that 73% had the same profession in 2014-15 as they did in 2010-11, and 88% were still working in the same workplace as in 2010-11. That gives us assurance that we are talking to people that can compare the three eruptions, Eyjafjallajökull, Grímsvötn and Bárðarbunga, from their professional perspective.

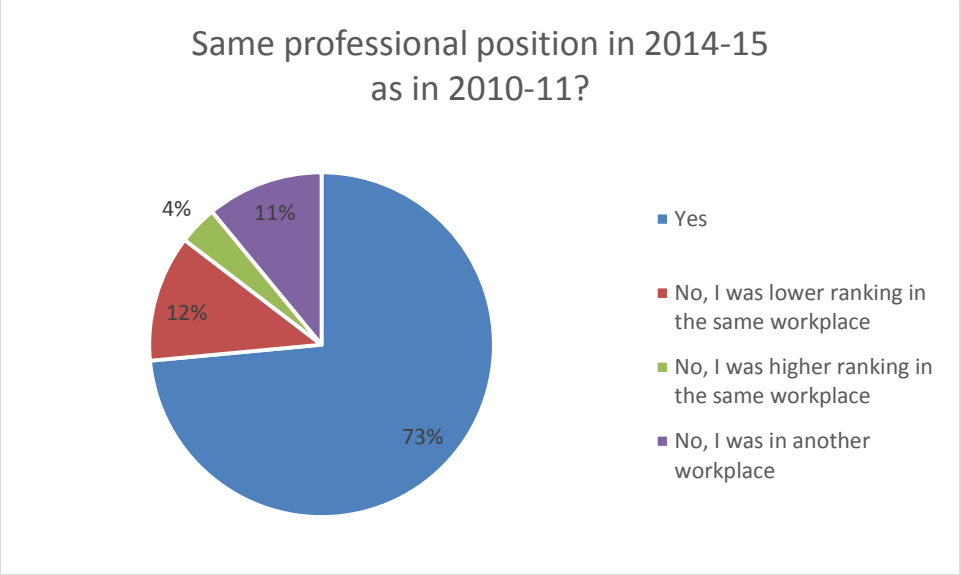

Figure 9 Question 12: Did you hold the same professional position in 2014-2015 as you did in 2010 and 2011?

In question 13 we ask if the respondents work in the same field of professional field as they did in 2010, and 87% did.

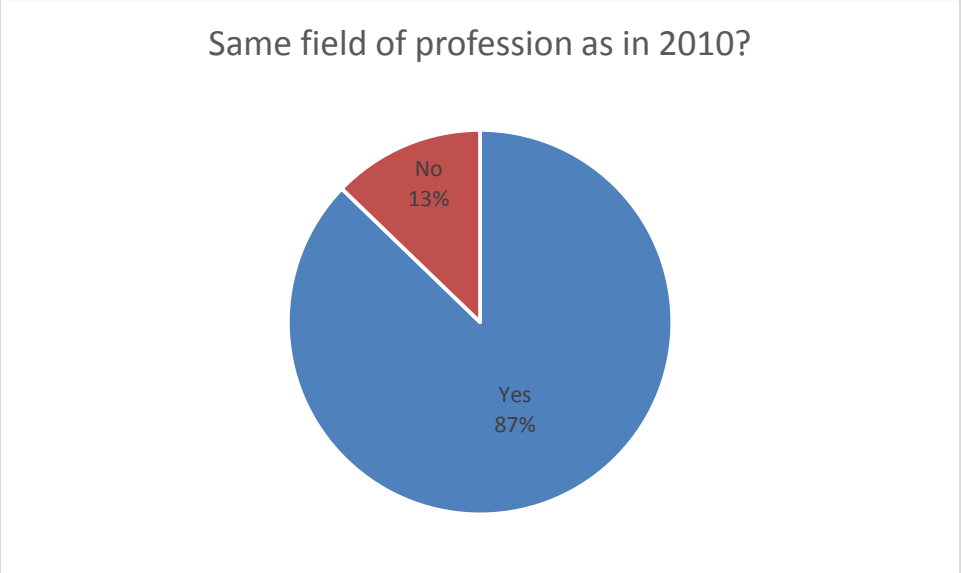

Figure 10 Question 13: Did you work in this field in 2010, during the volcanic eruption in Eyjafjallajökull?

In question 14 we asked if the respondents did work in the same field in 2011 during the Grímsvötn eruption, 85% did.

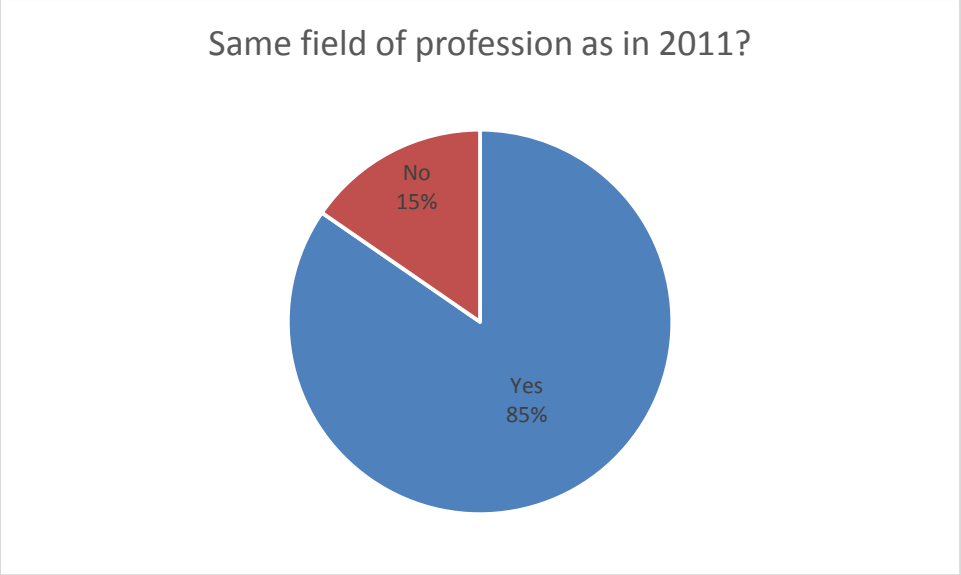

Figure 11 Question 14: Did you work in this field in 2011, during the volcanic eruption in Grímsvötn?

In question 15 we asked if the respondents worked in this professional field in 2014-2015 during the volcanic eruption in Bárðarbunga, and 93% of the respondents did. Those who did not were directed to question 33, on Hyogo Framework for Action, and did not answer further questions on flow of information in the three eruptions.

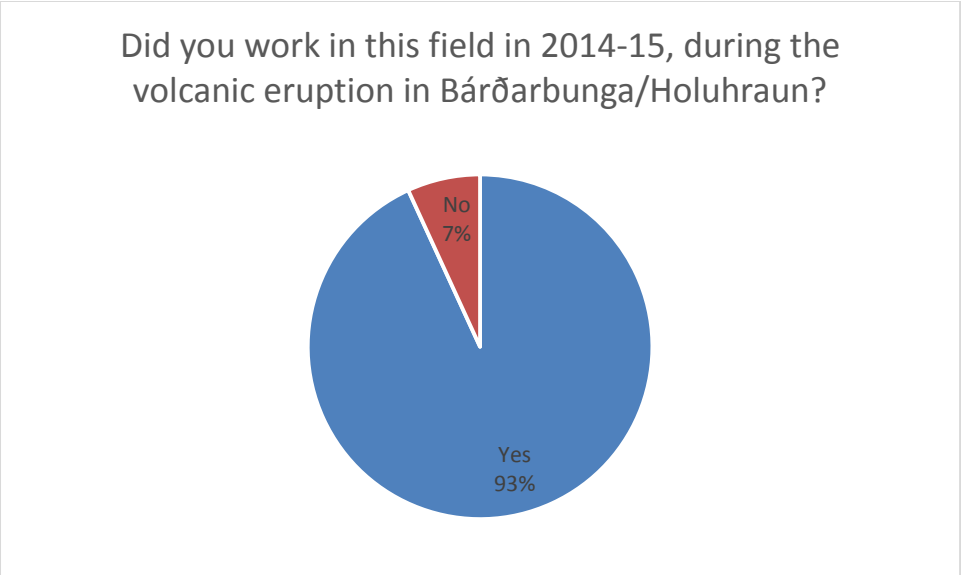

Figure 12 Question 15: Did you work in this field in 2014-2015, during the volcanic eruption in Bárðarbunga/Holuhraun?

In question 16 we asked our respondents to compare the flow of information in the 2011 eruption in Grímsvötn to the one in Bárðarbunga in 2014-2015. The improvements between 2010 and 2011 have already been documented in earlier FUTUREVOLC reports, see D3.1 (Heiðarsson et al., 2014). 32% of the respondents believe the flow of information and communication has improved significantly and 40% believe that communication has improved. Together that is 72% that believe the development to be in the right direction. 19% of the respondents selected the '*I don't know*' option that could have number of explanations e.g. that people were not paying a close attention to the issue, were not responsible for circulating these information etc.

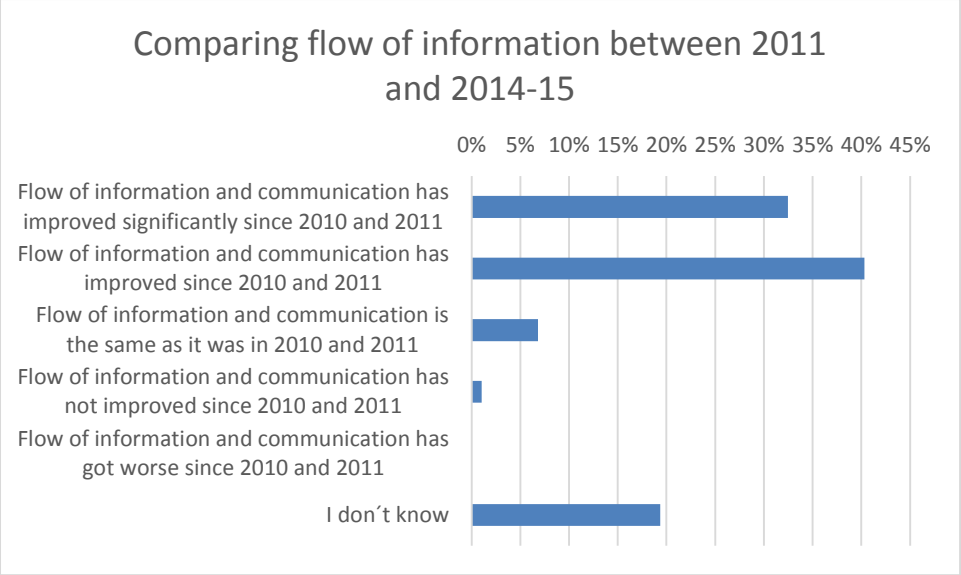

Figure 13 Question 16: Please compare the communication and flow of information from the Scientific Advisory Board of the Icelandic Department of Civil Protection during the volcanic eruption in Bárðarbunga/Holuhraun to the one in Grímsvötn in 2011.

In question 17, Figure 14, we asked about precursory information before the Bárðarbunga eruption. Again this question is in line with the questions we asked in our survey in 2013, documented in D3.1, page 43. The question is intended to capture whether *official* notification of unrest and/or precursory information has been received. These numbers are much higher than in the 2013 survey, where less than 20% of the civil protection sector answered the question with '*yes*' compared to close to 60% now. The trend is the same in all the sectors. The dyke intrusion that travelled over 40 km from the Bárðarbunga caldera to the eruption site in Holuhraun over the course of over two weeks, was well covered in the international media and it actually is during this period that the international media coverage was most intense. This fact has been documented in FUTUREVOLC report D3.3 (Loughlin et al., 2016) and can also be seen in Figure 15 created in Google Trend showing media coverage for the search term "Volcanic eruption in Iceland" from early 2014 until spring 2015 (Google Trends, 2016). According to the search the coverage peaked in the days between 24th and 30th of August 2014.

Although we take this into consideration, and if we add to the equation, access to precursory information before the Fimmvörðuháls, the flank eruption in the weeks prior to the Eyjafjallajökull eruption and the Grímsvötn eruption in 2011, as we did in FUTUREVOLC report D3.1, we still see a great change in the responses from all sectors. The only exception is the science sector, which scored higher in the Grímsvötn eruption, over 80%. The rapid escalation of monitoring signals before the Grímsvötn eruption was perhaps more strongly indicative of an imminent eruption than the Bárðarbunga dyking event which did not show a rapid escalation in intensity just prior to the eruption. This may explain the discrepancy in the scientists' results. In all of these questions one trend is emerging, the sectors are receiving information sooner. One explanation cannot be ruled out, that communication and flow of information from Iceland leading up to the eruption, has actually improved.

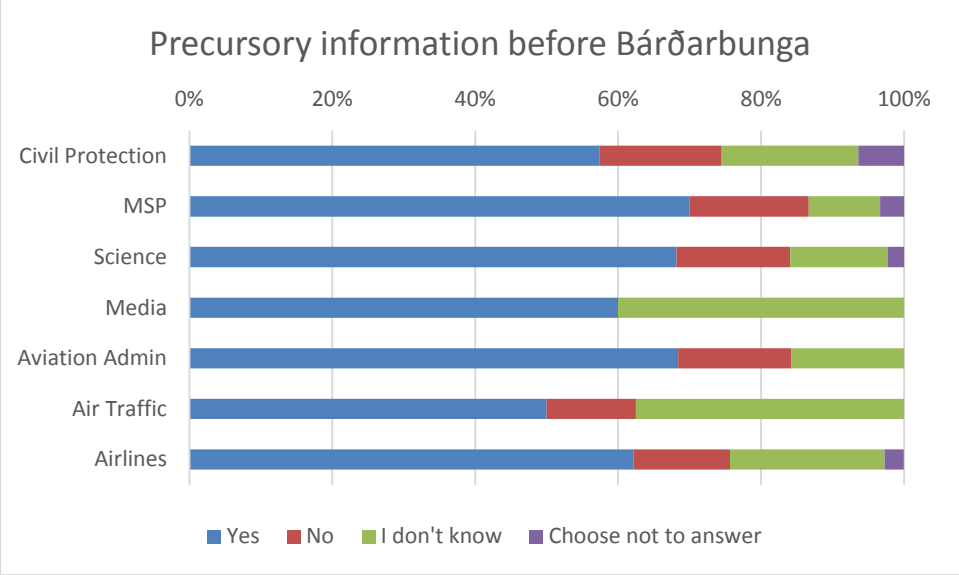

Figure 14 Question 17: Were you or your agency aware of any potential activity before the volcanic eruption in Bárðarbunga/Holuhraun on the 31st of August 2014?

Figure 15 Media coverage for "Volcanic eruption in Iceland" in 2014-2015 according to Google Trend.

In question 18 we asked about access to expert knowledge on volcanic activity during the Bárðarbunga/Holuhraun eruption. Here we see a similar trend as in the 2013 survey. Taken together the '*yes*' options got over 200 hits while the negative or '*I don't know*' options got around 70 hits. The proportion is roughly 75% versus 25%.

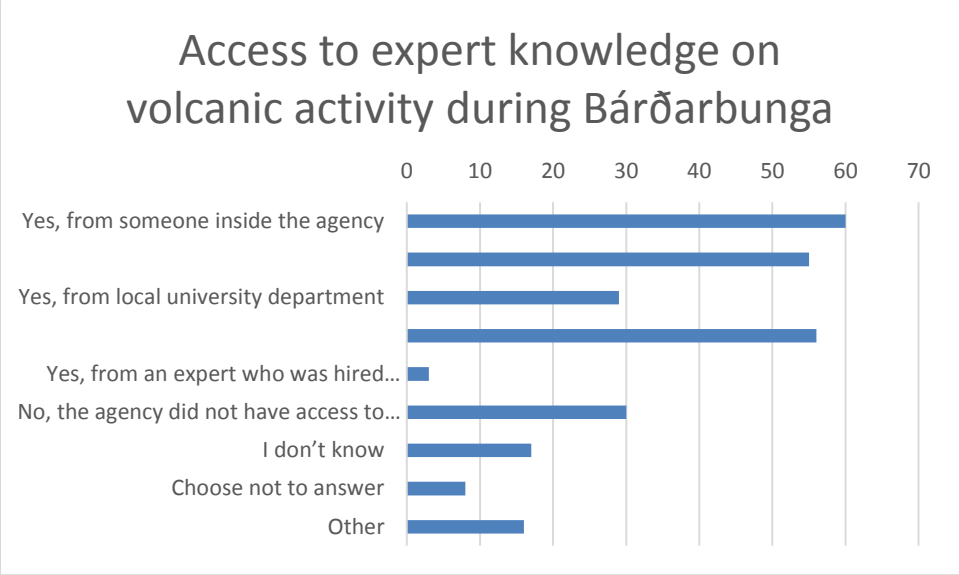

Figure 16 Question 18: Did you or your agency have access to expert knowledge on volcanic activity during the eruption in Bárðarbunga/Holuhraun in 2014-2015 (select all that apply)

In question 19 we asked if the respondents were responsible for producing information out of data during the Bárðarbunga eruption. As we see in Figure 17, collectively the '*yes*' answers are 197 compared to 72 for the '*no*' option. What we can take from this question is that these institutions and individuals are in most cases using data and information disseminated through our channels to further inform their own agencies and governments. These stakeholders clearly need good, understandable, and usable information that can be used to inform and educate all sectors of society such as government, media and the general public.

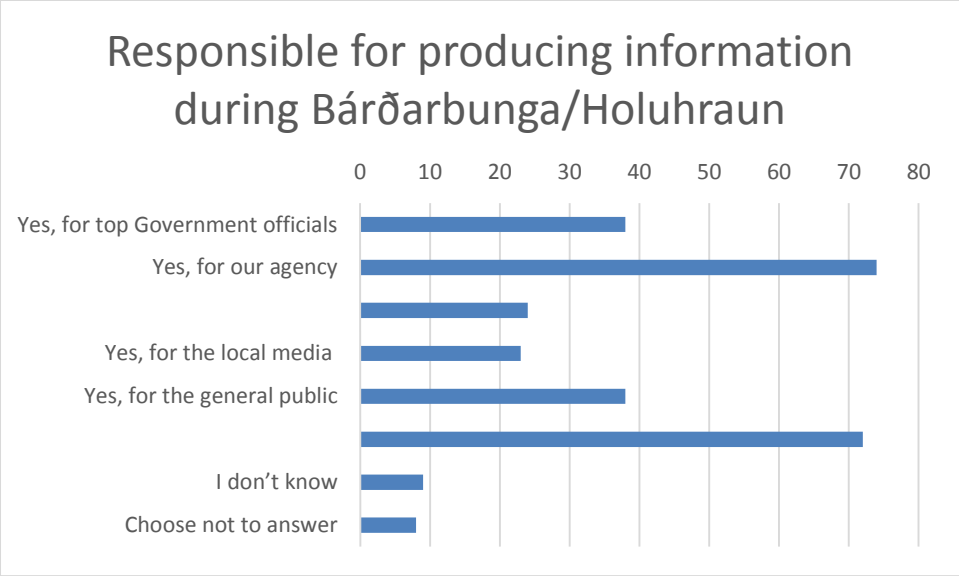

Figure 17 Question 19: Were you or your agency responsible for producing information out of data (interpreting data) during the eruption in Bárðarbunga/Holuhraun in 2014-2015 (select all that apply)?

In question 20 we asked if the stakeholders needed more information to be able to perform their duty during the eruption in Bárðarbunga. Over 90 respondents thought they had all the information they needed. In Figure 18 shows the type of information that other respondents thought they needed: more general information on volcanic activity; on gas (S02) cloud behaviour; on technical issues; more frequent information; and more authoritative information from the EU-ERCC. Here we see potential room for improvements.

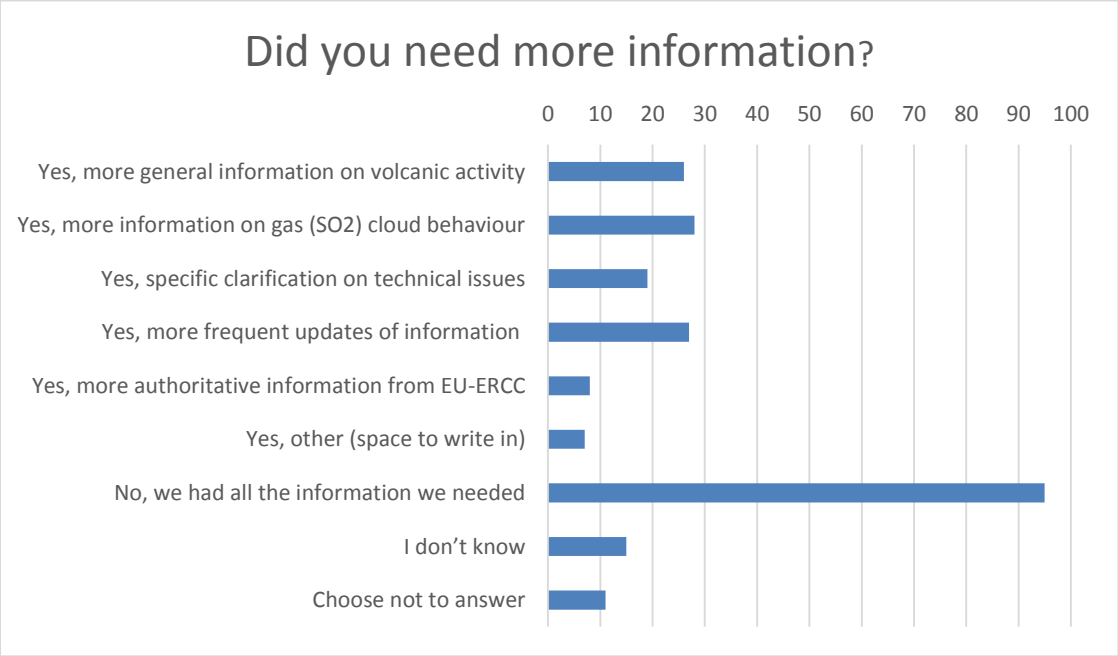

Figure 18 Question 20: Did you or your agency need more information to be able to perform your duty during the eruption in Bárðarbunga/Holuhraun in 2014-2015 (Select all that apply)?

In question 21 we asked if the sectors were responsible for giving advice to politicians (decision-makers) at top level in the national government during the eruption at Bárðarbunga. As can be seen in Figure 19, over 40% of the meteorological service providers are in that position, as well as around 30% of the science sector and aviation administration, and just over 20% of the civil protection (and government officials that fill this category). A small proportion of air traffic control, just over 10%, has this duty. These numbers are in line with the responses from 2013, although they are slightly lower for all sectors, and especially for the aviation sectors. This trend can be explained by the nature of the event, which did not impact aviation except for a few days when the dyke was still propagating under the ice cap, threatening to reach the surface and produce an explosive ash-rich eruption.

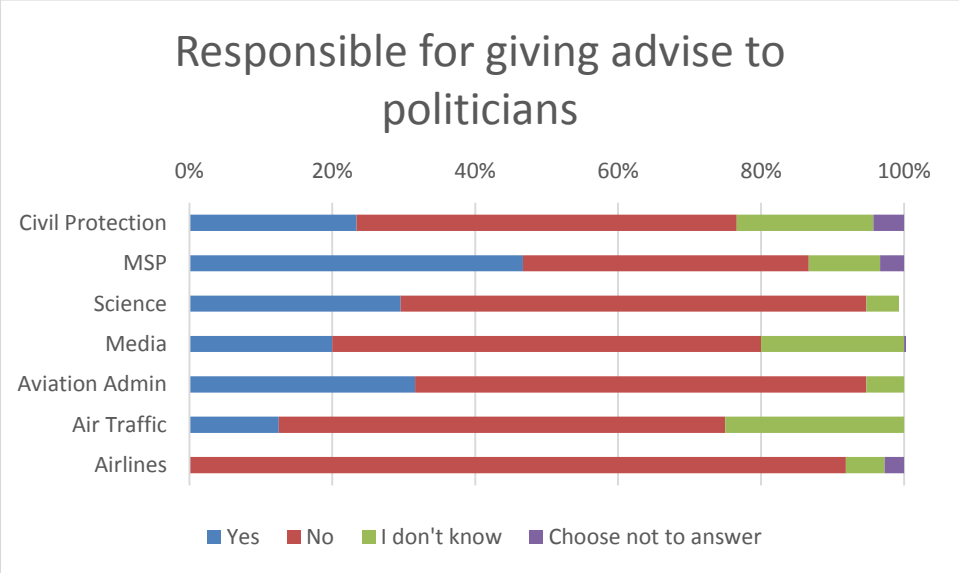

Figure 19 Question 21: Were you or your agency responsible for giving advice to politicians (decision-makers) at top level in the national government during the eruption in Bárðarbunga/Holuhraun in 2014-2015?

In question 22 we asked those who gave advice to decision-makers if they had good enough data to give good advice and 78% said they did, which must be confirmation of the quality of data being disseminated by FUTUREVOLC and its key partners.

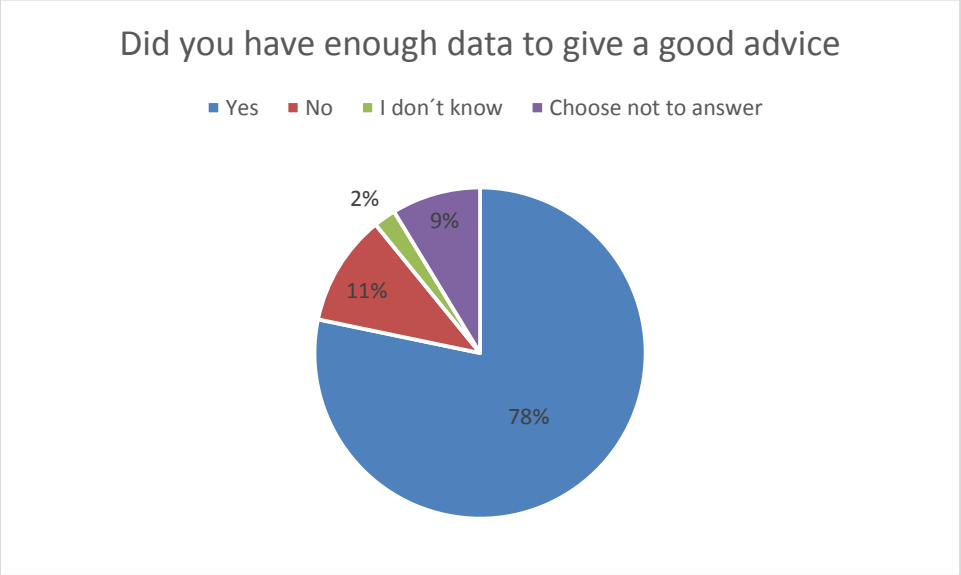

Figure 20 Question 22: Did you or your agency have enough data to give a good advice?

In question 23 we asked respondents who they disseminated information to during the Bárðarbunga eruption. Again this is a question that was asked in 2013 with very similar results as can be seen in Figure 21.

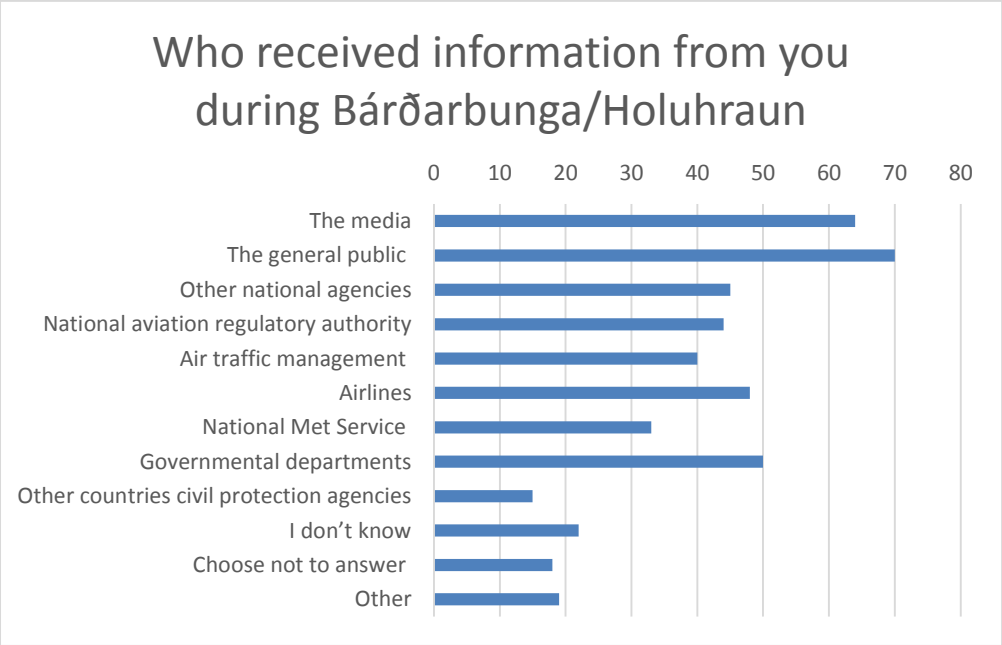

Figure 21 Question 23: Who received information from you or your agency during the eruption in Bárðarbunga/Holuhraun in 2014-2015 (Select all that apply)?

In question 24 we asked if there was a section on volcanic activity in the respondent's agency contingency plan before the eruption in Bárðarbunga. Here we see a real change compared to the 2013 survey. All the sectors have improved this part of their contingency plan and have included a special section on volcanic activity. The civil protection sector is now close to 50%

but was at 30%, aviation administration is now over 80% but only around 40% had a special section on volcanic activity before the eruption in Eyjafjallajökull in 2010. 100% of the air traffic control sector responded with '*yes*', and close to 90% of the airlines that we asked. The science sector, the meteorological service providers and the media did not get this question in 2013, so there is no comparison for those sectors, but those sectors now have a high ratio of the respondents selecting '*yes*'. Over 80% of the MSP, and 40% of the science sector and the media. One must keep in mind that we only received around 200 responses to the 2016 survey and around 320 responses to the 2013 survey, and in both of these surveys the media sector was by far the smallest one. So there are not many individuals behind those numbers. For the other sectors, the survey may not be large enough for the conclusion to be statistically significant, or a proof for this trend, but we have here a strong indication of the direction the development is going in.

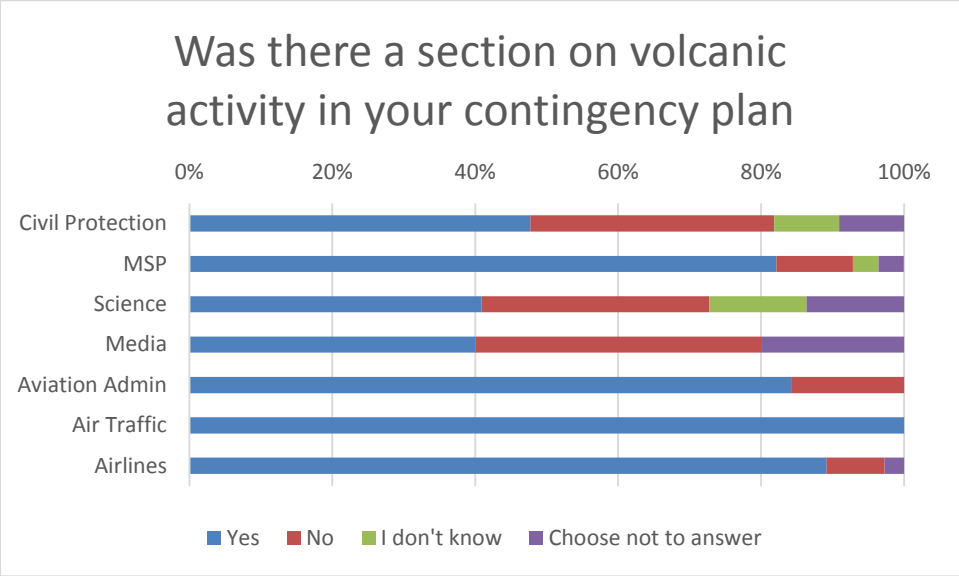

Figure 22 Question 24: Was there a section on volcanic activity in your contingency plan before the eruption in Bárðarbunga/Holuhraun in 2014-2015?

In question 25 we asked all the respondents, not only those that had a special section on volcanic activity in their contingency plan, how the existing contingency plan worked during the Bárðarbunga eruption. As can be seen in Figure 23, we have broken the answers down for each sector. In general we can say that the contingency planes are working. Around 40% or higher, in all the sectors, have chosen '*very efficiently*' or '*efficiently*' to describe how their contingency plan worked, and very few, or no more than 20% (and that is in the media sector with very few answers behind it), have selected '*rather inefficiently*' or '*very inefficiently*'. We must though notice that there is a rather high proportion of the respondents who '*don't know*' or '*choose not to answer*' this question. In the civil protection and the science sectors this is between 40 and 60%. In the aviation sectors this is not the case where this ratio does not go over 20%. So if we look at those who answer this question selecting either the positive or the negative evaluation we see a general trend for the positive one, as can be seen in Figure 24.

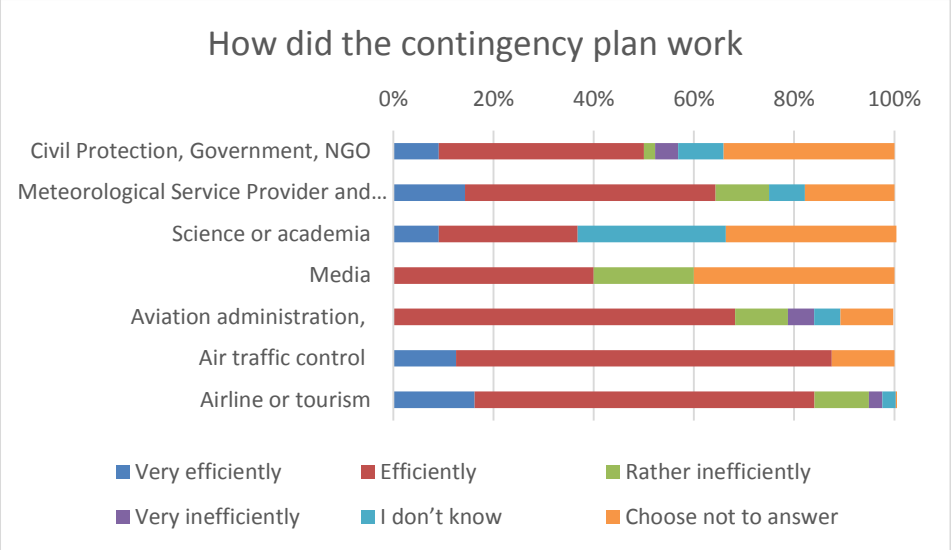

Figure 23 Question 25: How did the existing contingency plan work?

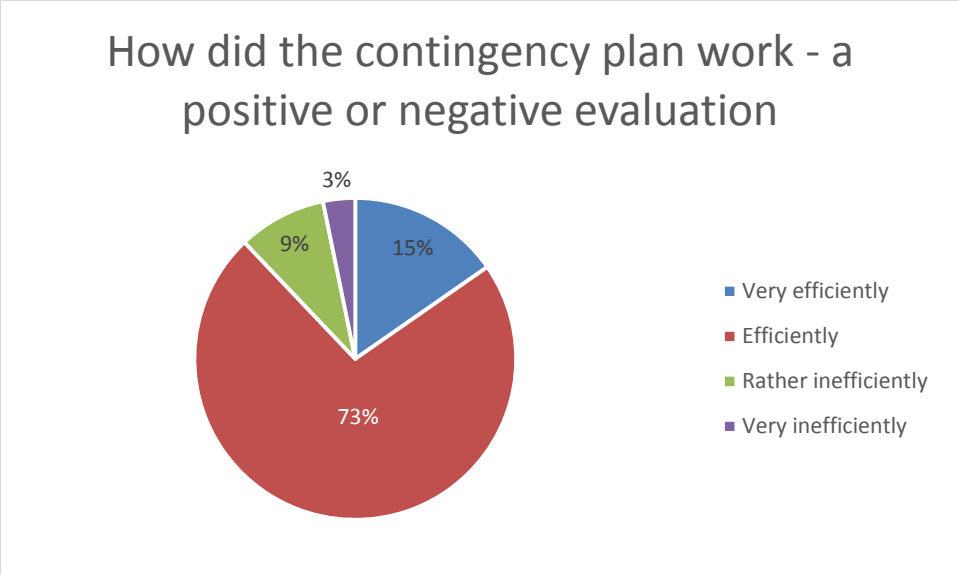

Figure 24 Question 25: How did the contingency plan work - a positive or negative evaluation

In question 26 we asked if the agencies altered their contingency plans following the eruption in Bárðarbunga. In short we see that a minority of the respondents in all sectors answered this question with '*yes*'. The trend to change or alter a contingency plan, following an event such as a volcanic eruption, is slightly stronger in the aviation sectors.

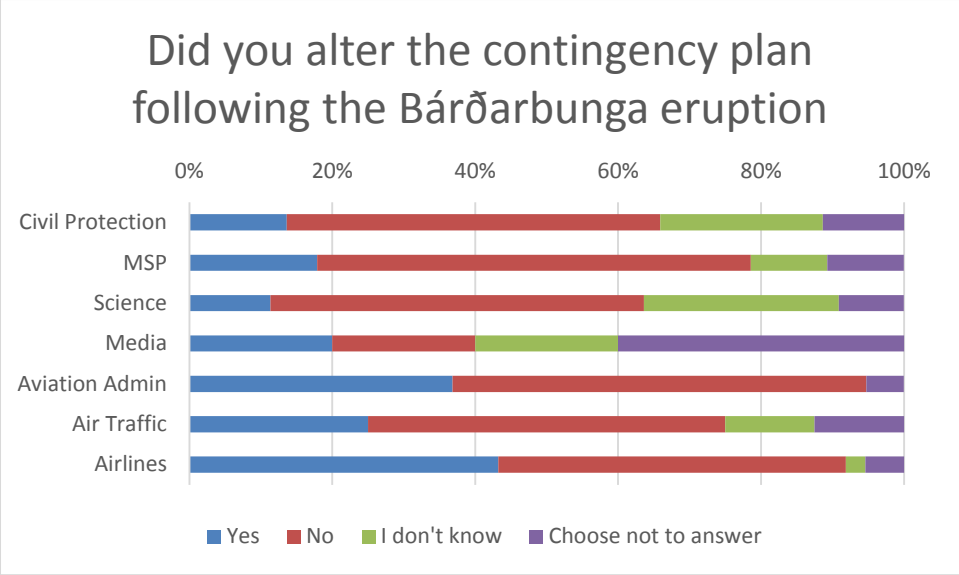

Figure 25 Question 26: Did your agency alter its existing contingency plan following the eruption in Bárðarbunga/Holuhraun in 2014-2015?

In question 27 we asked if the agencies received the Bárðarbunga Factsheet from the Icelandic Civil Protection Scientific Advisory Board (SAB). One would expect higher numbers for the '*yes*' option in this question, but that may possibly be explained by the high proportion of '*I don't know*' and '*choose not to answer*', which is a surprise. The dissemination of the Factsheet has also been covered in FUTUREVOLC report D3.3.

According to this survey the Factsheet is reaching around 50% of the civil protection and the MSP sectors, around 45% of the science sector, 60% of the media, but only around 30% of the aviation sectors.

In the two follow up questions no. 28 and 29 we asked those who received the Factsheet if it had been useful and 99% said it was, and when we asked how useful, around 15% selected '*vital to my operation*', 55% selected '*very useful*', and 30% selected '*informative*'. Question 30 was a follow up questions for those who did not find the Factsheet useful and was therefore empty.

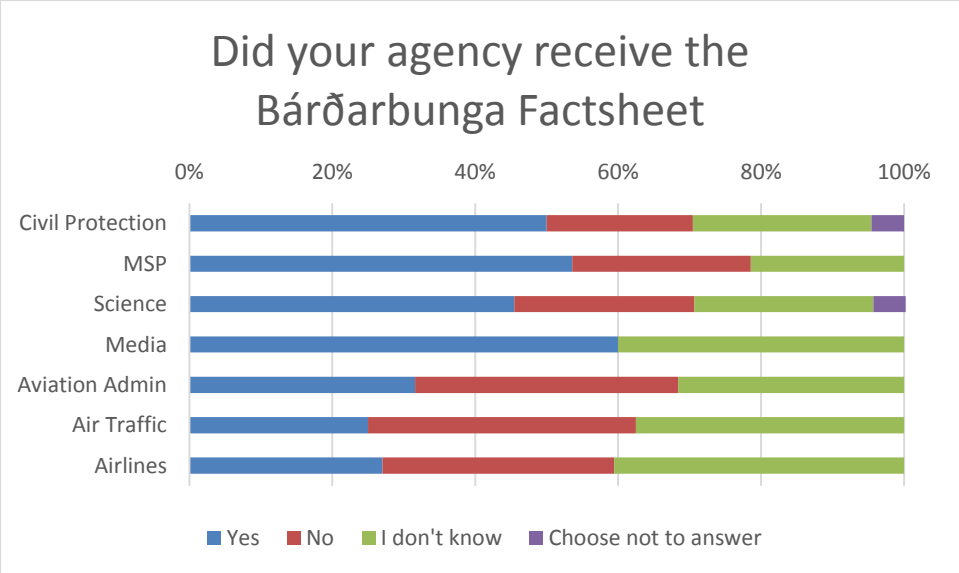

Figure 26 Question 27: Did your agency receive the Bárðarbunga Factsheet from Scientific Advisory Board of the Icelandic Civil Protection during the volcanic eruption in Bárðarbunga/Holuhraun 2014-2015?

In question 31 we asked about methods of communicating with the public during the Bárðarbunga eruption. The greatest difference we see in this question is that now, in the 2016 survey, all the sectors are now using social media but in 2013 it was almost exclusively the airlines that used that method of communication.

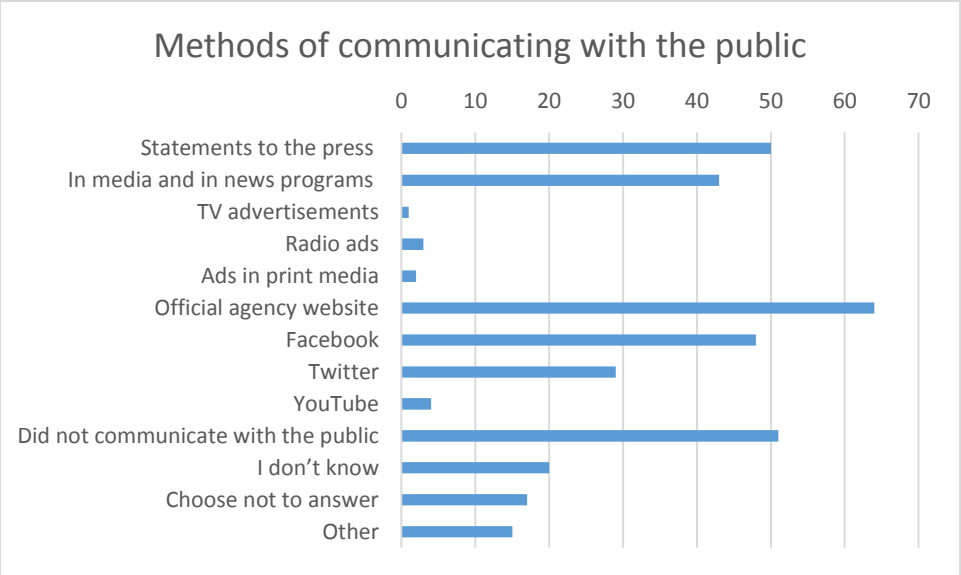

Figure 27 Question 31: What methods of communication did you or your agency use to communicate with the public during the eruption in Bárðarbunga/Holuhraun 2014-2015 (Select all that apply)?

In question 32 we asked if the respondents or their agencies were familiar with the Laki eruption in 1783-84 in Iceland and the concept of a '*Laki-type*' eruption scenario with potential impacts across Europe. If we look at the answers divided by the sectors, as can be seen in Figure 28, we see that almost all the sectors do know about that eruption. But if we separate the Icelandic respondents from the rest we see that almost 90% of the Icelandic respondents do know the Laki eruption while 50% of the respondents outside of Iceland do, and 36% of them say they don't know the eruption or the concept.

Again we must remember that there were only around 200 individuals who completed the survey, 32% of them are Icelandic and 68% from outside of Iceland. The population may not be large but the survey should give an indication of the knowledge in the sectors on these issues.

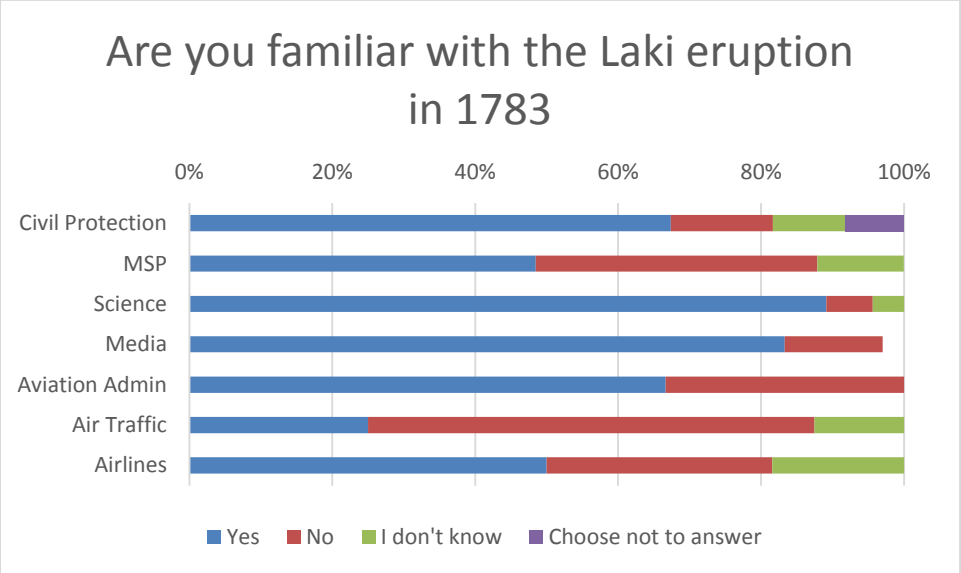

Figure 28 Question 32: Are you or your agency familiar with the Laki eruption of 1783-84 in Iceland and the concept of a 'Laki-type' eruption scenario with potential impacts across Europe?

In question 33 we asked if the agencies were familiar with UN Hyogo Framework for Action, now called the Sendai Framework for Disaster Risk Reduction. We asked this question in 2013 and in short there is no significant change in the responses from that time. The survey indicates that the UN disaster risk reduction framework is not a priority for our respondents. That does though not mean that the UN program is not successful, but only that this group is not involved in it. The UN program is aimed at a national level response and we would expect civil protection agencies to be fully aware of it.

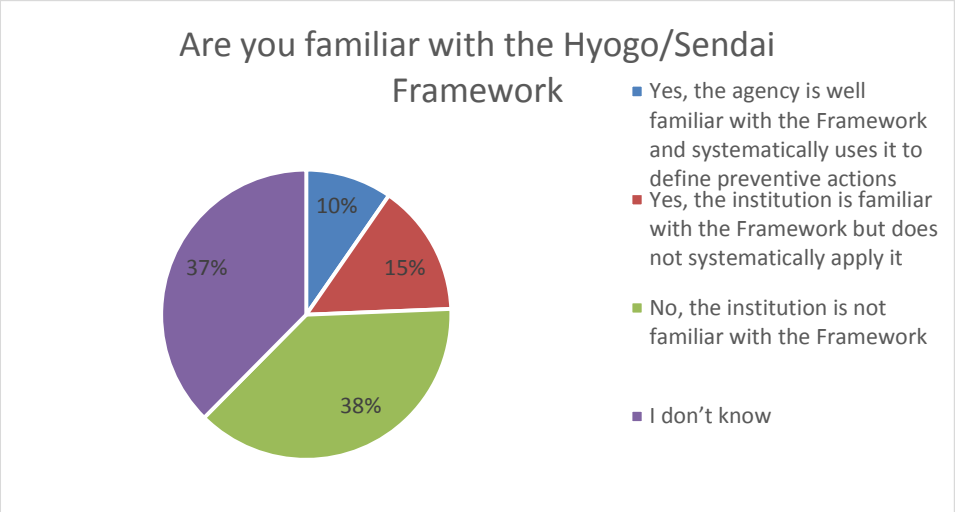

Figure 29 Question 33: Are you or your institution familiar with the UN Hyogo Framework for Action, now called the Sendai Framework for Disaster Risk Reduction?

In question 34 we asked our respondents if they are a part of the FUTUREVOLC research project and 28% were but 72% were not. Then we asked those who are not a part of FUTUREVOLC if they have heard of FUTUREVOLC and 27% have heard of the research project while 73% had not. The brand FUTUREVOLC, if one can use that term, is therefore not well known. One may ask if that is adequate or not, but one should also know that a research project is not necessarily disseminating information on volcanic risk in its own name but through its partners. The Bárðarbunga Factsheet did not for example contain any references to the FUTUREVOLC project.

Lastly we asked our respondents if there was anything they would like to say on what communication tools and processes are still required and/or need further development, regarding volcanic eruptions in Iceland. In the final question, no. 36, we provided our respondents with an open space to write in. Those answers cannot all be published here but some points that reflect the general trend of the comments are listed below.

- The daily updates on the IMO website during the Bárðarbunga episode were very useful.
- Information sharing through the EU-ERCC to civil protection were sufficient.
- We used Twitter to help spread information.
- The Factsheet was useful and we did forward it to our international partners.
- One can always use more information.
- New social media should be used as a communication tool.
- Communicate ash cloud location, including quantitative measure of confidence.
- It has improved a lot since 2010/2011 but still a bit uncertain which source to depend on for up to data information.
- Better graphics and coordination between MWO's regarding VA SIGMET.

- IT solutions with continuing updates are welcome.
- From the MET point of view, the VAAC's satisfy the requirements through the ICAO.
- Always a room for improvements in communication of complex and dangerous events like volcanic eruptions to decision makers and the public.
- Very interesting and useful subject, should be more present in mass-media.
- It was the Eyjafjallajökull eruption that really made us aware of the risks for aviation and on civil protection issues.
- An early warning on any volcanic behaviour with real potential for further eruption would be a great benefit for planning activities in aviation.
- Restrictions on media access to the Bárðarbunga site were heavy handed and interfered with the journalistic duty of media to report to and inform the public.
- People will now expect the SAB briefing document (Factsheet) on a daily basis during the next eruptions, it is important that the parties involved realise this and have procedures in place to enable this.
- I suggest to spread the information quicker and "trigger better" the volcanic ash dispersion model. A model to follow could be the "AVOID POLICY" by FAA and Alaska University.
- A good web site do not overuse social media (e.g. Facebook, Twitter etc.)
- Information from Iceland is much improved.
- I found that the FUTUREVOLC project acted as a great platform to test and improve the communication amongst various stakeholders and enhance collaborations amongst various agencies, both operational and academic. As a result, FUTUREVOLC was a fertile soil for the development of optimal strategies for the measuring and monitoring of active volcanoes.
- The work done in FUTUREVOLC needs not to be seen as temporary but many of the activities need to be kept beyond the project end.

3 Scientific Advisory Board Revision Meeting

The Scientific Advisory Board of the Icelandic Civil Protection was not created as a part of the FUTUREVOLC project but has a longer history as a cooperation platform for civil protection and the scientific community in Iceland, see also FUTUREVOLC deliverable D3.2 (Heiðarsson, Loughlin, Witham, & Barsotti, 2015, p. 13). The Advisory Board has though been an important venue for close cooperation and collaboration across sectors during the FUTUREVOLC project and became instrumental in bringing together scientific knowledge and disaster management operators during the prolonged Bárðarbunga volcanic eruption in 2014-2015, building the common situational picture for number of institutions and sectors across Europe. Feedback of the FUTUREVOLC role from the Board is therefore valuable.

Earth scientists, volcanologists, glaciologists, petrologists, seismologists, deformation experts, meteorologists, environmental scientists, geographers, medical doctors and epidemiologist, to name some of the disciplines represented at the advisory board, along with experts from the civil protection met in over one hundred meetings during the Bárðarbunga episode to discuss and share knowledge on the ongoing eruption. The key institutions were the Icelandic Meteorological Office (IMO), the Institute of Earth Sciences University of Iceland (UI), and due to the gas emission scientists from the Environmental Agency of Iceland (UST) and the Directorate of Health were presented at the meetings.

A number of FUTUREVOLC partners/institutions took part in the meetings of during the Bárðarbunga crisis, along with guests from institutions outside of FUTUREVOLC. To name some FUTUREVOLC partners: Cambridge University, Uppsala University, UK Met Office, Bristol University, and British Geological Survey. Guests outside FUTUREVOLC included: the Icelandic Road and Coastal Administration, the Administration of Occupational Safety and Health in Iceland, the Government Office of Iceland including both ministries of Interior and Foreign Affairs, and the Icelandic Aviation Administration.

3.1 Review Meeting

In March 2016 the National Commissioner of the Icelandic Police Department of Civil Protection and Emergency Management (NCIP) called for a special review meeting in the Scientific Advisory Board (SAB) to assess the Bárðarbunga operation and to define lessons learned and in addition the collaboration through FUTUREVOLC was evaluated. Present at the meeting were 12 scientists form IMO, UI, NCIP and UST.

Selected members of the SAB that were invited to the meeting, recognised the fact that SAB held many meetings during the Bárðarbunga eruption that lasted on average between two and three hours but generally agreed that it was time well spent. They stressed the fact that cooperation and collaboration between institutions, during an event of this kind, were extremely important and despite all communication technology there is nothing that can replace a direct face-to-face communication and interaction. Therefore the meeting format must not be underestimated or replaced with telecommunication of some sort. Personal relations became a crucial factor in strained situations where human lives, infrastructure, properties and natural resources are at risk. The SAB meetings are instrumental in building and maintaining these important personal relations that are the foundation of trust between individuals and institutions that do not work together on a day to day basis.

Although scientists and civil protection specialists may possess a great deal of knowledge on, in this case, Icelandic volcanoes, it cannot be fully emphasized that each event is unique and potentially incomparable to other similar events, even from the same volcanic system.

Members of the board also agreed on the importance and the advantage of writing a common statement collectively at the end of each meeting. During the Bárðarbunga eruption these statements were published after each meeting as the Bárðarbunga Factsheet (see FUTUREVOLC deliverable D3.3 for further information on the Factsheet (Loughlin et al., 2016). Writing a common statement compels members of the board to reach an anonymous understanding of the progress of the event. It also saves time since all the institutions would otherwise have to write their own independent report of the meeting and its conclusions.

Members of the board agreed that FUTUREVOLC collaboration supplied more data and information to discuss during the SAB meetings during the lifespan of the project and especially during the Bárðarbunga eruption. During the six months that the eruption lasted a number of scientists participating in FUTUREVOLC joined the SAB meetings, sharing their latest findings and taking part in the discussion. New research, new instruments, and new methods are important for progress of science, and having the chance to test these new methods on a volcanic eruption, is equally important. The SAB benefited from these visits and discussions and it was partly FUTUREVOLC that opened the doors of the meeting to the visiting scientists that would probably not have shared their knowledge with the Icelandic Civil Protection.

Finally members of the board discussed how the SAB meetings could be improved. A number of suggestions were aired, some very practical, regarding the agenda of the meeting, the meeting place, the language spoken at the meeting, and the publication of the meeting notes. All these ideas have been noted and will be used in writing new guidelines for the SAB.

4 The FUTUREVOLC Stakeholder Meeting

In November 5th 2015, following the annual general meeting of FUTUREVOLC, the consortium invited stakeholders, from key sectors across Europe and in Iceland, to participate in a one day meeting to discuss the impact and progress of FUTUREVOLC. These key sectors include: science, aviation, government, civil protection, police, European Commission, and media. The meeting was divided into a presentation session, where FUTUREVOLC partners presented the project and its main outcomes, and a working session, where all the participants were divided into three groups and were asked to answer or discuss five questions, see below, and report on the findings afterwards. The meeting is also documented in FUTUREVOLC deliverable D1.4 (Sigmundsson et al., 2015), but here the out-come of the working groups and brainstorming session were documented.

In total 98 individuals attended the stakeholder meeting from the following institutions in addition to FUTUREVOLC partners. A full list of participants can be found in Appendix 4 of the report D1.4.

US Geological Survey, USA
Istituto Nazionale di Geofisica e Vulcanologia, Italy
Institut de Physique du Globe de Paris, Observatoire Volcanologique du Piton de la Fournaise, France
Nationa Center for Atmospheric Sciences, UK
Government Office for Science, UK
Joint Research Centre of the European Commission
London Volcanic Ash Advisory Centre (VAAC), Met Office, UK
Toulouse Volcanic Ash Advisory Centre (VAAC), MeteoFrance
Avinor ANS (Air navigation services, Norway)
Department of Civil Protection, Italy
UNAVCO (USA non-profit university-governed consortium, facilitating geoscience research and education using geodesy)

Icelandic Institutions:
Ministry for the Environment and Natural Resources
Ministry of the Interior
Ministry for Foreign Affairs
Icelandic Coast Guard
ISAVIA (Icelandic Civil Aviation Administration)
Reykjavík Metropolitan Police (Commissioner)
The Icelandic Road and Coastal Administration
The Suðurnes Police Commissioner
RANNIS - The Icelandic Centre for Research
Civil Protection - South Iceland

4.1 The Questions

All the participants of the meeting were divided into three groups for the brainstorming session: science, aviation and civil protection. The three groups were given five questions as a guide for the one hour long session and after that they all came together and reported on their main findings.

The questions:

1. What information do you need?
2. Who will you ask for it?
3. How often do you need updates?
4. How will FUTUREVOLC be beneficial for your activities?
5. Is it important to make FUTUREVOLC sustainable?

The individual group sessions were not recorded but the reporting session was recorded by the University of Iceland (Hermannsson, 2015). The following summary is based on the video recording of the reporting session and from notes taken down in the three groups by their members where the five questions were used as a rough guide for the discussion.

4.2 The Science Group

The science group focused most of their discussion on the future of FUTUREVOLC and how it would be possible to make the project live on in a sustainable way. The main strength or asset for the future is the fact that the IMO is a leading partner in the project, and being an institution responsible for monitoring Icelandic volcanoes, would keep some of the instruments online and active as well as maintaining the FUTUREVOLC Catalogue of Icelandic Volcanoes (see Chapter 8).

The group acknowledged the fact that funding future research would be the main issue regarding the sustainability of FUTUREVOLC 2.0, as the group put it that would be a new research programme based on the research of FUTUREVOLC. Basic research would still be needed in the future with strong international collaborations. Key scientific questions, regarding volcanoes, are still unanswered. So the answer to question 5 is unquestionably yes, it is important to make FUTUREVOLC sustainable. The only question is how? A strong group effort is needed to keep the ball rolling, and to maintain the Supersite framework, with emphasis on funding and COST actions. Iceland is now a Supersite and it is important to keep the Icelandic Supersite running, which will require funding for research. The group concluded that FUTUREVOLC 2.0 would not be like FUTUREVOLC 1.0 with the strong emphasis on instrumentation, but with more emphasis on basic research.

The questions on data that were put to the groups may in a sense be turned around or flipped over for this group, since it is the scientific community that produces most of the data for the other groups, or stakeholders. For the science group the question of data is focused on open data, and how different data from permanent networks or projects is acknowledged? To keep data open and sustainable an important infrastructure must be kept alive and payed for by somebody. Maintaining instruments, storing data and dissemination requires regular salary payments. Bilateral exchange with stakeholders is though also needed as well as an effort by the scientific community to export new knowledge to other sectors.

4.3 The Aviation Group

The aviation group considered the needs of the Air Traffic Management (ATM) community in relation to FUTUREVOLC. As such, there were, among others, representatives in the group from Air Traffic Control, Airlines and the London VAAC, the latter considered to be a member of the Air Traffic Management community since the VAAC's sole purpose is to provide information about ash plume dispersal to Air Traffic Management customers.

Initially the purpose of FUTUREVOLC was discussed. It was agreed by the group that the purpose of FUTUREVOLC was to ensure the best possible observational information was made available to those teams who needed the information. They talked about whether this information was useful for people such as the Air Traffic Controllers, and the Civil Aviation

authorities. The consensus was that this "raw" information was not useful to these groups. However, this information was of use to the VAACs, who could use it to ensure that their forecasts were as accurate as possible, with any uncertainty clearly stated, and it was agreed that it makes sense that the ATM community take the plume forecast information from the VAACs, trusting their judgement and seeing them as the "authoritative voice" for plume forecasting.

When answering the questions that were posed to the group they referred to the needs of the VAACs (and specifically London VAAC).

1. What information do you need?

Timely and accurate information relating to the source term (e.g. plume height, with uncertainty clearly stated) is considered very important. In addition, an understanding of how long a particular eruption might last (as demonstrated by FUTUREVOLC scientists in relation to models of a volcano's deformation being used as a possible predictor for eruption longevity) would be information that VAACs could utilise to help the aviation users plan for beyond the short term (18-24 hours) and into the 3 to 5 day period.

2. Who will you ask for it?

London VAAC see Iceland Met Office (IMO) as the source of information described above. IMO would act as the "gatherer" of this information from the various sources, but they would filter it and pass only the relevant information to the VAAC.

3. How often do you need updates?

With something as dynamic as an ongoing eruption, regular updates are crucial. This is something that IMO and London VAAC have already implemented, e.g. during an eruption the volcano status (including plume height information) is passed from IMO to London VAAC at least every three hours. The plume information might be from a number of different sources, e.g. "web cam suggests plume height of 10km; radar suggests plume height of 12km; aircraft observations suggest plume height of 9km. Expert opinion of IMO suggests that plume height is 10km".

The representative from the Airlines mentioned that they would like information, like plume forecast information, to be transferred to them (i.e. the customer) each time it was updated, rather than them having to look for it.

4. How will FUTUREVOLC be beneficial for your activities?

As described above, the outcomes of FUTUREVOLC are crucial to understanding more clearly important points such as: What the source term should be? What is the likelihood that an eruption is going to begin? How much longer is an eruption likely to last? Improvements in this sort of information allow the VAACs to produce more accurate forecasts, with suitably accurate uncertainty bands, and this in turn helps the ATM community to minimise the impact of the ash.

5. Is it important to make FV sustainable?

Without doubt, ensuring that the current momentum that FUTUREVOLC has provided is maintained, is very important. The relationships that FUTUREVOLC has created will help to keep the momentum going for a while, as will the next ash rich event in Iceland, but there is a danger that if the next ash rich event does not occur for many years then focus on these important issues will wane and responses to the next event may well suffer as a result.

4.4 The Civil Protection Group

The main topics of discussion in the group are listed below. Members came from the civil protection sector, both in Iceland and abroad, with a few from academia and government.

1. What information do you need?

Civil Protection (CP) often have simple questions but don't always get the answers from scientists that they need. The Futurevolc project enables more interaction so there's a better chance of understanding what's needed and what's offered. Nevertheless, the civil protection group thought that scientists have a better idea of what we need due to FUTUREVOLC.

Civil protection could use more monitoring, maybe even a live link to the monitoring agencies from the NCCC. There is a strong need for science in volcano emergencies – there's much curiosity and opportunities when there's a crisis but civil protection need a continuous, reliable and robust method of gathering the information – perhaps more structured. The amount of information is not the point, it's the quality and focus of the data that counts.

2. Who will you ask for it?

Scientists, IMO, Scientific Advisory Board in Iceland. Elsewhere civil protection is more likely to ask national experts who translate IMO and SAB information.

The Scientific Advisory Board is a great platform for the interpretation and discussion at NCCC with quite a bit of detail but there are 18 more CP centers in Iceland that need information – there's a need to transfer the information in a meaningful way, they don't necessarily need the same level of discussion but need the critical information. Impact assessments are also important. SAB can actually provide too much information – it's sometimes a scientific meeting with much discussion. The SAB information should be on a 'need to have' basis rather than 'nice to have'. CP can handle it but perhaps FUTUREVOLC could filter some information before the SAB.
CP perhaps also need to get further 'stakeholders' more involved in the process to take more responsibility.

Meeting societal needs is all about team work – terms like 'end-users' are unhelpful. There has always been teamwork in Iceland with all equal partners and therefore a mutual safety net. The close interaction in Iceland between scientists and CP is an equal team – there has always been teamwork. Scientists should ideally not use the term 'end-users' to refer to CP and others.

Community engagement is critical – they are the society CP and scientists serve. They are also key partners in science – either running monitoring stations, providing observations or many other ways. The local community link is very important – they are the ones who ultimately need to respond to warnings and alerts. There are always more vulnerable groups who can be targeted.

It is very important to involve the public in CP – not just transfer – need to understand how they perceive the information from CP. Positive response can be encouraged by having community meetings and full-scale exercises – evidence from G Gisladottir's response. The info was originally received as 'top-down' but the dialogue became more equal – more of a partnership – strongly affected their response.
Public can do more than just take photos. Citizen science is very important and can be an essential element of response.

3. How often do you need it?

There are systems in place in Iceland and elsewhere. Depends on the situation.

How will FUTUREVOLC be beneficial for your activities?

How do we transfer to other communities where hazards can be more of a surprise?
How to engage public when there are large gaps between eruptions? There's a need for engagement in projects and educational activities. Raising awareness – especially with children. Evacuation plans need to be exercised, especially with the children. Often better to do this at a local level – not necessarily just top-down. Need individuals to take responsibility.

What about losing trust in scientists? There is a lot that scientists don't understand – need to be honest and transparent about what is not known. The best advice can be 'we don't know/understand'. But there is a risk of the public generating their own ideas…although if trust is there this may not be such an issue.

Need to be honest about the limits of scientists or we'll lose credibility. Sometimes people need a second opinion and reassurance that the official advice is ok. Community CP are very interested in the work of the scientists and would very much like to be involved (District Police)

Where there is sensitivity one can take familiar risks and treat them as analogues. Can explain unknown risks in terms of familiar risks. Would the trust of scientists and officials in Iceland change if there are casualties?

How to build trust? This is the same regardless of scale. It must be broken down into small chunks – small groups. Must stop people being passive and assuming someone else will do something.

What is the difference between a forecast and a prediction? In weather these are not considered to be different. In Iceland these two words mean the same thing, elsewhere they are very different.

How to export the Iceland example?
Culture and context really matters. Iceland is rather unique – small population, responsibility, awareness of hazards, frequent hazards. Much self-reliance and volunteerism is built into society.

People in urban and built-up environments have no time for natural hazards, they're simply an irritation. Can be complacency. Needs much more awareness raising. Government assessments might be made but the public aren't much involved. Need parallel work over many years from many sectors. It needs to permeate the whole of society. Sense in UK of complacency for natural hazards. Sometimes a disaster is needed to raise awareness. Hazards can be very localized - so floods for example didn't change UK national sense of natural hazards.

Resilience really is important – not always obvious which communities are resilient – developed (European) countries are often less resilient – depending more on systems and structures.

4.5 Summary

All the groups discussed the future of FUTUREVOLC, without suggesting a direct continuation of the project per se. The focus is more on how to secure a continuation of the work of FUTUREVOLC in a sustainable way. For argument sake that could be called FUTUREVOLC 2.0 but the emphasis would be on maintaining the instruments and funding basic research with strong international collaborations to keep the Icelandic Supersite running.

For the science sector basic research in relation to the Supersite concept is always linked with issues of open data and funding.
For the Aviation sector the most important issue is to keep the flow of usable information running from Iceland, via IMO, to the international aviation community, via the London VAAC. Here "raw" information are not useful but processed data in a format applicable by the aviation industry, e.g. timely and accurate information on plume height and estimated duration of the eruption.

For the Civil Protection sector the most important thing is to link research on volcanology with research on social issues. Social sciences can help build up trust between the local community and the community of earth sciences. Questions on trust and perception are as vital to the security of the local community as questions on geophysics.
The issue of public participation in planning, preparing and responding is vital for civil protection and in that context the concept of the 'end-users' is out-dated and should be replaced with more emphasis on team-work. Education is a key concept here, meaning to keep the community involved and well informed during all stages, from the research phase to the responding phase.

In that sense the current momentum of FUTUREVOLC is very important. Where questions on culture, human behaviour and identity are as important as questions on seismic activity, plume height and petrology.

5 Conclusion – Identifying Next-Steps

To conclude this report we identify both our main findings and what we see as the next-steps for the FUTUREVOLC research partners, operational institutions and stakeholders. The full engagement of this trio of operational research institutes, universities and stakeholders is the key ingredient in a successful research project like FUTUREVOLC. Without one of its parts the recipe would fall flat and the project would never succeed. Close cooperation and collaboration between different branches of science, between research and operational science, between scientists and stakeholders or end-users, and between project leaders and funding agencies, are both the premise and the outcome of our project. We would not have got off the ground without this close cooperation and collaboration, and we see that even closer cooperation and networking is needed to reach even further in our mission to make society more resilient to volcanic hazards.

Below we take together our conclusions and identify next-steps in bullets:

- A large portion, 72%, of our respondents believe communication and flow of information has improved during the live span of the FUTUREVOLC project. This has been shown in three surveys conducted in 2013, 2015 and in 2016.
- The number of contingency plans that contain a special section on volcanic activity has increased in all sectors since before the Eyjafjallajökull eruption in 2010. Here we see a real improvement. In 2010 only 40% of the aviation sector had a special section on volcanic activity compared to over 80% now in 2016.
- The overall experience of all the sectors regarding functionality of their contingency plans is positive. Close to 90% of all the responders, in the 2016 survey, believe that their contingency plan did work well, whether it included a special section on volcanic activity or not.
- Information about volcanoes in Iceland from key FUTUREVOLC partners is being used to further inform agencies, media and governments all over Europe.
- A large portion of our respondents do also believe they have all the information they need to be able to fulfil their duty in informing their agencies, media and national governments about the situation in Iceland during the volcanic eruptions. Those who did give advice to decision-makers during the Bárðarbunga event also had enough data to give a good advice.
- Precursory (forward look and early warning) information is also reaching a larger portion of the stakeholder sectors now than in 2010 and 2011.
- Social media is now used by all the sectors when communicating with the general public. This is a clear change since 2010 when social media was almost exclusively used by the aviation sector.
- The Bárðarbunga Factsheet from the Scientific Advisory Board of the Icelandic Civil Protection has proven to be a practical information sharing and dissemination tool. In the 2015 and the 2016 surveys close to 100% of our respondents have classified the Factsheet as useful. This document that contains outcomes of fruitful collaboration between a number of scientists from different agencies and the civil protection is being used as a reliable source of information for governments, media and the general public across Europe.

- A review meeting at the Scientific Advisory Board of the Icelandic Civil Protection has also revealed that face-to-face meetings of experts do build trust between agencies and individuals. Our stakeholder meeting also revealed that this trust must be shared with the community, where perception of information is vital for positive result in implementing preventive measures.

Next-steps:

- To integrate the volcanological community on a more permanent basis which would offer the opportunity to share best practice with others. The two European Supersites are currently operating independently but would benefit from a means to collaborate with each other and other scientists in Europe. It would also enable operational scientists to benefit from the focused expertise of full-time researchers. Europe is world-leading in research capabilities and operational capacity but these capabilities are highly fragmented.
- The EPOS project offers the opportunity to collaborate on important infrastructural matters concerning data quality and standards. An equivalent means of integrating the science community would be entirely complementary.
- A European scientific community could pick up the engagement with stakeholders that FUTUREVOLC has started and enhance it further by engaging with more stakeholders (including for example the private sector) and integrating the best science with planning and economic growth at a European scale.
- We strongly support multidisciplinary and interdisciplinary approaches alongside integrated local, national and international collaboration and cooperation.
- We have demonstrated clear achievements that show how science can contribute significantly to disaster risk reduction at multiple scales. A recent publication by the UNISDR Science and Technical Advisory Group Report 2015 emphasises: sharing knowledge for action, using a multidisciplinary approach to research and building systems resilience through local, national and international partnerships (Aitsi-Selmi et al., 2015). The FUTUREVOLC project is an example of how these approaches work.

6 Bibliography

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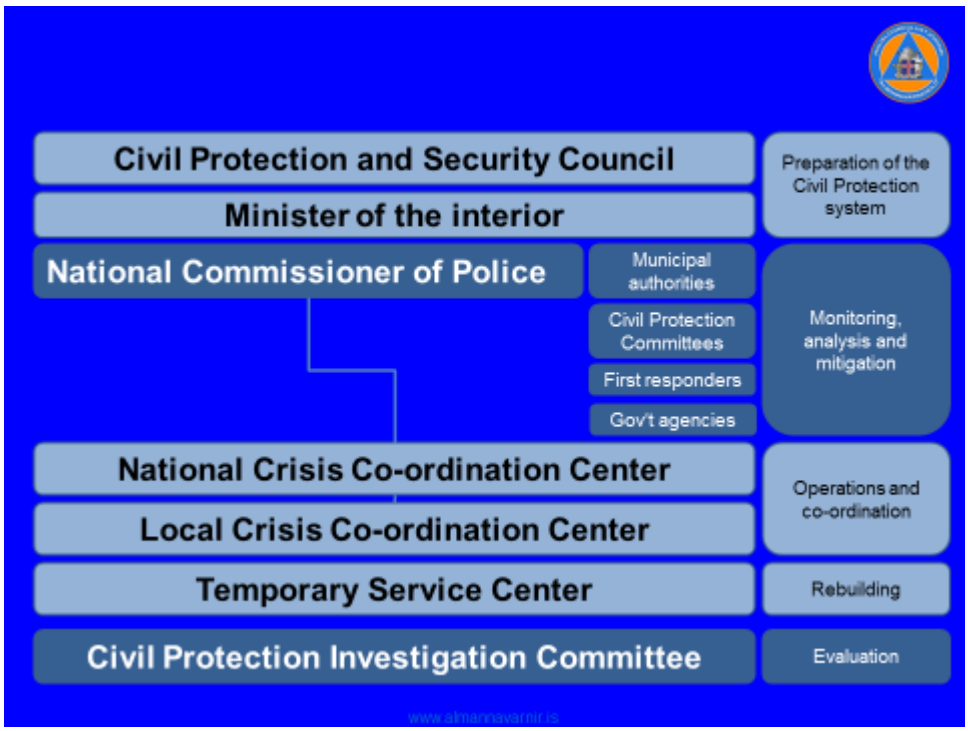
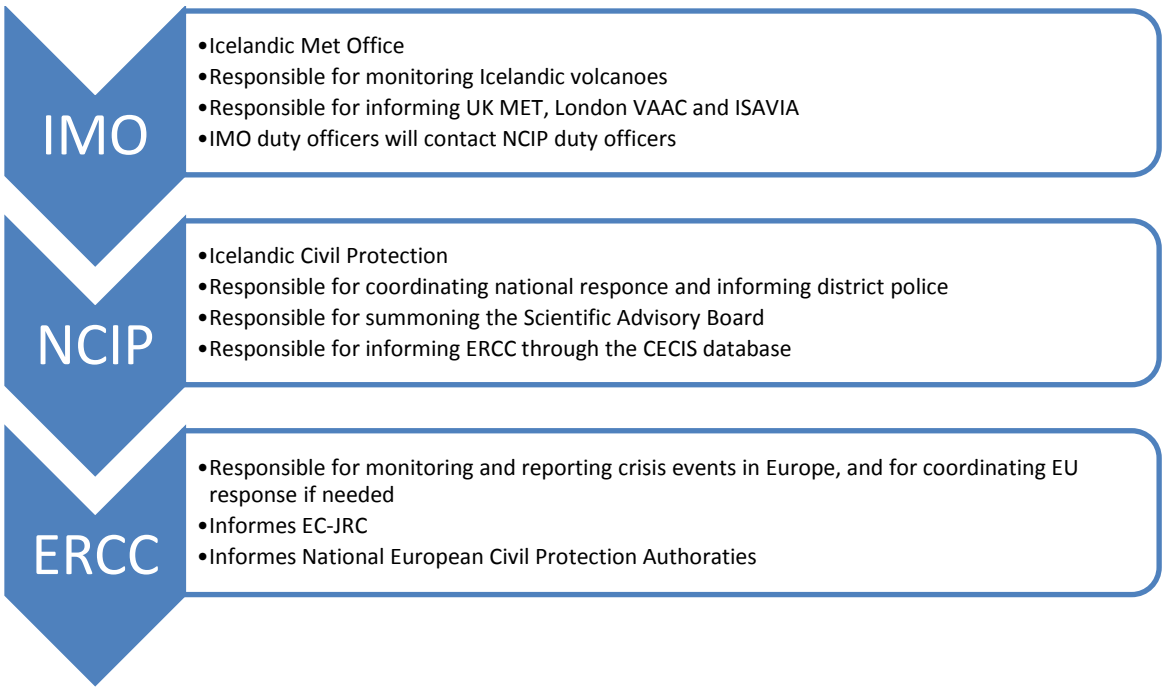
Sigmundsson, F., Valdimarsdóttir, H., Dumont, S., Braiden, A. K., Guðnason, S., & Vogfjörð, K. (2015). *European volcanological supersite in Iceland : a monitoring system and network for the future, Report D1.4 - Report on Final meeting and showcase* (p. 12). Retrieved from www.futurevolc.hi.is

7 Appendix 1: Disaster Management and Natural Hazard Monitoring in Iceland in Graphs

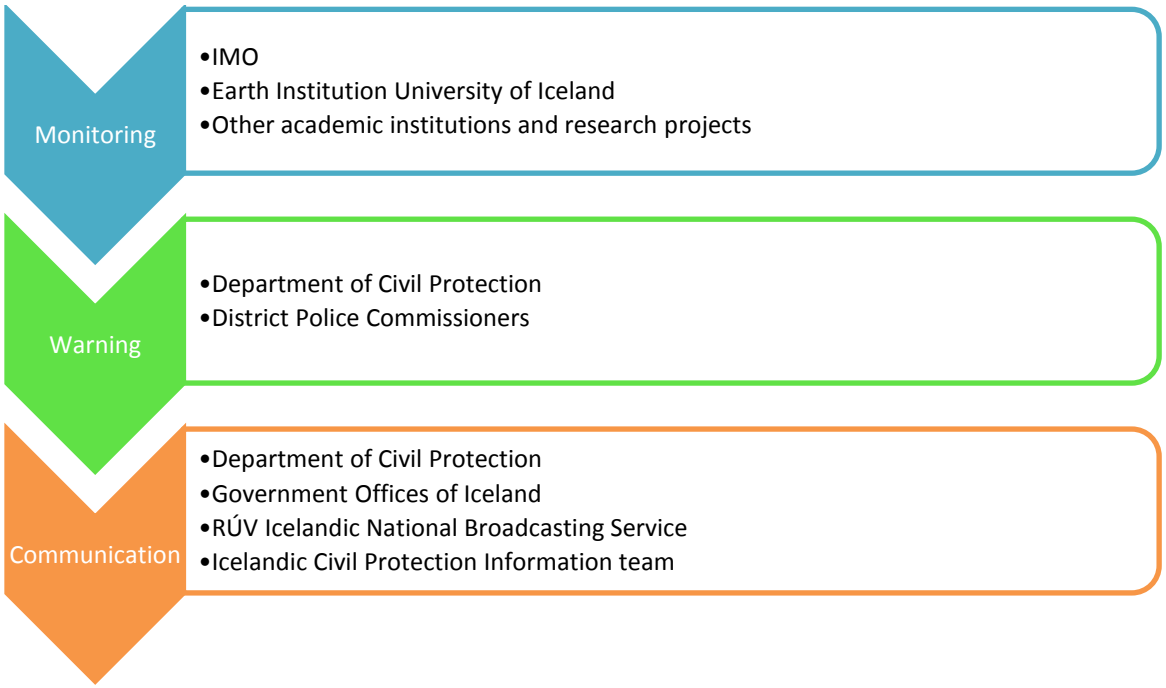
7.1 Organizational Structure of the Icelandic Civil Protection



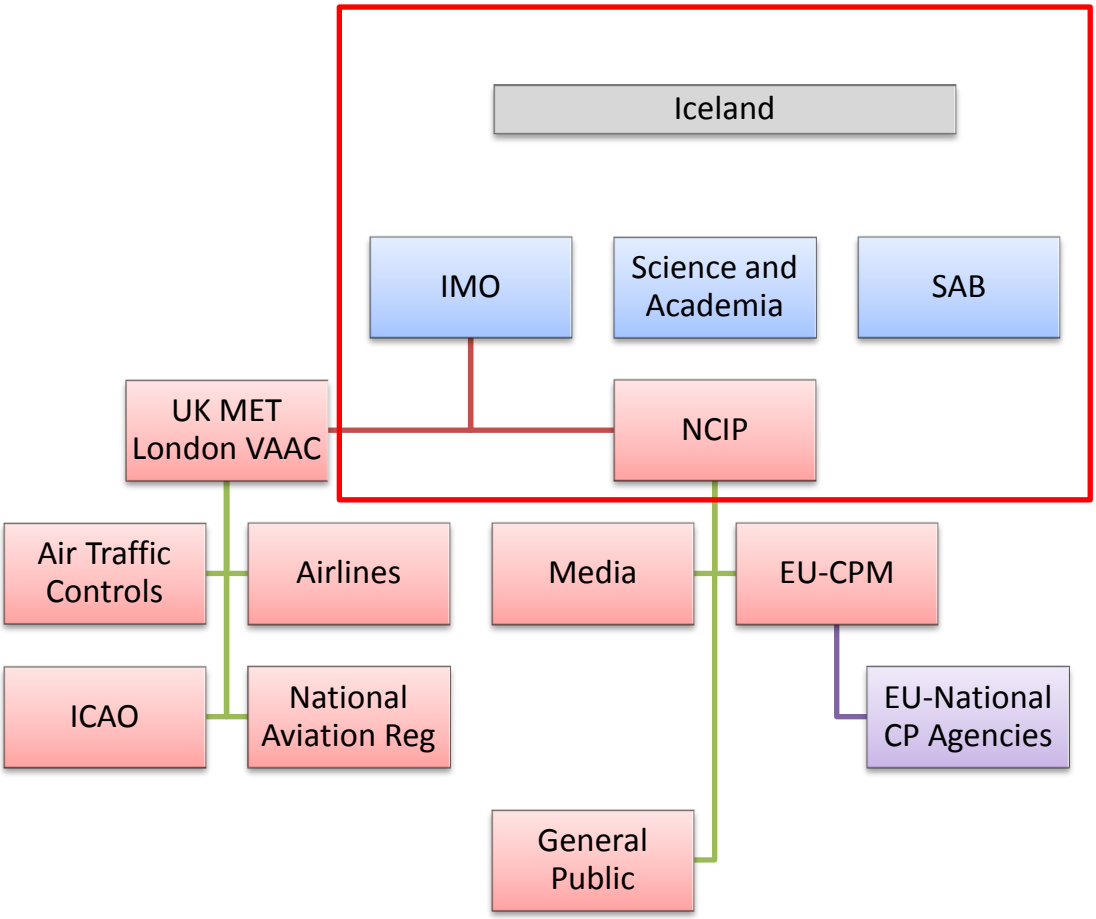
7.2 Monitoring and Information Sharing During Volcanic Events



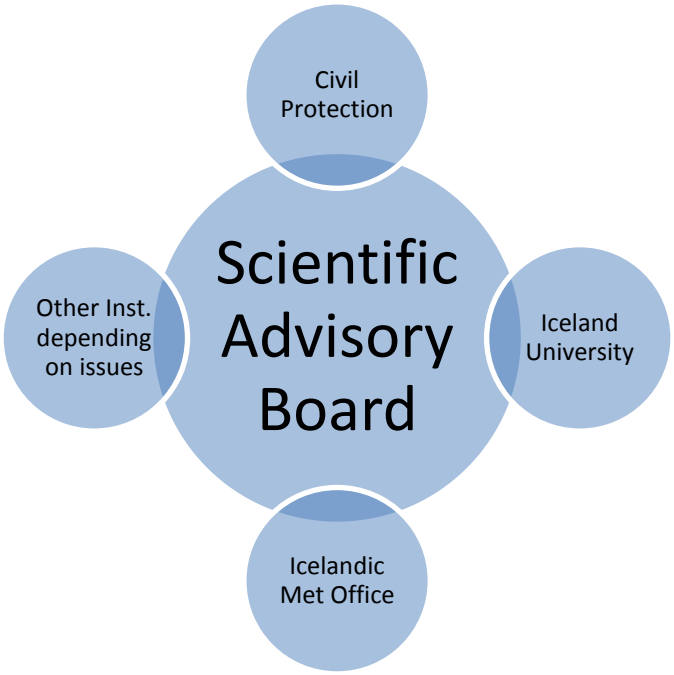
7.3 Monitoring – Warning – Communication



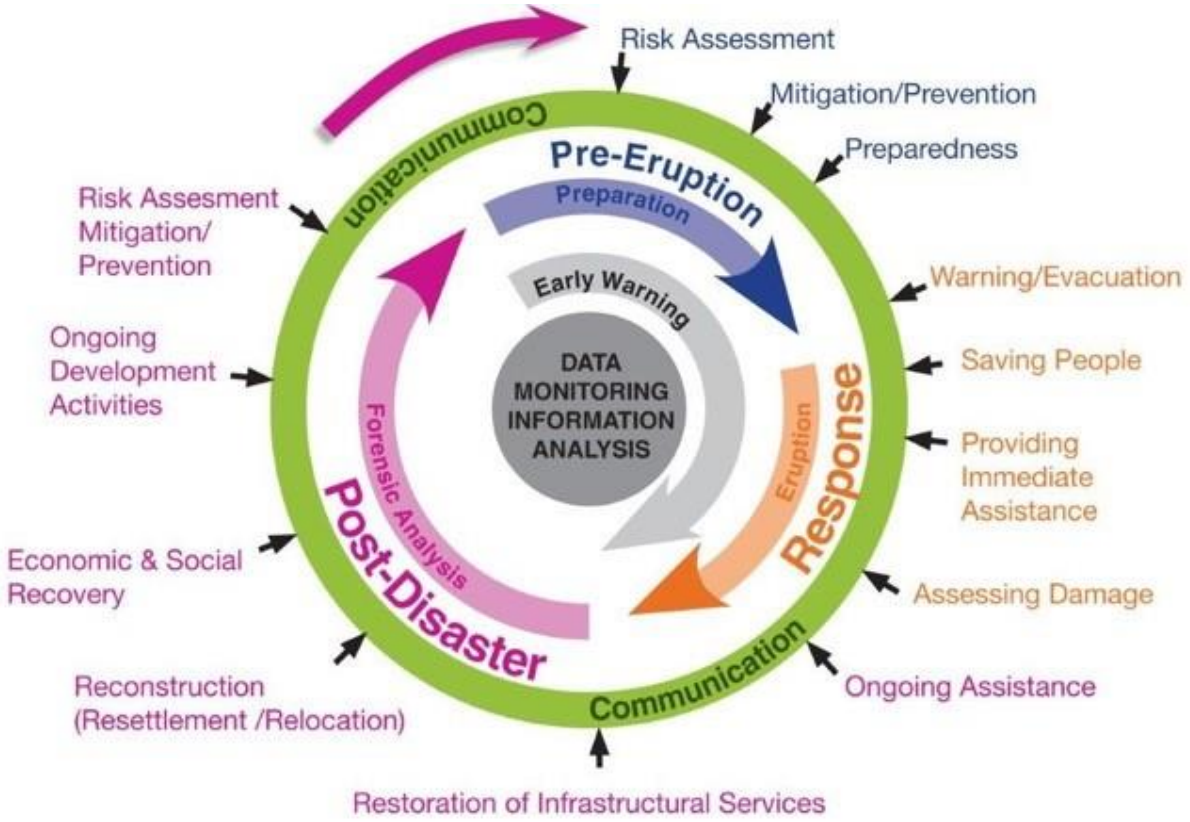
7.4 Stakeholders Map for Volcanic Events



7.5 Icelandic Civil Protection Scientific Advisory Board



7.6 Communication in the Disaster Management Cycle



8 Appendix 2: FUTUREVOLC Catalogue – Operating directions

One of the products of FUTUREVOLC is the Catalogue of Icelandic Volcanoes, a web based tool specially designed to communicate and disseminate accurate, open-access information about the 32 Icelandic volcanic systems (http://futurevolc.vedur.is/). The catalogue is designed with end-users in mind, such as the Civil Protection sector, the Aviation sector, the Media, and the general public. The Catalogue contains a vast volume of information displayed as text, tablets, graphs, maps and photos. The Catalogue also functions as a real-time data hub for scientists and was developed in FUTUREVOLC work-package 4 (WP4) and has been documented in Report D4.2 – First publication of the "Icelandic volcano catalogue" as an open-access website (Ilyinskaya, 2015).

A short overview of the Catalogue and its function is documented here following a request put forward at the FUTUREVOLC Stakeholder meeting in 2015 by a number of stakeholders from various sectors that emphasised the need for simple presentation of information regarding the Icelandic volcanic systems, the hazard, the response, and the disaster management (that has been covered in previous chapter no. 7). The following pages contain screen shots of the Catalogue with short instructions on operation.

"When using material published in the Catalogue of Icelandic Volcanoes, the individual chapters should be referenced as follows. The citation is based on an example from Katla volcanic system, but is transposable to all other volcanic systems defined in the Icelandic volcano Catalogue.

Larsen, Gudrún, Magnús T. Gudmundsson, Kristín Vogfjörð, Evgenia Ilyinskaya. 2015. The Katla volcanic system. In: Ilyinskaya, Larsen and Gudmundsson (eds.): Catalogue of Icelandic Volcanoes. IMO, UI, CPD-NCIP. Doi xxxxxxxxx

An individual Doi number will be soon available for all chapters of the catalogue. It will be indicated at the header of each chapter" (Ilyinskaya, 2015, p. 9).

Figure 30 shows the opening page of the Catalogue showing all the 32 Icelandic volcanic system with label tags on the map of Iceland and listed in the menu.

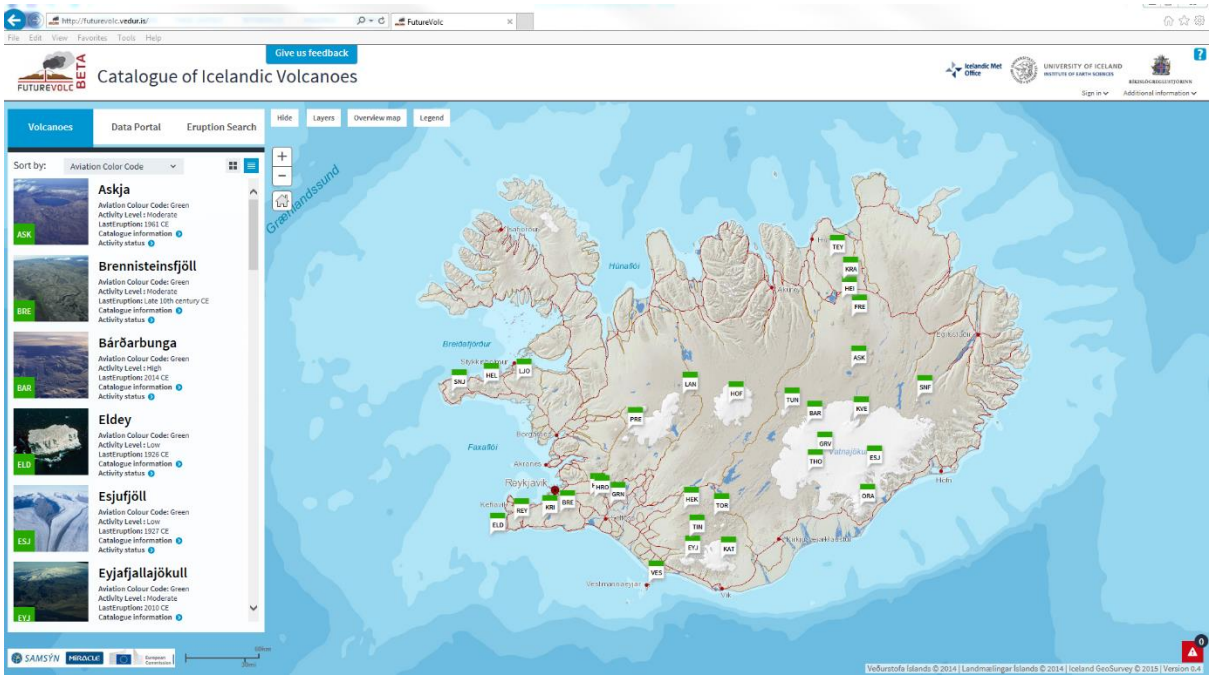


Figure 30 FUTUREVOLC Catalogue of Icelandic Volcanoes

Figure 31 shows the volcano Bárðarbunga that erupted in 2014-2015. A red circle has been drawn around a few items worth explaining. The green colour indicates the current Aviation Colour Code for the volcano. When this screen shot was taken all the Icelandic volcanoes were classified as green. A red circle has also been drawn around Bárðarbunga in the menu and around the interface card that pops up when Bárðarbunga is selected in the menu.

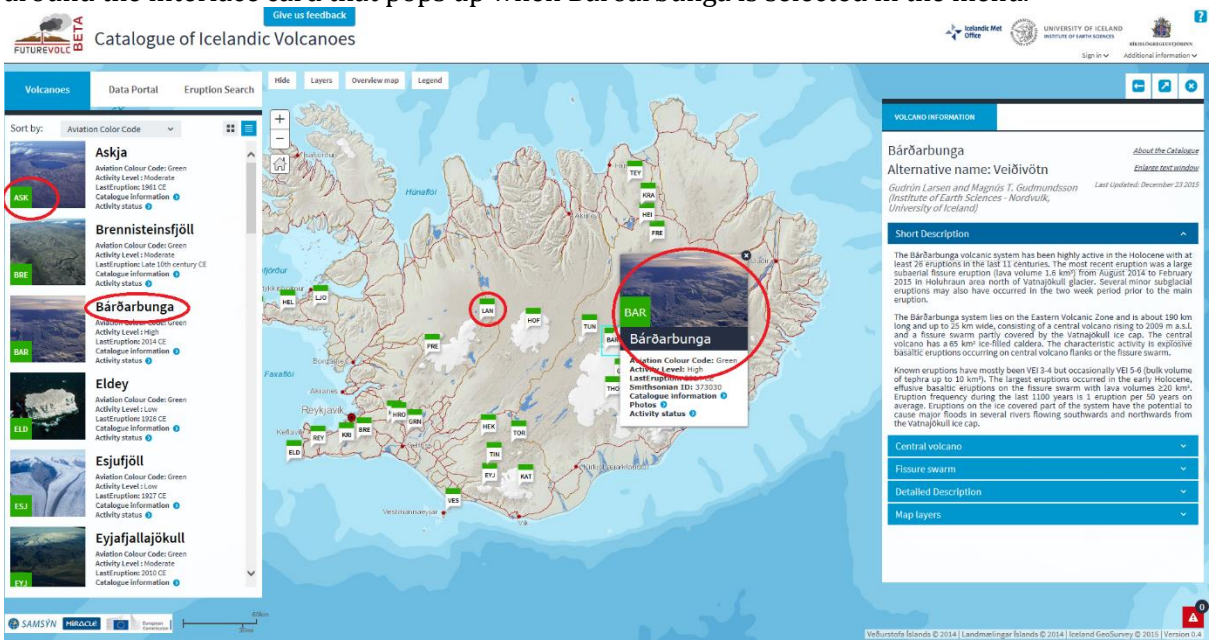


Figure 31 Catalogue entry Bárðarbunga

Figure 32 shows the Volcano Information menu that contains detailed information on each of the 32 volcanic systems. Here Bárðarbunga has been selected as pointed out with the red arrow. The red circles outline different layers that have been selected and appear on the map.

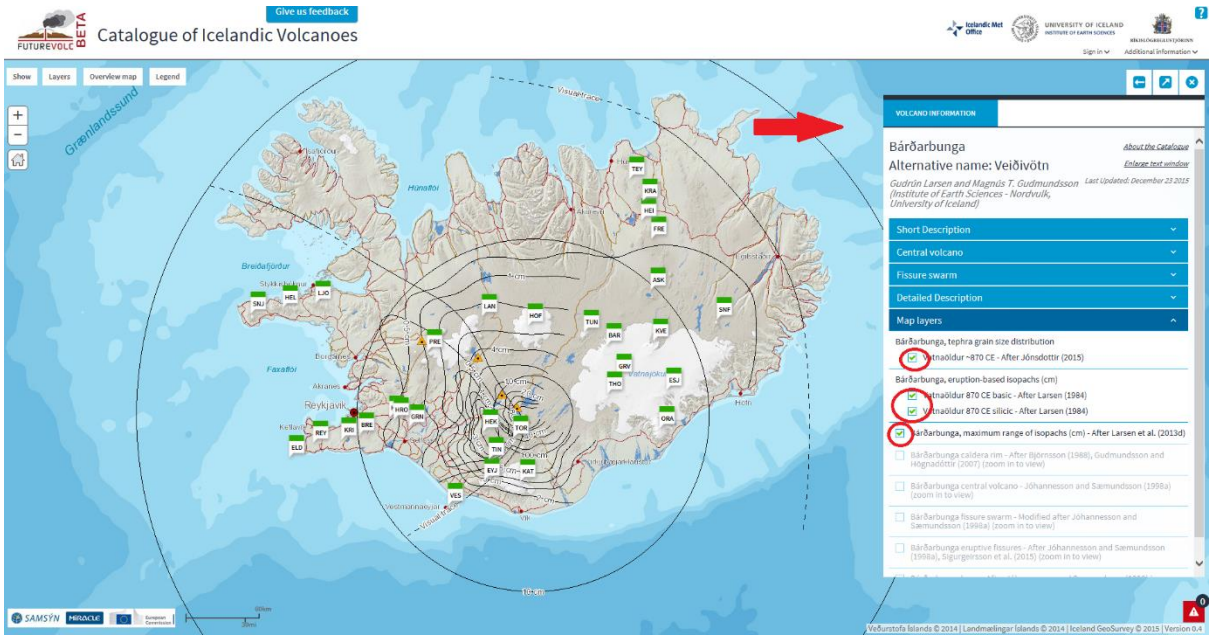


Figure 32 Volcano Information menu for Bárðarbunga with layers

Figure 33 shows another example of a layer, selected by checking a box (red circle), showing Bárðarbunga lavas in purple.

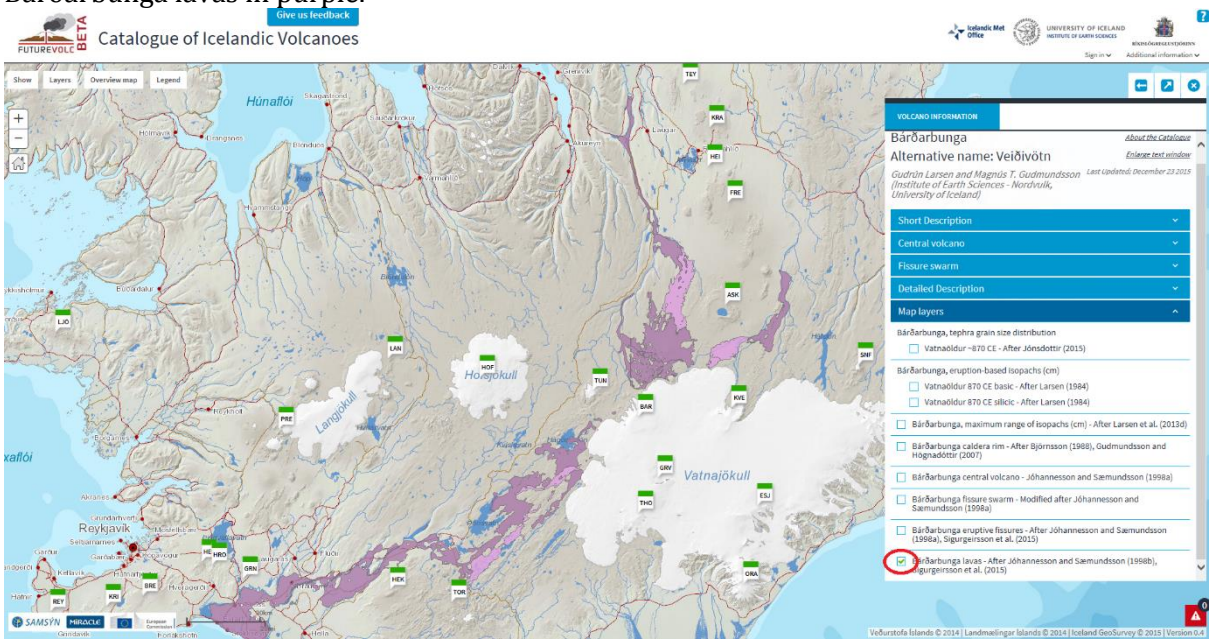


Figure 33 Layer showing Bárðarbunga lavas

Figure 34 shows additional layers that can be found in the upper left corner of the screen showing monitoring equipment, recent earthquakes and SAR image areas.

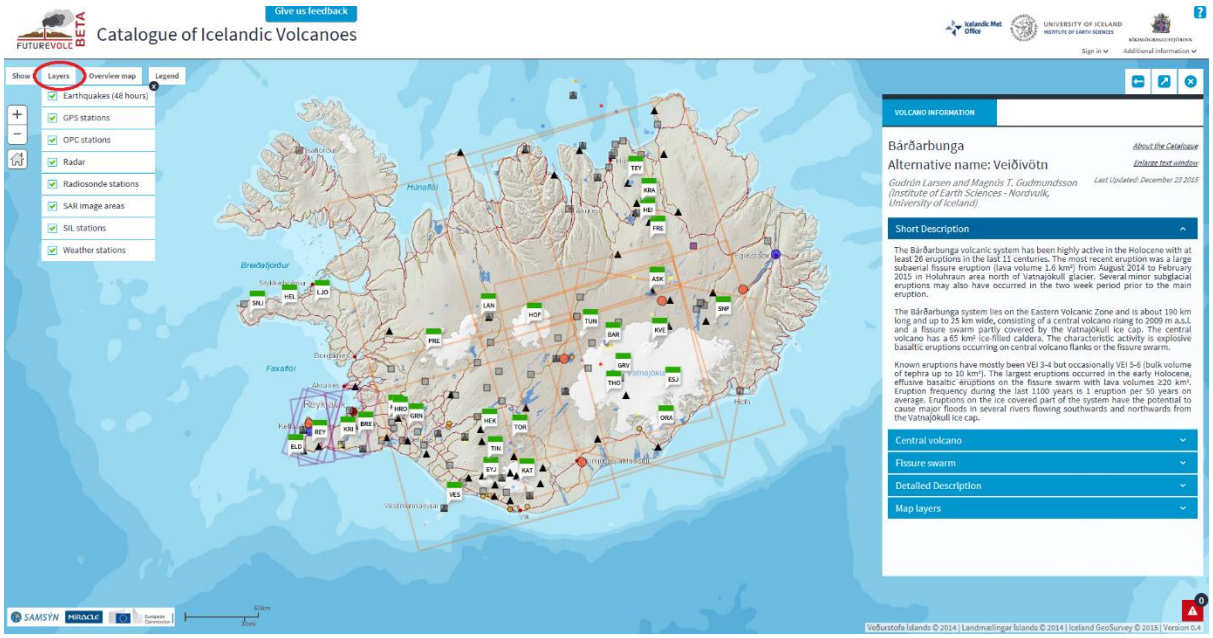


Figure 34 Layers showing monitoring equipment and earthquakes

Figure 35 shows an activity status, selected in the red circle, for Bárðarbunga, indicated with the red arrow. The live activity status compares the number of recent earthquakes (red) with the average (blue) giving an indication of how the volcano has been behaving in the last year, month, week or day.

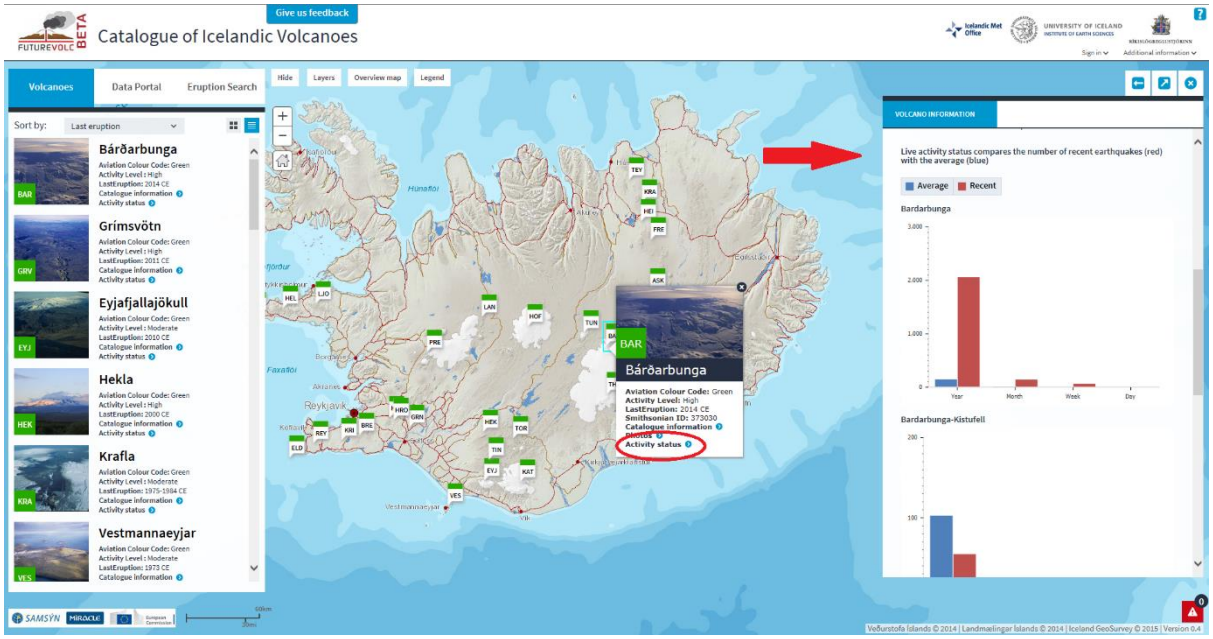


Figure 35 Activity status of Bárðarbunga

Figure 36 shows how the Volcano Information menu can be made larger, as indicated with the red circle. The red arrow points to a section of the menu with detailed description of the volcano selected. In this menu a great deal of historical information about the volcanic systems can be found, including a selection of scientific papers and photos, as shown in Figure 37.

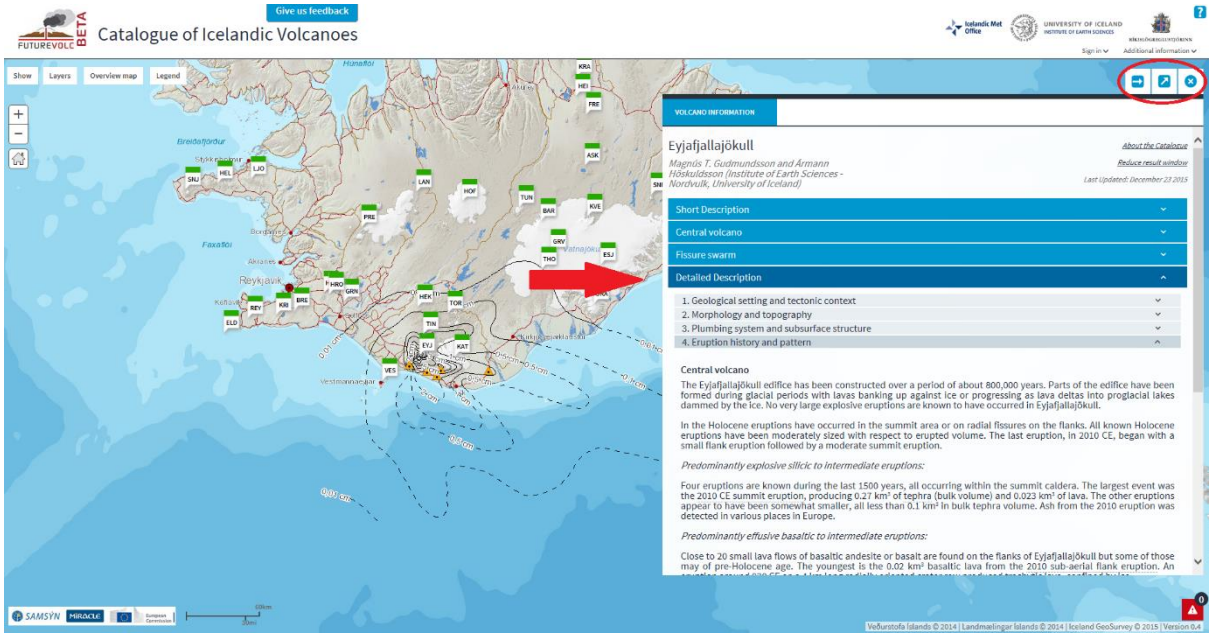


Figure 36 Detailed description of Eyjafjallajökull volcano

Figure 37 A photo of the volcanic eruption at Eyjafjallajökull in 2010 by Evgenia Ilyinskaya